CENTRE FOR
ECOLOGICAL SCIENCES

TECHNICAL REPORT No. 65

PROCEEDINGS OF THE
TRAINING PROGRAMME ON
" MANAGEMENT OF ENVIRONMENT "

DATES: 24-29 AUGUST 1992

COMPILED AND EDITED BY:

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INTRODUCTION

The Centre for Ecological Sciences has been involved in the training programme on " Management of Environment" for the officers of the Indian Administrative service for the fourth time in the last five years. The main objective of this course is to examine the whole range issues of environment and development ranging from the broad framework of development policies down to specific problems of management of resource base for industries, of Industrial effluent leading to pollution and conservation of biological diversity in natural reserves. This is a marked departure from our usual courses which are oriented towards serious minded scientific community. It continues to be a interesting experience to get across the range to issues on a subject of such wide scope as environment to administrators with varied background from many parts of our diverse country.

The variety of issues related to environment and development were addressed in this course. This course generated considerable awareness of the problems concerned to the environment among participants.

We are grateful to the authorities at IISc for providing facilities like accommodation for guest lectures, transport arrangements. We place on record the efficient handling of accounts at institute. Unit III handled the transport arrangement for field visit and daily transport requirement. Our thanks to Mr. Venkatesh, Assistant Registrar, Mr. Nagaraja, PRO, Mr. Sheshagiri Rao, Dy. Financial Controller, Mr. Srinivasa Rao, Mr. George, Accounts, for kind cooperation in the success of this training programme.

Mrs. T.S. Geetha, Mr. Raghavendra Rao & Mr. Manavalan assisted in preparation of this proceedings and course material contributing their skill and capabilities in usage of Harvard Graphics package and word processing.

Thanks to Dr. Somsunder, Vivekananda Girijana Kalyana Kendra for the lowcost beautiful bags spun by tribal children. Mr. Ravichandra and Mr. Manavalan co-ordinated with Vivekananda Girijana Kalyana Kendra, B.R. Hills and got them in time.

Mr. Yellappa Reddy, Conservator of Forests, Mr. Shivanna, Silviculturist, Mr. Gopala Krishna Gowda, Dr. Chandra Mouli & Mr. Nissar Ahmed, Range Forest Officers arranged the field visit and explained to the participants about the importance and medicinal plants, soil conservation and water shed development programme of the forest department.

This programme was supported by Department of Personnel & Training (Training Division), Ministry of Personnel, Public Grievances & Pensions, Government of India and Ministry of Environment and Forests, Government of India.

TRAINING PROGRAMME ON
"MANAGEMENT OF ENVIRONMENT"

C O N T E N T S

Training Programme On

"M A N A G E M E N T O F E N V I R O N M E N T"

Monday, 24th August 1992

Theme : Issues in Environment and Development

TIME	TOPIC	FACULTY	TELEPHONE NO.
9.00 - 9.30 A.M.	Registration		
9.30 - 10.15 A.M.	Introduction	Dr. N.R. Madhav Menon Director National Law School of India University Nagarbavi Campus Bangalore 560 072.	350160 (O) 351674 (O) 335957 (R)
10.15 - 10.45 A.M.	Tea		
10.45 - 11.45 A.M.	Managing Environment of Andaman, Nicobar and Lakshdweep Islands	Prof. C.J. Saldanha Director Centre for Taxonomic Studies, Museum Road Bangalore 560 001.	213380 (O)
11.45 - 12.45 P.M.	Forest Policies in karnataka : An overview	Shri. S. Parameshwarappa Principal Chielf Conservator of Forests - Karnataka Aranya Bhawan 18th Cross, Malleswaram Bangalore 560 003.	341484 (O) 322016 (R)
12.45 - 1.30 P.M.	Lunch		
1.30 - 3.00 P.M.	People's participation in managing the environment - Presentation by panelists	Shri Jayakumar Anagol 109, VI Main Road, M C Layout,Vijayanagar, Bangalore 560 040.	356766 (R)
		Dr. S N Rai, IFS Conservator of Forests Research & Utilisation Circle, 31, Aranya Bhavan 18th Cross, Malleswaram Bangalore - 560 052.	345593 (O)

		Mr. Nagesh Hegde Sudha Magazine Deccan Herald 66, M G Road Bangalore 560 001	588999 (O)
		Mr. Narendra Hegde Sahyadri Parisara Vardhini Yellapur Road Sirsi - 581 340 Uttara Kannada District.	
		Shri S.R.Hiremath Samaja Parivarthana Samudaya Ashadeep, Sapthapur Dharwad - 580 001	(08036) 40430
3.00 - 3.15 P.M.	Tea		
3.15 - 4.00 P.M.	Discussion		
4.00 - 5.30 P.M.	Cooking Stoves and Energy Conservation	Dr. S S Lokras Chemical Engineering Indian Institute of Science, Bangalore - 560 012.	344411 EXT 2322

FACULTY INCHARGE FROM CES : DR. N.V. JOSHI 340985 (O)

Tuesday 25th August 1992

Theme : Agriculture, Biomass & Energy

TIME	TOPIC	FACULTY	TELEPHONE NO.
9.00 - 10.00 A.M.	Assigning Conservation Value : A case study from India	Dr. N.V. Joshi Assistant Professor Centre for Ecological Sciences, Indian Institute of Science Bangalore 560 012.	340985 (O) 344411/2506 (O)
10.00 - 11.00 A.M.	Biogas	Dr. H. N. Chanakya Centre for Application of Science and Technology to Rural Areas, Indian Institute of Science Bangalore 560 012.	348575 (O) 344411 EXT 2447 334292 (R)
11.00 - 11.15 A.M.	Tea		
11.15 - 12.15 P.M.	Nuclear Energy	Prof. P. Vishnu Kamath Dept. of Inorganic Chemistry Central College Bangalore University. Bangalore 560 009.	211679 (O)
12.15 - 1.15 P.M.	Biomass	Dr. N H Ravindranath Centre for Ecological Sciences, Indian Institute of Science, Bangalore 560 012.	340985 (O) 344411 EXT 2506 348575
1.15 - 2.00 P.M.	Lunch		
2.00 - 3.15 P.M.	Watershed Development - Presentations by panelists	Dr. S Subramaniam Secretary Education Dept. Sector 2, 5th Floor M.S. Building Govt. Secretariat Bangalore - 560 001	267334 (O)
		Mr. Y.N. Chaturvedi Secretary, UGC Bahadur Shah Zafar Marg New Delhi 110 002.	3318849 (O) 673376 (R)

		Prof. Ram Prasad Dept. of Civil Engg. Indian Institute of Science,Bangalore -12	344411/2328 (O) 349853 (R)
		Dr. Ramachandra Chetty Principal Chief Conservator of Forests (Management) Aranya Bhawan 18th Cross, Malleswaram Bangalore 560 003.	342827 (O) 350362 (R)
3.15 - 3.30 P.M.	Tea		
3.15 - 4.00 P.M.	Discussion		
4.00 - 5.30 P.M.	Remote Sensing Experience on Forestry in India	Dr. B.L. Deekshatulu Director National Remote Sensing Agency Dept. of Space, GOI Balnagar, Hyderabad-500037.	262572 (O) (Hyderabad)

FACULTY INCHARGE FROM CES : DR. N.H. RAVINDRANATH — 344411/2506 (O)
340985

Wednesday, 26th August 1992

Field Visit :	To Danavantri Vana, Kengal and Mudugere.
08:30 A.M.	Departure from Hotel Harsha, Bangalore
09:00 A.M.	Arrival at Danavantri Vana
9:00 to 9:30 AM	Danavantri Vana - Plantation of Medicinal plants
09:30 A.M.	Departure Danavantri Vana
10:30 A.M.	Arrival at Kengal
10:30 to 11:30 AM	Kengal - Plantation of secred plants & floral orchards
	Tea
11:30 A.M.	Departure Kengal
12:00 Noon	Arrival Bamboo Plantation (Kengal)
12:45 P.M.	Departure Kengal for Hotel Harsha
01:15 P.M.	Arrival at Hotel Harsha, Bangalore

Accompanied by : (From Forest Department)

1. Shri A.N. Yellapa Reddy — 341538 (O)
   Chief Conservator of Forests
   Govt. of Karnataka
   Aranya Bhawan, 18th Cross, Malleswaram
   Bangalore 560 003.

2. Shri Shivanna, IFS — 341447 (O)
   Silviculturist
   Aranya Bhawan, 18th Cross, Malleswaram
   Bangalore 560 003.

3. Shri K. Raviraj
   Range Forest Officer
   Research Range, Channapatna

From IISc.

1. Dr. K. Chandrashekara
2. Mr. T.V. Ramachandra
3. Mr. P.R. Bhat
4. Mr. Raghavendra Rao

FACULTY INCHARGE FROM CES : DR. K. CHANDRASHEKARA — 340985 (O) 344411/2506

Thursday, 27th August 1992

Theme : Forestry and Environment

TIME	TOPIC	FACULTY	TELEPHONE NO
9.00 - 10.00 A.M.	Biosphere Reserves	Dr. R Sukumar Centre for Ecological Sciences, Indian Institute of Science, Bangalore - 12	340985 (O) 344411/2506
10.00 - 10.30 A.M.	Tea		
10.30 - 11.15 A.M.	Wildlife Conservation	Shri K. Ullas Karanth 499, Kuvempu Nagar Mysore 570 009	
11.15 - 12.00 P.M.	Forestry and Environment Perspectives of a Forester	Shri A.N. Yellappa Reddy Chief Conservator of Forests, Govt. of Karnataka Aranya Bhawan, 18th Cross Malleswaram, Bangalore -3	341538 (O) 630248 (R)
12.00 - 12.45 P.M.	Problems and prospects of environmental solutions in the rural scene	Prof.L S Prahlada Rao Sp.Ofr., Former Addl. Secy., Department of S & T, Ecology and Environment, GOK , 43, Ashwath, Radhakrishna Layout, III Stage Behind Co-op Training College Padmanabhanagar, Bangalore -80.	620734 (R)
12.45 - 1.30 P.M.	Lunch		
1.30 - 3.00 P.M.	Forest Management: Presentations by panelists	Mr. R.V. Deshpande, MLA Leader of the Opposition Karnataka Legislative Assembly "NILAYA', 372 R.T. Nagar Main Road Near Post Office Bangalore 560 032.	331934 (R)
		Shri P D Gaonkar Retired Cheif Conservator of Forests - Social Forestry Gangas - 41, Officer Co-operative Housing Society, 5th Cross, 16th Main, BTM Layout, 2nd Stage Bangalore.	649456 (R)

		Shri G.S. Bhat, Upponi Sahyadri Parisara Vardhini Yadahalli, Sirsi Uttara Kannada District.	6608 (Sirsi)
3.00 - 3.15 P.M.	Tea		
3.15 - 4.00 P.M.	Discussion		
4.00 - 4.30 P.M.	Tribal Development & Management	Shri Benjamin Kapthuama Regional Development Commissioner Govt. of Bihar, Ranchi Audrey House Ranchi - 834006	301480 (O) 304438 (O) 301055 (R)
4.30 - 5.00 P.M.	Housing & Environment	Dr. P.S.A. Sundaram Joint Secretary Ministry of Urban Development Govt. of India New Delhi - 110 011	3017665 (O) 6885184 (R)
5.00 - 5.30 P.M.	Environmental Education	Shri N.C. Vasudevan Chairman Cum Managing Director Warehousing Corporation Govt. of Orissa Bhubaneshwar	51585 (O) 50491 (R)

FACULTY INCHARGE FROM CES : DR. R. SUKUMAR 340985 (O)

Friday 28th August 1992

Theme : General Environment

TIME	TOPIC	FACULTY	TELEPHONE NO.
9.00 - 9.45 A.M.	Climate Change	Dr. J Srinivasan Centre for Atmospheric Sciences, Indian Institute of Science, Bangalore -12.	344411/2505/2356 331361 (R)
9.45 - 10.30 A.M.	The Magnitude of the earth's Biodiversity	Prof. Raghavendra Gadagkar Centre for Ecological Sciences,Indian Institute of Science,Bangalore -12	340985 (O) 344411/2506 (O)
10.30 - 11.00 A.M.	Discussion		
11.00 - 11.15 A.M.	Tea		
11.15 - 12.15 A.M.	Tribals & Forests	Mr. Jayadev Vivekananda Girijana Kalyana Kendra,B R Hills Yelandur Taluk - 571 441 Mysore District.	25 (B.R. Hills) Kollegal Extn
12.15 - 1.15 P.M.	Controversies about	Dr. Paul David Commissioner of Inquiries Block No.3, I Floor Dr. Jivaraj Mehta Bhavan Gandhinagar 382 010 Gujarat	23915 (O) 20628 (O) 405747 (R)
1.15 - 2.15 P.M.	Lunch		
2.00 - 4.00 P.M.	Pollution : Presentations by Panelists	Mr. Y.B. Ramakrishna Save the Western Ghats March 767, 18th Main,36th Cross 4-T Block, Jayanagar Bangalore 560 041.	647807 (R)
		Shri Shekar Borgaonkar 163/B, 5th Main 4th Block, Rajajinagar Bangalore 560 010.	
		Dr. R Doreswamy Chairman, Inst. of Engineers, P B No.1063 Old No.49, New No.2016 19th Main, II Block, Rajajinagar, Bangalore 560 010.	324535 (O)

Dr. R.R. Kongovi (08036) 40430
"Tribuvan"
State Bank Colony
Kelgeri Road
Dharwad - 580 008.

Mr. Y.B. Ramakrishna 647807 (R)
Save the Western Ghats March
767, 18th Main,36th Cross
4-T Block, Jayanagar
Bangalore 560 041.

4.00 - 4.30 P.M. Discussion

4.30 - 5.30 P.M. Tea

FACULTY INCHARGE FROM CES : PROF. RAGHAVENDRA GADAGKAR 340985 (O)

ORGANISING COMMITTEE	
Course Director : Prof. D.K. Subramanian	Ph:344411/2506, 2239 340985 (O) 340943 (R)
Members : Mr. T.V. Ramachandra	Ph:340985 (O) 344411/2506
Mr. P.R. Bhat	Ph:344411/2506 & 2535
Ms. T.S. Geetha	Ph:344411/2506 & 2535
Mr. Raghavendra Rao	Ph:340985

LECTURE NOTES

TRAINING PROGRAMME ON

" MANAGEMENT OF ENVIRONMENT "

FOR OFFICERS OF THE INDIAN ADMINISTRATIVE SERVICE

DATES: 24--29 AUGUST 1992

COURSE DIRECTOR: PROF. D.K. SUBRAMANIAN

VENUE
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WILDLIFE CONSERVATION

K.Ullas Karanth,
Wildlife Biologist,
Centre for Wildlife Studies,
Mysore - 570 023

1. Conservation of biological resources is now globally accepted as a necessary component of developmental efforts. Therefore, preservation and wise use of biological resources, of which wildlife is an important component, has been accepted as a national goal. Apart from moral, aesthetic and sentimental reasons, it is now widely accepted that our own economic and social well being also depend critically on the success of our efforts in biological conservation. Wildlife, including animals and their habitats, constitute a major part of our biodiversity.

2. Conservation Biology and Wildlife Management are essentially "technologies" that seek to apply the principles and information from ecological sciences to solve problems of conservation in the real world. Thus the scope of Wildlife Conservation includes all three among the following aspects:

1. Preservation of endangered species and habitats.
2. Sustainable harvest of some wildlife resources.
3. Mitigation of damage caused by wildlife.

The philosophy underlying Wildlife Management is thus guided by pragmatism, rather than by sentiments of Ahimsa.

3. Wildlife Management is usually practiced from a species oriented approach, though ecosystem of landscape oriented approaches are also gaining currency. The "in situ" preservation of species or ecosystems demands protection to representative areas called nature reserves such as National Parks, Sanctuaries and Biosphere Reserves. This invariably implies that we need to reduce or entirely give up ongoing levels of resource exploitation in designated nature reserves. Protecting and consolidating habitats from agricultural expansion, controlling livestock graing and forest fires, reducing forest produce collection by the organized and unorganized sectors, and controlling illegal hunting, are some of the first step in these efforts. Very often these steps come into conflict with immediate human needs, and use of force becomes necessary part of conservation efforts.

4. The simplistic philosophy of leaving nature alone often does not work. The fragmentation and changes induced by human intervention in natural ecosystems over the last several thousand years, makes it impossible for us to leave nature alone today. What is needed is a better understanding of these systems, leading to some degree of informed human intervention to achieve sustainable conservation goals. The science of Wildlife Biology provides the necessary scientific frame-work for manipulation of habitats and animal populations, to attain these goals. However, the technology of wildlife management needs to be integrated intelligently with people management in the form of appropriate socio-economic policies, if wildlife conservation efforts are to achieve long term success.

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FORESTRY IN KARNATAKA PAST,PRESENT AND FUTURE

BY S. PARAMESWARAPPA.

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Karnataka has a land area of 192.204 Sq.Km. spreading between latitude 11° 31' and 18° 0' north lattitude and longitudes of 74° 12' and 78° 40' east. The State has coastal plains of 10-50 Km wide along the Arabian sea. To the east of the sea coast are the Western Ghats hill ranges of 30-50 km width (rising up to 2000 m above sea level) and gently inclined plateau with drainage further to the east. Annual rainfall varies from over 6000 mm on the slopes of Western Ghat hills in the west to 375 mm in the north-east, resulting in a diversity of vegetation types. Most of the rainfall is received from the south-west monsoon between June and September.

Forest area of the state is 1.8 million hect. Towards the west and in the Western Ghats where there is less population pressure there are wet evergreen and semi-evergreen forests having species like Dipterocarpus indicus, Calophyllum tomentosum, Canarium strictum, Artocarpus species, Vateria indica, Mangifera indica and others. These forests rise to a height of 40 m and more. They have many other species in three to five discernible tiers. The species include Diospyros ebenum(ebony) Dysoxylum malabaricum (white cedar), Cinnamomum zeylanicum (cinnamon) and spices like piper nigram (pepper) Elettaria Cardamomum(Cardomum).

To the east of this zone lies moist deciduous forests rising to a height of 30m and have species like tectona grandis(teak), Dalbergia latifolia (rose wood), Terminalia tomentosa(Indian laurel). Pterocarpus marsupium, Lagerstroemia lanceolata and Bambusa arundnacea). These forests are of high economic value. These forests have pressure of grazing and collection of firewood and damage due to fire of medium intensity, compared with that faced

by the drier forests in the eastern part of the State. These forests constitute the home of elephant(Elephus maximus), tiger(Panthera tigris), Panther (Panthera pardus), bison (Bogaurus), Sambar (Cervus uni-color), spotted deer (Axis axis) and other animals.

The adjoining belt to the east, are the Dry deciduous, though degraded still retains some remaining pockets of forest rising to a height of 10 m. Some of the main species are Anogeissus latifolia, Terminalia Spp. Hardwickia binata, Buchnania latifolia, Phyllanthus emblica, Tectona grandis, Santalum album(Sandal wood) and Dendrocalamus strictus(bamboo). This zone is capable of supporting rich Wildlife including elephant, tiger, panther, spotted deer, wild dog (Cuon alpinus), and Wild pig(Suss croffa), if provided good protection from fire and grazing. It is also rich in economically important non wood forest products yielding species. The open scrub forests with Albizia amara, Chloroxylon swietenica and thorny Acacia species established over the driest zones are in a very poor condition, due to heavy biotic pressure.

Two million out of 3.8 hectares of forests in the State are in different stages of degradation.

Forest Management:

Scientific forest management in Karnataka began around 1860, thanks to the forethought and concern of the then rulers, both princely State of Mysore and Hyderabad and the British administration of Bombay and Madras presidencies towards forest wealth. Initially, forests were viewed as the main source of the State income and therefore forest management was mainly based on a Reservation Policy of consolidation. Reservations were set up to provide protection to blocks of forests, by preventing shifting cultivation and fires; restricting removals and controlling grazing. These forests were also expected to meet the ecological and economic (timber) needs of the State. The remaining areas were to meet the needs of the local people. These were common lands and generally twice the extent of the area constituted as Reserves, and were in addition to the individual privilege areas assigned as appendages

to agricultural holdings in the form of Betta, Soppinabetta, Kumki, Hadi and Bane lands. However, with the increase in population and consequent pressures on land, the common lands became an immediate alternative for the expansion of agriculture, whilst Reserve forests replaced the common lands in meeting the needs of the local people.

In the fifties, the priority accorded to developmental projects such as irrigation, energy and agricultural production and rehabilitation of people affected by these projects took a very heavy toll of the forest wealth of the country. Karnataka was no exception and lost 2 lakh hect. of prime forests for this. It is ironical that instead of recognising the objectives behind the Reservation of forests areas, the later administrators went on de-reserving the forests for various non forestry purposes. Forestry as a land use was not recongnised and the change of land use for non forestry purpose was freely permitted, till 1974, after which a bill to prevent this was brought, and the Karnataka Forest Act was amended, providing for concurrence of both the houses of Legislature for change of land use from forestry to non-forestry.

In 1970, a policy decision was taken not to divert any more forest areas for agriculture. In 1974, the powers to release forest areas for non-forestry purposes was surrendered to the Legislature. In 1975, a programme of free distribution of tree seedlings to farmers was started and this was intensified during 1983 under the Social Forestry Project (World Bank/ODA funded). In 1976, the Tree Preservation Act to protect trees in private lands was brought into force and in the same year, the number of trees that could be felled per acre under the Selection system of logging was reduced from 6 to 4. The system of clear felling of natural forests for raising plantations was given up in 1982 and in 1987, a total ban was imposed on the felling of trees in wet evergreen forests. From 1991, onwards extraction of timber is limited to removal of dead and fallen trees only.

Forest Produce: the raising of Plantations:

Conservation oriented forest management in the State have been so effective that the quantity of timber and other produce extracted from the forests in Karnataka State has come down to a third (1 millian M^3) of what was extracted a decade ago. However, the Forest Department is keenly aware that the State is facing an acute shortage of firewood, timber, bamboo and other forest produce. As against an annual demand of 1000 lakh tonnes, the total quantity of firewood from all possible sources is only 100 lakh tonnes. This demand is steeply rising with the increase in population and in rural areas firewood is the only source of energy and is likely to remain unchanged for atleast another three decades. What is to be done?

To bridge the gap in wood supply, Karnataka Forest Department has launched an ambitious programme of raising large scale plantations both by the Department as well as through the Forest Corporations. The Department is planting annually an extent of 40,000 hect on degraded forest lands, Government Waste lands, Gomal(grazing)lands, foreshore areas, roadsides and on institutional lands. Around Rs. 45 crores are being spent on these schemes annually. About 10 crore seedlings are being distributed annually. to farmers free of cost under Farm and Agro forestry programmes. The Jawhar Rojgar Yojana and the Area Oriented Fuel and Fodder Programme are some of the Centrally Sponsored Schemes for raising rural fuelwood plantations besides the work done under the World Bank assisted Social Forestry Project. Funding for some of these projects has also come from the Forest Development Fund of the State and the Soil Conservation and Afforestation of Western Ghats Development Project. The Forest Department has increased its annual tree planting target from about 30,000 hectares to 40,000 hectares since 1980.

Apart from these, the Forest Corporations, viz. Karnataka Forest Development Corporation and Karnataka Cashew Development Corporation have raised and are managing plantations of fast growing species of Eucalyptus and Casurina to the extent of one lakh(80,000 + 20,000) hectare. Besides this Karnataka Cashew Development Corporation has raised and are managing 10,000 hect. of Cashew plantations.

Details of plantations raised by the Department so far are:

Plantation type	Extent (i n hect.)
Teak	126,873
Softwood	57,537
Cashew	39,403
Eucalyptus	131,078
Fuel & Miscellaneous	565,585
Bamboos	7,283
Fruit orchards	2,265
Sandal	4,311
School Forestry	7,029
Avenue Planting(Kms)	13,012
Canal side(Kms)	2,865
	957,241

The State Government has also introduced a novel scheme by which 5% of lands in the command area of all irrigation projects have tobe reserved for the raising of forest plantations and nurseries.

Forest Produce: dis-incentives:

There has been a complete change effected in the system of extraction and sale of forest produce in the State. The earlier concessions given to various wood based industries for the supply of raw material have been withdrawn in 1981 and through an amendment in the Forest Act., all consumers have to pay the seignorage rates fixed by the State Government. A bill has been passed by the State Legislature to empower the Government to abrogate leased forest lands in the year 1983, if these are found detimental to the maintenance of the ecological balance in the area and with this all Forest Industrial leases have come to the end in 1989. Apart from the reduction in the number of trees that are allowed to be felled to 7 trees per ct, the system of standing sale of trees in coupes has been completely given up since 1982-83 and all extractions are now carried out departmentally. The produce of the plantations raised outside the reserved forest, will go to the villagers consequent on the transfer of such plantations to the Zilla Parishads and Mandal Panchayats as per G.O.No. FFD 75 FAP 83, Bangalore dated 23rd Jan 1986.

In order to prevent unscrupulous firewood traders from carrying away forest produce in cart loads from nearby forest lands, wood is supplied through a network of departmental firewood depots particularly in the richly wooded 'Malnad' (forested) areas. The concession is to the extent of nearly 90% of the seignorage value of the firewood and amounts to an extent of Rs. 2 crores per year.

Forest Produce:availability:

The Karnataka State Government has tried to make up for the shortage in fuelwood by introducing long term plans such as large scale plantations raising as well as reserving the produce of plantations raised under the NREP, DPAP, and RLEGP Schemes to make available firewood, poles and small timber primarily to villagers. These plantations have been taken out from the purview of industrial supply.

Moreover the forest produce from dry zone plantations that receive less than 500mm rainfall annually have also been exclusively reserved for villagers. A number of depots have been opened in forest headquarters for the supply of eucalyptus poles to villagers and for the supply of bamboo to Medars(Bamboo artisans) and other bonafide users.

Forests and Wild Life:

The State Forest Department has also taken up extensive measures to protect the wildlife that abounds in Karnataka Forests. Special efforts have been made to control the poaching of elephants and the smuggling of ivory. A wireless network has been established along the State's borders with Tamilnadu and Kerala and the specially created protective squads have been provided with vehicles and weapons. The rate of poaching and smuggling has come down considerably since 1981 when these measures were undertaken. The Government of India also proposes to launch the 'Project Elephant' particularly in Mysore and Coorg districts to improve the habitat for the elephant population in these areas. In 1974 the 'Project Tiger' was launched in the State to preserve the habitat of tigers, particularly in the Bandipur National Park and its adjoining forest areas. This was done with assistance from the World Wildlife Fund. The tiger population in the Project area has since increased from a mere 11 to around 50 where as it is estimated to be around 215 for the whole of state.

The State has 19 sanctuaries and 5 National parks and 17% of the Forest area is constituted as parks and sanctuaries.

Forests and industries:

The forestry wing of the Government owned Mysore Paper Mills has raised about 20,000 hectares of very good captive plantations on the degraded land areas leased to them by Government. The Plantations have been raised from 1983 with assistance from ODA of Great Britain. The mill is now getting 50% of its capacity requirements of raw material from own plantations. Besides this, the mill supplies firewood to the local people as per the agreement which allows 40% of the biomass from these plantations. The Company also organises free supply of seedlings to farmers.

Forests and People:

The State Government and the State Forest Department are very conscious of the fact that their schemes cannot be a success without the active participation of the people. Karnataka is the pioneer state to involve school children in planting of trees. A scheme for leasing of Government owned Waste lands to schools for free planting has been introduced and many schools have come forward to participate. The Department meets the cost of travelling of the children and for providing them some refreshment.

A large number of voluntary organisations have been motivated to take up the cause of tree planting in the State. These organisations have also made efforts at creating awareness among people about the benefits of tree planting. A few institutions have come up with pilot schemes to plant trees on community lands. The State Government has prevailed upon various financial institutions like NABARD and KASCARD Bank and various commercial banks to lend money to farmers for planting trees by leasing degraded revenue lands upto 10 hect. to individuals and 100 hect. to institutions vide G.O. No.

The Foreset Department has undertaken large scale tree planting in urban areas for the State as well. Over one crore trees have been planted in and around Bangalore City alone from 1983 onwards. A sizeable number of trees have been planted in other towns and cities too implementing the State Government's policy to encourage urban forestry and recreation forestry in the State.

The State Forest Department has also achieved remarkable success in the programme of raising seedlings in decentralised nurseries. Karnataka is the main beneficiary under the scheme of decentralised nurseries sponsored by the National Waste Land Development Board and 75% of the seedlings raised in the State today are from these Kissan nurseries. Emphasis is now to encourage private nurseries for production of seedlings.

Forest Corporations:

Karnataka has three forest based Corporations namely Karnataka Forest Development Corporation, Karnataka State Forest Industries Corporation and Karnataka Cashew Development Corporation.

The Karnataka Forest Development Corporation was established during 1971 to take up forest plantations through institutional finance, when the investment in forestry in the State was less than 1% of the total plan allocation. The Corporation now owns upto one lakh hect of plantation of fast growing species. This Corporation has now diversified into managing Rubber and Cocoa plantations. It has also taken up a wildlife tourisum project near Nagarhole National Park.

The Karnataka State Forest Industries Corporation was established during 1973 primarily to set up forest based industries in the forested belt making use of the forest produce which is secondary in nature. The Corporation is now handling all forest logging and extrction.

The Karnataka Cashew Development Corporation was established to raise Cashew Plantation in the coastal districts where there is vast potential. The Corporation has raised very good Cashew Plantations of about 10,000 hect which have come for bearing. This Corporation is also implementing a fuelwood project of Casurina in the Coastal Districts of the State with institutional finance from NABARD.

Forests - the future:

Karnataka is ahead of most other states in its conservation oriented forest management. An environmental forestry project with ODA/U.K. assistance for the Western Ghats of the State (8 districts) estimated to cost around Rs. 85 crores for a period of 6 years has been approved. Large areas of degraded forest land will be developed with the assistance of the local inhabitants and sharing with them the benefits of such development through the process of Joint Forest planning and management. The project also envisages the establishement of **G.I.S.** and **M.I.S.** system as also an independent Forest Reserach and Training Institute. A similar project for the eastern plains(12 districts) for an outlay of 200 crores is now ready.

The Forest Department of Karnataka knows where the future lies - in the protection and sustainable use of forest lands through people's co-operation. In its endeavour to save the environment from the ravages of 20th Century life, the Department makes itself partof a global programme to protect and cherish our earthly inheritance through the principle of **"THINK GLOBALLY AND ACT LOCALLY".**

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REMOTE SENSING EXPERIENCE ON FORESTRY IN INDIA

STRUCTURE OF PRESENTATION

Dr. B.L. Deekshatulu
Director
National Remote Sensing Agency

1. INTRODUCTION TO REMOTE SENSING
2. SATELLITE DATA ACQUISITION / GROUND SEGMENT
3. IRS – MISSION OVER VIEW
4. REMOTE SENSING APPLICATIONS IN NATIONAL PROJECTS
5. FOREST MANAGEMENT ISSUES
6. FOREST COVER MONITORING USING REMOTE SENSING
7. MANAGEMENT INFORMATION – REQUIREMENT
   - TYPE MAPPING
   - STOCK MAPPING
   - GRASSLAND MAPPING
   - SHIFTING CULTIVATION
   - FOREST ENCROACHMENT
   - BIO-MASS/ FUELWOOD ESTIMATION
   - FOREST CHANGE DETECTION
   - FOREST DEPLETION PROJECTIONS
   - DEFORESTATION AND GLOBAL WARMING
   - FOREST FIRE MONITORING
   - WILDLIFE HABITAT ANALYSIS
   - FOREST ECOSYSTEM ENERGY DYNAMICS
8. AERIAL PHOTOGRAPHY & FOREST VOLUME ESTIMATION
   * ADVANTAGES FOR QUANTITATIVE MEASUREMENTS
   * FOREST VOLUME ESTIMATION
9. GEOGRAPHICAL INFORMATION SYSTEM
   - WASTELAND SUITABILITY FOR TREE PLANTING
10. MICROWAVE REMOTE SENSING
11. FUTURE CAPABILITIES OF IRS 1C/1D

OPERATIONAL PROJECTS USING REMOTE SENSING

1. FOREST COVER MAPPING AND MONITORING
2. CROP ACREAGE / PRODUCTION ESTIMATION FOR RICE, WHEAT SORGHUM AND GROUNDNUT ETC
3. CROP ACREAGE ESTIMATIONS FOR CASH CROPS – COTTON, TOBACCO, SUNFLOWER
4. GROUND WATER PROSPECTING ZONES
5. AGRICULTURAL DROUGHT ASSESSMENT AND FORECASTING DURING KHARIF SEASON
6. POTENTIAL FISHING ZONES IDENTIFICATION AND FORECASTING
7. INTEGRATED LAND RESOURCES MANAGEMENT
8. WASTELAND MAPPING
9. LAND USE/LAND COVER MAPPING FOR AGRO-CLIMATIC ZONES CHARACTERIZATION
10. FLOOD DAMAGE ASSESSMENT
11. URBAN SPRAWL MONITORING
12. NATIONAL NATURAL RESOURCES MANAGEMENT SYSTEM (NNRMS)

FOREST MANAGEMENT ISSUES

1. FOREST COVER / MONITORING
2. FOREST GROWING STOCK ASSESSMENT
3. FOREST PROTECTION AND DAMAGES
4. FOREST CONSERVATION AND ENERGY
5. LOGGING / EXTRACTION PLANS
6. ENVIRONMENTAL IMPACT ASSESSMENT
7. FOREST RESEARCH / SILVICULTURE
8. AFFORESTATION SITES / PROGRAMMES
9. HYDROLOGY
10 WILD LIFE PROTECTION HABITAT

ETC.

FOREST MANAGEMENT

* FORESTS ARE MANAGED BY STATE DEPARTMENTS IN INDIA. AT THE NATIONAL LEVEL "FOREST SURVEY OF INDIA" IS ENGAGED IN FOREST COVER MONITORING OF THE ENTIRE COUNTRY. THE FOREST RESEARCH INSTITUTE (FRI), & WILD-LIFE INSTITUTES ARE ALSO WORKING ON FORESTRY RELATED ISSUES.

* BASICALLY THE FORESTS ARE MANAGED AT THE FOREST DIVISION LEVEL (REPRESENT A DISTRICT IN SOME STATES) WITH A "PLAN DOCUMENT" KNOWN AS "WORKING PLANS" OR "MANAGEMENT PLANS"

* THESE MANAGEMENT PLANS ARE GENERALLY VALID FOR 10 YEARS - HENCE NEED REVISION

* THESE PLAN DOCUMENTS ARE WRITTEN AFTER INTENSIVE GROUND INVENTORIES AND ADDRESSES ALL ISSUES COVERING FINANCIAL, CLIMATIC, SOCIO-ECONOMIC, HYDROLOGIC AND RESOURCE POTENTIALS.

* "MANAGEMENT PLAN" IS THE BASELINE DOCUMENT FOR ALL THE FORESTRY OPERATIONS

FOREST COVER MAPPING

AS PER THE FOREST POLICY HILL AREAS SHOULD CONSIST OF 60% OF TREE COVER AND PLAINS AT 33% . IT WAS BELIEVED TILL 1983 THAT INDIA HAS 22.7% OF GEOGRAPHICAL AREA UNDER FOREST COVER. DURING 1982-83 TIME FRAME "NRSA" FOR THE FIRST TIME CARRIED OUT A "NATIONAL LEVEL FOREST COVER MAPPING" USING SATELLITE DATA.

THE CATEGORIES IDENTIFIED ARE:

- CLOSED FORESTS :- A FORESTED AREA WITH 40% OR MORE TREE CANOPY COVER
- OPEN FORESTS :- AN AREA WITH 10-40% TREE CANOPY COVER
- DEGRADED :- LESS THAN 10% TREE COVER
- MANGROVES

ACCORDINGLY NRSA/FSI ESTIMATED TREE CLAD AREA AS:

TIME FRAME	CLOSED FOREST(%)	OPEN FOREST (%)	MANGROVES (%)	TOTAL (%)
1972-75	14.12	7.38	0.1	21.60
1981-83	10.88	8.41	0.12	19.52
1985-87	11.51	7.83	0.13	19.47
1987-89	11.73	7.63	0.13	19.49

* FSI IS NOW BIENNIALLY MONITORING THE FOREST COVER OF INDIA
* BASED ON THE 3RD ASSESSMENT (1987-89) IT IS OBSERVED FOREST COVER IS INCREASED BY ABOUT 0.02 % (560 SQ.KM)
* THIS IS BEING ACCOMPLISHED ONLY THROUGH USE OF SATELLITE DATA.

FOREST MANAGEMENT INFORMATION – REMOTE SENSING

1. FOREST TYPE MAPPING:

   * INDIA'S FOREST COVER CAN BE DIVIDED INTO 16 MAJOR "FOREST COVER TYPES". THIS IS THE LEVEL–II INFORMATION AND AMENABLE TO REMOTE SENSING.

2. FOREST STOCK MAPPING

   * THE GROWING STOCK OF A FOREST REPRESENT THE EXISTING STATUS OF FOREST IN TERMS OF ITS TREE CANOPY DENSITY AND HEIGHT OF THE CROP.

   * THE DETAILED STOCK DENSITY MAPS ARE EXTREMELY NEEDED AT 20 %(CANOPY COVER INTERVAL ON LARGE SCALE MAPS (1:15,000 OR 1:25,000 SCALE) FOR ASSESSING UNDERSTOCK AREAS.

   * REMOTE SENSING DATA IS USED BY VARIOUS FOREST DEPARTMENTS (MAHARASTRA, SIKKIM, AP) FOR STOCK DENSITY MAPPING.(CANOPY COVER)

3. GRASSLAND MAPPING

* INDIA IS HAVING AN ESTIMATED GRASSLAND OF 12 MhA (~ 4% TO TOTAL GEOGRAPHICAL AREA) AND ARE PRONE TO DEGRADATION.

* THE EXTENT AND DISTRIBUTION IS ESSENTIAL FOR FODDER MANAGEMENT PLANS

* NRSA DID A PILOT STUDY TO EVOLVE A SUITABLE METHODOLOGY FOR IDENTIFICATION OF GRASSLANDS IN WESTERN GHATS

* NATIONAL LEVEL GRASSLAND MAPPING IS IN THE PIPELINE

4. SHIFTING CULTIVATION

* JHUMING IS A TRADITIONAL PRACTICE IN NORTH EASTERN STATES, AP, MP, MAHARASTRA ETC. AND AS A RESULT FORESTS ARE DEGRADATION AT AN ALARMING RATE.

* THE MULTI TEMPORAL SATELLITE DATA PROVIDING ASSESSMENT ON DAMAGES AND TO MAKE PLANS FOR RESTOCKING JHUMED AREA

5. FOREST ENCROACHMENTS

* THE ILLEGALLY OCCUPIED AREAS UNDER FORESTS OVER A PERIOD OF TIME CAN BE DECIPHERED USING MULTI DATE DATA

* THE STUDY CARRIED IN NORTH DHULE DISTRICT OF SHIRPUR RANGE OF MAHARASHTRA BROUGHT OUT ENCROACHED AREAS AND ENABLED STATE FOREST DEPARTMENT TO WIN THE CASE IN BOMBAY HIGH COURT.

6. BIO-MASS/FUEL WOOD ASSESSMENT

* BIO-MASS MEANS NET ANNUAL INCREAMENT / GROWTH OF TREE PER UNIT AREA THAT CAN PRODUCE.

* THE ESTIMATION OF ANNUAL INCREAMENT / NET PRIMARY PRODUCTIVITY OF THE FORESTED AREAS ARE IMPORTANT TO MAKE PLANS FOR SUSTAINED SUPPLY FOR FUEL WOOD DEMAND.

* REMOTE SENSING BASED BIO-MASS MODELS AND FUEL WOOD ASSESSMENT ARE FOUND EFFECTIVE.

7. FOREST CHANGE DETECTION

* THE AREAS COVERED UNDER AFFORESTATION PROGRAMME OR THE AREAS UDER GOING RAPID CHANGES, ARE CRITICAL TO MONITOR THEIR EXTENT AND STATUS.

* THE DIGITAL AUTOMATED FOREST CHANGE DETECTION TECHNIQUES ARE EXTREMELY USEFUL FOR PLANTATIONS IMPLEMENTATION PROGRAMMES.

RESEARCH AND DEVELOPMENT

8. FOREST DEPLETION PROJECTIONS

* BASED ON 132 COUNTRIES POPULATION DENSITY AND % DEFORESTATION ESTIMATES, IT IS POSSIBLE TO DRAW A INVERSE SIGMOIDAL DISTRIBUTION.

* THIS STUDY INDICATE THAT FOREST DEGRADATION IS, ASSOCIATED WITH POPULATION DENSITY (SOME OTHER FACTORS ALSO)

* SO GIVEN FOR A DISTRICT'S FOREST DEGRADATION AND THE PROJECTED POPULATION DENSITY WE CAN EMPIRICALLY ARRIVE AT POSSIBLE CONSEQUENCIES AND TO TAKE ADVANCE STEPS TO COUNTER THE SITUATION.

9. DEFORESTATION AND GLOBAL WARMING

* THE INCREASED CONCENTRATION OF GREEN HOUSE GASES (CO_2, CH_4, NO_x etc) IN THE ATMOSPHERE CAUSING GLOBAL WARMING. THESE GASES INHIBIT THE OUTGOING LONG WAVE RADIATION IN THE EARTH'S ATMOSPHERE

* THE CO_2 IS INCREASING AT THE RATE OF 1 PPM PER YEAR AND REACHED 345 PPM

* IT IS ESTIMATED USING NOAA-AVHRR DATA THE RELATIONSHIP BETWEEN VEGETATION CHANGE AND CO_2 LEVELS. WITH THIS MODEL WE CAN RELATE THE FOREST DEGRADATION COMPONENT AND ITS CONTRIBUTION TO CO_2 RISE

10. FOREST FIRE MONITORING

- THE INDIA'S DRY DECIDUOUS FORESTS ARE PRONE TO FOREST FIRES ANNUALLY CAUSING EXTENSIVE LOSS TO THE FOREST WEALTH DURING SUMMER PERIODS.

- PRESENT FIRE FIGHTING OPERATIONS BY THE STATE DEPARTMENTS INVOLVE EXTENSIVE PATROLLING AND CREATION OF FIRE LINES INCURRING HUGE AMOUNT OF MONEY.

- REMOTE SENSING TECHNOLOGY PROVIDE BETTER MEANS TO MONITOR THE FOREST FIRES AND TO ASSESS THE DAMAGE MORE PRECISELY.

- THE MULTI-DATE SATELLITE DATA ENABLED THE MONITORING OF FOREST FIRE THAT OCCURED IN THE NAGARHOLE WILD LIFE SANTUARY OF KARNATAKA. THE PRE-FIRE, DURING FIRE AND POST-FIRE IRS PICTURES BROUGHT OUT THE EXTENT OF FOREST DAMAGE.

11. WILD LIFE HABITAT STUDIES

* THE SUITABLE BIO-GEOGRAPHIC AND HYDROLOGICAL CONDITIONS IN THE NATIONAL PARKS / SANCTURIES ARE VERY ESSENTIAL TO UNDERSTAND THE HABITAT SUITABILITY OF WILD-ANIMALS.

* SEVERAL STUDIES USING REMOTE SENSING PHOTO INCONJUCTION WITH GROUND DATA PROVIDED BETTER MEANS TO ASSESS THE HABITAT SUITABILITY.

* THE DEVELOPMENT OF "HABITAT SUITABILITY INDEX" (HSI) OF WILDLIFE USING LIFE REQUISITE PARAMETERS CAN BE MADE THROUGH USE OF REMOTE SENSING DATA.

12. FOREST ECO-SYSTEM ENERGTICS – IGBP

- THE LAND ENVIRONMENT HAS ALREADY BEEN EXTENSIVELY ALTERED AS A DIRECT RESULT OF MAN'S ACTIVITIES. THE DOUBLING OF THE HUMAN POPULATION IN THE NEXT FIFTY YEARS WILL INTENSIFY SUCH PRESSURES – IN ADDITION CHANGES IN ATMOSPHERIC COMPOSITION AND CLIMATE ARE EXPECTED TO HAVE WORLDWIDE EFFECTS ON THE STRUCTURE AND PRODUCTIVITY OF BOTH NATURAL AND MANAGED SYSTEMS. TOWARDS THIS UNDERSTANDING OF TERESTRIAL ECO-SYSTEM PRIMARILY THE GREEN MANTLE IS ESSENTIAL INTERMS OF ITS ENERGY EXCHANGAES.

  - NRSA IS CARRYING OUT A PROJECT AS PART OF ID/GBP FOREST ENERGY SYSTEM STUDIES IN WESTERN GHATS FOR

    - WATER BALANCE
    - HEAT BALANCE

  - BOTH EVERGREEN AND DY DECIDUOUS SYSTEMS ARE COVERED

AERIAL PHOTOGRAPHY AND FOREST VOLUME ESTIMATION

- THE USE OF AERIAL PHOTOGRAPHS PROVIDE INFORMATION WITH REGARD TO THIRD DIMENSION – HEIGHT OF THE TREES. IN ORDER TO OBTAIN QUANTITATIVE INFORMATION THE USE OF AERIAL PHOTOGRAPHS ESPECIALLY FOR FOREST VOLUME ESTIMATIONS ARE REQUIRED

- THE ADVANTAGES OF AERIAL PHOTOGRAPHY IN CONJUNCTION WITH SATELLITE DATA PROVIDE ON A MORE ECONOMIC BASIS FOR LARGER AREAS ON QUANTIFICATION OF FOREST WEALTH USING MULTI-PHASE APPROACH.

- THE SATELLITE DATA PROVIDE TWO DIMENSIONAL ASPECTS WITH REGARD TO EXTENT OF FOREST AREAS. FOR SOME SELECTED AREAS THE AERIAL PHOTOGRAPHY PROVIDE QUANTITATIVEI INFORMATION WHICH CAN BE INCORPORATED AS A SECONDARY SAMPLE FOR EXTRAPOLATING TO THE ENTIRE FOREST AREA.

- FOREST AREA X SUB SAMPLE QUANTITY (Q1) = VOLUME

- THE ESTIMATION OF FOREST VOLUMES ARE VERY MUCH REQUIRED FOR FOREST MANAGEMENT AND TO ASSESS THE PRODUCTIVITY POTENTIAL AND SUSTAINABILITY FOR CONTINUAL SUPPLY OF FOREST WOOD RESOURCES.

GEOGRAPHICAL INFORMATION SYSTEM

- THE LARGE DATA BASE FOR VARIOUS RESOURCE THEMES BEING GENERATED AT VARIOUS ADMINISTRATIVE LEVELS CAN BE INCORPORATED IN THE FORM OF GEOGRAPHICAL INFORMATION SYSTEM (GIS). THIS WILL ENABLE UPDATING, RETRIEVAL AND MODIFICATION OF INFORMATION BASE.

- THE SPATIAL DATA BASE GENERATED ON RESOURCES CAN BE MADE COMPATABLE TO COMPUTER FACILITATING MODELLING OF THE VARIOUS THEME INFORMATION BY DEFINED WEIGHTAGES.

- THE WASTELAND DATA BASE GENERATED THROUGH NATION WIDE WASTELAND MAPPING PROJECT PROVIDE INFORMATION ON WASTELANDS AT VILLAGE LEVEL. IN ORDER TO UNDERTAKE WASTELAND RECLAMATION MEASURES THE PREREQUISITE IS TO IDENTIFY THE SUITABLE WASTELAND CATEGORIES FOR SPECIFIC RECLAMATION / TREE PLANTING.

- A CASE STUDY CARRIED OUT IN A BIJAPUR TALUK OF KARNATAKA USING MULTI-LEVEL INFORMATION AND MODELLED FOR IDENTIFICATION OF SUITABLE SITES FOR WASTELAND RECLAMATION IS PRESENTED.

- THE USE OF GIS ESPECIALLY FOR SPATIAL DATA BASE MANAGEMENT IS A SPECIALITY AND PROVIDE GREAT ADVANTAGE IN THE FOREST MANAGEMENT ESPECIALLY IN AFFORESTATION PROGRAMMES.

MICROWAVE REMOTE SENSING

THE PRESENT CAPABILITIES OF SATELLITE REMOTE SENSING INCORPORATES OPTICAL AND INFRARED REGIONS OBSERVATION OVER THE LAND MASS. THESE SPECTRAL WINDOWS SUFFER AT TIMES DUE TO CLOUDS.

THE MICRO REMOTE SENSING PROVIDE ALL WEATHER CAPABILITY DURING CLOUD AND NIGHT TIMES PERMITTING HIGHER TEMPORAL SURVEILANCE OF LAND COVER TYPES ON EARTH.

THE AIRBORNE SLAR / SAR SENSORS DEVELOPED BY NRSA / SAC OF DEPARTMENT OF SPACE HAVE PROVEN TO BE OF IMMENSE VALUE FOR ESTIMATING LAND COVER INFORMATION.

THE IRS SECOND GENERATION SATELLITES ARE CONTEMPLATED TO HAVE THIS FACILITY.

THE ERS-1 SATELLITE WHICH IS IN ORBIT IS PROVIDING MICROWAVE DATA OVER INDIAN REGION PERMITTING ADDED ADVANTAGE TO OUR IRS -1A / 1B SATELLITES.

FUTURE CAPABILITIES OF IRS 1C

THE IRS 1C THIRD IN THE SERIES IS SCHEDULE FOR LAUNCH DURING 1993.

IT CARRIES THREE PAY LOADS :

1	LISS – III	WITH FOUR SPECTRAL BRANDS INCLUDING ONE MIDDLE INFRARED BAND (EQUIVALENT TO TM B 5) HAVING 20 MTR RESOLUTION.
2	PAN	PANCHROMATIC DATA WITH STEREO VIEWING CAPABILITY PROVIDING BETTER THAN 10 MTR RESOLUTION.
3	WIFS	770 KM SWATH WIDTH AND 180 MTRS SPATIAL RESOLUTION. THE REPETITIVITY OF THREE DAYS IN THIS MODE.

THE LAUNCH OF IRS-1C WITH ITS ENHANCED CAPABILITIES PROVIDE GREATER OPPORTUNITIES IN UTILISATION OF MULTI MODE OPERATIONS OF THE SENSORS BOTH IN MULTI SPECTRAL, PANCHROMATIC, STEREOSCOPIC AND WIDE IMAGING PICTURES WITH HIGH REPETITIVITY ENABLE TO OBSERVE HIGHLY DYNAMIC PHENOMENA ESPECIALLY THE CHANGE CONDITIONS OF CROPS ETC.

GENERAL POLICY

1. MINIMISING THE RAPID SHRINKING OF FOREST

2. ENSURE SUSTAINABLE SUPPLY TO MEET THE RURAL AND INDUSTRIAL SECTORS

SPECIFIC TO INDUSTRY

- SUPPLY OF RAW MATERIALS – AFFORESTATION

  - SITE IDENTIFICATION USING REMOTE SENSING

- POWER SUPPLY – HYDEL PROJECTS

  SITE IDENTIFICATION FOR MICRO-HYDELS

LANDUSE POLICY

33 % FOREST COVER ON THE PLAINS

60 % ON THE HILLS AS LAID DOWN IN THE FOREST POLICY OF INDIA CAN BE MONITORED THROUGH REMOTE SENSING

RURAL BIO-MASS/FOR FUEL/ENERGY

ENERGY PLANTATIONS – SITE IDENTIFICATION THROUGH REMOTE SENSING IS POSSIBLE

FOREST RETROGRESSION IN ANDMAN NICOBAR ISLANDS - AN INVESTIGATION USING AEROSPACE REMOTE SENSING TECHNIQUES

RATIONALE:

- FORESTS IN ANDMAN AND NICOBAR ISLANDS ARE MANIFESTATION OF UNIQUE ENVIRONMENTAL SET UP PRESENTING DIVERSE FLORISTIC COMPOSITION
- THESE FORESTS ARE UNDER COMMERCIAL EXPLOITATION
- RECENT DEVELOPMENTS HAVE ALLOWED SETTLEMENT AND PERMANENT AGRICULTURE IN MOST PRODUCTIVE AREAS AFTER CLEAR FELLING
- SINCE THESE FORESTS ARE IMPORTANT FOR THEIR SPECIES DIVERSITY & MAINTAINING ISLAND ENVIRONMENT; IT IS NECESSARY TO MONITOR CHANGES OCCURING DUE TO COMMERCIAL EXPLOITATION

APPROACH:

- FOREST TYPE MAPS FROM AERIAL PHOTOGRAPHS OF 1968 & LANDSAT TM (FCC) IMAGE OF 1986 HAS BEEN PREPARED ON 1:50,000
- FOREST TYPE MAPS OF 1968 & 1986 WERE COMPARED FOR CHANGE DETECTION
- FOREST SPECIES COMPOSITION HAS BEEN STUDIED THROUGH GROUND CHECKING

STUDY AREA:

- BARATANG FOREST DIVISION IS ARCHAEPOLAGO OF ISLANDS IN ANDMAN GROUP WITH UNIQUE EXAMPLE HOW ANTHROPOLOGICAL CHANGES HAVE SET IN RETROGRESSIVE PROCESSES IN FORESTS

- FUTILE ATTEMPT TO RAISE TEAK PLANTATION AFTER CLEAR FELLING

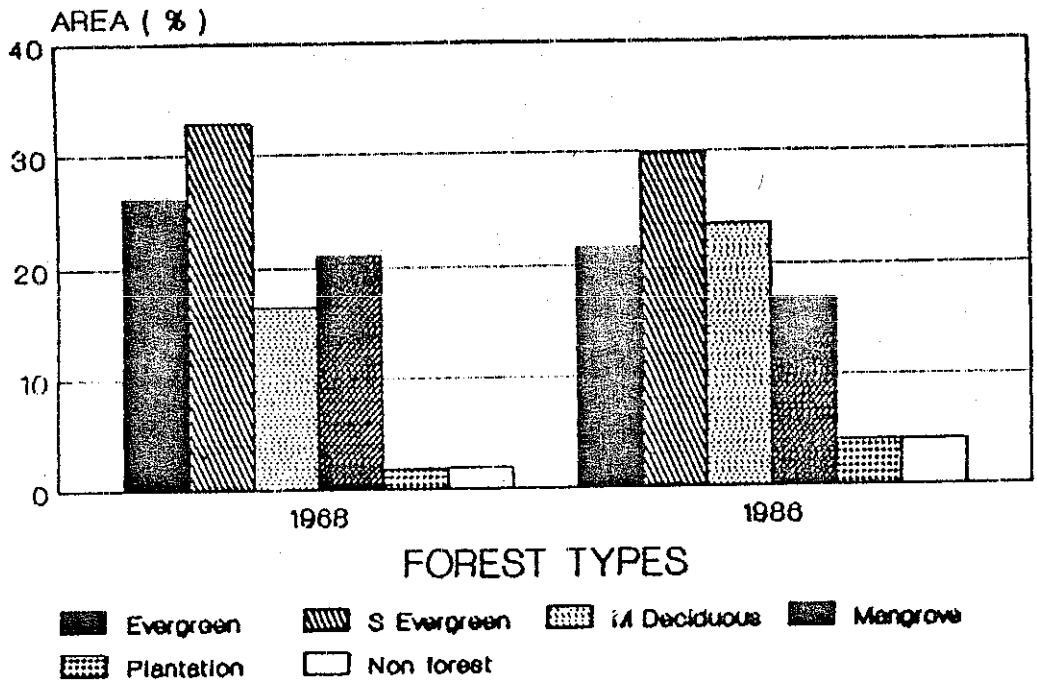
RESULTS

- OUT OF TOTAL AREA, 15.6 % HAS CHANGED TO OTHER VEGETATION TYPES (MOSTLY SECONDARY FORMATION) DUE TO COMMERCIAL EXPLOITATION
- ABOUT 2.11 % OF NATURAL FOREST AREA HAS BEEN CLEARED PLANTATION OF TEAK & 1 % OF FOREST AREA HAS BEEN DIVERTED TO AGRICULTURAL LANDUSE
- 4 % OF MANGROVE FOREST HAS BEEN LOST OR DEGRADED

- WHILE EVERGREEN & SEMIEVERGREEN FORESTS HAVE BEEN REDUCED BY 5% & 3 % RESPECTIVELY
- MOIST DECIDUOUS FORESTS (SECONDARY) HAVE INCREASED BY 4 %
- CHANGES ARE RETROGRESSIVE

BAR DIAGRAM SHOWING AREA UNDER FOREST TYPES DURING 1968 AND 1986

BARATANG FOREST DIVISION



PROSPECTS :

- MONITORING OF VEGETATION TYPE ARE IMPORTANT TO BRING BACK FOREST MANAGEMENT ACTION TO CORRECT RETROGRESSIVE PROCESSES

FORESTRY ON LNVIRONMENT PERSPECTIVE OF A FORESTER

A.N.YELLAPPA REDDY.IFS *

INTRODUCTION

In the year 1908 Dr.Theadore Roosevelt in the conference on the Conservation of Natural Resources said "We have become rich through lavish use of natural resources, and we have just reason to be proud of our growth. But the time has come to inquire seriously what will happen when our forests and other natural resources are exhausted when the soil has been impoverished and washed into the streams, polluting the rivers, denuding the field".

Despite of such warnings the destruction of the world's forests and other basic resources is accelerated. At the current rate of destruction much of our tropical forests, the most biological diverse areas of earth and sources of numerous medicines will vanish within 25 years i.e., over a million species may disappear from this planet. In addition to the above the soil erosion is sapping not just agricultural production,but a livelihoods of millions is being effected.

For the first time in the history we realised we are altering the atmosphere itself, destroying the ozone layer that protect us from ultra-violet radiation and raise the level of "green house gases" that are warming the earth.

Indiscriminate use of fertilisers, herbicides, pesticides, were destroying marine and fresh water life.

The motor vehicle exhaust, industrial pollution all along the watersheds are joining fresh water rivers, ponds, water eusterine and seas.

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* Conservator of Forests, Western Ghat Forestry & Environment Project.

The tropical forests were mysterious challenge in 1890, today the challange is saving them from dis-appearance. In 1890 automobiles invented and Aeroplanes were un-known, could our ancestors conceived every urban city in the world today is having millions of vehicles, the exhaust of smog reaching the atmosphere and becoming murkey and pioson and raising the level of "green house gases" that are warming the earth.

Even though, we are in the golden age of science with one technological revolution following another, the life of this planet is threatened. Many so called great technology achievements are found to be at the cross roads causing inclauculable, irreversible, un-manageable disruptions in the earth physical condition and altering the atmosphere and climate itself.

Efforts around the world would have shown the soil erosion and desertification can be arrested when the proper effort is made. Tropical forests do not have to be cleared for agriculture, there are many innovative methods of cultivation in forested areas. Grazing can be practiced in sustainable ways. The major systems all over the world today are affected by acid rains, deforestation, shrinking of wet lands, air pollution, destruction of resources, land degradation, climatic changes, change in water cycle are the systems causing concerned to every one. The responsibility of saving life squarely with us.

We are now at the dawn of another biological revolution. The deeper understanding of the molecular make up of cell makes it possible to manipulate the gene of plant organisms,each should have an enormous impact on agriculture, forestry, horticulture and human health. Genetic engineering should be steered towards increasing productivity nutrition and resistance to diseases etc.

Some how we seems to be blinded by the positive side of technology and ignored the dark side, probably it was not felt at that time. For example when automobile was hailed as a remedy for city pollution by horse manure during 1890. Now we decry the car's contribution to the acid rains, blood lead contents and carbon di-oxide build up.

Air conditioning what luxury? Spray Cans, what convenience: Then we learned that a chlorofluro-carbons used in both help destroy the stratospheric ozone that protect us from cancer causing ultra violet radiations. Of course, we have not felt when they were only a few automobiles and fewer refrigerators. Their destructive impact as come with the surge in their popularity in the world bulging population and consequently in their increased use. Today we are drowning in our own garbage.

As a Forester I would like to confine to 3 vital areas which are diretly related to forest; a) Climate b) Land and c) Water.

CLIMATE:

The threat of climate change stems from the increasing concentration of Carbon-di-oxide and their "green house gases" that hold heat in the lower atmosphere, allowing temparature to raise. The burning of coal and other Carbon based fuels such as oil and natural gas released carbon as the basic products of the combustion, while the large scale clearing of tropical forests adds additional carbon-di-oxide to the atmosphere.

Over the past 15 years the rate of accumulation of the Carbon-di-oxide in the atmosphere has been about 15 parts per million (PPM) per annum. During the last 2 years this rate is increased to 2.5 PPM per annum.

The burning of fossil fuel alone will result in the release of about 20 billion tonnes of carbon-di-oxide to the atmosphere annually.

Deforestation contributes to increase carbon-di-oxide in the atmosphere both due to decrease of carbon fixation and increase of carbon-di-oxide emission. A minimum of 4 lakh sq.k.ms. of new forest will be needed to absorb one gigation of carbon-di-oxide per year. Only vigorous efforts to protect remaining forest and to plant billions of trees each year can reverse the dangerous trend to global warming.

We are experiencing "green house gases" effect even at local levels. Main effects are:

(1) Warmer atmosphere hold more moisture

(2) Higher evoparative rate

(3) Changing circulation pattern

(4) Reduction in soil moisture, available for plant growth

(5) Droughts may occur more frequently

(6) Average production and reliable food out put decline until irrigation pattern and cropping systems are developed.

(7) Bringing in serious changes in the earth physical conditions

(8) Albido effect (share of sunlight reflected back from the earth)

a) Removal of vegetation in dry regions could cause rainfall to diminish because of increase in the Albido (T.G.Charney's Technology Meterologist, Massachussetts Institute)

b) Since subsiding air is dry, rainfall would decline.

(9) Effect of rainfall change in Evapotranspiration.

a) To occur Evopo-transpiration the soil must be sufficiently moist and vegetation must be present to bring that moisture into contact with the air.

b) Evapotranspiration is an important source of atmospheric water vapour in a given scale rainfall level could decline if it diminishes.

c) Diminishing the vegetative cover for evapotranspiration was linked to climatic change.

(10) 70 years Rainfall data of Karnataka State reveals drought was more persistant in Northern parts of Karnataka State where the albido and evapotranspiration would be greatest.

(11) Albido, soil moisture, carbon-di-oxide concentration affect atmospheric circulation, which has direct influence on rainfall, and rainfall distribution.

(12) Danger lies in the acceleration of climate change that appears imminent. Between 2030 and 2050, average temperatures could be 1.5 - 4.5° c, higher than they have been in recent decades or warmer than the earth has been for the past 2 million years. This implies a warming that is 5 to 10 times as fast as that experienced during the past century.

Global average temparatures, 1880-1987, with projections to 2040.

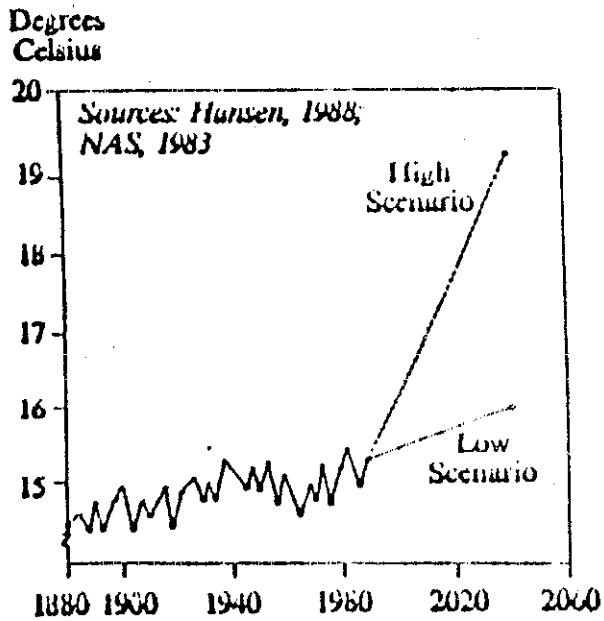

Figure 1-2. Observed Global Average Temperatures, 1880-1987, With Projections to 2040

OZONE:

Scientist found ozone decreased from 2.3% to 6.2%. If emissions of ozone depleting chemicals is not stopped, increase skin cancer, crop losses and damage to marine ecosystems is unavoidable.

