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ACTIVITY GUIDE BOOK 2018 & 2019

NATIONAL CHILDREN'S SCIENCE CONGRESS

FOCAL THEME

SCIENCE, TECHNOLOGY AND INNOVATION FOR A CLEAN, GREEN AND HEALTHY NATION

रविप्रौसंप NCSTC

A PROGRAMME OF

NATIONAL COUNCIL FOR SCIENCE & TECHNOLOGY COMMUNICATION

DEPARTMENT OF SCIENCE AND TECHNOLOGY

GOVERNMENT OF INDIA

NATIONAL CHILDREN'S SCIENCE CONGRESS

A Programme of
National Council for Science
& Technology Communication
Department of Science and Technology, Government of India

ACTIVITY GUIDEBOOK
2018 & 2019

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FOREWORD

The National Children's Science Congress (CSC) prompts children to ponder upon significant societal problems, think over its causes and subsequently try and solve the same using the scientific process. This involves close and keen observation, raising pertinent questions, predicting solutions, trying out various possible alternatives and arriving at an optimum solution using experimentation, field work, research and innovative ideas. NCSC encourages a sense of exploration, innovation and discovery of child scientists based on the process of learning of science through doing, using the method of science. .

National Council for Science and Technology Communication (NCSTC) aspire to popularize S&T among children especially, encouraging and introducing children to project based learning activity as opposed to rote learning. This in turn nurtures the critical thinking ability of the children and also to question the processes with the aim of step by step assimilation and extension of knowledge taking them to newer fields and higher areas of science.

So far the practice has been that the Activity Guide Book had both the general programme guidelines (Part 1) along with the Focal and sub themes parts (Part 2). But it has now been felt that since the programme guidelines remain more or less the same, it is better to separate the same as a separate booklet which is also being separately published.

This book focuses only on the Foal Theme and the sub themes for the years 2018 & 2019 and with the Focal theme "Science, Technology & Innovation for a Clean, Green and Healthy Nation" NCSC has once again proved that we are moving ahead of the times and always takes up core areas of science and technology where it really matters as to what is to be done in the focus of the Sustainable Development Goals (SDGs).

I am sure that child scientists, guides, experts and all those who are associated with this programme would find this book a good resource material not only for the coming CSCs but also as a good reference guide book for future years as well.

New Delhi
Date: 5 March 2018

(Dr.Chandermohan)
Scientist-G/ Head (NCSTC)
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ABOUT THIS BOOKLET

The Children's Science Congress (CSC), initiated in 1993, is a flagship programme of NCSTC, DST, Govt of India and has since crossed the silver jubilee year. It is an inclusive programme open to children of the age group of 10-17 years covering all backgrounds either school going or out of school system, belonging to geographic, language and cultural regimes across the country and open to all children including children with disabilities.

CSC programme has covered the topics like Environment, Nutrition, Clean-up India, Water Resources, Biodiversity, Land Resources, Energy, Weather and Climate during its journey of more than two decades of great success and also grow up with innovative ideas of child scientists through their innovative project work on a variety of relevant local issues of focal topics.

This Activity Guide Book which would be used for the National Children's Science Congress 2018 & 2019 has been prepared by the National Academic Committee which has been constituted to manage the academic part of the National Children's Science Congress in the National Brainstorming Workshop conducted at Ahmedabad during 15-17 June, 2017 and subsequently edited and finalized by in a Workshop of Sub Committee of the National Academic Committee along with invited members in Guwahati during 13-16 February 2018.

The focal and the sub-themes are very much relevant taking into account the focus on the Sustainable Development Goals (SDGs) and the importance that the Government of India has accorded to this in the form of leading national programmes.

New Delhi
Date: 5 March 2018

(Er. Sujit Banerjee)
Scientist F,NCSTC, DST, Govt. of India
National Programme Coordinator, NCSC

FEW WORDS FROM ASTEC

National Children's Science Congress (NCSC), arguably the flagship programme of the National Council for Science and Technology Communication (NCSTC), Department of Science Technology (DST), Govt. of India, is a platform for millions of children in the age group of 10-17 years to showcase their creativity in solving problems that envelope their mundane lives. They follow "Methods of Science" to tackle problems drawn from the focal theme and arrive at "alternatives", which are documented, presented and shared in larger platforms with all support systems. NCSC plays a pivotal role in inculcating scientific temperament in the children. When the education system in the world is focussing on Activity-based learning, NCSC has proved to be one such initiative in the Indian diaspora.

The focal theme for the year 2018 and 2019 is "Science Technology and Innovation for Clean, Green and Healthy Nation". The theme is quite exciting and will encourage children to find solutions for many of their societal problems. The children will have the opportunity to go beyond the boundaries of the school text books to find solution to these problems.

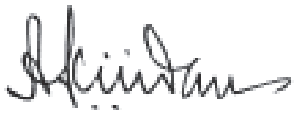
ASTEC is intimately involved with NCSC since its inception in 1993. It is the State Coorinating Agency of NCSC in Assam. The Third National Event was hosted by ASTEC at Guwahati in 1995, which in fact, started the tradition of holding the national event in all parts of the country outside Delhi. ASTEC felt privileged to have organised the Brainstorming Workshop for finalising the Activity Guide Book in Guwahati during February 16-19, 2018. This naturally offered us the opportunity to also print the Activity Guide Book. For reposing such faith on us, the NCSTC (DST) deserves our special thanks.

We thank Dr. Chandermohan, Scientist 'G' & Head, NCSTC for giving us the opportunity to execute these works.

Our special thanks to Er. Sujit Banerjee, National Programme Coordinator, NCSC & Scientist 'F', NCSTC for his confidence on us and constant support.

We would also like to thank each Member of theNational Academic Committee for their constant feedback and guidance.

We hope that the Activity Guide would be able to fulfil its cherished goals of providing all intellectual support to our children and guide teachers, resource persons and research scholars in not only internalising the key issues of Science, Technology and Innovation; but also act as a great Reference Book to introspect further into the unknown terrains of Science Technology and Innovation.



Date: 5 March 2018
Place: Guwahati

(Dr. Arup Kumar Misra)
Director,
Assam Science Technology
and Environment Council

ACKNOWLEDGEMENT

On behalf of the National Academic Committee (NAC) which met in Ahmedabad during June 2017 and subsequently the Working Group for design and development of the Programme Guidelines for the Children's Science Congress which met in Guwahati during February 2018, I am thankful to NCSTC, DST, Govt. of India for agreeing to the idea of bringing out the Activity Guide Book for NCSC 2018 & 2019, as a separate booklet which will be useful for all the stakeholders of NCSC.

I am extremely thankful to Dr.Chandermohan, Head, NCSTC, DST, Govt of India for his trust and confidence on the NAC for the design and development of this publication. He has been a guiding light to the NCSC programme all through the years and for also making NCSC a truly national, historic and massive programme.

I express my sincere thanks and regards to Er.Sujit Banerjee, National Programme Coordinator, CSC, NCSTC, DST, Govt of India for his great support and guidance in completing this task. He has been more of a friend to us than a team leader and we place on record his contribution to the NCSC programme.

I also take the privilege to express my deep gratitude and thanks for the wonderful support provided by GUJCOST by its Member Secretary Dr.NatrottamSahoo and his team during the National Brainstorming Workshop held at Ahmedabad during June 2017.

My sincere gratitude to the Director, Dr. Arup Misra, Head-In-Charge of Environment Division, Dr. JaideepBaruah and all the other members of ASTEC, Govt. of Assam for their whole-hearted dedication and involvement for making it a success. I strongly believe that without their help it would not become possible to get the work done at such short notice.

Last but not the least, I express my sincere thanks and regards to the esteemed members of the National Academic Committee, Members of the Sub Committee which finalized the Activity Guide Book as well as the invitees including the design team whose untiring sleepless nights and contributions have resulted in the completion of this booklet.

Date: 5 March 2018
Place: Puducherry

(Raghunath.T.P)
Chairman,
National Academic Committee, NCSC

NATIONAL CHILDREN'S SCIENCE CONGRESS (NCSC)

National Children's Science Congress (also referred to as Children's Science Congress at the district and state levels), is a platform for children to carry out small research activities at micro-level. The seeds of this programme were planted in Madhya Pradesh by an NGO called Gwalior Science Centre. It was later adopted by the National Council for Science and Technology Communication (NCSTC), Department of Science & Technology (DST), Government of India for extending it to the national level. Initially the programme was coordinated by the then NCSTC-Network (a network of non-government and government organizations used to work in the field of science popularization) as national organizer. Since 2014, NCSTC, DST has been organising the Children's Science Congress with the guidance and support of the National Academic Committee, a core group of experienced academic team constituted by the NCSTC, DST, Government of India.

It was a time when most of the country's science communicators were involved in massive science popularisation movements like *Bharat Jana Vigyan Jatha*(1987) and *Bharat Jana Gyan Vigyan Jatha*(1992). It was then felt that the large scale activities for developing science awareness among the masses were to be continued as a regular activity and hence the Children's Science Congress was conceived and launched as a nationwide programme in 1993. The expectation was that it would enhance scientific temperament, arouse scientific curiosity and improve understanding of the method of science among children vis-á-vis teachers with the aim that in the long run it would benefit the society at large. So the programme of CSC has been successfully conducted since then.

For the first time in 25 years of NCSC, we are bringing out an exclusive booklet on the Programme Guidelines and a separate Activity Good Book. This Activity Guide Book will deal with the specific Focal Theme for the years 2018 & 2019 which is "Science, Technology & Innovation for a Clean, Green and Healthy Nation".

The Sub Committee of the NAC with the approval of the National Programme Coordinator has also conceptualized and finalized a Logo for the Focal Theme which can be used by all the stakeholders during these years. A logo also takes the NCSC to the next level and over the years this has become a flagship programme of the Government of India. The unique logo gives special focus to the focal theme.

National Academic Committee

- Er. Sujit Banerjee, National Programme Coordinator
- Mr. TP Raghunath, Chairman
- Dr. Pulin B Chakraborty, Member
- Mr. Jayanta Kumar Sarma, Member
- Dr. Lalit Sharma, Member
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- Dr. Apurva Barve, Member
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Contents

NCSC 2018 & 2019

FOCAL THEME

SCIENCE, TECHNOLOGY AND INNOVATION FOR
A CLEAN, GREEN AND HEALTHY NATION

Science, Technology and Innovation for A Clean, Green and Healthy Nation

Clean, green and healthy are some common words of discussions in the context of planning and development since days of the evolution of the concept of welfare economics. It was started with measuring utility in terms of monetary value of social welfare, where life expectancy, per capita income, literacy, employment rate, etc. are considered as indicators, instead of only Gross Domestic Product (GDP) to measure growth . The progression of idea led to the concept of Human Development Index (HDI), with broad consideration of long and healthy life, knowledge and standard of living, taking into account Gender Development Index (GDI) considering variation of situation in the context of man and woman.

However, all these approaches are more or less anthropocentric in nature where status of ecosystems was not in prime consideration in assessing human progression. Brundtland Commission's Report on sustainability brings new light to the concept of sustainable development by interlinking ecology, economy and society and providing the core functionality of Sustainable development .

Here, ecosystem or ecological sustainability deals with eco-system integrity, carrying capacity, protecting and managing biodiversity. Economic sustainability focuses on growth, development, productivity and benefits at grassroots; whereas, social sustainability focuses

on equity, empowerment, accessibility, participation, sharing, cultural identity and institutional stability. In the contemporary period after reviewing through the challenges of development, Millennium Development Goals (MDG) were conceptualized in 2000. The MDG focussed on eradicating poverty and hunger, attaining universal primary education, gender equality and empowerment, reduce child mortality, improve maternal health, and ensure environmental sustainability through its respective goals.

Later on, after reviewing the progress of MDG in July 2014, the UN General Assembly's Open Working Group (OWG) proposed a new set of agenda with 17 goals to be put forward for the General Assembly's approval in September 2015. That document set the ground for Sustainable Development Goals (SDGs) and the global development agenda spanning from 2015-2030. In SDG, cleanliness, environmentally sound sanitation and health focused with emphasis including No poverty, Zero hunger, Good health and Wellbeing, Clean water and Sanitation, Responsible consumption and production, Climate action, Life below water, Life on land through its goals -1,2,6, 12,13, 14 and 15 along with other focuses. It is noteworthy that in the spirit of SDG, India also launched its own mission of Clean India (*Swachh Bharat Abhiyan*) in 2014. In this perspective leveraging through application of science, appropriate technological facilitation and capacity building are the means for implementation of goals of SDG and other national missions.

Therefore the focal theme for National Children's Science Congress – 2018 and 2019 has been decided as ***"Science, Technology and Innovation (STI) for a Clean, Green and Healthy Nation"***. The focal theme has been designed considering the following operational definition and desired dimension

In fact, natural resources in general, and water in particular, along with sanitation and health are integral parts of ecosystem, economy and society. Sustainability of an ecosystem, economy and society depends on sustainable natural resource management, water and sanitation related practices and their management; which regulate the status of health and environmental security. Ecological base of a region with its abiotic and biotic attributes determine the state of availability of natural resources and ecological services. Overuse of natural resources and associated practices are responsible for degradation of ecological security. When the amount of exploitation of natural resources exceeds its carrying capacity, it gives rise to ecosystem disturbances with implications on ecosystem's health. On the other hand, practices of sanitation are a major responsible factor not only for degradation of water quality but also for degradation of environmental services from an ecosystem.

"Sanitation generally refers to the provision of facilities and services for the safe disposal of human and domestic wastes. The word 'sanitation' also refers to the maintenance of hygienic conditions through services such as garbage and wastewater management."[11] Hence, hygiene is linked to sanitation, which refers to conditions and practices that help to maintain sound health and prevent the spread of diseases. Hygiene includes all circumstances and practices, lifestyle issues, premises and commodities that endanger a safe and healthy environment.

Hygiene in home and everyday life settings plays an important role in preventing spread of infectious diseases. It includes procedures used in a variety of domestic situations including hand hygiene, respiratory, food and water and general home hygiene (hygiene of environmental sites and surfaces), care of domestic animals, and home healthcare (the care of those who are at greater risk of infection etc.

Scientific understanding, analysis and interpretation on such issues help in developing appropriate technologies for harnessing water, its wise usage and management as well as treatment and storage for drinking water, along with managing sanitation according to the

Table-1. Operational definition of key words mentioned in the focal theme

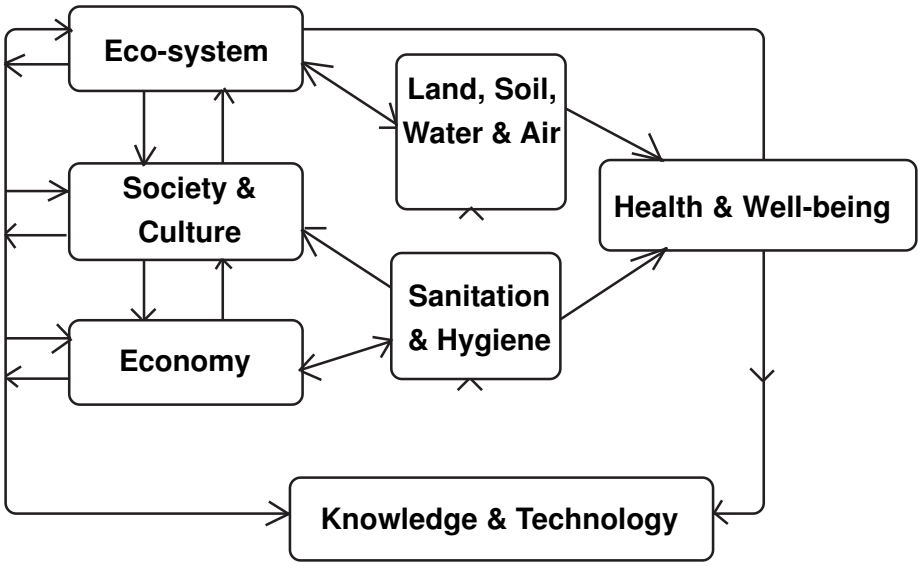
Key aspects	Broad view points	Desired dimension of outcome
Science	System of acquiring knowledge, following steps of observation, measurement, classification, comparison, analysis, interpretation, summarization, conclusion.	Leads to – From 'known to unknown or General to specific'.
Technology	The branch of knowledge that deals with the creation and use of technical means and their interrelation with life, society, and the environment.	Application of knowledge and understanding for practical ends.A solution (in certain cases increase of efficiency) derived through application of knowledge by certain processes and devices. Where process stands for principle followed and device can be means to address the problem.
Innovation	New idea, process, device or method.	It may be a new process/ approach/ means/ device/ product which helps in managing, maintaining and facilitating green, clean and healthy society for subsequent sustainable nation building
Green	A concept leading to environmental or eco-system sustainability (considering both the physical and human environment).	An approach/process/means to attain environmental sustainability For maintaining the carrying capacity of an ecosystem which comprises both manmade and natural elements
Clean	State of hygienic condition with absence of contamination, dirt, infection, adulteration (as per the standard derived by national norms, rule, law, act etc.)	An approach/process/means to attain the clean state linking sustainability of physical and human environment.
Healthy	It is the state of normal balanced situation in case of physical environment and a sound state of physical and mental condition.	An approach/process/means to attain ecosystem wellbeing.
Nation	A Nation is a country with its well defined physical, environmental, social and political structure and state. It also stands for people of the country. In this context how our issues of study or solution help in progress of the nation towards sustainable development.	An approach/process/means to attain national growth and development with the principle of "think globally and act locally".

principles of Reduce, Re-use and Recycle (3Rs). Pondering on such areas with overt local and regional issues may lead to innovative thinking and new solutions. At the same time, there is a need for societal and community mobilization to develop ideal scientific practices of hygiene management at individual, family and community levels. In the inter-connected world, issues of natural resource management, maintenance of balanced ecosystem sanitation and human health security is a global, national, as well as regional and local issue.

Frame work

While considering the overall health of nation, one cannot ignore the role of society and culture and its interconnectedness to livelihoods, lifestyles and above all sustainable progress. Clean and Green technologies and practices which, by definition, have positive impact on the ecology, economy and social health of a nation and plays a very important role to foster sustainability in the society.

One should also find out how indigenous knowledge based systems and practices were evolved from local experience, economic practices and resource management approach which have added values to overall health of the society. Evaluation, validation, re-approaches



of such systems are the key to tackle impending dangers of resource destruction, climate change risks etc. apart from the commonly visible negative impacts due to irrational uses of non-renewable energy sources, technologies which have negative impacts on the ecosystems.