LAND DETERIORATION AND ITS IMPACT ON ENVIRONMENT:

Structurally unstable systems which deteriorates in a series of irreversible steps linked with occurence of droughts.

Droughts and degradation rainforce each other by preventing land from recovering from stress.

Whereas a healthy land will bounce back to its former productivity after a drought, whereas a degraded and abused land will not.

In our country over 80 million ha. land degraded mainly due to abuse. Another 40 to 50 million ha. are under great stress soon it may reach terminal stage.

LAND UNSTABILITY:

i) Soil erosion is sapping not just agricultural production but livelihoods of millions of people in our country, and the extinction of plant and animal species is rapidly increasing.

Once the topsoil washes out, the surface is disrupted and cracked and rills lead to gullies. In denuded slopes erosion rate is around 65-75 tons.per ha.per year.

Ganga and Brahmaputra alone transports 3 billion tons of sediment to the Bay of Bengal each year, highest in any other river systems of the world.

ii) Agriculture is becoming more and more capital intensive an becoming unsustainable.

One third of the world's food is grown on the 18% of the crop land that is irrigated. Irrigated fields yield 2 to 3 times than those watered only by rain, poor irrigation practices have degraded much of this valuable crop land especially in our country. Nearly half of the irrigated area in our country has become a wet desert.

In dry region salinisation accompanies water logging as moisture evaporates leaving behind a layer of salt that is toxic to plants. UNEP's assessment placed the irrigated area damaged by salinisation at 40 m. ha. About half of it is in India and Pakistan i.e., 20 m.ha. More area is threatened due to abuse.

iii) The major cause of degradation and deforestation are soil erosion and reduces soil and water absorbing and water retaining capacity.

iv) There is an urgent need to stop land deterioration before it becomes unmanageable, before it leads to economic decline and social disruption.

v) Habitats rich in bio-diversity such as tropical forests, wet lands, mountain ecosystem and coastal ecosystems is subjected to destruction.

Tropical rain forest occupied 12% of the earth surface dwindled to half, but they hold 40% of all known species a greater range of animal and plants. Projected loss of 50,000 species of plants would form the ability to achieve continuous advance in biological productivity.

vi) It is difficult to characterise the structure and functioning of any ecosystem, but it is particularly difficult with highly complex tropical forests, coastal marshes, mangroves and esturies where land and sea meets. These adjacent ecosystems draw sustenance from one another through their complex linkages.

vii) In tropical countries have nearly 3000 million ha. of natural vegetation, on an average over 11.3 million ha. of natural vegetation is depleted every year.

viii) Western Ghats are the richest habitats in our country having high species diversity and multiple endemic, which hold over 600 bird species out of which 120 are endemic. It hold over 2000 plant species, 180 orchids, 50 wild palms, rare primates, reptiles etc, yet Western Ghat is the most endangered habitat today, many ecologically unfriendly developmental activities have been taken up in and around Western Ghats.

ix) Droughts has become an annual feature in our country, nearly 40 to 50% of the area experience inadequate and unseasonal rains and drought in an immutable reality today, despite of myriad of developmental programmes.

Food producing land is being sapped insidiously of its productive potential through over use, lack of care and unwise treatment.

Each year, irreversible desertification claims an estimated 6 million ha. in the world, our country adds 1/10th of it.

Over 20 million ha. annually become so impoverished that they are unprofitable to farm and graze, here India contributes nearly 1/10th of it.

x) Although technologies to restore, resilence and fertility to stressed lands exists so far the political will does not.

WATER MANAGEMENT AND HYDROLOGICAL CYCLE.

I. Annually renewable water resource of our country.	350 million ha.metre(mhm)
Water which reaches sea through rivers.	160 mhm.
Water impounded in reservoirs (investment Rs. 30,000 Crores)	17 mhm
Water held in the land mass as soil moisture.	128 mhm
Water held as ground water	45 mhm

Infiltration of water to the soil can be increased considerably by raising vegetation on denuded slopes and by building suitable engineering works as bunds, gullies etc.

If all the lands prone to erosion protected nearly 35 mhm of usable water in the form of soil moisture and underground water could be utilised.

In Karnataka over 2.5 lakhs borewells were dug by farmers investing over 25,000 crores. Underground water is receding due to loss of recharging mechanism in the catchment.

In Karnataka over 26,000 small and medium size tanks water storing capacity has reduced to one fourth due to siltation.

Catchment of almost all the tanks denuded due to reckless destruction of vegetation, faulty agricultural practices, coupled with over grazing.

II. In 1988 September, two thirds of Bangladesh was under water, a direct result of heavy mansoon rains, and due to disruption of hydrological cycle in the Himalayan watershed because of progressive deforestation in recent decades. 25 million of the Bangladesh's 110 million people become homeless.

All over India many developmental activities threatening to disrupt the powerful hydrological cycle.

III. Droughts are the bane of a farmer's existence, without sufficient water agricultural land will bear only a meagre harvest at best no matter how deep and fertile the top soil, how high yielding the variety of seed and how well-tended the farmers field.

IV. Research in the Amazon basin suggests that land degradation can alter the hydrological cycle in humid regions at greater scale.

In humid zone, if area is under good vegetation that stream carry 25% of rain fall, while transpiration by tree cover returns to the atmosphere nearly 50% and evoporation the remaining 25%. Thus, fully 3/4th of the rain water falling in the locality returns to the atmosphere.

South-west and North-East monsoon provides about half the water vapour leading to rainfall. Evapotranspiration from forest itself supplies other half. Thus, water recycling

plays a crucial role in sustaining rainfall levels.

Development without destruction:

The experts are of the opinion, that soil erosion and desertification can be prevented when proper re-afforestation efforts are made. Only thing required is innovative methods of soil and moisture conservation and planting of suitable species to ameliorate the deteriorating environment.

Immediate steps to be taken to stabilise population and consumption levels are brought into balance with environmental capacities, failing which it will be difficult to promote development without destruction.

A small biota plays disproportionately important role in the ecological processes that maintain life on earth, they are called ecological key species (Ex.Mangroves in Marine ecosystem, leguminous species in tropical and monsoon forests)

People normally use few species only which has become a part of their culture, called socio-economic key species (Herbal plants, nonwood resource yielding species i.e., fruits nuts, oils, perfumes, flavours, essences etc)

In re-afforestation programme species schedule has to be carefully prepared to meet fuel, fodder and other socio-economic key species and also ecological key species has to be integrated carefully in the package of enrichment planting and ecorestoration efforts.

i) we are not afford to loose any more time in preventing soil erosion and upgrading the degraded soils: ii) important area conservation and sustainable management of water resources. iii) preserving biological wealth to fulfil all the above three needs.

Future strategy

The major issues confronting us today is mass poverty and environmental degradation.

What we need today a long range ecological security. To achieve ecological security a serious appraisal of the priorities persuing the developmental activities which are impairing the ecosystem and destruction of resources needs immediate attention.

The future development pattern has to be sustainable, environmentally harmonious and ecologically efficient. Development should be based on the concept of carrying capacity of the earth.

There is a need to shift from emphasising the growth GNP to the creation of jobs. Forestry activities and forest product based home and cottage industries has ample scope in providing jobs and growth of GNP (Gross Natural Products).

There is a need of decoupling the energy consumption and economic growth.

There is a need for a shift from reliance on depletable nonrenewable fossil fuels to an energy sources which are renewable.

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The most reliable guess of scientists is that the universe, as we know it today, began as a great explosion of truly cosmic proportions about 25 billion years ago. Before this explosion, all matter of the universe is believed to have existed as a highly condensed "cosmic egg". This explosion, some what moderately termed the "big bang" is expected to have sent the matter in the "cosmic egg" flying out into the universe to form countless numbers of stars. Many such groups of stars constitute a galaxy and galaxies are known to be clustered into groups. Our own so-called cluster of galaxies called the "local group" consists of some 24 galaxies one of which is the Milky way. The milky way itself consists of over a hundred billion stars one of which deserves special attention - this is what we call the Sun. The sun, being one of these billions of stars, has 9 planets revolving around it. The third such planet, counted by distance from the sun is the earth, an approximately spherical body with a diameter of 12,754 kms and a surface area of over 510 million sq. kms. As far as we know our earth is the only planet among the many hundreds of billions that must be around, to possess that remarkable entity called Life.

The earth was born about 4.6 billion years ago and by complex chemical reactions, a primitive form of life is thought to have originated on earth about 3.6 billion years ago. The living entities, being capable of dividing and changing, set off a chain of events we now refer to as biological evolution. For nearly 3 out of these 3.6 billion years, life remained as microscopic blobs of protoplasm in the ocean. But about 600

million years ago living organisms became larger and more diverse and came to possess hard skeletal structures that leave behind impressions on rocks. These so-called fossils permit us a glimpse of the drama of life played on earth during the past 600 million years or so.

The major scenes in this drama were the evolution of plants and animals that could live on land instead of water about 400 million years ago, the arrival of insects and reptiles about 300 million years ago, of birds and mammals about 200 million years ago and flowering plants about 150 million years ago (Figure 1). This gradual and relatively smooth evolution of progressively more complex forms of life received a major jolt about 2 million years ago with the origin of a rather special lineage of primates referred to as the genus *Homo.* About 40,000 years ago a single species of this line called *Homo sapiens* had arrived on earth with all the qualities of modern man as we know him today. Perhaps the most distinctive qualities of *Homo sapiens* were their intelligence and their ability to manipulate their environment. These qualities permitted *Homo sapiens* to gain unprecedented mastery over their environment. The most important element of their mastery was the ability to control and manipulate other forms of life. Quite naturally *Homo sapiens* perfected the art of cultivating species of plants and animals that were useful to them - agriculture and animal husbandry are modern terms that describe these arts. Never before had one form of life gained such mastery over its physical and biological environments. Not only did *Homo sapiens* control other forms of life but it also

manipulated its physical environment to such an extent that for the first time a species of living organism cut loose from the constraints of biological evolution and produced five billion individuals. The same qualities of *Homo sapiens* that permitted space exploration and a visit to the moon also permit us to reflect on our past, present and future. This ability to reflect is perhaps our greatest saviour. The euphoria associated with mastery of the universe, with the ability to increase our own life expectancy, to genetically engineer other forms of life, to sequence the human genome, to contemplate setting up colonies of human beings on other planets, unfortunately led us to neglect the state of our own planet - a state caused by our own activities.

In the last 25 years or so however, there has been a rather sudden realization that we have damaged our planet beyond recognition and perhaps beyond repair. We have destroyed its life-support systems that had evolved before us over billions of years. We have burnt fossil fuels and cut down forests on such a large scale that the temperature of the earth has increased perceptibly. The planet earth cannot support our efforts to grow food, provide shelter, not to speak of consumer goods, to a human population that is growing in numbers and in its demands at the present rate. This chilling realization has perhaps begun to dawn on a reasonable number of us today. An even more chilling realization is however on its way. Not many of us realize that we are destroying, perhaps by the dozens every day, our fellow living creatures that have evolved like us over billions of

years. Man's activity on earth is rendering extinct these magnificent forms of life at a rate never before seen. This wealth of life is known by the term that has recently become fashionable - biodiversity. Biodiversity is on its way to becoming a house-hold word and has already entered the vocabulary of our politicians and administrators. But few of us realize that even scientists know very little about this biodiversity that we would now like to save.

What is this biodiversity after all. We do know a few things about biodiversity. We know that biodiversity is spectacular. The earth abounds in myriad forms of living organisms. Today it is customary to recognize five kingdoms of living organisms : (1) Protista (that consists of bacteria and blue-green algae), (2) Monera (that consists of advanced algae), (3) Fungi, (4) Plants and (5) Animals. Living organisms are found almost every where - the deep sea, the polar caps, the hot springs, not to mention the tropical rain forests. They range in size from viruses which may be not more than a millionth of a meter in size to the African elephant that weighs 6.5 tones and stands over three meters tall, the blue whale which may be over 30 meters long or the red wood tree that is over as 100 meters tall. They may swim in water, fly in the air, crawl on land or burrow under the soil. They may reproduce once every 20 minutes as some bacteria are capable of doing or once in 20 years as some mammals do. One especially surprising fact about biodiversity is its apparent "lopsidedness". An overwhelming proportion of the animal biomass in tropical forests is contributed by insects

(Figure 2) and among the insects by social insects such as ants and termites (Figure 3). In a Brazilian tropical forest for example, it has been estimated that the biomass of ants is approximately 4 times that of all vertebrates (i.e., amphibians, reptiles, birds and mammals) put together. Few of us realize the "insignificant" role of higher animals such as vertebrates compared to ants and other insects in tropical forest ecosystems.

All this is fine but pray - how many kinds of living organism are there on earth? Unfortunately that's asking too much. Seems a bit embarrassing does it not - we know about distant galaxies and have a reasonable guess of the number of stars in the universe but cannot ever guess the number of species on earth - our own fellow creatures with whom we share our entire past? Even ignoring the fact that many species are going extinct every day, it is not an easy task to record, describe or even count the number of species. Life forms are so diverse that many years of specialized training is required to be able to recognize and describe them. Even such training will render one literate only in the realm of one small group of living organisms. Small numbers of scientists, often unheard and unsung have been painstakingly naming and describing living organisms for about 200 years. Indian taxonomists have so far named and described some eighty three thousand species (Figure 4), while taxonomists the world over have described about 1.8 million species (Figure 5). From these numbers the total number of species of living organisms was being estimated, until recently, at about 5-10 million. Then came a major jolt.

Scientists from the Smithsonian Institution, especially T.L.Erwin realized that most insects studied so far were from the forest floor. The forest canopy was essentially unexplored. This last biotic frontier, the tropical forest canopy has now been carefully explored by using a new and more powerful method. This involves killing all insects and other forms of life inhabiting selected trees by covering the trees with a fog of insecticide. To everyone's surprise hundreds of species of insects entirely new to science were discovered on the canopies of just a few trees in Panama. Such richness and newness of tropical forest canopy arthropod fauna has been confirmed by other scientists such as Nigel Stork of the British Museum of Natural History using similar methods in Borneo. All this suggests the possibility that the number of species of insects on earth is really much larger than supposed earlier. One estimate puts the expected number at 30 million for arthropods alone (Table 1). Thus our estimate of the number of species of living organisms on earth varies from 5 million to over 30 million - not a very precise estimate indeed.

Conserving biodiversity is perhaps our most challenging task ahead. As Harvard University biologist Edward O. Wilson has said, "The worst thing that can happen - will happen - is not energy depletion, economic collapse, limited nuclear war, or conquest by a totalitarian government. As terrible as these catastrophes would be for us, they can be repaired within a few generations. The one process ongoing, that will take millions of years to correct is the loss of species diversity by the

destruction of natural habitats. This is the folly our descendants are least likely to forgive us." But we can hardly expect the political will, the hard work and the social participation needed to conserve biodiversity if there doesn't exist even a reasonable catalogue of biodiversity, let alone documented uses of different species. But estimating biodiversity is perhaps an even greater challenge. It will required millions of man days of painstaking work by highly trained biologists. More difficult, it will require foresight and imagination on the part of science administrators and the realization that this is a worthwhile exercise, deserving of all our support, financial and otherwise.

Clearly we need an urgent debate among scientists as well as policy makers about the significance of the findings that insects constitute such an overwhelming proportion of animal biomass and animal species and even more about the possibility that the total number of species of life forms may be of the order of 30 million. How should educated, informed citizens of the world respond to these rather shocking findings? Should we readjust our priorities. Is there any point at all in taxonomists continuing to describe new species at the slow present rate? Should we forget about 30 million arthropod species and let them go extinct. Or should we catalogue, describe and try to conserve as many of them as possible. What are the investments in time, effort and money that will be needed. How can we compute costs and benefits of our decisions in these matters? At the very least we need an informed debate.

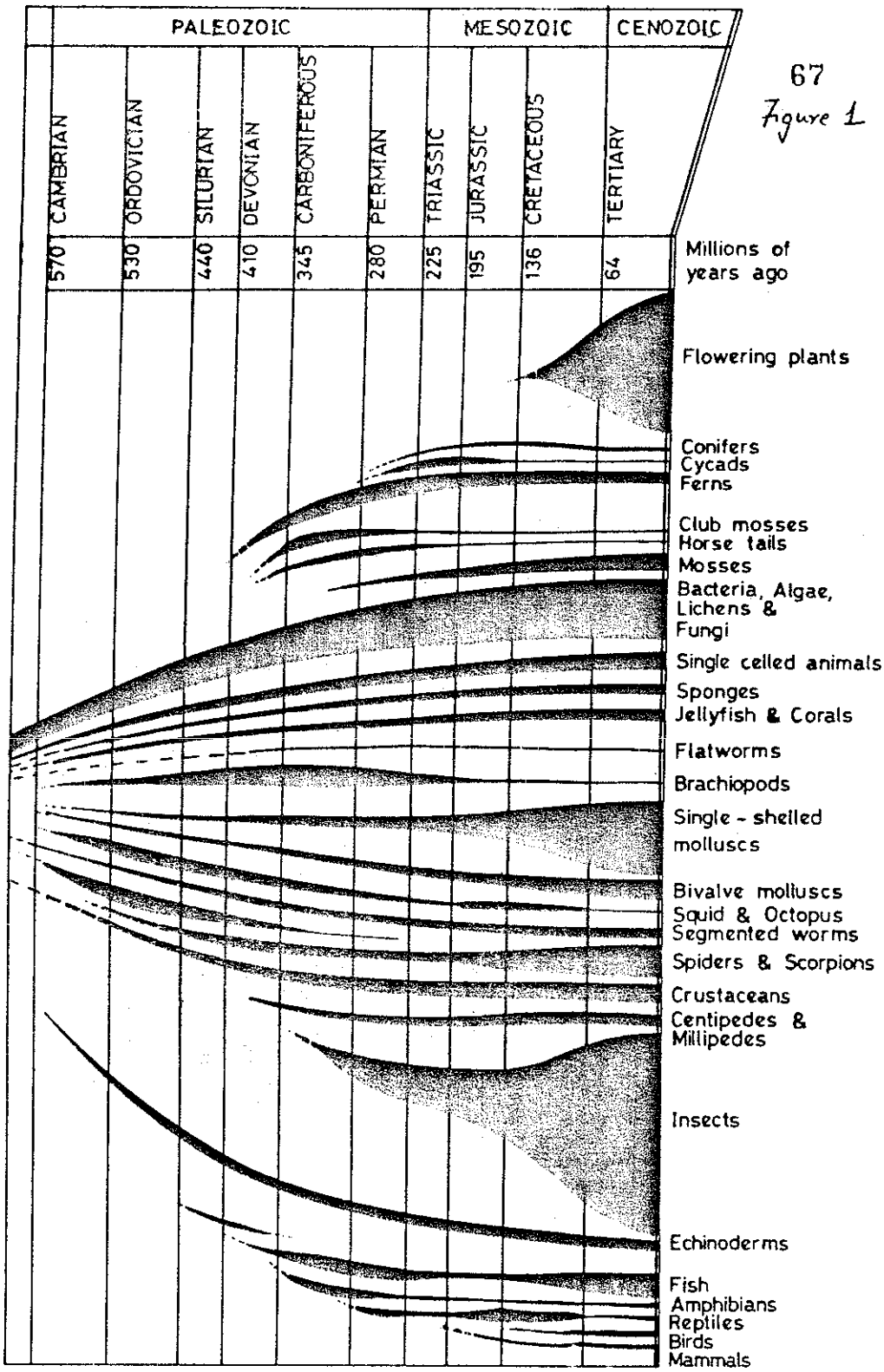
TABLE 1

ARTHROPOD SPECIES DIVERSITY – THE LOGIC OF THE 30 MILLION ESTIMATE

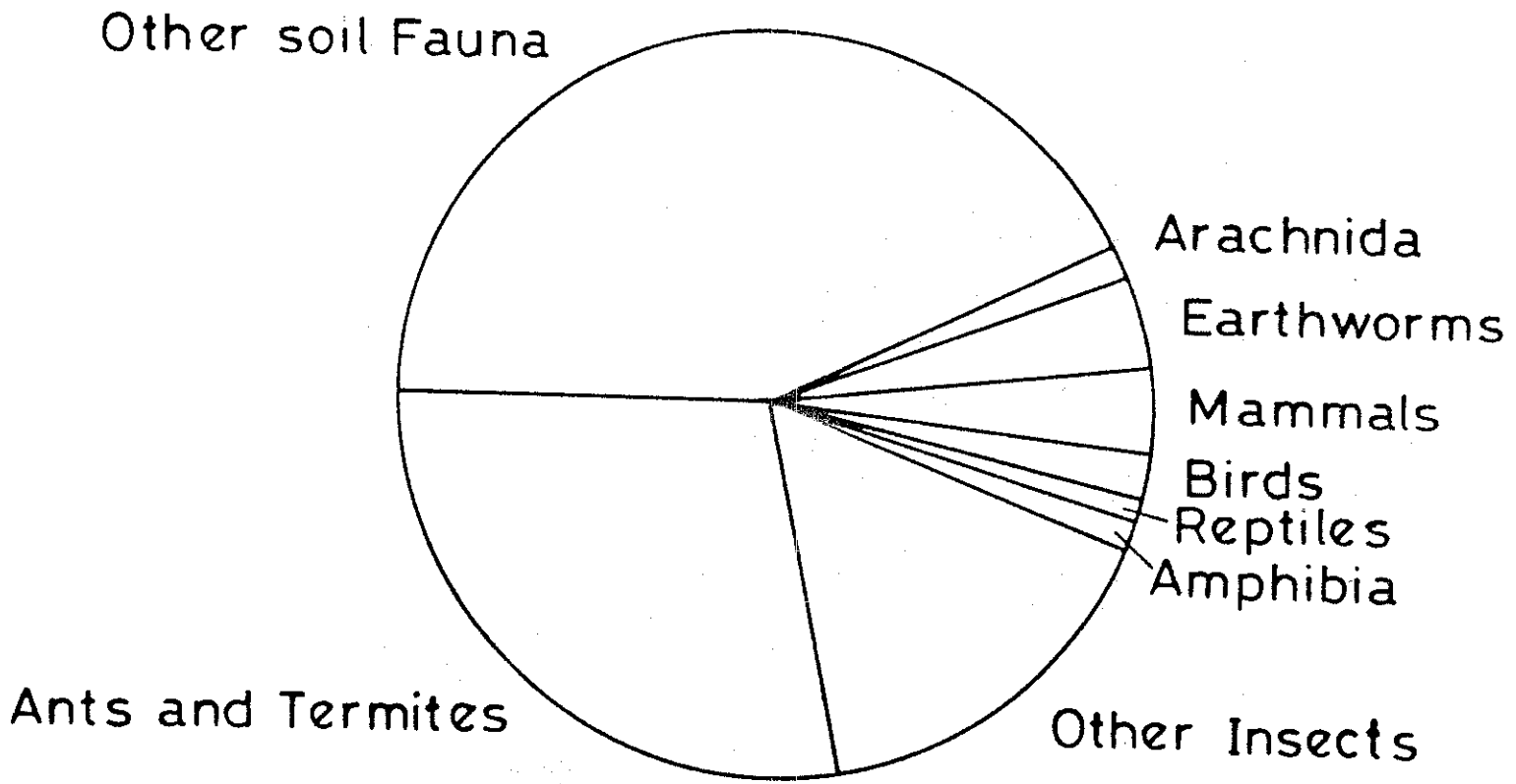
1. Number of beetle species fogged from 19 *L.seemannii* trees.....	1,200
2. Average host-specificity for beetles is 13.5% - therefore number of beetle species host-specific to *L.seemannii*.....	163
3. Number of tropical tree species is about 50,000 - therefore number of beetle species host-specific to these.....	8,150,000
4. Beetles represent 40% of canopy arthropod species, therefore number of species of tropical canopy arthropods.....	20,000,000
5. Canopy is twice as rich as the ground in species of arthropods, therefore total number of tropical rain forest arthropods..	30,000,000

[Modified from Stork (1988), Data from Erwin (1982)]

Figure 1


PALEOZOIC
MESOZOIC
CENOZOIC
CAMBRIAN
ORDOVICIAN
SILURIAN
DEVONIAN
CARBONIFEROUS
PERMIAN
TRIASSIC
JURASSIC
CRETACEOUS
TERTIARY
570
530
440
410
345
280
225
195
136
64
Millions of years ago
Flowering plants
Conifers
Cycads
Ferns
Club mosses
Horse tails
Mosses
Bacteria, Algae, Lichens & Fungi
Single celled animals
Sponges
Jellyfish & Corals
Flatworms
Brachiopods
Single - shelled molluscs
Bivalve molluscs
Squid & Octopus
Segmented worms
Spiders & Scorpions
Crustaceans
Centipedes & Millipedes
Insects
Echinoderms
Fish
Amphibians
Reptiles
Birds
Mammals

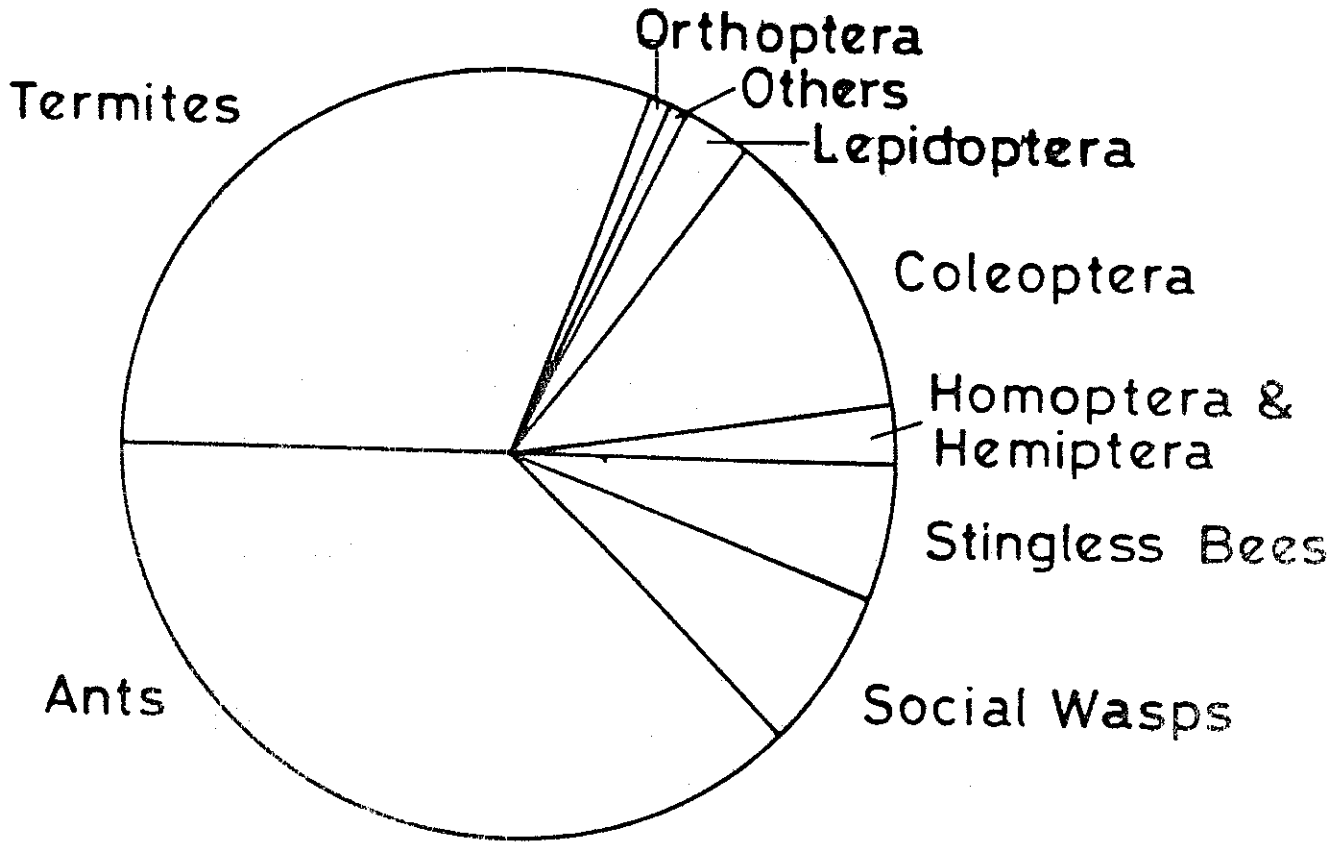
Total Animal Biomass



(Data from Fittkau and Klinge 1973)

Figure 2

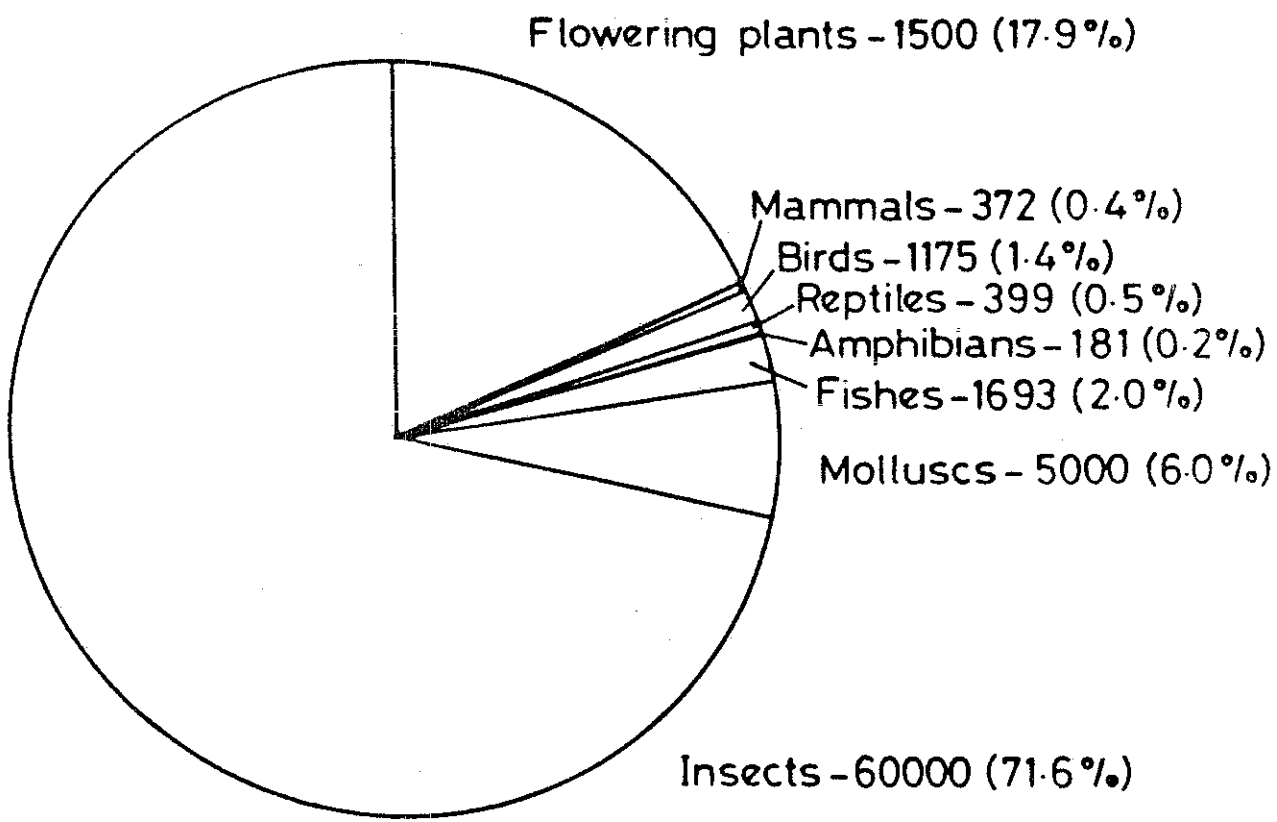
Insect Biomass



(Data from Fittkau and Klinge 1973)

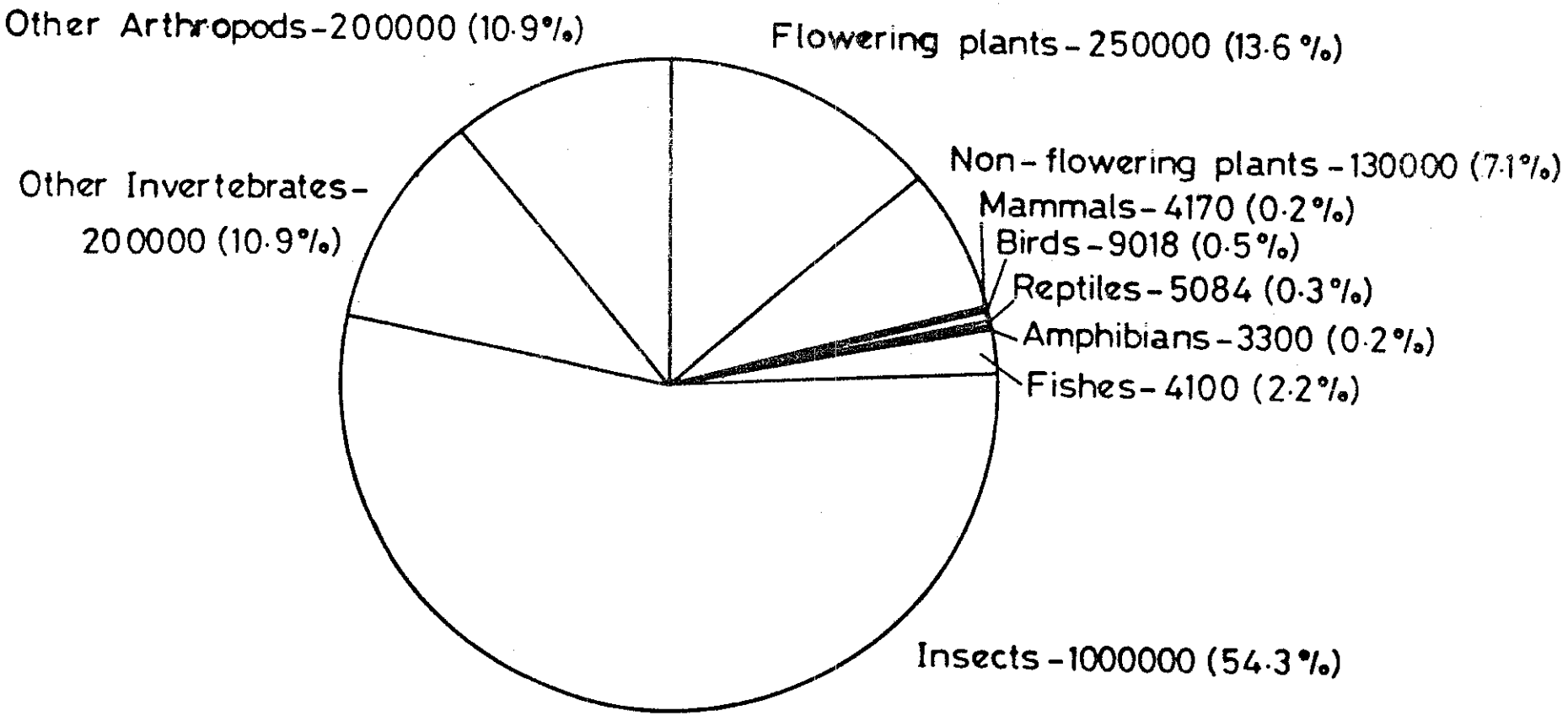
Figure 3
69

Described Indian Species



Data from Jairajpuri (1991) and N.C. Nair & P. Danial (1986)

Described World Species



Data supplied by Marc Collins

ENERGY, ENVIRONMENT AND DEVELOPMENT: DESIRABLE SCENARIOS

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DEVELOPMENT :

It is assumed that the main objective of a state is to develop or reduce underdevelopment. A state can play a lead role in development or a catalytic role. Many developing countries have a strong machinery for development. They go through a planning process to identify projects, a project planning step to detail the various subcomponents, a monitoring agency to monitor financial and physical progress, implementation agencies to execute the subcomponents of a project, an operational agency to maintain a project after completion and to handle financial and other aspects of operation, a feedback mechanism to find out whether desired objectives are achieved or not.

Such a major development program involves several actors - planners in a planning commission or board assisted by social scientists, engineers and economists, bureaucrats handling the financial and administrative machineries, engineers looking after implementation, agricultural scientists, financial and administrators operating the projects grass roots level social scientists perceiving the process od development on the target community and statisticians designing and working on feedbacks.

With several links it becomes clear that this kind of planning mechanism has several drawbacks :

(i) Linkages between policies and implementations are poor. Hence we may have a very good policy, but due to various factors like poor understanding and perceptions, leakages in the system, physical realities, poor control mechanisms, diluted feedbacks, the policy may not be implemented or may lead to wrong/opposite results.

(ii) Even when it is possible to implement a policy directly (like a power project), the plan depends on both financial and time estimates. In many cases both these estimates are wrong and this reduces benefits considerably.

(iii) Leakages are quite high. Due to many layers of administration, operational expenses also increase at a very high rate, thereby further reducing the benefits.

(iv) Since centalised planning operates on a very large scale (a country), its database is a highly aggregated one. Hence project selection become difficult. Several alternatives for a particular activity are not considered. Best example of this is

power projects. Intially, the desired power requirement is identified. This is followed by identification of a number of projects. A single index of benefit/cost ratio is used for selection. Since many projects are not considered and also many alternatives for a project are not looked at, the persons preparing feasibility reports try to play with numbers until they reach a desired benefit/cost ratio. Many aspects like acceptability, suitability, environmental damages are not looked at all. This results in an oversimplification leading to an erroneous situation.

(v) The entire process of development can be seen as an iron rectangle consisting of bureaucrats, scientists and engineers, politicians and industrialists and rich farmers. This iron rectangle ignores other realities - poor people.

Now we may ask, what is the yardstick for development ?

Normally, a simple measure is chosen. One of the measures is GDP (gross domestic product) or national income. Another is the per capita consumption of certain essential items - like fertilizer, steel, energy etc.

The common perceptions of a palnner are :

(i) Industrialisation leads to a progress. So it is desirable to set up industries. Because of economy of scale, the bigger the industry the better.

This resulted in urbanisation, discrimination based on skills and migration. Secondly, industrial pollution became an important issue. Thirdly, indiscriminate use of resources led to deforestation, and depletion of natural resources.

(ii) Agriculture needs irrigation. Hence go in for major irrigation projects. This needs more steel, cement. Further to justify the cost and increase benefits, change cultivation pattern to sugarcane and paddy. This means sugar for rich people and water logging and salanity. Create a workforce of engineers to maintain the dams and canals and another of accountants and tax collectors. Submerged area may be mostly forests and so this leads to deforestation. Further, due to soil erosion, the life of the dam comes down. The whole ecology changes.

(iii) Increased yield in agriculture means fertilizer. So, set up fertilizer plants, marketing agencies and advertising firms. This results in more energy requirements and increased use of fertilizers and pesticides leads is towards chemical pollution - contamination of water bodies and other surrounding environment, loss of soil quality.

The higher cost of fertilizer can be reached only by a rich farmer. He gets more yield and become richer. Poor farmers will enjoy the degraded environment.

(iv) The need for fertilizer, steel, cement, implements etc. results in further industrialisation and consequently the other side effects of pollution, depletion and urbanization.

(v) Since industries and agriculture need energy, we have to develop energy resources. Massive coal mines, and petroleum wells become necessary. Electricity, a secondary energy source, is an important energy source. Electricity can be generated by hydroelectric stations which convert potential energy of water or thermal power plants which use coal,oil or natural gas or nuclear stations. The high quality electricity is used for low quality work like heating water to $45^{\emptyset}$ c for bathing purposes in urban house holds. Generation of electricity by hydroelectric plants is normally done in hilly, forested areas. The reservoirs required to store water so as to generate energy throughout the year will be submerge forest areas and displays people-mostly tribals-living in that area. Large scale thermal plants will leabd to pollution and depletion of resources. Nuclear power station has its own story to tell.

Energy planning again is one sided-based on consumption only. We go on adding more and more plants, not bothering about the efficiency of usage.

(vi) As the capital costs of these industries, power plants and fertilizer units are high. It is desirable to introduce subsidies. We hear about subsidies for sugar, cement, electricity, firewood etc. This helps the rich people again. Industrial subsidies take the form of tax rebates, again benefitting industrialists. Subsidice result in inefficiency of use of raw materials thereby leading to wastage and greater rate of depletion of resources. This is opposite to conservation.

The subsidies also depress the market price of agricultural produce (which have no commercial value addition). Since many landless labourers and small farmers get wages in kind, their real wage earning is low. This increases their poverty level.

(vii) The setting up of industries need sophisticated machines and inturn this means demand on foreign exchange to import technology or machinery. In order to earn foreign exchange, several techniques are resorted to (a) sell your agricultural produce at an incredibly low price ; (b) sell natural mineral resources-like iron ore, copper ore, manganese, mica ore etc. (c) subsidize products heavily.

These again have similar side effects

Let us now look at the effects of such development. Some of the features are :

(i) It has generated consumerism for rich and middle classes and bypaseed poor people's requirements.

(ii) It has introduced additional components like transportation requiring more materials and energy and also foreign exchange.

(iii) It has allowed cities to grow at a rapid pace. This led to large scale migrations, development of slums, large demand on energy and water (water being brought from long distances by pipes and pumps by large pumps), and pollutions.

(iv) The demands on energy and natural resources have led to a large scale depletion of resources and forests. Bangalore city in sixtees, was getting its firewood from the neighbourhood. But the same city in eightees, got its firewood from places quite far off-even as distant as 600 Kms. Transport requirements grew exponentially. Hence, the stress on our environment is so high that we may see in a very short time the disappearance of forests and mineral and energy resources.

(v) Due to over crowding and pollution from industrial, agricultural and municapal wastes, the general hygine level went down-resulting in serious health problems. Waterborne diseases like typohid,cholera,enteric diseases,ect. Have their annual occurrences in many places in epidemic forms.

(vi) Emphasis on large industries meant reduced employment and increased skills requirement.

(vii) Despite several years of planning,the basic needs of food,shelter,clothing and health are yet to be met for a vast percentage of population.

Primarily our development is technology driven and consumer driven.Technology is physics and chemistry based.

We need to look at development from the other angle.

Development means meeting the basic needs of most (all) people.

Some of the desirable criterie are:

(i) The goal should be to look at the food , shelter, clothing, health and energy needs of a majority of the people; people oriented, nonconsumerist approach is needed.

(ii) Development should be sustainable hence it should be conservation based leading to minimal use of resources. Emphasis should be on reducing wastage, increasing efficiency of devices and use of good instrumentation and control strategies. Examples are drip irrigation, Astra ole, simple building materials etc.

(iii) It should be biology based. Bio pesticides, biological production of energy and other products should be encouraged.

(iv) It should be waste reduction oriented leading to minimum wastes in any process.

(v) It should start from the lower level encouraging traditional concepts of living through synergic living with environment, use of local resources, enrichment of local environment, increases in employment and development of small industries based on local resources and skills producing a balanced healthy development throughout a country.

(vi) Development should drive technology and not the otherway about. We should select technologies based on the requirements of people, and environment emphasis being on conservation, employment and cleanliness.

Similarly if there are several paths, we should choose a path based on the above and not on costs. Water economy will lead to better distribution of water amongst farmers and to increased production of dryocrops like maize, corn, ragi etc. (the food of poor people) as shown by the water panchayat system in Maharashtra compared to the major dams for irrigation which resulted in the production of sugarcane, and paddy leading to salinity and water-logging.

Since energy plays a vital role in development and energy consumption leads to the depletion of forest resources, we are looking at the energy requirements and ways and means of meeting them.

Environment and impact of Energy on it

By environment, we refer to the resources that are available to us in nature. Some of these resources like minerals are available in a stored form and we cannot increase their quantities. Some others grow very slowly. Soil is treated as belonging to this category. Some other resources are produced and used resulting in a balance. Water, carbondioxide etc. belong to this category. A proper usage is necessary; otherwise the balance will be tilted. Another type of resources were growing in the early days and are slowly getting destroyed now. Biological resources belong to this category. Many years ago, people were talking about million species. The rate of destruction today of these is alarming. The only store house and generating station for biological resources seems to be the forests.

In addition, forests provide us with many things we need, we get wood for fuel, furniture and timber; Forests give us resins, fodder for animals, medicines, fruits. Forests also control the flow of rain water-store the water, allow it to flow as streams, control floods. Soil erosion is prevented by forests. Further, the carbondioxide balance is maintained by the biological resources.

Forests are used by man for various purposes. He wants to settle, needs land for houses, offices, factories etc. Forests provide raw-materials for house building, fuel wood, and paper and pulp industries. Because of the various demands, we are loosing forest areas and also the quality of forests is dwindling.

India lost 401400 hectares of forests for river valley projects during 1951 and 1973. In the same period, 2,432,500 hectares were lost for agriculture; 54700 ha for roads, 124500 for industries and 387900 ha for miscelllaneous purposes. Grazing in forests is another menace that reduced the regenaration of species thereby reducing the quality. During 1973-74, it was found that 26.115 million cattle, 9.892 million buffaloes , 11.208 million sheep, 4.74 million goats, 0.121 million camels and 2.291 million other animals were grazing in the forests in India. It was also found that the number of animals grazing in the forests increased by 50% between 1956 and 1972 while the increase in actual population was 18%.

Another demand on forests is the tea, coffee, rubber and other plantations. In 1977, coffee plantations occupied 188000 ha and rubber occupied 233000 ha, the land displaced normally comes from forests.

Paper industry is a major user of forests. Initially, (in 1965), bamboo constituted 70% of the raw-materials for paper industry. But the non availability of bamboo has led to the increased use of hardwood by this industry. Wood required by paper industry is 5.8 million tons in 1985-86 and is expected ti increase to 51.017 million tons by 2000.

Dr. M. Adiseshiah states "Probably the most severe loos in the land resource environment resulting from development over 6 plan periods is in the forest area". The seventh plan refers to 23% of the area, that is 70mha, under forest cover. The target set is 33% 100 mha to be achieved. Even the figure of 70 mha is not accurate as shown by the remote sensing studies of NRSA. NRSA observes that area under more than 10% tree cover decreased from 55.18 mha in 1972-75 to 46.08 mha in 1980-82; forest area with a density of 30% decreased from 46.4 mha to 36.02 mha whereas the poor forest area increased from 8.75 mha to 10 mha. This means an annual loss of 1.5 mha of good forests. The replant rate is 0.12 mha and hence the net loss is 1.3 mha of forests per year.

Hence it is desirable to look at this problem. A serious threat to forests comes from the energy sector. Since most households use firewood as a major source of energy and the requirement /person is 0.5 tons per year, the total needs of India is around 350 million tons. It is estimated that about 30% of this is coming from forests. This means that 105 Hm tons are extracted every year from forests. This is a major threat. We also need fuelwood for many other activities like brick-kilns,

tile manufacturing, tobacco curinbg, silk filatures, jaggery making, agricultural processing, bakeries and many other industries. Secondly land is lost for reservoirs, colonies, transmission lines and roads required by electrical utilities to generate hydro power and transmit it to far away loadcentres - large cities.

Let us now look at energy consumption patterns essentially from the point of view of villages and find out ways of meeting these from various renewable energy sources and energy conservation techniques. These are described in latter sections followed by case studies on energy consumptions in industries in Karnataka aimed at showing the possibility of energy savings.

II. Energy Consumption in Villages

In a given energy system, we can think of several options for conservation.

a. the simplest is a direct conversion of energy source into usable form for end use activity like solar drying for grains. But it is not always possible or feasible to adopt this option for all end use tasks because of limitations of availability of source or technology of conservation or matching of need with resource quantitatively, spatially or time-wise. A major usage falling in this category is cooking with firewood in a stove.

b. more than one conversion plus storage and transportation.

c. conservation to intermediate/secondary forms plus conversions for end use acitivities. Example is energy - electrical energy.

d. Transport of source to various usage points and conversion or conversions ; (coal, firewood)

e. Transport, conversion to intermediate forms (like electricity, gas hydrogen etc.), transmission, distribution and conversions. This is a centralised generating method (whereas (d) is a localised method of generation).

Since national planning or developmental efforts primarily aim at defining the quanta of various commodities at several levels, the planning of an energy system implies working backward with the help of consumption/utilisation studies at the micro level - (villages).

We should also include human and animal energy sources into the model specially to include the effect of employment potential.

Let us now discuss energy utilisation in rural areas based on detailed surveys in six villages (Kunigal Taluk, Karnataka

State); a sector based energy source activity matirx has been developed and results are discussed further.

Characteristics of Villages :

The clusters of six villages chosen are in Kunigal Taluk and the extension centre of ASTRA is situated in Ungra - one of the six villages chosen for study. Population of these villages range from 357 to 981 - typical of many village in India. Table 1 illustrates educational status and number of households in these six villages. One of the prominent features is the high degree of illiteracy varying from 44.8% to 74.2%.

The population of these villages consists predominantly of the vokkaliga (agriucltural) caste. Table 2 shows the land distribution - a skewed one ; most of the population fall into small farmers categories (less than 5 acres) and large farmers (forming less than 10% of total households) having more than 50% of the cultivated land. Rice and ragi are the two main cereals eaten by people. Less than 10% o the households (52) buy sugar.

Energy Sources:

Animate sources of energy consist of men, women, children (human) and bullocks. The inanimate sources consists of firewood, husk, vegetable wastes, coconut shells, kerosene, electricity, coal and diesel (for tractor).

These sources are used for various end uses - functions, like cooking, fetching water, gathering firewood, grazing, lighting, industry etc. Table 3 gives the interlinkages between sources and functions. For example, human energy is used for fetching water, grazing, cooking, gathering firewood and industry. Some of the important observations are :

(i) Human Energy : Most of the human energy is used for domestic purposes (about 82% goes to domestic activities in Pura). Table 4 illustrates the various components of human energy sources for different functions in the six villages.

(ii) Bullocks : Most of the bullock energy goes to agriculture- except for 3040 bullock hours/year being used for industry.

(iii) Firewood : This forms the predominent source of fuel energy used in the villages. For example, Pura village uses 96% of firewood for cooking and water heating, the remaining 4% going to industry. The firewood consumption is about 217 tons/year for Purs and about 2140 tons/year for these six villages - leading to a per capita consumption of about 0.6 tons/annum.

(iv) Husk, Vegetable Wastes : These are mainly used for heating water and industries. Their use for domestic purposes vary from 1/6th to 1/20th of the weight of firewood consumed. Only one industry in a village uses husk.

(v) Kerosene: In Pura, 156 litres/year of kerosene is used for an industry and 1938 litres/year for lighting, 93% of the consumption goes for lighting. Even though Pura uses no kerosene for cooking, about 712 litres/year of kerosene is used in three villages for cooking. The use of kerosene by industries is marginal compared to electricity, firewood, coal, husk and wastes. About 5700 Kg of coal is used/year in industries. Kerosene consumption/household/month is about 2.9 litres resulting in a cost of Rs.10 whereas a better quality electricity for lighting will lead to a monthly cost of Rs. 2.50/- only.

(vi) Electricity : In Pura, 13 out of 56 households are electrified, the annual consumption for lighting being 3078 units (28% of total consumption). Only 97 out of a total of 560 houses have been electrified. Industry in Pura uses 720 units/year (7%). Total industrial consumption in all these villages is 6428 units/year.

In addition, tractors are used to a small extent-consuming 10 litres of diesel in a year for non-agricultural purposes, this being 20% of the total diesel used by tractors.

Let us know look at the energy consumption patterns from the end use angle.

End use Activities :

As already stated, major functions are domestic-fetching of water, grazing, cooking, gathering firewood, heating water, lighting, industry and other non-agricultural uses - in addition to agricultural activities.

Energy for Domestic Activities :

Major quanta of energy for domestic functions come from human sources and firewood. Various aspects of these functions are described below :

(i) Grazing :
Livestock grazing seems to occupy a considerable part of human energy sources (about 40-45% of total human hours used for domestic purposes goes to grazing). A major component for this is provided by children.

(ii) Firewood gathering :
About 80% of firewood used is gathered from waste lands. Table 5 gives the number of families dependent on this mode of firewood collection. Table 6 quantifies the distribution of firewood collecting methods. Whereas, purchased firewood belongs to the roots and logs classes. Gathered firewood is only twigs and small branches. In addition, children and women hours contribute to more than 60% of the human hours used in gathering firewood.

To gather the 1.74 tons/yea in Pura, the firewood gathering families spend 4.3 human hours day/family, the average gathering involving a distance of 4.5 - 6.6 Kms/day and collection of 5-10 kgs/day/family (Table 7).

(iii) Cooking :

Cooking is done mostly by women-an average of 3-4 hours/day/family.

Firewood accounts as a fuel in most of the houses. A few houses use kerosene for cooking. Vegetables wastes and husk are also used for heating water and cooking.

(iv) Fetching Water :

Normally one has to walk a distance of about 5-1.6 kms to fetch water. Mostly two trips are made in a day. The time taken per day is around 1.5 hours.

Lighting :

As seen earlier, most of the people use kerosene lamps and only about 17% of houses have electricity. Table 8 gives the information. Total electricity consumed by these 97 houses in the six villages is 24,371 units per annum. Even though electricity is cheaper than kerosene for lighting and provides better quality of light, it is not available to a majority of households due to expensive capital requirements.

Transport :

Bullock cart is used to transport manure and agricultural produce.

Industry :

There is a small percentage of energy flowing into industries like flour mill, pottery, carpentry, etc. The human hours employed is very small.

Energy Source - Activity Matrix for Pura

Table 9 gives a total picture of energy source and activity in a matrix form. To understand the inter linkages between sources and tasks, the various consumption figures have been converted into common standard energy unit - kilo calories. Table 10 is got from Table 9.

In order to compare various energy sources and activities, we convert the energy matrix into a percent form resulting in Table 11. To know the ordering of energy sources and activities, Table 12 and 13 have been generated. Table 12 orders sources on the basis of percentage of energy generated and Table 13 sorts out

activities based on their percentage energy requirements. In brief, we can see that

(i) Firewood is the major source of energy for villagers, 82.5% of energy comes from firewood. Out of this, a major portion goes towards the cooking needs of villagers (78.4%) - used mostly in a very inefficient manner. Efficiencies range from 2-8% for the energy conversion devices - open/closed type choolas-employed, the poorest using lower efficiency decices.

(ii) Domestic activities take a lion's share of total energy used - 87.93%. Most of this go towards cooking. Hence looking from the point of view of the major sources used and major end use, we see that cooking is the most important acitivity and significant changes in resources is possible by attacking this problem. A sizeable reduction of energy resources for cooking, is warranted beacuase of (a) Inefficient utilization, (b) depletion of natural resources like firewood and environmental imbalances, (c) inefficient/ineffective utilization of human energy (for firewood gathering, distances are increasing with depletion of nearby sources).

(iii) Even though agriculture is a predominant employment activity, it consumes lesser percent of energy than industry. The only other significant activity is lighting.

(iv) Next to firewood, human energy is the major source accounting for 7.59% of total generated energy. Vegetable wastes, bullocks and kerosene account for 3.92%, 2.94% and 2.14% respectively of energy. Other sources are not used significantly.

(v) Husk usage is negligible and cow dung is not used as dung cakes.

Efficient Options for Cooking :

Since cooking is the most predominant consumer of energy in rural sector, it is desirable to consider this activity and other options available to improve efficiency and reduce energy consumption.

Some of the basic Characteristics of cooking are :

(i) It is highly decentralised activity (with no possibilities of centralisation)

(ii) Normally, the activity is performed for 4-7 hours in a day divided into 2-4 times per day.

(iii) This activity is constrained by the time requirements of other activities like agriculture, industry, cattle grazing, firewood gathering, etc. Hence the duration and

actual period of cooking in a day are fixed according to these constraints.

(iv) Time sharing of cooking with other activities might result in a slower pace (speed of cooking, interrupted form of cooking etc.)

(v) Devices used are choolas predominantly and kerosene stoves in some cases.

(vi) Cooking and water heating activities use 8546.9 million kilocalories or 15.3 million kcals/household; Approximately 4.18 tons/family/year of fuels are used for these activities. If we assume that production of biomass from trees is about 5 tons/year, each family absorbs nearly biomass growth in one hectare of trees.

Optimal energy scenario for rural areas :

If we assume that rural domestic energy requirements are the same as it is today for cooking and lighting needs for each family, then we can use mathematical models to optimize this energy requirements. The optimization may

(i) minimize the total cost of energy or

(ii) maximize the total efficiency of use or

(iii) minimize use of nonlocal resources.

Several studies were done for a typical village with the following characteristics :

Number of households	: 150
Cattle population	: 350
Firewood potential	: 550 Kg/day
Agrowastes available	: 200 Kg/day
Average biogas potential	: 91.5 cum/day

Daily energy requirements were computed as :

Cooking	= 213750 Kcals
Lighting	= 2065 Kcals

Energy paths considered were :

Cooking : firewood and stove ; agrowastes and stove; biogas and burner; kerosene and stove ; solar cooker

and lighting : kerosene and wick lamp; biogas and mantle lamp; electricity and bulb; biogas-dual fuel engine-electricity bulb.

We know the potential of energy sources available in the village, requirements for enduses and energy conversion paths and their characteristics. We have to match the sources to enduses. This was done by an optimization model. The results obtained are summarised below :

(i) If the wood stove used for cooking is the traditional one with a low (10-15%) efficiency, then biogas is the best choice for cooking. This leads to a saving of 400 tons of firewood/year otherwise consumed for cooking. Also an additional saving of 100,000 hours spent by people to gather and branches results.

(ii) When ASTRA Ole is used, then firewood is best suited for cooking. The consumption of firewood is reduced to 50 tons/year which can be obtained from a 50 hectare woodlot in the village with species having a moderate annual yield

of 5 tons/ha. The woodlot management needs a strong social participation by the village. The village should identify a person to maintain (protect) the woodlot, check the firewood gathering activity, maintain a nursery and take up the watering of plants.

The present lighting option is very poor - based on kerosene. Electricity provides a better option. With subsidies, electric bulb bacomes the best option for lighting. If internal efficiencies and subsidies are taken into account, then biogas mantle lamp is ideal for lighting.

(iii) The energy bill/day for the village is Rs.270/- now. The best options of electricity for lighting and firewood for cooking via ASTRA Ole leads to a cost of Rs.52.14/- only. This means a savings of 75% of energy costs. The option of biogas for lighting and firewood for cooking gives us a cost/day for the village of Rs. 80.85/-. There is an additional benefit of employment. The decentralised energy system will lead to the employment of 2-3 persons per year.

III. Energy Sources :

Initially man used energy sources that were available nearby. Hence wood became an old energy source used for water heating, cooking and smithy applications. Discovery of coal and oil led to their becoming important fuels. This was followed by electricity. Electricity is essentially a secondary soure, because we derive it from primary sources that are naturally available. Solar energy can be used to meet many end use requirements.

Since most of the energy we get is from sun, the sources are either directly or indirectly derived from sun. Such sources are known as renewable energy sources. Examples are direct solar

energy, hydel sources, wind, etc. Some forms of energy sources are due to slow energy accumulation to generate fuels over a very long period of time. These sources, once used get depleted and cannot be easily regenerated and hence are known as depletable or non renewable resources. Examples are coal, oil etc. Biomass is an indirect form obtained from sun. If our use of biomass/year is equal to regeneration, it becomes renewable source, else it is depletable. Present usage of biomass, mainly in the form of firewood, leads to depletion and hence it can be construed as a depleted one.

There are also indirect forms of energy obtained from various activities that are going on, (wrongly called wastes). For example, we can get biogas from animal, human and factory wastes. We can get lignin from paper factory wastes. We can also use agricultural residues like straws, husks, shells etc. for energy purposes. Rice husk, rice straws, stalks from ragi, coconut shells, groundnut shells, coconut leaves, etc are some examples. Since we are producing food every year to feed our population, since the production will be increasing every year and since the residues form a sizable form of the plant, it is appropriate to consider them as source of renewable energy.

Some energy sources like coal, oil, electricity are priced and available in the market and hence are known as commercial energy sources. Some others like agrowastes, firewood, cowdung etc. are privately obtained through various means (like gathering, got from one s own fields etc.). These are known as non commercial energy sources. In our countries with dominant rural economics, noncommercial energy sources play a dominant role. An underestimation reveals that the percentage on noncommercial sources is more than 50% for a country and the percentage for villages is nearer about 90%.

Eventhough non-commercial energy plays a vital role, our entire planning, design and implementation activities revolve around commercial sources. We have electricity utilities, coal agencies, oil corporations etc. and also distribution centres; planning and budgeting focuses only on these resources. Recently, noncommercial energy has come to the attention of the planners - but in a very small way only. There is no integrated approach to plan the utilisation of noncommercial resources.

Any energy plan should take ino accout various factors like

(i) preferred form of energy converters
(ii) major end use of energy like cooking
(iii) preferred use of renewable energy
(iv) avoidance of (or minimization of) use of depletable sources
(v) maximization of efficiency of energy use.

Since renewable energy sources are very important from the point of view of sustained development, let us look at some of these sources.

Hydel Energy

In hilly terrains, wherever water falls down a height, there is a potential for hydro energy. This has been tapped in the early days to run water wheels to run grinders and later on to run turbines to produce electric power. Since large water drops and dence forests go together, many hydroelectric projects are constructed in such places far away from consumption centres. Because of abundance of rain-fall, the Western Ghats has a number of rivers with good potential for electrical power. Starting with Shivanasamudram in 1900, many of them have been tapped. For example Sharavathy, Moyar, Pykara, Idukki, Kali, Koyana etc., are some of the power stations in the Western Ghats region.

Power consumption is almost evenly balanced throughout the year - as more than 70% of electrical energy is consumed by industres; but water availability is many of these rivers is restricted to the duration of monsoons - about three months say. So in order to generate energy evenly, water is stored in reservoirs. This resulted in the submergence of large areas - of prime forests. The philosophy in the design of such projects seems to be to use every cc of water and every centimeter of head. The consequences to forest areas are not considered in the design. These days, one sees design of dams with carry over capacities. Such designs ignore the following factors : (i) forests provide certain life structure. They have a value beyond the commercial value; (ii) Even the commercial value is replaced by a nominal value; (iii) The biomass in that area can produce firewood which is also energy. Hence the total energy should be the net energy (energy from water - energy from annual growth of firewood in the area under submergence). When this was considered, it was found that in Bedthi project, the existing design yielded less energy from water than can be got from firewood. (iv) Effect of silting is not considered. (v) Resettlement costs are not taken into account properly. (vi) Need for a minimum, contiguous forest area for biological diversity, for better ecology, and for water and soil conservation is not taken into account.

From the above, it can be seen and shown that for minimum damage to ecology and social structure, it is desirable to go in for some peaking plants with minimum storage and a large number of micro/mini hydro electric plants. With new technologies, micro hydel plants operate at higher efficiency with minimum maintenance. Becuase of the higher costs of construction of dams and their support structures, and the need and cost for long distance transmission lines, micro hydel plants are becoming economical.

Microhydel plants can also provide electricity to the neighbourhood, thereby providing a much needed dispersal in electricity usage.

Biogas can be obtained from cattle waste, sewerage, organic wastes (like leaves, fruit and vegetable wastes) water hyacinth, industrial wastes (like cotton willow dust, spent wash in distillaries etc); The potential for biogas is great - about 240 billion units (thermal) per year - nearly three times the lectric energy produce/year. Also biogas units give us two important advantages - (i) we get more manure (three times nitrogen is got as compared to open composting); (ii) the surrounding are clean, so health and hygine improves. In the case of industrial wastes, bio-degradation takes places.

Biogas, a by product from these digestion plants, can be used for cooking, lighting, lifting water, running tractors etc. It will be a substitute for firewood, diesel and kerosene. Hence these plants are being popularized in our country. The following problems exist in biogas usage.

(i) At present, many tested designs - like KVIC, UAS, etc., are being popularized. The existing designs still have many problems - flooding, economics, nongeneration of gas in winter. Hence many new designs are being investigated. The adike Belagarara Sangha, Sagar is popularizing a model. This model uses less cement; By using simple feed back concepts, it is possible to get gas in winter. Digging of a trench around the plant has reduced flooding of the plant in monsoon. Pressure of gas is increased by keeping outlet point for sludge at a higher position than usual.

ASTRA, IISc has come up with an optimized design of KVIC model and this has been experimented for over one year. Incorporation of a solar water heater on the top and charging dung with hot water obtained from the water heater has increased yield by more than 50 percent.

Some of the problem are :

(i) a good design using simple materials with minimum trouble shooting is needed.

(ii) Research is yet to be done to get maximum carbon from wastes so that yield is quite high. At present only some forms of cellulose are decomposed; other carbon components are not changed and thereby they go with the sludge.

(iii) Existing designs are good for cowdung and sewerage. Lot of work is still to be taken up for digestion of other wastes like water hyacinths, vegetable and agro wastes and industrial wastes.

(iv) Eventhough biogas plants are put up in many places, there is no follow up activity - both to understand its soical effects and to provide maintenance. There is a claim that putting up a large number of biogas plants will deprive poor people who do not own cattle from collecting cowdung available in village common

grazing areas. Similarly, many people do not use gas for cooking due to religious convictions. These social aspects need a study.

A brief survey of biogas plants in Karnataka undertaken several years back showed that repair and maintenance of biogas plants is a serious problem. Many plants were lying unrepaired for want of skilled persons. Skill generation and training of local artisians for maintenance will have to be taken up along side popularization of these plants. popularization of these plants.

(v) Community biogas plants have many social problems and many of them are failing due to non-availability of dung, non-cooperation etc. One of the main reasons of failure is the fact that the gas is used for cooking. People have firewood for cooking at zero or marginal costs. Hence there is no strong motivation to cooperate. (Benefits, if any, - like ease of cooking, reduced cooking time, no smoke etc., - go to womenfolk). Instead of other end uses like lighting, lifting water are chosen, there may be greater chances of success. Also, it is not necessary to have a plant for the entire village. One can experiment with a plant for a group of houses in the same social level. Another problem is that of operation and maintenance. Hence, it is desirable to study the many large plants already put up and ascertain reasohs for failure as weel as social implications.

Instead of trying traditional uses, one can think of other uses also. For example, Gowlis in U.K. Dist., have a large cattle population, and have enough dung. If their cattle are stall fed, the dung is put through a biogas plant, the sludge is used for fodder production, the gas is used for pumping water and for chilling milk and for producing milk products, then their life style will improve, they won't graze forest areas and the neighbourhood will improve ecologically. They may not migrate from place to place also.

Other Renewable forms - Solar and Wind

These sources - solar and wind - are mainly used as a subsititute for firewood and electricity and to that extent, they reduce the degradation of forests. Estimates of wind potential in karnataka is around 40 billion units. Wind is a good candidate for pumping water. The major problem with wind mills seems to be their costs. At the present market situations, wind energy seems to be expensive.

Solar energy has been used from very early days - both directly and indirectly. Here we consider the direct use. Simple devices in urban areas to provide hot water for industries, hotels, canteens etc., can reduce consumption of electricity, firewood, kerosene and furnace oil. The hot water system installed in the silk filatures factory at Kanakapura, Bangalore District will replace the boiler. Similarly, there is a strong potential to use solar hot water system in hotels,

canteens, dairy, textiles industries, etc. All such uses will indirectly benefit environment.

Agrowastes are also being used as fuel. They have many competing uses - as a fodder, to fertilize soil and as a fuel. The present day use of agrowastes as a fuel (energy equivalent of 200 billion units/year)is very inefficient. It is desirable to develop technologically simple, easy to use, less expensive, high efficiency and easy to maintain conversion devices. Large scale units might divert agrowastes from a waste to a marketable commodity with a price. This, according to some, will deprive poor people of their fuel. Indepth analysis of such problems and linkages is necessary. Because such a statement is not true of all agrowastes. It has been found that many agrowastes like rice husk, arecanut husk and shell, sugarcane bagasse, etc., are not used by poor people. Hence, it is desirable to find out efficient methods of using such non-competitive agrowastes.

Similarly, industrial wastes especially from paper industries contain a large amount of lignin. It is possible to use them as a fuel thereby saving firewood and reducing pollution of water sources.

Biomass

Biomass is a generic name to include various types of plant mass that grow on earth-both land and sea. Table 16 illustrates the various sources of biomass. Some of the sources like forestry are grown naturally; some like social forestry, agricultural crops are cultivated by man; some like agrowastes are byproducts of our activities; some others like weeds grow on their own. These weeds, once considered a problem, are now grown and cultivated by man. The annual growths of biomass are very large.

One of the basic problems connected with biomass is the selection of proper uses. There are many contention uses for biomass. Table 17 lists various uses of biomass; the important being food for man, fodder for animals, fertilizer, fibres and fuel. The main uses of agrowastes in India are (a) fodder for animal, (b) nutrient to the soil; (c) fuel and (d) industrial products like particle boards, papers etc. Another smaller use is as building materials - specially for roofs. The majority of uses of agrowastes have been as fodder and fuel. Hence it is imperative that emphasis on one use should not reduce the availability of the raw material for another use. In a poor country like India with a vast cattle population, fodder is an important problem. Today, some of the agrowastes have been diverted for production of paper and boards and poor people are deprived of their fodder.

This does not mean there is no agrowaste available for energy production. There is still a large quantity of biomass - non edible and edible - available for energy generation.

In India we use most of our biomass - natural and wastes-. but the biomass is used for energy in an inefficient manner. Efficiencies of combustion are in the range of 10-15%. So by improving these efficiencies, we can either reduce consumption of biomass (and thereby increase the biomass going for fodder or soil nutrition) or use the remaining part of biomass for new activities.

Table 18 shows the various possibilities of use for the biomass fuels. The diffused nature of availability of biomass in various parts of our country makes it possible to build localised energy centres which will supply energy to many local small industries. Table 3 contains many decentralised uses like jaggery making, bricks manufacture, village hotels, etc.

The advantages of using biomass for energy are given in table 19. The problems are also listed. The technologies are commercially available, financially viable and environmentally sound. The energy centres will be spatially distributed.

Because of the many advantages, many countries not only find ways and means of using these wastes, but also go ahead for intensive cultivation of some of the plants, weeds and algae - as a viable alternative to conventional energy generation methods.

The problems are not serious or insurmountable. They can be solved and a balanced land use pattern can be achieved.

Potential of Biomass

The calculated potential of biomass is very revealing. For agrowastes, we know the residue factors and crops production. With these, we can claculate the availability of agrowastes every year. Table 20 gives the residue factors for some important crops.

The available potential of biomass is ten times the current annual energy use. This shows that biomass is a prime candidate renewable resource for energy production. Economically and technologically also, biomass is very competitive. Developing countries get 50% or more of their energy from biomass. Even developed countries are increasing their dependence on biomass. Other advantages are improvement to our environment, renewable nature of this fuel and increased production with increased population.

Table 21 shows the energy calculations from fossil fuels and biomass and table 22 gives the annual world production of biomass. Karnataka's agowastes potential is given in table 20. The total energy available is 46 billion units/year. This is nearly five times the current electrical energy production in the state and nearly double the total energy consumed in 1979. The total commercial and noncommercial energy consumption in the state of Karnataka is equal to 27 billion units. The agrowastes used for energy was only 2.536 million tons of coal equivalent.

table 23 gives the maximum potential available nearly 111.589 billion units (thermal) based on 1979 production figures.

Table 24A gives a partial picture of use of biomass for energy in some countries. We can see that gasohol, energy plantations, biogas, and hydrocarbons from plants have become important alternative for energy generation.

Energy conversion from biomass

There are many different ways and routes of using biomass for energy. The oldest and simplest is the direct use - burning in stoves or furnaces. Many agrowastes have been used at very low efficiencies because of their nature and characteristics as well as devices used for combustion.

To improve the efficiency and the quality of fuel, other indirect methods were invented - like densification, pyrolysis, fermentation, anerobic digestion etc. Similarly improved - high efficient - devices like stoves, ASTRA OLE, boilers for hot water have been developed. The ASTRA OLE can reduce and has reduced consumption of biomass by half.

Various energy conversion routes are given in table 9. Wood chips and other processed biomass can be fed into a wood has generator which produces woodgas. The quality of fuel has been increased considerably in many cases that it can become a substitute for oil or coal or coke. Similarly, we can produce electricity through various routes and the electricity can be used for lighting, water lifting, running motors in rice mills etc.

IV Energy Conservation

So far we looked at the resources;since energy consumption is met by these resources by various routes and device,it is possible to improve efficiency of conservation routes and device thereby reducing requirements for energy.This means that we can meet the needs for development-industries or irrigation or institutions-with lesser quanta of resources.This aspect of energy conservation does not directly affect the ecology af Western Ghats,but it has an indirect effect.Energy-particularly electrical energy-planner always claim that "Energy aids in development-bread forstarving millions"-and on that basis,they seek funds for additional projects-like Silent Valley,Bedthiand Gangavalli etc.
This startegy of building more and more projects to meet growing demands on energy is not the only solution.Is this true? If we look,particularly,at electrical energy,we come to know that the amount of used energy is very much less than 10 percent. Out of 100 percent energy available in coal,say,the following energy reductions occur:

	Perecent	Perecent
Transporting of coal	10 remainder	=90
Power station efficiency	30	=27
Transmission and distribution losses	30	=18.9

Device efficiencies vary from 5 percent-60 percent.Only electrical motors have a high efficiency.If we assume an average efficiency of 25 percent,than the usuable amount is given by 0.25x18.9=4.725.Hence about 95 percent of energy goes as waste to atmosphere.

The above does not include wastage of energy in the process,in the management etc.(common example to illustrate the point are a stove burning withiout any cooking done on it,an over designed large furance being used to heat small items in a foundry etc.)Through energy audit and process redesign,it is possible to reduce these wastages also.

Hence it can clearly be seen that new generating plants are not the only solutions to produce additional energy.Energy conservation is the answer.This is illustrated by a few examples below:(By energy consrevation we mean that for a given process and for a given production,energy used is reduced).

(i) Irrigation pump sets are one of the important consumers of energy. The total load in this category is 16490 MW,number of consumers is 4.233 million and consumption is 3420 units/consumer. Inspite of this being a major load,no efforts are being done to improve energy efficiency.Formers use normally very high capacity pumps. Studies reveal that most formers buy pumps with capacities 10 hp or more. They operate these pumps at less than half its rated capacity. This reduces efficiency. Secondaly,quality control in motors and pumps is not very good. Slight changes in the dimensions of air gap and in the casting of pumps reduce efficiency further.Thirdly low power factors and low load densities increases losses.Studies reveal that efficiencies vary from 15-40 percent and power factors from 0.3-0.8.There is high a probability to improve this situation and save energy.An interesting example of management-which should be encouraged-is community pump sets.A few persons buy a pump together. This reduces the total pump capacity.If 5 persons join together and buy one set of 15 hp, the capacity reduction will be 35 hp,(from a capacity of 5x10 =50 hp to capacity of 15 hp). This reduces capital costs of pumps,distribution lines,substations etc.Secondly,hours of operation increases,thereby improving load factor and increasing the revenue of the elctricity boards. Thirdly,due to better capacity utilization,efficiency also increases. A spin off from this can be piped water supply for drinking water to the village. Since the cost of pump has come down to the group,they can siphon off part of the savings in capital cost to the cost of piping.

(ii) The energy conversion devices using firewood are crying for our attention.To cite a few examples (i) chulas used for cooking have low efficiencies of conversion- about 10 t0 15 percent - resulting in wastage of 85-90 percent of usuable energy,(ii)water heating devices also have poor efficiencies,(iii)devices used to boil water in agroprocessing,in sericulture in hotels and canteens,and in small industries have low efficiencies of the order of 20 percent.(iv)Tobacco curing barns use firewood. Because air vents are not properly designed, efficiencies are poor.(v)Tile and brike making kilns consume large quantity of firewood. In almost all processes that employ firewood,energy efficiency was not a factor in the design and also they employtraditional and old methods. These lead to the following studies and soluations:

(i) The major problem of chulas is being studied at various centres.Many designs of smokeless and partially smokey chulas have been developed.The ASTRA ole designed scientifically to minimize heat losses has three chambers whose openings are to be so determined as to fit closely vessels used and a chimney. A grate is provided with an air inlet to allow proper flow of air so as to maintain a steady flame and to trasfer heat to the vessels in the neighbouring chambers. In the fuel box,one can put firewood logs,twigs,agrowastes like stalks etc,and fire them.The chula has been popularised in four parts of Karnataka - Aneka Taluk, a dry area; Ungra village in Kunigal Taluk, a semidry area;Sirsi Taluk,high rainfll,hilly,forested area;Kumta Taluk,coastal area. More than 200 numbers have been consructed and addition to the fact that the efficiencies are in the range of 25-35 perent,the chula has other advantages-it cooks food faster,the flame is steady so one need not go on blowing the firewood and no smoke with suspended particles are reaching the eyes of women who are cooking. As this chula can be made locally,it is only necessary to provide an intensive training to local people to build it in houses. Chula really provide a major impact on enviroment.Hence,popularization of chulas is a major activity. This has three stages - training, construction, monitoring. Many organizations-technical institutions, voluntary groups, industries-have been coming with manydesigns of chulas. Many of them do not have a good efficiency and this has brought a bad name to smokeless chulas-as these are called.Hence,a test house to help in testing and certification is essential-at least to inform governments and organizations of the different types of stoves available,their properties,their efficiences,their uses and suitable places/types of usage.

(ii) Allied to the problem of household chulas is the problem of design of stoves for hotels,canteens,balawadis,schools,and hostels.Since they consume wood from forests as already stated,heat transfer in these stoves should be studied and based on it,proper,high efficiency stoves should be brought out. Some private persons,sometime back produced cooking devices in which cooking is done by steam. This reduced time of cooking and alternate fuels like electricity,firewood,coal,kerosene can be used easily in them.Eventhough claims were made about their

better efficiencies,no detailed studies were made.These cooking devices are to be found in many hostels and hotels which use gas/firewood/electricity. It is worthwhile studying this option versus the large traditional chulas used in many hostels, canteens etc,from the point of view of efficiency.

(iii) Another allied problem is water heating.A sizable part of firewood and agrowastes are used in preparation of hot water for bathing."Devices" used are very inefficient.Many developments are taking place in this area in improving existing devices-(a)trying to use fuel gas from the chula,(b)designing a device based on smokeless chula model.(c)designing a boiler-an individual person in Sagar Taluk in Shimoga District has built a boiler that works on arecanut shells.There is a great need to develop and popularise such devices in various areas.

(iv) Tobacco curing consumers a large quantity of firewood.Eventhough, this activity is going on for many years,the design of air vents is not properly done. I was given to understand that installing a gas jacket with a reduction in size of air vents will reduce consumption by 30 percent.Again detailed studies on efficiencies of existing barns,and on the design of boilers and air vents are necessary to reduce firewood consumption.

(v) Firewood is used in traditional activities like brick kilns and tile factories.By redesigns and by proper reuse of heat (either from the kiln or from other sources)it is possible toreduce consumption of firewood. Unless concerted actions based on proper and detailed studies are taken,these traditional industries will be consume more "power".

As regards bricks,it has been shown that it is possible to produce copressed mud blocks (with surki) which have the same strength as burnt bricks.This method saves energy from fules,provides employment to local people and saves transportation expenses. A compressing machine,named ASTRAM,has developed and used in various places.It is desirable to use this this in construction programmes extensively.Studies on similar extrusion technologies for tile making are under progress.

(vi) Sericulture industry uses hot water for cooking and reeling.It may be desirable to introduce effcient devices in them.

V. Specific Energy Consumptions in Industries

Another index one can use to see whether sufficient energy savings is available is the study of specific energy consumption i.e.energy required to produce one unit of an item or to produce goods worth one rupee.One of our studies conducted on some industries in Karnataka shows some interesting characteristics.

Table 24 contains the values for specific energy consumptions for some sectors of industries like engineering,metallurgical,paper,textiles,suger,chemical,tiles,and oxygen.The table also gives the minium and maximum values for SEC.Some interesting points based on this table are:

(i) There is a large difference in energy consumptions per unit of production in the industries within a sector.For example,one paper unit uses 17245 units/unit of production whereas another uses only 12510. Similarly in textiles,one industry uses 8102 units and another 5345 units.The variation in tiles manufacture is from 4.55 to 7.65 and oxygen is from 0.27 to 0.46.This reveals potentials for energy conservation.(ii) when compared with norms for electricity only,some sectors like paper,textiles etc,have SECs for electricity greater than those for all India.

Similarly results of the variation of SEC over a period of five years are giving in table 25. In many cases,there is an increase in SEC revealing the fact that efficiency of use is decreasing.

In the case of heavy engineering industry,the increas is 155.2% over five years. This means that for the same production in 1983-84,the industry is using 1.55 times more energy than that consumed in 1979-80. In the case of some industries,there is a reduction in SEC (negative values in col.4)indicating an increase in the efficiency of use.

So progressive inefficiencies in table 25 also suggest that ther is a good potential for energy conservation.

VI Energy Use in Small Scale Industries

1. Small Scale Units in Karnataka

Let us look at the general picture of the small scale industrial scene in Karnataka especially from the point of view of their spatial distribution,investment costs,growth rates and man power generation.Even though these aspects are not directly releated to the energy consumption patterns, they throw light on the developmental aspects and also indirectly influence energy and environment.

Table 26 gives the growth rate of SSI units in the State starting from 1969-70 onwords.Investment and number of persons employed are also given. We can see that the investment job varies with years. Initially ther was a downward trend. This was followed by an oscillatory behaviour; but the trend has become upward (increasing) from the year 1978-79 onwards.It has more than doubled in six years.

Table 27 looks at district-wise details for the year 1982-83. This table lists the number of units registered in 1982-83 as well as the cumulative figures upto that year.Since comparison is possible only after normalisation,table 28 has been derived from table 27.

Table 28 gives the percentage of SSI units in each district,percent investment and percent of employment (both cumulative and for the year 1982-83). The percentage of units varies from very low values (1.31 for Kodagu,1.32 for Monday,1.06 Utter Kannada,1.68 Chikmagalur,1.96 Hassan) to very high values (15.81 for Bangalore,12.36 for Mysore). The pattern for investment is similar. Bidar, Chikmagalur, Gulbarga, Hassan,Kodagu,Mandy are on the lower side wheras Bangalore,and Mysore are on the higher side. A matching pattern emerges for percentage pf persons employed.

The variations are more marked for the cumulative calculations. Percentage of units varies from 1.23 (for Kodagu) to 30.59 (for Bangalore). Bidar has 1.06%on investment while Bangalore takes a 38.22% share. Percentage of persons employed varies from 1.04 (Chikmagalur) to 36.25 (Bangalore).

2. Engery Consumption in SSIs

The number of Small Scale Industries in the state is very large. Hence it is not possible to obtain data from all of them. So, data obtained from a sample were looked at. The SSIs have been coded into different groups. Even though about 140 gruops were identified in the sample,many of them have a very few samples. Hence, we derived from the sample a secondary sample- we discareded all groups with a small sample. This resulted in reduced sample of 47 groups.

Table 29 lists the SSI gruops and their industrial codes. It has a variety of manufactured-bakery, food grains, furniture, garments,printing, leather chapples, polythene bags,plastics,soaps,oils,bricks,cement products,steel and structural products, agricultural tool, utensils, electroplating, machinery electrical appliances,automobile parts etc.

In order to compere the energy utilization, we calculated energy use/rupee of production for every group (this was also calculated district-wise as discussed in the next section).

Table 30 gives the specific energy consumption for the 47 groups. It gives the maximum value,minimum value,average and standard devition for every group. The maximum value gives the maximum used by an industry in the group. Similarly the minimum is calculated. We can see that energy consumption in kilowatt hours/rupee of production has a considerable variation in each group; the variations being more than 100 times in some sectors. These wide variations show that there is a very good scope for improvement in energy use and conservation of energy. Allgroups exhibit strong variations.

Some sectors show a very high value of energy consumption and they deserve attention. Some examples are bricks and tiles,bakeries,tyre retread-plastic foam products,castings and agricultural implements.

In order to see the economic impact and survival of SSIs (with reference to energy use), table 31 is computed. This gives energy consumption in rupees per rupee of production. This again reveals the variations pictured in table 30 Industries in many groups use more than 30 paise for energy in a rupee of production. Two industries use more than 70 paise for energy per rupee for production. They belong to agarbathi and casting groups. Survival of many industries depends on energy conservation as revealed clearly especially in the case of those which use more than 25% of cost for energy.

Table 32 compares energy consumption with man power. In addition to the fact that there is a wide disparity in intersector and intersector units, there is also a striking feature that the higher values of energy consumptions per person in some groups are greater than the similar figure for H.T. industries. This deserves further analysis and improvments are desirable. This also shows that all small scale units are not employment generating units.

VII Rural Electrification - Dynamics and Implications

When we looked at the rural energy scene, we found that the requirements of lighting is met by kerosene and the illumination level of this is very low leading to an optimal energy scene of lighting through electric bulbs. Let us see the

scenario of rural electrification. Despite many years of electrification activities, the process is yet to reached, the number oof households having electricity is low - about 25%.

Uttara Kannada District in Karnataka has a number of hydroelectric projects and the new atomic power plant is also located in Kaiga in that district. If we see the rate of rural electrification, it is only 42% in 1982. The progress is also slow; the number of villages electrified in 1971-72 was 20 and the number in 1981-82 was 44 - just about twice. It may take 10-20 years to electrify other villages and hamlets. Even if a village is electrified, the electricity does not reach all households because of high capital costs. The present cost of a connection is more than Rs.1000/- and this is not affordable by many rural households. Hence eventhoughthe cost of electrical energy/month is less than the cost of kerosene, people are not moving towards electricity.

In order to reduce the cost of electrification and cost installation, we have proposed a new pattern of circuitry. This will reduce cost of electrification by about 50% and cost of installation by 80-90%.

The important characteristics of this are:

(i) Run a seperate lighting line. Optimize the route of this line with the help of optimization techniques.

(ii) Supply power for fixed hours in the evening in order to avoid metering and meter charges. Fixed charges can be collected from households.

(iii) Each household is restricted to 2-3 bulbs only.

(iv) Every tap from the mainline runs through 5-6 houses thereby reducing the line length from tap point to the houses and also reducing the cost/installation.

(v) Each houses is provided with a simple main switch and cutout.

(vi) Voltages can be reduced to 18V/36V if bulbs are manufactured for that purpose. Inexpensive inverters or transformers can be installed for this purpose. Currently bulbs for automobiles are available at 12V. The idea is to reduce shocks and increase safety.

(vi) Since rural electrification is going to take a long time, it is desirable to go in for decentralised systems using biogas/woodgas generation system, duel fuel engines and an electrical generator. The cost is around Rs.1.8-2.00/unit of electricity generated. This compares favourably with grid electricity-after removal of subsidies.

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Table 1 : Population and education

Educational Level	No. of persons					
	Arjanhalli	Hanchipura	Keelara	Pura	Sugganahalli	Ungra
Illiterate	207	172	378	204	216	276
Literates	82	91	248	35	59	136
No. with Primary Education	54	36	127	20	25	75
No. with Sec. Education	22	30	68	14	13	50
Post High School	5	7	23	2	6	7
Total	370	336	844	275	319	544
No. of Households	74	66	165	56	72	127

Table 2 : Distribution of land holding

Land Holding Class	Village 1	Village 2	Village 3	Village 4	Village 5	Village 6
Landless	8	6	20	10	3	19
Marginal Farmer (Less than 2.5 acres)	23	15	53	10	24	46
Small Farmer (2.5-5 acres)	24	26	45	18	22	30
Medium Farmer (5-10 acres)	13	14	31	13	13	23
Large Farmer (10 acres and more)	5	4	16	5	6	9

Table 3 : Domestic functions and sources

Energy Sources / Functions	Human	Animal	Firewood	Husk	Vegitable wastes	Dung	Kerosen	Electr-icity	Coal	Others
Fetch water	✓									
Gather firewood	✓									
Grazing	✓									
Heat water			✓	✓	✓					
Cooking	✓									
Cooking(fuel)			✓	✓	✓					
Lighting							✓	✓		
Non-agrl. purposes		✓								Tractors
Industry	✓	✓	✓	✓			✓	✓	✓	
Agricult-ure	✓	✓			Coconut Shells					✓

Table 4 : Human energy for domestic use

Activity	Hours. (Village Number)					
	Village 1	Village 2	Village 3	Village 4	Village 5	Village 6
Firewood Gathering	32,412	31,548	84,464	47,642	58,649	98,894
Fetch water	39,963	39,879	99,237	32,441	41,129	57,645
Cooking	1,24,352	98,489	2,35,828	67,871	95,574	2,12,346
Carry food to farm	51,218	38,498	1,11,898	36,488	51,328	85,898
Livestock grazing	1,52,587	1,41,937	3,22,955	1,18,293	1,35,372	2,51,293
Total	4,00,524	3,58,261	8,53,566	3,02,647	3,74,044	6,98,023

Table 5 : Source of firewood

Number of Households

	Village 1	2	3	4	5	6	Total	
Gathering only	17	21	55	43	54	43	23.3	(41.6)
Purchase only	55	16	35	2	5	40	123	(22)
Own source	6	6	21	2	3	15	53	(9.46)
Gathering and others	26	22	53	9	8	26	144	(25.7)

Table 6 : Domestic consumption of firewood
kgs/year (Village Number)

	1	2	3	4	5	6
Quantity Bought	1,72,861	1,43,329	2,76,466	7,943	24,599	1,84,551
Quantity from own source	49,231	55,642	1,45,832	34,142	46,489	1,12,844
Quantity gathered	1,02,819	91,527	2,33,489	1,74,653	1,98,568	1,52,138
Percent of FW gathered to total	31.5%	31.5%	35.6%	88.5%	72.8%	34%
Total	3,23,311	2,90,498	6,54,987	2,16,738	2,61,738	4,48,733

Table 7 : Average distance of firewood source for gathering

Village No	Average distance (Km)
1	2.32
2	2.12
3	2.78
4	2.69
5	2.67
6	1.46
ALL	2.4

Table 8 : Domestic lighting - electricity & kerosene

(Village Number)

Activity	1	2	3	4	5	6
No. of houses with electricity	23	0	17	13	17	27
Percentage	31%	0	10.3%	23.2%	23.6%	21.3%
Electricity consumption (units/year)	4968	0	3403	3078	3398	9524
Kerosene consumption (Lit)	3185	3394	6781	1938	2924	5358
Average kerosene consumption	42.3	51.4	46.6	34.7	40.6	42.4

Table 9 : Energy matrix for all villages (natural units)

	Agriculture	Domestic	Lighting	Transport	Industry
Human hrs	7,21,181	29,79,865	-	-	1,67,634
Bullock hrs	1,17,537	-	-	13,372	1,528
Firewood	-	21,41,328	-	-	1,12,618
Husk	-	1,185	-	-	325
Veg.wastes	-	1,98,537	-	-	5,352
Coal	-	-	-	-	5,731
Kerosene	-	712	23,165	-	1,157
Electricity	42,188	-	24,371	-	6,428
Diesel	148	-	-	-	-

Table 10 : Energy matrix for all village (x 10^6 cals-normalised)

	Agri-culrure	Domstic	Lighting	Trans-port	Industry	Total
Human	165.3	584.02	-	-	39.52	789.82
Bullock	270.04	-	-	30.7	3.5	304.6
Firewood	-	8140	-	-	426	8,566
Husk	-	3.5	-	-	0.97	3.47
Veg.wastes	-	397	-	-	10.7	407.7
Coal	-	-	-	-	25.8	25.8
Kerosene	-	6.4	200	-	18.4	224.8
Electricity	36.1	-	20.6	-	5.53	62.23
Diesel	1.33	-	-	-	-	1.33
	473.13	9131.1	228.6	30.7	522.42	10,385.95

Table 11 : Energy matrix for all villages (percentages)

	Agri-culture	Domestic	Lighting	Trans-port	Industry	Total
Human	1.59	5.62	-	-	0.38	7.59
Bullock	2.61	-	-	0.296	0.034	2.94
Firewood	-	78.4	-	-	4.1	82.5
Husk	-	0.03	-	-	-	0.03
Veg.wastes	-	3.82	-	-	0.1	3.92
Coal	-	-	-	-	0.25	0.25
Kerosene	-	0.06	2.0	-	0.1	2.16
Electricity	0.35	-	0.2	-	0.5	0.60
Diesel	0.01	-	-	-	-	0.01
Total	4.56	87.93	2.2	0.296	5.014	100.00

Table 12 : Ordering of end uses (activities) on the basis of usage.

Sl.No.	Activity	Percent
1	Domestic	87.93
2	Industry	5.014
3	Agriculture	4.56
4	Lighting	2.2
5	Transport	0.296

Table 13 : Ordering of sources

Sl.No.	Energy source	Percent
1	Firewood	82.5
2	Human	7.59
3	Veg.Wastes	3.92
4	Bullock	2.94
5	Kerosene	2.16
6	Electricity	0.60
7	Coal	0.25
8	Husk	0.03
9	Diesel	0.01

Table 14. Monthly per capita consuaption of energy of the Rural Households Sourcewise and Districtwise : 1977-78

Sl. No.	District	Expenditure (Rs)	Coal (Kg)	Kerosene (Lt)	Electricity (KWH)	Firewood (Kg)	Dung (Kg)
1	Bangalore	55.98	0.00	0.71	1.09	23.50	0.33
2	Belgaum	59.23	neg.	0.61	0.27	22.81	1.82
3	Bellary	63.35	0.00	0.51	0.28	20.06	0.34
4	Bidar	48.36	0.00	0.37	0.03	25.35	3.06
5	Bijapur	56.76	0.00	0.37	0.22	13.98	1.81
6	Chikmagalure	74.91	0.00	0.58	0.63	68.69	10.93
7	Chitradurga	48.31	0.00	0.53	0.53	17.23	2.89
8	Dakshina Kannada	61.21	0.00	0.55	0.96	13.69	0.00
9	Dharwar	62.93	0.02	0.62	0.51	20.90	6.84
10	Gulbarga	56.61	0.00	0.53	0.01	21.64	4.67
11	Hassan	64.23	0.00	0.73	0.53	55.97	6.84
12	Kodagu	81.83	0.00	0.33	0.00	29.51	0.00
13	Kolar	67.16	0.00	0.55	1.69	27.54	0.02
14	Mandya	63.00	0.00	0.52	0.74	38.00	0.12
15	Mysore	49.02	0.00	0.49	0.22	20.62	0.00
16	Raichur	58.31	0.03	0.51	0.50	30.58	1.75
17	Shimoga	61.28	0.00	0.46	0.55	43.64	0.04
18	Tumkur	43.33	0.01	0.47	0.66	22.06	0.00
19	Uttara Kannada	66.19	0.00	0.49	0.40	73.35	0.00
	Karnataka	58.69	neg.	0.54	0.54	20.38	1.69

Table 15. Per capita monthly Consumption of Energy : Urban

Sl. No.	District	Expenditure (Rs)	Coal (Kg)	Kerosene (Lt)	Electricity (KWH)	LPG (Kg)	Firewood (KG)	Cowdung (Kg)
1	Bangalore	99.36	0.07	1.38	6.28	0.27	14.12	0.14
2	Belgaum	57.85	0.15	0.54	1.18	0.00	22.66	0.07
3	Bellary	74.73	0.01	0.52	2.34	0.19	20.48	0.37
4	Bidar	47.75	0.00	0.46	0.33	0.00	28.09	2.44
5	Bijapur	59.47	0.02	0.48	0.60	0.04	17.58	1.23
6	Chikmagalur	78.67	0.00	0.45	2.71	0.00	24.32	0.00
7	Chitradurga	78.38	0.20	0.74	4.48	0.00	26.32	0.00
8	Dakshina Kannada	99.71	0.00	0.60	3.3	0.12	16.56	0.00
9	Dharwar	86.13	0.48	0.90	2.21	0.08	17.03	0.28
10	Gulbarga	71.27	0.73	0.69	0.93	0.00	18.32	1.76
11	Hassan	56.63	0.00	0.73	1.43	0.00	48.96	4.38
12	Kodagu	(Not available)						
13	Kolar	85.62	0.13	1.05	2.07	0.08	20.68	0.00
14	Mandya	74.27	0.00	0.59	1.42	0.00	32.12	0.00
15	Mysore	68.11	0.47	0.82	1.52	0.02	19.31	0.00
16	Raichur	64.14	0.11	0.51	1.42	0.00	25.42	1.05
17	Shimoga	82.96	0.07	0.63	3.70	0.13	37.11	0.02
18	Tumkur	65.09	0.00	0.84	3.28	0.00	21.09	0.00
19	Uttara Kannada	74.78	0.29	0.45	1.07	0.05	66.39	0.12
	Karnataka	88.04	0.16	0.98	3.12	0.11	21.56	0.59

Table 16 : Sources of Biomass

1. Field crops (grains, sugar, roots, oil, hydrocarbons)
   (hydrocarbons - Euphorbia lathyrus)
2. Forest crops (leucaena, copaiba, chinese tallow, poplar, casuarina, prosopis juliflora, acaecia auriculiformis, jalitrees)
3. Foreset residues (twigs, leaves etc.)
4. Forest weeds (Euphetorium, lantana)
5. Grass lands (Napier grass)
6. Agro wastes (crop residues, grain residues, husks)
7. Domestic wastes (food, rubbish, sewage)
8. Animal wastes
9. Industrial residues (forest based, food processing and agro industries)
10. Aquatic plants (algae, weeds like water hyacinth, hydrialla etc.)
    - (Uni cellular - Chlorella, Navicula ; multicellular algae - keep etc.)
11. garden wastes (coconut, areca)

Table 17 : Biomass uses

Pharmaceutical
Fragrance
Food
Fillers
Feed
Fibre, Paper, Boards
Film
Timber
Chemicals
Fertilizer
Fuel

Table 18 : Energy Needs where agrowastes can be used

Domestic	Cooking, hot water
Agriculture	Water lifting
	transport
Small industries	Jaggery making; Paddy drying; bricks and tiles making ; lime burning black smithy sericulture activities tobacco curing crafts - toy making milk/sweets making coffee/tea prooessing textiles rayon soap paper making vanaspathy timber curing
Commercial	hotels
	shops

Table 19 : Advantages and Problems in Biomass for Energy

Advantages	Problems
1. Stores energy	1. Land water use competition
2. Renewable	2. supply uncertain and seasonal
3. Versatile conversion and products; some with high energy content	3. Soil requirements
4. Technology known;	4. Existing practices
5. Low capital input	5. Transportation
6. Available to many strata of the society	6. Bulky storage
7. Large potential	7. Low efficiencies
8. Employment generation	
9. Reasonably priced	
10. Ecologically safe	
11. Availability in many places (diffused)	
12. Does not increase atmospheric CO_2	
13. Potential many inorease with population	
14. Potential reduction of weeds like Euphetorium	

Table 20 : Residues yields per tonne of at Harvest (left above the ground)

Crops	Residue factor
Beans and peas	0.68
Cotton	1.2
Maize	0.6
Groundnuts	1.15
Potatoes	0.12
Rice	1.15
Sun flower	5.15
Wheat	1.83

Table 21 : Fossil fuel reserves and resources, biomass production in the world (1979)

1	Proven reserves	Tonnes coal equivalent
	Coal	50×10^{10}
	Oil	20×10^{10}
	Gas	10×10^{10}
		80×10^{10} t = 2.5×10^{22} J
2	Estimated resources	
	Coal	85×10^{11}
	Oil	5×10^{11}
	Gas	3×10^{11}
	Unconv.oil and gas	20×10^{11}
		113×10^{11} t = 30×10^{22} J
3.	Fossil fules used till 1976	2×10^{11} t carban = 6×10^{21} J
4.	World's annual energy use	3×10^{20} J
5.	Annual photosynthesis	
	a) Net primary production	8×10^{10} t = 3×10^{21} J
	b) Cultivated land only	0.4×10^{10} t = 1.5×10^{20} J
6.	Stored biomass	
	a) total (90% in trees)	8×10^{11} t = 20×10^{21} J
	b) cultivated land only (standing mass)	06×10^{11} t
7.	Atm. CO_2	7×10^{11} t carban
8.	CO_2 in ocean surface layers	6×10^{11} t
9.	Soil organic matter	$10\text{-}30 \times 10^{11}$ t
10.	Ocean Org. matter	17×10^{11} t

Table 22 : Annual Biomass Production (tonnes)

Net primary production (Org.matter)	2×10^{11}
Forest production (dry matter)	9×10^{10}
Cereals	1.5×10^{9}
Roots	5.7×10^{8}
Sugar	1×10^{9}

Table 23 : Total energy potential from agrowastes for Karnataka (year 1979)

Crop	Area (million ha)	Total energy content (million units)
Rice	1.146	15050
Jowar	1.98	8141
Ragi	1.03	9800
Bajra	0.663	1370
Maize	0.184	6000
Wheat	0.344	1520
Small millets	0.402	350
Pulses	1.375	2750
Oilseeds	1.45	5688
Fibres	1.08	10050
Sugarcane	0.158	40000
Coconut	0.156	7800
Others	--	3070
	Total	1,11,588

Table 24_A : Some Biomass uses for energy in other countries

Kenya	75%	)
India	60%	)
Chain	33%	) of their total energy requirement
Brazil	25%	) from Biomass
Sweden	9%	)

Brazil	-	alcohol from sugarcane - 10-14 billiom litres/Yr
Zimbabwe	-	ethanol from sugarcane - 40m litres
USA	-	gasohol from maize - 1m. barrels/day
	-	silviculture plantations of pines, willows, oaks, maples, sycamores etc
	-	Euphorbia Lathyrus in Arizona - 1.5 tons/Yr/ha
France	-	methane generation, use of charcoal, carburol
Sweden	-	Fast growing willows
Mexico	-	Parthenium argentatum
Australia	-	Botryococus braunii (alga) (produces a hydro carbon liquid)

Energy Conservation

Thermo chemical

Direct combusion - stove, furnaces
Densification
Fluidised bed combusion
Pyrolysis
Liquefaction
Gasification (Woodgas)

Biological

Fermentation (ethanol)
Anaerobic Digestion (Biomethanation)

Table 24$_8$ Specific Energy Consumptions for some sectors

Sector	Total energy in ∎ (units)	Energy in units/Rs of Production				SEC for electricity only (avg)
		Avg	max	min	Std Dev	
1.Engineering	37.3	0.22	1.48	.011	0.65	0.081
2.Metallurgical I	203.6	0.26	0.36	0.05	0.10	0.164
3 " II	1766	1.73	1.78	1.59	-	0.45
4 " III‡	49.4	19.4	25.0	14,4	-	7.98
5.Paper‡	1358.4	16467	17245	12510	5511	2220
6.Textiles‡	232.1	5567	8102	5345	1865	1450
7.Sugar‡	844.2	9657	11162	5264	3514	44.53
8.Chemicals‡	351.7	2689	7013	2511	-	1172
9.Tiles‡	19.9	5.05	7.65	4.55	-	0.071
10.Oxygen	8.31	0.41	0.46	0.27	-	0.41

‡ The SEC - Values are energy in units/unit of production.

Table 25 : Variations in SEC in five years in some industries

Types of Industry	SEC for 1979-80	SEC for 1983-84	Perecent Increase
Engineering	0.006	0.011	83.3
*	0.045	0.07	64.4
*	0.02	0.04	100
Heavy Engg*	51.45	131.3	155.2
Electrical	0.019	0.01	-47.4
Metallurgical	0.19	0.23	21.1
*	3.1	1.6	-48.4
*$	126.9	148	16.6
Paper	1.02	0.93	-8.8
Textiles	0.57	0.38	-33.3
*	0.51	0.65	27.5
*	1.3	0.90	-30.8
Sugar*	14883	11162	-25
Agromachines	0.027	0.034	25.9
Oxygen	0.33	0.46	39.4
*	0.44	0.27	-38.6
Glass	2.14	0.92	-57.0

Table 26 : Growth of Small Scale Industries in Karnataka

Sl No	Year	No of Regd. SSI units	Investment (Rs.in lakhs)	Persons Employed	Persons Employed Cumulative	Investment/ job (Cumulative) Rs/Job
1	1969-70	3,890	3456.70	47,960	47,960	7207.46
2	1970-71	1,900	2279.43	44,295	92,255	5146.02
3	1971-72	2,372	1389.39	21,343	113,598	6134.98
4	1972-73	2,272	1350.10	22,490	136,088	6003.11
5	1973-74	3,043	1638.23	21,814	157,902	7509.99
6	1974-75	1,907	3991.27	56,043	213,945	7121.79
7	1975-76	1,562	1641.36	12,783	226,728	12840.17
8	1976-77	1,420	1482.51	15,406	242,134	9622.93
9	1977-78	1,621	1517.11	24,750	266,824	6129.73
10	1978-79	1,975	1451.46	16,957	283,841	8559.65
11	1979-80	2,910	3255.01	34,376	318,217	9468.84
12	1980-81	2,776	3041.83	26,164	344,381	11626.01
13	1981-82	3,396	4955.16	41,375	385,756	11976.21
14	1982-83	6,896	6255.29	46,420	432,176	13475.42
	Total	37,161	37,624.85	4,32,176		8705.90 (average)

Table 27 : District-wise data on SSIs during the year 1982-83

Sl No	Districts	No of Regd. SSI units	Investment (Rs.in lakhs)	Persons Employed	Total No of Regd SSI	(Cumulative) Investment (Rs.in lakhs)	Persons Employed (Cumulative)
1	Bangalore	964	2333.46	8,675	11,368	14,381.78	1,56,691
	Bangalore (Urban)	433	642.82	3,897	6,539	7,374.11	94,505
	" (Rural)	531	1590.67	4,778	4,829	6,987.67	62,186
2	Belgaum	581	474.82	4,067	2,010	1,856.93	16,082
3	Bellary	159	177.32	1,113	1,530	786.16	8,133
4	Bidar	157	62.87	1,099	625	400.79	5,790
5	Bijapur	263	98.95	1,831	1,282	604.15	12,979
6	Chitradurga	193	158.27	1,351	1,638	979.92	11,417
7	Chikmagalur	103	42.47	927	598	388.12	4,583
8	Dakshina Kannada	438	398.67	3,369	2,444	4,094.75	64,714
9	Dharwar	530	298.47	3,710	2,641	2,027.17	23,989
10	Gulbarga	202	113.39	1,414	850	642.62	7,830
11	Hassan	120	88.72	900	824	550.90	6,133
12	Kodagu	80	62.94	720	460	959.61	10.936
13	Kolar	396	275.76	3,168	1,816	1,124.85	11,672
14	Mandya	81	75.87	567	1,887	624.54	6,275
15	Mysore	754	645.25	6,032	2,871	2,619.16	23,153
16	Raichur	150	215.10	1,050	855	1,767.17	19,670
17	Shimoga	460	380.90	2,760	1,904	2,022.83	13,779
18	Tumkur	480	325.20	3,082	1,492	1,279.13	17,737
20	Uttara Kannada	65	128.14	585	798	537.23	9,214
	Karnataka State	6896	6255.29	46,420	37,161	37,624.85	4,32,671

Table 28 : District-wise Indices for SSIs during the year 82-83

Sl. No.	Districts	Regd. %of SSI in the Dist.	%of Invest-ment	%of Persons Emplo-yed	%of SSI in the Dist. (Cumul-ative)	% Invest-ment(Cumu-lative)	%Persons Employed (Cumula-tive)
1	Bangalore	15.81	37.30	18.68	30.59	38.22	36.25
	"	7.10	10.97	8.39	17.59	19.59	21.86
	"	8.71	26.42	10.29	13.00	18.73	14.39
2	Belgaum	9.30	7.59	8.76	5.40	4.93	3.72
3	Bellary	2.60	2.83	2.39	4.11	2.00	1.88
4	Bidar	2.57	1.50	2.36	1.60	1.06	1.33
5	Bijapur	4.31	1.58	3.94	3.44	1.60	3.03
6	Chitradurga	3.16	2.53	2.91	4.40	2.60	2.64
7	Chikmagalore	1.60	0.67	1.99	1.60	1.07	1.04
8	Dakshina Kannada	7.10	6.37	7.25	6.57	10.00	14.97
9	Dharwad	8.69	4.77	7.99	7.10	5.30	5.50
10	Gulbarga	3.64	1.81	3.07	2.20	1.70	1.84
11	Hassan	1.96	1.41	1.93	2.21	1.46	1.42
12	Kodagu	1.31	1.00	1.55	1.23	2.56	2.53
13	Kolar	6.49	4.40	6.82	4.80	2.90	2.70
14	Mandya	1.32	1.20	1.22	2.92	1.65	1.45
15	Mysore	12.36	10.31	12.99	7.72	6.96	5.35
16	Raichur	2.46	3.43	2.26	2.30	4.69	4.55
17	Shimoga	7.54	6.00	5.94	5.22	5.37	3.20
18	Tumkur	6.56	5.19	6.66	4.01	3.39	4.29
19	Uttara Kannada	1.06	2.04	1.26	2.34	1.42	2.23

Table 29 : Industrial Groups chosen for Analysis

Sl No	N. I. C	Description	Sl No	N. I. C	Description
1	2018	Ice Candy, Cream, Baby Milkfood	26	3261	Marble Slabs, Stone Polished
2	2041	Milling of foodgrains	27	3289	Asbestos Cement, Products, Glazed Tiles
3	2042	Paddy Hullling, Rice	28	3291	Concrete Blocks, Hume Pipes
4	2043	Fried Rice	29	3311	Castings & Forgings
5	2051	Bread, Cake, Biscuits	30	3402	Steel Trunk, Accessories
6	2053	Biscuits	31	4303	Moulding-Drums, Tanks,Metal Containers
7	2110	Oil, Vansapathy	32	3410	Structural Metal Products
8	2132	Coffee Power	33	3420	Iron Furniture, Alminium Furniture
9	2150	Cold Storage	34	3435	Agricultural Handtools Implements
10	2641	Ready made Garments	35	3440	Electroplating, Polishing, Enamelling
11	2710	Wood sawing	36	3452	Utensils
12	2721	Wooden packing	37	3499	Miss.Metal Products including wire mesh, Safety pins
13	2760	Wooden Furniture	38	3549	Industrial Machinary
14	2799	Wooden Photoframes, Articles	39	3578	Parts, Accessories of Machine tools
15	2850	Printing & Binding	40	3598	Parts, Accessories
16	2890	Commercial Printing	41	3599	Gen. Engg.
17	2913	Leather Chappals	42	3699	Misc. Electrical m/c Apparatus & Applines
18	3004	J.W.Tyre Retraeding	43	3748	Automobile parts & Acc
19	3035	Polythene Bags	44	3781	Bullock carts & Parts
20	3039	Plastic Foam Products, Buttons	45	9730	Auto,Scooter,Cycle reparing
21	3053	Wax Candles	46	9731	Auto,Scooter Servicing
22	3101	Heavy Inorganic Chemicals	47	9760	M/C & servicing Pumpsets
23	3142	Washing soap & Powder			
24	3199	Agarabathis, Misc.Chemicals			
25	3209	Non ceramic Bricks, Tiles			

Table 30 : Specific Energy Consumption (KWH) PR.(Rs)

Sl No	Pr. Code	No.of Ind	Max	Min	Avg	S.D
1.	2010	8	0.3264	0.0217	0.1545	0.1142
2.	2041	13	0.8654	0.0064	0.0223	0.3055
3.	2042	123	1.9375	0.0027	0.2595	0.3032
4.	2043	14	0.4032	0.0002	0.0749	0.1292
5.	2051	24	3.8409	0.0077	0.7479	1.049
6.	2053	12	0.4128	0.0268	0.2090	0.1897
7.	2110	43	0.3214	0.0052	0.0770	0.0874
8.	2132	13	1.9365	0.0140	0.2560	0.5140
9.	2150	15	1.4043	0.0500	0.4748	0.4826
10.	2641	44	0.5150	0.0007	0.0554	0.098
11.	2790	90	0.1375	0.0050	0.1890	0.196
12.	2721	12	0.3545	0.0015	0.0711	0.1031
13.	2760	47	0.4000	0.0032	0.0745	0.0812
14.	2799	15	0.2000	0.0042	0.0648	0.0617
15.	2850	166	1.0667	0.0037	0.0591	0.0949
16.	2890	21	0.2661	0.0080	0.0498	0.0676
17.	2913	15	0.2400	0.0095	0.0621	0.0806
18.	3004	23	3.8923	0.0063	0.7677	0.9518
19.	3035	11	0.3600	0.0025	0.0676	0.0991
20.	3039	35	4.3636	0.0009	0.1843	0.7298
21.	3053	12	0.0511	0.0095	0.0320	0.0223
22.	3101	10	1.9751	0.0024	0.2817	0.6043
23.	3142	10	1.4608	0.0282	0.3463	0.525
24.	3199	95	202511	0.0007	0.0959	0.3179
25.	3209	12	8.5372	0.1667	3.4434	2.9122
26.	3261	14	0.3158	0.0076	0.0630	0.0816
27.	3289	33	4.2067	0.0032	0.0325	0.0495
28.	3291	11	0.1200	0.0023	0.0363	0.0384
29.	3311	47	3.7017	0.0055	₹ 7749	0.0853
30.	3402	12	0.6957	0.0068	0.1350	0.2127
31.	3403	18	0.3870	0.0088	0.0747	0.0863
32.	3410	79	0.5760	0.0052	0.1021	0.1056
33.	3420	36	1.6354	0.0029	0.0834	0.2681
34.	3435	134	5.1120	0.0086	0.7272	0.8173
35.	3440	13	0.5255	0.0375	0.2362	0.1654
36.	3452	35	2.0135	0.0035	0.2538	0.3767
37.	3499	14	0.3742	0.0038	0.0701	0.0967
38.	3549	10	0.1981	0.0095	0.0579	0.0556
39.	3577	21	0.4248	0.0046	0.0806	0.1307
40.	3598	14	0.1060	0.0080	0.0335	0.0274
41.	3599	134	1.6867	0.0194	0.1565	0.2026
42.	3669	11	0.0362	0.0023	0.0175	0.0102
43.	3748	10	0.2203	0.0093	0.0745	0.0823
44.	3781	20	1.2077	0.0067	0.2746	0.3087
45.	9730	36	0.3330	0.0167	0.1120	0.0942
46.	9731	18	0.6113	0.0500	0.1693	0.1378
47.	9760	12	0.6483	0.0444	₹ 1659	0.1769

Table 31 : Specific Energy Consumption (Rupees)

Sl No	Pr Code	N.I	Max	Min	Avg	S.D
1.	2018	8	0.1346	0.0161	0.0696	0.0408
2.	2041	13	0.3462	0.0031	0.0111	0.1398
3.	2042	123	0.3846	0.0011	0.1058	0.0993
4.	2043	14	0.1629	0.0002	0.0373	0.0589
5.	2051	24	0.3000	0.0038	0.080	0.0804
6.	2053	11	0.2700	0.0052	0.081	0.0846
7.	2110	43	0.1563	0.0022	0.0351	0.0416
8.	2132	13	0.4862	0.0050	0.0802	0.1272
9.	2150	15	0.4667	0.0250	0.02147	0.2232
10.	2641	44	0.2075	0.004	0.0248	0.0405
11.	2710	90	0.3750	0.0024	0.0841	0.0784
12.	2721	12	0.1022	0.0037	0.0251	0.0290
13.	2760	47	0.2000	0.0013	0.0361	0.0400
14.	2799	15	0.1131	0.0017	0.0354	0.0366
15.	2850	166	0.5503	0.0019	0.0296	0.0489
16.	2899	21	0.2158	0.0050	0.0257	0.0449
17.	2913	15	0.1167	0.0019	0.0294	0.0378
18.	3004	23	0.2545	0.0030	0.0873	0.0741
19.	3035	11	0.1992	0.0010	0.0354	0.0555
20.	3039	35	0.0968	0.0029	0.0584	0.0261
21.	3053	12	0.0462	0.0020	0.0144	0.0114
22.	3101	10	0.1728	0.0010	0.0649	0.0651
23.	3142	10	0.0714	0.0042	0.0292	0.023
24.	3199	94	0.8657	0.003	0.0428	0.1306
25.	3209	12	0.3383	0.0667	0.2501	0.1028
26.	3261	14	0.1276	0.0036	0.0286	0.0339
27.	3289	33	0.0260	0.006	0.0129	0.0143
28.	3291	11	0.0480	0.0009	0.0174	0.0169
29.	3311	47	0.7800	0.0022	0.1422	0.1523
30.	3402	12	0.3478	0.0027	0.0485	0.0885
31.	3403	18	0.1400	0.0038	0.0341	0.0343
32.	3410	79	0.2000	0.0036	0.0427	0.0362
33.	3420	36	0.2900	0.0014	0.0291	0.042
34.	3435	134	0.2500	0.0025	0.0839	0.0826
35.	3440	13	0.2400	0.0225	0.0982	0.0807
36.	3452	35	0.1837	0.0015	0.0560	0.0565
37.	3499	14	0.0572	0.0019	0.0245	0.0199
38.	3549	10	0.0760	0.0047	0.0307	0.0222
39.	3578	21	0.3333	0.0049	0.0513	0.0766
40.	3598	14	0.0733	0.0046	0.0233	0.0196
41.	3599	134	0.3600	0.0100	0.1003	0.0946
42.	3669	11	0.0234	0.0015	0.0102	0.0064
43.	3748	18	0.0748	0.0055	0.0188	0.0209
44.	3781	28	0.2500	0.0012	0.0552	0.0582
45.	9730	36	0.2133	0.0083	0.0553	0.0438
46.	9731	18	0.4438	0.0200	0.0963	0.0968
47	9760	12	0.2980	0.0178	0.0707	0.0790

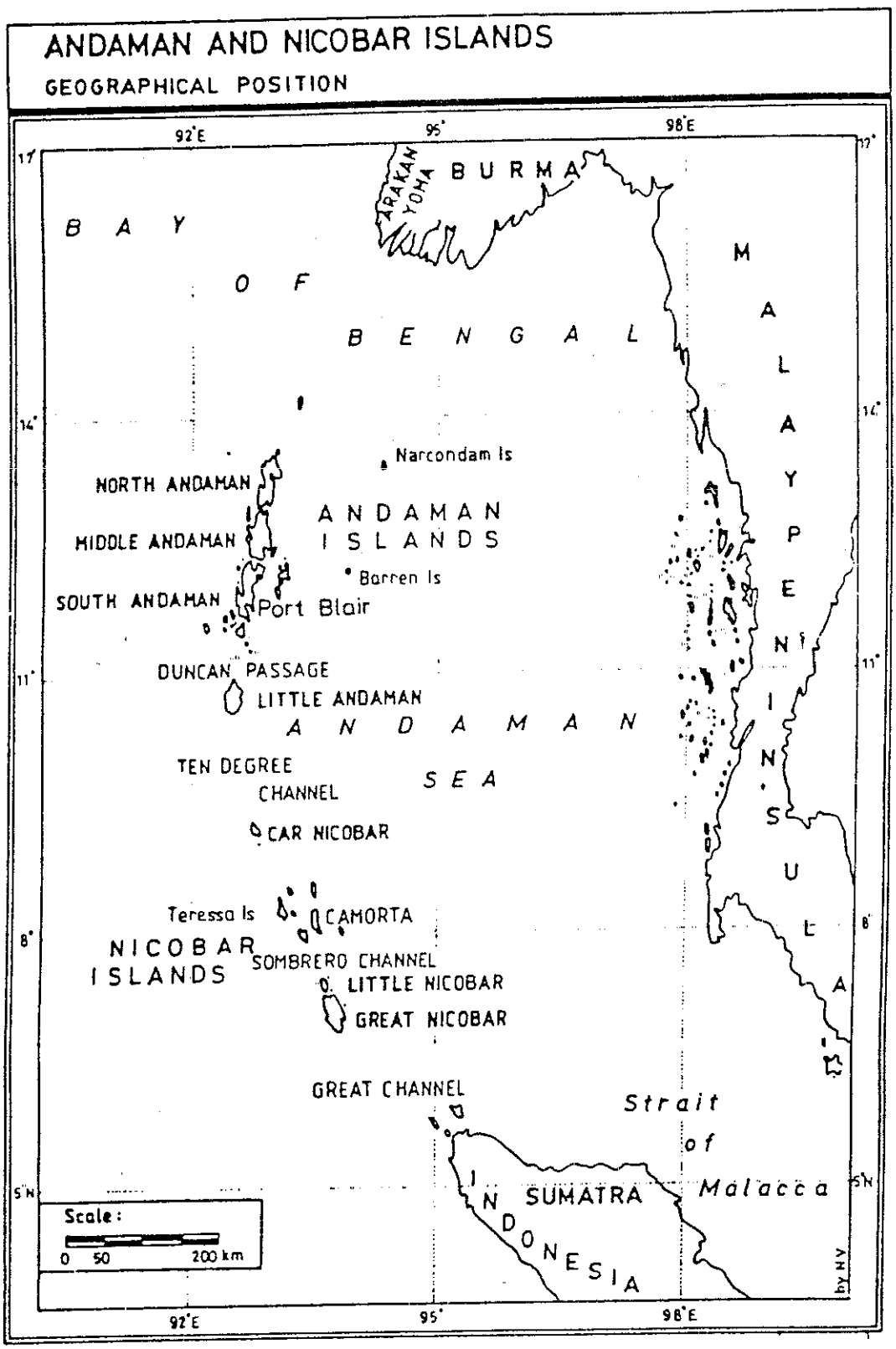
Table 32 : Energy per Manpower of Employment

Sl No	Pr Code	No. of Ind.	Max	Min	Avg	S.D
1.	2048	8	3879	300	1514.42	1406.80
2.	2041	13	9875	360	3415.70	2564.76
3.	2042	123	7535.71	214.29	1810.99	1439.02
4.	2043	14	25250	120	3274.33	6632.26
5.	2051	24	5550	31.25	1365.54	1348.17
6.	2053	12	29451	120	5591.25	8093.79
7.	2110	43	120000	250	4602.50	18112.90
8.	2132	13	6235.29	83.33	1658.36	1655.55
9.	2150	19	23233.33	166.67	3929.77	7034.55
10.	2641	44	5455.58	7.36	373.22	822.29
11.	2710	90	4900	58.22	852.48	607.42
12.	2721	12	2044.60	107.14	671.99	575.29
13.	2760	47	2666.67	30.00	368.92	417.18
14.	2799	15	2450	80.00	570.35	603.84
15.	2850	90	4127	25.00	373.52	490.44
16.	2890	21	6636.13	72.00	743.11	1422.66
17.	2913	15	14000	17.00	1108.44	3569.81
18.	3004	23	13400	200.00	2908.28	3410.04
19.	3035	11	2987.50	200 00	1529.98	852.25
20.	3093	35	15000	58.75	1406.89	2660.83
21.	3053	12	400	48.00	164.22	114.86
22.	3101	10	6500	94.67	2324.56	2266.78
23.	3142	10	8333	116 67	1545.60	2483.30
24.	3199	95	126250	12.20	3181.50	15521.79
25.	3209	12	58500	734.97	9678.93	15625.26
26.	3261	14	2666.67	50.00	587.31	656.56
27.	3289	33	6800	55.56	750.45	1266.90
28.	3291	11	988.89	40.00	208.99	341.08
29.	3311	47	17472	105.43	3783.06	3602.09
30.	3402	12	1000	75.00	316.07	290.60
31.	3403	10	1714.29	122.50	662.40	479.61
32.	3410	79	3108.69	85.71	650.52	510.52
33.	3420	36	1800	68.00	458.79	455.27
34.	3435	134	12500	50.00	917.82	1335.05
35.	3440	13	10909	450.00	2976.04	2999.32
36.	3452	35	5988.36	125.00	1368.90	1946.40
37.	3499	14	9920	143.75	1573.62	2495.59
38.	3549	10	895 50	167.57	532.60	257.44
39.	3570	21	4171.43	187.78	754.69	845.06
40.	3590	14	1518.52	140.00	623.36	438.77
41.	3599	134	3600.00	83.33	877.00	996.57
42.	3669	11	800.00	61.54	341.40	237.90
43.	3740	10	8898.54	298.60	1344.00	2662.34
44.	3710	20	4166.67	50.00	902.66	986.80
45.	9730	36	6200	62.50	753.85	1047.00
46.	9731	10	3944.44	200.00	892.70	800.54
47.	9760	12	3377.67	100.00	714.82	884.52

MANAGING THE ENVIRONMENT OF ANDAMAN AND NICOBAR ISLANDS

- PROF. C.J. SALDHANA

Environmental management often needs the balance of a tight-rope acrobat. Development has to take place without however destroying the resource base or undermining the quality of life. The proper environmental management of the Andaman and Nicobar Islands could serve as a small scale experiment that could help formulate ecodevelopmental strategies in other more complicated situations.



The following box presents some of the salient features of these Islands which are probably made up of emergent peaks of a sunken mountain range linking the Arakan Yoma in Burma with the Indonesian Island of Sumatra. Indira Gandhi Point, the southernmost point of the Union of India is about 150 km from Sumatra and overlooks the shipping lane leading to the Pacific.

		Andaman and Nicobar Islands	
Location	:	6° 45' N 13° 41' N lat 92° 12' E 93° 57' E long	
Distance	:	Port Blair—Madras	1,133 km
		Port Blair—Calcutta	1,255 km
Area	:	8,249 sq km	
		Andaman Group	6,408 sq km
		Nicobar Group	1,841 sq km
Coastline	:	1,962 km (1/4 of Indian coastline)	
No. of Islands	:	More than 325 (21 inhabited) in Andaman Group	
	:	More than 24 (13 inhabited) in Nicobar Group	
Excl. Eco. Zone	:	6 lakh sq km (30% of E.E.Z. of India) (approximate)	

ECOSYSTEMS

An insight into the natural and man-made ecosystems in the Islands would help in evolving a sound and holistic developmental programme. The natural ecosystems could be placed under 3 categories - the Land, the Sea and the intermediate and intertidal system of Mangroves. The man-made systems could be considered under People and their households, Forestry, Agriculture, Industry, Fisheries and Services.

Land: There are more than 325 islands in the Andaman Group of which 21 are inhabited. The Nicobar Group consists of more than 24 islands of which 13 are inhabited.

Most of the islands of the Andaman Group have rugged features. Hills abound while flat terrain is limited. The larger islands are deeply indented by meandering creeks.

Proximity to the Equator and to the sea ensures a hot humid, uniform climate with day temperataures around 30 degrees Celsius. The mean annual rainfall which is from both the S.W. and N.E. monsoons is 3,800 mm. The flat terrain is water-logged for several months during the monsoon. On the other hand there is scarcly any ground-water. The soil is poor and porous with very little water-holding capacity. Patches of clay occur in the lowlands restricting permiability.