With these perspectives the following sub-themes have been proposed under the focal theme of National Children's Science Congress to promote the spirit of inquiry based science learning by the children in the year 2018 and 2019 based on their curricular, observational and experiential learning in their immediate neighbourhoods.

For convenience of the children, the focal theme has been narrowed down to the following five sub-themes-

I. Ecosystem and Ecosystem Services.
II. Health, Hygiene and Sanitation.
III. Waste to Wealth
IV. Society, Culture and Livelihoods
V. Traditional Knowledge Systems.

Meeting point for inclusiveness:

It is very essential to guide the Person with Disabilities (PWD) for NCSC project work with respect to their potentialities. In relation to the present focal theme and sub-themes, it is expected that one can think on the specific issues related to access to Natural Resources Manegment(NRM), Health, Energy, Food, Nutrition, Hygiene (specially for people with orthopedic impairments having no mobility crawling on streets etc), equity, quality, impact due to lack of NRM to PWDs, study related to problems of PWDs in certain hostile eco-systems, problems related to Disasters with special focus on PWDs as they are the most affected ones, problems of livelihoods (and lifestyles also) for PWDs etc. One can also think of accessibility audit of public buildings, validating inclusive, innovative teaching methodologies, studies related to validation and field testing of accessibility gadgets and improving them with users' feedback, and many more.

End note

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7. http://www.sdgfund.org/mdgs-sdgs;
8. http://www.undp.org/content/undp/en/home/sustainable-development-goals.html
9. http://www.pmindia.gov.in/en/government_tr_rec/swachh-bharat-abhiyan-2/
10. It is the benefits obtained from ecosystems. These include provisioning services, such as food and water; regulating services, such as regulation of floods, draught, land degradation and disease; supporting services such as soil formation and nutrient cycling and cultural services such as recreational, spiritual, religious and other non-material benefits.
11. http://www.who.int/topics/sanitation/en/; retrieved on 27.04.17
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13. UNSECO Discussion paper on " Water in the post-2015 development agenda and sustainable development goals" UNESCO International Hydrological Programme Paris, France 2014

Sub-Theme I

Ecosystem and Ecosystem Services

Ecosystem and Ecosystem Services

1.1. Background

An **Ecosystem** is a community of plants and animals interacting with each other in a given area, and also with their abiotic (non-living) environments. The abiotic environments include weather, climate, sun light, soil and water. The ecosystem relates to the way that all these different organisms live and interact in close proximity to each other. Usually ecosystem components are divided into Abiotic and Biotic; basically it is functional relationship within and between these components which ultimately helps the organisms to survive.

Ecological services are the benefits arising out of from the ecological functions of the ecosystems. Such services benefit all living organisms in the niche, including animals, plants, and human beings. Millions of organisms on the Earth gain energy to support their metabolism either directly from the sun in the case of plants, or in the case of animals and microbes from other organisms through feeding on plants, predation, parasitism, or decomposition. In the pursuit of life and through their capacity to reproduce, organisms use energy; plants obtain most of their nutrients from soil or water, while animals tend to derive their nutrients from other organisms. Microorganisms are highly versatile obtaining nutrients from soil, water, food, or other organisms.

The concept of **ecosystem services** was given increased public recognition through the Millennium Ecosystem Assessment (MEA)[1] launched in 2001 by the UN Secretary General and completed in 2005. A conceptual framework was developed to highlight the real impacts of the ecosystem services on human health, security, social relations and physical wellbeing to explain the integrated aspects organized into four categories (Fig. – 1.1).

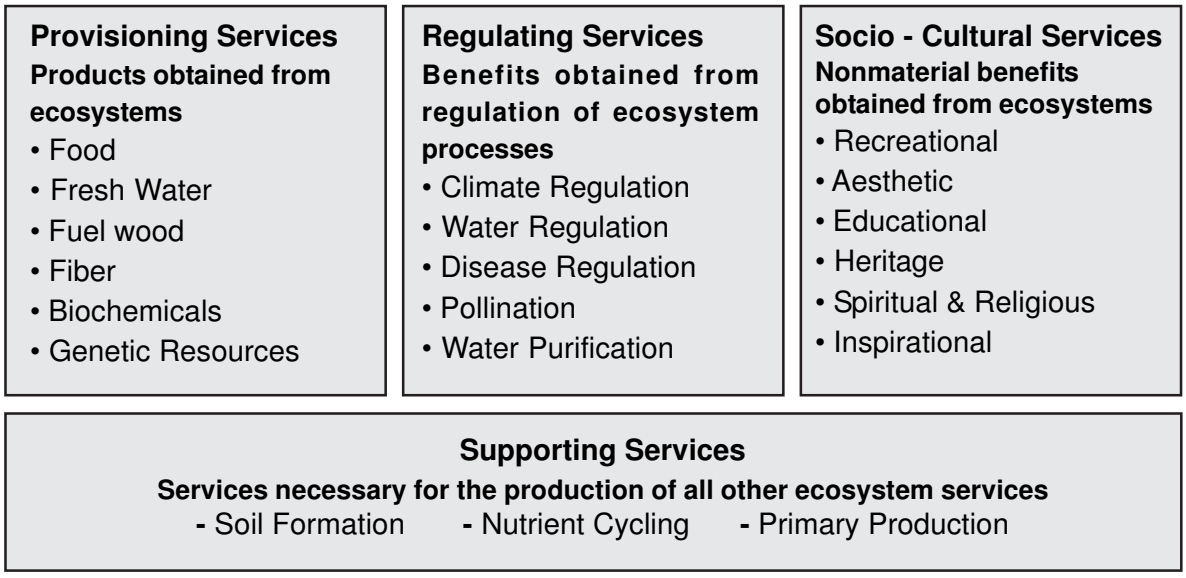
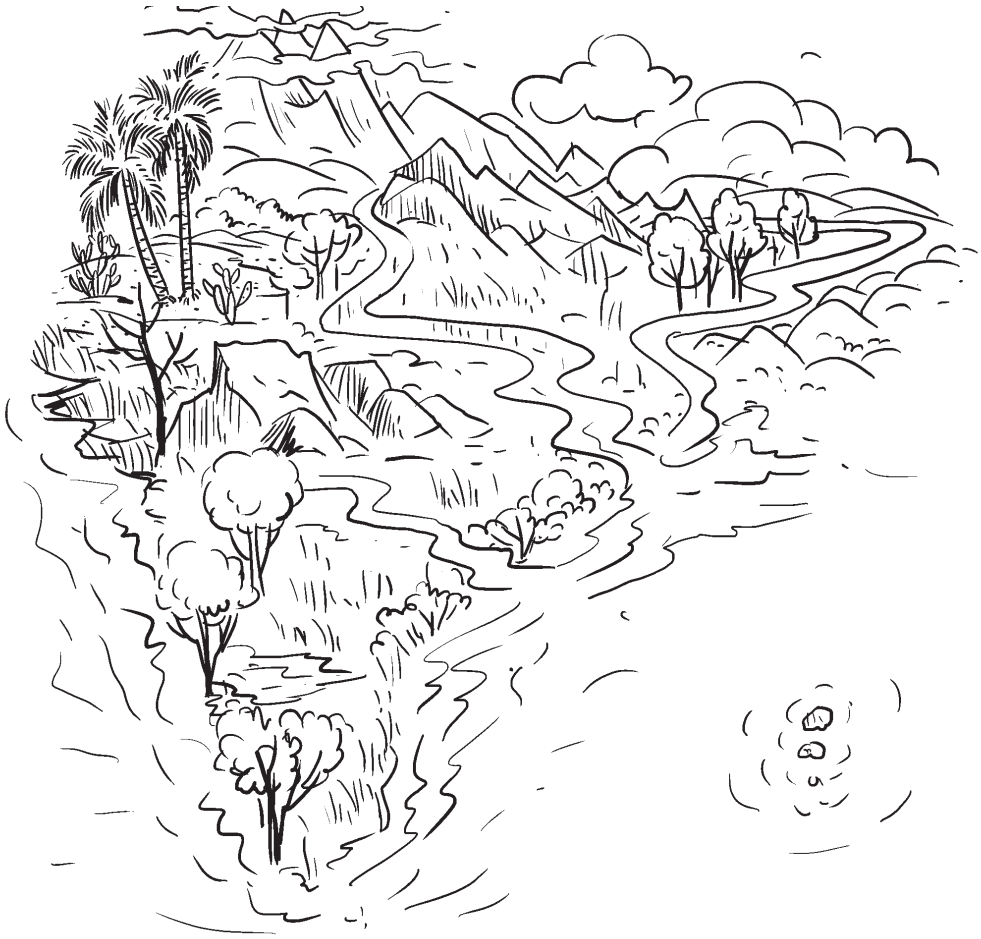


Fig.-1.1: Classification of ecosystem services developed by the Millennium Ecosystem Assessment. *Source: MEA (2005)*

In a sense, the entire biosphere of Earth is an ecosystem since every element interacts with each other. But considering the spatial delimitation of an ecosystem based on several factors like distribution of organisms, the biophysical environment and spatial interactions, broadly 10 categories of eco-systems have been identified by the international community

Box -1.1.

Globally recognized broader natural systems -	
1. Marine	2. Coastal
3. Inland Water	4. Forest
5. Dryland	6. Island
7. Mountain	8. Polar
9. Cultivated	10. Urban



1.2. Indian Scenario

India has distinct physiographical zones, viz. northern mountain, southern plateau, Indo-Gangetic plain, Desert and Coastal area; along with broad tropical, temperate, humid subtropical, desert and mountain regions, besides 15 different agro-climatic zones which are linked to 10 different bio-geographical regions. These geo-ecological backdrops have

given rise to different ecological zones, where ecosystem status and functions vary with variation of flora and fauna and associated key stone or flagship species.

Ecological Zones in India

India is one of the mega-diversity countries in the world by virtue of its diverse ecosystems and bio-geographical features. Scientists have recognized the following geographical features namely the Himalayan mountains, northern plateau, peninsular plateau, deserts, coastal plains, islands, tropical wet evergreen forests, deciduous forests, scrub jungles, montane forests, alpine forests and meadows, wetlands and back waters. Based on the biogeographic characteristics, the following zones have been recognized. However, the Indian sub-continent has been divided into 15 Agro-ecological Zones, shown through the figure- 1.2.

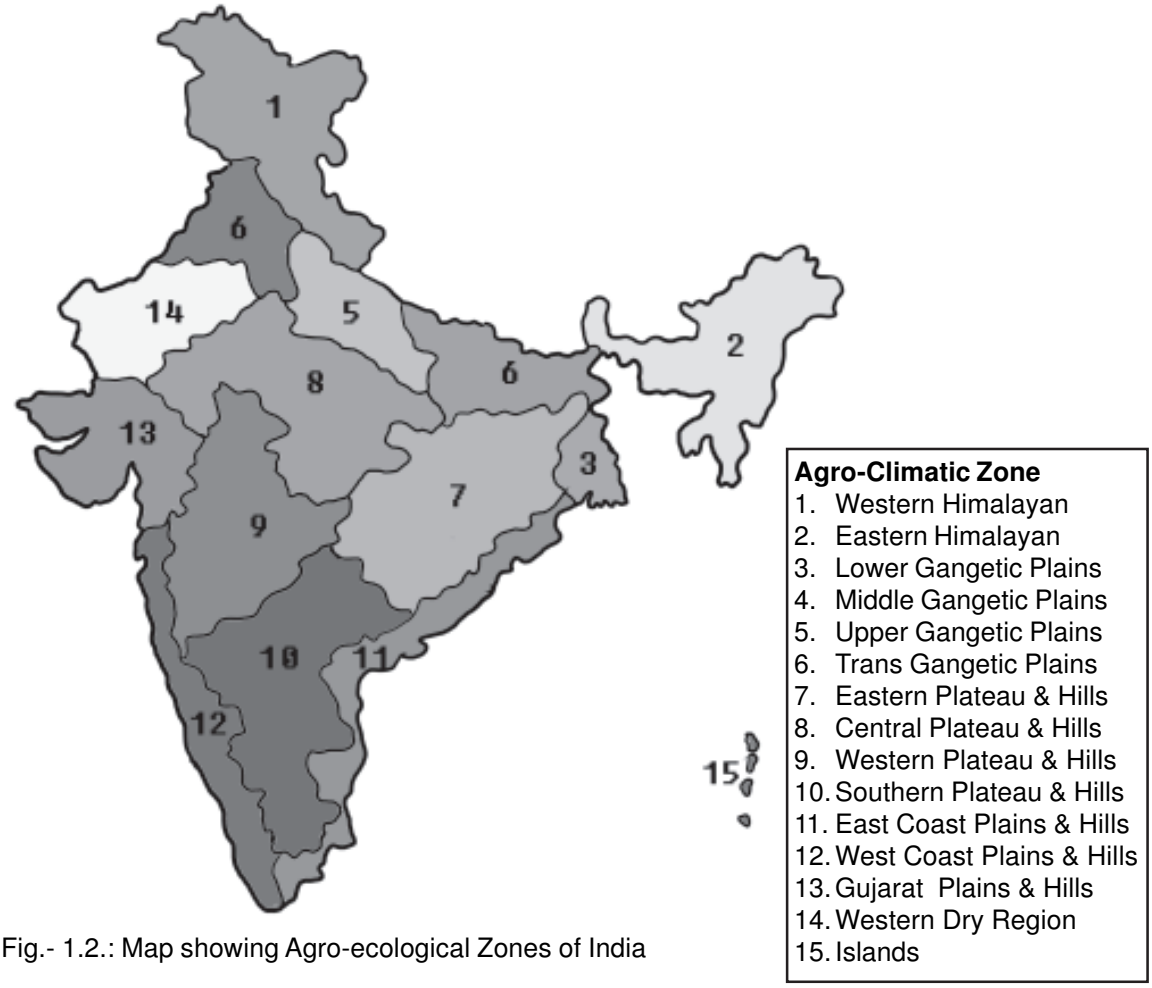


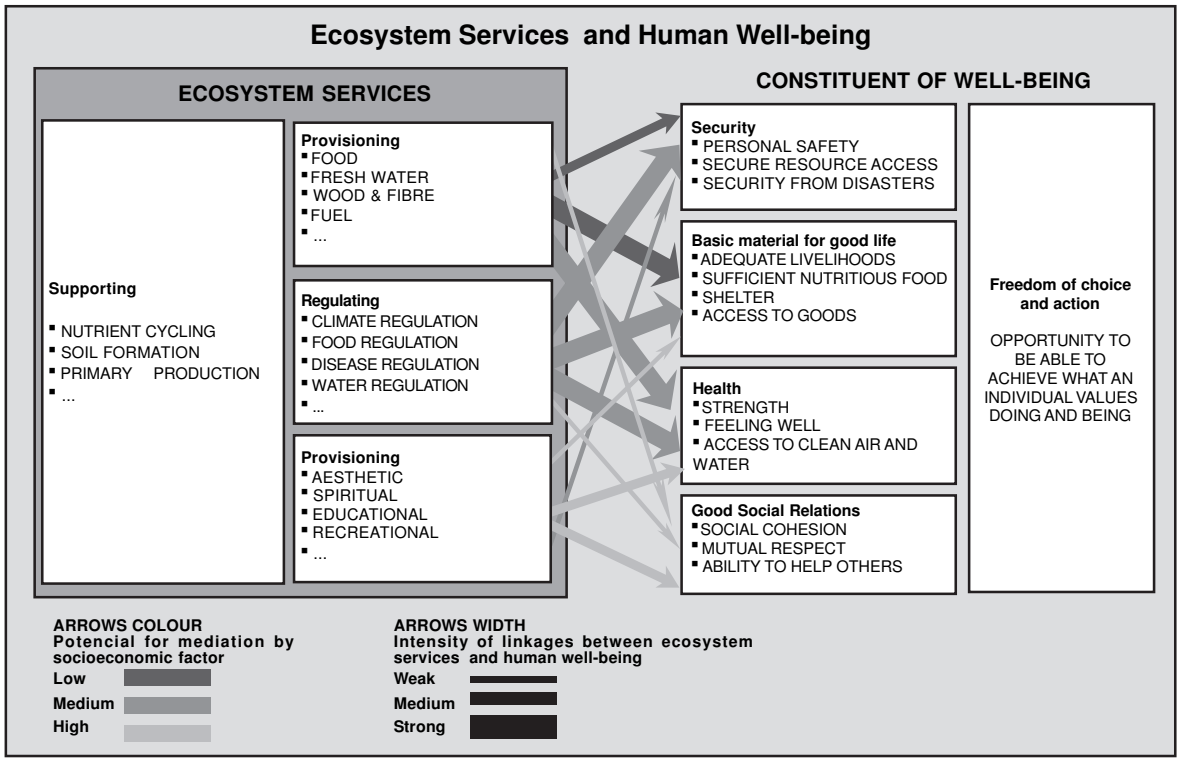
Fig.- 1.2.: Map showing Agro-ecological Zones of India

Each of these zones has its own characteristics. The Trans Himalayan zone situated immediately north to the Himalayan range is with sparse vegetation but the prime habitat to many endangered mountain ungulates of the world. The Himalayan region is known for its steep gradient and rich temperate flora. Semiarid zones adjoining neighbourhood of the northern deserts is characterized by discontinuous vegetation cover with open areas of bare soil having soil-water deficit throughout the year. The Western Ghats are very significant Biodiversity Hotspots in the world. The varied climate and diverse topography in different altitudinal zones and aspects create a wide array of habitats that support unique sets of

plant and animal species. The Western Ghats are well known for many endemic fishes, amphibians, and mammals; many of which are listed in the Red List by International Union for Conservation of Nature (IUCN). The Lion Tailed Macaque, Nilgiri Tahr and birds like Nilgiri blue robin and Nilgiri laughing thrush are few such examples. The climate of North West is characterized by very hot and dry summer and cold winter where rainfall is less than 70 cm. So, the plants are mostly xerophytes. Deccan Plateau is the largest unit of the Peninsular Plateau of India, lying south of the Satpura range. Major rivers like Godavari and Krishna traverse the plateau. The highlands and valleys of the plateau are covered with different types of forests, which provide a large variety of forest products supporting livelihood of the people in the region. The Gangetic plain in the north extends up to the Himalayan foothills which covers about 72.4 million hectares area with rich alluvial sediments. The North East zone is one of the richest flora- fauna regions with many birds, butterflies, amphibians, bamboos, ferns and other plants. It belongs to Eastern Himalayan Biodiversity Hotspot .The islands in the Arabian sea (Lakshadeep) and in the Bay of Bengal (Andaman Nicobar Islands) due to its physio-geography, tectonics and has different characteristics of flora and fauna . The islands in the Lakshadeep are among the best coral areas in the nation and in Andaman Islands we have the best preserved lowland evergreen forests. India has a coastline of 7516.6 touching 13 States and Union Territories. The east coast it is lined by the Bay of Bengal. These coastal areas are also rich repository of biodiversity.