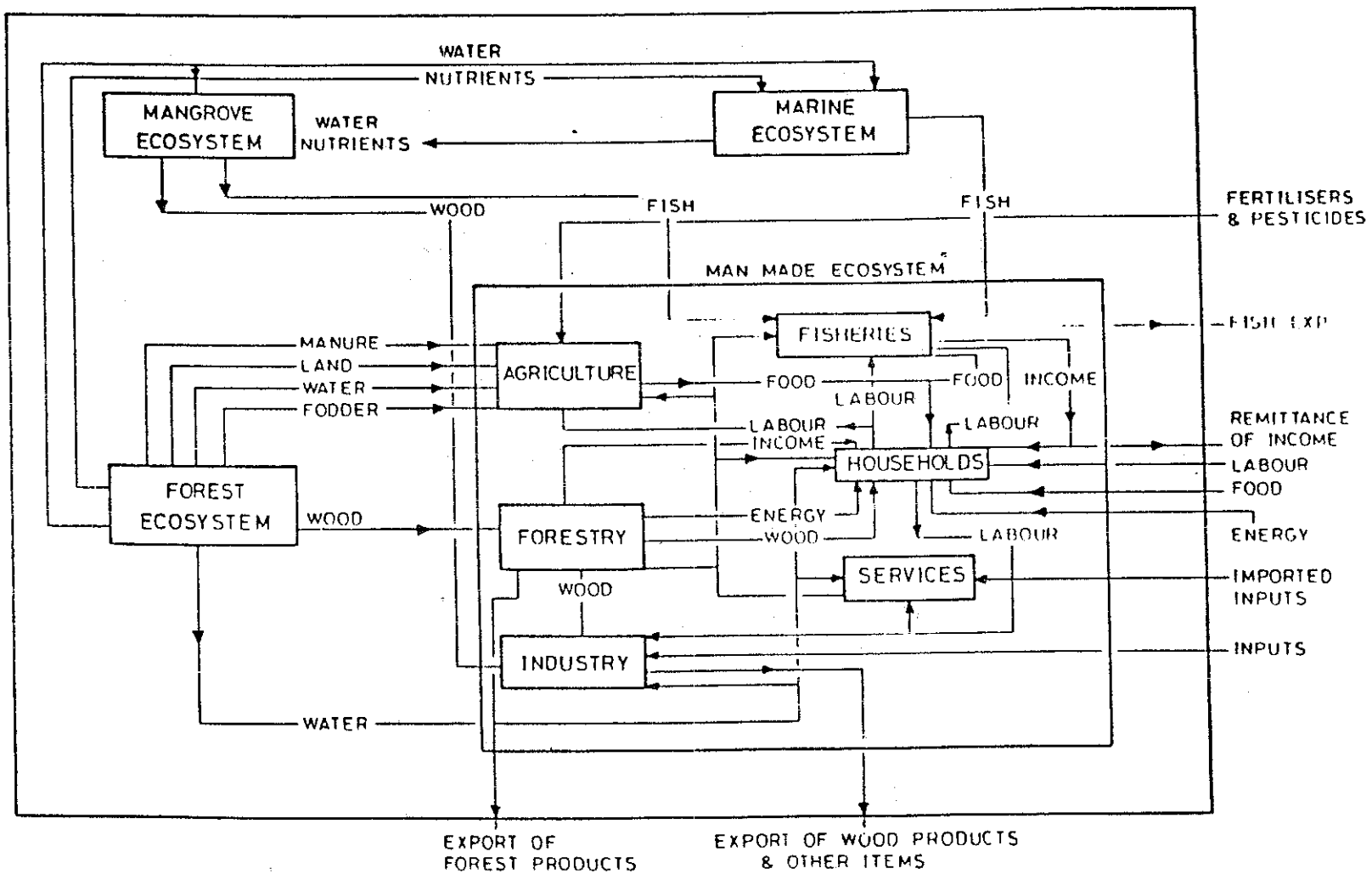


Fig. 2. ECOSYSTEM LINKAGES IN THE ANDAMAN ISLANDS

Forests: Most of the islands have a rich plant cover. 1,370 Angiosperm species have been named. Of these 206 are endemic and occur nowhere else in the world.

The forests have been classified into six types by Champion & Seth. A simplified summary is given below:

Forest Types in the Andamans

1	Giant Andaman Evergreens	Climax formation in lowlands Almost extinct due to large scale clearance of flat terrain for agriculture
2	Andaman Tropical Evergreens	Multi storied, closed canopy forests Grow in hilly terrain
3	Andaman Moist Deciduous Forests	Open canopy forests with seasonal leaf fall Occur on lower slopes on 45 per cent of total area Yield timber of more economic value
4	Andaman Hill top Evergreens	Stunted, wind resistant forests
5	Littoral Forests	Open formations of tall, sturdy trees with limited undergrowth On sandy beaches above high water level
6	Mangrove Forests	Dense formations well adapted to salinity tidal fluctuations and marshy soil Interphase between land and marine ecosystems

The Giant Andaman Evergreens once grew on the alluvial soil along streams and on the water-logged soil of the lower valleys. Magnificent buttressed trees festooned with climbers and epiphytes rose to over 30 m. Due to forest clearing for agriculture, this type of forest is almost extinct.

The Andaman Tropical Evergreen and the Andaman Moist Deciduous Forests form a mosaic on the lower hills of the Islands. However, in the Great Nicobar the virgin tropical evergreen forest occupies most of the central hills.

The Hill-top Evergreens are a stunted community on the wind-swept peaks that rise abruptly from the seashore. Saddle Peak (737 m) in the North Andaman and Mt. Ford (435 m) on Rutland are good examples of hill-top forests

Littoral forests occur as a narrow belt on sandy or shingle beaches just beyond the high tide mark. The trees are sturdy and have to withstand the fury of the monsoons and cyclones.

The absence of mammalian carnivores is a surprising aspect of terrestrial animal life in the islands. The largest native land animal is the andaman pig. The deer and feral elephants are introductions from the main land.

The Sea: The land area of the Andaman and Nicobar Islands is only 8,249 sq.km. but the Exclusive Economic Zone of the islands extending to 200 nautical miles from the shore line is 75 times larger, approximately 6 lakh sq.km. This is an enormous real estate comprising 30% of the E.E.Z. of India.

The waters around the islands have been studied by several Indian and overseas expeditions. The euphotic zone limited by the silt load from the Gangetic and Irrawady deltas increases in the region of the islands. This has a direct bearing on the productivity of the waters around the Andaman and Nicobar Islands. There is an abundance of fish in the shallow waters as well as in the deep sea. A conservative estimate puts the annual catch at 50,000 tonnes. (A reported estimate by N.I.O. places the annual catch at 4,74,000 tonnes/an.) Shrimps and lobsters, crabs and molluscs add to the variety and abundance. Of the marine mammals the Dugong moves about in shallow water while the Dolphin gambols around shoals of shimmering fish in the open seas. Four species of sea turtles come to the sandy beaches to lay their clutch of eggs in shallow pits just above the high tide mark.

The continental shelf is narrow and slopes rapidly to great depths. The Central Basin in the Andaman Sea plunges to over 3,000m. The narrowness of the shelf is compensated for by the numerous bays, lagoons and creeks replete with a variety of plant and animal life.

The western side of the Andaman Islands has a coral reef running intermittently for about 350 km. The islands of Ritchie's Archipelago, the Labyrinth Islands and the inshore waters of Cinque Islands have beds where multicoloured fish flit about among the marvels of coral architecture.

The Mangroves: The Mangroves form an easily discernible transitional system between the forests on land and the life in the open sea. Mangroves in the Andaman and Nicobar Islands are estimated to occupy 1,15,000 ha of which 50,000 are in the Andaman Group. These Mangroves are considered to be one of the most important surviving formations in the world.

The push and pull of the tide, the limitations of water-logged slush and the salinity gradients of the creeks require special metabolic and morphological adaptations. Stilt roots anchor plants; breathing roots turn upwards as if gasping for air. Seedlings nurtured on parent trees until they are capable of a secure, independent existence.

MAN-MADE ECOSYSTEMS

People :

Tribals

The Andaman and Nicobar Islands have been inhabited for centuries by 2 distinct groups of tribals. The first group is of remnants of hunter-gatherer Negritos from the Great Andamanese, Onge, Jarawa and Sentinelese tribes. From a population of about 5,000 in 1858 they have now dwindled to less than 400. The Andamanese numbering 28 have been shifted to Straight Island. The Onge once the sole inhabitants of Little Andaman have been herded to 2 small settlements at Dugong Creek and South Bay. The Jarawas and Sentinelese who are trying to preserve their way of life are often termed 'hostile'. The former have 2 reserves in the middle and south Andamans. The Sentinelese isolated on Sentinel Island greet any visitor with a shower of spears. The following figures from Dr. T.N. Pandit of the A.S.I. tell a tale of a dying race.

Tribal Population in the Andamans

Tribe	Year								
	1901	1911	1921	1931	1951	1961	1978	1980	1985
Great Andamanese	625	155	209	90	23	19	21	25	28
Onge	672	631	346	250	150	129	106	97	98
Jarawa		114	114	70	50	500	250	250	200
Sentinelese		117	117	50	50	500	100	500	50

All italicised figures are estimates Total tribal population in 1858 was 5000 i.e. about 3,500 Great Andamanese and 1,500 Onge Jarawa Sentinelese (After Pandit)

The second tribal group is of mongoloid origin and probably of Indomalayan stock. The 2 tribes of this group, the Nicobarese and Schompens dwell in the southern Nicobar Group of islands.

The Nicobarese are horticulturists and herders and adept at boating and fishing. 22,000 in number, they have a well organised tribal structure of villages governed by 'captains' and 'vice-captains'. Relatively well educated,they have been able to assimilate outside influences both in their life style and religion. The dominance of monopolistic trading groups, and the pressure of an increasing population are matters that need to be looked into.

The Schompens are a semi-nomadic, monogamous, mongoloid, forest tribe numbering about 214 individuals. Living in groups, they move from place to place within the forests in Great Nicobar. They are a shy people and almost totally dependent on the forest.

Settlers

By far the larger proportion of the Islanders is made up of settle rs from the mainland. The first settlers were from reprieved convicts. A small group of Karens from Burma have made their home at Webi near Mayabundar. A significant change in the population occured when the Govt. of India resettled Bengali refugees from Bangladesh in the Andaman Group and Ex-Servicemen in Great Nicobar. They received clear felled flat land for agriculture and hilly land for other uses. Free royalty timber and several subsidies were also accorded to them. The Ranchi tribals who have been responsible for most of the hard work in forestry, PWD,Harbour works etc. came as contract labour right from the British period. Some of them stayed on in the islands and are living there for many decades. They are not accorded tribal status nor have they been given any land. Tamils, Telugus, Malayalees and many other groups have also migrated under different sponsored projects. Licit as well as clandestine im migration is continually pushing up the population. The increase is causing alarm. The following official figures show the growth rate.

Population Growth in Andaman and Nicobar Islands

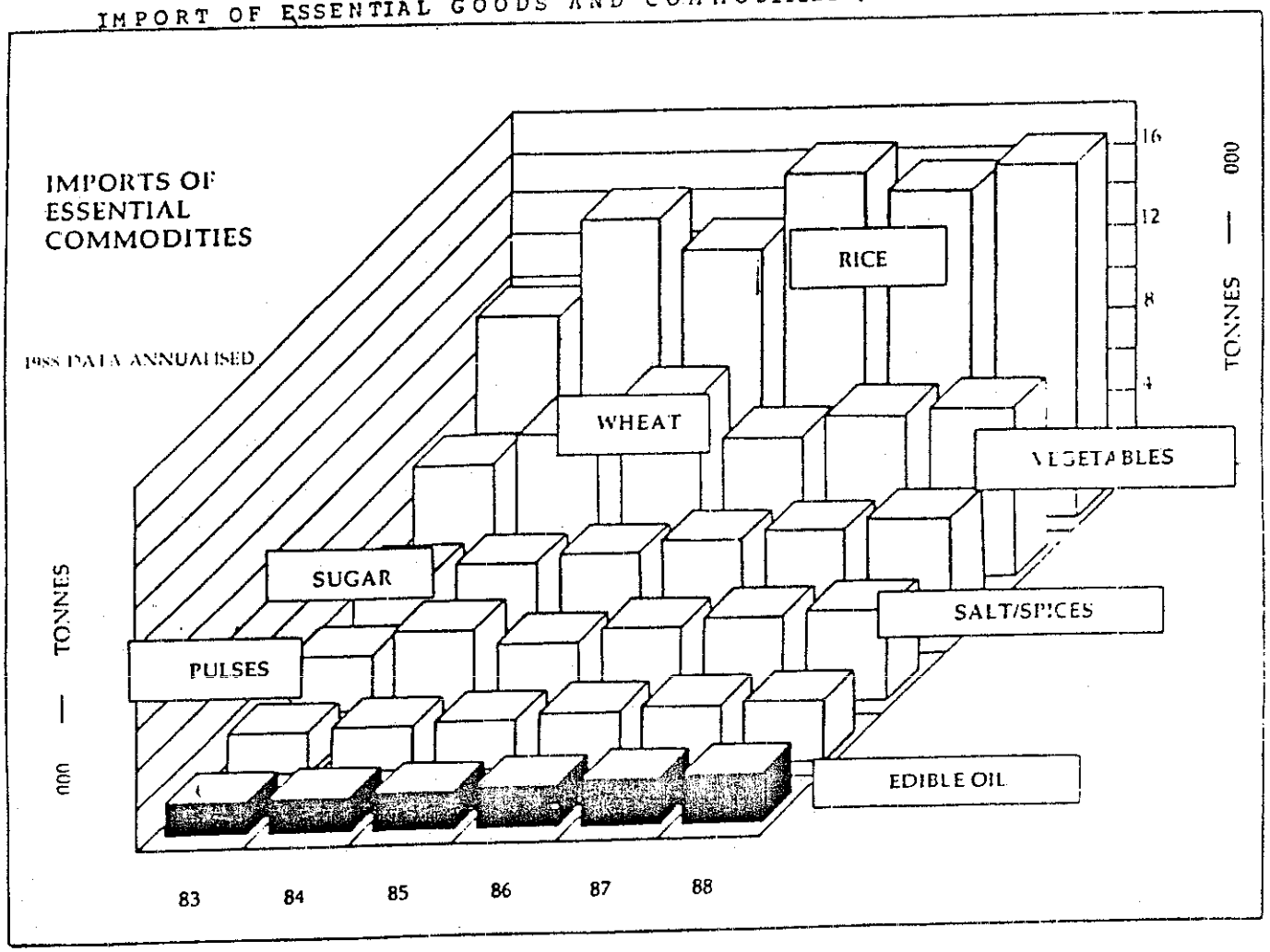
Year	Population	Decennial Increase
1911	26,459	
1921	27,086	+627
1931	29,476	+2,390
1941	33,768	+4,292
1951	30,971	—2,797
1961	63,548	+32,577 (105% incr.)
1971	115,133	+51,585
1981	1,88,741	+73,608
1985 (est.)	2,50,000	+61,259
2000	4,05,000	+1,55,000

As a consequence of this population increase there is demand for more land, need for more food,increased transportation and greater services.

There is pressure to increase the extent of revenue land. The Home Ministry has issued a note identifying 8 needs for the conversion of land for non-forest use: (1) defence (2) health (3) education (4) government offices (5) residential quarters (6) public undertakings (7) P.W.D. (8) social services. Utmost restraint needs to be exercised in asking for this conversion. Priorities should be carefully identified.

The islands are unable to support the present population with local resources. Food, building material, petroleum products, clothing and even paper have to come from the mainland and made available at subsidised rates.

IMPORT OF ESSENTIAL GOODS AND COMMODITIES (GOVT. SECTOR)



Transportation from the mainland to the islands and from island to island is inadequate and antiquated. The annual plans for the islands have tried to make provision for more vessels. There has been a time lag between the placing of an order and the supply of a vessel. Road transport is being improved by the construction of motorable roads and increase in the number and frequency of buses. Air travel is by daily flights from the mainland. A helicopter service has been operating between islands but is subject to technical problems. Most officials and their families are permitted to travel by air from the islands at State expense. Helicopter travel, though limited is highly subsidised.

The entire system in the islands is not economically viable. Systems that have to be kept going by costly and artificial means are liable to collapse at any time.

Forestry and forest-based industries:

Forestry has been the most important activity in the islands since more than a century. About 7,144 sq.km. (86% of the land area) is said to be under forest cover. Of this 41% constitutes tribal reserves so that the area available is reduced to 4,115 sq.km. Only 30% of this is commercially exploitable. Hence projections made on the assumption that 86% of the area is available for forestry is likely to be misleading.

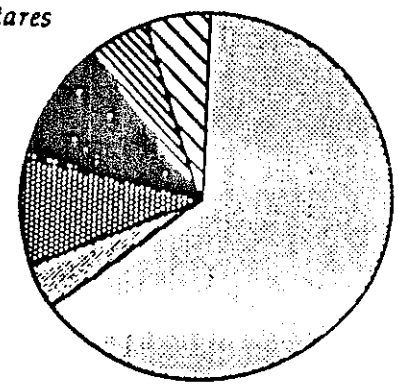
The post-1950 period has been characterised by an increasing demand for timber within the islands. Wood-based industries also have increased rapidly. Thus extraction which was around 49,000 cu.m./an in 1950 has touched 1,45,000 cu.m./an in 1986. As the number of commercially exploitable species has shot up from 4 in 1952 to 40 today the very structure of the forest changes resulting in run off, soil degradation and erosion. Although there is a good deal of reliance on Natural Regeneration of forests, the rate of regeneration is far from satisfactory. Therefore, the sustainability of forest operations is debatable.

Forest Extractions in Andaman and Nicobar Islands

Date	Average Annual Extraction in cum
Pre 1950	
1869-1929	15300
1930-1950	49700
Post-1950	
1951-1962	88800
1968-1983	1,18800
1986	1,45000

FOREST DATA
(AREA UNDER PLANTATION)

Unit: Hectares



- TEAK-9564 H.
- RUBBER-600 H. *
- RED OIL PALM-1549 H. *
- PADAUK-1500 H
- MATCH WOOD-803 H
- O APP-795 H

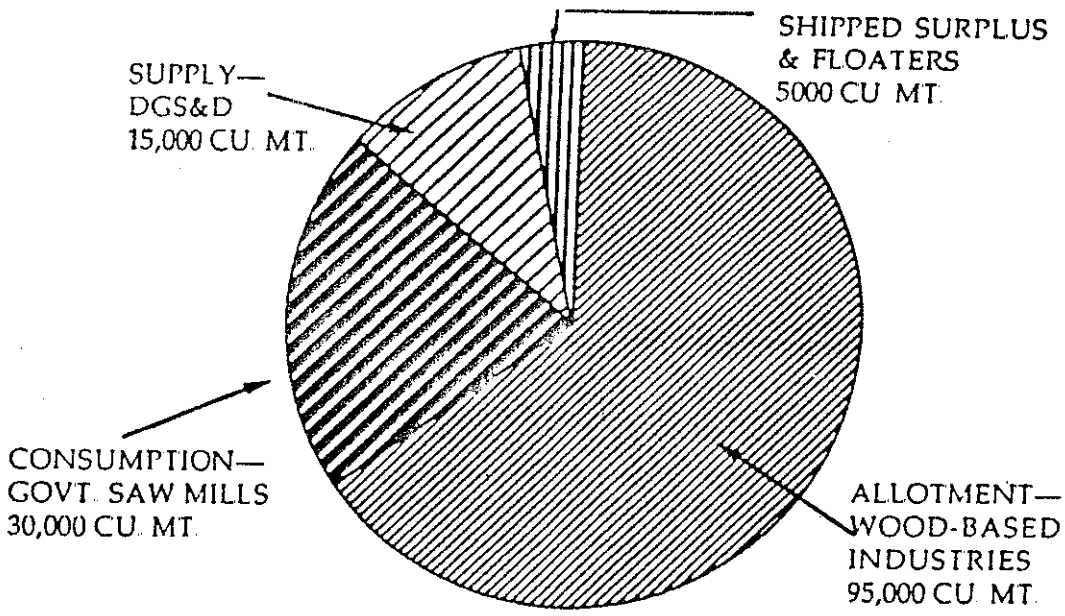
* *Forest Corporation*

Forest and other commercial plantations in the islands have come to stay. However, extension of plantations at the expense of virgin forests of a unique type is far from acceptable. The Red Oil Palm plantation started in 1975 is a point in question. 1,549 hectares have been planted and the present yields are promising. Nevertheless should a unique type of vegetation that now covers the island be destroyed for the sake of a commercial crop which has to be uprooted and replanted every 22 years in a poor soil on a steep slope ? The original forest once destroyed will probably be lost for all time.

The 9,564 ha planted with Teak by the Forest Dept. after clearing virgin forests is today a failure and the area left untouched. The Teak having failed, the question is what should be done with this relatively large area. Before destroying forests in other areas, plantations if needed should be in these 95.64 sq.km.

There is a significant increase in the demand for timber. The following diagram shows the distribution of wood to forest-based industries. Here again the question is 'Who profits, with what long term and possibly irreversable degradation to the plant cover of the islands ?

DISTRIBUTION OF EXTRACTED WOOD 1987—88



TOTAL WOOD DISTRIBUTION
145,000 CU. MT.

Agriculture in the islands has been at the expense of forest land. Up to 1901 the area cleared was 10,198 hectares of which 4,198 hectares were cultivated. The area under cultivation in 1981 was 16,544 hectares. This excludes the 18,000 to 20,000 hectares under plantations in the tribal areas. According to the Department of Agriculture the area cleared for agriculture, plantations and horticulture in all the islands stands at 48,000 hectares.

The main categories of agricultural crops are: (1) non-vegetable field crops, (2) vegetable field crops, and (3) plantation and fruit crops.

Since rice is the staple food of many of the settlers, the largest area is set apart for paddy cultivation. Twelve thousand hectares of more or less flat land is used to raise one or two crops a year. This land was converted by clearing and even burning the giant trees of the lowland Giant Andaman Evergreens.

It was soon found that part of this area was prone to floods during the monsoon period. Further, the alluvial soil is highly leached and has poor water retaining capacity. The humus and phosphorus content is low. Consequently, the production is low. Attempts are being made to augment the yield by increasing the use of fertilisers, pesticides and improving irrigation facilities by the construction of tanks, wiers and check-dams. High yielding rice varieties which respond better to application of fertilisers have been identified and are popular with the farmers. It is hoped that double-cropping and rotation with oilseed and pulse crops would improve matters.

Hand tools and wooden ploughs drawn by animals have been in use in most places. There are reports that agricultural animals are subject to 'hump sore' caused by stephanofilarial nematodes transmitted by insect vectors especially *Musca* spp. Control measures have not been successful. There is therefore a proposal to import tractors. The freightage for transport from the mainland, it is suggested, should be paid by the Government and the machines be distributed to the lucky few at half their market value. The proposal to add to the already debilitating subsidies will only increase dependence instead of developing initiative among the farmers.

The increased use of pesticides might set in a chain reaction. Given the high rainfall and prolonged rainy season, the agricultural chemicals are liable to be washed into the sea which is always close by. The accumulation of chemicals in inshore waters and their bioamplification by living systems are well-known consequences. These should be carefully avoided especially in the Andamans with their rich marine flora and fauna.

Vegetable growing has met with some success. The markets have a number of locally grown vegetables and fruits. North Andaman, Little Andaman and Neil Island are the more important centres. Banana, drumsticks and sweet potato are common. Tomatoes are available in season. Potato has not been a success. The giant african snail (*Achatina fulica*) a harmful introduction into the islands, is a serious pest on all vegetables.

Mango, citrus, papaya and sapota have been tried. Cinnamon, clove, nutmeg and pepper are grown in about 560 hectares in the islands. Oilseed crops and pulses planted in rotation with rice have been remunerative. Areca is popular.

There are 8094 agricultural holdings in the Andamans. On an average each household has two hectares of paddy land and two hectares of hilly land. As the Director of Agriculture observes "They have hardly put the hilly land into proper use". The hilly land is deforested even when the slope is high. Except for a few banana plants the soil is exposed and eroded within a season. Some hillsides have become wastelands, either invaded by noxious weeds or remaining as ugly scars on a once beautiful island setting. The trials on multiple cropping on hillsides carried out by the Department of Agriculture at Sippighat and Jirgatang are promising. However this technology has made only a small dent on the local agriculturists.

Despite the enthusiasm and dedication of the officers of the Department of Agriculture and the scientific help from CARI, the success of field and plantation crops is not encouraging. The utilisation of land and water by the farmer is not efficient and so farming becomes uneconomical. A track record of over 20 years shows that the land which could support the giant evergreen forest has not been able to support worthwhile agriculture.

The fisheries potential in the Andamans is enormous Fishing operations in the island waters have been reported since 1908 A private company was floated in the forties It was wound up despite its reporting that the "potential was enormous' Another operation started in 1951, also failed The Department of Fisheries was set up by the Andaman and Nicobar Administration in 1955 Since the islands did not have a non-tribal population of local fishermen, a "fishermen settlement scheme" was initiated in 1955 and families of fishermen from Kerala and Andhra were brought and settled in the Andamans Something has been done but much more has yet to be done Estimates place the annual available catch at 50,000 to 4,74,000 tonnes The actual catch in 1986 was 10,638 tonnes

Several techno-economic surveys on fisheries potential have been conducted The need for harbours and processing plants has been recognised A joint TataThai venture for deep-sea fishing was launched from Port Blair in 1978-79 Indian as well as international investigative research on oceanography and marine biology has been carried out by several vessels over a span of several decades The CMFRI established a research centre at Port Blair This was subsequently taken over by CARI and forms its Division of Fisheries Science

Fisheries in Andaman and Nicobar Islands

Fishermen (1986)		
	Full time	2,261
	Part time	435
	Occasional	203
Fishing Fleet (1987)		
	Country craft	1,082
	Mech. boats	88
Fishing Equipment (1986)		
	Trawl nets	6
	Gill nets	714
	Cast nets	574
	Anchor nets	26
	Shore seine nets	28
Fish Landing Centres		
	Andamans	38
	Nicobars	16
Facilities		
	Ice plant	5 tonne capacity
	Chilled storage	15 tonne capacity
Fishermens Training Centre		1

Source: Department of Fisheries, Andaman and Nicobar Administration

Shell fish form an important marine product in the Islands The Z S I has carried out several studies on the *Trochus* and *Turbo* fisheries as well as on the giant clams of the genus *Tridacna* of which four species are found in the Andaman and Nicobar seas As a result of these studies, shell fishing has been regulated by the Fisheries Regulation Act of 1938 and the Shell Fishing Rules of 1978. Rights to fish for shells in nine identified fishing areas are auctioned by the Andaman and Nicobar Administration which also controls extraction and export of the shells to overseas markets

Fish Landings in Andaman and Nicobar Islands

	tonnes
1950	44
1955	69
1960	129
1965	224
1970	500
1975	1,104
1980	1,803
1984	6,226
1986	10,638

There is a wealth of resources in the marine ecosystem that remains untapped These have been alluded to in an earlier part of this report It is surprising that no serious and successful attempt has been made to harvest these resources Mariculture has immense possibilities if modern technologies are adapted to local conditions and developed with proper infrastructural facilities ONGC and Oil India have begun exploratory drilling for oil and gas in the ocean bed The studies initiated by NIO could be intensified to produce results

The basic reason for this inertia in utilising the marine wealth is, according to those who were kind enough to respond to our questions that our planning stems from a mainland viewpoint concentrating on a land based pattern If a country like Iceland can develop fisheries in the cold waters of the North Atlantic, there is no reason why India cannot do the same in the seas around the Islands Thailand which a few years ago was behind India in deep-sea fishing has outstripped us

Tourism

Tourism is one among the major activities proposed for the Islands The scenic beauty of sunrise and sunset, of beach and creek, of secluded islands and rich coral beds can attract visitors An IUCN study *Ecological Guidelines for Island Development* by McEachern and Towle has given guidelines for the development of tourism in island settings (pp 46 77) This development needs integrated planning at the highest level rather than become a single project decision made by outsiders insensitive to an island's distinctive characteristics

The type of tourism and the strategy to be employed for its development should be decided in advance keeping in mind environmental values and infrastructural needs The design, style and location of structures, control of litter and disposal of waste have to be foreseen and planned for Adequate and fresh supplies of food and beverages have to be ensured The density of tourists should not destroy the aesthetic and other values of the Islands Access to beaches should be carefully balanced between overcrowding and the exclusiveness of a high tariff clientele

Tourism in the Islands can destroy the very basis on which it is built The "unspoilt" can be "spoilt" by the construction of large hotels and accessory facilities The "waste loading" could exceed the assimilative capacity of the area This puts off the visitor seeking peace, beauty and the enchantment of unspoilt nature In the meantime, advertising increases the influx of a different type of tourist To satisfy the demands of large groups with urban tastes the promoters of tourism try to remake the face of the Islands This has an impact on the culture and quality of life of the local people

A third type of tourist follows The visitor is rich demanding seeking diversion, distraction and self satisfaction Casinos and cabarets spring up Saunas and massage parlours become euphemisms for vice dens Men and women are used for the entertainment and comfort of this type of tourist

(Figures 3 to 5 schematically represent the inputs/outputs of each of these types of tourism.)

As far as the Andamans are concerned, the main attractions are their scenic spots and wilderness areas There is good potential for water sport especially in the numerous protected creeks These could deteriorate rapidly due to mass tourism Providing infrastructural facilities to attract conventional tourists will require high investment Water is the most critical local resource Most other inputs will have to come from the mainland over a thousand kilometres away To be profitable it may be necessary to promote large scale tourism This will only help degrade the environment

Tourist Arrivals in the Andamans

Year	Foreign Tourists	Indian Tourists
1979-80	440	4,050
1980-81	845	7,500
1981-82	1,808	8,835
1982-83	1,721	12,721
1983-84	2,025	14,020
1984-85	976	16,000

Source: Basic Statistics (1985)
Data on arrival of Indian tourists pertain to calendar year

The above table on tourist arrivals is a pointer to present trends It is likely that attempts will be made to divert the Indian tourist holidaying in Kathmandu Bangkok and Singapore to the Islands and thereby stop the outflow of foreign exchange An ecological, cultural and economic cost-benefit analysis at the highest level is urgently called for before sectoral interests decide issues

Free Port

We have not been able to examine the proposals for a free port in the Andaman and Nicobar Islands. Yet we were asked our views on the proposal. There was an indication that the free port could be located in the Great Nicobar.

The issues are complicated as there are political, strategic, commercial, socio-economic and environmental angles to such a proposal. Our remarks will only be with regard to the environmental impact of such a proposal.

The location of a free port in the Great Nicobar is unlikely to be in the Campbell Bay Area. This area is being rapidly deforested for the township, airstrip and defence establishment. The area is also subject to seismic tremors and tidal waves. (The latest incident was in February 1987 when part of the breakwater was washed away with the loss of an engineer's life and injury to others.)

South or Galathea Bay has been mentioned as another possible site. The Galathea river joins the sea here. Thickly wooded hills enclose a flat expansive beach.

The development of this area would mean destruction of the vegetation not only within the port area but also in the hinterland. The harbour and other construction works will make inroads into the surrounding areas for sand and stone, both scarce commodities.

The influx of a large population will need a chain of service facilities. As there is no local supply to meet the needs of such a port, most things from food to fuel will have to be imported. Skilled manpower will also have to come either from the mainland or from the countries of southeast Asia. The free port will thus influence the whole Island if not the entire group of Islands.

The Great Nicobar is extremely rich in natural wealth especially in its unique vegetation. Not much of this will remain once the area is "developed".

Speculation about the possibility of a free port has already raised land values. The commitment of the settlers to farming is being further eroded because of rumours of a "Hong Kong type" of development.

RECOMMENDATIONS

Long term

1) The long-term developmental strategy needs a change in emphasis. Land based planning should take a secondary place in the development of the Islands and exploitation of the resources from the sea should be given greater importance.

The marine wealth has to be harvested by deep-sea fishing through a well equipped and properly manned fishing fleet. An adequate infrastructure of fishing harbours, freezing, processing and canning facilities has to be created without delay.

Mariculture also has great potential. The Fisheries Department should adapt recent technologies to local conditions and in collaboration with CMFRI, CIFNET and other expert groups initiate work without delay. Here also facilities on land and in water should be built up.

Since earlier attempts at deep sea fishing and mariculture have not been successful, the causes of this failure need to be identified and appropriate remedial measures undertaken.

There are two groups in the Islands which have exhibited familiarity with the sea—the Nicobarese and Karens. These should be motivated to participate in this development. Any new immigration into the island should be of specialised groups capable of exploiting the sea resources.

2) The land area and the land resources are basic for the survival of the Islands and their inhabitants. The present manner of utilising them is not conducive to prudent use. Given the ecological role and linkages of the forest utmost priority is needed in preserving the forest cover. Therefore : (a) there should be a progressive reduction in timber supplied to industries or to the mainland (including the Railways and Defence). (b) Protection of forests being necessary, adequate staff with required support and means to enforce the law needs to be provided.

3) Forest land should not be converted into revenue land except in very exceptional circumstances. Strict action against new encroachments must be taken.

Immediate action

1) The present population of the Andaman Group of Islands exceeds the carrying capacity of local resources. Food, clothing, building material, paper and petroleum products come from the mainland and some of these are in very short supply. Fresh water, available only by precipitation, is in short supply during the dry months or during long dry spells during the monsoons. Therefore: (a) there is need to check immigration into the islands by instituting an entry permit for a specified stay even for mainland Indian citizens. (b) Households should be encouraged to store rain water and house architecture must include rain-water collecting and storing facilities. (c) Proper town planning and installation of sewage treatment plants should be part of urban growth especially in Port Blair, Mayabundar, Rungat, Campbell Bay, Malacca etc.

2) Inter-island communication (VHF or satellite) needs to be improved. So also inter-island shipping, both for the passenger and cargo traffic, needs to be modernised and improved.

3) Agriculture production needs to be encouraged. The know-how for better rice crops, vegetable gardens, hill-side multiple cropping should reach the farmers and be carried out on a larger scale. Farmer education and motivation needs to be improved. Unutilised excess land may have to be resumed by Government and redistributed.

Uncontrolled multiplication of low-yielding cattle and of goats is becoming a menace in urban agglomerations. Vegetable crops and tree saplings are being destroyed. The "hump sore" disease is spreading. Proper livestock improvement and control is needed.

4) A land use survey is being conducted by another group appointed by the Government. The enclosed land use map is based on information kindly supplied by the Andaman Forest Department. Revenue lands, tribal reserves and forest reserves are indicated in these maps.

5) Reserves set aside for the aboriginal tribals—Jarawa, Sentinelese, Onge and Schompen—should be inviolate whatever be the pressures for land and timber. Attempts at winning over "hostile" groups and in resettling the Onge and Schompens are suspect and must be immediately evaluated by the A.S.I.

6) Tourism of a selective nature, which does not harm the aesthetic and environmental values of the Island should be promoted. Attempts at easy gains through casinos and saunas should be seriously discouraged as they will destroy the Islands and the people. The area from Chiriyatapu to Cinque Islands could be developed for international tourism.

CECIL J. SALDANHA

PROBLEMS AND PROSPECTS OF OF ENVIRONMENTAL SOLUTIONS IN THE RURAL SCENE

Prof. L.S. Prahlad Rao

When I addressed a similar group under this programme on the above subject some time back, a few very vital and interesting questions cropped up in the discussions on the issue of environmental problems vis-a-vis the rural scenario. Quite a few of the participants had reservations on treating the environmental issue specially with the rural context as the focus, as they felt that the rural and urban distinction was famous in dealing with the environmental issues. I felt this definitely merited serious consideration. But looking at the very vast ramifications of the environmental question, one has perforce to view the issues to a certain extent specially and subsequently build up a network carefully considering the interphases. We all know in the Indian context, we have over 5,7600 villages and hence "if villages perish India persishes". We also realise that it is indeed a far cry that through central grids, we can meet the minimum basic needs of all the villages.

Essentially, as Agarwal (1984) has aptly observed, "vast majority of the rural households meet their daily needs through biomass or biomass-related products". Hence, the village society and economy is bio-mass-based and for amelioration of the condition of the rural poor there is a need to enhance the productivity of bio-mass on a holistic basis. This has been often talked about as the "Agri-sylvi-pastoral" model of development. But we are yet to see a perfect translation of the theoretical perceptions. This is because there are several gaps in our knowledge of the Natural Ecosystem. The perspectives of ecology are quite different from those of economics. Ecology emphases limits rather than continuous growth, stability rather than continuous development. Moreover, the most vital difference is that the socio-economic system is focussed on only one species - the human being. Thus it is unidirectional. If we consider this in the context of the biological wealth of our own country of nearly 45,000 plant species and 65,000 animal species, it becomes quite evident that every aspect to converge on the human being is a serious ecological mistake. In order to achieve greater yields or for other purposes man deflects the natural flow of energy, by passes natural processes, severs food chains, simplifies eco-systems and uses large subsidies to maintain a delicate artificial equilibrium. This increasing, unidirectional, unlimited human wants naturally results in an ecological crisis, upsetting the geo-biological balance of an ecosystems in which human being was only a part. It is this which calls for a reformed approach to resource consumption.

When we are talking about the environment, what is involved is really a few centimeters of soil on which terrestrial life is dependent, a few meters of water in which aquatic life can exist and a few kilometers of air without which nothing can survive. These are absolutely finite sources which requires a very careful use.

There has been a tendency to point a finger at the rural set-up for all environmental degradation. But it is really the urban high-energy and high consumptive life style which is at the root of all environmental crisis. Not only this, ultimately the rural areas come under tremendous pressure to get oriented to the consumption pattern especially of unwanted goods. A survey conducted in Thailand brought forth this point in a clear way. Except for the metropolis of Bangkok Thailand is just a rural set up with rice cultivation and forestry taking up the rest of the area. But it was observed that there was just a one-way flow in all aspects. Even marketing of the agricultural produce and forest produce became the virtual monopoly of the urbanites in Bangkok.

What is most crucially needed in the rural context is a precise, integrated land use planning. This component has been over used and abused. Land is the most vital natural resource. This is just not an environmental problem but basic to the future of the country. There are a number of competing demands on the land like: Agriculture, forestry, grass lands, mining and transport. Unfortunately the database on land is so very confusing and unreliable that meaningful planning is not possible. Land capability and land use related to soil quality becomes imperative. Connected to land use-planning is watershed management. In fact Himalayas are said to the most threatened watersheds of the world. With scientific reclamation work, sediment loads in rivers and reservoirs have been brought down. Watershed management becomes very important.

Agricultural production has been quite impressive. We have to realise that this has to go upto 275 Mt in 2000 to feed a billion people. Can we tune the land to this task ? Production permit area per unit of time is to be boosted. China is stated to have achieved this eventhough it has 1.5 times more population than India eventhough the land are is less.

While examining the carrying capacity of several countries, the fact has come to light that Burma, India, Pakistan and Thailand can become surplus countries only when inputs are guaranteed at intermediate or higher levels and we can feed 2 to 5 times more people. Loss of top soil (18.5% of the total loss at the global level), grass lands and over grazing are aspects which have not received the desired attention. Looking at the explosion in livestock numbers,urgent measures are required in this sector.

Forestry is another aspect which has the most vrital bearing on the ecosystem. Which significant strides have been made specially in Karnataka, one has to be careful not to reduce it to a game of numbers (number of samplings planted). There seems to be also a mismatch between species planted, their end-use and the land-use. This is a grave error. For example, a mismatch between a food-crop and land will cost us 6 to 12 months but a similar mistake in forestry will cost us one generation !

Biomass :

Perhaps the most beneficial and crucial aspect in a proper safeguard of the natural ecosystem might be the accent we gave to the all pervasive, all encompassing concept of biomass. It is in this context that trapping and storing of solar energy in green plants becomes the focal point. This is the most vrital process of photosynthesis. The biosphere as we see it today has been created as a result of photosynthesis about 300 to 350 million years ago. Plant material, animal waste, manure all come under the biomass concept.

Solar energy to lead to biomass production is abundant in our country. According to Vohra (1980) nearly 6000 K Cal is available per person per year in India and this added with over 88 million hectares of non-agricultural land, energy requirement from plant sources has vast potential. The total solar radiation received in India is about 60x10 MH with 250 to 300 days of sun shine in a year. A proper use of this source of energy could result in an increased output of food, biomass and energy.

In this context, the significant work done at the National Botanical Research Institute at Lucknow has to be mentioned where work on biomass production in user land using alkali - tolerant and plants has been successfully done. What was once a sleepy, useless, desested village of Banathra is now a smiling land of vegetation. This work is an indicator as to what could be achieved under the wasteland development project. Aquatic weeds like the water hyacinth and algal biomass from sewage are the other two possibilities. In the ultimate analysis, agriculture and biomass production (Forests included) have to form a symbiotic association.

It is this aspect which Dr.Swaminathan has taken into account to propose the "Photosynthetic Model of Development". From all accounts this may prove to be the panacea for all environmental ills. Protection and conservation of the Natural ecosystem just doesn't happen by just "putting a fence around an area". It is much more than this. It requires a strategy based on Genetics and evolutionary biology principles.

Advances in Biotechnology are holding out high hopes for proper environmental management. Anaerobic digestion, vermicomposting (earthworm soil conditioning), biofertilizers, organic farming are some of the new approaches which are most premising in proper maintenance of the Natural ecosystem.

But, for all this another significant problem specially in the rural area is the lack of proper awareness of environmental issues due to which the rural population has their own way of looking at the environment as an inexhanstive store house of resources for all time to come. Unfortunately there has been really no significant effort in this dissection by environmentally knowledgeable people. Either the whole thing is reduced to technical jargon and figures or a wholesale condemnation of all efforts by environmental activiste. What is urgently required is to strike a optimal balance between environmental and developmental issues which has so for evaded humanity.

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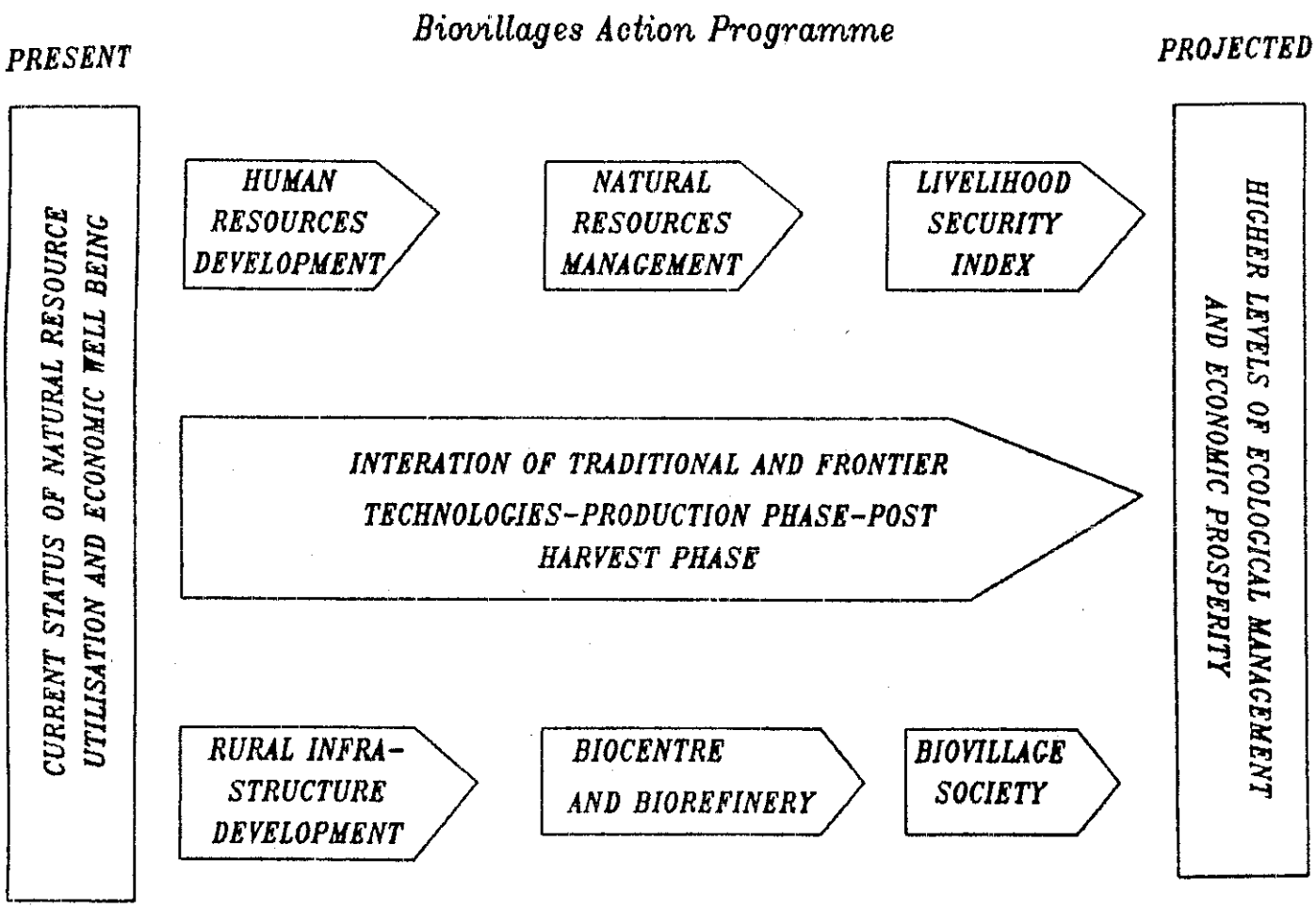
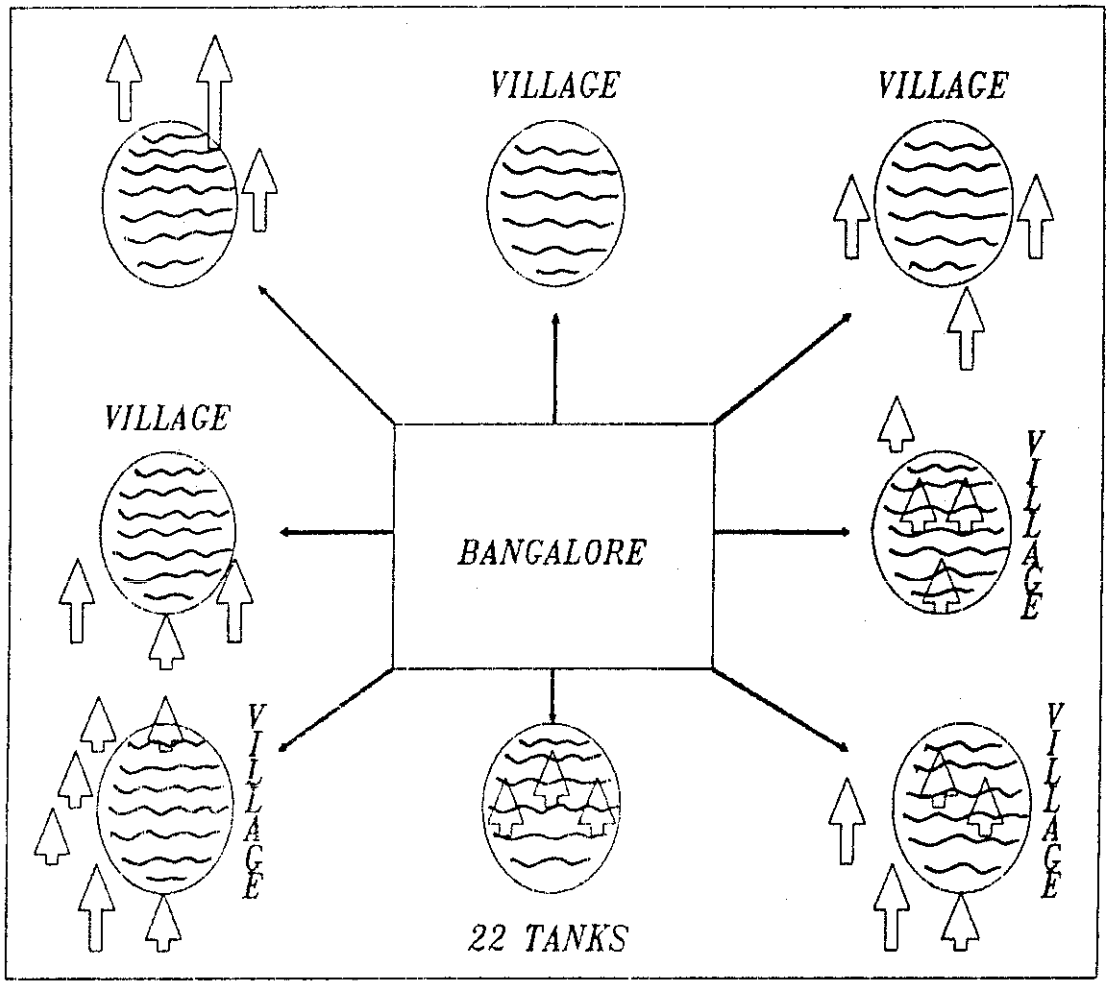
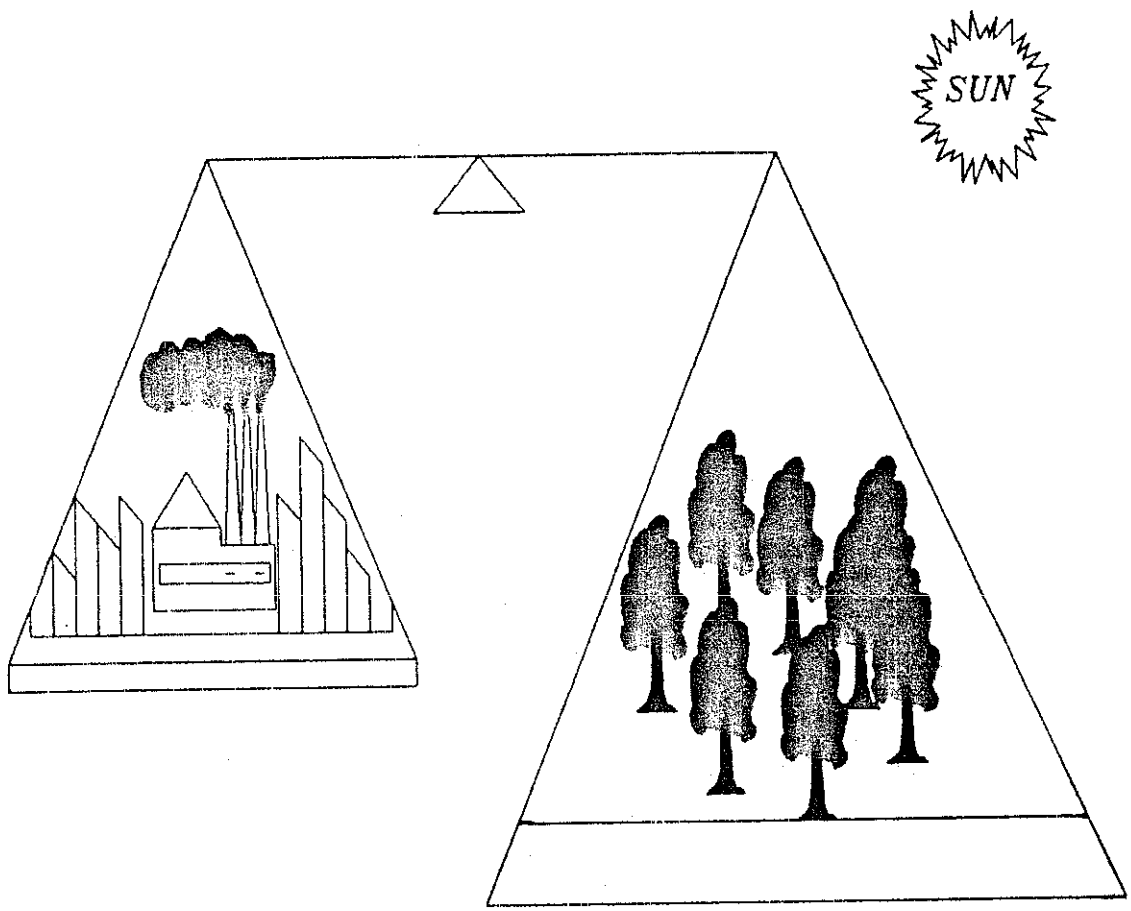


Conceptual diagram of the biovillage Project

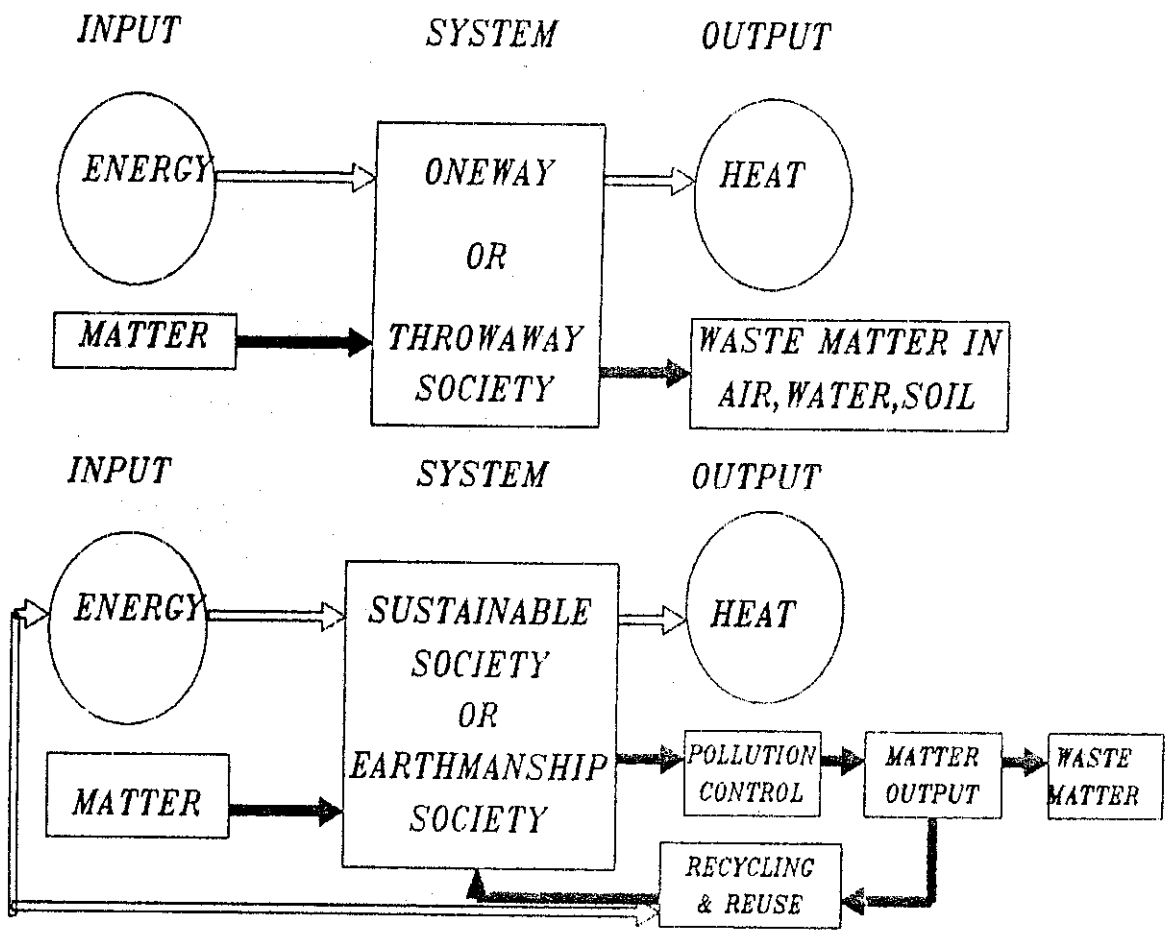


URBAN AREA ------> VILLAGE --------> URBAN AREA
MUNICIPAL AREA : 1960 ---> 68 sq.km : 1990 ---> 1500 sq.km



THE BALANCE AS IT SHOULD BE
PHOTOSYNTHETIC MODEL OF DEVELOPMENT

RELATIONSHIP BETWEEN
RESOURCES AND TYPE OF SOCIETY



WATERSHED DEVELOPMENT

(Panel Discussion on 25.8.1992)

by

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The aim of watershed development is to
(i) conserve moisture in situ
(ii) use available water optimally
and (iii) dispose of surplus water safely.

These are achieved by

(a) vegetating the foreshore areas of tanks and reservoirs, upto a little above full reservoir level.
(b) vegetating boundary bunds, contour ploughing, mixed cropping, construction of farm ponds and building gully plugs and drop structures in arable land.
(c) contour trenching, revetment, construction of diversion channels, gully plugs and drop structures in non-arable land.
(d) constructing vegetative bunds across nalas at 1m contour intervals.

It should be noted that a consequence of watershed development is that the increase in vegetation cover leads to increased evapotranspiration and hence to lower runoff. Inflow into tanks will therefore be reduced. In some cases, groundwater recharge also may decrease.

After a watershed is developed, annual maintenance grants should be provided. When there is a budget crisis, one tends to cut maintenance funds assuming that it is not going to hurt if there is no maintenance for a year. But budget crises recur in succeeding years. After ten years of neglect, it will cost ten times more to rehabilitate a watershed than if it had been properly maintained.

Simple evaluation criteria can be evolved to
(i) know how worthwhile the investment is
(ii) calculate the relation of benefit to cost
(iii) find out how well the aims have been achieved
and (iv) provide guidelines for modification or future replication.

Groundwater levels, and biomass production in different categories can serve as the evaluation criteria.

Assigning Conservation Value: A Case Study from India

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Abstract: *We assign conservation values to ecological zones, habitat types, and specific localities of the south Indian district of Uttara Kannada on the basis of occurrence of bird taxa. This is a two-step process, assigning values first to individual bird taxa and second to spatial elements based on the occurrence of birds. The attributes of bird taxa considered are geographical distribution at four levels, habitat preference, taxonomic position, and degree of endangerment. The criteria translating the attributes into values are based on the assumption that the rarer, more taxonomically unique, or more endangered the taxon, the more valuable it is. The conservation value of a given bird taxon is thus a point in a seven-dimensional space. We reduce this to three dimensions by using internal correlation and clumping of values. Each spatial element may then be assigned a conservation value based on number of taxa and the total and mean conservation value along the three dimensions. The*

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Resumen: *Hemos asignado valores de conservación a zonas ecológicas, tipos de hábitat, y localidades específicas de Uttara Kannada, que es un distrito sureño de la India, en base a la presencia de los grupos taxonómicos de aves. Este es un procedimiento en dos etapas. Primero se le asignan valores a taxa individuales de aves y segundo a los elementos espaciales basados en la presencia de las aves. Las características de los grupos taxonómicos de aves considerados son: la distribución geográfica en cuatro niveles, hábitat preferido, posición en la taxonomía, y nivel de riesgo. Para transformar estas características en cifras, se parte de la base de que los grupos taxonómicos más valiosos son los más raros, los que tienen características taxonómicas más especiales, o los que corren mayor riesgo. El valor de conservación de un grupo taxonómico dado es, por lo tanto, un punto en un espacio de siete dimensiones. Hemos reducido estas dimensiones a tres, mediante el uso de correlaciones internas y agrupamientos de valores. Cada elemento espacial recibe un valor de conservación basado en el número de taxa, y el valor total y promedio del valor de conservación a lo largo de los tres ejes. Los valores totales están altamente corre*

total values are highly correlated with number of taxa, permitting a simplification of the problem at the level of spatial elements to four dimensions. The analysis provides a basis for assigning specific conservation values to five ecological zones of the district; to fifteen natural, quasinatural, and manmade habitat types; and to 107 specific localities. Our analysis shows that degraded evergreen forests, exotic tree plantations, and urban settlements have low conservation value; the other habitat types considered rank high along one or more dimension. We also identify 12 different sets of 20 localities each that would maximize either the diversity of bird taxa or conservation value along the different dimensions. We thus attempt to synthesize diversity and quality of taxa to generate conservation prescriptions, whereas the existing methods tend to emphasize either rare or endangered taxa or total diversity. Such prescriptions would be one useful input into working out an overall conservation strategy for a geographical region.

lacionados con el número de grupos taxonómicos, lo cual permite una simplificación del problema de los elementos espaciales a cuatro dimensiones. El análisis sirve para asignar valores específicos de conservación a cinco zonas ecológicas del distrito, a 15 tipos de hábitat naturales, seminaturales y artificiales, y a 107 localidades específicas. Nuestro análisis demuestra que los bosques perennes degradados, las plantaciones de árboles exóticos, y las colectividades urbanas tienen un valor de conservación bajo; los otros tipos de hábitat considerados tienen un valor alto en una o más dimensiones. También hemos identificado 12 juegos diferentes de 20 localidades cada uno que podrían incrementar ya sea la diversidad de los grupos taxonómicos de aves o el valor de conservación a lo largo de distintas dimensiones. Así hemos tratado de sintetizar la diversidad y la calidad de los grupos taxonómicos para generar recomendaciones sobre la conservación. En contraste, los métodos actuales tienden a enfatizar los grupos taxonómicos raros o de alto riesgo, o la diversidad total. Dichas recomendaciones podrían ser útiles al elaborar una estrategia de conservación general para una región geográfica.

Introduction

Conservation action demands value judgments because such action often involves a choice among a set of alternatives. Some alternatives must therefore be considered to be of higher priority than others. It is useful to make explicit such a process of forming value judgments to help reduce the chance that arbitrary actions will be based on some momentary emotional appeal or compromise. This is the motivation underlying a number of recent attempts to assign specific conservation values to biological and landscape elements. The elements in consideration may vary from an isolated population of a plant species to a major biome such as the tropical rain forest (Nature Conservancy 1983, Usher 1986). We present here an attempt to assign conservation values, and we describe their use in deriving specific conservation prescriptions. Our work pertains to valuation of ecological zones, habitats, and specific localities in the Uttara Kannada district of the state of Karnataka in South India based on the presence and absence of bird taxa.

Study Area and Methods

The Uttara Kannada district along with the adjoining taluk (= county) of Hangal from Dharwad district (13° 55′–15° 32′ N; 74° 05′–75° 05′ E) is located centrally on the Malabar biogeographic province. The Malabar, c. 160,000 km^2 in extent, comprises of a narrow coastal strip 50–100 km in width along with the hill chain of Western Ghats running north-south parallel to the west coast between 8° and 20° N lat. (Fig. 1). The hill chain is a long band 50–100 km in width ranging in altitude between 400 and 2680 m. It is broken by just one narrow gap, the Palghat gap, over its entire length of 1600 km. The annual rainfall in this province averages 2000 mm, but it is as high as 6000 mm on the crest and as low as 600 mm in the eastern rain-shadow region. Its range of habitats includes beaches; estuaries; low-, medium-, and high-elevation tropical wet evergreen forests; and moist and dry deciduous forests and scrub (Subramanyam & Nayar 1974). There are a number of manmade habitats too. Ali and Ripley (1983) and Daniels (1989) record 586 taxa of birds (which includes 515 full species, some of which exist as two or more distinct subspecies in the Malabar) and broadly distinguish 24 major habitat types for the Malabar province.

The study area (Fig. 2) of 11,000 km^2, characterized by low hills with only a few peaks above 600 m, has a great diversity of habitats, including 21 of the 24 habitat types described for the Malabar province (Daniels 1989). Based on rainfall, vegetation, the extent of human interference, and the pattern of diversity and distribution of birds, the district may be divided into five ecological zones: the coast, the northern less-disturbed evergreen forest, the southern more-disturbed evergreen forest, the moist deciduous forest, and the dry deciduous forest and scrub (Pascal 1982, 1984, 1986; Daniels 1989).

The bird fauna of Uttara Kannada is relatively well known. Davidson (1898*a*,*b*) published detailed notes on distribution and habitat preference of birds of the district based on collections from 1888 to 1896. Subsequently Koelz (1942) published a supplementary list based on a 3-month survey. Daniels (1989) maintained detailed notes on bird taxa throughout the district over

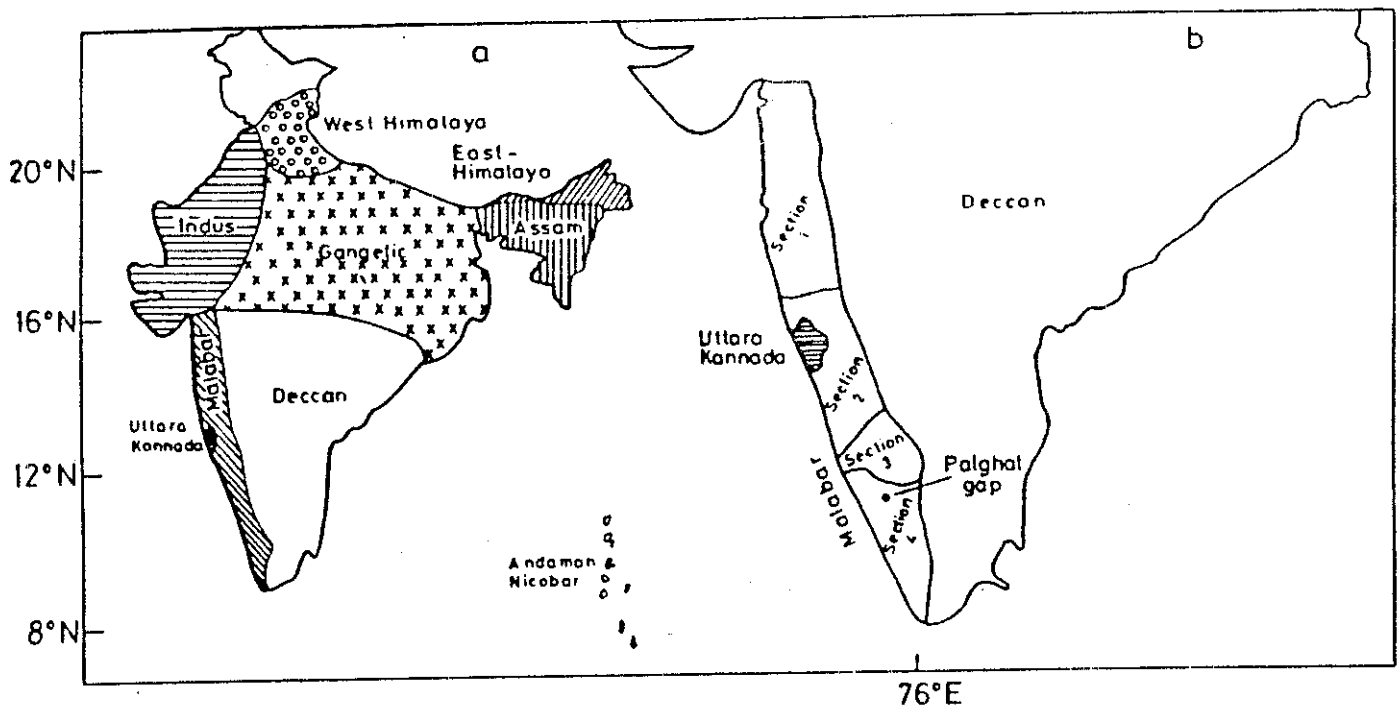

Figure 1. The Uttara Kannada district in relation to the major biogeographic provinces of the Indian subregion (a) and the four sections in the Malabar province (b)

a 5-year period involving 1018 days of field observation. During this period he visited 237 localities scattered over the district and recorded the presence and absence of bird taxa. For the sake of mapping the spatial distribution of each taxon of bird, the district was divided into 498 grids of 5 km × 5 km. Using the vegetation maps (1:250,000; Pascal 1982, 1984) and the Survey of India toposheets (1:250,000 & 1:50,000), the distribution of the major habitats of the district was mapped onto these grids. Notes were maintained on the presence or absence of each taxon by grids and by habitat types during the 5 years of field work. This information was used to assign the different taxa of birds to the respective zones and habitats. These data have been supplemented by systematic 2-hour, 600-×-200-m strip transect samples from 107 localities. These localities were chosen to encompass the total range of variation in climate, topography, and habitat types over the district. The transects were covered on foot between 8:00 and 10:00 hours in forests and associated habitats and between 7:30 and 9:30 hours in nonforest and open habitats such as marshes during the nonrainy seasons (November–May) of 1986–1988. Additional information made available by three amateur naturalists on birds in this district has also been utilized. The total was 420 taxa of birds (402 full species and more than one subspecies of some of these species) recorded over the century from this district. Daniels et al. (1990*a*) analyze the changes in the bird fauna over the time span that these records reveal.

Assigning Conservation Values

Conservation value is assigned to an element such as a taxon or a locality with reference to an *attribute* for instance, the extent of geographical distribution of a given bird taxon or the number of resident bird taxa in a given locality. The different states of such attributes are then assigned values based on a *criterion*. Thus, we may decide that the more restricted the geographical distribution of a taxon, the greater the *value* of the taxon, or the larger the number of taxa present in a locality, the more valuable the locality is. The actual values may either be ranks along a scale or a specific number (Nature Conservancy 1983; Usher 1986).

In the endeavor contemplated here the conservation values would be one of the inputs for identifying a set of protected localities. The values are computed on the basis of the presence and absence of different bird taxa in particular localities, habitats, or ecological zones. We set this up as a 2-step process, assigning values to (1) individual bird taxa, and (2) localities, habitats, or zones based on the values of the bird taxa occurring therein.

Step One: Bird Taxa

The attributes of bird taxa of the Malabar considered are the extent of their geographical distribution, their habitat preference, their taxonomic position, and their degree of endangerment. The criteria translating the attributes into values are based on the assumption that the

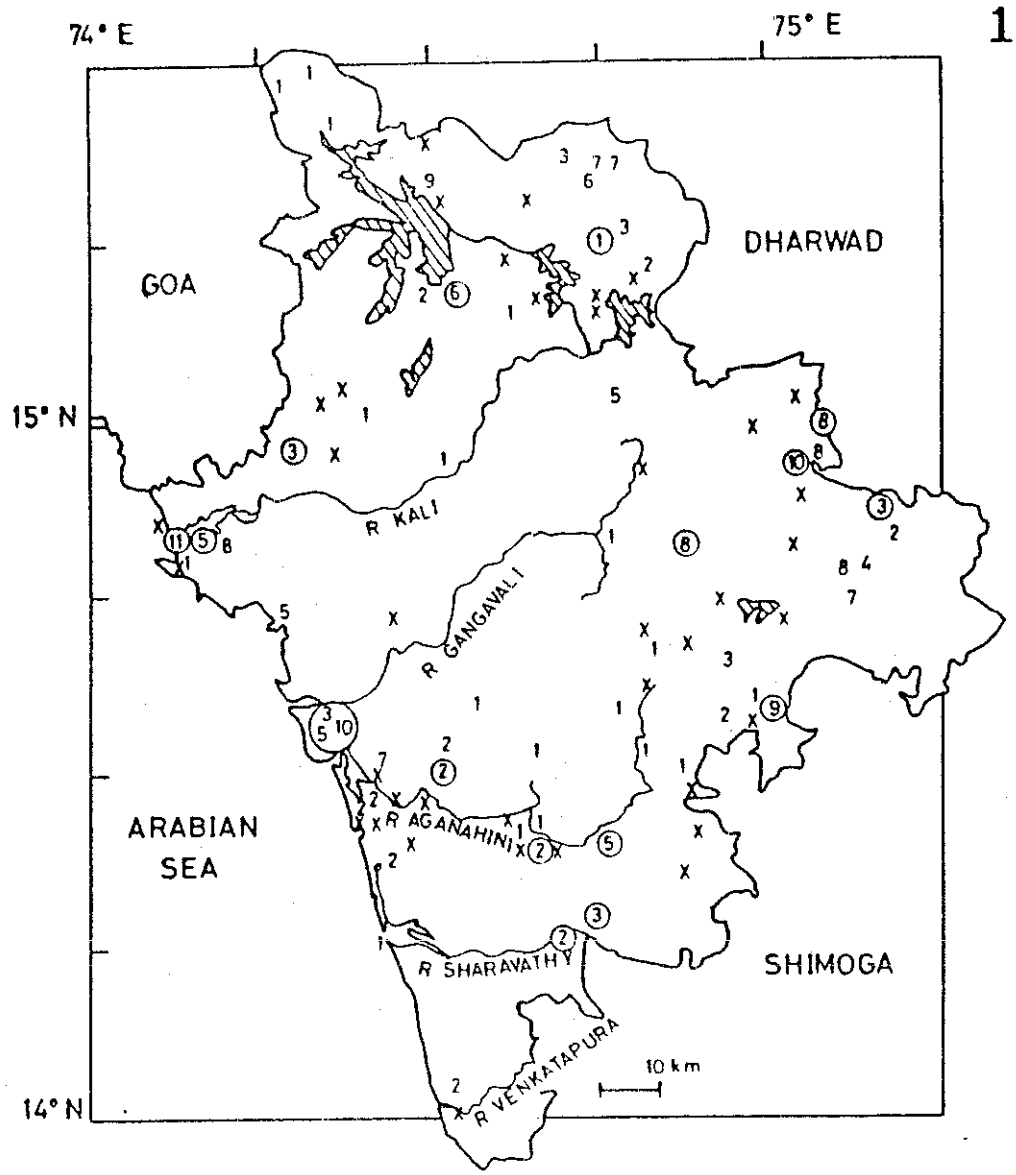

Figure 2. Uttara Kannada district and the adjacent Hangal taluk of Dharwad district showing the 107 localities sampled and the 18 localities of conservation interest. The numbers indicate the number of times a locality was represented in the 12 approaches attempted in this analysis. "X" indicates localities sampled that never occurred within the first 20 in any of the approaches. Circled localities are those recommended for conservation. Hatched areas are major reservoirs.

rarer or more restricted a taxon the more valuable it is, and the more taxonomically unique or endangered a taxon the more valuable it is (Nature Conservancy 1983; Dony & Denholm 1985; Miller et al. 1987; Wheeler 1988; May 1990). The measures proposed below ensure that all the values lie in the range 0 to 1.

We have selected for this analysis seven attributes of bird taxa. Four of these relate to the geographic range of the bird taxa; G_1, over the entire world (divided into six zoogeographic regions); G_2, over the oriental region (divided into nine subregions); G_3, over the Indian subregion (divided into eight provinces); and G_4, over the Malabar province (divided into four sections) (Chatterjee 1939; Subramanyam & Nayar 1974; Cox & Moore 1980; Ali & Ripley 1983). The conservation value for a taxon by geographic range is given as

$$G = (N - a)/(N - 1)$$

where N is the number of subdivisions at a given geographic level and a is the number of subdivisions from which the taxon is known. We treat the four levels of geographic distribution as separate dimensions in view of the distinctive patterns of distribution along each level. For instance, a taxon restricted to the Malabar may be widespread within the province. Similarly, a taxon may be found only in the Malabar in India but may be widespread elsewhere in Southeast Asia. The data on

geographical distribution used in this analysis are based on Howard and Moore (1980) and Ali & Ripley (1983).

The conservation value of each taxon by habitat preference was computed using the index

$$H = (N - a)/(N - 1),$$

where a is the number of habitats in which the taxon is known to occur and N is 24, the total number of habitats for the Malabar province; thus, birds with more restricted habitat preference are assigned higher values. This appears appropriate as birds utilizing more habitats also tend to use the more man-modified ones in the Malabar (Daniels 1989).

The conservation value of a taxon reflecting its taxonomic distinctness was calculated using the index

$$T = 1/(a \times b),$$

where a is the number of species known in the family to which the taxon belongs and b is the number of races under the species to which it belongs based on the information provided by Wallace (1963) and Howard and Moore (1980). The rationale behind such a treatment is that the races or subspecies are the lowest distinct taxonomic units below the level of species and that they indicate the totality of the genes contained in any species (Chambers and Bayless 1983). It would certainly be better to measure taxonomic distinctness on the basis of detailed information contained in the phylogenetic tree of birds, with a taxon having fewer existing relatives taking a higher conservation value than another with more relatives (May 1990). Since we do not have access to such complete information, we have used a simpler index.

The conservation value by degree of endangerment for each taxon was assigned by

$$E = p,$$

where p is the proportion of endangered taxa in the family to which the taxon belongs. We prefer this to using the available lists of threatened birds, because only three bird taxa of Uttara Kannada figure in such a list and our field studies strongly suggest that this choice is arbitrary and does not reflect the true situation. The Peafowl (*Pavo cristatus*), the Nilgiri Wood Pigeon (*Columba elphinstonii*), the Lesser Adjutant Stork (*Leptoptilus javanicus*), and the Redfaced Malkoha (*Phaenicophaeus pyrrocephalus*) are the only Malabar birds among those listed as endangered in India (World Conservation Monitoring Centre 1988). The Redfaced Malkoha, however, does not occur in Uttara Kannada. The wood pigeon and the stork are locally rather common in appropriate habitats over the Malabar (Daniels, personal observation) and the Peafowl is widely distributed in India with many pockets of local abundance thanks to strict religious protection.

In a taxonomic survey of endangered birds, Temple (1986) distinguished four types of birds: (1) taxa that are endemic to islands (2) taxa that are narrowly confined to scarce habitats, (3) taxa that are particularly sought after by human consumers, and (4) taxa that depend on easily-disturbed food chains. The first category is irrelevant to this analysis, but the other three are pertinent. Birds of prey and those in families such as Podicipedidae, Haematopodidae, Gruidae, Rallidae, Phasianidae, and Psittacidae are more threatened than others because they share some common trait (more palatable flesh, ground- or hole-nesting, poorly developed dispersal abilities). Temple argues that families in which 10% or more of the constituent birds are endangered should be considered especially sensitive. Our assignment of conservation values reflects this notion, and birds in families with more endangered taxa are assigned a higher conservation value on the basis of the proportion of endangered taxa in a family (Temple 1986).

We thus arrive at a conservation value for each of the 586 bird taxa of the Malabar as a point in a seven-dimensional space (Figs 3 & 4). The set of bird taxa of interest to us is those occurring in one of the provinces, the Malabar. Fully 40% of these are restricted to the Oriental region, and within the Orient, 29% are restricted to the Indian subregion. The distributions of conservation values at global and regional levels are therefore unimodal, with the mode occuring at the higher extreme of the conservation value. Within the subregion, however, a much smaller proportion, 17%, are confined to the Malabar province, many being shared with two other provinces. Hence this distribution is bimodal. Finally, a high proportion of taxa (41%) are distributed over all the four sections of Malabar. Hence this distribution is unimodal, but with the mode occuring at the lower extreme of the frequency distribution. Taxa restricted to India are necessarily restricted to the Oriental region; many of these are also confined to the Malabar. Hence the conservation values along these axes are highly positively correlated.

The frequency distributions of values along the other three axes are unimodal; those for taxonomic value and degree of endangerment are confined within a very narrow range at the lower extreme. This implies that most bird taxa belong to families with several species or species with several subspecies, the only monotypic family in the Malabar being the Dromadidae represented by *Dromas ardeola*. Similarly most taxa of birds in the Malabar belong to families in which only a very small proportion of species are listed as endangered.

REDUCING THE DIMENSIONALITY

The conservation value of a bird taxon can thus be represented as a point in the seven-dimensional space. Because it is difficult to visualize and inconvenient to han-

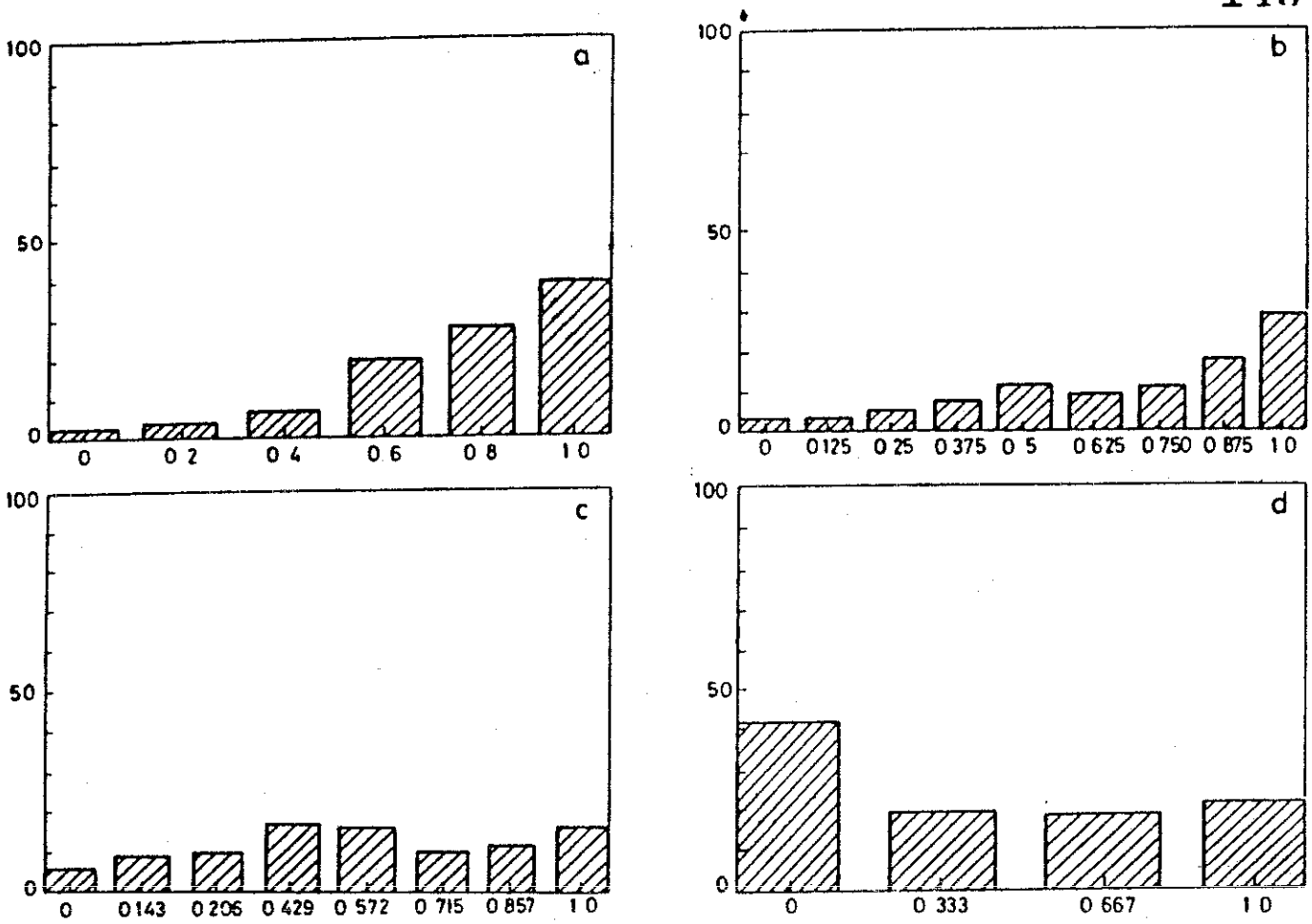

Figure 3. Frequency distribution of conservation values based on geographical distribution for the 586 taxa of Malabar birds. (a) G_1: Global; (b) G_2: Regional; (c) G_3: Subregional; and (d) G_4: Provincial.

dle the distribution of points in space of such dimensionality, it would be useful to reduce it. We may do this in two ways. First, if the conservation values in two or more dimensions are highly positively correlated, it would be enough to retain only one of those dimensions. To explore this possibility we have computed the correlation matrix in the 7 × 7 dimensional space for the 586 bird taxa of the Malabar (Table 1). As discussed above, the conservation values in dimensions G_1, G_2, and G_3 are significantly correlated among each other, and it should be sufficient to choose just one of these. The dimension to be so chosen should be minimally positively correlated to the other six. An inspection of the matrix shows that G_1 satisfies this condition. We therefore propose to leave G_2 and G_3 out of further consideration in this presentation. We did, however, look at the implications of continuing to take G_2 and G_3 into account and found that they do not change our subsequent conclusions. We have also considered the use of techniques such as principal components analysis; this does not affect the final conclusions in any way either. It therefore appears justifiable to leave out the dimensions G_2 and G_3 and thereby further simplify analysis.

As a second device for reducing the dimensionality of the problem, we looked at the distribution of the conservation values along each individual dimension. It turns out that for the dimensions of taxonomic position and degree of endangerment, most of the values are concentrated in a very narrow range between 0 and 0.05 (Figs. 4b & 4c). This is because the Malabar bird fauna, as discussed above, includes just one taxon belonging to a monospecific family (Dromadidae) and only a few taxa belonging to families such as Phasianidae, Gruidae, etc., that have a high proportion of threatened taxa. We can therefore further reduce the dimensionality of our analysis by leaving out these two attributes. Again we have carried out the full analysis retaining these dimensions and confirmed that the conclusions are not affected in any way.

We therefore suggest that it is useful to reduce the dimensionality of the valuation procedure by using internal correlations and distribution of the values over the total range. We do not, however, imply that the specific dimensions removed in our analysis would turn out to be the dimensions to be neglected in other such analyses. We propose only that all possibilities of reduc-

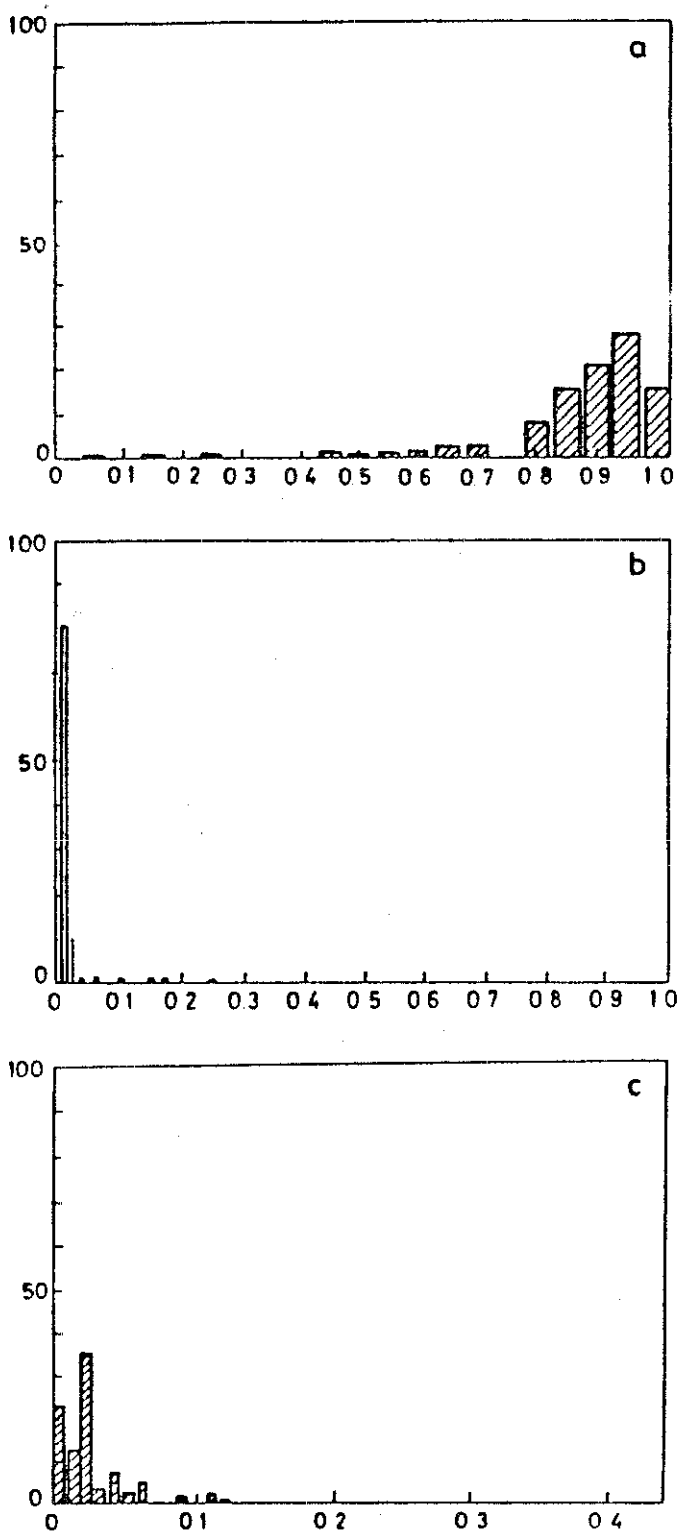

Figure 4. Frequency distribution of conservation values for the 586 taxa of Malabar birds. (a) H: Habitat preference; (b) T: Taxonomic position; and (c) E: Degree of endangerment.

tion of dimensionality should be explored and judged on a case-by-case basis.

Step Two: Geographical Element Level

The second step in the process concerns the occurrence of bird taxa in given localities, habitats, or zones. The criterion for assigning conservation value to such geographical elements could be species richness (number of bird taxa) or a measure of diversity (e.g. the Shannon-Wiener Index), the total conservation value summed for all taxa occurring in a given geographical element, or the mean conservation value of a taxon in each geographical element. We carry out this analysis with the conservation value being considered as a point in the reduced three-dimensional space of G_1, G_4, and H. We do not have adequate data on the relative abundance of taxa to compute an index such as the Shannon-Wiener diversity index. This means that any given geographical element could be assigned a conservation value along one of the following seven dimensions: richness of taxa and total as well as mean conservation value along the dimensions of G_1, G_4, and H.

Again it is possible to reduce the dimensionality of the problem. Table 2 presents a 7 × 7 matrix of correlation between the conservation values for the 107 localities. It is evident that the total conservation values along all three dimensions are very highly correlated with richness of taxa. Indeed, similar analyses for habitats and ecological zones show the same trend. We therefore retain just the simplest parameter, number of taxa, for further analysis. As before we have gone through the analysis preserving the full dimensionality of the problem and confirmed that deleting these three dimensions does not change our conclusions. We thus have reduced the problem of valuation of geographical elements to a four-dimensional problem with values being assigned for (1) number of taxa and mean conservation value in terms of (2) global geographical distribution, (3) distribution within the biogeographic province of Malabar, and (4) habitat preference.

Conservation Values

Zones

Table 3 presents the conservation values along these four dimensions for the five ecological zones, the five natural and quasinatural and seven manmade terrestrial habitats, and the three aquatic habitats. Of the five ecological zones none has the highest conservation value along all four dimensions. The coastal zone with its rich aquatic habitats has the highest value for birds with narrow habitat preference and restricted geographical distribution within the Malabar. The northern evergreen forest zone scores highest in the global geographical

Table 1. Spearman's correlation coefficient r between the conservation values under the seven attributes for the 586 taxa of the Malabar birds.

Attributes	G_1	G_2	G_3	G_4	H	T	E
G_1: Global	—	0.31**	0.33**	−.12**	−.19**	−.05	−.07
G_2: Regional		—	0.72**	0.22**	−.08*	−.06	−.04
G_3: Subregional			—	0.22**	−.07	−.03	−.07
G_4: Provincial				—	0.29**	0.08*	0.06
H: Habitat preference					—	0.07	0.11*
T: Taxonomic position						—	−.02
E: Degree of endangerment							—

*$p \leq 0.05$
**$p \leq 0.01$

distribution, harboring a number of taxa restricted to the Oriental region and Indian subregion. The moist deciduous forest zone has the highest number of taxa sheltering a large number of land birds. The dry deciduous forest-scrub zone with freshwater lakes shares the highest conservation value for habitat preference with the coastal zone. It is only the southern evergreen forest zone with its extensive man-modified habitats, especially betelnut (*Areca catechu*) orchards, that does not score the highest along any dimension. While human interference has not had an adverse effect on the total diversity of birds within the district, it has affected the "quality" of birds, generalist invaders displacing the birds more specialized to utilize the natural forests (Daniels et al. 1990*a*,*b*).

Habitats

Among the natural and quasinatural terrestrial habitats, the evergreen forest scores highest on the dimension of global geographical distribution because many forest bird taxa are restricted to the Indian subregion of the Oriental region. The moist deciduous habitat is richest in taxa, the scrub in taxa having narrow habitat preferences, and the scrub and dry deciduous forest in taxa with restricted distribution within the Malabar province. Again it is the degraded evergreen forest that is not among the highest along any of the four dimensions.

Of the manmade habitats, eucalypt plantations score high on richness of taxa and on birds with restricted distribution within Malabar. This is because in this district the plantations are in small patches and share a number of taxa from the surrounding habitats, mostly of dry deciduous forest and scrub (Daniels et al. 1990*b*). The betelnut plantations closely resemble the evergreen forest in their structure and microenvironment and share bird taxa characteristic of the latter, such as the Malabar Whistling Thrush (*Myiophonius horsfieldii*) and the Spiderhunter (*Arachnothera longirostris*). Hence they score high on birds restricted to the Indian subregion and Oriental region. Finally the cultivation does well for taxa with limited habitat preference, resembling the scrub with which it shares a number of taxa. Teak (*Tectona grandis*) follows the betelnut closely with regard to globally restricted taxa of birds. Other exotic plantations such as *Acacia auriculiformis*, coconut groves, and urban settlements do not score the highest along any of the four dimensions (Table 3).

The three aquatic habitats score quite high along three of the four dimensions. Freshwater ponds and lakes have a high richness of taxa, even exceeding that of the moist deciduous forest. Estuaries and beaches have taxa scoring high in terms of habitat preference. As expected, aquatic habitats score very poorly in terms of geographic distribution on a global and regional scale, many migratory taxa having a worldwide distribution.

Localities

This assessment of the conservation values of ecological zones and habitats is useful for developing a regional conservation strategy. Furthermore, our analysis can

Table 2. Spearman's coefficient r for the correlations between the conservation values of birds from the 107 localities.

		Summed values			*Mean values*		
Attributes	R	G_1	G_4	H	$\bar{G}_1$	$\bar{G}_4$	$\bar{H}$
R: Richness of taxa	—	0.90**	0.70**	0.99**	0.00	−.07	0.11
G_1: Global		—	0.54**	0.81**	0.42**	−.18	−.09
G_4: Provincial			—	0.74**	−.20*	0.64**	0.33**
H: Habitat preference				—	−.09	−.02	0.31**
$\bar{G}_1$: Global					—	−.28*	−.46**
$\bar{G}_2$: Provincial						—	0.35**
$\bar{H}$: Habitat preference							—

*$p \leq 0.05$
**$p \leq 0.01$

Table 3. The number of taxa of birds and the mean conservation value of a taxon in the different zones and habitats of Uttara Kannada.

Zones/Habitats	R	$\bar{G}_i$	$\bar{G}_s$	$\bar{H}$
Coastal zone	130	0.70	0.18	0.85
Northern evergreen zone	111	0.89	0.12	0.81
Southern evergreen zone	165	0.84	0.13	0.83
Moist deciduous zone	185	0.83	0.14	0.84
Dry deciduous zone	160	0.77	0.17	0.85
Natural and quasinatural terrestrial habitats				
Evergreen forest*	33	0.97	0.13	0.76
Degraded evergreen forest	36	0.94	0.09	0.71
Moist deciduous forest	43	0.93	0.13	0.72
Dry deciduous forest	28	0.88	0.14	0.70
Scrub	28	0.74	0.14	0.81
Manmade terrestrial habitats				
Eucalypt plantation	41	0.90	0.13	0.71
Teak plantation	37	0.92	0.11	0.72
Betelnut plantation	36	0.93	0.09	0.70
Other exotic plantation	35	0.83	0.09	0.71
Coastal coconut garden	29	0.80	0.09	0.71
Urban	29	0.74	0.09	0.74
Cultivation	42	0.71	0.12	0.78
Aquatic habitats				
Freshwater ponds or lakes	47	0.76	0.13	0.77
Estuarine	35	0.66	0.15	0.79
Beach	24	0.71	0.15	0.77

* Average number of bird taxa per sample has been used for the habitats because 2–20 transects were sampled in each habitat type

help pinpoint localities that merit protection under a nature reserve system on a priority basis. In the specific context of Uttara Kannada, the state Forest Department, which is responsible for nature conservation, has set up a network of nature reserves by constituting a large wildlife sanctuary at Dandeli and protecting several freshwater marshes notable for water birds as bird sanctuaries. The large wildlife sanctuary functions only on paper, being severely disturbed by the construction of several dams and a paper mill inside its boundaries. The official approach thus is of little value (Rodgers & Panwar 1988). The scientific approaches largely focus on identifying localities harboring rare or endangered taxa (Dony & Denholm 1985; Miller et al. 1987; Slater et al. 1987; Wheeler 1988) or maximizing the number of taxa protected (Hague et al. 1986). Both approaches have serious limitations in the present context. First, only three taxa of birds have been considered endangered in Uttara Kannada, and since there is reason to doubt the appropriateness of the choice, this cannot serve as a useful basis. Second, as we will see in more detail below, attempts to maximize the number of bird taxa protected would lead to a focus on secondary habitats and birds with wide ranges and habitat preference. Our attempt therefore is to bring information on a number of attributes to bear on the choice of localities to be protected.

The data base for this analysis is the 273 taxa of birds noted during the 2-hour transects over the 107 localities. This is only a fraction of the taxa actually present in each locality. For the present purpose, however, we want the data to be strictly comparable and hence do not take into account bird taxa sighted at other times in these localities. These 107 localities also include 15 of the 21 broad habitats in the district. The six habitats left out are insignificant because they occur either as small patches (dimensions less than that of a transect) or as mosaics, as in the case of a freshwater marsh-paddyfield complex.

Given the variety of information available, it is possible to devise several alternative methods of valuing the localities and ranking them in terms of conservation priorities. Table 4 lists twelve such alternatives. Each involves choice of an initial starting point and a criterion for adding another locality. The natural choice for a starting point can be a locality scoring highest on any one of the attributes, for example, the total number of bird taxa, total conservation value, or the average conservation value of a taxon in terms of habitat preference. The criterion for adding a locality may refer to some property of the totality of bird taxa represented when that addition is made. Such a property could be total diversity, total conservation value, or average conservation value of bird taxa. A decision also needs to be made as to the total number of localities to be selected. Following Rodgers and Panwar (1988) we may aim at bringing 6% of the total area under the network of protected localities. If this is a highly dispersed network, the minimal size of protected localities may be fixed at 30 km^2, since reserves of this size are considered appropriate for tropical forest birds including some of the raptors (Leck 1979; Thiollay and Meyburg 1988). This

Table 4. Localities of Conservation Interest in Uttara Kannada.

S. No.	Procedure followed: Criteria	Starting point	Criteria for subsequent choices	No. of taxa (out of 273), habitats (out of 15), predominant habitats and zones (out of 5) represented in the first 20 localities chosen: Taxa	Habitats	Predominant habitat type	Zones
1	Maximizing number of bird taxa	The locality with the highest no. of taxa	Choosing the next locality with the maximum no. of taxa different from those that have already been included	212	6	Marsh, beach, and manmade	5
2		The locality taking the highest rank $\overline{G}_1$	As in 1	239	9	Marsh, beach, and manmade	5
3		The locality taking the highest rank $\overline{G}_4$	As in 1	244	8	Marsh, beach, and manmade	5
4		The locality taking the highest rank under $\overline{H}$	As in 1	244	8	Marsh, beach, and manmade	5
5		Localities ranking the highest under no. of taxa $\overline{G}_1$, $\overline{G}_4$, and $\overline{H}$	As in 1	238	8	Marsh, beach and manmade	5
6	Maximizing total conservation value	Locality ranking the highest under $\overline{G}_1$	Next locality chosen such that it maximizes the total conservation value	242	8	Marsh, beach, and manmade	5
7		Locality ranking the highest under $\overline{G}_4$	As in 6	229	9	Marsh, beach, and manmade	5
8		Locality ranking the highest under $\overline{H}$	As in 6	243	7	Marsh, beach, and manmade	5
9	Maximizing the value per taxon protected	Locality ranking the highest under $\overline{G}_1$	Next locality chosen such that the value per taxon remains at the highest level possible	109	5	Evergreen forest	3
10		Locality ranking the highest under $\overline{G}_4$	As in 9	162	5	Beach and marsh	1
11		Locality ranking the highest under $\overline{H}$	As in 9	165	8	Beach and marsh	3
12	Equal representation of all 4 attributes	Localities ranking the highest under no. of taxa, $\overline{G}_1$, $\overline{G}_4$, and $\overline{H}$	Those ranking the next and thus up to the first five ranks	207	5	Marsh and evergreen forest	5

suggests that we should identify about 20 localities for this purpose.

The first eight alternatives listed in Table 4 all lead to essentially similar results because the total conservation value is highly correlated with the total number of taxa. These procedures all lead to representation of a high proportion of taxa (about 240 out of a possible 273), habitat types (six to nine out of a possible fifteen), and all five ecological zones in the first 20 localities selected. A major drawback of these choices is the emphasis on secondary, manmade habitats and taxa with broader habitat tolerance. Such habitats and taxa do not really need special conservation efforts. Alternatives 9 through 11 attempt to maximize average conservation value. Hence they tend to emphasize taxa with narrow geographical ranges or habitat preference, a relatively small number of total taxa being represented in the top 20 localities. The last alternative, 12, attempts to bring together the desirable features of both sets of alternatives. It selects the localities with the five highest scores on the four attributes, namely the total number of taxa, average conservation value along two levels of geographic distribution, and average conservation value on habitat preference. Because of some common representation this leads to the selection of only 18 instead of 20 localities. While with this procedure the total number of taxa and habitats represented is somewhat lower than for the first eight procedures, it ensures good representation of primary habitats deserving urgent attention, namely the evergreen forests, beaches, estuaries, freshwater marshes, and dry scrub (Table 5). Figure 2 shows the distribution of all the localities, 66 in all, that were identified as worthy of preservation by any of these 12 procedures and the number of procedures in which each locality was represented. The 18 localities of procedure 12 are specially highlighted as we believe these represent a very good combination of the various attributes that may be employed toward selecting localities for conservation (Table 4).

Discussion

Valuation of localities of high priority for conservation purposes is one of the many significant inputs to a conservation strategy. However, most often it is limited by choosing just one set of organisms such as flowering

Table 5 Attributes of 18 localities identified as possessing the five highest conservation values along the four dimensions of total richness of taxa (R), mean value for geographical distribution on a global scale ($\bar{G}_1$), mean value for geographical distribution on the scale of the Malabar ($\bar{G}_4$), and mean value for habitat preference ($\bar{H}$).

Locality	Ecological zone	Habitat	Dimension
Sunkeri	Coastal	Estuary	$\bar{H}$
Sanikatta	Coastal	Estuary	$\bar{G}_1$
Madnegeri	Coastal	Estuary	$\bar{G}_1$
Thenginagundi	Coastal	Estuary	$\bar{H}$
Karwar	Coastal	Beach	$\bar{G}_1$
Bargadda	N. evergreen forest	Evergreen forest*	R
Patoli	N. evergreen forest	Evergreen forest*	R
Anegundi	S. evergreen forest	Evergreen forest	$\bar{G}_1$
Doddamaneghat	S. evergreen forest	Evergreen forest	$\bar{G}_1$
Unchalli	S. evergreen forest	Evergreen forest	$\bar{G}_1$
Mastimane	S. evergreen forest	Evergreen forest	$\bar{G}_1$
Malamane	S. evergreen forest	Evergreen forest	$\bar{G}_1$
Bharatnalli	Moist deciduous forest	Freshwater lake	R
Madurahalli	Moist deciduous forest	Freshwater lake	R
Sambrani	Dry deciduous forest or scrub	Freshwater lake	R
Salgaum	Dry deciduous forest or scrub	Freshwater lake	$\bar{H}$
Nyasergi	Dry deciduous forest or scrub	Freshwater lake	$\bar{G}_4$
Yelavatti	Dry deciduous forest or scrub	Scrub	$\bar{H}$

* With a considerable admixture of trees typical of the moist deciduous forests

plants, or as in this case, birds, for the evaluation. It would be ideal if other groups of organisms such as insects, amphibians, and mammals are also included in the analysis. For instance, if we go by diversity alone in the evaluation procedure, it can be misleading because bird diversity in Uttara Kannada is negatively correlated with angiosperm diversity (Daniels 1989) and insect species diversity is correlated with neither of these (Gadagkar et al. 1989). The analysis discussed above has not, however, emphasized diversity alone, nor does it try to recommend the sole use of birds in a conservation evaluation procedure. Birds were chosen primarily because a good deal of data is available on their status and distribution locally, regionally, and even continentally. Such data bases are rather incomplete for most other groups of organisms in India. A second limitation of this approach is that it leaves out details of the area of each protected locality and the distances separating them. Third, it does not specifically look into endangerment due to human pressures, the ecological roles played by birds, and other relevant issues such as social acceptability, cultural and aesthetic appeal, and long range economic benefits (McNeely et al. 1990). We are therefore conscious that a whole range of issues would have to be brought in before a conservation strategy is given proper content (Gadgil, 1991). We have already looked at some of these issues in the context of working out an ecodevelopment strategy for Uttara Kannada (Gadgil et al. 1985–86). In a companion paper to this study we have elaborated a first proposal for a broader conservation strategy that takes into account many of the aspects left out here (Daniels et al., in preparation). However, within this overall context we believe that derivation of conservation prescriptions based on an explicitly stated procedure with all assumptions clearly exposed as has been done above is very useful.

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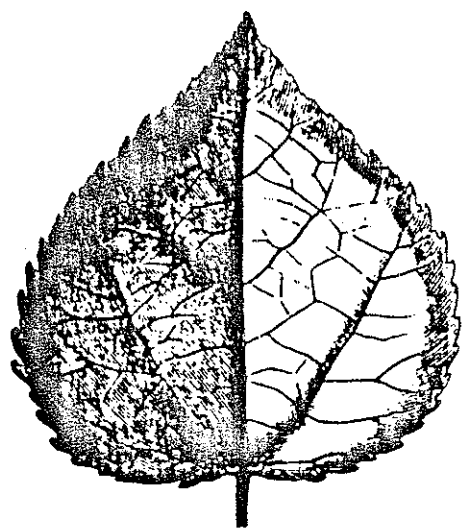

DISSEMINATION AND EVALUATION OF FUEL EFFICIENT AND SMOKELESS ASTRA STOVE IN KARNATAKA

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ABSTRACT

Fuel efficient and smokeless ASTRA stoves are being disseminated in Karnataka since 1984. A number of studies have been conducted to study the acceptance and performance levels of the ASTRA stove at micro and macro levels. The major findings of these studies are analysed with respect to the level of acceptance and performance based on measurements, as well as opinions of housewives.

The results at macro level showed that 40 per cent households were not using the ASTRA stove and 45 per cent households reported a higher fuel consumption in the ASTRA stove. However, all the studies indicate that 80 per cent of the households reported smokelessness in the kitchens. Removal of smoke seems to be an important factor in determining the acceptance of the stove. The diffusion strategy adopted in Karnataka has been analysed and implications are drawn for improvements. There is a need for more research for developing different models of the ASTRA stove for different food zones.

INTRODUCTION

Cooking is a dominant activity in rural areas of the Third World. In the recent past, there has been a greater awareness of the energy, environmental and health aspects of the cooking activity. During the past few years, across the Third World over a hundred wood stove diffusion programmes and a vast number of tree planting schemes have been launched (Agarwal, 1986). In India also, fuel efficient and smokeless stoves have been developed and disseminated in different states. In Karnataka, the ASTRA (Application of Science and Technology to Rural Areas) centre of the Indian Institute of Science, Bangalore, has developed a fuel efficient and smokeless stove called the ASTRA stove (Lokras et al, 1983) with financial assistance from the Karnataka State Council for Science and Technology (KSCST). The ASTRA stove was disseminated at the micro level by ASTRA during 1983-84. Based on the success of this programme, the State Government has undertaken large-scale dissemination of ASTRA stoves since 1984.

A number of evaluation studies have been conducted in Karnataka at the micro and macro levels. An attempt is made here to analyse the performance and the level of acceptance of the ASTRA stove at the micro level (where the stoves were disseminated by ASTRA) and at the macro level (where the stoves are being disseminated through the government). The stove dissemination programme in Karnataka is analysed and implications are drawn for developing strategies to improve the acceptance and performance levels of the ASTRA stove.

FEATURES

The ASTRA stove is a high efficiency stove designed to permit simultaneous cooking in three pans. This high ther- [illegible] two principal design factors, namely:

a) Increased generation temperature by controlled and optimized excess air in combustion; and

b) Improved heat transfer efficiency by proper dimensional and structural design of the passages with respect to the pans.

The ASTRA stove is a mud stove (Fig 1) built *in situ* with stove holes custom-built to suit individual household vessels, consisting of an enclosed firewood feeding port permitting long pieces of wood to be used, a grate on which firewood burns, ports for primary and secondary air, snugly fitting pan seats and a chimney to remove the smoke. In the laboratory (Lokras et al , 1983), a Percent Heat Utilisation (PHU) in the range of 40-45 per cent and a Specific Fuel Consumption (SFC) of 150 gm per kg of cooked food has been obtained It is possible to reduce the SFC further by using the stored heat in the stove body. The cost of a stove is around Rs. 120, of which the asbestos cement pipe and labour wages account for nearly 50 per cent of the cost The cost can be reduced further (to about Rs 100) by using handmade circular mud rings for the chimney. A trained stove builder and an unskilled worker can build a stove in 10-12 hours Anyone can be trained in stove construction within one week, and stove construction manuals are also made available for those who are keen to learn

FIELD STUDIES ON THE ASTRA STOVE

ASTRA and KSCST have conducted a number of studies at the micro and macro levels The present report is based on the findings of the following studies* :

1. *Ungra Study* : ASTRA conducted periodic studies on the stoves in Ungra area during 1984, 85, 86, and 88 This study conducted by Ravindranath et al (1989), would be referred to as the 'Ungra study'.
2. *KRVP Study* : ASTRA, with the assistance of KSCST and the teachers of Karnataka Rajya Vignana Parishad (KRVP), conducted an extensive study covering all the 3 food zones during 1986. This study, conducted by Jagadish et al (1987), would be referred to as the 'KRVP Study'
3. *Intensive Study* : ASTRA conducted an intensive study of the performance of the ASTRA stove in 3 districts, each representing Rice, Ragi and Jowar food zones during 1987. This study, conducted by Ravindranath et al (1988), is referred to as the 'Intensive study'.
4. *Karnataka Study* : Revankar et al (1989) conducted an extensive survey covering 40 taluks in 14 districts in Rice, Ragi and Jowar food zones during 1988. This study would be referred to as the 'Karnataka Study'

Micro Level Dissemination in Ungra Area

ASTRA has a village research centre at Ungra in Tumkur district. The ASTRA stove was field tested in and around Ungra village (Ragi zone), as well as at Unchigi in Uttara Kannada district (Rice zone) The following steps were adopted during field testing :

Step 1 : A few stoves were built for field testing in Ungra village, under the supervison of ASTRA scientists. The housewives were instructed on the method of operation

Step 2 : The housewives, after using the stove, were convinced of its benefits and requested ASTRA to build such stoves in their kitchens

Step 3 : ASTRA trained several village youths in the construction of stoves ad they, in turn, built about 100 stoves in Ungra.

Step 4 : As the news of these stoves spread to neighbouring villages the demand for the stoves increased and several villagers were selected and trained in stove construction for neighbouring villages

Thus, about 450 stoves were built during 1983 and 1984. The two crucial factors to be considered are : firstly, the stove construction quality was initially monitored closely by ASTRA scientists and secondly, the proper method of operation and maintenance was initially explained to the women by ASTRA scientists.

Dissemination of ASTRA Stove at Macro Level

After the positive response from Ungra (in Tumkur district) and Unchigi (in Uttara Kannada district) areas the State Government decided to disseminate the ASTRA stove on a large scale under the National Programme on the Demonstration of Improved Chulha (NPDIC). The strategies that were adopted and the institutions that were involved, are described below and in Table 1

Department of Non-Conventional Energy Sources (DNES)

As a part of the national programme, DNES promoted the stove programmes, fixed targets for Karnataka and also provided the subsidy component to the Karnataka Government.

Department of Rural Development and Panchayati Raj (RDPR)

At the state level, Dept. of RDPR is in charge of the stove dissemination. RDPR fixes the targets to the districts, takes policy decisions and provides funds for implementing the programme to the districts

Karnataka State Council for Science and Technology (KSCST)

The role of KSCST was to coordinate and monitor the programme. Initially, KSCST selected the district level stove experts and organized training programmes in the construction and maintenance of the ASTRA stove. These experts were then posted to the districts for conducting training camps for the stove builders. The district level experts conducted periodic surveys of the stove programme.

Application of Science and Technology to Rural Areas (ASTRA)

The ASTRA centre developed the improved stove. After field testing at Ungra and Unchigi areas, ASTRA, in association with KSCST, conducted intensive training programmes to train district level experts. ASTRA also wanted a feedback from the field and thus periodically assisted KSCST in monitoring and evaluating the stove programme.

Table 1 : Institutions Involved and Dissemination Strategy

DNES CENTRE	- Fix targets - Provide subsidy to states - Certify stove models
RDPR STATE	- Fix targets to districts - Frame policies - Fund districts
KSCST STATE	- Coordinate at State level, - Scientific and implementing agencies - Select and organize training for stove experts - Monitor the programme
ASTRA STATE	- Provide technical expertise - Train district level experts
ZILLA PARISHAD DISTRICT	- Fix targets to blocks/ panchayats - Supervise district level expert - Coordinate at district level
BDO OR PANCHAYAT BLOCK OR PANCHAYAT	- Select builder trainees - Organize builder training programme - Select houses for stove construction - Supply stove components - Provide subsidy to beneficiaries
STOVE BUILDER	- Build the stove - Provide information to users
JUNIOR OFFICIAL/ OFFICIAL LEVEL	- Monitor stove programme - Certify stoves/payments

Training of Builders and Stove Construction

- The stove builders were selected by the Block Development Officer (BDO) in each block or *taluk*.
- A 10-day training programme to train the builders was conducted by the district level expert in the respective blocks.
- The households for stove construction were selected by the BDO or Mandal Panchayat.
- The pre-fabricated components necessary for the stove were provided by the BDO/Mandal Panchayat.
- BDO also disbursed the subsidy component to the beneficiaries.
- The stove was constructed by the builders.
- The whole process was monitored by a junior official in the Block Development Office.

Subsidy : For Schedule Caste and Scheduled Tribe (SC/ ST) houses, 100 per cent subsidy was provided, and for other households, partial subsidy was given.

Achievements : Targets for different years and the total number of stoves built are given in Table 2. By the end of the 1988-89 financial year, nearly 2.38 lakh ASTRA stoves will have been built. It can be observed that the targets fixed were nearly double that of the achievements during 1985-86 and 86-87. The implications of this are discussed later in the report.

Table 2 : Targets and Achievements

Year	Target fixed	Number of stoves built
1984 - 85	20,000	21,469
1985 - 86	1,50,000	81,694
1986 - 87	1,17,500	50,075
1987 - 88	50,000	41,171
1988 - 89	50,000	43,940
Total	3,87,500	2,38,349

FINDING OF EARLIER STUDIES

Level of Acceptance of the Stove

The level of acceptance of the ASTRA stove at the micro level and at the Karnataka level is given in Table 3.

Table 3 : Level of Acceptance of ASTRA Stove

	Year of study	Sample size	% of stoves in use	% of stoves not in use	Age of the stove (months)
Ungra Study	1984	150	100	0	6
	1985	450	97	3	18
	1986	450	91.5	8.5	30
	1988	450	84	16	45
Karnataka Level Studies					
1 KRVP Study	1986	2201	79 6	20 4	-
2 Intensive Study	1987	351	65 0	35 0	-
3 Karnataka Study	1988	3294	60 0	40 0	-

The stoves built initially under the supervision of ASTRA under the Ungra study, were monitored periodically The percentage of stoves in use declined from a 100 per cent level when the stoves were 6 months old, to 84 per cent, when the stoves were nearly 4 years old

It can be observed that the percentage of stoves in use declined from 80 per cent in 1986 to 60 per cent in 1988, at the Karnataka level. Even the intensive study of a small sample of villages showed a 65 per cent level of use of stoves in 1987

When the proportion of stoves in use during 1988 were considered in the Ungra area, it was 84 per cent compared to 60 per cent at the Karnataka level The questions that arise are : why is the rejection level as high as 40 per cent at macro level dissemination, and why does it increase with the age of the stove?

ASTRA STOVE PERFORMANCE IN CONTEXT OF FUEL CONSERVATION BASED ON MEASUREMENTS

Data on fuel consumption is available from the various studies viz. the Ungra, Intensive and KRVP studies. The results are given in Table 4. Fuelwood consumption was measured on a daily (24-hourly) basis and repeated over a period of 3 to 7 days on ASTRA and traditional stoves In Ungra area, the percentage reduction in fuel use was seen to be declining with the age of the stove. Even when the stoves were 30 months old, a 33 per cent reduction in fuel use was observed at the Ungra level The KRVP study during 1986 showed a 19 per cent reduction in fuel use Surprisingly, the Intensive study conducted in 3 districts during 1987 also showed a 19 per cent reduction in fuel use The findings have to be cautiously interpreted as the size of the sample subjected to measurement was small

Table 4 : Performance of Stoves with Respect to Fuel Conservation*

		Per capita/day fuel use			
	Year of study	TS (kg)	AS (kg)	% reduction in fuel use	No of AS monitored
Ungra Study	1984	-	-	52	150
	1985	0 88	0 46	47	8
	1986	0 81	0 54	33	15
KRVP Study	1986	1 06	0 86	19	280
Intensive Study	1987	1 02	0 83	19	86

* Fuel conservation is measured by comparing the daily fuel use over 3 to 7 days

** During 1984 Specific Fuel Consumption (SFC) was compared (grams of fuel used/kg of cooked food)

TS = Traditional Stove
AS = ASTRA Stove

Opinion Survey on Performance of ASTRA Stove with Respect to Fuel Conservation

Opinion of the housewife regarding fuel consumption was recorded during the KRVP study (1986), the Karnataka study (1988) and the Intensive study (1987), the findings of which are given in Table 5. According to the KRVP study, during 1986, 82 per cent of the households reported reduction in fuel use. However, the 1988 Karnataka study covering a larger sample showed that only 28 per cent reported reduction in fuel use and 45 per cent households reported a higher fuel consumption. This raises several questions like :-

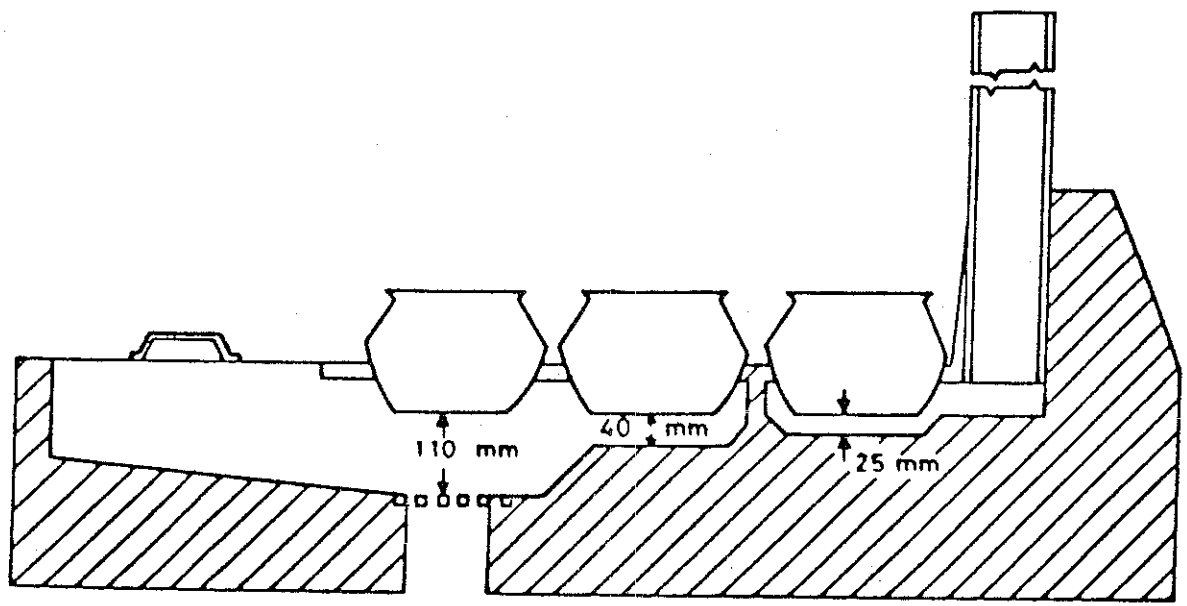

Figure. 1. THE ASTRA STOVE : A CROSS SECTION.

i) What are the reasons for the recorded opinion of higher fuel consumption ? and

ii) Why are they using the stove even though it is supposed to be consuming more fuel ?

Smoke in the Kitchen: The percentage of households complaining of smoke in the kitchen, and those who felt smokelessness is given in Table 5. The results from all the three studies indicate that a majority of houses reported smokelessness in the kitchen. Even according to the Karnataka study (1988) 79 per cent of the households reported no smoke or insignificant smoke in the kitchen. Thus this seems to be a major benefit derived by the households from the ASTRA stove.

Table 5 : Opinion Survey on the Performance of ASTRA Stove

(% of households)

	KRVP Study 1986	Intensive Study 1987	Karnataka Study 1988
Number of stoves studied	280	86	3294
Fuel consumption (%)			
- Lesss than TS	82	64	28
- Same as TS	10	24	27
- More than TS	8	12	45
Smoke in the kitchen			
- No smoke	94	80	79
- Smoky	6	20	21
Cooking time			
- Less than TS	93	66	43
- Same as TS	3	24	26
- More than TS	4	10	31

TS = Traditional Stove

Cooking Duration : The opinion of the households regarding any reduction in cooking duration is given in Table 5. The Ungra study based on measurements has shown that there was a 36 per cent reduction in cooking time in ASTRA Stove, compared to traditional stoves. The opinion survey at the Karnataka level (1988) showed that 43 per cent households reported reduction in cooking time. However, 31 per cent households reported increased cooking duration.

Conditions Necessary for Satisfactory Performance of ASTRA Stove

The ASTRA stove is a vessel specific mud stove built *in situ* for the vessels used for cooking on normal days. To derive optimum efficiency, the stove has to be built according to the design specification. This is a necessary condition but not a sufficient one. To obtain the desired performance, the stove has to be operated in a specific way. The structural, operational and maintenance conditions necessary are considered here.

Structural Parameters

The builders have to explain and ensure that the housewife uses the vessels used for cooking on normal days. The sensitivity of stove efficiency for different structural parameters is given in an earlier report by Lokras et al (1985). The internal dimensions of the stove have been optimized. Here only one of the crucial parameters is considered. For instance, the clearance below the vessels in the first hole is optimized to be around 11 cms (Fig. 1). If the clearance below the first vessel is higher than the optimum clearance,

a) the volume of the combustion chamber increases, giving scope for higher burning rate (kgs of wood burnt/hour);

b) the ratio of the vessel to wall surface area decreases which, in turn, decreases the heat transfer rate to the vessels; and

c) when the clearance is high, short circuiting of the flame and hot gases results.

Similarly, if the clearance below the second and third vessel increases, the efficiency of the stove decreases. Thus, the builder has to adhere to the optimized dimensions.

Operational Parameters

a) The housewife should preferably use the vessels that were given while stove construction for measurement of the stove holes for the main cooking on normal days, to ensure proper internal dimensions. However, she

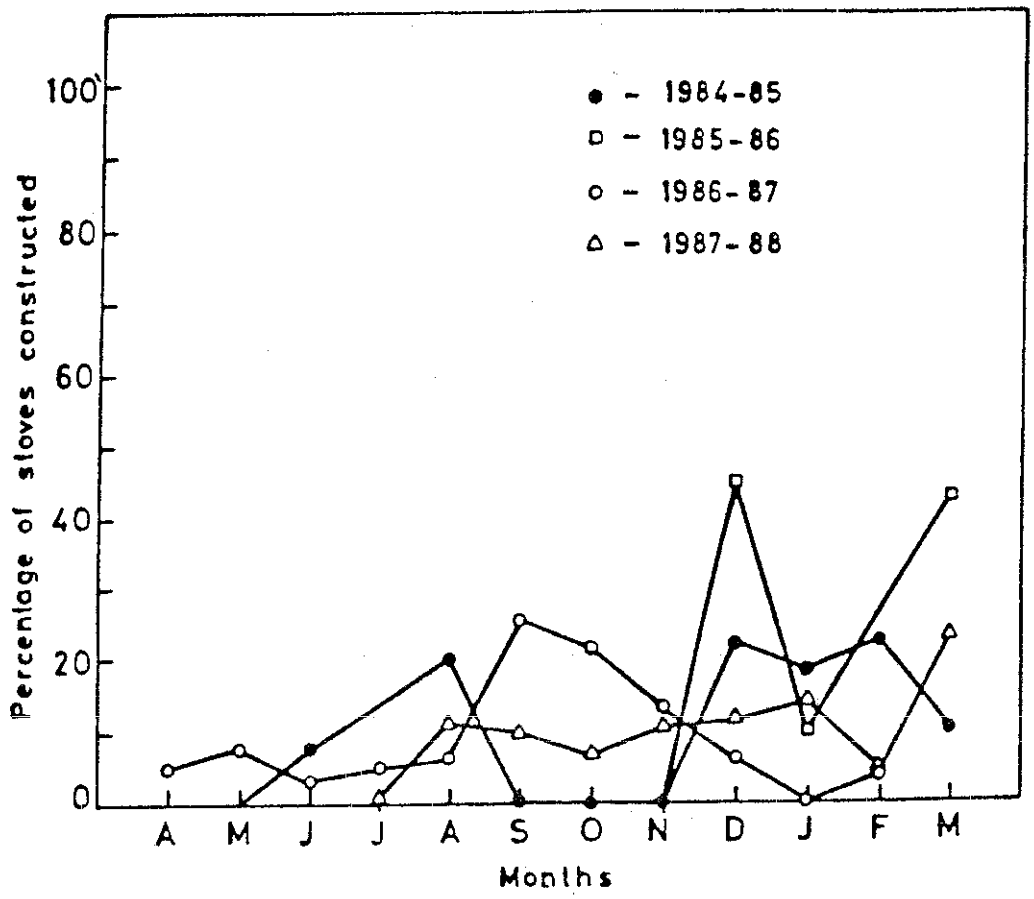

Fig 9. Monthwise percentage of stoves constucted during 1984-85, 85-86, 86-87 and 87-88

can use other vessels on special days and she can use a reducer for keeping smaller vessels

b) The grate must be cleaned every day to ensure proper air supply for combustion.

c) The firebox lid has to be closed for a large part of the cooking duration to control the excess air supply.

d) The housewife is expected to shift the vessel between the holes as they do in traditional stoves. She must ensure that vessels are always kept on all the holes, at least with vessels containing water. As far as possible, the heating potential of all the holes should be used for cooking or heating water.

e) The chimney must be cleaned of soot periodically to ensure smooth passage for smoke.

f) To increase the efficiency, the stored heat inside the stove could be used by removing the burning wood about 10-15 minutes earlier and closing the fire box. Simmering could be carried out, using stored heat.