In all these ecological zones some unique ecosystems are present with specific composition of abiotic and biotic components. Such ecosystems through their functional interaction produce different ecological services having different linkages to environmental security and human well-being (Fig.-1.2).

Fig.-1.2. Functional interaction of different ecological services



Quantification of value of such services reveals some surprising facts which cannot be visualized through observation only. In 2015 Indian Institute of Forest Management (IIFM) with National Tiger Conservation Authority (NTCA) carried out a study to estimate the value of ecological services of Tiger Project Area of India. Some example are in the table-1.1 given below.

Table-1.1 Ecological services of Tiger Project Area of India

Value of different services	Corbett Tiger Reserve (In INR)	Kanha Tiger Reserve (In INR)	Kaziranga Tiger Reserve (In INR)
Flow benefits / hectares	1.14 lakhs	0.80 lakhs	0.95 lakhs
Gene pool protection/ year	10.65 billion	12.41 billion	3.49 billion
Provisioning of water to downstream area / year	1.61 million	558 million	NA
Employment to local communities / year	82 million	NA	NA
Recreation value / year		384 million	21 million
Sequestration of carbon/year	214 million	219 million	17 million

Source: IIFM, NTCA "Economic Valuation of Tiger Reserves in India : a value + approach" 2015, page-11

However, over the period of time, different issues emerged which challenge these ecosystems and their ecological services.

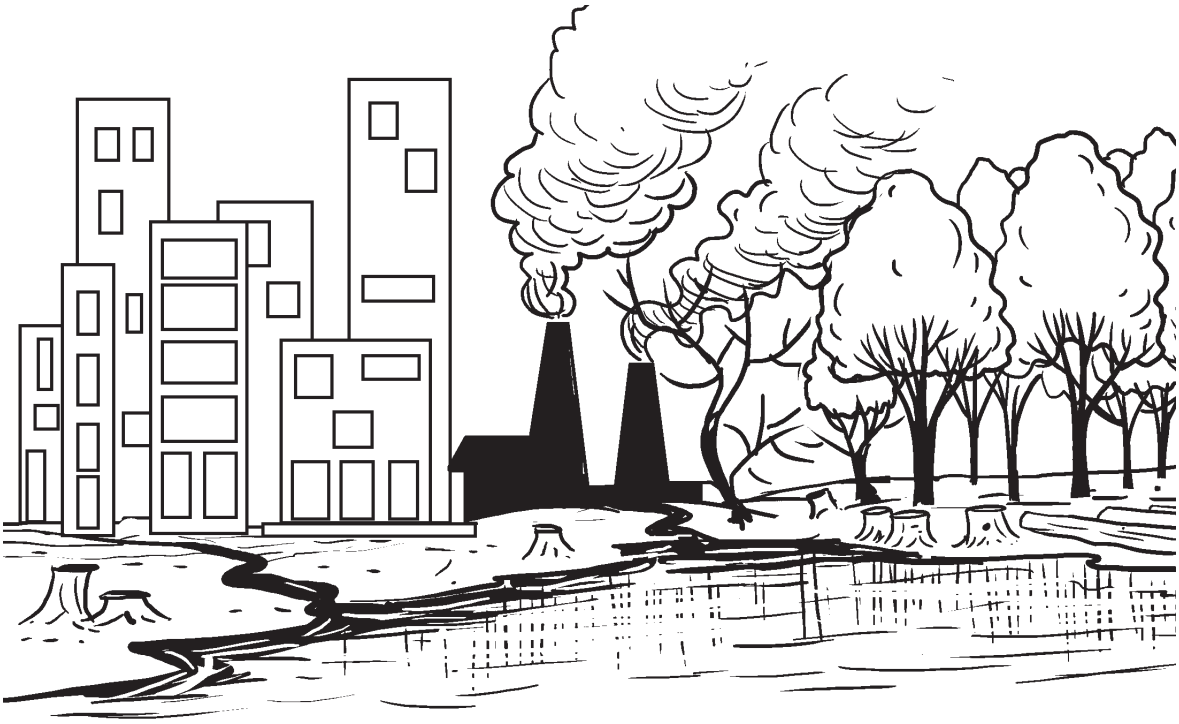
1.3. Challenges

Challenges to ecosystem and ecological services can be categorized as Natural and Anthropogenic challenges. Natural challenges are climate-induced viz. impact of weather and climatic anomalies, natural calamities and disasters, etc. Anthropogenic challenges emerged with growth of human population, in the form of agricultural, mining, industrial activities and expansion of human settlement including urbanization.

1.4. Impacts of Ecosystem Degradation

All living organisms in a habitat interact with each other and also with the non-living environment like weather, soil, water, atmosphere etc. In other words, an ecosystem is a dynamic complex of plant, animal and microorganism communities as well as nonliving environment interacting among each other resulting a functional unit. The entire earth system is an expression of the various ecosystems in totality. Humans are completely dependent on healthy environments for their health and well-being. The integrity of peoples' food systems, culture and survival is intimately connected to the overall health of the environment. Recent declines of environmental quality, loss of biodiversity and environmental contamination combined with social, economic, political and cultural factors threatening health and well-being of people.

The current knowledge on ecosystem services (the benefits arising from the functions of the ecosystems; such benefits accrue to all living organisms including humans.) enabled us



to understand and predict the impacts of the degradation happening in various ecosystems. The ecosystem services are derived from natural and managed ecosystems upon which welfare of human society depends, and include everything from clean air, water, food and fuel. Purification of air and water, maintenance of biodiversity, food and fodder availability, decomposition of waste, soil formation, nutrition cycling (or biogeochemical cycle), ground water recharge through wetlands and forests, seed dispersal, greenhouse gas mitigation, aesthetics, regulation of climate, control of natural disasters etc. all are the ecosystem services.

1.4.1. Anthropogenic Activities

Humans were living in tune with the rhythms of nature till the beginning of settled agriculture. They started selective breeding of crops, animal husbandry, taming the rivers and water bodies and started irrigation in the agriculture in the settled areas. Other activities that developed afterwards were expansion of settlements coupled with guarding territories, urbanization, technological advancements etc. that led to various short and long term impacts on ecosystems.

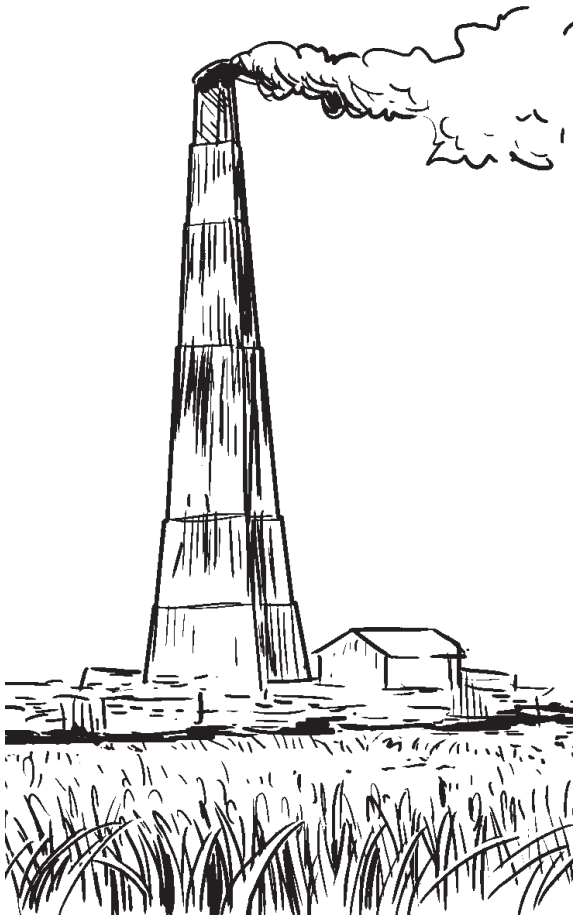
The modification of the ecosystems impacts ecosystem services which are being manifested in various ways. Nonetheless, following Industrial Revolution, development of transport systems, urbanization

and exploitation of fossil fuel increased greenhouse gases leading to global warming, climate change and it's subsequent consequences. Rate of deforestation that also added to the devastation affects to the wellbeing of human societies, is alarming. It is estimated that during 2000 and 2012, 2.30 million sq.km forests around the world were cut down. Deforestation causes biodiversity loss and extinction, changes in climate, soil erosion, desertification and displacement migration of indigenous communities. The hydrological cycle also gets affected by deforestation, reducing percolation of rainwater in to the soil leading to surface runoff, erosion of soil quality and reduce ground water recharge.

Global warming and changing rainfall patterns resulted in shifts and extinctions in species' range in every terrain, region and ecosystem not only in India but also across the globe. If it is indicative of a wider unfolding process related to climate change, a staggering number of species in India would move home range adversely affecting human habitat. It, therefore, makes explicit that conservation is not a question of people vs. nature, but rather involves trade-offs between different groups of people and/or their basic needs.

1.4.2. Land-use Changes

In the current scenario of rampant urbanization and other developmental activities, the land use planners are faced with decisions regarding whether and how land is to be developed, allotted, used, and many more. For most part, such land use decision making occurs without taking into account impacts to biological resources as a whole. Implementing biologically sensitive spatial planning early in the development process will help preserve our natural heritage for the future, since the most crucial time for planning is when first 10 to 40 percent of the natural vegetation is altered or removed from the landscape (Forman and Collinge, 1997). However, these professionals often lack the necessary information to incorporate ecological principles into their decision making and to transform their traditional planning approaches into progressive, ecologically-based conservation tools. To encourage and facilitate better integration of ecological knowledge into land use and land management decision making, the ecological information in terms of baseline and trends are essential.



1.4.3. Fragmentation of Natural Habitats

Land-use practices influence the geographical extent of habitats whereby contiguous natural areas are reduced in size and separated into discrete parcels. Fragmentation results from a reduction in the area of the original habitat due to land conversion for other uses such as residential and commercial development. Further when habitat is divided by roads, railroads, drainage ditches, dams, power lines, fences or other barriers prohibit the free movement and migration of plant and animal species to the considerable extent. When habitat is destroyed, a patchwork of habitat fragments is left behind, often resulting in patches that are isolated from one another in a modified and inhospitable landscape.

Such changes in the landscape have varying impacts on species' persistence and ecosystem's sustainability. Survival of plant and animal species in the natural systems is most essential to provide services in relation to recycling of nutrients, flood and pest control, and maintenance of clean air, water, and soil, that depends upon where and how land is used, converted, and managed.

1.4.4. Invasive Alien Species:

Land use change resulting from development and associated human activities (e.g., colonizing, agriculture, grazing, deforestation, hunting, industrialization etc.) alter the abundances and varieties of native species of many organisms, which are new and usually replaced by detrimental non-native species to the area. This in turn affects composition and abundance of native species. The long term persistence of the non-native species is called 'Alien species', further degrades the biodiversity as well as integrity of the affected natural areas.

When alien species starts proliferating and spreading beyond its definite limits, it is said to be invasive. The term 'invasive' is interpreted in different ways and sometimes used interchangeably with other terms like, 'pest' or 'weed' that can apply to native as well as alien species. The Convention on Biodiversity (CBD) provides the following definition: *Alien invasive species: an alien species which threatens ecosystems, habitat or species.*

Invasive species means an alien species which becomes established in natural or semi-natural ecosystems or habitats, act as an agent of change, and threaten native biological diversity (IUCN guidelines on biological invasion). As per the Global Invasive Species Programme (GISP) of the IUCN, invasive alien species are defined as *Invasive alien species are non-native organisms that cause, or have the potential to cause, harm to the environment, economies or human health.*

1.5. Degradation of the Wetlands

The Ramsar Convention on Wetlands defines wetlands as the areas of marsh, fen, peat land or water, whether natural or artificial, permanent or temporary, with water either static or flowing, fresh, brackish or salt. It also includes areas of marine water, the depth of which at low tide does not exceed six metres (Article 1.1 of the Ramsar Convention, 1971).

Wetlands are link between land and water and belong to the most productive ecosystems in the world. The ecosystem services by the wetlands are of extreme value. Wetlands provide habitat for a wide variety of flora and fauna besides, collection, filtration, cleaning and storing flood water act like kidneys for other ecosystems.

At the intersection of land and sea, mangrove forests support a wealth of life in their saline woodland habitats where fine sediments, often with high organic content, collect in areas protected from high-energy wave action. Mangrove swamps protect coastal areas from erosion, storm surge and tsunamis because of their massive root systems which are efficient at dissipating both wave and wind energy. Hence, the assessment of mangrove areas at country level is a prerequisite for its restoration, management and conservation. According to the Government of India report on status of mangroves, India lost 40% of its mangrove area during the last century. Of this, east coast has lost about 26%; west coast area about 44%; and Andaman and Nicobar Islands about 32%. Mangrove loss reduces biodiversity, eliminate fish nursery habitat, adversely affects adjacent coastal habitats and eliminate a major resource for human communities that traditionally rely on it for numerous products and services. Effective governance, better planning for eco-restoration of degraded mangroves and creation of awareness among local communities are the need of the hour to conserve, protect and restore the valuable mangrove wetland ecosystems.

1.6. Community Conserved Areas

There are large numbers of areas rich in biodiversity which are outside the domain of protected areas (sanctuaries and national parks etc.) and are protected and managed by the communities. These are called Community Conserved Areas (CCAs). CCAs are natural or modified ecosystems having immense biodiversity values and ecological services being conserved and protected by people through customary laws and practices. The CCAs includes sacred groves, panchayat and community forests, private interspersed forests in tea, coffee and cardamom gardens and other production landscapes, like farm lands, wastelands, wetlands, coastal habitats, heronries, wintering wetlands of birds, catchment forests, turtle nesting sites, pastures, desert ecosystems, river systems etc.

In India, sacred groves are one of the prominent community conserved groves distributed in almost all the states. Sacred groves are known by different names in different regions (Table-1.2).

Table- 1.2. Sacred Groves as Known in different states of India

State	Name of Sacred Groves
Assam	Than or Madaico
Bihar	Sarna
Chattisgarah	Devgudi or Sarana
Himachal Pradesh	Dev-Van
Jharkhand	Jaherthan or Sarana
Karnataka	Devarakaadu or Kans
Kerala	Kavu
Maharashtra	Devrai or Devgudi
Manipur	Umang Lai
Meghalaya	Law Kyntang or Law Niam
Orissa	Jahera or Thakuramma
Rajasthan	Orans
Tamil Nadu	Kovilkaadu
Uttarakhand	Bugyal or Dev Van
West Bengal	Garamthan or Jahiristhan

Many valuable medicinal plants and wild relatives of cultivated species are present in the sacred groves which have definite role to play. Presence of wild cultivars of crop plants having better pest resistance quality and productivity are mostly observed in the sacred groves. The role of sacred groves as resource forests offering both livelihood sustenance and ecological security is also of considerable importance. Some of the major ecosystem functions of sacred groves are as follows-

- Conservation of Biodiversity – The sacred groves are important repositories of floral and faunal diversity that have been conserved by local communities in a sustainable manner. They are often the last refuge of endemic species in the geographical region.
- Recharging of aquifers – The groves are often associated with ponds, streams or springs, which help meet the water requirements of the local people. The vegetative cover also helps in the recharging the aquifers.
- Soil conservation - The vegetation cover of the sacred groves improves the soil stability of the area and also prevents soil erosion.

The threats to sacred groves vary from one region to the other and even from one grove to the other. Common threats to sacred groves include pressure of increasing fodder and wood collection, rapid urbanization and developmental interventions such as roads, railways tracks, dams including commercial forestry. Encroachment has led to the shrinkage of some of the largest groves in the country. Invasion by non-native weeds like *Lantana camara* and *Prosopis juliflora* is a serious threat to some of the groves across the country.

Diminishing size and lack of proper recognition affect the ecosystem services from sacred groves especially regulatory and supporting ones. A smaller grove can support local biota, may provide goods like Non Timber Forest Product (NTFP), medicinal plants, fuel wood, etc. but long lasting services e.g. ground water recharge, flood control, fire resistance require larger level management efforts. There is hardly any study in this direction to assess the potential of the sacred grove for ecosystem services and their importance in livelihood maintenance. Moreover, their land category is not clearly defined in the revenue records, therefore demarcation of sacred groves on the ground as well as separate land-use category in the revenue records is also required.

The book 'Silent Spring' by Rachel Carson published in 1962 was a land mark in the environmental awareness movement. The book documented the hazardous effects of pesticides like DDT. She explained how the bird communities had vanished from the forest, plantations and agriculture fields of America because of indiscriminate use of DDT.
Exactly after ten years another important event marked a turning point in the human attitude towards the environment issues was the UN conference on Human environment, held in 1972 at Stockholm. This mandated a set of reports from the UN secretary-general suggesting that the conference focus on "stimulating and providing guidelines for action by national governments and international organizations" facing environmental issues. Environment protection initiatives and the legislations followed to strengthen the legal frame work showed the commitment of the nation to this end.