Proper Maintenance

Since it is a mud stove, it is likely to get damaged with usage. The weakest point is the pan (vessel) seat. Whenever there is a crack or mud is peeling off, the housewife is expected to keep the original vessel and paste mud to ensure the original diameter of the hole.

ANALYSIS OF ACCEPTANCE AND PERFORMANCE OF ASTRA STOVES

Understanding the Level of Acceptance

In Ungra area, even when the stoves were nearly 4 years old, 84 per cent households were using them, and at the Karnataka level, only 60 per cent households were using the stove. It is possible to say that the households derive some benefit from the stove and that is why they continue to use it. But it is difficult to say which is the major benefit according to their perception. In Ungra area, no opinion survey was conducted; therefore, it may be said with caution that they are deriving one or more benefits, namely; fuel saving, smokelessness and saving in cooking time.

However, at the macro level there is a clue that even though 45 per cent households reported increased fuel use, 79 per cent reported smokelessness. Thus, smokelessness may be an important factor in determing the acceptance of a stove. Some households may be deriving multiple benefits, even though they are complaining of smoke, they are continuing the use of the stove, both in Ungra area as well as at the Karnataka level. Households which have rejected the stove may not be deriving any of the 3 benefits. This could be due to faulty construction of faulty operation or even incompatibility of the stove design. According to observations made in Ungra area, some of the reasons for dismantling the stove were; shifting of kitchens, splitting of the joint families and shifting to a new house, etc. Another complaint was that the stove was built at a wrong place in the kitchen or that it was too large for the small kitchen.

Explanation for the Observed Performance

The performance of the stove depends on several structural and operational parameters. Laboratory studies have shown that burning rate, clearance below the vessels, operation of the firebox lid, extent of use of different pan holes for cooking, gaps in the vessel seats, pan surface area exposed to heat, etc. determine the efficiency of the stove in the field. Some of these parameters have been measured in the Ungra study, the Intensive study and the KRVP study.

Clearance Below the Pans

It can be observed from Table 6 that the clearances below the vessels for a large proportion of stoves were larger than the optimum level for all the three pan holes. Larger clearance leads to higher burning rate reduction in pan surface area exposed to heat and short circuiting of the flame and hot gases into the chimney. This leads to higher fuel consumption.

Burning Rate

The burning rate according to the Ungra study was 1.5 kg/hour and according to the Intensive study, it ranged from 1.3 to 1.8 kg/hour, as against a desired level of 1 kg/hour. As the clearance below the pans is larger than the optimum level in a majority of houses (Table 6), housewives tend to increase the burning rate to direct the flame to the first pan and to speed up cooking. Higher burning rate means higher fuel consumption.

Table 6 : Distribution of Clearances Below the Vessels

(values in %)

		KRVP Study	Intensive Study
Clearance below first vessel (optimum = 11 cm)			
	Upto 11	30	13
	11 to 13	42	16
	13.1 to 15	13	22
	15	15	49
Clearance below second vessel (optimum = 4 cm)			
	Upto 4	35	3
	4.1 to 5	28	3
	5.1 to 6	12	9
	6.1 to 7	6	5
	7	19	80
Clearance below third vessel (Optimum = 2.5 cm)	2.5 cm	30	2
	2.6 - 3.5 cm	31	4
	3.6 - 4.5 cm	16	2
	4.6 - 5.5	8	14
	5.5	15	78

Operation of Firebox Lid

According to the Ungra, Intensive and KRVP studies, only a small proportion of the households closed the firebox while cooking.

Compatibility of Vessels to the Stove Holes

The Intensive study has revealed that the ratio of the diameter of the vessel (at maximum point) to the diameter of the stove holes was greater than 1 for over 78 per cent of the stoves. This shows the incompatibility between the stoves and vessels. Either the housewife has given vessels smaller than the normal vessels or the housewife has given larger vessels and later reduced the hole diameter to fit the normally used vessels. When the stove hole diameter is reduced, it leads to larger clearances, reduction in pan surface that is exposed to heat, and finally, to higher fuel consumption.

Utilization of Heating Potential of Third Pan Hole

The Intensive study has revealed that the heating potential of the third hole was not used for cooking dishes. In fact, in a significant number of 3-pan stoves, the third hole was either closed with a lid (leading to larger clearance) or kept open (leading to leakage of smoke and hot gases in to the kitchen).

Variations in Cooking Practices of Different Food Zones

The Intensive study has clearly brought out the variations in cooking practices of Ragi, Rice and Jowar zones. Thus, the study has highlighted the need for different models for three food zones. However, in the dissemination strategy, the same model of ASTRA stove has been disseminated in all the food zones.

IMPACT OF DISSEMINATION STRATEGY ON ACCEPTANCE AND PERFORMANCE OF ASTRA STOVE

The impact of the dissemination strategy on the level of acceptance and performance of the ASTRA stove is analysed and the inferences are drawn below.

The Type of Stove Built

Initially, only 3-pan stoves were built. However, based on the response of the households, modified 2-pan stoves were also built. The results of the Karnataka Study show that 27 per cent households with 2-pan stoves actually preferred 3-pan stoves and 24 per cent households with 3 pan stoves actually wanted 2-pan stoves. This shows the incompatibility between the requirement of the household with respect to the model of the stove and what they actually got. It is likely that either the builders were not trained properly on this aspect or the builder did not care to find out the requirement of the type of stove from the household. It is also likely that the households did not know about the merits or demerits of the two types of stoves.

Different Models for Different Food Zones

Even though the cooking practices varied between the three main food zones which necessitated different models; the same stove model (2 or 3-pan) has been disseminated in all the food zones.

Target Chasing

The current practice is that DNES at the centre fixes targets for states. At the state level, the Department of RDPR, in turn, fixes targets to districts. At the district level, the Zila Parishads finally fix targets to Blocks or Mandal Panchayats.

While fixing targets, no consideration is given to the availability of trained builders, of stove components and the time required to build these stoves. At the same time, pressure is brought on officials at lower levels to achieve the targets. To achieve targets :

i) untrained builders were drafted to construct the stove;

ii) contractors were entrusted with the work ;

iii) it was observed that each builder was constructing 2 to 3 stoves per day, whereas to build a stove properly, one day is required per builder and accordingly wages have been fixed.

In the process, quality was the casualty. It can be observed from Table 2 that the targets fixed were far higher than the achievements. In Karnataka, the State Government has a scheme for rewarding the district officials who exceed the targets. Thus, the questions that arise are : should targets be fixed? who should fix the target levels : and which factors should be considered while fixing targets ?

Concentration of Stove Activity During Feb-March

It is clear from Fig. 2 that the stove construction activity is concentrated mainly during December, January, February and March. This may be related to the release of funds to the implementing agency. In the process, the quality suffers due to several factors listed earlier while disscussing the target chasing problem. Pressure is brought on the officials and builders to achieve the target in a short time.

Stoves in Janata Houses

The State Government clubbed the stove programme with the Janata house programme. The contractors had to build the ASTRA stove in all the Janata houses before the family moved in. This led to incompatibility between the vessels used daily for cooking and the stove, leading to rejection by the users. The housewife who moved in was also not given any information regarding the stove. The practice is continuing despite failure of the programme and rejection of the stove.

Quality Control

A junior official in the Block Development Office is in charge of the programme. He will have several other programmes to monitor in addition to the stove programme. This official is not trained to monitor the quality of stoves and he has neither the time nor the facilities to do this. It can be observed from Table 5 that clearances were larger than the optimum level in a majority of stoves. This is an indicator to the fact that proper stoves were not constructed. This also indicates that in the present programme, there is no scope for checking the quality of stoves. The main motivation for the junior official is to cross the targets and for the builder to make more money by building more stoves in the shortest time possible. The question is : how to incorporate quality control into the dessemination strategy ?

User Education

To derive maximum benefit, the housewife has to be educated on the proper method of operation and maintenance of the stove. In the present programme, there is no scope for educating the housewife. Firstly, the builders are inadequately trained to do this and secondly, they have no time or incentive and there is no compulsion to educate the housewife.

Subsidy Component

It has been observed in the field that SC/ST households are often coerced to have the stove constructed in their houses. A contractor goes to a village and, in one stretch, gets the stove constructed in all the SC/ST houses without providing any information to the housewife and without even obtaining their consent. The Karnataka study has shown that the stove rejection level was higher in SC/ST than in other houses. It has to be noted that the rejection rate was considerably high even for the non-SC/ST houses. Thus, mere payment towards the stove may not ensure quality construction properly.

CONCLUSIONS AND RECOMMENDATIONS

Improved stoves have a definite role to play and if disseminated properly, they could conserve biomass, remove smoke and reduce the cooking duration considerably. The Ungra study has demonstrated that conservation of biomass is much cheaper than producing biomass. The impact of

such stove programmes on deforestation may not be large, but they would reduce the pressure on local trees. Williams (1985) suggests that a fuel efficient stove programme could represent a far more cost effective means of dealing with the fuelwood crisis than any other 'supply oriented' approach. These studies in Karnataka have shown that village women attach a lot of importance to the removal of smoke. The improved stoves can achieve the twin objective of fuel conservation and removal of smoke. In the light of the findings of the studies conducted in Karnataka, a few implications could be drawn for improving the acceptance and performance of the ASTRA stove in the field.

Modifications to the Design

Field studies have highlighted a number of faults in the construction and operation of the stove. Given the nature of the faults like larger clearances, higher burning rate, cracking of pan seats and non-use of firebox lid, *suitable modifications in the present design are necessary*. It may be necessary to make the stove relatively fault tolerant through design modifications. The performance of mud stoves seems to deteriorate with age due to erosion and damage to the stove top or pan seat. Alternative materials of construction have to be used to increase the life of the stove.

Cooking practices vary considerably between different food zones in Karnataka, namely the Rice, Ragi and Jowar zones. For each zone, different models may have to be developed to cater to the requirement of large (and affluent) and small (or poorer) families. It is also necessary to explore the possibility of prefabricating stove parts to ensure proper dimensions. Local potters could make a number of combinations to suit the local needs.

Provision of Reducer

To overcome the problem of reduction of stove hole diameter to fit smaller vessels, it is necessary to provide a reducer to all households.

Removal of Smoke and Health Effects

The Karnataka study gives a clue to the fact that rural women attach a lot of importance to the removal of smoke. Households seem to use a stove even if it consumes more fuel as long as it removes smoke. In this context, Ramakrishna (1988) has concluded that smoke is a big nuisance and on the basis of the available information, the level of air pollution in rural kitchens is undesirable and should be reduced, regardless of the proof that it does not have adverse health effects. Thus, there is a need to ensure that the stove is smokeless and to give proper instructions to use it. Smokelessness enhances the acceptance of fuel efficient stoves.

Training Programme for Builders

The builders are expected to perform a number of functions, namely:

i) offer different models to the housewife ;

ii) insist on vessels used on normal days ;

iii) build the stove according to the design specifications;

iv) demonstrate the correct method of stove operation ; and

v) explain, with the aid of demonstrations, how to repair and maintain the stove.

The existing training programme seems inadequate to equip the builders to these tasks. Thus, a more intensive training programme is deemed necessary to provide opportunities for the operator to operate the stove and learn how to rectify the common problems that occur in daily use of the stove. Sarin (1985) says women are better suited to disseminate the stoves, as they themselves use similar stoves. It is desirable to encourage more women to take up this task and construct stoves not only in their own villages, but also in the neighbouring villages.

Subsidy

No household should be given a 100 per cent subsidy. There should be a graded subsidy, such that even SC/ST houses make a small token contribution (of say, Rs. 10) and large farmers could be expected to pay about 50-75 per cent of the cost. Subsidy is necessary, as Agarwal (1986) says, because the benefits are going to be non-financial for the poor like saving in fuel gathering time or cooking time.

Fixing of Targets

If targets must be fixed, they will probably have to originate from the bottom. It is necessary to involve the actual implementing agency and factors like, availability of trained builders and components of stove and the period available, should be considered.

Distribution of Stove Construction Activity

There is a need to release the funds to the implementing agency in such a way that stove construction could be carried out throughout the year, probably excepting the months of monsoon. This reduces the pressure on builders and the lower level officials.

One Stove Per Day

Wage rate per stove is fixed, considering one stove per builder per day to ensure good quality of construction and greater interaction with the housewife. It must, however, be recognized that it is very difficult to enforce the rule 'one stove/day 'builder'.

Modified Approach to the Janata Houses

Construction of stoves has to be delinked from the Janata housing scheme. In Janata houses, it is desirable to construct ASTRA stoves only after the family has shifted in to the house.

Demonstration - First Approach

Before building a large number of stoves in any village, 2 or 3 stoves must be built first and adequate information about the operational aspects must be provided to the housewife. An opportunity must be given to these families to use the stove for a fortnight. The news of the stove's efficiency would spread on its own by word of mouth. After a fortnight or a month the remaining stoves could be built in the village depending on the demand.

Cluster Approach

Within an adminstrative unit like a block or a mandal panchayat, it is advisable to adopt the cluster approach. It is better to build all the sanctioned stoves in one or a small cluster of villages. This would facilitate the organization of monitoring and education programmes.

Quality Control

This is the most crucial aspect of the dissemination programme. Quality control can be monitored by the following ways :

i) Only trained builders should build stoves and attempts have to be made to enforce the condition of 'one stove/day/builder'.

ii) Builders have to be trained to insist on getting vessels used for cooking on normal days, from the housewives, to ensure custom built stove holes to suit their vessels.

iii) There is a need to encourage the supervisor to make random checks on the dimensions of the stove.

iv) It is necessary to develop incentives for the builder and to make him responsible by asking him to visit the village after a fortnight or a month from the day of building the stove. His full payment for the stove could depend on obtaining a signature from the household.

v) Wages could be appropriately increased and paid in two instalments - the first at the time of construction and the second after obtaining the certificate from the household saying that they are fully satisfied with the performance of the stove.

User Education

Once an appropriate stove model has been properly constructed, then there arises the need to educate the housewives on the correct methods of operation and maintenance of the stoves. To achieve this, a multipronged and multimedia approach may have to be adopted :

i) Demonstration of the method of operation and maintenance in the villages by the builder ;

ii) Supplying effective visual aids like pictorial posters on the do's and dont's for the desired impact ;

iii) A video film could be shown in all the villages with large concentration of stoves to drive home the message; and

iv) Training local lady teachers, volunteers of mahila mandals or women members of panchayats in the operation and maintenance of stoves.

Monitoring and Evaluation of the Programme

There is a need to train the block level official incharge of the stove programme. Periodic visits and checks by him are necessary for ensuring the good quality of stoves.

The stove programme has to be periodically evaluated in different zones to study the performance of the stove model and to provide feedback to scientists and the implementing agencies. There is great scope for an agency like KSCST, to play a significant role in the effective implementation of the stove programme.

NOTES

a In this report, only the major findings and implications of the studies are considered. For details, refer to the respective studies

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NILGIRI BIOSPHERE RESERVE – FROM THEORY TO PRACTICE

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ABSTRACT

The Nilgiri Biosphere Reserve covering an area of 5,520 km^2 in the States of Karnataka, Kerala and Tamil Nadu was established in 1986. For the purpose of management, the Reserve has been classified into core zones (1,240 km^2), manipulation forestry zones (3,239 km^2), tourism zones (335 km^2) and restoration zones (706 km^2). Since the Biosphere Reserve is mostly falling within the forest land, it will be administered by the Forest Departments of the respective States. Other major areas of action are ecodevelopment and improvement of the quality of life of the people, especially the tribals, which is of utmost importance. It is also suggested that a zone of co-operation be established along the boundary of the Reserve where education and training in environmental issues can be taken up involving the local people and also provide them employment in the ecorestoration efforts, as their co-operation will largely tell upon the success of attaining the goals of setting up this Reserve.

INTRODUCTION

It must have been a scene straight out of a fairy tale: a vast blue carpet undulating over the hills as far as the eye could see, broken only by the verdant shola patches nestling in the folds of the hills. The blue came from gregarious masses of the shrub *Strobilanthes kunthianus* which blossom only once in a decade or so. Whether this floral decoration originally inspired the name Nilagiri or Nilgiri (blue mountain) has been much debated.

But today all this is only a memory. Ever since the British discovered the climatic delights of the Nilgiris in the early 19th century, colonization has increasingly turned the landscape brown. However, the forests girdling the outer slopes are largely intact. It is to conserve the diverse biological and cultural treasures of the Nilgiris that India's first biosphere reserve was recently established.

The concept of a biosphere reserve emerged from the 'Man and Biosphere' programme sponsored by the UNESCO during the early seventies. Prior to this, conservation efforts had a tendency to focus on a few animals like the tiger, while ignoring the overall diversity of living organisms. They also did not successfully reconcile the need for development with conservation. The Biosphere Reserve is an attempt to rectify these lacunae and make conservation more meaningful, given the socio-economic realities of the region. About 250 reserves had been established in 65 countries by 1986.

NILGIRI BIOSPHERE RESERVE

In 1978, an advisory group of the Indian National Man and Biosphere Programme identified 12 sites ranging from Nanda Devi in the Himalayas to the Gulf of Mannar in the Bay of Bengal, representing the diverse biogeographic provinces in the country. Of these, the project proposal for the Nilgiri Biosphere Reserve was first prepared in 1980, but it took another six years for the reserve to be officially established.

Covering an area of 5,520 km^2 in the States of Karnataka, Kerala and Tamil Nadu, the Nilgiri Biosphere Reserve (Fig. 1) has been designed to encompass extremities of habitat. From 100 m above msl in the Nilambur plains, it goes up the vertical slopes of New Amarambalam to the rugged heights of the Mukurti peak (2,554 m) and drops on the east to 250 m in the Coimbatore plains. The western slopes get over 500 cm of precipitation annually while the sheltered eastern valleys receive less than 50 cm. Corresponding to

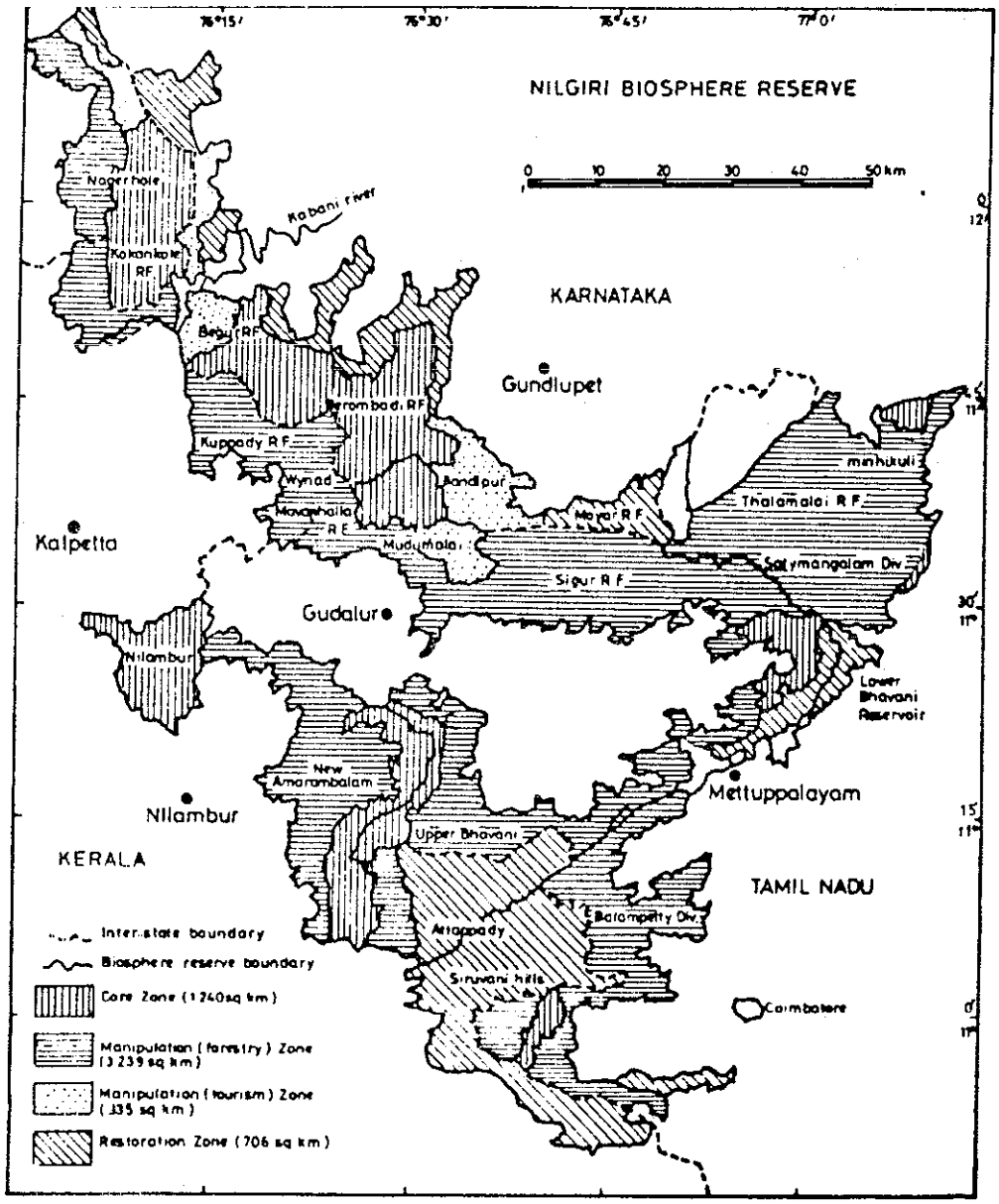

Fig. 1 Map of Nilgiri Biosphere Reserve to show different zones and areas under each zone.

these altitudinal and climatic gradients, the natural vegetation changes from tropical wet evergreen forest along the western slopes to montane stunted shola forests amidst the grassy oowns on the upper plateau (Fig 2) and, on the east, progressively drier deciduous forests ending in thorny scrub. This setting is the home for a variety of animals – the lion-tailed monkey in the evergreen forests, (Fig 3) the Nilgiri tahr in the grassy downs, the black buck in the dry scrub and the tiger and the elephant throughout the region.

Fig 2 *Mountane shola forests and grasslands in the upper Nilgiri plateau.*

Fig 3. *The endangered Lion-tailed macaque.*

To the North, the Biosphere Reserve begins in the Nagarhole National Park of Karnataka and the adjoining Wynad Sanctuary of Kerala. The moist deciduous forests and teak plantations of Nagarhole harbour abundant populations of gaur, spotted deer, sambar and wild pig which support a sizeable number of carnivores such as tiger and leopard Nagarhole is perhaps the best place in Southern India for sighting these large cats. The forest cover along the Kabini river has been reduced due to the construction of an irrigation dam. It was along the banks of this river that elephants were regularly captured for nearly a century by the 'khedda' method until 1971. Even today an evening ride on a coracle along the river banks during the dry months may be rewarded with the sight of herds of over a hundred elephants (Fig. 4).

Fig. 4 *A tusker in the Nilgiri Biosphere Reserve*

South of the Kabini, the dry deciduous forests of the Bandipur National Park were declared as a Project Tiger area in 1973. Contiguous with Bandipur lie the Mudumalai Sanctuary of Tamil Nadu and a portion of the Wynad Sanctuary. The natural vegetation of this tract is moist deciduous forest with *Lagerstroemia microcarpa, Xylia xylocarpa* and *Bambusa arundinacea*, and dry deciduous forest characterized by *Anogeissus latifolia, Tectona grandis* (teak) and *Dendrocalamus strictus*. The fauna is similar to that of Nagarhole with elephants in large numbers.

East of Mudumalai, the vegetation over the Sigur plateau and the Moyar river valley, lying in the rain shadow of the Nilgiri massif, becomes drier. Thorny plants such as *Acacia* dominate along with *Albizia amara, Hardwickia binata* and *Gyrocarpus jacquinii*. In addition to the fauna of the deciduous forests, striped hyena, jackal and four-horned antelope are seen here. The black buck has disappeared from the Sigur plateau but a viable population of 300 to 500 is still found in the Moyar valley. They can be easily seen in the evening along the foreshore of the Lower Bhavani reservoir. The Moyar valley is the junction of two great hill chains of Peninsular India – the Eastern Ghats and the Western Ghats. A portion of the Talamalai-Satyamangalam plateau has been included in the Nilgiri Biosphere Reserve as representative of the Eastern Ghats.

Over the eastern slopes of the Nilgiris, the forest cover extends southwards as a narrow belt into the Bolampatty and Siruvani hills. The Siruvani reservoir on the Kerala side provides water for Coimbatore city. A good stretch of evergreen vegetation covers the higher reaches of the Siruvani hills. Adjoining these hills to the North-West, the Attappady

valley is mostly under cultivation. The large tribal population here has been practising shifting cultivation for a long time. As a result, the forests over the surrounding hills have largely degraded. A well preserved stretch of evergreen forest with *Dipterocarpus, Mesua* and *Palaquium* is seen West of the Attappady Reserve, extending into Silent Valley (Fig. 5), New Amarambalam and through a narrow corridor into Nilambur. The endangered lion-tailed monkey of Silent Valley fame is highly adapted to such evergreen habitats. The controversy regarding the proposed dam across Kunthipuzha in the Silent Valley seems to have been laid to rest with the entire area being declared as a National Park in 1985.

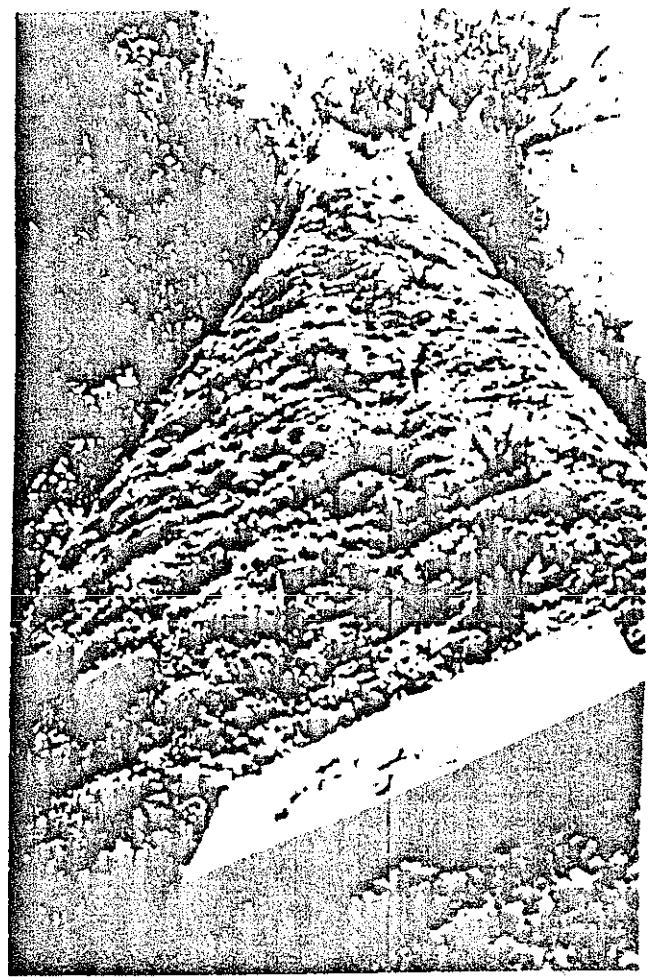

Fig. 5. *A Cassine glauca tree with profuse growth of mosses on its bark.*

Perhaps the largest pristine evergreen forest in Peninsular India is the New Amarambalam Reserve, which has escaped the axe simply because its steep terrain is inaccessible. This is home to the Cholanaickans, the only genuine hunter-gatherers in the Peninsula.

The upper Nilgiri plateau has been altered by human activities into one vast stretch of cultivated land and settlements around Udhagamandalam. Both slopes and valleys here grow tea, coffee, cinchona, fruits and vegetables such as potato. Extensive plantations of Blue gum (*Eucalyptus*), Wattle (*Acacia*) and Pine (*Pinus*) have also been raised. These have resulted in enormous loss of the top soil. To tap the potential for generating hydro-electric power, a series of dams have been constructed across the Bhavani river and its tributaries.

A major portion of the upper plateau has been excluded from the Biosphere Reserve. Only the western and southern ridges, which retain some of the natural shola and grassland vegetation along with monoculture plantations have been included. A sanctuary has been declared here to protect the Nilgiri tahr.

CLASSIFICATION

For the purpose of management, the Nilgiri Biosphere Reserve has been classified into core zones (1,240 km^2), manipulation-forestry zones (3,239 km^2), tourism zones (335 km^2) and restoration zones (706 km^2).

The core zones include regions where no exploitation of the resources in any manner is permissible. Apart from tribals such as the Cholanaickans in New Amarambalam, who have been already living in the proposed core areas, no human habitation is to be allowed in this zone. To preserve the natural biota in as many diverse habitats as possible, the core zones have been constituted in different vegetation types – the evergreen forests of Nilambur, New Amarambalam, Silent Valley and Siruvani hills, the shola grasslands of the Nilgiri tahr sanctuary, the deciduous forests of Nagarhole, Bandipur, Mudumalai and Minchikuli valley, and the thorn scrub of the eastern slopes of the Nilgiri.

FORESTRY ZONE

Due to current use of land, a major portion of the area has been classified as manipulation-forestry zone. Here, exploitation of the resources for grazing, timber, fuelwood and other forest produces may be allowed on a sustainable basis. While the existing plantations can be felled, no natural forest is to be cleared for plantations. Tourism zones have been defined in Nagarhole, Bandipur and Mudumalai to provide for recreation and education of visitors to these sanctuaries. Areas depleted of natural vegetation have been designated as restoration zones where suitable afforestation programmes may be taken up. The restoration areas may also be corridors to link any severed forest connections or catchment areas of reservoirs where soil conservation measures have to be promoted.

AGRICULTURAL ZONE

Special agriculture zones have been proposed to preserve the rich genetic pool of traditional varieties of crops and livestock. These would cover numerous enclaves of cultivation within Sigur, Talamalai, Attapadi and other regions of the Biosphere Reserve. Since cultivators are gradually abandoning traditional varieties adapted to local conditions in favour of hybrid crops and livestock, there is a danger of the former being altogether lost. Incentives will be given to compensate any loss the farmers might incur in continuing traditional agriculture. Villages participating in the Biosphere Reserve Programme will also receive priority in schemes for protection of crops from wildlife.

Since the Nilgiri Biosphere Reserve has been constituted largely on forest land, it will be administered by the Forest Departments of the three States. The Central Government will provide financial assistance and oversee the implementation of the Programme. Research is an important component of the Programme and will be carried out by universities, institutions, non-government organizations and government departments. This will be

multi-disciplinary and will include the physical environment, plant and animal life, human communities and alternative models of development Research will generate scientific information necessary for the management of the Biosphere Reserve

QUALITY OF LIFE

Other major areas of action are ecodevelopment and improvement in the quality of life of the people, especially the tribals The Nilgiri Biosphere Reserve has been occupied for centuries by an exceptionally diverse tribal population including the Todas, Kotas, Badagas, Cholanaickans, Irulas, Kurubas, Sholagas, Chetties and Pannias In the past, their traditional practices may have been largely in harmony with their surroundings since their populations were low With the 'outside' civilization making roads into their habitation, they have become subservient and lost their basic human dignity Today, they face a crisis of identity Can they survive by maintaining their traditional lifestyle or should they join the national mainstream? Resolving this issue is of utmost importance not only for the success of the Biosphere Reserve Programme but also for the future of tribals all over the country

Apart from the tribals, the interests of other people in the area have also to be considered For enlisting the help of all the people who are likely to make an impact on the Biosphere Reserve, a zone of co-operation along its boundary may be defined Education and training on environmental issues should be taken up here The people should be provided employment in ecodevelopment efforts such as afforestation Ultimately, success of the Biosphere Reserve depends on the cooperation of administrators, scientists and the local people

From September 24 to 26, 1986, the Department of Environment, Forests and Wildlife, Government of India, held a national symposium on biosphere reserves at Udhagamandalam The symposium, attended also by delegates from abroad, provided a forum for detailed discussions on administrative, scientific and socio-economic aspects pertaining to biosphere reserve programmes It became clear that the Nilgiri Biosphere Reserve is one of the most complex in the world in terms of diversity of biological communities, human population, cultural practices, developmental activities and political administration It is an almost Utopian experiment in reconciling conservation with the genuine need for development It is a formidable challenge to its promoters and custodians

A MODEL SYSTEM?

Captain Limond, writing in 1832, expressed the view that 'no power on earth can keep down the approved and tried celebrity of the Nilgiris; in the process of time they will become one of the noblest colonies in the known world'. The world will now be waiting to see whether the biosphere reserve experiment will transform the Nilgiris into a model system where man and nature dwell in harmony

Global Warming

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ABSTRACT

The annual mean global surface temperature has increased by 0.5°C in the last hundred years. One of the reasons for this increase could be the increase in 'greenhouse' gases such as carbon-di-oxide, methane, nitrous oxide and chlorofluorocarbons. If these gases continue to increase at the same rate for the next forty years, then the global surface temperature can increase by 1.5 to 4.5°C. These predictions are based on numerical simulations by climate models. There is a large uncertainity in the predictions of these models because of the uncertainity in the nature of cloud-radiation feedback and ocean-atmosphere coupling. If a global warming above 2°C takes place it can cause a sea level rise of more than 50 cm which can inundate many coastal regions. Global warming can also cause changes in climate pattern and hence affect global agricultural yields.

INTRODUCTION

The annual mean global surface temperature has increased by about half a degree centigrade in the last hundered years (Fig. 1). The six hottest years in this century occurred in the last ten years. What factors govern this global warming? Is this a part of natural climatic variability or is it on account of industrial or agricultural activities of human beings? The climate of the earth is governed by a complex interaction between solar radiation, atmosphere, ocean, hydrosphere and biosphere. We need to unravel the nature of these interactions in order to understand this phenomenon.

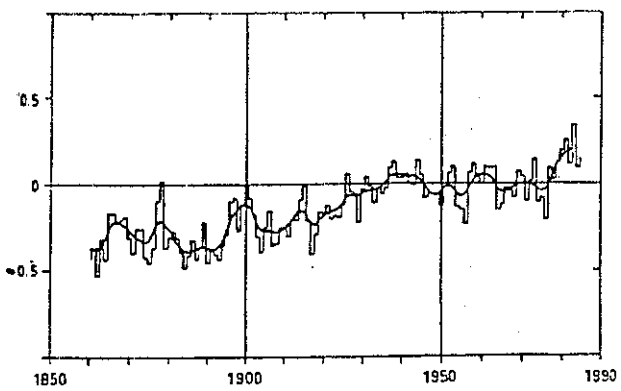

Fig. 1 Global mean annual surface temperature change

RADIATION AND CLIMATE

This two major constituents of the earth's atmosphere, that is, nitrogen and oxygen are radiatively non-participating. Hence they do not have a direct impact on the earth's climate. On the other hand, three minor gases, namely water vapour, carbon-di-oxide and ozone play a dominant role in controlling the surface temperature of the earth. In the absence of these gases the earth's surface temperature would have been as low as -18°C. These three minor gases increase the annual mean global surface temperature to +15°C. They are able to increase the surface temperature of the earth because they do not absorb most of the solar radiation but absorb strongly the infrared radiation emitted by the earth's surface. These gases trap infrared radiation from the earth in a manner similar to the glass in a greenhouse and hence are called greenhouse gases. The other greenhouse gases in the earth's atmosphere are methane, chlorofluoro-carbons, and nitrous oxide.

INCREASE IN THE ABUNDANCE OF GREENHOUSE GASES

The amount of carbon-di-oxide in the atmosphere has increased from 280 ppm (parts per million) to 350 ppm in the last hundred years (Fig.2). This increase is primarily on account of burning of fossil fuels and deforestation. About half the carbon-di-oxide released in the atmosphere is absorbed by the oceans and the rest contributes to an increase of about 1.5 ppm per year. It is expected that the carbon-di-oxide content of the atmosphere will reach 600

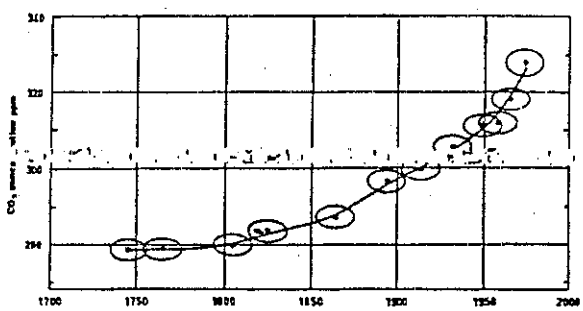

Fig. 2 Atmospheric CO_2 concentrations measured in glacier ice formed during the last 200 years

Proceedings of the 26th Annual Convention and the Seminar on 'Global Change' held during 15-17, March 1990, Indian Geophysical Union, Hyderabad, INDIA (1991)

ppm by the middle or end of the next century depending upon the rate of fossil fuel use. The amount of methane in the atmosphere has increased from 0.8 ppm to 1.7 ppm in the last hundred years (Fig.3). The methane increase is attributed to increase in rice farming, fossil fuel burning and cattle. The amount of chloroflurocarbons in the atmosphere has been increasing at the rate of 5% per year in the last thirty years. These substances are used in refrigerators, air conditioners, aerosols, and solvents. The production of chloroflurocarbons has been restricted by the 1989 Montreal protocol since it causes a reduction of ozone in the stratosphere

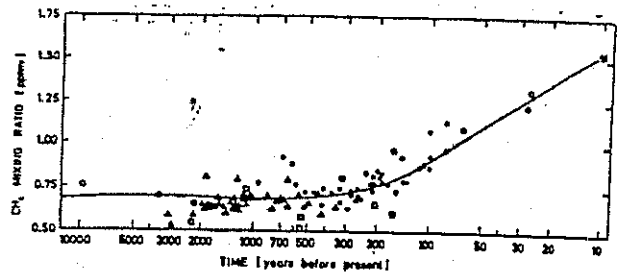

Fig 3 CH_4 mixing ratios measured in air trapped in ice cores

EFFECT ON CLIMATE

The increase in the abundance of greenhouse gases will increase the trapping of infrared radiation in the atmosphere. This should cause global warming if all the other factors affecting climate of the earth do not change. If the surface temperature of the earth increases this will increase evaporation and hence the water vapour content of the atmosphere and will enhance the greenhouse effect The increase in water vapour in the atmosphere can cause an increase in cloudiness. An increase in cloudiness can cause extra warming or cooling of the surface.

This is because clouds reflect solar radiation (and hence can cool the surface) and also trap infra-red radiation from the surface (and hence can warm the surface). Oceans occupy most of the earth's surface and hence influence the climate of the earth strongly. Oceans possess a large thermal inertia and therefore can delay global warming. The oceans absorb a lot of carbon-di-oxide and hence can control climate. Can we predict how these complex interactions between water vapour, clouds and ocean will respond to the increased trapping of infrared radiation by greenhouse gases? Climatologists use the basic conservation laws of physics and the computational power of supercomputers to predict the effect of increase in greenhouse gases. Climatologists have studied in great detail the effect of increase in carbon-di-oxide from 300 ppm to 600 ppm on the earth's climate. The car bon-di-oxide content of the atmosphere is expected to reach 600 ppm by the year 2080. The other greenhouse gases such as methane and chloroflurocarbons are more effective than carbon-di-oxide, because they absorb infrared radiation in the wavelength region 8 to 12 microns (one micron is one millionth of a meter) where other gases do not absorb. The amount of these gases can be converted to equivalent amount of carbon-di-oxide for the purpose of simplification of analysis. The equivalent amount of carbon-di-oxide in the atmosphere will reach 600 ppm by the year 2030.

RESULTS OF NUMERICAL SIMULATIONS

The simplest numerical model used to simulate the effect of doubling of carbon-di-oxide is the radiative-convective model. In this model the variation of temperature with height is calculated assuming radiative equilibrium. If the temperature profile so calculated is greater than the moist adiabatic lapse rate in any region, then the temperature profile in that region is modified to moist adiabatic lapse rate. This is known as convective adjustment. A review of 17 radiative-convective models by Schlesinger and Mitchell (1987) indicates that the global surface temperature can change by 0.5 to 4°C on account of the doubling of the concentration of carbon-di-oxide. There is such a large difference in the prediction of different models on account of the different assumptions made in these models. Some of the assumptions are with respect of variation of water vapour content, lapse rate of the atmosphere, and variations in cloud (amount, type and height). One way to avoid making some of these assumptions is to model the dynamical and thermodynamical changes occurring in the atmosphere. This can be done by the numerical solution of the partial differential equations governing the conservation of mass, momentum, energy and water vapour in the atmosphere. These models are usually three-dimensional. These are called General Circulation Models (GCM) and many groups around the world have developed such models. These models predict a temperature rise in the range 1.3 to 4.5°C on account of doubling of carbon-di-oxide content of the atmosphere from 300 ppm to 600 ppm. There is a large difference in the predictions of different models on account of the differences in the manner in which they model clouds and ocean-atmosphere coupling. Mnanbe and Wetherlad (1980) have compared a model with fixed clouds and another with variable clouds (internally determined) and indicate that both models predict a temperature rise of about 3°C on account of doubling of carbon-di-oxide. Washington and Meehl (1983) have also shown no difference in a model with fixed clouds and another with variable (internally determined) clouds.

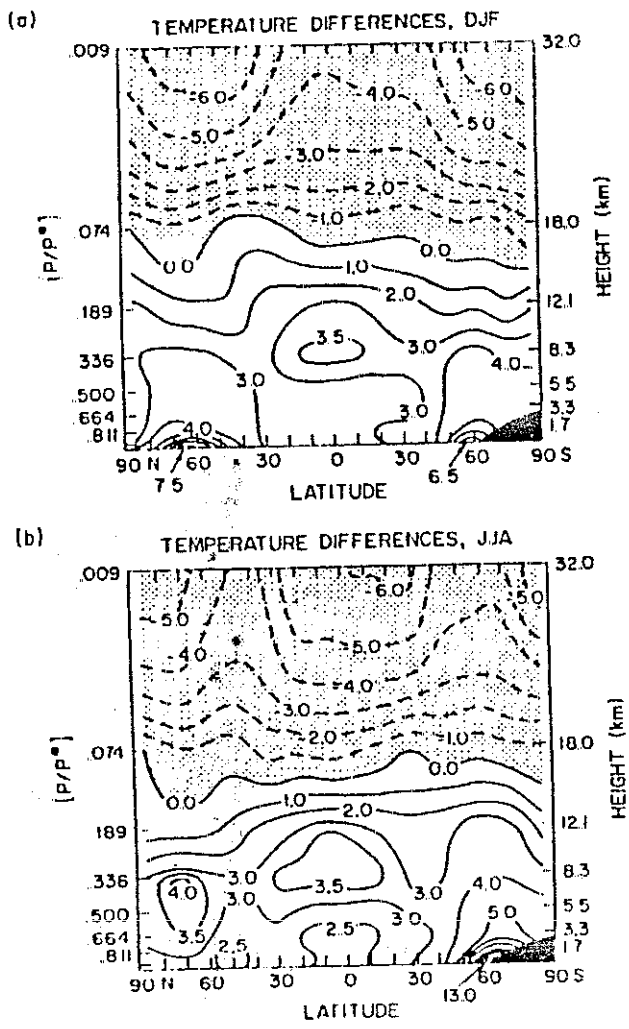

Fig 4 Zonal average temperature change in °C versus altitude and latitude for a steady-state doubling of CO_2 according to the model of Washington and Meehl (1984). Top frame is for December to February; bottom frame is for June to August. Cooling in the stratosphere is shaded.

These GCM's predict that a doubling of carbon-di-oxide will increase the global annual precipitation by 3 to 13%. Global warming will also cause an increase in evaporation. Manabe and Wetherlad (1980) predict that soil moisture will increase equatorward of 35° latitude and decrease poleward of 35° latitude. A decrease in soil moisture will cause an adverse impact in agricultural yields. The variation of global warming with latitude and altitude as predicted by Washington and Meehl (1984) is shown in Fig.4. We find that warming is more in polar region than in the tropics. This is on account of ice-albedo feedback. Ice reflects most of the solar radiation (i.e., high albedo). When ice melts and becomes water, the latter absorbs most of the solar radiation. Hence there is a large increase in surface temperature. Atmospheric layers above 10 km cool because as the amount of greenhouse gases increase more radiation is emitted to space by the layers above 10 km.

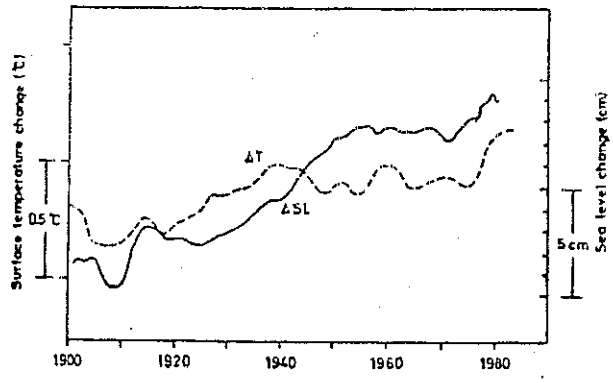

Fig 5 Comparison of changes in the global mean sea level with the global mean surface temperature.

CONSEQUENCES OF GLOBAL WARMING

The most obvious effect of global warming is the rise in sea-level (Fig.5). The sea level will rise by about 15 cm for every degree rise in global surface temperature. The changes in ice-sheets of Greenland and Antartica will tend to counterbalance and hence not contribute substantially to rise in sea level. A catastrophic collapse of the west Antarctic ice sheet might occur if the global warming exceeds 4°C. This can cause a sea level rise of 5 meters in 200 years. A gradual and monotonic rise in sea level will cause a disruption of human settlements near the coastline. Countries such as Maldives and Bangladesh will be subject to large scale flooding. There is, however, sufficient time for these nations to make contingency plan in such an eventuality. In tropical regions, the number and intensity of cyclones may increase.

There is no firm evidence to show that the increase in carbon-di-oxide and climatic change will have an adverse impact on different ecosystems. The increase in carbon-di-oxide concentrations will increase the yield of major food and fibre crops. The increase will be in the range of 10 to 50%. The crops in the central regions of large continents will be subject to moiture stress and hence may contribute to a reduction in crop yields in these regions. Paleoclimatic evidence indicates that a warmer earth will result in a wetter climate in the tropics and a drier climate in the interior of large continents. The prediction of general circulation models as regards regional climate is not reliable because their resolution is too coarse.

CONCLUSIONS

A global warming on account of increase in greenhouse gases of more than 1°C can be expected by the middle of the next century. This global warming can

have adverse impact on agriculture and human settlement if the global warming is much more than 1°C. Present climate models are not in a position to resolve whether the global warming will be small (around 1°C) or large (around 4°C). By the beginning of next century, satellite and ground observations should indicate whether global warming is above natural climatic variations.

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The Great Climate Debate

Greenhouse effect and the prospect of global warming is the subject of scientific and political controversy. Should we take steps now to avoid consequences we cannot foresee?

by Robert M. White

In the waning years of the 10th century, millions braced themselves for the apocalypse, believing that the approaching year 1000 was the very millennium—the end of the heavens and the earth prophesied in the Bible's Book of Revelation. Not surprisingly, the prospect of the impending Day of Wrath terrified normally sane people into rash and (in retrospect) foolish actions. Some gave away all of their possessions; others hastened to do harsh penance for their deeds.

In this final decade of the 20th century, a different kind of apocalypse causes widespread concern. This time the hand of God has been replaced by more visible agents: belching smokestacks, gasoline-powered automobiles, power-generating stations and the voracious destruction of forests, all of which may be turning up the heat on an overburdened environment. Global climate warming, some claim, threatens the very habitability of the planet. Others hold that the predictions of environmental collapse are not well founded and are goading us into hasty political action. Is our planet the "Endangered Earth," as *Time* magazine would have it in its 1988 year-end cover story? Or is it as *Forbes* magazine put it, "The Global Warming Panic: A Classic Case of Overreaction"?

Debate in the media reflects uncertainty among climatologists and geophysicists. Some of the world's eminent authorities on the atmosphere recently hurled verbal brickbats at one another in the pages of the prestigious journal *Science*. Their charges of "junk science" and "science by consensus" reflect the acrimonious nature of the debate within the scientific community. Some members of the National Academy of Sciences, including one of its former presidents, charge that policymakers are being induced to take unwise actions on the basis of uncertain scientific evidence. Set against this view is the recent statement of the Union of Concerned Scientists urging action by the government. It was signed by 52 Nobel laureates and more than 700 members of the NAS.

In spite of the scientific uncertainty, government and nongovernment groups are rushing to outdo one another in urging drastic action now to "stabilize" the global climate. From Washington to Toronto and The Hague, from Cairo to Moscow, international conferences of experts and political leaders have called for action. Soviet President Mikhail S. Gorbachev, President George Bush, British Prime Minister Margaret Thatcher and French President François Mitterand share similar views on the climate-warming issue.

Back home, debate within the Bush administration on how the U.S. government should act is intense. Caught between the urgings for action from the Environmental Protection Agency and Congress and cautions from his science adviser and chief of staff, President Bush called two major conferences to address the issue of climate warming. The first, held in April, brought together the heads of scientific, economic and environmental agencies of many governments. The second will be an initial meeting of governments, scheduled for early 1991, to begin negotiation of an international convention to stabilize global climate.

While there are still doubts in the White House, Congress has been environmentally hyperactive. Many pieces of legislation have been introduced to address the predicted climate warming. Leading the bipartisan effort have been Senator Timothy E. Wirth of Colorado, Senator Al Gore of Tennessee and Congresswoman Claudine Schneider of Rhode Island. Some of this legislation is comprehensive and far-reaching. It offers suggestions for action on the energy, agriculture and transportation fronts as well as for intensified research.

The actions proposed would radically change the most vital functions of human economies. They could include such diverse actions as using energy more efficiently, shifting the fossil-fuel mix from oil and coal to natural gas, relying more heavily on renewable energy sources and using more nuclear and solar energy. Measures could also include implementing reforestation, phasing out use of chlorofluorocarbons (CFC's) and changing agricultural practices.

Policy initiatives of this kind would

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alter the technology and economics of energy. Our use of land and water would also need to change. Economic growth in nations dependent on fossil fuels might be slowed. And the problems of arresting the growth of global population would become even more pressing. How can national and international policy formulation be moving so rapidly to address the specter of climate warming when agreement about the science is lacking and the economic and social costs of action have hardly been tallied? At the root of this thinking is a confluence of diverse scientific, economic and environmental forces.

The idea that the actions of humanity might change the composition of the atmosphere and hence the world's climate has deep historical roots. As early as the 1860's, it was suggested that slight changes in atmospheric composition might bring about major variations in climate. Increases in carbon dioxide (CO_2) and other atmospheric trace gases can contribute to what has been called greenhouse warming because these compounds allow the sun's energy to reach the surface of the earth, thereby warming it, while preventing much of that energy from being reradiated to outer space.

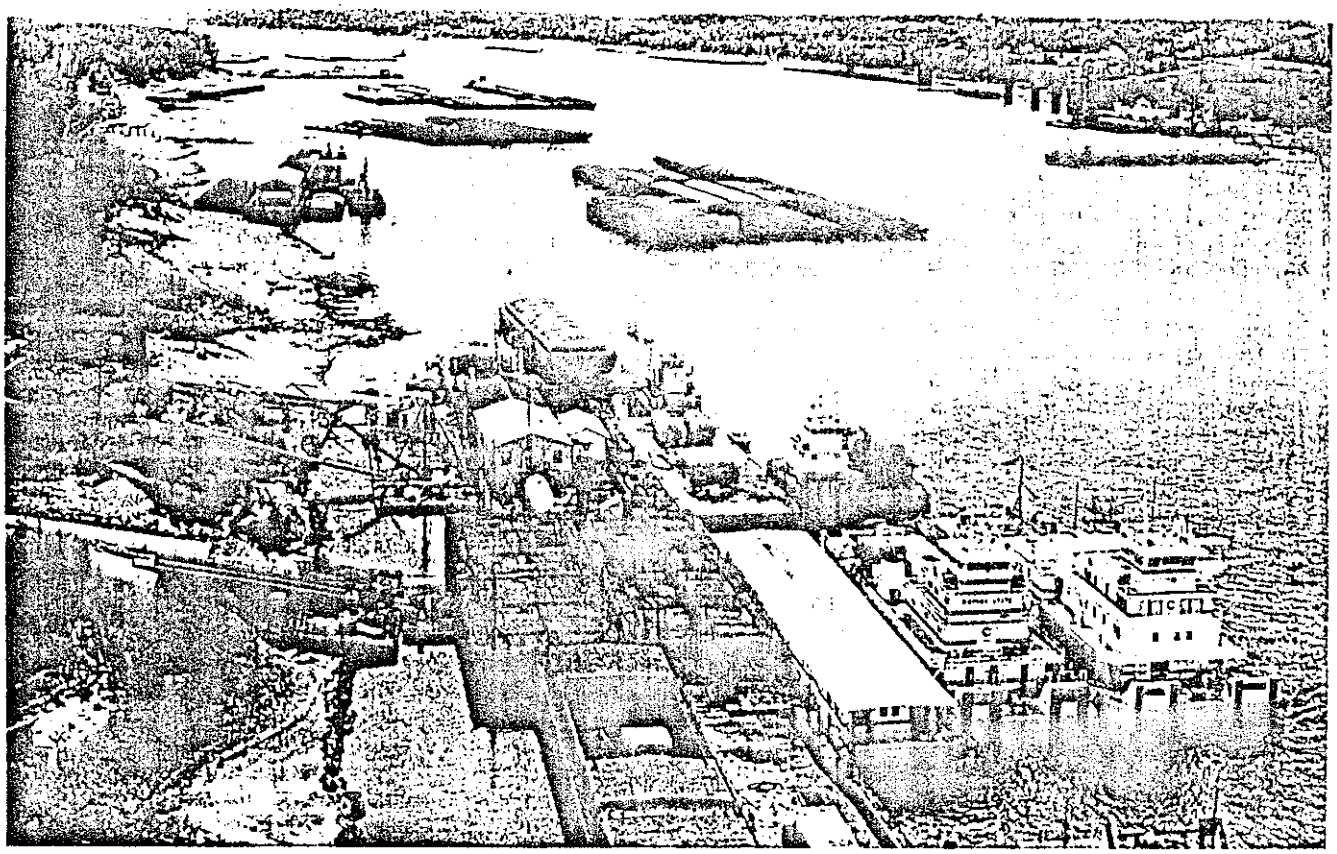
At the end of the 19th century the Swedish scientist Svante A. Arrhenius calculated how changes in carbon dioxide content would affect the temperature at the earth's surface. He estimated that a doubling of carbon dioxide would produce a global warming of about seven to 11 degrees Fahrenheit (four to six degrees Celsius), not too far off modern calculations. Yet it was only with the inception of the International Geophysical Year, a worldwide experiment in 1957 to monitor the global environment, that scientific data validating the increase of carbon dioxide in the atmosphere became available.

Roger Revelle, then director of the Scripps Institution of Oceanography, his colleague Hans E. Suess and C. David Keeling, his student, undertook such measurements. Revelle had long contended that humans were carrying out an unintended geophysical experiment on the atmosphere by burning fossil fuels. Determined to monitor the carbon dioxide content of the atmosphere, he persuaded Keeling to develop the instrumentation.

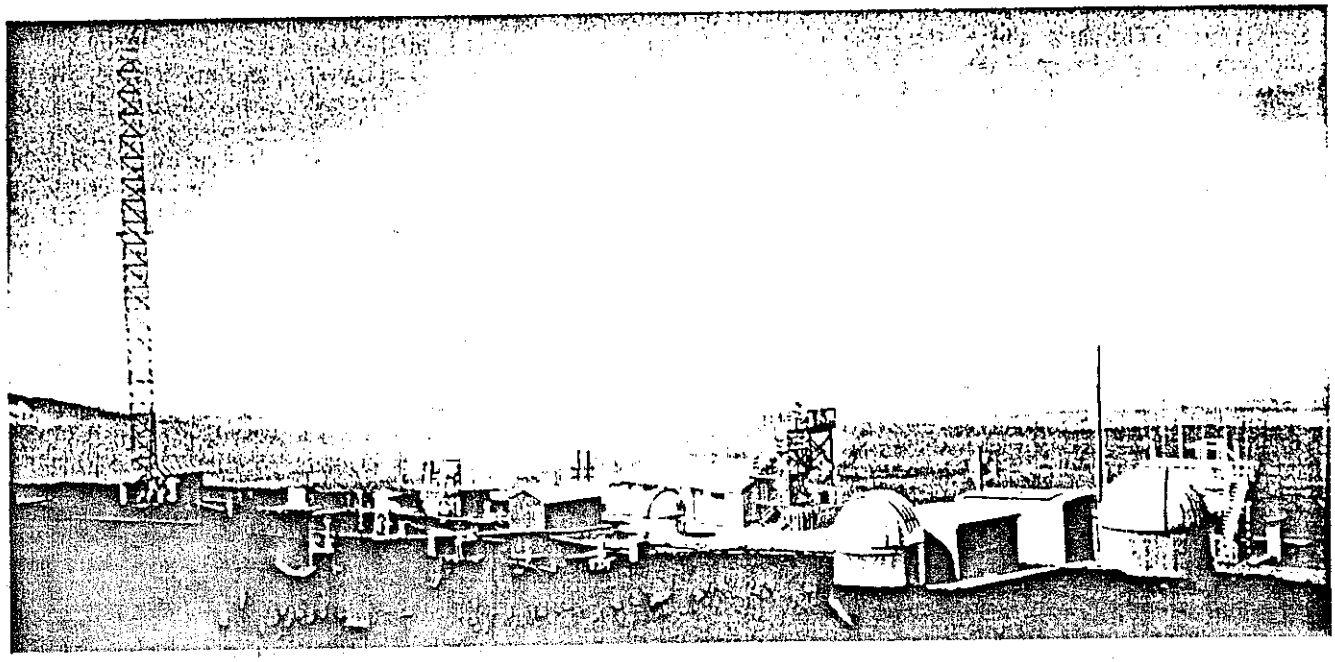
The measuring devices were placed in the Mauna Loa climate observatory in Hawaii at an altitude of about 11,000 feet. Beginning in 1957, the data they collected revealed a systematic increase in atmospheric carbon dioxide. Keeling's observations were verified at the South Pole and at other locations around the world. To date, the change from 290 parts per million in 1880 to 352 parts per million in 1989 represents more than a 20 percent increase over the course of the past century.

Just before the International Geophysical Year began, on the other side of the continent from Scripps, another development key to unraveling the climatic consequences of increasing carbon dioxide emissions was taking place. Under the leadership of the world-famous mathematician John von Neumann at the Institute for Advanced Study in Princeton, N.J., the first attempts were made to represent the atmosphere mathematically on digital computers.

Von Neumann's team of brilliant young scientists was headed by Jule G. Charney. Later known as the father of



BARGES STRANDED by all-time low water levels on the Mississippi River were one effect of the record-breaking drought of 1988. That long, hot summer thrust the greenhouse effect into the public eye and set off the present policy debate.



MAUNA LOA CLIMATE OBSERVATORY in Hawaii is located at about 11,000 feet. Data collected here, beginning in 1957 and continuing through the present, were the first to document a steady increase in atmospheric carbon dioxide levels.

numerical weather prediction and arguably the most important American figure in the transformation of weather prediction from art to science, Charney demonstrated the feasibility of using computers to perform the task. Von Neumann and Charney calculated the first 24-hour weather forecast in 1950 on a primitive digital computer, the ENIAC, maintained by the U.S. Army Signal Corps in New Jersey.

Looking beyond these efforts, von Neumann called climate forecasting the "infinite prediction." One of the young scientists in the Princeton group, Norman Phillips, made the first attempt at modeling the global atmosphere in 1956. It was coincidence that later, in 1963, an unusual laboratory of the National Oceanic and Atmospheric Administration (NOAA) was established on the campus of Princeton University under the leadership of Joseph Smagorinsky, a strong-willed and hard-driving young scientist who had been one of von Neumann's group. The laboratory was totally devoted to the mathematical modeling of the atmosphere using the largest and fastest digital computers available.

Called the Geophysical Fluid Dynamics Laboratory, the center harbored researchers from many nations interested in this new approach to the study of the atmosphere. Among them was a young Japanese scientist, Syukuro Manabe. Modest and retiring but completely dedicated to the work, he developed the first climate model in collaboration with his colleague Richard T. Wetherald in the 1960's. In 1975 they calculated that a doubling of the carbon dioxide content of the atmosphere would produce a global climate warming of about five degrees F (three degrees C), averaged over the surface of the earth. This calculation has been verified in many different laboratories and has not changed substantially.

Keeling's observations, together with the calculation of Manabe and Wetherald, triggered the wave of climate-change research that has marked the past two decades. Studies have since been undertaken in many parts of the world, including Europe and the Soviet Union. In the U.S. the National Research Council conducted studies in 1966, 1977, 1979, 1983 and 1987. These inquiries were chaired by such leading scientists as Gordon J. F. MacDonald, Revelle, Thomas F. Malone, Charney, William A. Nierenberg and economist William D. Nordhaus.

Yet because there were no immediate consequences for human health and no evident manifestation of climate change, the work was slow to arouse political concern. The most politically influential study was the one prepared in 1979 at the request of Frank Press, now president of the NAS, who was then White House science adviser to President Jimmy Carter. It was also in 1979 that the World Meteorological Organization in Geneva, recognizing the potential global significance of the issue, convened the first World Climate Conference.

Gradually, scientific awareness that humanity might actually be causing a planetary disruption began to register in the political world. Although there was much debate over the validity of projections from computer models, the observations of greenhouse-gas increases, however, were precise, well measured and verified in many parts of the world. These were corroborated by additional data that documented increases in other greenhouse gases such as methane, or natural gas, and CFC's.

Meanwhile mathematical-modeling groups in this country had been established not only by the NOAA but also by the National Aeronautics and Space Administration, the Department of Energy and the National Science Foundation. The leaders of these laboratories became the "gurus" of climate warming. Incisive and original in their work, Stephen H. Schneider of the NSF's National Center for Atmospheric Research in Boulder, Colo., and James E. Hansen, the leader of NASA's Goddard Institute for Space Studies, were soon to become frequent witnesses at innumerable congressional committee hearings on the subject.

Although the mathematical models of all the groups yielded similar results, the details of the geographic distribution of climate changes differed from one model to the other. All projected that an increase in carbon dioxide would bring about a gradual warming, but the timing of this warming would depend on the rate of global energy use. They all agreed that

if reasonable assumptions were made about future global energy consumption, it would be around the middle of the next century that the carbon dioxide content of the atmosphere might double.