1.7. Objectives

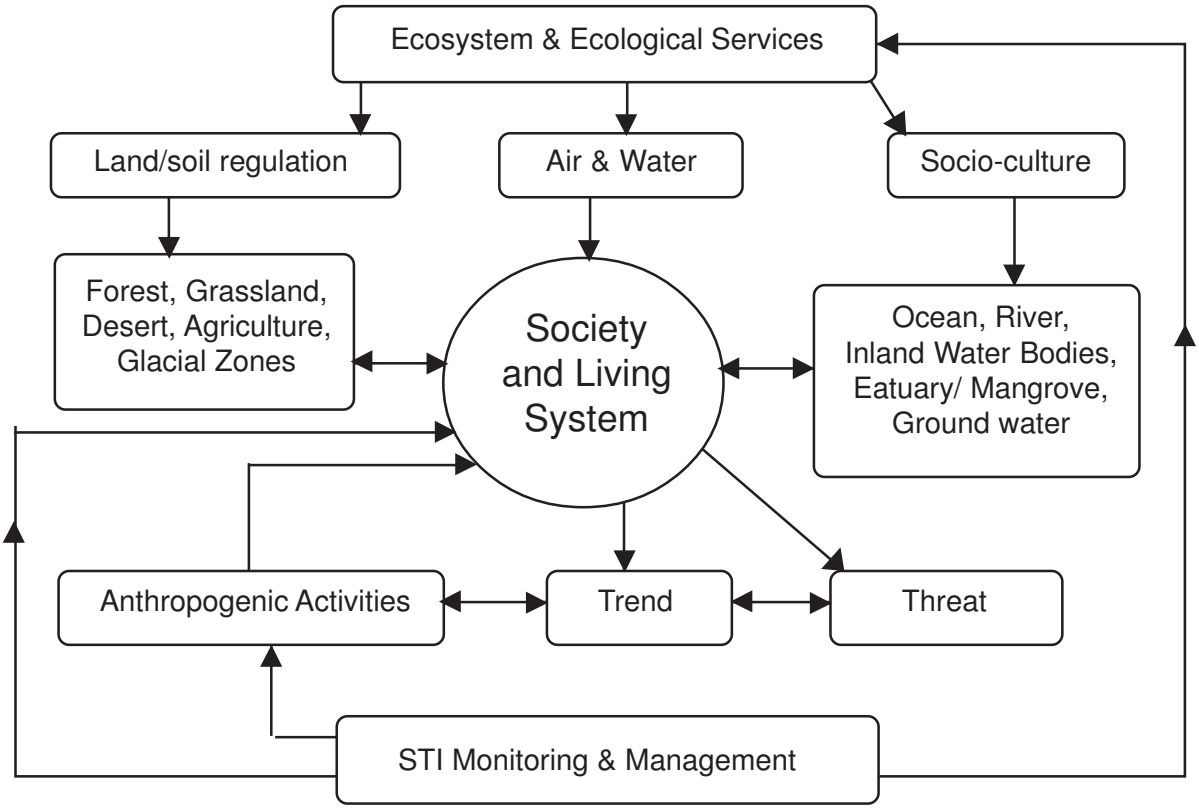
- To improve the understanding on environmental components in a broader context, i.e. Ecosystems and the ecological services provided by them.
- To develop sensitivity and ability to assess the status, quality and timeline changes in the dynamics of ecosystems.
- To develop attitude of monitoring and analyzing the impacts of anthropogenic activities on the natural systems and to question the undesired changes caused to surrounding environmental components.
- S & T based innovative / practical interventions to address and mitigate the problems
- To promote community participation in management and governance of natural resources for clean, green and healthy environment to avail better ecological services.

1.8. Scope of the sub-theme

The sub-theme will cover aspects related to the understanding of the ecology and ecological/ ecosystem services including ecological niche, their assessments as to current status vis-a-vis the historical changes that occurred to the system, the reasons thereof causing the current degradation, if any as well as of preserving and augmenting the existing systems. It will also include solutions related to compensate the loss and restoration of original conditions, piloting activities to test and validate the remedial measures and application of innovative scientific and technological methods to preserve the integrity of natural cycles of the ecosystems with community participation.

1.9. Logical Framework

Water, Air and Land (including Soil) are three major components of ecosystem.



The Whole Ecosystem, Not Just Its Parts

In most of the countries separate agencies are in charge of different aspects of ecosystems, viz. Agriculture, water, forests, fish, and wildlife etc. as well as different drivers of change viz. energy, transportation development, and trade. A key challenge is to develop more holistic strategies that incorporate all of these concerns including integrated watershed management, integrated management of river basins, or national sustainable development strategies. The ecosystem approach integrates management of land, air and water and living resources that promotes conservation and sustainable use in an equitable way. Thus the ecosystem approach is directly linked with a clean, green and healthy condition conducive to sustainable development. As organisms interact with each other and their physical environment, they produce, acquire, or decompose biomass and the carbon-based or organic compounds associated with it. They also move minerals from the water, sediment, and soil into and among organisms, and back again into the physical environment. Terrestrial plants also transport water from the soil into the atmosphere. In performing these functions, they provide materials to humans in the form of food, fiber, and building materials and they contribute to the regulation of soil, air, and water quality. These relationships sound simple in general outline, but they are, in fact, enormously complex, since each species has unique requirements for life and each species interacts with both the physical and the biological environment. To a large extent, anthropogenic activities have added greater complexity by changing the nature of those environments.

1.10. Project Ideas

Project – 1:

Ecological Significance of the Local Wetland and Impacts of Anthropogenic Activities on Its Ecosystem Services

Introduction

Wetlands are one of the most unique, productive ecosystems where terrestrial and aquatic habitats meet. They are nurseries for freshwater and marine fish and other aquatic species. Almost all of the world's water birds use wetlands as feeding and breeding grounds. Migratory water birds use wetlands throughout their range and their site fidelity for *en route* halt and feeding is quite unique. With greater species diversity nutrient recycling and niche specialization than most other ecosystems, wetlands are one of the most productive habitats in the world.

Wetlands have high ecological, historical, scientific, recreational and cultural values. They provide a wide range of ecosystem services. They regulate wa-ter availability through storage, groundwater recharge and discharge. They play an important role in erosion control, retention of sediments and nutrients. They also play a role in regulation of local climate and floods and protection from storms.

Wetlands have been under constant threat of environmental degradation due to natural as well as anthropogenic activities. Some of the major environmental threats to the wetlands and their biodiversity are encroachment, pollution, siltation, weed infestation, commercial fishery, earth mining, landscaping, commercial operations etc.

In most states, wetlands and inland water bodies are not recognized as a unique land use category and these are often clubbed with 'wastelands' meant to be used for alternate developmental purposes. Management of wetland ecosystems calls for continuous research inputs to address the drivers of change. However, much of the research is focused on structural elements (limnology, biodiversity) and very limited emphasis is given on their functional aspects such as ecosystem services and community livelihoods.

Considering this there is imperative need to identify and evaluate the ecological services provided by the wetlands and also examine the anthropogenic factors impeding the wetland services, so as to explore the appropriate measures for the protection and management of local wetlands.

Objectives

i. Understanding the significance of the local wetland in terms of the ecosystem services it provides; the ecological aspects of the wetland and its utility to flora, fauna and human beings.
ii. Preparation of inventory on the state of the health of wetland including anthropogenic activities and change in characteristics of the wetland (e.g. morphological characters / physico-chemical parameters and their temporal and spatial changes)
iii. Piloting with protection and management measures through innovative approaches of science and technology.

Hypothesis

The anthropogenic activities are the causes of adverse changes in the wetland ecosystem and have impact on the quality of the ecological services it provides.

Material Needed

Field guides to identify plants and animal species (no need for sampling), water sampling bottles, spade, ziplock polythene bags, binocular, camera, cadastral map and topographical sheet (if easily available), GPS instrument (or simply mobile GPS function can be used), compass, measuring tape, thin nylon rope, hand gloves, graph paper, designed data sheets etc.

Methodology

- First have a reconnaissance visit of the wetland and develop insight on why the prevailing conditions need to be documented and analysed and what kind of interventions can be made to prevent the adversities.
- Set the criteria to be examined and parameters to be analysed. Design the data collection tools for sample coding, criteria-wise documentation of observations, data recording of physico-chemical parameters, surveys etc.

*** See sample data sheets 1, 2 and 3 for physico-chemical parameters, morphological details of wetland and ecosystem services respectively.**

- Set the time frame for collection of water and soil samples (take care that the site, depth and distance from the shoreline, time of sampling remains same for all sampling frequencies)
- Collect water samples for physico-chemical analysis of parameters at set intervals (follow prescribed standard sampling methods for water and soil and do it under supervision of your guide teacher).

  (water parameters to be assessed - pH, Turbidity, Total Dissolved Solids, Dissolved Oxygen, Biochemical Oxygen Demand (BOD), Conductivity, Chlorides, Alkalinity, Hardness, Phosphate, Sulphate, Nitrate etc.)

  (Soil parameters to be assessed - Texture, pH, Conductivity, Nitrogen, Phosphorus, Potassium, Water Holding Capacity etc.)
- Collect data pertaining to various aspects, viz. (i) morphological characteristics of the water body; (ii) ecosystem services - water availability, water use by local community for domestic, agriculture, commercial purposes etc, old/large trees; bird breeding & nesting sites; sites and distribution of other animals like certain insects, rodents, reptiles, birds and mammals etc; aquatic plants, fishes, aquatic reptiles, molluscs, arthropods etc; habitat for important plant and animal species (including migratory species); life-cycle activities of ecotone species (e.g. amphibians); local food chain and food web; microclimate regulation (temperature, humidity etc); cultural, recreational and aesthetic aspects etc.
- Record the anthropogenic factors causing adverse changes (use photographic / mapping tools like cadastral map or a simple hand drawn map to mark the reference points (e.g. points of human activities; disturbances; Record human activities affecting the habitats, lifecycle and diurnal activities of animals & plants) in relation to time and space.
- How do specially-able people use the wetland for their purposes?

- Collect above information in separate data sheets at definite time intervals.
- With the help of GPS handheld instrument or the mobile GPS application, record the landmark location of the wetland and also the limits of the extreme ends of the wetland in east, west, north & south directions. Similarly record the geographical coordinates of water and soil sampling sites, locations of important plant and animal sites, location of human activity points (viz. bathing & washing sites, earth mining sites, wild animal visit sites, bird nesting sites, resting sites of important terrestrial and aquatic animal species, fishing sites, nearby open defecation sites, nearby sewage channel or sewage inlet sites, water body overflow/outlet points etc and depict them in one or combination of cadastral map, topographical map, hand-drawn resource map.

  The geographical coordinates can also be uploaded on google maps and snapshots can be taken to obtain representative location pictures of the recorded aspects. Google earth files can also be saved with the uploaded geographical coordinates of various factors that may help in live presentation of the situation in public and official meetings / awareness events etc.
- Consolidate the data and carryout analysis. Depict the data through graphs, figures and maps; ascertain the numerical values like average, maximum, minimum, standard deviation and correlation etc. Derive the qualitative and quantitative inferences based on the data analysis and hypothesis.
- Plan Innovative approach to address the identified problem and carryout piloting activities and collect the related resultant data in the same way like that of baseline/inventory as reference for comparison.
- Compare the data obtained before and after the intervention using criteria and indicators.

Follow up

The document so prepared be discussed with experts and get the data validated by them. The results would be utilized as baseline for the conservation plan of the wetland.

The study document to be shared with the village panchayat, state forest department, irrigation department and local administrative bodies etc, so as to help them develop better conservation plan for the wetland.

If the wetland is situated in the rural area then request the Panchayat to call Gram Sabha and take proposals for works (that would help in restoration of the pristine conditions of the wetland) under MGNREGA (see MGNREGA Operational Guidelines for details of work that can be taken for wetland conservation and development). If the wetland is situated within municipal limits of the urban area than approach the district administration with the validated study record so that the report could be taken for reference by the administration for the conservation planning of the wetland.

Work on one wetland can be replicated on other wetlands of the area with required modification according to their local conditions.

Solution Approach

A holistic approach towards wetland ecosystem and its related aspects will develop, that will help derive better analysis of the current status of the wetland and will also help addressing the problems related to it through converged activities by various line departments.
Wetland uses by persons with disabilities can also be identified and feasible usage facilities will be developed.

Expected Outcome

The study will help to develop an understanding about ‘wetland ecosystem’ as opposed to just a ‘water body’ or water logged area. Traditional knowledge linked to the system could be analysed, better perception will develop on wetland hydrology, physical, chemical, biological health of the ecosystem, identification of sub-eco-systems (e.g. nesting, hibernating sites etc), ecosystem services, adjacent ecosystems having energy flow with it, seasonality, users/stakeholders relationship etc.

Anthropogenic impacts on the local water body will be identified and their scientific / logical analysis will be done. Better solutions based on validated study data will be possible to approach.

Sample data sheet-1: Table format for recording the obtained value of physico-chemical parameters of water and soil samples

S. No.	Parameters	Sampling Frequency (for samples collected at set time interval, i.e. weeks or months)				Average	Standard Deviation
		I	II	III	IV		

Sample data sheet-2: Format for recording the morphometric details of the wetland -

S. No.	Attribute	Value
1.	Geographical Location	for example - N24º 34'41" E 73º 49'31"
2.	Physical extent of limits (coordinates or landmark on four sides)	Eastern - Western - Northern - Southern -
3.	Maximum Length at full level (meter/km)	
4.	Maximum Width at full level (meter/km)	
5.	Catchment Area (square meter / sq. km)	
6.	Estimated Storage (cubic meter/cu.km)	
7.	Highest Fill Level (feet/meter)	
8.	Average depth (feet / meter)	
9.	Maximum depth (feet / meter)	
10.	Altitude (meters from mean sea level)	
11.	Direction of inlet drainage(s) (from - towards)	
12.	Direction of overflow (downstream side)	
13.	Nature of wetland (e.g. masonry dam, concrete check dam, natural water body etc)	
14.	Dam Length (meter)	
15.	Other ..... - Ownership of the wetland (Govt dept. / local municipality / urban improvement trust / panchayat etc) - Geographical details of drainage (regional catchment / sub-basin as part of major river basin / drainage order / connectivity to another water body or drainage etc)	

Sample data sheet-3: Format for recording the ecosystem services provided by the wetland -

S. No.	Ecosystem Service	Quantitative or Qualitative Value	**Beneficiary community** (i.e. approximate number of people benefitted / area benefitted / species benefitted	**Period for which the service is available** (i.e. days / weeks / months / whole year)
A. Provisioning Services				
1.	**Food** i. Commercial Fishery ii. Other aquatic animal catch iii. Wild fruits iv. Aquatic plants/fruits v. Other			
2.	**Fresh Water** i. Storage ii. Supply for irrigation iii. Supply for drinking water iv. Consumption by domestic animals v. Supply to commercial purposes or industries			
3.	**Other resources** i. Fodder (terrestrial and aquatic origin) ii. timber iii. Fuel wood iv. Fiber v. Ornamental etc			
B. Regulating Services				
4.	**Local Climate** i. Temperature ii. Absolute and Relative Humidity iii. Rainfall etc			
5.	**Hydrological Regime** i. Groundwater recharge ii. Catchment Area etc			
6.	**Other** i. Flood control ii. Soil retention iii. Sediment storage etc			

C. Cultural Services				
7.	**Spiritual** i. Religious performances ii. Festive rituals etc			
8.	**Recreational** i. Visit by tourists ii. Community feasts iii. other recreational activities like boating, photography, light & sound show etc			
9.	**Aesthetic** i. Landscape ii. Regional geographic peculiarity iii. Natural features etc			
10.	**Educational** i. Opportunity for flora & fauna studies ii. Educational tours / field studies iii. Formal & informal trainings etc			
D. Supporting Services				
11.	**Biological Diversity** i. Number of plant species identified ii. No. of native plant species iii. No. of animal species iv. Migratory species v. Habitats for specific species vi. Non-native (alien) species	<u>both terrestrial and aquatic species</u> - Separate lists of plant habits viz. trees, shrubs, climbers, herbs, grasses etc) - Separate list of animal classes (viz. mammals, birds, reptiles, amphibians, fishes, insects & other invertebrates etc) - List of migratory birds and other animal species List of non-native (alien) plant & animal species		
12.	**Nutrient Cycling** i. Nature of nutrient and load (including sources like inflow and/or produced) ii. Storage of nutrients and processing iii. Bottom soil / accumulation of organic matter			
13.	**Other .....**			

Project – 2:

Sacred Groves (*Orans*) as Ecologically Important, Community Conserved Areas

Introduction

Sacred groves comprise of patches of forests or natural vegetation – from a few trees to forests of several acres – that are usually dedicated to local folk deities or tree spirits and are protected by local communities because of their religious beliefs and traditional rituals that run through several generations. The degree of sanctity of the sacred forests varies from one grove to another.

The ecological, biological, cultural and historical values of sacred groves are invaluable. According to the National Environment Policy of India, ancient sacred groves should be treated as possessing “Incomparable Values”. *Orans* serve as grazing grounds for livestock, supporting biodiversity and having the capacity to reduce impacts of the climate change. They help in protecting watersheds and water sources that harbour springs, aquifers and ground water storage, watering and resting place for the livestock. They act as repositories of rich genetic diversity while also conserving the endemic species, medicinal plants, wild cultivars and other species of conservation importance including internationally conferred threatened species. *Orans* show significant ethno-botanical, ethno-zoological and social codes of relation and regulation vis-à-vis nature.

Despite being recognized by the traditional communities and cultures for their valuable contribution to livelihood, groves are often subjected to negligence (especially the smaller ones) in terms of ecosystem services which require urgent attention from conservationists as well as decision makers. Changes in socio-economic scenario, increasing human intervention, inflow of visitors, soil excavation works and other developmental pressures

have resulted in deterioration of many sacred groves in the recent past. Considerable changes have taken place in the extent of the sacred groves, in their vegetation structure; invasion of exotic weeds is also a major threat.

Therefore, a holistic understanding of the current status, structure and function of sacred grove is essential for assessing their ecological role and formulating strategies for their conservation. There is a lack of characterization of sacred groves at the patch level or quantification of the rate of change in surrounding land-use/land-cover at the landscape scale in respect to space and time, which are crucial indicators of the current status of sacred forests, trends in the recent past and requirements for their future conservation. Therefore present work aims to assess the ecosystem service potential of sacred groves and their role in ecological characterization through application of geospatial tools and techniques.

Objectives

- Identification of Oran(s), mapping and preparation of baseline database
- Documentation of ecosystem services provided by the oran (including biodiversity, socio-economic and institutional arrangements) and identification of factors responsible for the changes within the landscape over the time and space.
- Preparation of baseline maps on separate as well as integrated aspects related to demarcation, land-use changes, impacts and changes in the Oran; demarcation of Oran as land-use category in the revenue cadastral map.
- Suggestive tools and techniques based on baseline and maps for effective conservation of Oran.

Hypothesis

Hypothesis-1: Identification and demarcation of Oran is an effective way for identifying its ecosystem services and threats to it.
Hypothesis-2: Geospatial approach is an effective tool in identifying the conservation priorities for the Oran.

Materials Needed

Cadastral map of the area, topographical sheet (at 1:50000 scale), GPS handheld instrument or mobile phone having GPS application, compass, measuring tape, graph paper, designed data sheets, field guides to identify plants and animal species, geographical and geological features etc.
GIS software / or help from a GIS expert to generate integrated maps.

Methodology

A. Collection of secondary information

- Collect the existing information in the form of published and unpublished literature, reports and other sources that is related to the selected sacred grove.
- Prepare the systematic record of the reported status of flora & fauna, geographical, geological and past climatic events, historical cultural practices etc. This will form a base to which further additions through fieldwork will be made.

B. Boundary Mapping (Perambulation)

Walk along the customary boundary of the oran and mark its extent and limits in the respective cadastral map so as to demarcate a clear boundary of the identified Oran for further reference. Identification of landmarks at the boundary limits and their marking in the map would help in real demarcation of the area on the ground.

The same exercise may be done more precisely with the GPS handheld instrument. Keep the track log of the GPS 'ON' while moving around the boundary limit till the complete circle is done; the recorded track log will be later transferred to GPS software (e.g. MapSource) for further digitization and overlaying on the cadastral or topographical maps.

Alternatively a local resource map showing the total area of the Oran, can be prepared in consultation with the local people. This map should be then carefully and neatly redrawn for including it in the document and depiction of other area aspects in it.

The boundary map further can be divided into grids (size of grid to be decided according to the total size of the area). The grid map is useful for recording distribution of species or various phenomenon or aspects that are likely to be plotted in the mapping of the location information.

C. Field survey / primary information

- Record the existing ecosystem services from the sacred grove - Provisioning services (e.g. Water availability and uses, drainage lines, soil types and fertility, medicinal plants, non-timber forest products (NTFP), fruits, fodder and fuel wood etc) Regulating services (e.g. Flood prevention, soil erosion control, runoff control, groundwater recharge, landslide reduction, fire resistance etc) Cultural and amenity services (e.g. Religious and cultural practices, research opportunities, educational activities, community governance and management, aesthetics etc) Supporting services (e.g. Biological diversity i.e. flora and fauna and microhabitats for characteristic plant and animal species, nutrient cycling, pollination and seed dispersal,regeneration etc)
- Record the existing threats / factors identified for unnatural changes (e.g. Fragmentation patches, invasive alien species, pollution, wood extraction, lopping, grazing, poaching, mining, fire incidences, land-use changes, encroachment etc)
- Collect the information on above aspects of the ecosystem using data tools and standard ecological sampling techniques like quadrate, plots, point count, area search, line, belt and vehicle transect, random survey etc.
- Record the status of natural resources and other focused aspects using abundance rating – qualitative assessment (e.g. low, moderate, high and very high).

* *See Sample data sheet-4, 5 and 6 for collecting basic information, location details of different ecosystem aspects and location details of threats and conservation priority respectively. The details of ecosystem services can be documented in the similar format given in sample data sheet-3 (modified according to the aspects to be documented).*

D. Mapping

The mapping shall cover two broader aspects distinctly -

1. Spatial information (i.e. point location or area in terms of time and space) based on secondary and primary information, viz. biodiversity, micro-habitats, landscape features, drainage, etc.
2. Non-spatial information (viz. factors of undesirable changes, threats and suggestive measures etc).

Application of GPS approach: For precise and accurate plotting of spatial information GPS is an effective application technique. The spatial information can be recorded using the GPS handheld instrument or through mobile GPS application in android or smart phones. The Global Positioning System (GPS) is used to mark point location, length of the line followed in walking, estimate land areas as well as making border by walking along the boundary of study areas. It is equally useful in collection of integrated location information in the study areas and its depiction in the digital maps.

Application of GIS approach: Geographical Information System is a computer application for designed to store and manipulate data, integrating and further analysis of other types of information (for example ArcGIS 10.2 software or open source QGIS software). In the present study GIS can be used as a complimentary technique to prepare thematic or integrated maps based on collected primary and secondary information. All map digitization shall be done based on GPS points recorded in the plots of the study areas, this will include demarcation of the central location of the Oran and its boundaries, superimpose all prepared data on toposheet or cadastral map and preparation of base maps.

All above information on ecosystem services, disturbances and threats and recommended measures etc shall be mapped to finally deriving critical areas/aspects within the sacred grove for conservation on priority.

Follow-up

The documented information and different maps of identified Oran can be used for identifying or predicting temporal changes that may occur positive or negative way, based upon the intervention done. The digital maps of can also be ported to Google Earth or any other satellite imagery to visualize the three dimensional image of the pre and post intervention conditions.

The geospatial approach just like applied on individual oran can also be applied on larger area having multiple Oran sites and their individual details can also be integrated to visualize on larger scale like regional or district or state level maps.

Solution Approach

The database generated for the above work could be of immense help in conservation & management of Oran with potential to derive the information on status of existing conditions, measures undertaken and mapping of different aspects in thematic or integrated way for better visualization.

Expected Outcome

Sacred groves are lifeline for the local community in many ways either resource supply, socio-cultural or livelihood support. Although their biodiversity and ecological functions have been documented largely but their linkages with ecosystem services and support to resources and livelihood has been less focused. This study tried to assess the ecosystem service potential of the groves with an aim to strengthen the ongoing conservation efforts taken by government, NGOs and local communities. The assessment would be helpful for prioritizing the aspects for conservation purpose based on their ecosystem services.

Sample data sheet-4: Format for recording the basic information of the sacred grove -

S. No.	Attribute	Information
1.	Name of the Site	
2.	Geographical Location (centre location)	
3.	Geographical Location (Physical extent of limits - coordinates or landmark on four sides East, West, North & South)	
4.	Village / Town / District / State:	
5.	Land-use category (Forest Block/Revenue Khasra etc)	
6.	Whether declared and recorded as Oran in revenue records (if yes than date of declaration and copy of revenue record)	
7.	Approximate area of the site (hectares/km^2):	
8.	Nearest Forest Block	
9.	Map and Photograph of the site (Either cadastral map or hand drawn map indicating location and extent in reference to other landmarks)	
10.	Diety and Worshipper Community (if community specific)	
11.	Ownership: Public / Govt.; Community / Individual	
12.	Values: Regional, Ecological, Cultural, Religious, Biological, Historical, Geo-heritage	
13.	Floral diversity: habit-wise number of plant species, Threatened and Endemic Species, Culturally protected species etc.	
14.	Faunal diversity: Class-wise number of species, Threatened and Endemic Sps, Culturally protected species etc.	
15.	Water availability: Sources (Stream, Well, Water Hole, Anicut, Handpump etc), Drainage, storage	
16.	Resource Use: Grazing, soil extraction, collection of fodder, fuel wood and timber, water use etc	
17.	Present status: Qualitative assessment rating (e.g. Fair/ Moderate/ Good/ Bad based on score from 1 to 10) Elaborate the opinion	
18.	Threats: Fragmentation patches, mining, encroachments, fire, pollution, change in land-use, tree cutting or lopping, invasive alien species etc	
19.	Priority (for better conservation & management): Priority points and their suggested intervention sites	
20.	Name of the key persons /agency to be useful in future activities	

Note: For points 11 to 18, mention the information here in brief and give details separately in appropriately designed data sheets.

Sample data sheet-5: Format for recording the location details of different ecosystem aspects of the sacred grove -

S. No.	Attribute	Location (Geographical Coordinates)	Occurrence / Availability#

Note: Use qualitative or quantitative scale to mention, Very Common / common / less common/ rare or Frequent / Seasonal / round the year.

Sample data sheet-6: Format for recording the location of threats and/or proposed intervention in the sacred grove (in one or separate sheets)

S. No.	Attribute	Location (Geographical Coordinates)	Priority##
Threats (viz.			
Proposed Interventions (viz.			

Note: Use numerical scale to show the priority level -

Low	Moderate	High	Very High
1	2	3	4

Project – 3:

Mangroves: Impacts due to Anthropogenic Effects, Biodiversity, Social, Ecological and Economic Aspects

Introduction

The mangrove ecosystems are the breeding ground for a wide variety of organisms like barnacles, oysters, crabs, shrimps and fishes which are pivotal in the food chains and food webs in the oceanic ecosystems at large. More than 35% of the world's mangroves are already gone. Mangrove forests have often been seen as unproductive and smelly, and so cleared to make room for agricultural land, human settlements and infrastructure (such as harbours), and industrial areas. More recently, clearing for tourist developments, shrimp aquaculture etc.

Mangrove ecosystem is very sensitive to destructive intervention. Any serious disturbance in the intertidal area affecting the mud banks and breathing roots may spell doom to the mangrove forest. Children in the coastal areas may pay a few visits with the teacher guide and elders to

understand the ecology and ecosystem services of the mangrove forests not far off from the school. During the visit identify areas which are intact and in healthy ecologic condition and areas with serious disturbance like cutting of trees, dumping of waste, reclaimed areas or destroyed for making housing plots etc. A comparative study can be done in the plant /animal communities in the intact areas and disturbed areas applying appropriate methods.

Objectives

- To understand the ecology and ecosystem services of the mangrove forests
- To understand the impact of anthropogenic activities to the fragile mangrove ecosystem and how the impacts impair the ecosystem services provided by this ecosystem
- Comparative account of the healthy v/s disturbed/ degraded mangrove areas

Hypothesis

- Mangrove ecosystem is one of the most fragile ecosystems in the world which will respond fast to disturbances leading to its degradation in quantity and quality.
- Conclusions can be drawn on the impacts of anthropogenic activities by quantifying the community structure of the Mangrove ecosystem of a locality.

Material Needed

Cadastral map of the area, data sheet, sampling net, note book, nylon string, long nails, wooden or metallic quadrate frame etc. are required.

Methodology

- **Quadrat Method -** Scientists usually calculate the plant population frequency using the quadrat method. A quadrat is a sample plot of a specific size used for the study of population or a community. Quadrats are used in many different scientific disciplines like vegetation assessment, including plant density, plant frequency and plant biomass. Frequency is highly influenced by the size and shape of the quadrats used. The area that is chosen for study

must not be so big that it cannot be sampled adequately, or so small that the habitat is difficult for sampling. For herbaceous vegetation a metre square quadrat is normally used.

- **Frequency -** Determining plant population frequency using quadrat method has become popular primarily because it is relatively simple and objective. Children can easily handle this method. Frequency indicates the number of times a plant species is present within a given number of sample quadrats. It is measured by noting the presence of a species in random sample areas which are distributed as widely as possible throughout the area of study. Once analyzed, the sample data enables the child scientist to calculate population frequency of the entire population by the following method:

% Frequency = (Number of sampling units in which the species occurs /
Total number of sampling units employed for the study) X 100

- For example suppose in the mangrove area studied, seven plots/quadrats are taken for study, the Mangrove tree *Rhizophora mucronata* is present one each in five plots, hence the percentage frequency of ***Rhizophora mucronata* = ($^{5}/_{7}$) X 100 = 71.42%**. Likewise for other species can also be analysed. The organisms like crabs, prawns, oysters, sponges, ishes, worms (not necessary to go to species level) etc. also can be studied by using the same method.
- The size of the quadrat may vary according to the size of the plant/organisms subjected to study. For the study of trees in a mangrove area, quadrat size of about 5m X 5m may be suitable. The boundaries of the quadrat can be marked by using a rope. For shrubs and seedlings quadrate size can be 1m x 1m which may be marked on two corners of the tree quadrats already demarcated. For organisms like fishes, crabs, worms etc. quadrats of 1m x 1m may be chosen. This can be in the same tree quadrat area, but readings should be taken in the initial stage itself without much disturbance to the plot. For organisms, wooden/metallic quadrat frames may be employed.
- The number of sample plots/quadrats is decided based on the total area available for conducting the study.
- Economic, social and livelihood aspects are to be studied by conducting survey with appropriate samples. Questionnaire is to be framed to elicit responses in tune with the objectives of the study.

Follow-up

The result of the study may be presented before the students and the teachers of the school and a collective effort may be made to make the administrators and public at large, aware of the ecosystem services provided by the sensitive ecosystem and how the human activity impacts affected the ecosystem and services provided by the mangroves. Further efforts may be initiated to restore the lost/degraded mangrove areas with the participation of the appropriate authorities and public**.**

Solution Approach

The comparative study may reveal the degree of disturbance and its impact on the community structure and also on ecosystem services. The impact on livelihood of the local communities and on society at large also can be shown in the result by analyzing the survey and plot study data. Stopping further degradation and initiating eco-restoration process in the degraded

areas are the only ways to conserve the mangroves and make sure that the ecosystem services provided by this fragile ecosystem are continued.

Expected Outcome

The child may be able to analyze which all species in the community are most sensitive to anthropogenic activities. The data on seedlings may reveal the impact of disturbance on the level of recruitment and the child may be capable of predicting the future of the mangrove ecosystem if the disturbance be continued at the given rate.

1.11. Additional Project Ideas

- Allergic problems due to pollen dispersal
- Alternative uses of weeds (e.g. water hyacinth, lantana, Mesquite)
- Application of GPS tool in studying distribution of particular plant or animal or group of species.
- Application of Geographical Information System - Remote Sensing (GIS-RS) techniques in studying ecosystem or species.
- Assessment of living and non-living components of an intermediate zone (Ecotone) and its associated conservation issues.
- Beach Erosion - causes, impacts and restoration
- Butterflies and host plants
- Carbon footprint studies
- Catchment treatment for water conservation
- Change in drainage pattern due to land use changes and impact on ecosystem characteristics
- Comparison of soil biota in organic farms and other kind of farms
- Coral Reef diversity and ecosystem services (livelihood)
- Crop diversity in relation to varied topography and its linkage to soil quality
- Crows -response to changes, including nest building
- Distribution pattern of flora & fauna in different landscapes and their significance
- Diversity of aquatic plants in local water body / bodies and their role in aquatic ecology
- Environmental Impact Assessment (EIA) of developmental activities in the locality
- Grazing and spread of plant species through dung/excreta
- Heronries / rookeries in your village/town and their significance
- Impacts of anthropogenic activities on coral reef ecosystem productivity including coral bleaching.
- Impact of invasive alien plants on ecosystem services of terrestrial native vegetation (groves / gardens / forest)
- Impact of sounds on animal behaviour (Zoo / domestic / stray animals)
- Indicator species and ecosystem health
- Inland wetlands and the Livelihood
- Insect-Pests and natural enemies - dynamics
- Invasive alien fishes and their impact on the aquatic ecosystem
- Invasive aquatic plants and their impacts
- Invasion of pine in non-glacial zones of the Himalayas
- Is house sparrow disappearing from our houses and markets? - a critical analysis.
- Mangroves and ecological services

- Monitoring Rare, Endangered & Threatened (RET) taxa and conservation measures (prioritizing species)
- Nectar plants in the gardens and visitation by birds and butterflies
- Optimal water requirement for different plant species
- Plastics / garbage and impact on mangroves
- Pollination dynamics / pollinating agents like insects, bats and birds
- River bank / sand stabilization by appropriate plant species
- Road networks and comparative ambient air temperature (with and without avenue trees)
- Role of natural reed beds in controlling pollutants leading to water body
- Seed Poisoning and Bird Mortality
- Shrinking Wetlands and Its impacts
- Selective planting of trees and its impact on local ecosystem / biota
- Status of road side trees in city areas and their significance in regulation of urban climate and ecology
- Status of water regime (i.e availability of water in different forms, viz. precipitation, surface and ground water, snow, soil moisture, humidity etc and its cyclic process) in village / city environment and ascertaining the anthropogenic and natural factors causing changes in it
- Study of biodiversity hotspots in urban environment
- Study on the natural seasonal changes in a garden or natural grove and impact of anthropogenic activities on that
- Study on Road Kills of animals and its ecological consequences
- Study on the competitive ability of alien invasive species and native species (e.g.Anogeissus pendula an excellent native competitor to invasive alien Prosopis juliflora;)
- Study on the invasive pathways of alien species in different landscapes
- Study on urban biodiversity
- Urban bird communities
- Vegetation as wind Breaks (comparative studies and applied aspects)

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Abbreviations used in this section

CBD	- Convention on Biological Diversity
CCA	- Community Conserved Areas
GIS	- Geographical Information System
GISP	- Global Invasive Species Program
GPS	- Global Positioning System
IUCN	- International union for Conservation of Nature and Natural Resources
MEA	- Millennium Ecosystem Assessment
MGNREGA	- Mahatma Gandhi National Rural Employment Guarantee Act

Sub-Theme-II

Health, Hygiene and Sanitation

Health, Hygiene and Sanitation

2.1. Background

Health is the level of functional and metabolic efficiency of a living organism. The World Health Organization (WHO-2006) defined human health in its broader sense as “a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity”. *(http://www.who.int/governance/eb/who_constitution_en.pdf)* Health, or health and well-being, are also includes a supportive environment, personal security, freedom of choice, social relationships, adequate employment and income, access to educational resources, and cultural identity (Diaz et al., 2006; Millennium Assessment 2005).

Over the last decade, health promotion practitioners have increasingly been asked to think about the relationships between humans and the environment in terms of ecosystems (Brown, 1994) and to adopt an ‘ecological’ approach to health promotion (Kickbusch, 1989) with the environment an integral part of human development (Hancock, 1993a).

Hygiene is a set of practices performed to preserve health. According to the World Health Organization (WHO), “Hygiene refers to conditions and practices that help to maintain health and prevent the spread of diseases. Hygiene is a concept related to cleanliness, health and medicine. It is as well related to personal and professional care practices. In medicine and everyday life settings, hygiene practices are employed as preventative measures to reduce the incidence and spreading of disease. Hygiene practices vary, and what is considered acceptable in one culture might not be acceptable in another. In the manufacturing of food, pharmaceutical, cosmetic and other products, good hygiene is a critical component of quality assurance.

The terms cleanliness and hygiene are often used interchangeably, which can cause confusion. In general, hygiene refers to practices that prevent spread of

disease-causing organisms. Cleaning processes (e.g., hand washing) remove infectious microbes as well as dirt and soil, and are thus often the means to achieve hygiene.

Sanitation generally refers to the provision of facilities and services for the safe disposal of human urine and feces. The word 'sanitation' also refers to the maintenance of hygienic conditions, through services such as garbage collection and wastewater disposal.(WHO).

Environmental sanitation envisages promotion of health of the community by providing clean environment and breaking the cycle of disease. It depends on various factors that include hygiene, status of the people, types of resources available, innovative and appropriate technologies according to the requirement of the community, socioeconomic development of the country, cultural factors related to environmental sanitation, political commitment, capacity building of the concerned sectors, social factors including behavioral pattern of the community, legislative measures adopted, and others. India is still lagging far behind many countries in the field of environmental sanitation.(Pandve, 2008).