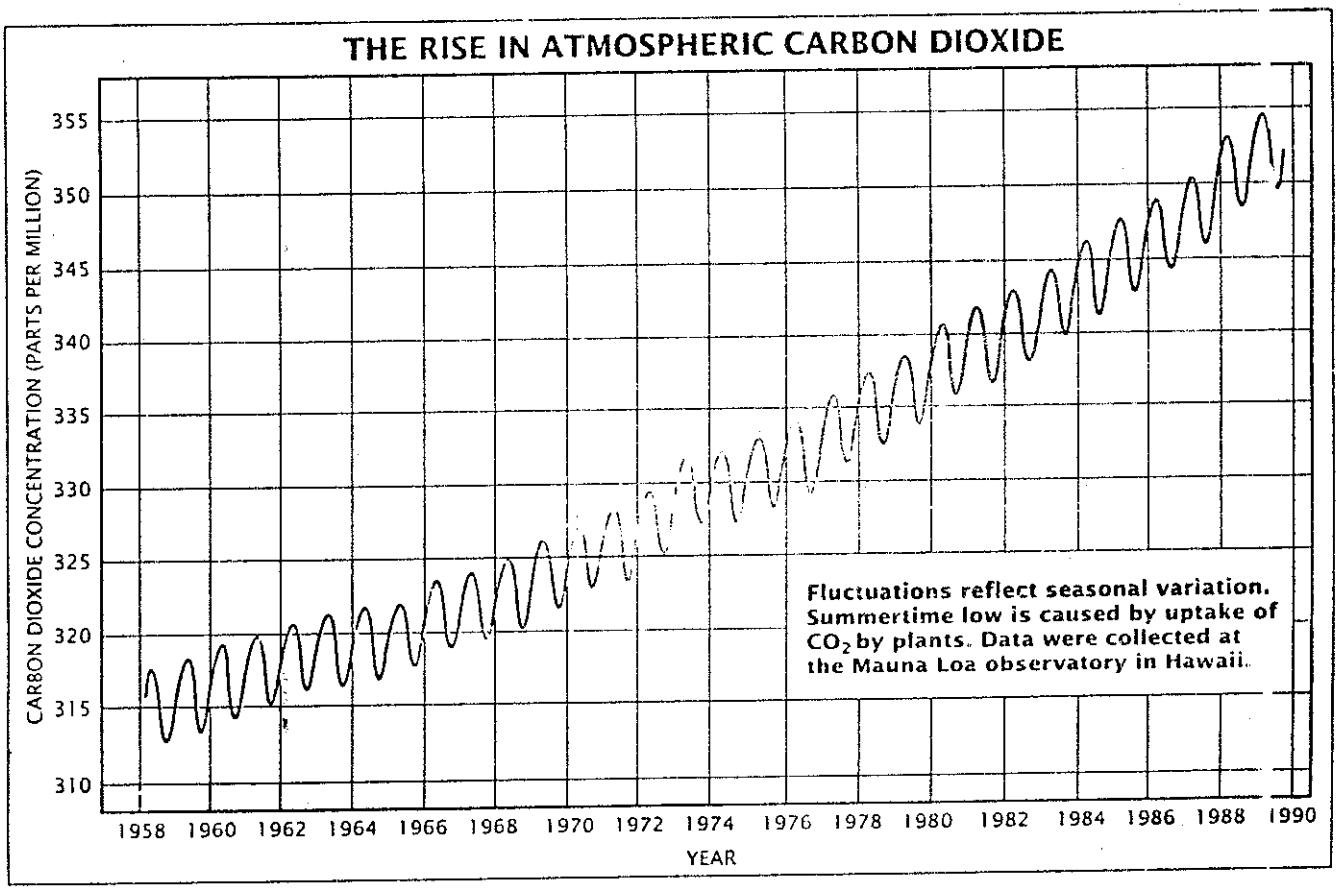
Just how much this doubling of carbon dioxide would increase temperatures, however, varied greatly from model to model. Some predicted as little as a two-degree F (one-degree C) increase, whereas others predicted increases of as much as nine degrees F (five degrees C). The differences in predictions became central elements in the debate about whether the models were sufficiently reliable to warrant policy actions. Further, it made a great difference whether the actual increase was at one or the other end of this range. At the low end, the normal resilience of society would probably be sufficient to accommodate the changed climate. Changes at the high end portended severe disruptions.

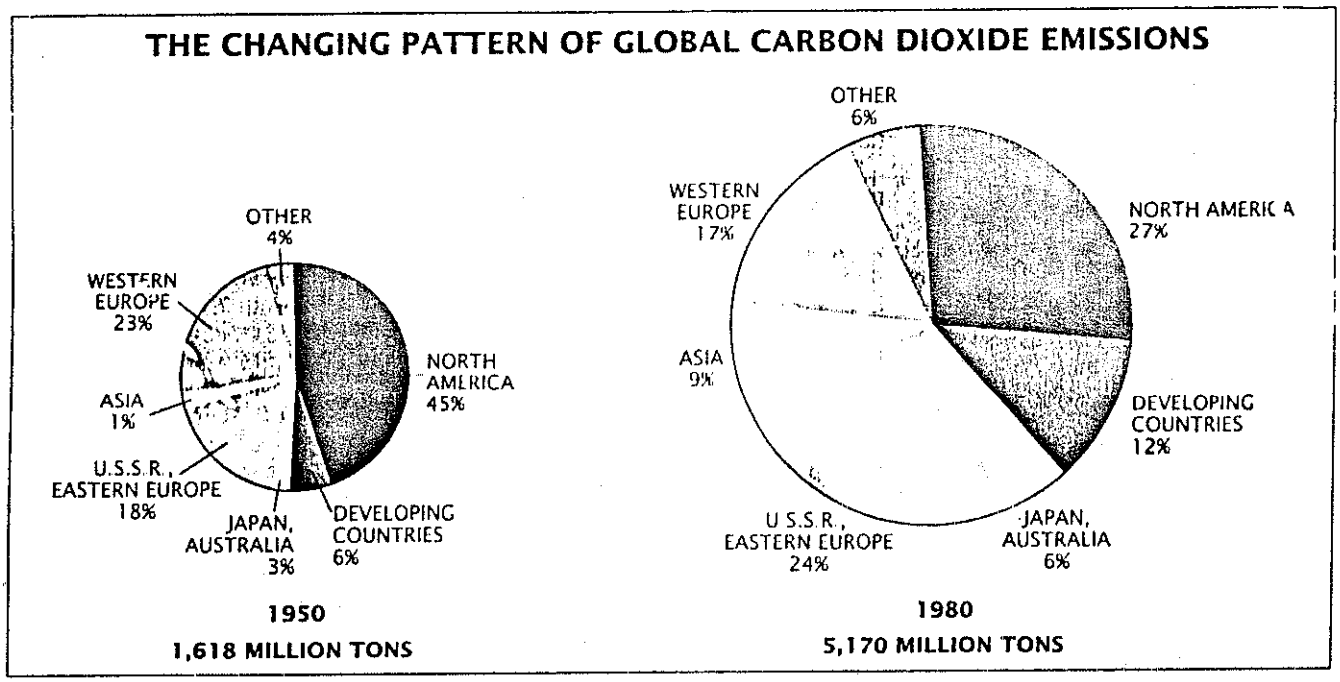
These projected temperature changes may appear innocuous because variations of this magnitude are experienced in the normal course of daily and seasonal weather. Their full implications can be appreciated by noting that it took only a two-degree F average decrease in temperatures in Europe to cause the run of several frigid centuries (from the 1400's to the 1800's) known as the Little Ice Age. Nine degrees F is believed to be the difference in temperature that separates the end of the last great ice age 12,000 years ago from the present. Further, the projections indicate that the Northern Hemisphere would experience in just a half century an unprecedented temperature change, 10 to 50 times faster than the change since the last ice age.

Those who are not familiar with mathematical models or the way computers are used to make these projections can be forgiven for being confused—or even annoyed—by the great disparities in the results. Among investigators it is understood that mathematical models are only approximations that attempt to simulate the processes that govern atmospheric behavior. The atmosphere is so complex that it is impossible to represent it in very great detail in these mathematical models. It is possible to represent only certain features and to make assumptions about how the oceans and the atmosphere interact, how the rate at which the oceans take up carbon dioxide varies and how clouds affect the exchange of energy between the earth and the atmosphere. Even the largest computers cannot represent the atmosphere, oceans and land surface in fine detail. Indeed, scientists approximate the conditions in the atmosphere by thinking of it as a set of observations spaced about 500 kilometers apart.

The political calls for action are being played out against the backdrop of that uncertainty. On one side, the view is that if there is a chance that model predictions could be correct, the consequences could be so dire that immediate action to arrest climate change would be imperative. The alternative view, equally cogent, is that commitment to action with vast economic and social consequences is unwarranted in light of both the scientific uncertainty and the absence of knowledge of the economic costs. John H. Sununu, White House chief of staff, in remarks he made at the annual meeting of the National Academy of Engineering in the fall of 1989 gave voice to this position:

> *Although I agree that* [global warming] *is a critical issue, the fact is that the models with which analysis is being done and with which policy is being moved, as good as they may be, still are based on element sizes measured in hundreds of kilometers in length and width, and tens of kilometers in thickness. I suspect that no one who has ever been involved in engineering simulation would feel comfortable making major*





bilities of increasing rainfall, changing the intensity of hurricanes and modifying hailstorms by cloud-seeding techniques proved abortive.

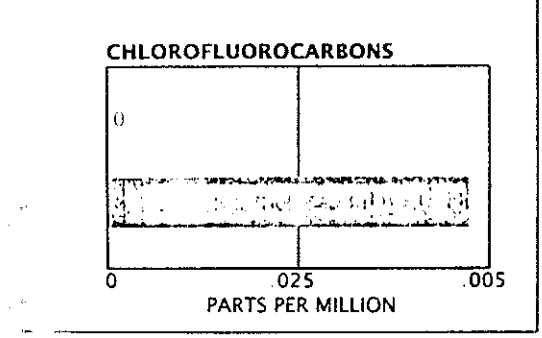
Then, in the early 1980's, it was postulated that dust thrown into the atmosphere by a nuclear exchange between the Soviet Union and the U.S. would result in a "nuclear winter." This idea was deflated by Schneider and his colleague Stanley L. Thompson, who showed with the same models used in the prediction of climate that the "initial nuclear winter hypothesis can now be relegated to a vanishingly low level of probability."

Given this "cry wolf" history, it is not surprising that many meteorologists harbor deep reservations about taking costly actions on the basis of the predictions of a climate warming. But the push for policy has other constituents. Climate warming also unites those who are concerned about biodiversity and species extinction, economic development, human population growth, urban air pollution, acid precipitation and ozone depletion.

Political leaders stimulated by public concerns about environmental deterioration see these issues as important platforms and as springboards to public office. Those interested in increasing the competitiveness of American industry see greater energy efficiency as an important step toward that goal. It also serves the interest of those concerned about U.S. dependence on foreign energy sources. The issue of nuclear power is also underscored. Because fossil fuels are the main source of atmospheric carbon dioxide, strategies for stabilizing climate must envision non-fossil-fuel sources. Here at last is justification that proponents of nuclear power can forcefully advance to support expansion of nuclear power facilities throughout the world.

The issue of global climate warming also offers an opportunity for advancing the "new economic order" long advocated by Third World nations. International action will require technological and economic assistance to such nations if they are to participate in a global effort to reduce atmospheric pollution or arrest deforestation. In fact, the world faces the prospect that the greatest increases in emissions of carbon dioxide will occur in developing countries as their need for economic growth is followed by increased demand for energy.

In like manner, those interested in arresting population growth especially in the Third World, point out that the climate-warming problem is probably not solvable as long as the number of human beings continues to rise. After all, it is people who consume natural resources and energy and who farm the land. Without population control, prospects for stabilizing the climate and arresting the deterioration of the habitability of the planet are abysmal.



Are the consequences of climate warming to be feared? People experience extremes of temperature in the natural course of events. The fact is that we do not know enough to predict the severity of the consequences. Because the warming would not be uniform over the surface of the earth, it would probably produce both winners and losers among regions and nations. Some parts of the earth would become warmer, some wetter and some drier. It is not possible on the basis of the evidence at hand to predict who would benefit and who would lose in such a global redistribution of so-called climatic resources.

Some aspects of global climate warming would be greatly beneficial in the view of agricultural researchers. Increased carbon dioxide will foster more active photosynthesis and enhance crop growth, to say nothing about the lowered plant requirements for water in a CO_2-enhanced atmosphere. In the words of Jerry D. Mahlman, director of the Geophysical Fluid Dynamics Laboratory, "The things we can say with confidence, the policymakers are not interested in. And the things [they] are interested in, we don't know with confidence."

Models do, however, agree that the polar regions of the world would undergo greater increases in temperature than would the tropics. Some of the projections of temperature increases in polar areas are startling in their magnitude, predicting as much as 18 degrees

decisions in which the elements were orders of magnitude greater than the details on which they were looking for information. And yet the fact is that we are moving toward binding international policy based on conclusions being drawn by policymakers who have no sense at all of the difference between the levels of confidence they should have and levels of confidence they want to have. A system is not valid just because it gives you the answers you want. And yet so much policy is being made in reaction to that principle.

The solution to the dilemma should be simple: Since the carbon dioxide content of the atmosphere has increased by more than 20 percent over the past century, we ought to be able to detect the climate warming in the global temperature record during the same period. Researchers have sought to do this, but it is a much more difficult task than it first appears. The problem is that climate is always in a state of natural fluctuation. Separating out the changes that are caused by increasing carbon dioxide from the natural changes is tricky scientific business. Moreover, the climatic temperature record is based on scattered and irregular observations not taken specifically for the purposes of determining climatic conditions.

Even so, careful analysis of these temperature records by scientists in the U.S. and in the U.K. sought to detect whether a climate warming has occurred and whether such warming is consistent with the prediction of the models. The prevailing view is that the climatic record over the past century for the entire globe reveals a net increase in temperature ranging from .5 to 1.0 degree F. (from .3 to .8 degree C.). But set against this conclusion is the disturbing result that similar increases in temperature cannot be detected over the past century in the U.S., where observations are numerous and accurate.

Even if the temperature rise is real, a puzzle remains that workers have been unable to unravel: Is the rise in global temperature a natural fluctuation or a result of the increase in greenhouse gases? All that can be said is that the observed increase is consistent with the lower end of the temperature increases predicted by the computer models. Consequently, the temperature records, as well as the predictions of mathematical models, provide substance both to those who believe the evidence warrants action now and to those who believe the evidence is still too weak.

The rush to policy action was, I believe, catalyzed by the disastrous drought of the summer of 1988. During this drought, one of the worst on record, the water in the Mississippi River fell so low that navigation was impossible over long stretches, urban water supplies were threatened and crops throughout the grain belt were devastated. Both officials and the public wondered whether this was the greenhouse effect manifest. Indeed, records show that in the U.S. five of the years of the 1980's were among the hottest on record, and the average temperature for the decade as a whole was the warmest since instrumental records have been kept.

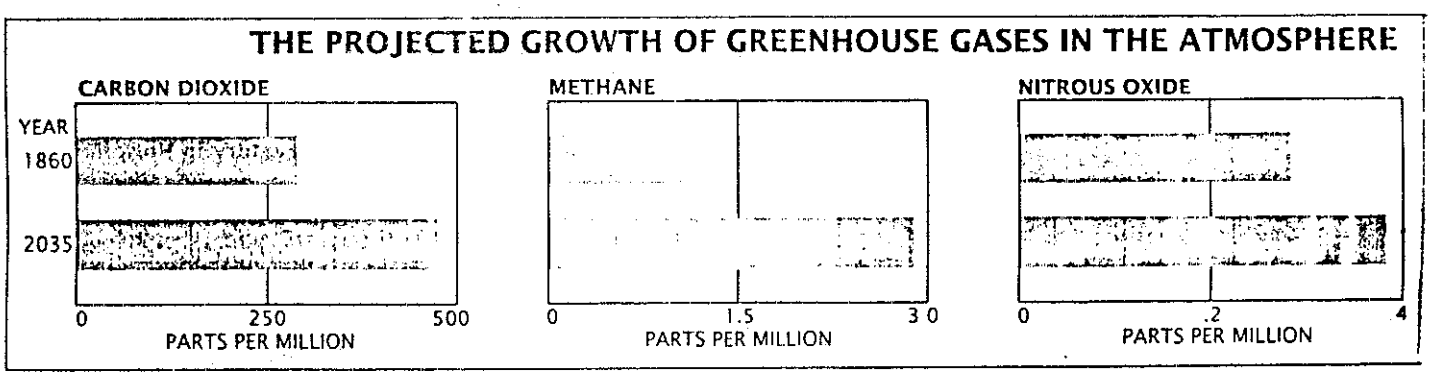
Prompted by heat and drought, congressional hearings addressed the question of whether the greenhouse effect had arrived. These hearings were unremarkable except for a statement by Hansen. When he stated that he was 99 percent certain that the greenhouse warming had begun, as evidenced by the sequence of warm years in the 1980's, the public took notice. His opinion prompted members of Congress to consider whether the prudent course was to move rapidly to legislation aimed at protecting the habitability of the planet from catastrophic consequences.

Hearings followed hearings. Both the atmospheric researchers and the more general environmental community began to choose sides on whether immediate policy action was justified. The reaction from environmentalists was quick and vociferous. Several environmental and scientific groups began to advocate international agreements restricting the emissions of greenhouse gases.

At this point, some influential atmospheric researchers, who believed that policy actions were beginning to outrun the scientific evidence, weighed in with their views. Richard S. Lindzen of the Massachusetts Institute of Technology and Jerome Namias of Scripps, the nation's most distinguished long-range weather-forecasting expert, wrote a letter to President Bush urging that no action be taken. Three other members of the NAS, including its former president Frederick Seitz, joined in a report, published under the auspices of the Marshall Institute, calling into question the scientific basis for policy actions. They recommended a major research program in mathematical modeling. They pointed out that there might be alternative explanations for the climate warming that had taken place. Thus, the great climate debate had been joined.

Meteorologists did not look with favor on the prospect of yet another public debate involving their field: they had been proved wrong many times before. As long ago as 1924, Sir Gilbert Walker, then head of the British government's Indian weather service, discerned unusually close connections between rainfall, temperature and pressures in the Pacific Ocean and the Indian subcontinent. Claims were made that the problem of forecasting the Indian monsoon was solved. Were it true, it would have been a great boon to Indian agriculture. But it was soon recognized that the correlations had little predictive power.

Later, in the 1940's and 1950's, widespread claims were made, based on the work of the late Irving Langmuir, Nobel laureate from the General Electric Company, and Vincent J. Schaefer of the State University of New York at Albany, that seeding clouds with dry ice or crystals of silver iodide could bring about an increase in rainfall. Several decades of research into the possi-



F (10 degrees C) on the average in the Northern Hemisphere and only slight increases in tropical regions.

What are the general consequences of such a change in the temperature difference between equatorial and polar regions? We experience similar differences every year as the seasons change. In summer when arctic temperatures are warm, we do not suffer the great storms of winter; precipitation belts move farther north. Areas such as the southwestern part of the U.S. experience very dry conditions.

If arctic regions were to undergo significantly greater warming than equatorial regions and if precipitation belts were to move farther north, countries in the north temperate and polar zones would probably stand to benefit greatly. Their growing season would lengthen, and their precipitation would increase. With suitable soils, agriculture might thrive. These are speculations, however.

Such speculations are formulated in "scenarios" asking the question, What if? Unfortunately, an infinite number of such "what if" questions may be asked. What if the flow of rivers in the American Southwest, already fully utilized, were to be reduced by 20 percent? What if temperatures were to increase in the corn belt and precipitation were to move farther north? What, then, would be the consequences in the U.S. for agriculture, for resource availability, for energy generation, for national parks and conservation of nature?

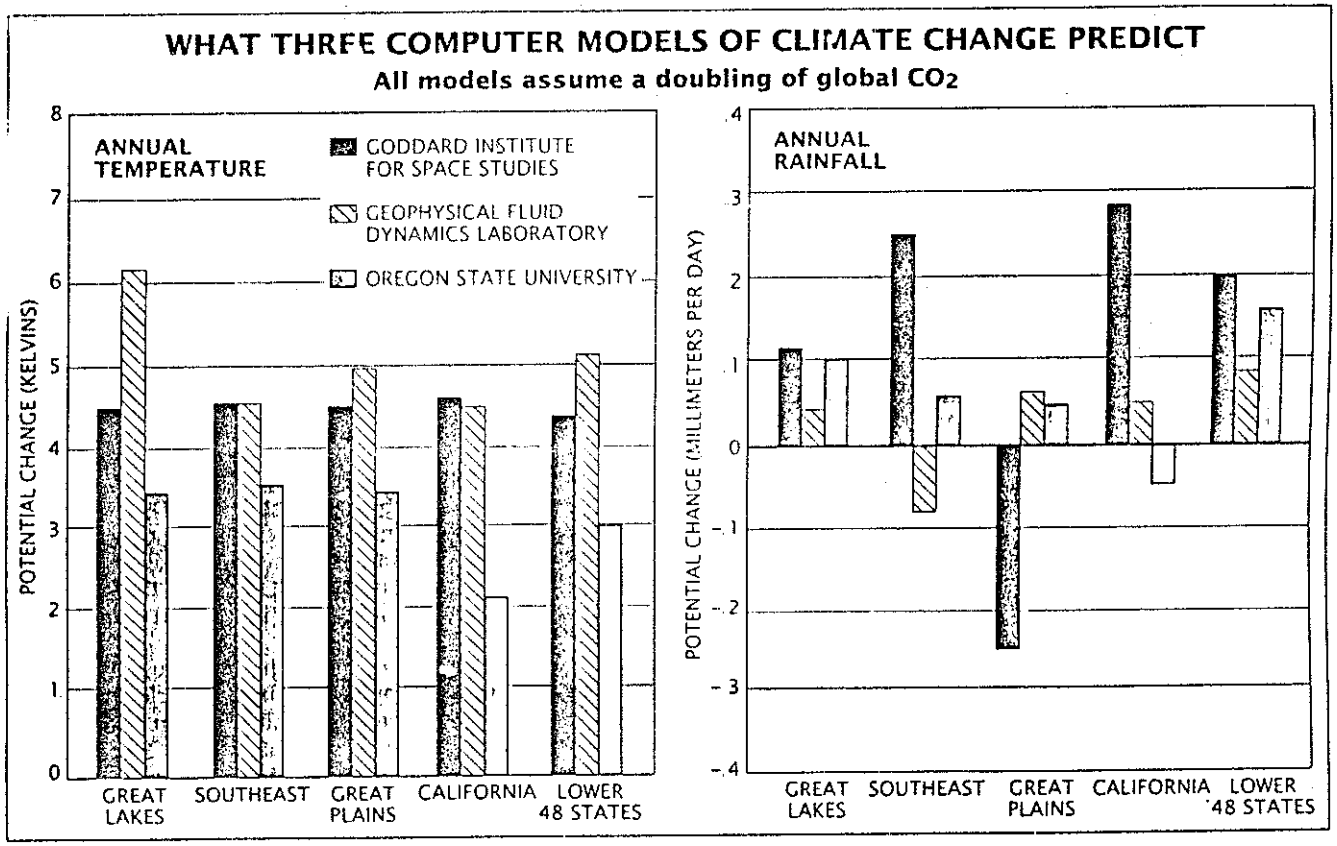
The consequences of changed climates can be seen in historical records going back thousands of years, and we have seen them in recent climatic events. We know, for example, that the Danes were able to settle Greenland and the Vikings to sail the North Atlantic to North America during a period of warm climate around the year 1000. Then a significant change in climate caused the collapse of the Danish settlements, prevented further exploration of the North American continent and ushered in the Little Ice Age. In just the past few years we have witnessed the effects of drought in the Sahel region of Africa and northeast Brazil, as well as in parts of North America.

Such scenarios can suggest apocalyptic possibilities. A recent film in the *Infinite Voyage* television series showed the U.S. Capitol under water as the result of one possible climate-warming scenario. Some foresee vast migrations of people as areas of the world become uninhabitable. Others see threats to national sovereignty and national security. President Gorbachev has stated that ecological security, not military security, will be the principal concern of all nations in the next century as environmental conditions cause disruptions worldwide.

But scenarios should be qualified with the caveat that although the events portrayed might in some cases be plausible, they are not real predictions. What, then, is a wise course in the face of great uncertainty? Clearly, it would be one that recognized uncertainty but would not permit that uncertainty to forestall action. Steps for which other economic and environmental reasons make sense would be taken first, whether or not a climate warming is taking place [see "The Changing Climate," by Stephen H. Schneider; SCIENTIFIC AMERICAN, September, 1989].

Then, as scientific knowledge reduced uncertainties, more costly measures could be taken if warranted, hence closely tying policy actions to the state of knowledge. Scientists and others have called this a "no regrets" policy. In gambling it would be known as "spreading your bets."

A recent report of the Council of Economic Advisers lends weight to this approach. It states that the cost of controlling carbon dioxide emissions and of taking other actions to address climate change would run into hundreds of billions of dollars. Because such reallocations of resources raise the specter of grave economic consequences, we need to be reasonably sure such ac-



tions are worth the cost. Any rational no-regrets policy would foster as one of its prime objectives adequate investment by governments in global monitoring and mathematical modeling to reduce the scientific uncertainties.

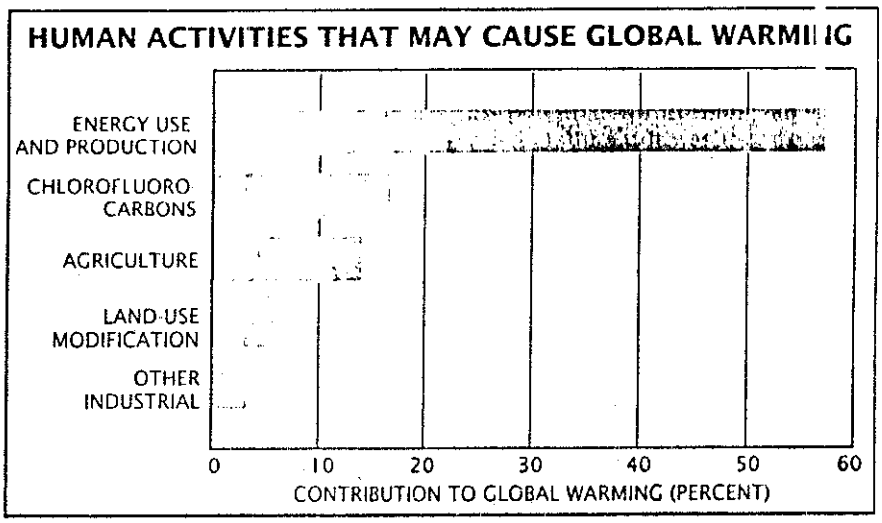
Where might we start? Energy conservation and efficiency along with the phaseout of CFC production would be the first priority for national and international action. Achieving greater energy efficiency justifies itself handily in economic terms. Increased energy efficiency would also ameliorate urban air pollution and acid precipitation. Shifts in the fossil-fuel mix from coal and oil to natural gas could significantly reduce carbon dioxide emissions per thermal unit. Technology is also available for more efficient power generation and for increased gasoline mileage.

Wisdom would also dictate major investments in nonfossil-energy sources. The circumstances favor significant new investments in passively safe, publicly acceptable nuclear power. Further development of forms of solar energy—photovoltaics or biomass, for example—makes good sense. Reforestation and forest preservation constitute a benign policy that yields many ecological and climatic benefits. Research aimed at producing stress- and disease-resistant crops would also be wise.

The public, however, must not be misled. These no-regrets initial policy steps will not solve the climate-warming problem. Their effectiveness will only modestly retard climate warming, and the future may require more drastic actions. No matter what policy actions we take, fully arresting the climate warming just does not seem to be in the cards.

The difficulties of reaching an international agreement on procedures for mitigating climate warming will be difficult and lengthy. The negotiations for the Law of the Sea Treaty provide a good lesson. They consumed 15 years and produced a treaty that the U.S. has yet to sign because of demands by developing nations for significant technology transfer and economic assistance. These issues will be even more complicated and more pervasive in any "Law of the Atmosphere Treaty."

It is likely that humanity will have to adapt to some climate changes. Modes of adaptation by society have not been well studied. Individuals, corporations and communities can adapt to climatic vicissitudes in myriad ways. Farmers can change crops, water use can be regulated and management practices can be altered.



Other modes of adaptation would be needed if climate changes were severe. Sea-level rise, which is one of the predicted concomitants of a climate warming, might inundate low-lying coastal areas and cause salt water to intrude into freshwater bodies. Were this to occur, society would have to decide whether to invest in protective structures along coasts or adapt by changing land-use patterns. The North Sea dikes in the Netherlands are an outstanding example of adaptation to relative rise in sea level.

Some adaptations would take considerable time to implement. If the price of energy were to escalate, energy-efficient habitations would be necessary. Present cities with their great suburban sprawl are not energy efficient, and so we might return to more compact cities. If we chose to maintain agriculture in dry areas, society would need to decide whether to invest in the necessary irrigation systems. In fact, the economic growth of the entire western part of the U.S. has been based on major investments in water storage and transport for irrigation and industrial use.

Fortunately, time may for once be on our side. Governments generally act only when threats become real. They act in the face of military threats or when areas are endangered and destroyed by natural disasters. If the climate changes, the expectation is that it will do so gradually. We should be able to see the initial evidence of coastal inundation in an increasing frequency of high tides and in the undercutting of seacoasts. Climate warming itself should be evident in a rising frequency of heat waves or in other weather anomalies. The effects of a global climate warming are likely to take 30 to 50 years to become serious, and that is a long enough span in which actions to adapt to these changes should be possible.

What of the debate in the atmospheric, environmental and political communities? Our global environment is under attack on many fronts. Climate warming is but one, perhaps the most complex, of these issues. If the changes occurring in our atmosphere are likely to cause consequences, we must understand the problems and promote sensible policies to remedy them. What would be unwise is to lapse into apocalyptic thinking or ostrichlike denial. We like to believe ourselves far more sophisticated, more enlightened than preceding generations. Until we can calmly and objectively approach our environmental challenges without promoting public hysteria and exciting shortsighted, self-interested reaction, we cannot claim that we are.

FURTHER READING

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TRIBALS AND FOREST

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The tribals and forest is one of the important issue of modern developmental trends in India. India's forest cover is less than the world's average and we are loosing forest at the rate of 1.3 million hectares every year according to N.R.S.A. (National Remote Sensing Agency). On the other hand tribals constitute 6.94% of the country's population and in Karnataka they make up 1% of the total population and most of them are forest dwellers. In such a situation the developmental programmes for tribals have to be meticulously worked out such that they are environment friendly, and that they provide real alternative livelihood. If not the antisocial elements may misuse him and create further pressure on forest. In such a situation it is often misconceived that forest conservation and tribal welfare are the diagonally opposite issues and that the positive efforts to one should always mean negative to the other. But as we can see the two issues are confluent with each other so much that a solution in isolation to each of them is not likely to be feasible. The pressure on forest will be continue unless a long term solution to the problem of tribals is worked out.

It is in this background that the ensuing discussion on tribals and forest is centered around. The following discussion is the synthesis of experience of many of us, working at the grass-root level for tribal development, and no less important, the priority we accord for environmental protection.

(i) TRIBALS, FOREST AND TRIBAL CULTURE

In Karnataka the tribal people are spread over the forest areas of 4 districts viz., Mysore, Coorg, Chickmagalore & Dakshina Kannada. Earlier they were food gatherers and hunters and were subsisting on agriculture by shifting cultivation. They shared their green habitat with wild animals in perfect harmony. Their life style culture and attitude are all inextricably linked with forest so much that a life without forest in unimaginable to them. Even today they form an integral part of the whole ecosystem.

The changing times have adversely affected the tribal life and culture. Till recent time the mother nature was the single largest factor influencing the tribal culture. But the onset of modernisation and its attendant need of more and more fuel and timber has led to rapid destruction of forest. Forest regulation acts have not been able to effectively check the deforestation. On the contrary the ways and means of tribal living is narrowed down. The commercialisation of the forest has shifted the self reliant tribal economy to the one of the dependence. Earlier except common salt and cloth there was nothing else that the

tribal society required from the modern world. Now that the forests are reduced, hunting and agriculture is restricted the very survival of tribals depend on what is supplied from outside world. In such a situation the cordinal aspects of positive tribal culture like sharing, co-operative community living, etc., are lost. The alienation from his culture, forces him into an inferiority complex and he develops diffidence to any new exposure. To fill up the lacuna of this alienation he is taken to alchohol. Many other psychological hazards of alienation are discussed in my paper "Impact of development on tribal culture - A study".

(ii) TRIBALS, FOREST AND AGRICULTURE LAND

Tribals have been surviving in the forest from time immemorial and are subsisting on agriculture. It is natural therefore for tribals to think that forest belongs to them first and to the others next. But after the shifting cultivation was stopped and tribals were colonised, hardly any land was provided to them. On the other hand many non tribals who were good at developing records over land rights could get patta land. The tribals were used to develop plantation and were allowed to cultivate in between these plantation. But soon they were shifted to new places where such plantation were required. They were moving with forest department from place to place until the green cover was augmented and only to find themselves at last with no job and no land. This has happened specially in the national parks areas of Bandipur, Nagarahole and H.D.Kote. The national parks now have full green cover and the forest department does not need the services of the tribals any more. Human entry is totally prohibited in the core areas and hence tribals cannot collect the M.F.P. also. Thus the very survival of tribals is threatened. The hunger deaths recently reported indicate the abject poverty and miserable state of the tribals in this area.

Food and Agricultural Marketing Research Academy (FARMA) has conducted a detailed socio economic survey of the soliga tribes with the assistance of Vivekananda Girijana Kalyana Kendra in three taluks viz., Chamarajanagar, Yalendur and Kollegal. The following statistics of land holdings is of interest.

Total tribal population of 3 Taluks	.....	12,711
Number of families	.....	2.995
Average size of the family	.....	4.24

TOTAL LAND HOLDINGS

Patta Land	.....	692 Acres
Temporarily cultivable land	.....	1,152 Acres

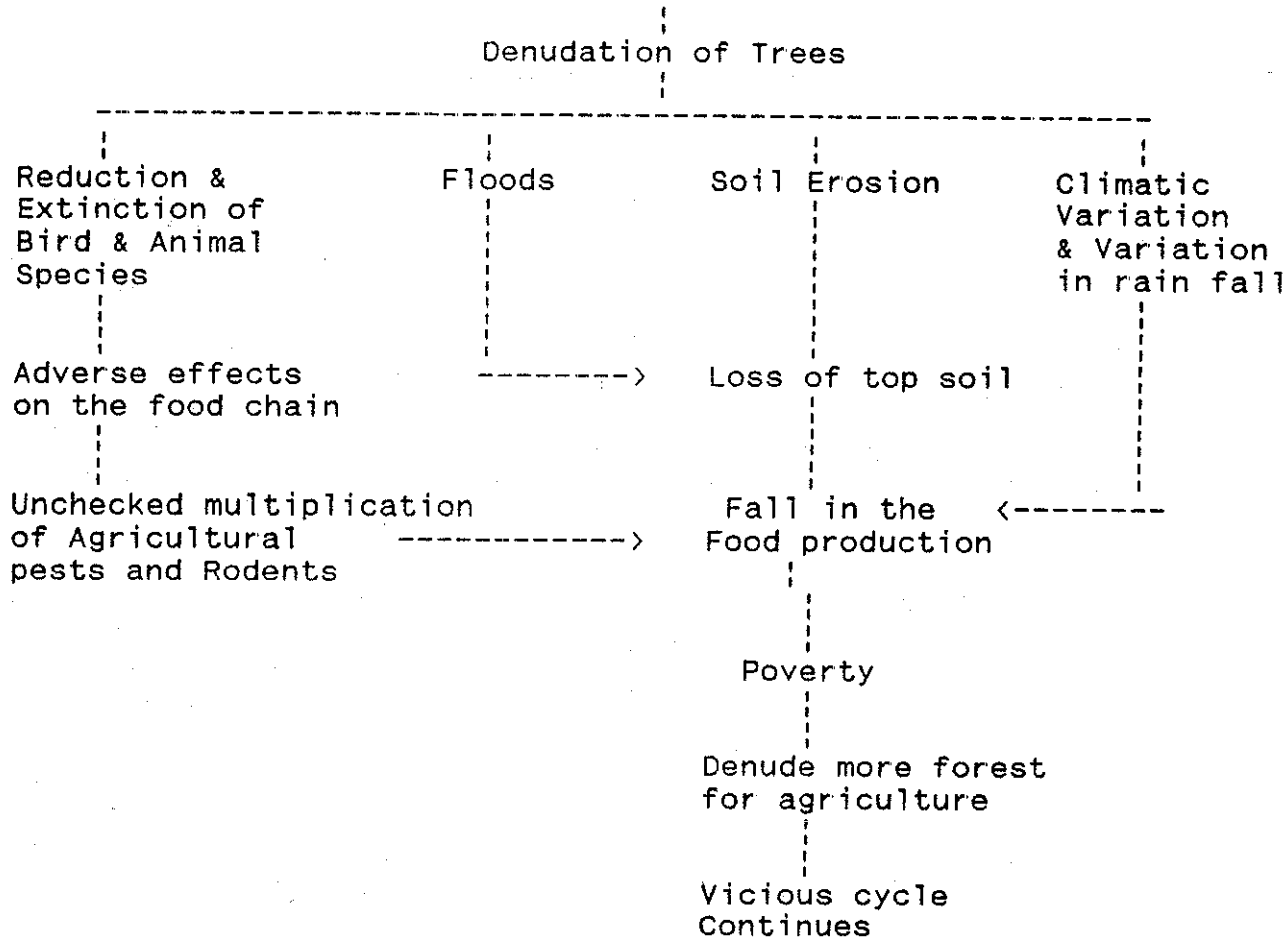
By this statistics it is evident that less than 25% of the tribal families own patta land and to an extent of less than 3 Acres per family. The temporarily cultivable land consists of forest land and the land given for fruit orchards. On the other

hand many non tribals own patta land in the midst of reserves forest. Such a case of glaring discrimination is conspicuous in the Kakana Kote area. A group of non tribal people called Odigas are cultivating about 3,000 acres of land in the heart of the forest on the Manandavadi road, while tribals who inhabited this area for ages are devoid of agriculture land. The Odiga people are cultivating forest land on exalease of Hangami lavdi system and forest department has released forest land for agricultural purpose with a nominal tax of Rs.15 payable to forest department. In fact even until 1980 the D.C.F. was empowered to lease out any part of the reserve forest of this Hangami lavdi system is continued officially is doubtful. This only shows that tribal people did not have enough support and awareness to process the papers required to get land on such exalease system. The forest department which made use of the tribals in every way did not head for a long term welfare of the tribals and the efforts to rehabilitate the displaced tribals in this area is yet wanting.

In B.R.Hills range in the midst of reserve forest there are about 4,000 acres of coffee estate owned by Birla's and other wealthy people. But tribals were forcibly evicted during 1970's by bulldozing their crops and hut settlement by elephants in the place called Guruvina Gadde. This was carried out under the leadership of a forest official. According to revenue department Guruvina Gadde has revenue land and even housing sites were distributed by the revenue department. Few relevant documents to this effect are still available. After eviction the whole area of Guruvina Gadde is converted into eucalyptus plantation.

The government seems to have not made an early attempt to settle the agricultural land for tribals. It was easy for the government to implement forest conservation act on the voice less, unorganised tribals. But we have many examples of forest being denuded and given. The tibettians were rehabilitated in Kollegal taluk by providing 3,000 acres of forest land. 65% of the Soliga tribes of Mysore district live in this taluk but without appreciable agricultural land. In the present times of diminishing forest and reducing Biodiversity it is not appropriate of denude forest for agriculture purpose. Multifaceted effects of denuding forest are depicted in the following chart.

(iii) DENUDATION OF FOREST FOR AGRICULTURE



(iv) THE EXISTING GOVERNMENT TRIBAL WELFARE PROGRAMMES AND ITS EFFECTS ON FOREST

A variety of Tribal Development programmes are implemented by government for the past 2 decades. Recently they have been intensified with fairly good budget allocations, but often much of it has gone back unimplemented. Often the programmes are duplicated by different government departments leading to misuse of the redundant material input.

The main drawbacks of government programmes are,

1. Lack of co-ordination between different govt. departments.
2. Lack of follow up.
3. Lack of people's participation.
4. Many programmes are not environment friendly.

The tribal environment and attitude is very much different and the usual models of development like animal husbandry and agriculture development are successful in tribal areas. But agriculture development has some relevance to tribal life and has been fairly successful in some areas. The fruit orchard scheme

is a very good programme consorting with forest environment but tribals have problem of day to day living until the fruit orchards start yielding. This can be solved if the forest department can employ the respective tribals to work in his own fruit orchard. The responsibility of raising fruit orchards should be taken up by forest department and not by the tribals to ensure the success of the programme.

Animal husbandry programmes with goat should be avoided. The cross bred cows and buffaloe programmes have been largely a failure. Moreover the live stock spread contagious diseases to wild animals. Large scale loss of bamboos is attributed for over grazing by live stock rather than by fire or natural death, a fact attested by Mr. Yellappa Reddy and Mr. Somasundar (State Environment Report 1984.)

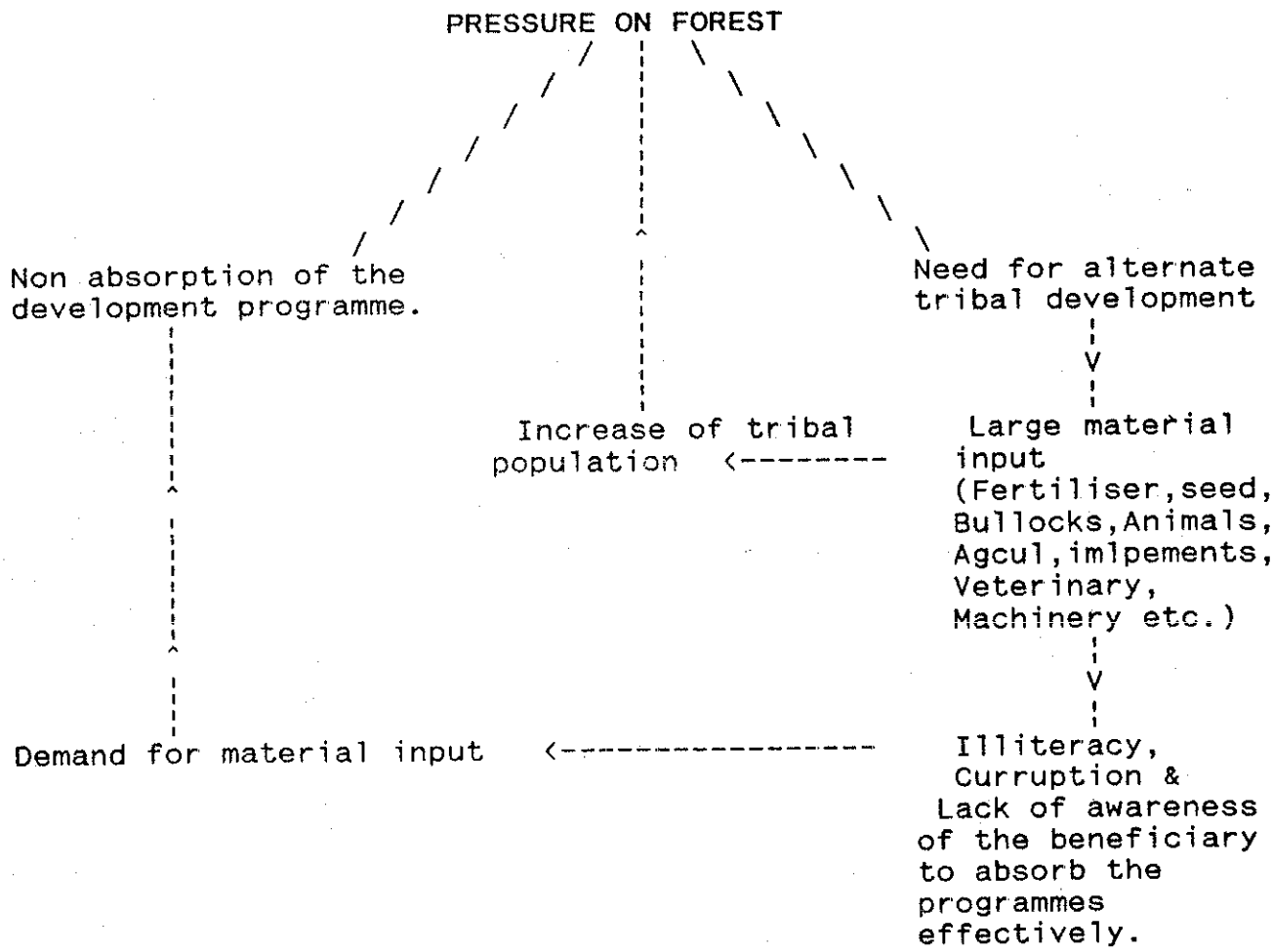
(v) LACK OF CO-ORDINATION HAMPERS IMPLEMENTATION

Often lack of co-ordination between revenue department and forest department has caused unwarranted problems in the tribal field. For example in Nagarahole National Park area and in Kakanakote area the I.T.D.P. programmes could not be implemented because of lack of co-ordination between Zill Parishath and Forest Dept. There is a project co-ordinator exclusively to co-ordinate the tribal tribal development programmes. But the efforts of co-ordination is hardly tangible in the national park. Let alone the tribal development programme, even the names of some tribal hamlets are not enlisted in the voters list, and they aren't on any government record. The names of the villages are missing. Similarly in the same area Z.P. sanctioned for construction of 210 tribal houses but could not carryout the project because the forest department did not release land for this purpose. However an enquiry with forest department it is revealed that a request to this effect has never been made by Z.P. There is one more example of lack of co-ordination in implementing the I.T.D.P. programmes. At the village Macchur, situated 5 Km away from a hamlet called Sebinakolli at the bank of Kabini river a huge project of lift irrigation was accomplished few years back. The now defunct pump and pipe lines costed 10 lakh rupees on the tribal budget to reach functional state when installed. To our surprise the lift irrigation project served non tribals rather than tribals and not even a single tribal farmer could make use of the irrigation facility as none of them even had land in this area.

Similarly the of lack co-ordination between banks and agricultural departments, banks and S.C., S.T. corporations delay in implementation of several programmes like Irrigation and assistance by agricultural implements. The lack of co-ordination often results in non utilisation of alloted budgets which is credited back as the lapse grant.

Alien models of development, not consorting to the tribal situation remain unabsorbed and hence fail to provide alternate means of livelihood. In such situation tribals have nothing to

fall back than the forest itself and many continue to exert pressure on forest. The unabsorbed development programmes and its effects are depicted as below.



(vi) DEVELOPMENT ALTERNATIVES FOR TRIBALS: The development alternatives for tribals should take following criteria into consideration.

1. It should have environmental consideration and tribal cultural consideration.
2. It should harness the potential of forest environment and should make use of raw material easily available in forest.
3. The tribals have special skill like their ability to animal tracking, honey collection etc., and this special skill of the tribals should be made use.
4. Cottage industries like herbal medicine, special bottlled food made from forest produce can be explored.
5. Tribal people should be employed in large numbers into forest department.
6. Tribal should be encouraged to develop fuel wood cum fruit orchard plantation so that pressure on forest for fuel wood is reduced.

(vii) MINOR FOREST PRODUCE AND TRIBAL CO-OPERATIVES

Minor forest produce (M.F.P) like Alalekai, (Myrabalam) Goose berry, Honey and lichanes, Antavalakai etc., have a great demand in modern times. Earlier private contractors obtained the benefits of M.F.P. but now tribal co-operatives by name Lamp Operates and the benefits are shared by tribals who are the share holders of the society. However in Mysore districts except Chamarajanagar Lamp no other society seem to be making profit. On the contrary some of the lamp societies like those of H.D. Kote are being subsidized by government to pay salary for the non tribal staff of the society. Kakanakote and Nagarahole areas are considered as core areas and hence the tribals are not allowed to collect M.F.P. certain areas of the H.D.Kote reserve forest are ear marked to collect M.F.P. Although the M.F.P. collection is not allowed in the core area logging of old trees is going on to meet the fuel wood demand of the towns. Even in the permitted area collection of M.F.P. is sub-contracted to Kakas and not to tribes. This is an un-official understanding between Kakas and Lamp Society - says the forest official.

If the M.F.P. collection and sale is properly managed by lamp it provides a lot of employment opportunity to tribals, some of these produces can processed into the final goods and can be released to market. For example Honey can be processed and bottled. Similarly the industrial use of other M.F.P. are not known to lamp and are auctioned blindly for the best quotations. The buyers may be making an inordinate profit out of M.F.P If only the lamp knows the exact use of each M.F.P it can regulate the auction price.

Thus M.F.P. is one such very potential alternate to provide livelihood for tribals. Hence the plantation programmes in the forest should oriented towards increasing the production of M.F.P. at the same time preserving the bio-diversity. There is need for research in cottage industries which make use of M.F.P.

In the present trend of demand for herbal medicine it is possible to establish cottage industries and produce herbal medicine in co-operation with tribals. This generates year round employment and the profit can be used for the tribal welfare.

(viii) TRIBALS IN FOREST MANAGEMENT

Tribals are born and brought up in the forests. During their childhood and later they become very familiar with every kind of tree and its distribution, the animals and their movements. Hence his familiarity of forests for excels that of any forest official posted to the place anew. This inexhaustible knowledge of the tribals can be made use for management of forest and there could be joint management of forest by forest department and tribals. This concept is not very new and is tried in several parts of the world. In west bengal there is an example of such an experiment. Certain areas of the forest can be ear marked and alloted to the responsibility of tribals. By this the tribals will gain a sense of belonging, responsibility and a sense of true participation. Since they live day and night within the forests they will keep a better vigil on forest fire, intruders and poachers. Even now the forest department depends on tribal watchers to manage the interior of forest. But unfortunately many of them do not have the employment guarantee and work on temporary basis being terminated regularly to break the service. Moreover the recruitment policy of forest department provides very less scope for their promotion to higher cadre.

(ix) FOREST FIRE AND TRIBALS : The recurring fire is one of the important factor inhabiting the ecological succession towards climax forest. Tribals have many blind belief about the beneficial effects of fire and are often the cause of it. Hence they need to be educated. If they are made the partners of forest management they are likely to be more responsible. In the present system of forest management forest department is spending a lot of money for fire prevention but with no benefit. Without the co-operation of the people forest department alone cannot do appreciable conservation. Hence it is necessary that people at large have to be involved. The recent incidents of Nagarahole National Park indicates the importance of people's participation in the forest management.

(x) CONCLUSION : In the present status of dwingling forest and reducing bio-diversity, it is not possible to provide agriculture land for all the tribals, although by way of natural justice they should have got it. Added to this tribals are scapegoated for destruction of forests. The real cause of forest destruction are :

1. Industrial exploitation
2. Clear felling and mono culture
3. Smugglers and poachers
4. Construction of big dams and other such projects.

The tribal people are marginalised and pushed to the periphery of the forest because of national park or construction of big dams. For example in the H.D.Kote area tribals are displaced because of construction of Kabini reservoir and declaration of the area as national park. Added to this projects like II stage Kabini dam are in the process. It is surprising that the government takes very liberal attitude and shows least concern for environmental preservation while carrying out big projects. But when it is the question of the development of voice less tribals, greatest valour for protection of environment is shown. In this context it is worth noting what our Prime Minister said during 1986 (From Deccan Herald, 5th October 1986)

"Mr.Gandhi questioned the premise that development had led to environmental degradation ----
efforts should be made to ensure that development projects did not harm the environment. At the same time no project should be stopped for environmental consideration."

I do not understand why we should not stop a project for environmental consideration. A project like Narmada Valley which displaces lakhs of people and destroys thousands of acres of forest should be stopped. It is necessary that government takes a uniform attitude of environmental conservation whether it is tribal development or a big project. Then only the sacrifice we except from tribals for the sake of environment will be meaningful. There should be basic policy changes in the government to prevent possibility of misuse of the forest environment. For example in Kerala State contagious to Kakanakote area there is a sandal wood oil extraction factory. The sandal wood is smuggled from Kakanakote to this sandal wood factory. The tribals are constantly being misused to carry out a dangerous task head loads of sandal wood for a paltry sum - The forest department of Kakanakote can do nothing to remove the sandal wood factory of Kerala. The inter state borders in the forest areas are a cause of repeated trouble. There is no co-ordination between the forest departments of different states and officials of each state are concerned only about their boundary and show an attitude of utter apathy to what happens to the forest of other state. Ultimately the tribals are victims of this border phenomenon.

In total it is clear that the priority accorded to forest conservation is never the cause of tribal decadence. It is rather our reluctance to encompass tribals also into this ambit of conservation and development. A holistic perspective of conserving nature can never exclude the tribals who are an integral part of the whole ecosystem.

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Biogas-A Clean Energy Source for the Present and the Future

Many of you would have heard the Prime Minister's Independence Day speech recently which dwelled at length on a drive to promote self reliance with regards to rural energy needs by way of promoting several renewable energy technologies in a big way in the coming years. It is proposed to spend a significant amount of money and effort in supplying reliable renewable power in rural areas and make our villages self reliant in power and energy. India has a long history in promoting renewable energy technologies in urban and rural areas. However, among the energy technologies for rural areas biogas technology has a prime place because it is not merely an alternate energy device but also it has many other benefits by way of

i. increasing availability of quality manure and thereby increased productivity and income from the agricultural sector.
ii. improved rural sanitation
iii. improvements in rural health by way of reduced incidence of epidemics and reduced exposure to smoke and direct flames and reduction in human drudgery
iv. generating potential for meeting many other energy services such as domestic and street lighting, lifting domestic water, operating light commercial industry, etc.
v. being environmentally friendly.

Biogas technology is conventionally believed to be feasible only with animal dung as input feed and that too in rural areas. This is far from true. While it is true that the biomass feeds required for operating biogas plants are more easily available in rural and semi urban areas, there are several places in urban areas and in industry wherein biogas can form a significant energy source. However, considering that any biomass based energy device /technology is likely to have a major impact in rural areas it is first necessary to examine the energy scene in rural areas of our country.

Energy Scene in Rural India:

In order to understand the role and potential for biogas energy in rural India it is necessary to firstly examine the current rural energy scene and determine /identify energy services that can be replaced by biogas route. There have been several studies today on the energy utilization pattern in rural India from which it can be seen that firstly biomass fuels supply over 80% of the energy needs in villages and secondly that upwards of 70% of this domestic energy is used in cooking and related activities (Ravindranath *et al*, 1981; Ravindranath and Chanakya, 1986; Reddy and Ravindranath, 1987; Ravindranath and Chanakya, 1992; DNES, 1992). These studies have made it clear that the low quality of life in rural areas is linked to the low quality and quantity of energy and energy technologies deployed. Therefore any improvement in the quality of these primary energy sources and technologies is likely to improve the quality of life in rural areas and therefore the country as a whole. Currently this requirement is met by using inferior biomass fuels such as twigs, branches (dead wood), crop residue, cattle dung, etc. (In southern Karnataka dung is increasingly being burnt as fuel only recently). The devices used for burning these fuels are also inefficient with sensible heat utilization ranging between 5-15% and is accompanied by great human drudgery of exposure to smoke and direct flames, etc. It has been projected that with

the present trends continuing, over 45% of the domestic energy needs will be met by directly burning cattle dung by the year 2000 (Moulik and Mathur, 1991). It is this energy related activity that the biogas route can firstly hope to replace.

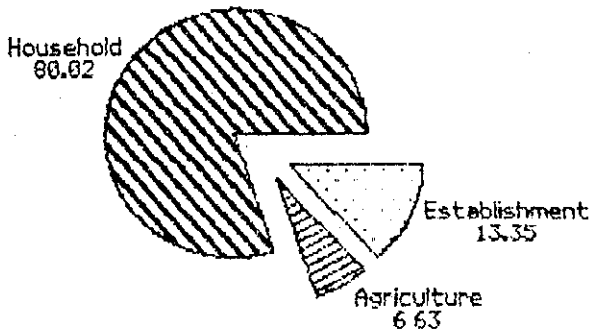

Figure 1:
Sector wise energy use

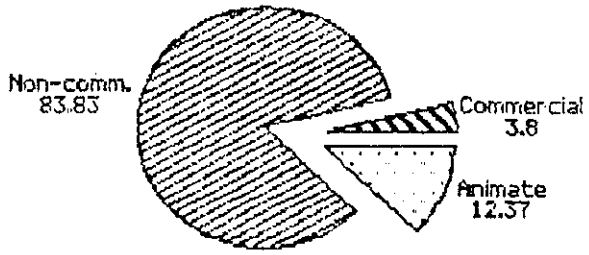

Figure 2:Source wise energy use

Importance of Biogas in Rural Areas:

It is far more sensible and efficient to obtain energy and manure from dung by the biogas route than by direct burning of dung in traditional stoves. This becomes more apparent when the end use energy conversion device is also considered in efficiency calculations which therefore projects the sensible heat available to the user rather than the embodied heat (which alone is usually considered) and is calculated as follows. One kg dung would provide energy through either of the two routes below

$$\frac{0.04\ (m^3\ gas) \times 5400\ (kcals/m^3) \times 0.45\ (burner\ efficiency)}{0.18\ (kg\ TS) \times 3100\ (kcals/kg) \times 0.11\ (stove\ efficiency)} = 1.584$$

This suggests that about 60% more useful heat can be generated from the biogas route than by direct burning of cattle dung. Secondly, it is much more sensible to collect the output of the biogas plant for manurial purposes than even a direct composting because during conventional aerobic composting only about 40-45% of the N content is retained by the compost whereas during biogasification all the nitrogen can be recovered in the slurry. This may be computed to show its usefulness in the following manner (assuming a biogas plants using 100kg dung daily is operated),

$$\underset{(dung)}{100kg} \times \underset{(TS)}{0.18} \times \underset{(N\ \%)}{0.0125} \times \underset{(d/yr)}{365} \times \underset{(imp.\ N)}{0.6} = 50\ kg\ N\ /yr$$

All this Nitrogen can be made available to crop plants and hence its equivalent in commercial fertilizer urea (40%N, use efficiency 40%) may be calculated as

50 / {0.4 (% N in urea) X 0.4 (% of applied N used)} = 300kg urea = Rs 2200.

Considering that this is obtained from an initial investment in the range of 6-7000 Rs the net returns can be found to be very high.

The problem however, lies in the ability to physically demonstrate this advantage. The improvements caused by the use of organic manures become apparent only after a period of 3-5 years of continuous application. The use of biogas burners removes smoke from the kitchen and other health hazards, the benefits from which is not easily perceived at an individual level. Further,

the reduction in insect vectors as a result of non exposure of dung for them to breed, reduces several epidemics and improves sanitation of the area. This becomes more obvious when community toilets coupled to biogas plants are opted for. The benefits from these last few above mentioned reasons are immense and measurable easily at a national level in terms of improved health, reduced expenditure on primary health, reduced morbidity and mortality leading to increased productivity of labour in rural areas, etc. all finally leading to improved quality of life in rural areas. As these latter benefits are immense at national levels but not easily perceived at individual levels it becomes necessary to support this technology for a few years through the states' machinery until it becomes difficult for individual farmers to revert back to old habits.

Biogas Potential in the Country:

The biogas potential in the country has been shown to be immense (10-40 million family size units) but specific estimates on the real potential varies with the interest and background of research workers. Also, it is not easy for obtaining the real estimate due to several factors relating to the heterogeneity of agro climatic conditions and land resources within the country. The method of estimation also has a great bearing at the micro level in ascertaining the feasibility of setting up biogas plants also because most often feasibility of setting up biogas plants are made on the number of cattle head rather than attempting to ascertaining whether the minimum quantity of dung would be available.

The quantity of dung available from an adult cattle head varies from locations and the breeds normally found because larger breeds would consume more feed and fodder and thereby excrete more dung. Secondly most parts of the country is dependent on the monsoon for its agriculture and fodder. As a result during five months in a year green fodder is easily available when cattle flourish well whereas during the dry months that follow, the feed intake as well as the dung output is low. The cattle (draught animals) are maintained to meet peak draught power for ploughing in the narrow ploughing window available (10d) and are used only for about 300h annually (Ravindranath and Chanakya, 1986). Thus during this period the cattle are fed well and subsequently maintained on a sub maintenance ration by feeding dry straw and letting out to graze. Therefore, the true dung available for feeding biogas plants comes only from night droppings when they are tied within the cattle sheds. This practice therefore would be unable to provide 40-50 kg dung daily from four adult animals required to optimally run a small, family size biogas plant.

This above practice therefore greatly influences the availability of dung for use in biogas plants. It has been found that the dung availability (that which can be sensibly collected from overnight droppings in the above mentioned mode of cattle rearing) in semi arid peninsular India fluctuates between 2.8 to 7 kg /animal /d (4.03 +/-2kg). Thus the use of the thumb rule that 4 cattle heads are adequate for running a biogas plant is often questionable. However, inspite of this, it has been found that biogas plants have gained acceptability in rural areas because of a few lesser mentioned reasons. Firstly, the low dung availability coincides with the summer season accompanied by high ambient temperatures. During such high temperatures the rate of biogas production is high as a result more gas is extracted from a unit quantity of dung fed into the biogas plant. Also, because the daily feeding of the plants are low the gas extraction from dung occurs over a longer period and consequently more gas is produced from the same feed. Thirdly, it has been found that the biogas requirement of is also lower than that normally expected in many parts of the

country. In the above mentioned zone studies have shown that for the cooking practices followed, the per capita gas required is about 180 L compared to the expected 300L (Ravindranath *et al*, 1992 unpublished data). All these three factors appear to play a key role as to why these biogas plants, even though are being fed less than the required daily feed, are still found to be viable in many parts of rural India.

In the light of the above findings the true potential of the country may be calculated in two ways. Firstly a conservative method,

(240	X	0.4	X	4	X	0.04	/ (0.9)	= 15 million biogas plants
million		40%		kg dung		gas	gas req.	
cattle		for BG		daily		m^3/kg	/ family	

Secondly, it has been reported that of the 75 million rural families in India, only 43% own the minimum required number of cattle (4 or more) to run biogas plants and therefore the full potential for the country is about 32 million plants. However it is likely that only 50% of them will opt for a biogas plant and therefore it is estimated that 15-16 million biogas plants are feasible for our country (Khandelwal, 1990). However, other estimates put the potential as to be 25 million (Moulik and Mathur, 1991; 40 million, DNES, 1992). It must be remembered at this juncture that the biogas potential discussed about is only from cattle dung alone. However, recent research within the country show that viable biogas plants for directly fermenting leaves, garbage, crop residues etc. can be built as a result the biogas potential in the country would be much larger than most of the above estimates (Kurup, 1990; ASTRA 1991).

In light of the above understanding it is necessary to promote biogas technology so that when biogas plants using alternative feed stocks (other than dung) are ready for diffusion, the people would already have been ready to accept biogas technologies to meet many of their day to energy requirements or energy services. This aspect is discussed later.

Biogas Situation in the Country:

Even though biogas was introduced in India way back in 1897, the spread of biogas has been far more slower than the neighboring China. Cattle dung based biogas plants were promoted from 1956 onwards by KVIC and later much more rapidly by the National Program on Biogas Development in 1972. With the setting up of Commission on Additional Sources of Energy and Dept. of Non Conventional Energy Sources' promotion of biogas plants received a big boost and the extent of biogas plants constructed in the country is presented in Figure 3. As against the earlier mentioned potential there are only 1.5 million biogas plants that have been built in the country today. It has been calculated from several surveys that about 85% of them are workable or working, about 11% have been stopped due non

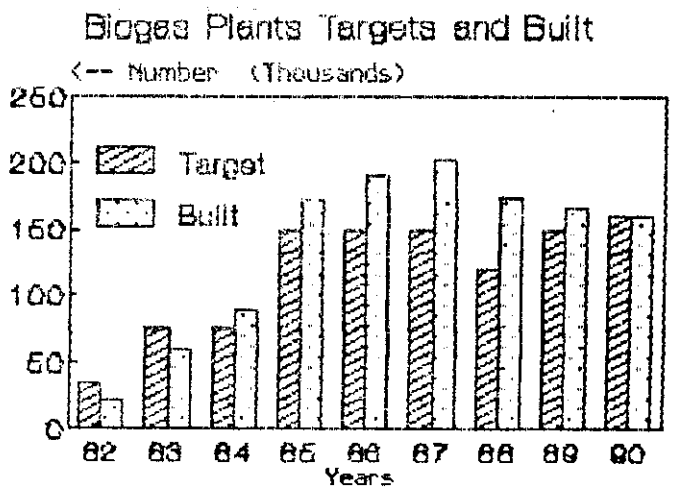

Figure 3 Plants built in India

availability of dung /feed and only 4% are defective plants (Khandelwal, 1990).