Ecological sanitation, which is commonly abbreviated to ecosan, is an approach, rather than a technology or a device which is characterized by a desire to "close the loop" (mainly for the nutrients and organic matter) between sanitation and agriculture in a safe manner. Put in other words: "**Ecosan systems** safely recycle excreta resources (plant nutrients and organic matter) to crop production in such a way that the use of non-renewable resources is minimized". When properly designed and operated, ecosan systems provide a hygienically safe, economical, and closed-loop system to convert human excreta into nutrients to be returned to the soil, and water to be returned to the land. Ecosan is also called resource-oriented sanitation

Sustainable sanitation considers the entire "sanitation value chain", from the experience of the user, excreta and wastewater collection methods, transportation or conveyance of waste, treatment, and reuse or disposal. The term is widely used since about 2009. In 2007 the Sustainable Sanitation Alliance defined five sustainability criteria to compare the sustainability of sanitation systems. In order to be sustainable, a sanitation system has to be economically viable, socially acceptable, technically and institutionally appropriate, and it should also protect the environment and the natural resource

Sustainable Development – the core concept for the Post-2015 Development Agenda – provides *an integrated response* to the complex environmental, societal, economic and governance challenges that directly and disproportionately affect children. With appropriate focus, investment and innovation, the Post-2015 Development Agenda presents an unprecedented opportunity to create *a World Fit for All Children.*

The relationship between children and sustainable development is symbiotic. Progress in sustainable development underpins child rights and well-being, and conversely, child rights and well-being underpin lasting and equitable development progress. Finding the balance to achieve progress for all in today's world and for future generations depends upon three key propositions:

1. Sustainable development starts with safe, healthy and well-educated children;
2. Safe and sustainable societies are, in turn, essential for sensitive groups such as children, women and elderly; and
3. Children's voices, choices and participation are critical for the sustainable future we want.

2.2. Focus of the Sub theme

The primary objective of this sub theme is to explore, document and analyze the role of health, hygiene and sanitation on the health of not only humans but of the entire ecosystem and thus its impact on sustainable development in terms of use of science, technology and innovative approaches and ideas. The brief objectives are could be :

i. Identifying the status of prevailing sanitary and hygiene conditions which affect the health and wellbeing of living beings. This may in turn have major impact on economic productivity, since inadequate sanitation impacts individuals, households, eco systems, communities and nations as a whole.
ii. Addressing mental health problems amongst children and adolescents which include depression, anxiety, eating and sleeping disorders that can be attributed to several reasons such as decrease in physical activities, spending too much time in the virtual world which put such children at risk of delayed emotional and social development.
iii. Improving health conditions of the urban/peri-urban and rural citizens, especially children, women and elderly through providing access to safe drinking water, sanitation and introducing preventive interventions in domestic places, workplaces and outdoors.

2.3. Logical Frame work

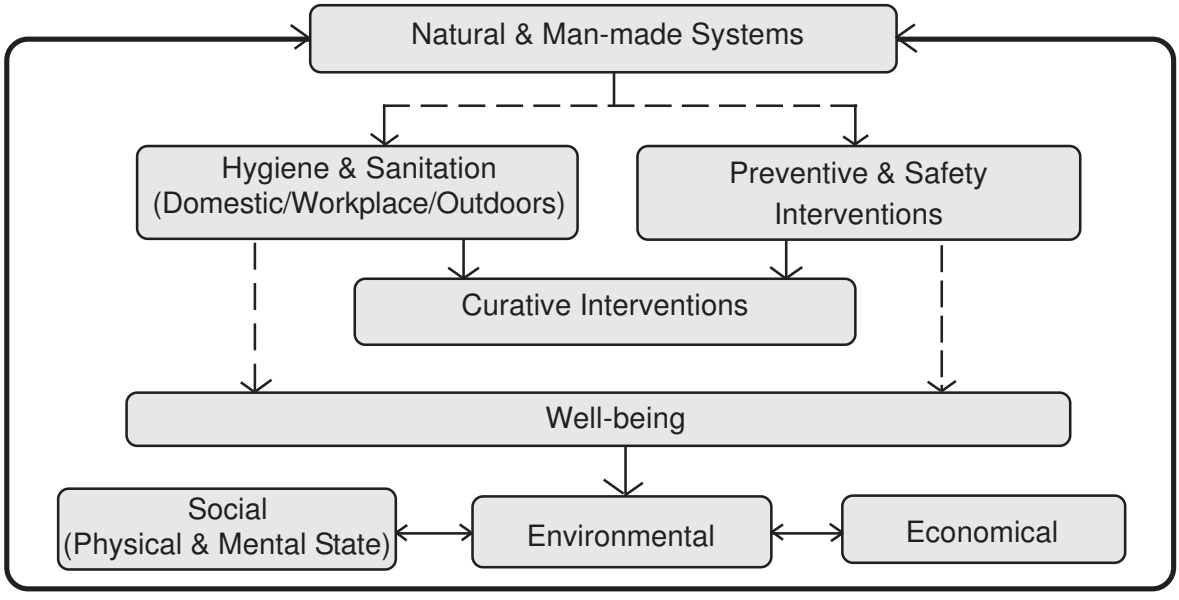
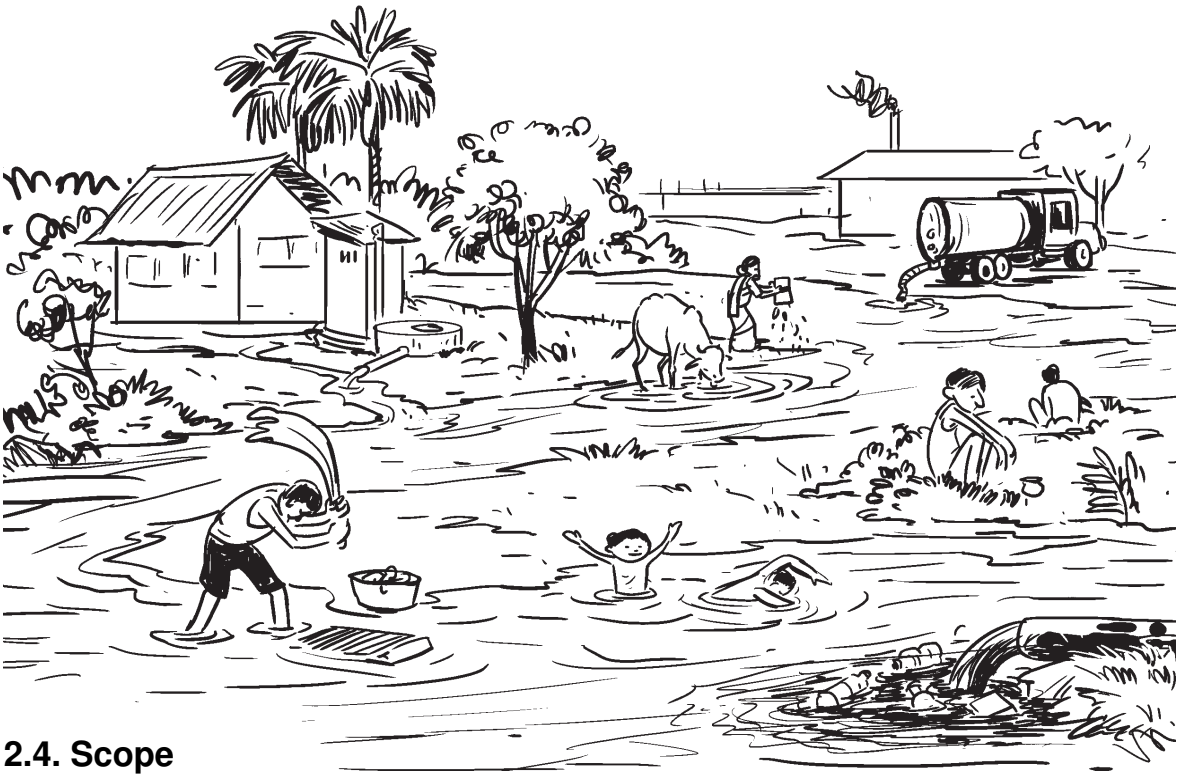


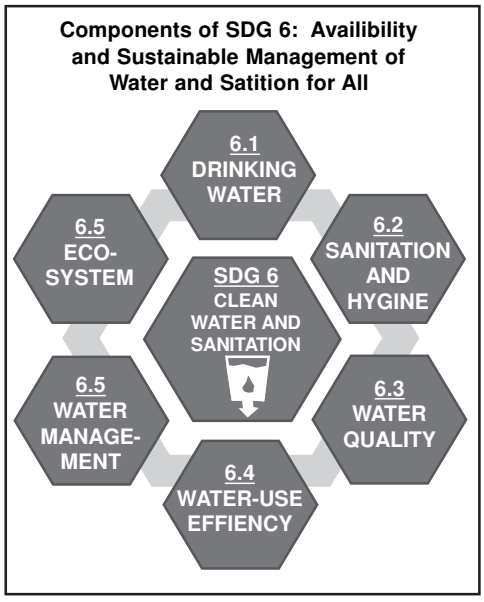
Fig.-2.3. Flow chart showing relationship of health, hygiene and sanitation with sustainable development



2.4. Scope

The strong synergies between health and nutrition (World Bank 2013) are well-documented; good health is not possible without good nutrition. Malnutrition remains one of the main determinants of the global burden of disease, with 45% of child mortality attributable to under nutrition (Black et. al. 2013).

The major challenges faced by the sanitation sector are the lack of proper sanitation for the majority, ill effects owing to poor sanitation, water shortage and pollution, food insecurity and unplanned urban growth. The population un-served by sanitation facility is about 40% of the world population. Approximately 6000 children die every day from diarrheal diseases related to inadequate sanitation and hygiene. About 1 billion people worldwide-mostly children - are infested with intestinal worms and as a result suffer from nutritional deficiency and poor growth. Both these groups of diseases are mostly transmitted through unhygienic conditions. Sewage discharges are a major component of water pollution all over the world. Only a small portion of the polluted water is treated before it is discharged into open water channels or bodies. Pollutants also leak into ground water from sewers, septic tanks, soak pit toilets and cesspools. By 2030, more than half of world population will face shortage of water.



The sanitation practices promoted today are either based on hiding the human excreta in deep pits (drop-and-store) or on flushing them away and diluting them in rivers, lakes and the sea (flush-and–discharge). Whereas ecological sanitation is based on three fundamental principles which are preventing pollution rather than attempting to control it after we pollute; sanitizing the urine and faeces; and using the safe products for agricultural purposes (sanitize – and –recycle).

Spurred on by Agenda Goals, along with changing national realities, many low and middle-income countries will need to invest heavily in sanitation in the next decade. The decisions they make and the approaches they take today will have far-reaching consequences for sustainability and for the well-being of their citizens.

Sanitation is an integral piece of the sustainable development puzzle. The right sanitation systems can not only minimize health and environmental risks associated with open defecation and poorly managed waste disposal, but also, in many cases, yield multiple benefits in areas from health to food security, resilient livelihoods, business growth, energy, and ecosystem services. The Initiative focus on “productive” sanitation approaches.

Hygiene - specifically hand-washing with soap - is one of the most important interventions for human health and development and is a universal necessity. Fundamental to fighting under nutrition, reducing child mortality, overcoming antibiotic resistance, and advancing access to education, hygiene underpins the delivery of several other SDGs and ultimately advances gender equity, dignity, and human rights.

Promotion and demonstration of safe hygiene practices – i.e., hand-washing with soap, food hygiene, menstrual hygiene management, safe stool disposal, and solid waste management – at the household, community and institutional level needs to be carried out collaboratively with the health, education, community development and business development sectors . The success of these programs involves ensuring that schools and health facilities enable the practice of safe hygiene behaviors and those health workers and educators are trained on appropriate behavior change Communication. Developing educational and communication materials for WASH, and strengthening school health club programs, are also instrumental to reinforcing hygiene promotion in schools.

The concept of **WASH**, groups together water, sanitation, and hygiene because the impact of deficiencies in each area overlap strongly. Addressing these deficiencies together can achieve a strong positive impact on public health.

The UN’s Millennium Development Goals included improvement of WASH services in Target 7.C: “Halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation. This has been replaced by the Sustainable Development Goals, where Target 6 aims to “ensure availability and sustainable management of water and sanitation for all”.

Access to WASH, in particular safe water, adequate sanitation, and proper hygiene education, can reduce illness and death, and also affect poverty reduction and socio-economic development. Lack of sanitation contributes to approximately 700,000 child deaths every year due to diarrhea. Chronic diarrhea can have a negative effect on child development (both physical and cognitive) In addition, lack of WASH facilities can prevent students from attending school, impose a burden on women and diminish productivity.

Although access to sanitation has been improving over the past decades, the World Health Organization (WHO) estimates that still “2.5 billion people – more than one third of the global population – live without basic sanitation facilities”. In 2015, 750 million people lacked access to safe, clean drinking water and approximately 2,300 people die every day from diarrhoea

Policies made in all sectors can have a profound effect on population health and health equity. The health of people is not solely a health sector responsibility; it is also impacted by issues such as transport, agriculture, housing, trade and foreign policy. To address the multi-sectoral nature of health determinants requires the political will to engage the whole of government in health. The health sector should promote "Health for All" policy across sectors that systematically takes into account the health implications on decisions, seeks synergies and avoids harmful health impacts in order to improve population health and health equity and address the social determinants of health.

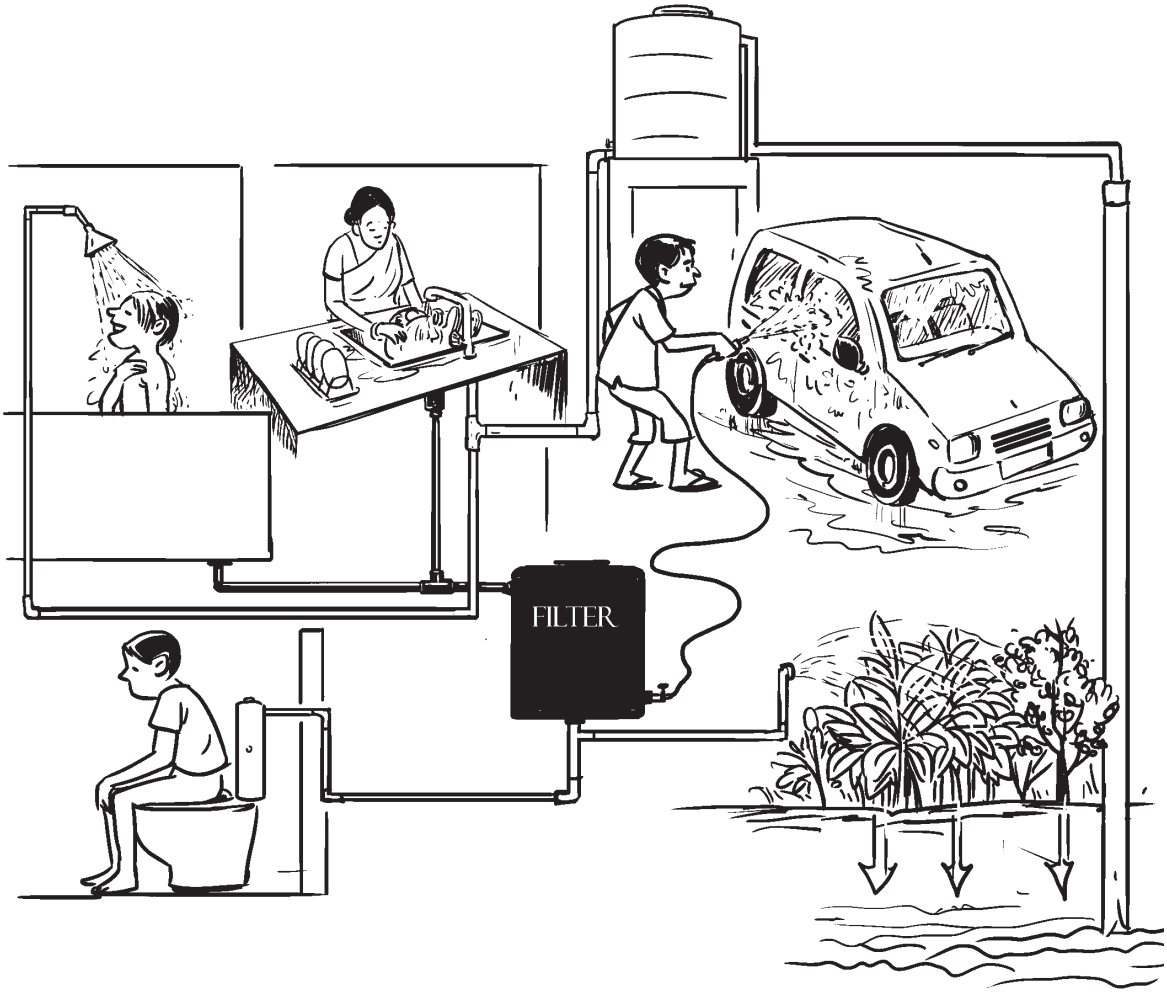
In short;

- Today more than 1 billion people are chronically undernourished and food insecure.
- Undernourishment compromises immune systems, which leads to a higher incidence of illness and disease that in turn contribute to lower productivity and life expectancies.
- Poor nutrition undermines economic growth. According to UNICEF, billions of children younger than 5 are chronically malnourished. Chronic undernourishment in children creates a vicious cycle of compromised physical and cognitive development that reduces their economic productivity when they become adults, miring people in poverty that, in turn, leads to chronic undernourishment and poor health in the next generation.
- A massive disease burden is associated with deficient hygiene, sanitation, and water supply and is largely preventable with proven, cost-effective interventions.
- The total benefits of these interventions are greater than the health benefits alone and can be valued at more than the costs of the interventions.
- Hygiene, sanitation, and water supply are development priorities, yet the ambition of international policy on drinking water and sanitation is inadequate.
- Hygiene, sanitation, and water supply continue to have health implications in the developed world.
- The active involvement of health professionals in hygiene, sanitation, and water supply is crucial to accelerating and consolidating progress for health.

2.5. Project Ideas

Project – 1:

Bio-filtration/bio-remediation processes to improve water quality for reuse



Introduction

About 30% of the drinking quality of water is used everyday to flush the toilets, Grey water (from kitchen, bath and wash) generated in a household if treated can be reused for flushing toilets and gardening purposes using reed-bed (a channel filled with pebbles with aquatic plants growing on it), it would be possible to improve the quality of water for reuse.