Comparison with Chinese Biogas Program:

It is interesting to compare the biogas program of China and learn a few lessons from it. The slow pace of the spread of the Indian biogas program is often contrastingly portrayed against the Chinese Biogas Program for the rapid pace of dissemination and spread of technology. The essential qualitative difference between these two needs to be carefully examined before drawing obvious inferences. The Chinese biogas program (mid 70's) aimed chiefly at improving village sanitation in the context of the reigning menace of pathogens common to pigs and humans. The second target was meeting atleast a part of its fertilizer needs through a captive composting scheme (biogas plant), both of which was easily discernible to a sensitized user group. The energy aspects of the system was finally a secondary issue compared to the improvements in the hygiene, sanitation and availability of manures. This emphasis may be made discernible by the extent of research and development information made public with respect to the pathogen survival, ideal position of outlet for domestic plants (based on the region where the least number of nematode cysts and ova are detected at different zones), etc. In other words the health and manurial benefits dictated the design of plants (Chinese Biogas Manual, 1979). Further, on a comparative basis it has been shown that setting up a biogas plant would in equivalent terms meant obtaining capital resources equivalent to only two months income in China (RMB 50 Yuan) while in India it was closer to two years average income (Rs. 3000) during the corresponding period (Rajabapaiah and Chanakya, 1983). These factors coupled to a strong political will provided the rapid impetus to the chinese biogas program. The low emphasis on the energy aspect appears to be the reason why even though there were only a 60-70% success rates of biogas plants (out of 7 million plants of the mid seventies) in China people still opted for biogas plants (Rajabapaiah and Chanakya, 1983). Therefore even in India political will accompanied on a multipronged campaign is necessary to boost the acceptance of biogas programs.

It must also be remembered that out of the 7 million plans built within a span of 2-3 years in China in the mid seventies only a few seem to have survived (Keyun and Yunzhu, 1990). The major reasons for their failures appears to be manifold but reports essentially suggest that the program was not carefully laid out with different forms of contingency plans and adequate technical and maintenance infra structural backup. The major causes of failures listed are (Fu Guoyang, 1990).

1. many technical problems not solved before dissemination.
2. Farmers training in its use and application neglected.
3. Large number of digesters failing rapidly, etc.

The modified program of the eighties seems to take cognizance of the above and the following and therefore, by default, these were also the diagnostic features capable of correcting the failed program of the seventies (Keyun and Yunzhu, 1990).

1. standardization of biogas plants and their appliances,
2. solving many technological problems hitherto unresolved,
3. allocation of responsibility to specific departments,
4. mobilize peoples initiative and motivation through demonstration,
5. adopting an integrated approach,
6. strict adherence to availability of raw material at the household,
7. commercialization of biogas sales, etc.
8. developing infrastructure for imparting a formal training in the use of

biogas plants and providing for repair and maintenance units close to the users.

9. Providing a minimum of a 2 year adaptation for new or imported designs, etc.

It may therefore necessitate that the pattern of perceived benefits, namely manures, improved agricultural productivity, increased incomes, and finally energy and saving fuelwood costs (highlighting opportunity costs of wood saved) is likely to improve the demand and use of biogas technology in India. Especially when location specific problem solving is made the first of list. For the emphasis of manurial value of the derived compost and the opportunity costs of the saved trees and wood, it is necessary to quickly develop biogas plants with multifeed capacity. One of the major advantages of the Chinese biogas programs and designs was the ability to feed straw along with other slurry wastes and capability to extract the manure on a once yearly or more frequent basis.

Family Biogas Plants Program in India:

a. Biogas plant designs:

Today there exists several biogas plant designs of which about seven only are approved for availing subsidy from the governing body, the DNES. Currently in India both basic plant designs namely the floating drum and the fixed dome designs form the basis for several variants involving alterations in material of construction, shapes and dimensioning, etc. Many of these plants are popular in different regions of the country depending upon the successes of the dissemination efforts of implementing agencies and voluntary organizations involved.

The fixed dome designs are characterized by a lower cost in general but they are also subject to higher level of risks of plant failure. The cost reduction is achieved by reducing the steel and concrete component to a bare minimum. Construction of masonry domes which will be gas proof in due course is a skill which is elaborate and needs careful training. This is often the reason why several adaptations of the basic design work well in the Institution where they have been designed but fail during large scale dissemination. In order to overcome this, insurance schemes against its failures have also been introduced a few years back. The fixed dome designs available in India are essentially locally adapted Chinese biogas plant designs.

The floating drum designs are essentially adapted and modified KVIC designs of the 1950s. Most adaptations (called designs in common parlance) are locally suited and optimized based on local costs and availability of skills.

There are also a few innovative designs that are likely to suit special niches in the diverse agro climatic diversity occurring in the country. One major variant is the LDPE bag type digester of which only a few have been disseminated in pockets of the country. This latter type is often applicable to low dung availability and is relatively less long lasting than the masonry counterparts described. It is reported to have an estimated life between maintenance of about 2 years (Anand et al 1992) when the LDPE film is likely to fail and requires replacement. The pattern of designing appears to rely heavily on the potential of conventional bicycle mechanics in the village to pick up the fabrication, repair and maintenance at the village level.

Performance details of Chinese biogas program

In China there has been a gradually increasing trend in the pattern of energy utilization from about 0.4 tCE (1980) to 0.65 tCE (1985). Of this trend 68% biomass in 1980 had fallen to 48% in 1987. In many demonstration experiments the soil organic matter (OM) in impoverished soils had risen from 1.3 to 2.7% in 6 years. Normal family size digesters are expected to produce about 250- 300m³ of biogas in a working year of 8-10 months suggesting an average daily gas production of 1m³ and thus an average per capita daily consumption (computed) of about 0.2m³ of gas (Gyuoyuan, 1990). A total of 4.7 million biogas plants are currently reported (1988) which have been constructed at a rate of 500,000 plants annually between 1980-1985 and subsequently at the rate of 250,000 annually (Gyuoyuan 1990).

Perception and Acceptance by Rural Users:

Like many other renewable energy devices, biogas too offers many benefits following adoption. In the case of the efficient wood stove program the perceived benefits by the users were, priority-wise 1.smokeless-ness 2.faster cooking and 3.reduced fuel consumption. Whereas the rated order of importance by the developers of this technology was exactly opposite. While this has been well documented for wood stoves, the rating for biogas plants by the developers and users in the family size biogas program has not been well documented. The primary reason for this may be because in the case of wood stoves the direct beneficiary, the village women are directly accessible and fewer men are directly involved in its adoption. In case of biogas plants, while the major effort in terms of finding the required finance, getting convinced of its benefits, supervising /overseeing its construction and commissioning, meeting the required officials etc. are to be carried out by the menfolk, the major perceptible benefit in terms of reduced drudgery of cooking (reduced exposure to irritating smoke, reduced cooking time, reduced washing problems etc.) is accrued by womenfolk. Whereas the more useful manurial aspect is not easily perceptible and needs to be highlighted. This disparity of perception has been to be taken cognizance of and needs to be some how bypassed in any popularization /diffusion program for biogas plants.

It has been the experience of many a renewable energy technology diffusers wherein following a successful dissemination of NRSE technologies, the menfolk of the villages have asked "now that you have done so much only for the womenfolk why not do some beneficial devices for the menfolk". (Srinivas, 1990 per comm.). What is being attempted is to show that in the biogas program both men and women have to be convinced to enable its effective spread. There is little information today as to how this potential problem is tackled at the implementing level for the family sized biogas program. It appears that a multi pronged campaign needs to be devised depending upon the local situation. One of the foremost factors leading to successful adoption in the country appears to be through personal contact and visual ascertaining of a working plant nearby. Therefore a program for dissemination needs to have in its agenda identifying potential and lead farmers from whom personal contacts about the benefits etc. may trickle to a much larger slower adopters. In other words due emphasis on a demonstration program involving both men and women needs to be taken up seriously for a rapid spread of biogas technology in the country.

Community Biogas Plants:

In most villages the cattle holding pattern is such that even though there are a large number of cattle in the village and the cattle to human ratio is better than 1:1, the cattle holding is such that only about 20-40% of the

families own large number of cattle in adequate numbers to run biogas plants effectively. Often the number of cattle held exceed their potential biogas requirement. The conventional family size plants would then only serve a small fraction of this group, thus biogas spread would only be limited and cater to only the affluent of the villages. On the other hand biogas plant costs are known to be subject to economies of scale so much so that cost of a large plant is always less than say 'n' number of small plants where the cost of a large plant roughly works out to be $n^{1/3}$ times the cost of small plants (upto 50-70m^3/d, Rajabapaiah *et al*, 1979). Under such circumstances community size biogas plants makes more sense in economic terms. The major problem however is to find such situations.

Though the task of either organizing rural communities or finding such already existing coherent and closely knit communities which would co operate on the long run in making biogas plants successful, seems difficult it is not always so. This may be deduced from the past and present experiences of many attempts of running community biogas plants in the country. Biogas has conventionally been believed to be an ideal fuel substitute for fuel wood in domestic kitchens and consequently even for community biogas plants is expected to restrict its major function to supply cooking energy needs. However, considering that even today most villages collect fuel wood at zero private costs the impact of converting kitchens to use biogas has little perceptible advantages to these communities. Their felt needs however, are very different and often look forward to having access to several energy services such as supply of piped domestic water in their kitchens or nearby, having reliable lighting in their houses as opposed to the poor reliability of grid power supply in villages, accessibility to simple commercial energy services such as flour mills, and even sometimes ability to watch favorite programs on the TV, etc. Under such circumstances the gas produced in community biogas plants may be used to generate electrical or shaft power to meet all the above energy services as has been found in many experiences in Kunigal Taluk's Rural Energy Centers.

In these semi arid villages first of all accessibility of clean drinking water and secondly availability of piped drinking water in or around their kitchens is an important felt need. In at least four villages, inspite of the presence of grid electricity, the villages as a community have come forward to accept community biogas plants and other energy services capable of meeting the above need as well as offering to organize themselves in a manner to carry out the day to day running of these plants by themselves. Long term experience with a community biogas system at Pura village appears to be an adequate demonstration set up for the neighboring villages to be convinced of the advantages of utilizing and operating a community facility for meeting energy services required for pumping drinking water and supplying domestic electricity.

In the neighboring village of Hosahalli wherein these above energy services have been met by a wood gasifier system and captive energy forest, it has been found that inspite of several political affiliations and differences in thinking villagers have consciously not allowed their differences to interrupt in any way the working of the above facility. Similarly in the case of Pura community biogas system too, the village community has appointed a managing committee which decides the day to day operation of the facility without major disruptions for over a period of 5years. All these cases go out to say that community biogas systems are viable even in the presence of various social and political differences when they are linked to a few essential services that are common to all the villagers.

Biogas - Future potential and Horizons

As biogas systems will keep increasing in the country both at the individual family and community levels, there will be a greater demand for techniques and technologies in the following directions, namely, supplementary and additional energy services catered to by the biogas energy, more economical and efficient biogas plants and newer feedstocks for conversion to biogas.

End use Devices:

The ability of biogas systems to generate energy services including electrical power to meet some of the basic energy services such as domestic water lifting, irrigation water lifting, running light commercial units, other shaft power applications in agriculture, etc. will become important for which generating and setting up infra structural facilities in rural areas will become important. These requirements will become more pronounced when increased biogas production by way of a greater number of biogas plants using biomass feedstocks become more and more acceptable in villages.

Industrial and Urban applications:

At the industrial scale several distilleries and molasses utilizing factories have taken to setting up biogas plants (anaerobic treatment systems) firstly to meet several inplant energy requirement and secondly to reduce the pollution load discharged by them. Gradually, many more of the agro processing industries are likely to accept biogas technologies in recycling their solid and liquid wastes such as those in fruit and vegetable processing, coffee, tea and plantation product industries, dairies, fiber based industries, urban garbage etc.

Types of Biogas Plants in Future:

There has been a great deal of research and development efforts towards designing viable biogas plants operating on solid biomass wastes such as leaf litter, aquatic and terrestrial weeds, crop residue, sugarcane trash, cotton stalks, willow dust, non edible oilcakes' wastes etc. in the agricultural sector; press mud, whey and dairy wastes, fruit and vegetable pulp wastes etc. in industrial sector; domestic garbage and garden litter, local sewage treatment (in multi storeyed buildings and colonies) etc. as in urban applications, etc. While many of these plants will be designed for specific feeds some of them will be specific for applications. For these applications and feed stocks Solid Phase Fermenters and Plugflow reactors (solid biomass wastes), UASB, ABR, Anaerobic Packed bed reactors, (liquid wastes) etc. would soon be adapted to Indian operating conditions. With the increased use of these alternative materials the biogas potential and use in the country will rise up enormously. The magnitude and extent however, will depend upon the political will and commitment of the implementing agencies.

Tasks Ahead:

The immediate tasks ahead in order to ensure large scale application in the country include adopting dissemination strategies wherein long term use of biogas plants to replace conventional fuels are planned along with potential created to expand their use both in the number of energy services for which they will be used as well as the feed stocks to be added later.

1 Emphasis in the diffusion program equally placed on training of the end users to adapt to the different applications of biogas energy, daily operation and maintenance,

2. Routine follow up every year to assess health and operation of plants by end users,
3. Setting up demonstration plants within easy access to most villages,
4. Increase the number of infra structural facilities capable of constructing and maintaining a much larger number of biogas plants (proposed in future programs as well as existing ones),
5. Including both men and women in demonstration programs,
6. Providing additional training and increasing motivation /rewards of biogas personnel at grass root levels to enable micro level planning, ensure stringent supervision and therefore achieve increased and effective spread of biogas technologies,
7. Emphasize importance of manurial benefits in the awareness campaign along with its use as fuel.
8. Provide adequate and dedicated manpower to the program,
9. Increase skill levels of masons and fabricators with repeated training programs to ensure reliability of biogas plants in the field.
10. Utilize the lessons of the chinese biogas program for evolving popularization and dissemination strategies.

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FUEL-EFFICIENT DEVICES

By

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ABSTRACT

Applying the principles of combustion and heat transfer, we have developed fuel-efficient wood and other biomass-burning stoves and furnaces for domestic and large-scale cooking, midday meals, anganwadis, bathwater heating, areca processing, silk reeling, jaggery processing, lime burning and drier for cardamom, areca, and similar agricultural produce. While the domestic model has been disseminated on a very large scale in Karnataka, the other devices have been field tested on smaller scale, ranging from one to one hundred. Saving of fuel over conventional devices of the order of 30 to 75 per cent is observed in the field. Strategies for the large scale dissemination of these devices are being worked out.

In the early nineteen eightees a need was felt to conserve fuel, subsequent to the energy crisis of the seventies and the general awareness regarding the large scale deforestation and the consequent effect on ecology and environment. Our extension centre at Ungra in Kunigal taluk, Tumkur district of Karnataka State had brought to our attention the need to look into the domestic wood burning stove and lime burning to make these operations fuel-efficient. This was complimented by a request from the farmers of Unchagi village near Kumta, Uttara Kannada district to help them in making jaggery, an important source of cash income to them, which was becoming uneconomical as the cost of fuelwood, then being used to make jaggery, was increasing every season. Our involvement in this field can be attributed principally to these causes.

We conducted scientific studies on these devices, and applying the principles of combustion and heat transfer generated designs for the domestic stove and the jaggery furnace which were successfully field tested and then disseminated. This led to applying the same principles to develop stoves and furnaces for large scale cooking, midday meals, anganwadis, bath water heating, areca processing, silk reeling, ayurvedic medicine manufacture and cashew processing, and in recent times, for designing driers for agricultural produce like areca and cardamom. A brief account of the scientific principles, their application to develop the various devices and the field testing and dissemination is given in this paper.

Fuel, be it fuelwood or other biomass, is burned to generate heat, the oxygen required to burn the fuel being supplied by air. A given mass of fuel when burned completely requires a definite quantity of oxygen and gives out a definite quantity of heat. However, it is very difficult to carry out the combustion with exact quantity of oxygen (air) and thus air is always in excess to that required. The heat generated by combustion is taken up by the products of combustion, mostly carbon dioxide and water vapour, together with nitrogen accompanying the oxygen in air already used up and the excess air, and results in a rise in the temperature of these gases. These hot gases come in contact with the

external surface of the container having the material to be cooked or processed and transfer heat to it. Heat gets transferred from a region of high temperature to one of low temperature, which in our case are the flue gases and the container. The amount of heat transferred increases with the temperature difference between the flue gases and the container.

Now if exact quantity of air were used for combustion of a given quantity of fuel, the heat would be taken up by a smaller quantity of gases than if excess air were used, when the same quantity of heat would be taken by a larger mass of gases. This results in a higher temperature of flue gases when fuel is burned with exact quantity of air and in a progressively lower temperature with the increase in the extent of excess air. As will be explained later, higher temperature is condusive to higher heat transfer and thus our aim is to burn the fuel with as low a proportion of excess air as possible.

Summarising, we can say that one should carry out the complete combustion of the fuel with as little excess air as practicable to generate the highest temperature of flue gases

For achieving the above, we carry out combustion of fuelwood over a grate in an enclosed fuel box with ports of suitable size for entry of air. The grate helps in entry of air (primary air) below the fuelbed to burn the char as well as for separation of ash from fuel, as also to define the zone of combustion. Air required for burning the volatile matter released as a consequence of heating the fuel, called the secondary air, enters through a port at a level slightly above the grate. For complete combustion of a given quantity of fuel in a given time, a definite combustion volume has to be provided over the fuel bed. After thus achieving complete combustion to generate highest temperature of the flue gases, we have to see that maximum quantity of heat gets transferred for useful work, i.e. to the pans. For doing this, we take recourse to the principles of heat transfer.

Heat gets transferred by the mechanism of conduction, convection and radiation. The theory of heat transfer by all these mechanisms tells us that heat transfer per unit time increases with increase in coefficient for these mechanisms, with the area of heat transfer and with the temperature difference between the hot and cold media. We have already seen how to increase the last of these, namely the temperature difference. For increasing the remaining parameters, we first look into the area of heat transfer which is common to all the three mechanisms.

The area in question here is that area of the vessel which is exposed to the hot flue gases. Our design should bring a larger area of a given vessel in contact with the flue gases. Another strategy is to increase the number of vessels in a stove so that more area is brought in contact with the gases to increase the heat pickup. If possible, the effective surface area can be increased by the use of extended surfaces, called fins. Depending upon individual cases, we have tried all these techniques in our fuel-efficient devices.

The third parameters, the coefficient, which is specific to each mechanism, can be increased to a certain extent by suitable design, manipulating the stove internals and materials of construction. First we consider radiation. Here one can increase the radiative transport for given pan by making the stove internals such that most of the pan surface 'sees' the hot gases (flames). In a multi-pan stove, radiation plays an important role in the first pan and, to a certain extent, in the second pan. The inside area of the stove is made such that it reflects the heat onto the pan bottom

Conduction plays a role in the choice of the material of construction of the pan and the stove body. The pan material should have higher conductivity, lower thickness to conduct more heat for a given area and time, while the material of construction of stove should be a bad conductor to avoid heat losses to the surrounding. Since the stove is constructed with brick and mud with an inside lining of mud mortar mixed with rice husk which gives a higher thermal insulation, the latter condition is met. While the choice of the material of construction of vessel is not under the designer's control, it does not normally impair the efficiency as the coefficients for other mechanisms, particularly convective heat transfer, may be the one which governs the quantity of heat transferred to the pan, unless one is using a thick mud pot.

It is the improvement in convective heat transfer which gives a substantial increase in thermal efficiency. The coefficient for this mode of heat transfer increases with the velocity of flue gases, past the vessel surface. For a given volumetric flow rate of flue gases, one can increase the velocity by reducing the cross-sectional area of their flow. In our devices we achieve this by making the distance between the pan bottom and stove surface as small as practical. As the hot gases go from the combustion zone to the outlet, their temperature decreases and thus their volumetric flow rate also comes down. Consequently, to obtain the same high velocity of gases, one has to progressively decrease the distance below the pans. Another factor is that gases should be made to flow such that they come in contact with the pan surface instead of bypassing it. This is facilitated by use of flow directors or baffles.

The question may well arise as to how does the air get sucked in the combustion chamber, since it is an enclosed construction and how does it flow from the first to the subsequent pans. The answer lies in the presence of a chimney pipe of suitable diameter and height towards the end of stove, which, due to the flow of hot flue gases through it, creates draught, which is responsible for the flow of air in and the flue gases out of the stove. The chimney does another important job of dispersing the smoke away from the zone (room) of cooking, making our device smokeless.

This draught, or suction, created by the chimney, increases with the temperature difference between flue gases and the surrounding air, the diameter of the chimney and its height. The smallness of the distance between the pan bottom and the stove body, mentioned above, depends upon the extent of this draught; draught should be large enough to be able to suck the flue gases through the smallest passage in the stove. Otherwise air would not be sucked in and burning of fuel would stop. If the distance is large, less heat would be transferred to pans and because of bypassing, most of the heat will be released to the atmosphere through the chimney. A stove with a chimney thus runs the risk of being thermally inefficient if the distances below pans and stove body are unusually large.

Summarising what has been discussed so far, to have high thermal efficiency, we carry out combustion of firewood in an enclosed chamber over a suitable grate, with proper opening for primary and secondary air to generate the highest combustion temperature and then maximise the heat transferred to pans by making the stove out of a poorly conducting material, with interior compatible in shape to the pans for a higher radiative transfer, with flue gas passage below the pans to facilitate maximum gas- pan surface contact and as high a velocity of gases as practical, with multiple pans or extended surfaces to increase the area of heat transfer, and with a chimney of suitable height and diameter to create draught and disperse smoke away from the cooking zone.

In all the energy efficient devices we have developed, the above mentioned points are followed. The combustion zone consisting of enclosed firebox, grate, ash pit and air inlet ports is similar in all devices, except for size. Higher area for heat transfer is taken care of by multiple pans in cooking stoves, cottage basin cocoon cooking stove, complete immersion of vessels in stoves for bathwater, areca, anganwadi, charka silk reeling, ayurvedic medicine manufacture, extended surfaces and multiple pans in jaggery and paper-pulping cum black liquor evaporation furnaces.

The maintenance of high velocity of flue gases below the pans is brought about by progressive reduction of the cross sectional area below successive pans in the multiple-pan stoves. In a single pan stove, like bath water or areca processing stoves, the pan is completely immersed in flue gases, and the gas passage is made narrower from bottom to top or from combustion side to chimney side.

The 3-pan ASTRA OLE, the domestic model, has been widely disseminated. More than 3.5 lac stoves have been built in the Karnataka state since 1984. The large sized cooking stove has been built at more than 60 places; the numbers for other stoves are: bathwater 75, areca 75, midday meal 15, anganwadi 5, silk reeling 30, jaggery 30, cardamom/areca drier 3, ayurvedic medicine manufacture 3, cashew processing 3. All these stoves show a saving in fuelwood ranging from 30 to 75 percent. Strategies for dissemination of these stoves are being developed. It is earnestly hoped that we are able to transfer the technology from laboratory to the field to save the fuelwood, the forests and thereby improve the environment.

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Forest Management - People's Perspective

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The National Forest Policy 1988 states that the principal aim must be to ensure environmental stability and maintenance of ecological balance including atmospheric equilibrium which are vital for subsistance of all life forms- human, animal and plant. The derivation of direct econiomic benefit must be subordinated to this principal aim.

The policy insists on meeting the basic needs of the people, especially fuelwood, fodder, and small timber for the rural and the tribal people, and advocates people's active involvement in programmes of conservation and management of forests. In the light of the above we put forth the following suggestions for consideration.

Classification: It is necessary to reclassify the forests to specify the role of the local people. A thorough discussion and study involving the local community regarding the following aspects have to be made, before classifying the forests.

i. The needs of the local people - fuelwood, fodder manure, non-wood forest produce based needs etc.

ii. The rights and previleges of the local community regarding usages of the forests.

iii. The vicinity and other conveniences helpful to the local community for the usage of forest produces.

iv. Existing encroachments on the forest land.

v. The productivity of each hectare of forest land-

Zonation of Forest Land:- Inspite of the legal classification and status of the forests, the forests shall be developed and used as per the following zonation. Local users group should be fully involved in this process.

i) Prohibited Zone:- Bio-sphere or pavitravana which can be considered as prohibited zone where full protection should be given to maintain the genetic resources and living creatures of the locality. Local people can assist the Forest Department to conserve this zone.

ii) Protected Zone:- The present reserve forest can be considered as protected zone where land can be managed by the forest department and the local people can assist the department in protecting this land against fire, grazing and smuggling. As an incentive to this service they may be allowed to get a

reasonable share in the produce from this land, which should be utilised for community benefit. Local users group should be allowed to collect non- wood forest produce in a sustainable way.

iii) Utilization Zone or Multiple Needs Zone:- The needs of the local community like fuelwood, fodder, manure etc., should be met out from this zone. JFPM Committee shall be responsible to plan, develop, protect and manage this zone in a sustainable way and to share and distribute the forest produces among its members. The role of Forest Department shall be confined to supervision, technical guidance, provision of financial support and advice. The community lands like gomal, panchayat lands, minor forests etc., can be included in this category.

iv) Development Zone or Privately Managed Zone:- Privately managed land can be considered for the tree crops cultivation wherever possible and suitable. Extension services, proper marketing network and liberalized government control for selling the produce from this area are necessary. Marketing should be through JFPM Committees which should also have the right of supervision and providing advice.

People's Involvement:-

Village level committees refered to as Joint Forest Planning and Management Committee or JFPM are the basic structures proposed for peoples' involvement in forest management. JFPM should not only be a link between people and forest department, but also a true representative body of the people endowed with responsibilities and power to solve the connected issues.

There should be committees involving the people and Forest Department at divisional, circle and state level to supervise and co-ordinate the task of forest management.

Constitution of JFPM Committees:-

JFPM shall be constituted in each village with elected members from the Gramasabha. All the permanent residents of the village above the age of 18 years shall be the members of Gramasabha. The managing body of the JFPMC should have 9 to 19 members depending on the population of the village. There should be representation to different sections of the society like landless labourers, small and marginal farmers, rural artisans, women, businessmen and other categories, in the management committee. The Gramasabha will also nominate members from Non Government Organisation, Mandal Panchayat and Milk Societies. Section Forester and village livestock Inspector should be ex-officio members of JFPMC.

JFPMC should be responsible for development, protection, management of forests and marketing and distribution of forest produces; to protect the forest from encroachment, tresspass, fire, smuggling, grazing etc.

JFPMC should get grant and aid from government in the initial stage, but turn into a self sustaining economic unit in a reasonable period. All the income from utility zone, income from

sale of non-wood forest produce from protected zone, service charges collected from development zone will be the main source of income.

JFPMC should have power to stop illegal and harmful activities in forest area. There should be divisional circle and state level committees with representatives from JFPMC, concerned government departments, marketing agencies (such as consumer co-operatives, artisans co-ops etc.), NGOs etc. These committees are responsible for co-ordinating and supervising activities of JFPMCs at various levels to make arrangements to meet the requirement of towns, cities, industries etc., for fuelwood and other forest produces.

Enforcement Committee:- Though there are stringent rules to protect the natural forest, in effect it has become the teeth without biting ability. One cannot expect public interest litigation from the villagers for the violation of these rules. Threrefore, an enforcement committee or a watch dog committee at the district level in the lines of consumer protection forum with necessary legal powers is essential.

Role of NGOs:- The NGOs may participate in the JFPM by motivating, educating and training the villagers in forest management. They can act as link between committees at various levels, and be a watch dog of the entire system. However, the NGO shall not be entitled for any share from JFPM income.

Role of Forest Department:- The role of Forest Department will be more of scientific nature, providing technical guidance, supervising the work of JFPM, assisting JFPM in planning, marketing, protection, development of 3rd and 4th zone. The Forest Department will have more responsiblity in prohibited and conservation zones.

Forest Management for Eco-restoration:- While redesigning the forest management plan it is necessary to consider the social aspects and technical possibilities with integrated approach.

Social aspects of forest management which need consideration:-

i) Bonafide needs of the rural , tribal and local people

ii) Requirements of the local artisans

iii) Indentification, conservation and sustained utilization of nonwood forest produce of that locality and the local dependents on these produce.

iv) Socio-economic aspects of the poor people who are depending on forest produce for their survival.

v) Requirement of herbal medicines.

Technical Possiblities:- Loss of vegetative cover is evident at many places. The two major problems like soil erosion and water shortage, are also the results of deforestation, which are not easily visible.

Soil erosion prevention technique are adopted mainly on private lands, whereas the barren forest land remains neglected while taking up the scheme.

Water shortage is taking up severe turn with many of the places facing even drinking water shortage. Those who can afford are going in for tapping underground water either by deep-wells or tube wells. The underground water level is going down very fast.

Water harvesting technology has been devised to suit many agroclimatic zones. However, this technique will be effective when adopted on a large area. Small and marginal farmers cannot afford to effectively implement this technology. Wherever, water harvesting technique is adopted, the benefit is derived by those few who take up tapping of underground water source. Loss of vegetative cover can be made up within few years, but conservation of soil and water needs an integrated approach.

Integrated approach:-

i) The entire catchment area has to be considered instead of only the land managed by forest department.

ii) Proper land use planning has to be chalked out for the entire catchment, involving the local people and if necessary other related departments, such as agriculture, horticulture, animal husbandry etc.,

iii) Emphasis should be given to conserve soil, water and the vegetation of that area in a comprehensive manner.

Burning Problem of Fuelwood:- To overcome the shortage of fuelwood and other essential raw materials the farmers may be encouraged to grow tree crops and fodder crops on marginal lands which are not profitable for traditional agricultural crops cultivation.

The farmers are unable to compete with the state agencies, as these agencies are supplying the forest products at concessional prices without considering the production and transportation cost.

Blanket subsidy for forest produce including for fuelwood supply should be abolished. Instead of this, fuelwood and other essential forest products may be supplied only to those who are below poverty line at subsidised rates.

The subsidy amount which is being spent for the supply of fuelwood etc., may be curtailed to those who are above poverty line and the same may be utilised for giving incentives to those

villagers who come forward to grow forest produce on marginal lands.

The incentive should not be in the form of cash payments. But it should be as an interest concession on loan amount, compulsory purchase of the produce at economic price and the liberlization of government control. Efficient methods of utilising fuelwood should be popularised.

Efficient use of fuelwood is helpful for conservation of natural forest by reducing the pressure on it. By increasing efficiency the quantity used will be reduced thereby the total amount spent on fuelwood will be almost same even if the cost of fuelwood is doubled by the abolition of subsidy.

Fuelwood requirement of the villages should be met by JFPM. Fuelwood requirements of the towns and cities should be met by the divisional, circle or state level committees, as the case may be. While collecting fuelwood from different zones first preference should be given to privately managed zones, followed by utility zone, and lastly by collecting dead and fallen trees from protected zone.

There should be direct link between JFPM and consumer co-operatives engaged in distribution of fuelwood, under the supervision of appropriate level committee.

Needs of the rural people:- Meeting the requirement of agriculturists and rural artisans, rural housing along with fuelwood needs is the primary responsibility of JFPMC by proper planning and distribution systems.

Requirements of Urban artisans:- Wood requirement of artisans of towns and cities is to be met under the supervision of district and circle level committees utilizing the existing institutions, in the lines of fuelwood supply system.

Requirements of Industries:- Wood requirement of industries either in the form of timber, fuelwood or otherwise is to be planned in advance and suitable arrangements be made for the supply in the lines of fuelwood supply systems involving JFPMs.

Other aspects of forest management:- Using the forest as grazing land, encroachments, smuggling activities, customary rights and concessions on forest land and many issues need to be faced while, implementing the JFPMC concept. To tackle a few of such problems our suggestions are as under:-

i) Encouraging environmental friendly practices in livestock management; development and supply of fodder resources should be a part of the scheme. Proper marketing arrangements for the animal produces is very essential.

ii) The forest resources develoment project shall include the programmes to provide permanent settlement to Gowlis, tribals,

those engaged in shifting cultivation. Provision of civil amenities and alternate employment opportunities, make it more effective.

iii) The issue of encroachment of forest land needs humanitarian consideration. This can be regularised by giving usufructory rights and encouraging them to grow tree crops. Provisions should be made for planned expansion of villages and towns. It is necessary to put a strict end to further encroachment of forest land.

iv) While using forest land for rehabilitation programmes a comprehensive and humanitarian plan should be worked out keeping in view the overall development of the forest area.

v) To bring the betta lands under the perview of comprehensive development strategy, it is felt necessary to facilitate proper divisioning and development under the guidance of JFPMC.

vi) Improved and alternate technologies for energy conservation and housing should be popularised. If cheaper and alternate technologies, are used in construction of government and public buildings, it will create confidence among the mass.

vii) Creation of social awareness through extension education regarding role of forest in ecosystem management needs emphasis. This education needs to be given right from policy makers, to village level workers, the politicians and the masses.

Viii) There is a necessity to overhaul the laws and rules connected with forest, and make them more people oriented in view of the JFPMC concept.

ix) Research activities regarding the natural resources development, utilization, conservation, marketing social and legal aspect need to be encouraged.

With active involvement of the people the policing job of forest official shall be changed to more of a technical, planner and manager of natural resources and ecosystem; and then only lofty ideals of national forest policy will be realised.

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INDIAN FOREST MANAGEMENT

P.D. GAONKAR (IFS)
Retired Chief Conservator
of Forests, Karnataka

Introduction:

Systematic forest management in India started over a century ago. The Indian Forest Act enacted in 1865 was a first step towards systematic management of forest. Though all the presidencies in India, then did not adopt the same at the same time. The activity of forest management and preparation of working plans followed next. By the end of 19th century good forests of most of most of the presidencies under the British rule and control resorted to scientific management under the purview of working plans prepared. By this time well organised forest department also came into existence throughout the country. The scientific forest management also progressed well under these conditions. However with the outbreak of World War - II, the scientific forest management suffered a set-back, in majority of the forests were exploited, or rather over-exploited for Defence supply. Major deviations had to be effected in regular working of the working plans.

At present over 75% of good forests of most of states in India are covered by working plans written by trained forest officers, after careful study of the growth terrain and other local conditions; though here and there these plans had to be given rest or had to be held in abeyance for accommodating Five Year Plan targets, of afforestation. However the Five Year developmental plans, in order to improve and increase vegetative cover, afforestation schemes plantation programmes, survey of forest resources, improvement of forest communication, survey and demarcation of unorganised forest areas, preparation of working plans for unorganised forests, strengthening of forest research and education, strengthening of forest administration, preservation of wild life, creation of wild life sanctuaries and national parks were spelt our clearly. As a result we find today most of these in existence in our forest administration and management.

The national forest policy of 1952 gave concrete shape to the post war forest development. It was in this forest policy stress was given to increase the National forest percentage to 331/3 %, though many of the states even today are not having forests to this extent. One of the reasons attributed for this is availability of adequate funds. The total outlay in forestry at national level is less than 2% . Even now majority of the states are not better than this.

Forest Management :

Forest management is similar to any other estate or industry management. But the time taken in forestry is rather long, since the trees take a long time to grow and attain useful size in forestry. However between the time taken for planting and harvesting or for that matter in management of natural forests, there is availability of intermittent different useful products like hutment material, poles and fuel wood. This will have to be also managed properly.

As we know forests satisfy a great range of human needs, in terms of timber, fire wood, poles, gums, resins, bamboos, canes and other innumerable minor forest produces. In India forest area is a major source of grazing and fodder production, making forest management rather a complicated and difficult issue, on many occasions. In forest management, the manager is responsible not only for ensuing satisfactory growth of plants, by planting, tending and replacement, but also for their harvesting and sale as well. As a result this needs laying of roads for communication, buildings for labour dwelling and mechanical equipment for other necessary operation. To accommodate all these, the manager of forest manager has to carefully study these and provide for the same. In forest management care will have to be taken of the following also :

1. Biological side of plants, i.e. plant morphology, physiology, taxonomy, ecology, entomology, plant pathology, wood anatomy and most important of them all, the silviculture of trees.

2. Sociologically, the marketing and economics, land use, logging, saw milling, wood seasoning, preservation fire control etc.

   Considering all these factors, a management plan called working plan, the back bone of forest management is preparcel.

Working Plan :

The working plan for a forest either natural or man made, in general is prepared on the following lines, and will include the following basic ingredients : -

(i) Survey of the facts :
   (a) the forest and the site factors.
   (b) growing stock.
   (c) the administration and economy.

(ii) Foundation of the plan - analysis of the facts - Division of the area etc.

(iii) Management of the growing stock.

(iv) General management of the facts.

(v) Appendices and supplementary maps.

(1) Survey of the facts will have description of situation, extent of area, history and legal status. It will also specify the topography, altitude, drainage system, climate, geology and soils. Variable factors like biotic interference will life existence, incidence of fire will be summarised. A mention of ecology, suitability of tree species for the site also will be made.

The survey of the growing stock will consist of silvicultural assessment, past silvicultural treatment, present state of forest i.e. its composition, structure health, vigour, extent and distribution. Methods of treatment, assessment of volume and increment, and removal of yield will also be described. It will also describe management practices to be adopted to the forests in future.

Apart from this the administrative organisation, the managerial charges, man power, housing, market, extraction, transport etc. will be clearly stated.

2. The foundation of the plan will indicate the present position and prospective plans. The long term policy, the methods chosen for management and the frame work of the plan.

3. The management of the growing stock will indicate, the management design, silvicultural design, regulation of yield, regeneration and tending, forecasts of yield etc.

4. General management will describe of protection, plant supplies, nursery operations, exploitation, administration, control and records buildings, roads and bridges existing and to be constructed summary of income and expenditure etc.

5. The appendices chapter, will include other detailed information connected with glossaries of historical and other forms, area statement, maps of all types, description of compartments, calculation of yield etc.

With all these information collected a preliminary working plan report will be drafted and on the basis of this, a draft working plan will be prepared and sent to the officer empowered to approve of the same. Generally the Conservator of Forest, incharge of the area of working plan is the approving authority. When the draft working plan is approved the final plan is prepared, and sent to the Government through proper channel for approval and. While doing so, the Deputy Commissioner of the District will be referred to

comment on the rights and privileges of the people over the forests covered under the working plan. This is where the Deputy Commissioners are involved in the management of forests.

Now with the advent of social forestry, in the management of the wood lots, and the plantations created, the concept of joint management has crept in. Here the implementing agency, and the users, i.e. people who will be having benefit of the resources created, will be managing the free growth to the best of their benefits.

POLLUTION

-Shekar Borgoankar,

Energy is generally defined as the capacity to do work. A more comprehensive definition of energy would be as follows, "Energy is an agent which is capable of transforming the state of a system." The table below will give an idea of the different types of energies and the transformations they are capable of inducing,

Sl No.	Types of energy	Some possible transformations
1.	Electrical Energy	-Mechanical energy in motors -Ionize air/gas under certain conditions -Produce heat in resistance -Electrolyse solutions -Etc
2.	Heat Energy	-Evaporate liquids, melt solids -Heat liquid solid & gas -Expand all substances -Induce chemical changes -Etc
3.	Chemical Energy	-Release heat -Changes the composition of substances -Release light -Induce electrical activity -Etc
4.	Light / Radiation	-Cause chemical changes -Generate heat -Cause nuclear changes -Etc

5. Mechanical Energy
mechanical, sound
wind

-Generate electrical energy
-Promote chemical activity
-Generate heat through friction
-Etc

Energy is measured in Joules. One joule of energy is the amount of energy required to lift 1 Kg of mass through a height of about 11 Cms.

The amount of heat energy released by burning a 1 gram of coal is about 30,000 Joules.

Not all kinds of energies are of the same type and effectivity. Thus same 1000 joules of electrical energy and 1000 joules of heat energy and 1000 joules of chemical energy cannot really produce equivalent amounts of transformation. We shall have to understand the nature of energy much more deeply how these things work. At present it is sufficient note that there are what are called grades of energy is the efficiency with which it can be used to effect transformations. It represents some kind of orderliness of the energy which helps its minute control in a transformation.

Thus electricity is a very high grade energy. Mechanical and Chemical er[illegible] are less of a grade. Heat is the lowest grade energy having very low internal order. The conversion of heat into mechanical work is governed by the laws of Thermodynamics. It tells us how huge quantities of heat are converted into relatively small amounts of high grade energy like electricity is a very inefficient process.

POLLUTION

With this introduction to energy let us now address the theme of the topic - pollution. The central idea of this paper is the following: "Energy is used to produce a desired transformation. This transformation takes place with a certain efficiency. The energy which cannot be used to effect the desired transformation but is however consumed - does escape into its environment inducing all kinds of unforeseen and unindented transformations. All these unindended transformations constitute environmental pollution".

Examples of Pollution: (1). Wood Chulha

(a) Chemical energy ---- Heat energy
Wood + Air ----- Heat + CO_2 + H_2O

If the process is carried out under perfect conditions then we get about 17,000 joules of energy per gram of wood burnt. The heat is present in the hot gases viz CO_2 & H_2O. The pollution is in this phase is zero. However in most practical Chulha's the combustion does not take place under optimal conditions, the ordinary transformation looks like this,

Wood + Air ---- Heat (less) + Soot (pollution 1)
+ Wood tar (P2) + CO (P3)
+ Complex wood distillates (P4)
+ CO_2 + H_2O

Soot, wood tar, CO_2, complex wood distillates are 11 substances having untransformed energy and continues to interact with the environment when possible - like the people's bodies when breathed in, plant life other activities of man like cooking etc.

(b) Heat energy of gases -----10% heat energy in water
-----90% heat in affluents let into atmosphere
-----Radiation
-----Influences - weather, health chemistry.

Example 2 : Inefficient Chemical Plant

Input chemicals + Conditions for reaction heat + Stirring etc. ---- Output chemicals + Energy loss

(a) If the reaction is incomplete some input chemicals will be present in affluents.
(b) If recovery of output chemicals is not complete they will be present in the chemical affluents.
(c) If all known conditions are met does not guarantee optimality -- some energy escapes in the best known transformation in the form that may be potentially dangerous like reactive chemicals.

Example 3 : Refining ores into pure substances is actually transforming a low grade or sparse material into a concentrated high grade material. This process very highly energy intensive and a potential source of pollution.

Example 4 : Concentration of high energy (highly reactive) chemical substances or nuclear ores is also a highly polluting process for instance.

Example 5 : Motor with friction in the shaft
Electrical energy --- Mechanical energy + heat energy work done + Wearing of shaft.

Example 6 : Noisy Workshop

Mechanical energy --- workdone + noise + heat + light energy
Noise energy ---- disturb people and lead to other unintended transformation like damage ears
Light or sparks ---- damage eyes.

Resources

In social million transformations are structured in a very complex way and many times the energy acting behind transformations is not directly visible . Hence we shall use the term resources as a general agent of transformations. The table below gives example of resources,

Sl No	Resources	Property
1.	Money	Highly reactive. can move things in a very many circumstances
2.	Land/housing	Not very reactive. Important for most activities. In fact growing cities its value shoots up. Only well to do people transact with land frequently. Does not touch landless + Basic necessity
3	Water & Air	An important infrastructure
4.	Goods	Value depends on demand. For instance electronic goods/camera can be exchanged with money easily
5.	Contacts	Good will & contacts with important people can move things
6.	Food/Clothing	Basic necessity of human beings
7.	Transport facilities	A very useful necessity

Just as in the case of energy one resource can be converted into another. The efficiency of transformation is determined by the nature of the resource and the end application of that resource. Again inefficient transformation leads to spillover of reactive resources into the environment leading to a chain reaction of interactions and transformations all of which will be unintended but not necessarily begin.

TRIBAL DEVELOPMENT MANAGEMENT.

- B KAPTHUAMA
Reg. Dev. Commissioner
Govt of Bihar, RANCHI

Issues :-

1. Tribal people are generally honest and simple.
2. They are not responsive to new ideas hence perseverance in dealing with them is necessary.
3. Social drinking is common among them and the tribal women are exploited as a result thereof.
4. Economic , social and political change in the country also adversely affected their tribal culture and traditional life.
5. Fruits of Development do not reach them.
6. Corruption too has crept into the Tribal Society.

The general approach to the tribal development administration in the Country continues to be bureaucratic in nature. The 'I know better than them' principle continues to be the guiding factor to our approach to their development. Since the tribal people are generally docile by nature anything offered to them whether they like it or not is accepted. These do not necessarily contribute to their welfare and development. Hence approach to the tribal development needs drastic change. The IRDP does not benefit them to the extent assumed. The loan component in the IRDP instead of being a boon becomes a bondage to them.

Adequate time spent with the people could elicit valuable information as to what they like and dislikes. Therefore development schemes and welfare measures proposed to be taken could be more meaningful when planning is done in consultation with them. Infrastructural development schemes do not generally benefit the tribal people even though more than 80% of our schemes are spent on them. Income generating economic activities should form the major chunk of our developmental strategy. Development of women in the tribal area forms one most important area of activities for building up the tribal economy and capability. Trysem schemes and other training programmes do not benefit the targetted group due mainly to improper selection, contents of the courses and follow up programme. Training course should necessarily include supply of assets for which training has been imparted to them.

The role of Non-Governmental organisation (NGO) in this regard is extremely important. The sooner we realise that development of the tribal people is through the beneficiary participation in planning, selecting, execution, implementation and maintenance of the schemes, the better the result of our programmes would be. Participative Rural Management, to me, is the answer to our Tribal Development Progoramme.

....

CONTROVERSISES ABOUT SARDAR SAROVAR DAM ON RIVER NARMADA

- A.W.P. DAVID *
IAS,

Relevant Points. :-

(1) only less than 5% of the Narmada Waters have so far been harnessed. Large areas in M.P., Gujarat and South Rajasthan Continue to suffer from droughts and flood.

(2) Height of the dam 450 ft.. The Narmada Valley Scheme envisages 32 major dams, 150 medium and 3000 minor dams.

Controversies :-

1. Big dam vs small dams
2. Water logging
3. Lack of adequate water flow to reach the tail ends of the various canals
4. displacement of humans
5. Destruction of enviornement and the eco-system.
6. Lack of funds.

Reaction of the dam authorities :-

1. Greater good for greater number of people
2. Adequate resettlement package.
3. Precautions against water logging.
4. Small dams inundate more area and are less econonically effective.
5. Compensation of degration of enviornment provided.

Demand from those who appose the dam. :-

1. Search for alternatives and in the meantime stop the construction.
2. Rehabilitation of the displaced impossible.

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GUJARAT

HOUSING AND ENVIRONMENT

- Dr P S A Sundaram IAS
Joint Sec GOI, New Delhi

Provision of adequate shelter with basic services is an important input for environmental quality reduction of morbidity and mortality and sustainable development. The National Housing Policy emphasises environmental protection in terms of the norms for housing and services for settlements, of neighbourhood planning and open spaces, control of pollution as well as removal and disposal of liquid and solid wastes.

2. The urban centres witness extremely deprived living conditions, with large sections of the citizens living in squatter settlements and crowded dwellings with poor access to potable water and sanitation. About 30 to 40% of the population in larger cities live in slums, 27% of population lacks access to safe water and over 50% has not been reached by water-borne sanitation. Indian cities have a high level of air and water pollution, aggravated by the rapid growth of two wheelers and other automobiles. As the country continues to industrialise, the cities face the problem of indiscriminate and polluting disposal of effluents and wastes, and the Bhopal disaster is the grim human dimension of how much can go wrong. Water pollution severely affects surface and ground water. The superthermal plants create their own brand of air pollution and waste land. Meanwhile, the reliance of bulk of the poor on firewood decimates the forests.

3. The Housing strategy of central and state governments focusses on environmental hygience in low income settlements, occupancy rights and construction assistance for slumdwellers, convergent delivery of basic services for the urban poor with community participation, and increased access of different income groups to serviced land infrastructure, housing finance and materials. This will be implemented within a framework of balanced urban settlements and increased investments to raise the coverage of urban population to 100% potable water supply and 75% for basic sanitation, and the total elimination of manual scavenging.

4. Housing and human settlements development can thus serve the cause of environment. However, the content and direction of housing effort dictates its effect on environment and energy conservation. Hence the emphasis on low rise construction, use of alternate energy saving materials, encouragement to traditional materials for construction, stress on wood substitutes and materials produced out of waste, minimising transport requirements by bringing housing and workplaces together, in situ upgradation and conservation of housing stock and vernacular architecture. The involvement of NGOs and community associations and sensitisation of professional attitudes is vital in this task.

'MANAGEMENT OF ENVIRONMENT - WATERSHED DEVELOPMENT'

* * * Mr. Ramachandra Chetty

(1) Watershed, Sub-Water shed and Micro Watersheds

(2) Character and constituents of a Water Shed.

a) Common property resource

b) Private resource

(3) Arable and Non- Arable characters

(4) Present Senario of land use

(5) Optimum land use

(6) Pressure factors.

a) Human Population

b) Cattle Population

c) Edanic characters

d) Man made pressure factors like fire and wrong land use practices

(7) Arable lands

a) Farm Forestry

b) Agro Forestry

(8) Non Arable lands

a) Block plantations

b) Canal Bank plantations

c) Revenue plantations

d) Railway side plantations

e) Afforestation of foreshore - tanks and reservoirs

f) Gully control

g) Range lands ; Silvi pasture

(9) Silvi - systems

a) Afforestation of barren areas

b) Natural regeneration

10) Participation of NGOs, village Committees and private enterpreners in Water Shed Development.

11) Incentives for forestry development within water shed.

a) Decentralised nurseries.

b) Assistance in Farm Forestry and Agro Forestry

c) Involvement of institutional finances

12) National Forest Policy

a) $33\frac{1}{3}$ % of the land to be under forest, 66% of the land in hills to be under vegetation.

DHANVANTRI VAN

(HERBAL GARDEN)

Field Visit

*****

In the year 1989 directorate of Indian System of medicine has requested the Forest Department to establish a Herbal Garden for the use of the students of Indian System of medicine. They handed over 35 acres of land, out of which 28 acres which was free from encroachment has been developed.

The area was undulated rockey and barren. The Forest Department has taken up levelling and installed a bore-well and started the nursery and planting of seedlings simultaneously.

The experts were consulted and the Herbal plants which were found in Karnataka were collected and planted and nursery work also started.

The object of establishing this Garden is, in our country the rural health remains very unsatisfactory. About 70% to 75% of the Rural people are not getting any health care and it is beyond their means to get basic health care.

The situation in the urban centres has dramatically changed, as Hitech health care attention is increasing and it is becoming beyond the reach of even middle class citizens.

Even though National Health Policy speaks about providing primary health care to all the citizens in the country, but factually the health coverage is far from satisfactory. The health condition of the disadvantaged population groups particularly children and women is really very pathatic in the rural areas. Indian System of medicine and traditional medicine were found to be quite effective, simple and cheap.

A team of Ayurvedic Doctors and Karnataka Forest Department started a programme called 'Sasya Sanjeevini' with the help of the All India Radio and broadcasted 13 episodes explaining about the uses of 25 medicinal plants and given the simple recipes. The response to this programme was beyond our expectation. About 8 to 10 lakh people have participated in the programme and requested the Department to publish a small booklet for their use and lakhs of people were benefited and the simple recipes was found efficacious and useful. The public has requested the Department to launch another programme. Recently another programme called "Sasya Surabhi" was launched and just completed covering another 30 plants. In this programme also lakhs of people were participated and we are going to release a small booklet for the use of the people. The experts has given simple recipes and prescriptions for many ailments which are curative, preventive and promotive. The prescriptions recommended are simple and effective.

From the nursery of this Herbal Garden we have supplied over 25 lakhs seedlings to public at free of cost. The demand for the herbal plants which are covered in the programme is increasing and many people started raising in their kitchen gardens and using them. The total expenditure incurred to establish this Herbal Garden is about 9 lakhs.

In this Garden we have raised so far over 800 species used in Indian System of medicine and also in traditional medicine. We are also aiming to develop a package to raise poly-culture Herbal Gardens with an object of producing maximum quantity of crude drugs in a small unit area. We are also planning to develop post harvest technology and also primary and secondary processing technology so that the farmers can get value added price for the products they cultivate.

These centre will serve as gene bank. From this Garden we are going to collect seeds and supply seeds and seedlings to the users. We are also planning to initiate studies to inter cultivate suitable Herbal plants in sub-marginal lands profitably.

*****

RESORT OF SACRED PLANTS

"Everybody needs beauty as well as bread, place to play in and pray in, where nature may heal and cheer given strength to body and soul alike" Keeping this in view we have established a resort of sacred plants which are used in rituals.

Normally everyone likes to have a glimpse of widerness, mountains, rivers in its serene beauty. But modern man has treated forest has only source of getting timber and fuelwood and place to graze his cattle, with the result virgin forests is shrinking and loosing its structure and beauty due to interference of man.

The essential compatibility of man and nature has been the basis of our earliest religious and philosophical thought. Nature in all its forms and plants in particular, have been sacred to us. Tree worship formed an integral part of pre-Aryans culture. Our ancestors have earmarked certain areas of forest as Devarakadus, Pavitravanas, Nagavanas and preserved them as sacred and inviolable forests.

As the pantheon of gods grew, their worship became elaborate, the texts came to associate particular species of plants and flowers with certain gods and goddesses to be used in their worship. Using this literature we listed out the species and established small plots containing species used in each rituals for each deity. The concepts evolved by our ancestors seems to be quite relevant even today and is vital for survival of mankind itself. This is all the more found to be necessary for a modern man to refurbish our memory and remind the posterity of our indebtedness to nature and inculcate the philosophy the best way to save ourselves is to understand the nature and save the nature to save the mankind.

Since one decade people all over the world are talking about the environment and ecology and becoming more and more conscious about it everyday. But one has to marvel at the manner in which our forefathers without the benefit of the modern education but mainly based on commonsense approach and deeper understanding, thought about it and devised their own plans in a myriad ways to bring home the message one of such attempts was to establish sacred gardens.

In the year 1989 we established the resort of sacred plants in Doddamana Gudde reserve forests. The area was degraded scrub forest, we laid out the plots depending upon the number of plants to be planted in each ritual. We have also collected information in our mythology about the plants listed in Ramayana particularly in Ashoka Vana all the plants listed by Sri Valmiki have been identified and planted.

Similarly we have also identified the plants mentioned in the Biblical records and established a Garden of Eden and also Garden of Mohamed.

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LIST OF IAS OFFICERS ATTENDING ONE WEEK TRAINING PROGRAMME ON

"MANAGEMENT OF ENVIRONMENT" FROM 24TH TO 29TH AUGUST 1992

ORGANISED BY CENTRE FOR ECOLOGICAL SCIENCES, I.I.SC, BANGALORE

SL NO.	COMPUTOR IDENTITY NO.	YEAR	NAME AND OFFICE ADDRESS	TELEPHONE NUMBER	RESIDENTIAL ADDRESS	TELEPHONE NUMBER
1	RJ 020627	1979	SHRI P.C.AGARWAL SETTLEMENT COMMISSIONER & EX-OFFICIO DIRECTOR OF LAND CONSOLIDATION & JAGIR COMMISSIONER, JAIPUR, RAJASTAN	373904	4-YA-4 JAWAHAR NAGAR JAIPUR -302004	562224
2	UP 022600	1963	SHRI ARVIND VARMA DIRECTOR, U.P.ACADEMY OF ADMINISTRATION NAINITAL - 263001	3141	DIRECTOR'S RESIDENCE UP ACADEMY OF ADMINISTRATION NAINITAL - 263 001	3217
3	BH 017501	1965	SHRI BENJAMIN KAPTHUAMA REGIONAL DEVELOPMENT COMMISSIONER, GOVT. OF BIHAR AUDREY HOUSE RANCHI - 834008	301480 & 304438	OPP: AUDREY HOUSE MEARS ROAD, RANCHI - 834 001	301055
4	MP 016400	1964	SHRI Y.N.CHATURVEDI SECRETARY, U.G.C., BAHADUR SHAH ZAFAR MARG, NEW DELHI - 110 002	3318849	C -II, MOTI BAGH, NEW DELHI - 110021	673376
5	KN 023606	1982	SHRI C. CHIKKANNA DIRECTOR, AGRICULTURAL MARKETING, NO. 16 11TH RAJBHAVAN ROAD BANGALORE 560 001	564192 575174	NO. 235,14TH CROSS M.C. LAYOUT VIJAYANAGAR BANGALORE 560 040	355298
6	AP 028600	1980	SHRI P. DAYACHARI DIRECTOR OF MARKETING GOVT. OF ANDRA PRADESH HYDERABAD - 500 004	242307 242306 242305	PLOT NO.58, CAN BANK APT. P&T COLONY GANDHINAGAR HYDERABAD	611011
7	AP 021200	1972	MISS. C.R. GAYATHRI VICE-CHAIRMAN & MG. DIRECTOR, A.P.HANDICRAFTS DEVELOPMENTS CORPN.,TARAMANDAL,SAIFABAD, HYDERABAD - 500 004	243093 243094 243493	"AMBUJA", 20A ROAD NO.2 , JUBILEE HILLS HYDERABAD	248876
8	MH 034014	1982	DR.GOVIND M. GARE	27494	MUNICIPAL	28309

			MUNICIPAL COMMISSIONER, MUNICIPAL CORPORATION, AURANGABAD - 431 001		COMMISSIONER'S RESIDENCE, DELHI GATE AURANGABAD (MAHA)	
9	MH 015303	1964	SHRI N.H.R. HYNNIEWTA DIRECTOR, Y.CHAVAN ACADEMY OF DEVELOPMENT ADMN., PUNE, MAHARASHTRA			
10	JK 002600	1968	SHRI H.L.KADALBAJU DEVELOPMENT COMMISSIONER, KANDLA FREE TRADE ZONE, GANDHIDHAM (KUTCH)	52194	23, SECTOR 3, GANDHINAGAR (KUTCH) 230370	23236
11	MH 030008	1976	SHRI V.K.KOLHATKAR MUNICIPAL COMMISSIONER, SOLAPUR - 413 001 MAHARASHTRA	25708	83 - E, RAILWAY LINE, SOLAPUR - 413 001	22413
12	RJ 011400	1962	SHRI MAHENDRA SINGH PRINCIPAL SECRETARY LABOUR AND EMPLOYMENT GOVT. OF RAJASTAN, JAIPUR	520386 (0141)	5J 2A JAWAHAR NAGAR JAIPUR RAJASTAN	562786 (0141)
13	WB 019101	1969	SHRI S.N.MENON MANAGING DIRECTOR W B INDUS.DEV.CORPN LTD., 5,COUNCIL HOUSE STREET, CALCUTTA - 700 001	28-6648 28-6583	P 404/5 GARIAHAT RD. CALCUTTA 700029	742791
14	TN 022400	1977	SHRI MRUTYUNJAY SARANGI DIRECTOR (THERMAL - I) MINISTRY OF POWER SHRAM SHAKTI BHAWAN RAFI MARG NEW DELHI - 110 001	3717753	N - 530, SECTOR 8, R.K.PURAM, NEW DELHI- 110 022	606867
15	MH 018800	1967	SHRI U.K.MUKHOPADHYAY SECRETARY, INDUSTRIES,ENERGY & LABOUR DEPT., GOVT. OF MAHARASHTRA, MANTRALAYA BOMBAY - 400 032	202 67 67	FLAT NO.10-S, DILWARA MAHARSHI KARVE ROAD BOMBAY 400021.	
16	KN 008800	1965	SHRI H. NAGARAJA SETTY COMMISSIONER & SECRETARY GOVT OF KARNATAKA, NO.610, 6TH FLOOR, III STAGE, MULTISTOREYED BUILDING, BANGALORE - 1	261297	NO. 383/8, 10TH CROSS, II BLOCK, JAYANAGAR BANGALORE - 11	630401

17	BH 022700	1973	SHRI U.N.PANJIAR ADDL.INDUSTRIAL DEVT.COMMR. CUM SPECIAL SECRETARY,INDUSTRY BIHAR, PATNA	224772	14/60 OFFICERS FLAT, BAILEY RD. PATNA 800001	230611
18	GJ 012300	1966	SHRI A.W.PAUL DAVID COMMISSIONER OF INQUIRIES, BLOCK NO. 3, FIRST FLOOR, DR.JIVRAJ MEHTA BHAVAN, GANDHINAGAR - 382 010 GUJARAT	23915 & 20628	D-4,SAMARPAN FLATS GULBAI TEKRA, AMBAWADI, AHMEDABAD-380 009 GUJARAT	405747
19	AP 026900	1978	SHRI M. SAMUEL COLLECTOR & D.M., ANANTPUR DISTRICT, GOVT. OF ANDHRA PRADESH ANANTPUR	20801 20081		
20	GJ 022300	1981	SHRI S.C. SANEHI DIRECTOR,PROHIBITION & EXCISE, GOVT. OF GUJARAT NEW MENTAL ASHARWA, AHMEDABAD - 16	376006	BLOCK NO.G/253 SECTOR - 19, GANDHINAGAR GUJARAT	22599
21	HY 007200	1966	SHRI R.L.SUDHIR COMMISSIONER & SECRETARY TO GOVT. OF HARYANA, TOURISM,MINES GEOLOGY & ELECTION DEPT. HARYANA CIVIL SECRETARIAT, CHANDIGARH.	540278	KOTHI NO. 10 SECTOR - 7, CHANDIGARH	43100
22	UP 033100	1972	SHRI SUJIT BANERJEE REGISTRAR, CO-OPERATIVE SOCIETIES, U.P., 14, VIDHAN SABHA MARG, LUCKNOW - 226 001	242267 & 234632	B - 1, DILKUSHA COLONY, LUCKNOW - 226 002	236704
23	MH 016100	1966	DR.P.S.A.SUNDARAM JOINT SECRETARY MIN.OF URBAN DEVELOPMENT, GOVT. OF INDIA, NIRMAN BHAVAN, NEW DELHI - 110 011	3017665	HOUSE NO.C.1/1, M.S.FLATS, SECTOR XIII, R.K.PURAM NEW DELHI - 110066	6885184
24	KN 008600	1965	SMT. TERESA BHATTACHARYA MANAGING DIRECTOR, MYSORE SUGAR COMPANY LTD., N.R. ROAD,BANGALORE	220988	3288,12TH MAIN HAL II STAGE BANGALORE	563652
25	MH 0227600	1974	SHRI Y.P.S. TOMAR TRIBAL COMMISSIONER NASHIK,MAHARASHTRA	77510	TRIBAL COMMISSIONER'S RESIDENCE,GOLF GOLF CLUB RD. NASHIK	75804

26	OR 018500	1977	SHRI N.C. VASUDEVAN CHAIRMAN CUM MANAGING DIRECTOR STATE WAREHOUSING CORPN., GOVT. OF ORISSA BHUBANESWAR	51585	675,CUTTACK RD. BHUBANESWAR	50491
27	UP 030500	1970	SHRI VINOD KUMAR MALHOTRA COMMISSIONER & DIRECTOR, DEPT. OF INDUSTRIES G.T. ROAD, KANPUR-208002	218401	PILI KOTHI COMPANY BAGH NAWABGANJ KANPUR- 208 002	292020
28	HY 014308	1980	SHRI ZILE SINGH KHOBRA LABOUR COMMISSIONER HARYANA, 30 BAYS BUILDING FIRST FLOOR, SECTOR- 17 CHANDIGARH - 160 017	541266	HOUSE NO.2523 SECTOR 27 CHANDIGARH	24963