Objective

1) To assess the quality and quantity of water required for different household uses
2) To understand the influence of growing microbial and plant communities on the quality of water passing through it
3) To understand the influence of residence time on the emergent water quality

Methodology

1) Collect samples of Grey water (Kitchen, Bath, Wash) and check for its quality (bacterial and physical)
2) Construct a reed bed in a plastic drum by filling it with clean pebbles and planting wetland plants (plants growing on the submerged edges of ponds)
3) Pass the grey water from the bottom to emerge from the top
4) Monitor the water quality difference between the incoming and outgoing water
5) Increase the residence time of grey water in the reed bed and record its influence on emergent water quality
6) Determine the optimum size of a reedbed required by a household

Expected outcome

1. Understanding the way in which wetlands purify water
2. Understanding designing and sizing of a reedbed to suit family needs
3. Appreciation of simple, economical ways of reusing & conserving water at household level

Project – 2:

Study of plant and animal diversity in a pond as an indicator of water quality

Introduction

Aquatic biota are very sensitive to water quality. As the water quality deteriorates the plant and animal communities also change. Studying the presenceof flora and faunain ponds of different water quality will help in understanding the tolerance of biota to pollution.

Objective

1. Understanding the influence of water quality on the aquatic biota
2. To relate the presence or absence of aquatic fauna and flora to pollution levels

Methodology

1. Identify ponds of different pollution status in your locality
2. Study the presence of macro fauna and flora, and identify them
3. Collect the water samples from the ponds and test their quality (physico-chemical and biological including bacteriological)
4. Relate the water quality to the presence of the aquatic biota

Expected outcome

1. To appreciate the sensitivity of the aquatic biota to changing water quality
2. To understand the influence of pollution level on the aquatic ecosystem
3. To be able to use the presence or absence of the aquatic biota to predict water quality

Project – 3:

Personal hygiene – for not missing out on studies

Objective:

To establish role between personal hygiene and health in everyday life, particularly for students

Methodology

1. Design and develop a questionnaire with key questions related to personal hygiene (hand-washing, bathing, using soap, cleanliness – hair, nail, frequency of keeping oneself clean, and the likes)
2. Record number of children absent for a definite period (may be for a month)
3. Assess reasons behind the absence, and identify number absent due to illness
4. Correlate type of illness with parameters of personal hygiene (a common factor among children)
5. Record number of classes, chapters in different subjects missed out by the absentees
6. Record level of personal hygiene followed by the others who has been present all through the study period
7. Create awareness about personal hygiene measures to be taken and the manner in which these are to be adopted

Expected Results

Establish the role of personal hygiene with the missed out studies, signifying importance attached to personal hygiene on day-to-day basis.

Project- 4:

Improving quality of potable water

Objective

Assess quality of potable water in school / community and make it fit for consumption (if not consumable) using suitable mechanisms / process

Methodology

1. Collect 100 ml of water sample in a dry and clean (free from any kind of chemicals) bottle or container from the source
2. Analyze the sample collected for physical (color, smell, turbidity, etc.), chemical (pH, metals, etc.), and microbial (algae, bacteria, etc.) properties, at school / college / research institute / laboratory
3. Establish whether the sample water, based on properties analyzed, fit for consumption
4. If found unfit for consumption, use suitable mechanism / process, like bio-filtration (filtration through specific type of plant and the likes)
5. After processing, reanalyze for properties

Expected Results

Establish the efficacy of the bio-filtration

Project – 5:

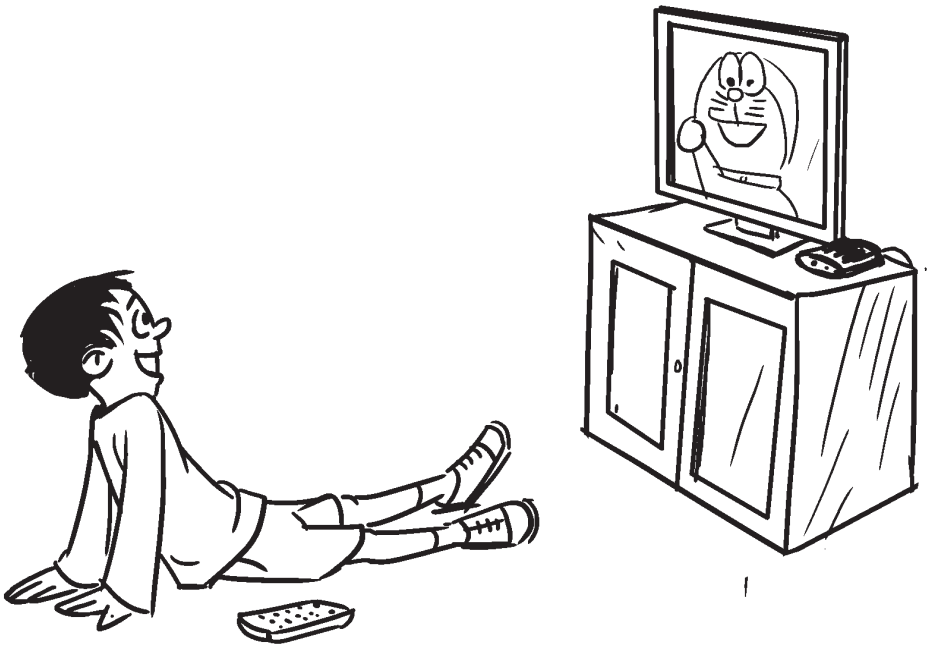
Perform studies to understand the cognitive development in kids due to extended exposure to electronic media

Objectives

1) To develop an understanding of changing lifestyle amongst children
2) To explore and understand the overall psychological problems of children.
3) To develop a comparative understanding of lifestyles of rural children and urban children with respect to the impact of exposure to electronic media day to day activities
4) Finding out if there is any relationship between children who are engaged in excessive exposure to Internet/cell phones with behaviours such as parent conflict/difficulty in making friends/other social changes in behaviour

Background

Changing lifestyles: lack of physical activities, excessive uncontrolled use of digital gadgets and online social media, decreasing social communication, competitiveness, diversified backgrounds and many such reasons attributing to growing stress, anxiety and other disorders amongst children.



Methodology

1) Base line surveys of children living in rural areas as well as urban areas
2) Surveys should act as an instrument to understand children's engagement with Digital Gadgets and Online Social Media/Apps eg. (Facebook, Twitter, Instagram, WhatsApp) and understanding their response, activity and behavioral patterns of the students etc.
3) Key information interviews/questionnaires – children, parents and teachers from both rural and urban communities

Expected Results

1) Change in Rural & Urban lifestyle Map with respect to exposure to digital Media and its Impacts.
2) Analysis of current trends in use of electronic media for a given set of demographic conditions
3) Report on relationship between children who are engaged in excessive exposure to Internet/cell phones with deviant social behaviours

Case Study-1

Aging is a critical societal concern in developed countries and many high class families in developing countries like ours as well. Especially, the elderly living alone may face various health problems in their daily lives. Social welfare organizations or people themselves hire social caregivers to help the senior citizens who live alone; however, there often is a shortage of professional caregivers due to steep increase in elderly population and insufficient budget. You would like to address this problem by developing a cheap technology-driven solution to monitor and help the elderly on a daily basis.

Case Study-2

What causes sustainable changes in hygiene behaviour? A cross-sectional study from Kerala, India (Cairncross et al., 2005)

This study was designed and the field work carried out by a non-governmental organization (NGO) responsible for implementing hygiene promotion. The sustainability of changed hygiene behaviour was studied at various periods up to nine years after the conclusion of a multifaceted hygiene promotion intervention in Kerala, India. Various methods including a questionnaire to assess knowledge, spot observation, demonstration of skills on request, and household pocket voting were used and compared for the measurement of the hygiene outcome. Pocket voting gave the lowest prevalence of good practice, which we infer to be the more accurate. Good hand washing practice was reported by more than half the adults in intervention areas, but < 10% in a control area. Hand washing prevalence showed no association with the elapsed time since the interventions, indicating that behaviour change had occurred and persisted. Recall of participation in health education classes was significantly associated with good hygiene as indicated by women's hand washing practice (OR 2.04, CI 1.05–3.96) and by several other outcomes, suggesting that the classes were an effective component of the intervention. The evidence for a specific impact on behaviour from home visits and an awareness campaign is less strong, although the home visits had influenced knowledge. The finding of an association between interventions and male hand washing, in ecological analysis (comparing administrative areas i.e. panchayats) but not at individual level, suggests that the effect of the interventions on men may have been indirect, via women or neighbours, underlining the need to direct interventions at men as well as women. The finding that hygiene behaviour persisted for years implies that hygiene promotion is a more cost-effective health intervention than previously supposed.

Problem: Unobtrusive Fall Monitoring

Lots of elderly people fall unexpectedly at home due to their weakened muscles and motor ability. Also, internal health problems like stroke could cause sudden falls. Fall is one of the biggest threats to the elderly, especially for those who live alone, since they cannot get immediate help from their family. You would like to design an accurate and robust sensor-driven system to monitor if an elderly falls. Upon the detection of fall, your system will automatically call an ambulance and notify a nearby hospital.

Objectives

You have the following four objectives for the design of your system: (1) high coverage (the whole apartment unit needs to be covered), (2) low cost (the cost of sensors should be less than 15,000INR per house), and (3) low false negative rate (ideally, all falls need to be detected while you can have a few false positives), (4) passive monitoring (the elderly does not want to wear or hold any types of devices).

Methodology

A key part of this system is to monitor the occurrence of falls. The requirements for its first version are:1) to detect 'catastrophic falls' where the elderly person falls and unconscious or immobile for more than 30 seconds, and 2) to cover a one-bedroom apartment unit (with 1 main door, 1 living room, 1 bedroom, 1 kitchen and 1 bathroom) where one elderly person lives alone. You don't have to consider scenarios where the elderly falls and gets up within 30 seconds or there are visitors at home who can provide *in-situ* help.

2.6. Additional Project Ideas

1. Metals / heavy metals in potable water and its management
2. Water quality assessment
3. Biofilteration / bioremediation processes to make water available for recycling
4. Hygiene at personal / familial / community level and its impact on community health
5. Assessment of hygiene maintained at regular basis
6. Level of hygienic conditions during different seasons
7. Occurrence of diseases due to breakdown in hygienic conditions and its management
8. Waste management (eg.Diapers)
9. Diseases (microbial / parasitic) and their impact of social / economical / environmental parameters
10. Impact and management of zoonotic diseases
11. Impact and management of conditions arising out of vital nutrient deficiency / malnutrition
12. Comparison of sanitation before and after Swachch Bharat campaign, in terms of behavioral change
13. Impact of cookware used to cook on health
14. Effect of Indoor Air Pollution on health
15. Maternal health and hygiene during pre and post-partum stages
16. Gender specific health and hygiene and its control / management

17. Safe use of anthropogenic waste in agriculture.
18. Impact of use of public transport on community health.
19. Improving occupational health.
20. Promoting city health through sensing technologies
21. Unobtrusive fall monitoring of the elderly.

Swachh Bharat Abhiyan

"A clean India would be the best tribute India could pay to Mahatma Gandhi on his 150 birth anniversary in 2019," said Shri Narendra Modi as he launched the *Swachh Bharat* Mission at Rajpath in New Delhi. On 2nd October 2014, *Swachh Bharat* Mission was launched throughout length and breadth of the country as a national movement. The campaign aims to achieve the vision of a 'Clean India' by 2nd October 2019.

Swachh Bharat Abhiyan has become a '*Jan Andolan*' receiving tremendous support from the people. Citizens too have turned out in large numbers and pledged for a neat and cleaner India. Taking the broom to sweep the streets, cleaning up the garbage, focussing on sanitation and maintaining a hygienic environment have become a practice after the launch of the *Swachh Bharat Abhiyan*. People have started to take part and are helping spread the message of 'Cleanliness is next to Godliness.'

MISSION INDRADHANUSH

Zindagi Indradhanush Banayein!

Full immunization against preventable childhood diseases is the right of every child. With a view to provide this right to every child, the Government of India launched the Universal Immunization Program (UIP) in 1985, one of the largest health programs of its kind in the world.

Despite being operational for over 30 years, UIP has been able to fully immunize only 65% children in the first year of their life and the increase in coverage has stagnated in the past 5 years to an average of 1% every year.

To strengthen and invigorate the program and achieve full immunization coverage for all children at a rapid pace, the Government of India launched Mission *Indradhanush* in December 2014.

Mission *Indradhanush* will ensure that all children under the age of two years and pregnant women are fully immunized with all available vaccines.

National Deworming Day

The National Deworming Day is an initiative of Ministry of Health and Family Welfare, Government of India to make every child in the country worm free. This is one of the largest public health programs reaching large number of children during a short period.

More than 836 million children are at risk of parasitic worm infections worldwide. According to World Health Organization 241 million children between the ages of 1 and 14 years are at risk of parasitic intestinal worms in India, also known as Soil-Transmitted Helminths (STH).

About STH:
Helminths (worms) which are transmitted through soil contaminated with faecal matter are called soil-transmitted helminths (Intestinal parasitic worms). Roundworm (Ascarislumbricoides), whipworm (Trichuristrichiura) and hookworms (Necatoramericanus and Ancylostomaduodenale) are worms that infect people.

STH transmission:

- Adult worms live in human intestines for food and survival and produce thousands of eggs each day.
- Eggs are passed in the faeces of infected person.
- Infected people who defecate outdoors spread worm eggs in the soil.
- Eggs contaminate the soil and spread infection in several ways: ?
- Ingested through vegetables that are not carefully cooked, washed or peeled;
- ingested from contaminated water sources;
- ingested by children who play in soil and then put their hands in their mouths without washing them.
- STH infectionscan lead to anemia, malnutrition, impaired mental and physical & cognitive development, and reduced school participation.

STH Infections can be prevented by:

- Using sanitary toilets, not defecating outside
- Hand-washing, particularly before eating and after using toilets
- Wearing slippers and shoes
- Washing fruits and vegetables in safe and clean water
- Eating properly cooked food

Objective of National Deworming Day:

The objective of National Deworming Day is to deworm all preschool and school-age children (enrolled and non-enrolled) between the ages of 1-19 years through the platform of schools and AnganwadiCenters in order to improve their overall health, nutritional status, access to education and quality of life.

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Sub Theme- III

Waste to Wealth

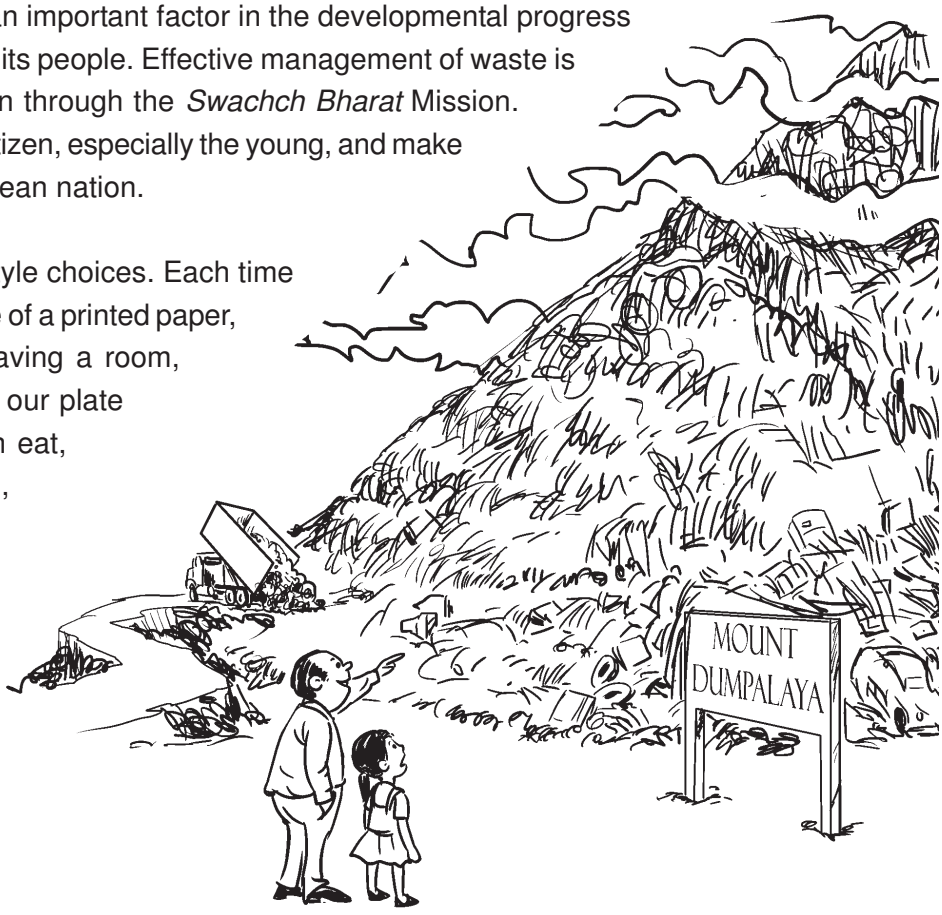
Waste to Wealth

3.1. Background

Waste is a natural by-product of the phenomena of life and growth of societies. It is viewed as unwanted or unusable material that has been disposed or discarded after primary use. Plants shed leaves, animals excrete. Humans in their day to day life create a boundless heap of waste of countless variety.

Industrialization is inevitable for the development of any nation. It leads to demand for a variety of goods for improving habitat and standards of living, greater production, as well as greater consumption. This escalates production of waste in variety of forms, many of which cause serious environmental pollution and degradation. Persons with disability are prone to greater threat from mishandling of waste. In the absence of proper mechanisms for disposal and management, waste is often viewed as a menace. It not just spoils the aesthetics of living spaces, but becomes a source of pollution and poses a major hazard to health and life of all organisms.

Efficient handling of waste is an important factor in the developmental progress of any nation and the health of its people. Effective management of waste is now a national priority as seen through the *Swachch Bharat* Mission. This seeks to sensitize every citizen, especially the young, and make them a partner in creating a clean nation.



Waste is deeply linked to lifestyle choices. Each time we decide to use the blank side of a printed paper, turn off lights and fans on leaving a room, use water judiciously, take on our plate only as much food as we can eat, decide not to use a plastic bag, we contribute to reduction of waste or resources. In fact, since times immemorial, all societies and cultures have looked for effective management of waste and often, to put it to good use. Used and discarded materials are transformed to beautiful artifacts. Leftovers from food commonly form the

base for fresh dishes. The patched quilt is generally found across cultures. Generation of less waste, reuse of consumables, recycling of waste and recovery of valuable resources from waste are considered as good practices. They help conserve valuable natural resources and energy and also lower environmental damage caused by socio-economic development. Thus waste management is strongly linked with the idea of sustainable development.

Meeting the goals of sustainable development is an outstanding global challenge. So is waste management. Finding innovative solutions for effective management of waste is difficult as breakdown of waste requires special processes that entail time, energy, and expense. The new thinking is to address the problem at the grassroots starting at the very origin of waste generation. It is now recognized that we cannot afford to lose it as mere 'waste'. Instead, it is important to view 'waste' as a valuable 'resource' that can be converted into a variety of useful products. This process of conversion of waste to a product that can be put to primary use can be viewed as a process of generating wealth. Hence the phrase 'Waste to Wealth'.

Waste management that leads to generation of substances and products that can be put to primary use is an emerging major sector for employment to meet the livelihood needs of the vast majority of India's rapidly growing population. Given the magnitude of waste generated, innovative waste conversion processes can create micro-entrepreneurship opportunities on a massive scale. In India, the potential of waste to wealth enterprise is very high. Currently not enough has been done. Increasing opportunities for this enterprise can have manifold advantages. It can bring back useless, discarded waste products into economic use and lead to

1. Reduction of pressure induced by waste on the environment;
2. Creation of opportunities for income and employment generation in a relatively new area thereby enhance economic activity; and
3. Impact quality of life.

3.2. Objectives

To understand

- the challenge posed by waste and its impact on environment and health;
- how day-to-day activities generate waste;
- classification of different types of waste and mechanisms for their disposal;
- concept of 5R: Refuse, Reduce, Reuse, Recycle, Recover;
- hazards posed to health and environment and safety measures to be adopted in handling waste;
- innovative processes that generate products from waste creating wealth;
- the scope of livelihood generation through entrepreneurship.

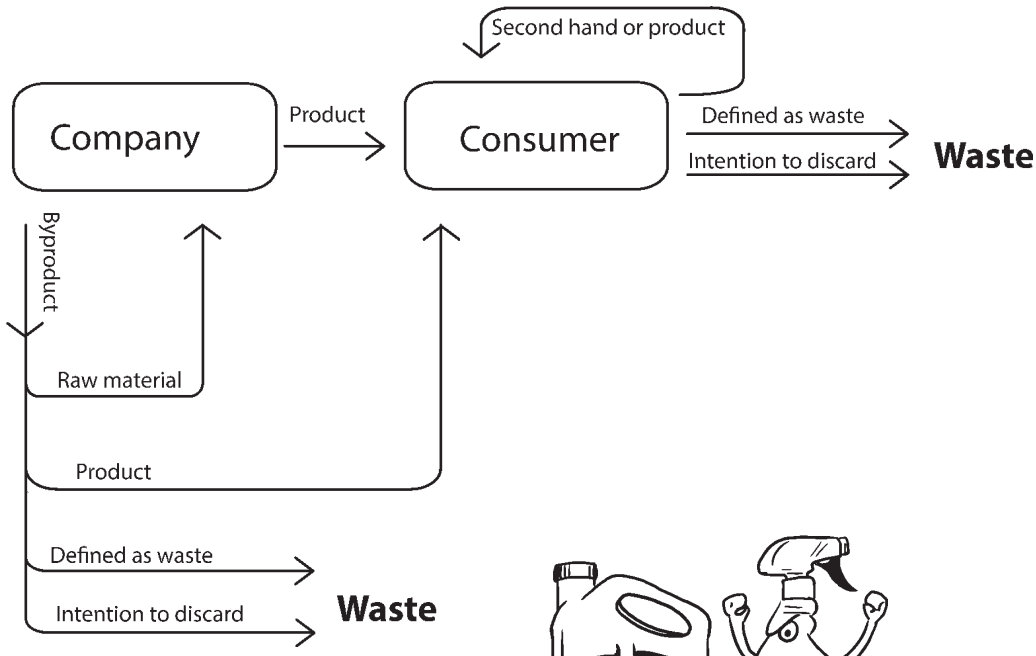
3.3. Scope of the Sub Theme

The primary focus of this sub theme is to understand the science and art of waste management and product development. It will trace the life cycle of various forms of waste, starting from its generation to diverse forms of disposal; classification as biodegradable or non bio-degradable and hazardous or non-hazardous; process for management; mechanisms for conversion to usable products, if any; impact on health, environment and socio-economic issues.

3.4. Waste: Types & Nature

Definition: ***Waste*s** are unwanted or unusable objects or materials which are discarded after primary use, or declared as worthless, defective and of no use. Municipalities require these to be disposed of by the provisions of national law.

Examples include Municipal Solid waste (MSW) which is household trash/refuse, hazardous waste, wastewater (such as sewage, which contains bodily wastes – faeces and urine – and surface runoff), radioactive waste, e-waste and others.



Hazardous waste

Hazardous waste is any waste which by reason of characteristics such as physical, chemical, biological, reactive, toxic, flammable, explosive or corrosive, causes danger or is likely to cause danger to health or environment, whether alone or in contact with other wastes or substances.

3.4.1. Biodegradable (Bio-waste)

Definition: Biodegradable materials are composed of waste from living organisms and the actual plant, animal or other organisms when its life ends.

Examples: These include human and animal waste; plant products, wood, paper, food waste, leaves, grass clippings and other horticulture waste; and remains from death of living creatures such as animal carcasses.

Hazards posed: It is usually believed that biodegradable waste does not cause environmental damage and is harmless. However, a quick glance at our own habitat is enough to prove that it poses health if not disposed of properly. Stagnant waste emits foul smell as it decays and becomes a breeding ground for mosquitoes and other disease causing organisms. Rotting waste emits greenhouse gases such as methane, carbon dioxide and produces chemicals like ammonia. Too much of biodegradable waste in water can deplete oxygen impacting marine life. Again, too much of cattle manure can cause health concerns.

Another major problem arises when instead of being segregated and composted, biodegradable waste ends up in large garbage dumps or landfills and gets buried under mounds of non biodegradable waste, rendering it difficult for microorganisms to break it down.

Bio-degradation or decomposition: This is the process of changing biodegradable materials into a useful resource. A quick look at any ecological system shows widespread synergy between organisms. Waste from one living entity often helps create a healthy environment for another organism, providing nourishment and conditions conducive for its survival and growth. Decayed organic material (compost) is commonly used as manure or

fertilizer for growing plants. It improves soil structure and provides nutrients. The process of compositing requires making a heap of wet organic matter known as green waste (leaves, food waste) and waiting for the materials to break down into humus after a period of weeks or months. The decomposition can be accelerated by other living organisms such as bacteria, fungi, insects, worms, etc. and abiotic elements like temperature, moisture, oxygen, ultraviolet light, etc.

Creating sustainable wealth

Organic Agriculture: With greater sensitivity to issues related to sustainable development, agro-ecological farming methods are gaining in popularity. These rely on ecological processes to sustain the health of soil as well as treating farming as an integrated, holistic, interconnected process of food production by optimizing the farm in design and closely knit nutrient and resource recycling. Instead of synthetic fertilizers and pesticides, compost, green manure and bone meal are key ingredient in organic farming and also on non-chemical modes of pest and disease control, . Consciousness towards healthy lifestyle has seen organic farm production and trade emerging as an important sector in India as in other parts of the developing world. According to business chamber ASSOCHAM, current organic food market was estimated to be about Rs.3350 crore in 2016 and predicted to treble in next four years.

Bio-fuels: Another important direction in bid for sustainability is use of bio-fuels from biomass or bio-waste. Biogas production is a clean low carbon technology for conversion of organic waste into clean renewable biogas and a source of organic fertilizer. Biogas obtained by anaerobic digestion of cattle dung and other loose and leafy organic matter/ wastes can be used as energy source for cooking, lighting, refrigeration, electricity generation and transport applications.

Biomass has always been an important source of energy in our country. According to the Ministry of New and Renewable Energy (MNRE), about 32% of the total primary energy use in the country is still derived from biomass and more than 70% of the country's population depends upon it for its energy needs. MNRE is promoting development of efficient technologies for its use in various sectors of economy. Biomass materials used for power generation include bagasse, rice husk, straw, cotton stalk, coconut shell, soya husk, de-oiled cakes, coffee waste, jute waste, groundnut shells, saw dust etc.

Applications range from use of bio-fuel in rural/urban kitchens to grid power generation to meet varied energy demands of a sugar mill, an entire village and even a smart city. This is an industry that attracts an investment of Rs. 600 crore every year, generating more than 5000 million units of electricity and yearly employment of more than 10 million man-days in rural areas. Maharashtra leads by example generating about 1220 MW of Biomass power.

3.4.2. Non Biodegradable Waste

Definition: Non Biodegradable waste includes materials that do not breakdown or decay naturally, that is, cannot be decomposed by microbes and abiotic elements or dissolved by natural agents or biological processes.

Examples: These include glass, metal, baked pottery**,** ceramics and plastic items**;** most forms of medical waste (Biomedical waste); electronic/ electrical devices (E-waste); construction and demolition waste (C&D). Most of the inorganic waste is non biodegradable in the sense that it could take from a few weeks and years to thousands of centuries to decay. In fact, our understanding of ancient civilizations rests on archeological findings of non biodegradable artifacts of that era.

Plastics: About 15,342 tonnes of plastic waste are generated in India everyday, of which 6,137 tonnes remain uncollected and littered, 9205 tonnes are recycled. Lack of awareness and absence of effective tools to collect back the discarded plastic products including the wrapping material has led to the indiscriminate littering and disposal of plastic waste.
Biomedical Waste is generated during the diagnosis, treatment or immunization of human beings or animals or in research activities pertaining thereto or in the production or testing of biologicals. Common examples are diapers, sanitary pads, syringes, shaving blades, ear buds, finger nails, band aid, dressings, used cotton, dry cloth items, surgical waste, body parts, animal bones etc.

E-Waste: Electronic products nearing the end of their "useful life" are termed as "E-waste". *Examples include discarded computer monitors, motherboards, cathode ray tubes,* televisions, VCRs, stereos, *Printed Circuit Boards (PCB), mobile phones and chargers, CDs, headphones, Liquid Crystal Displays (LCDs)/ plasma televisions, air conditioners, refrigerators and so on. In India, computer equipment accounts for major fraction of e-waste material.*

Construction and Demolition Waste: This refers to materials that are unused, damaged or unwanted during construction and the demolition debris. The list is large and includes rubble, drain silt, marble sludge, bricks, concrete, tiles, wood, nails, pipes, roofing, plaster

boards, electrical wires, insulation, etc. Site preparation can involve digging and felling of trees. Construction waste may contain lead, asbestos, paint, etc. It is estimated that almost 10 to 15% of the materials that go into construction of a building are wasted.

Hazards posed

Disposal of non biodegradable waste is a major challenge. It ends up taking space, cluttering habitat and creating land mess. Or it ends up being burnt, dumped in water bodies and landfills. Such waste deposits cause large scale pollution of land and water posing several environmental and health problems.

Plastics: Consider the commonly used plastic. The plastic boom started after the second word war. It is ubiquitous and used in carry bags, bottles, other packaging, toys, cellphones, refrigerators, automobiles, pipes, construction materials, microfibers, *et cetera*. Consumer needs have led to newer types of plastic and polyester clothing that is more durable and lasts even longer. By one estimate, industry has made 9.1 billion tonnes of plastic since 1950. Nearly 7 billion tonnes are no longer used. About 9% got recycled; another 12% was incinerated. This leaves 5.5 billion tonnes of plastic waste littered on land, inside landfills and floating on water bodies. Even when shred into smaller pieces, they last for thousand years. Because plastic is made from polypropylene or polyethylene, toxic chemicals can seep into land and water. Animals that eat plastic can strangle on it. In lakes, rivers, oceans, it can harm fish, seabirds and other marine life that mistake it for prey. It also has potential for greenhouse gas emissions and trans-boundary migration of organic micro pollutants (dioxins and furans) and volatile heavy metals.

E-waste: This *is a complex mixture of materials and components and* needs careful handling at all stages from manufacture to disposal. Batteries if improperly disposed can leach lead and other toxic chemicals into soil and groundwater. These Several electronic manufacturing operations involve coating a product, such as electroplating or painting. Chemicals are used to strip off coating from rejected products so that they can be recoated. These chemicals, which can include acids, caustics, cyanides etc. are often a hazardous waste and must be properly managed.

In India, only 5% e-waste recycling is done formally whereas the rest is done informally. Informal recycling of e-waste causes several threats to human health. E-waste products can have over 1000 different substances, of which many of which are toxic, like lead, cadmium, mercury, hexavalent chromium, plastic, PVC, BFRs, barium, beryllium, and carcinogens like carbon black and heavy metals. These can contaminate soil and ground water. They can cause severe health problems like liver, kidney and neurological disorders in those handling the waste. PCBs, for example, contain heavy metals like antimony, gold, silver, chromium, zinc, lead, tin and copper. The method of extracting these materials from circuit boards is highly hazardous. Informal recyclers use primitive and hazardous methods like acid stripping and open air incineration for processing e-waste. These methods are highly unsafe and cause pollution by releasing toxins from e-waste into the environment.

3.4.3. Creating sustainable wealth

Non-biodegradable waste disposal poses a major challenge to planet earth and civilization. Characteristics of various waste items determine the potential these have for wealth generation.

Recyclable waste: Those non biodegradable materials which can be put to use again in the same or different form – that is, reused, refurbished, or recycled – are known as "Recyclable Waste". Inorganic waste, such as PET and plastics, waste paper and tetra packs are now increasingly recycled. These are used to create innovative products through organized or unorganized sector at micro or small scale. Recycling waste of useful materials puts them back into circulation for consumers. Large amounts of functional electronic items are phased out or discarded in favour of new models. These can be easily put to use. This would reduce the consumption of scarce and expensive resources/raw materials. It would also reduce consumption of energy. All these interlinks have positive impact on economy and environment.

Government has adopted new rules that provide for ways and means to minimize plastic waste generation, adoption of extended producer responsibility for collection of waste and sustainable plastic waste management, recycling and utilization of plastic waste in road construction, energy and oil generation.

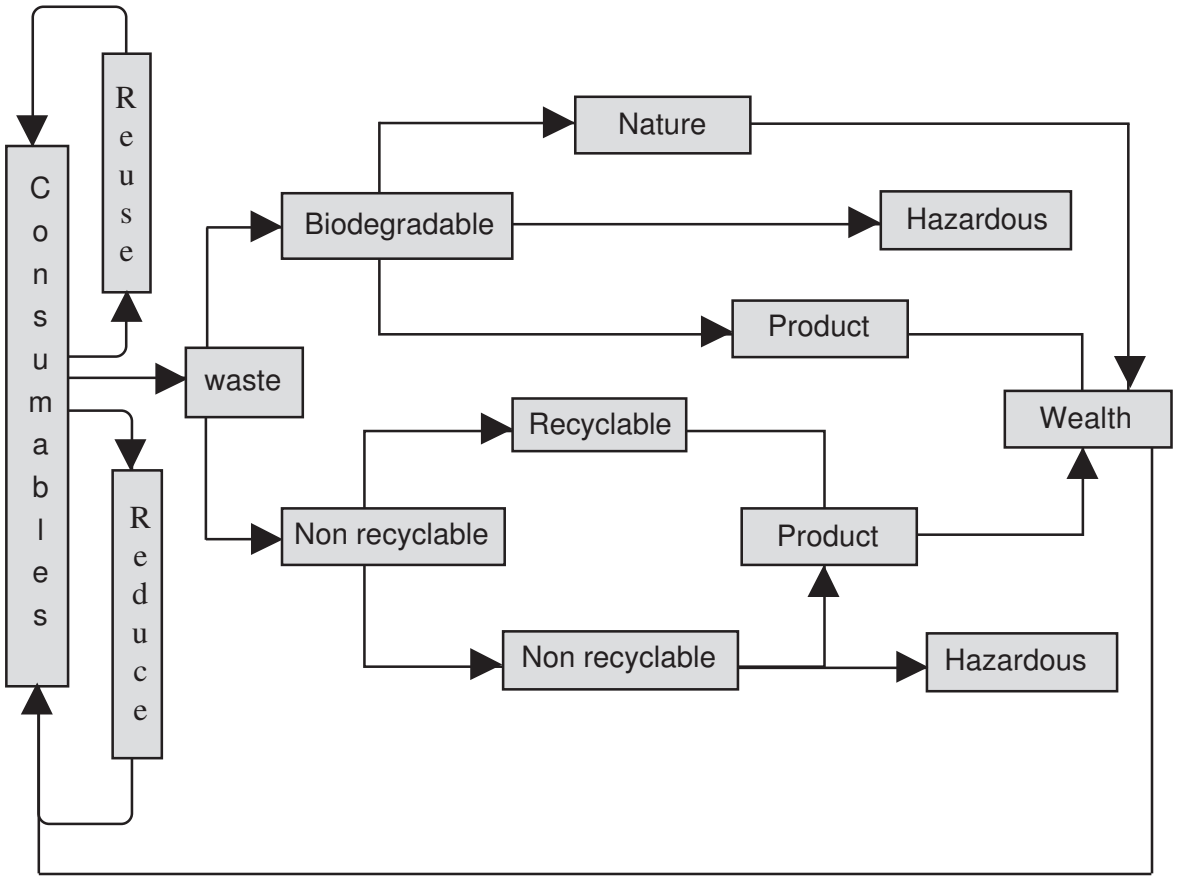
Another form of recycling is salvaging or recovering certain materials from complex products. This could be

(i) Because of their intrinsic value, such as lead from car batteries or gold from circuit boards. *Around 10% of total gold worldwide is used for their production*.
(ii) Due to the intrinsic hazardous nature, such as removal and reuse of mercury from thermometers and thermostats.

Non recyclable waste: Those non biodegradable materials which can not be put to use again are termed as "Non Recyclable Waste". Traditionally these are disposed off by (i) transporting to a distant site and dumping them in a landfill; and (ii) incineration or burning. Environmental concerns have led municipalities to develop better management of these wastes. Major initiatives have been launched to look at non recyclable waste as a resource to make energy. As an example, base liner systems are installed in landfills to prevent escape of leachate from waste into the environment. Installation of the leachate tank and methane extraction pipe allows these to be harvested as source of energy. Municipal Solid Waste Incinerators (MSWI) transform waste into solid ash that can be recycled for various applications. Energy is extracted from the hot gasses / fumes produced by generating steam in a boiler. This is used to turn a turbine to produce electricity. Development of flue gas scrubbing technology for MSWI cleans the toxic fumes before these are released into the environment.

All t*his contributes to resource efficiency and wealth generation through what is termed as a circular economy.*

3.5. Logical Framework



The figure- 3.1 indicates the different processes for wealth generation from available wastes.

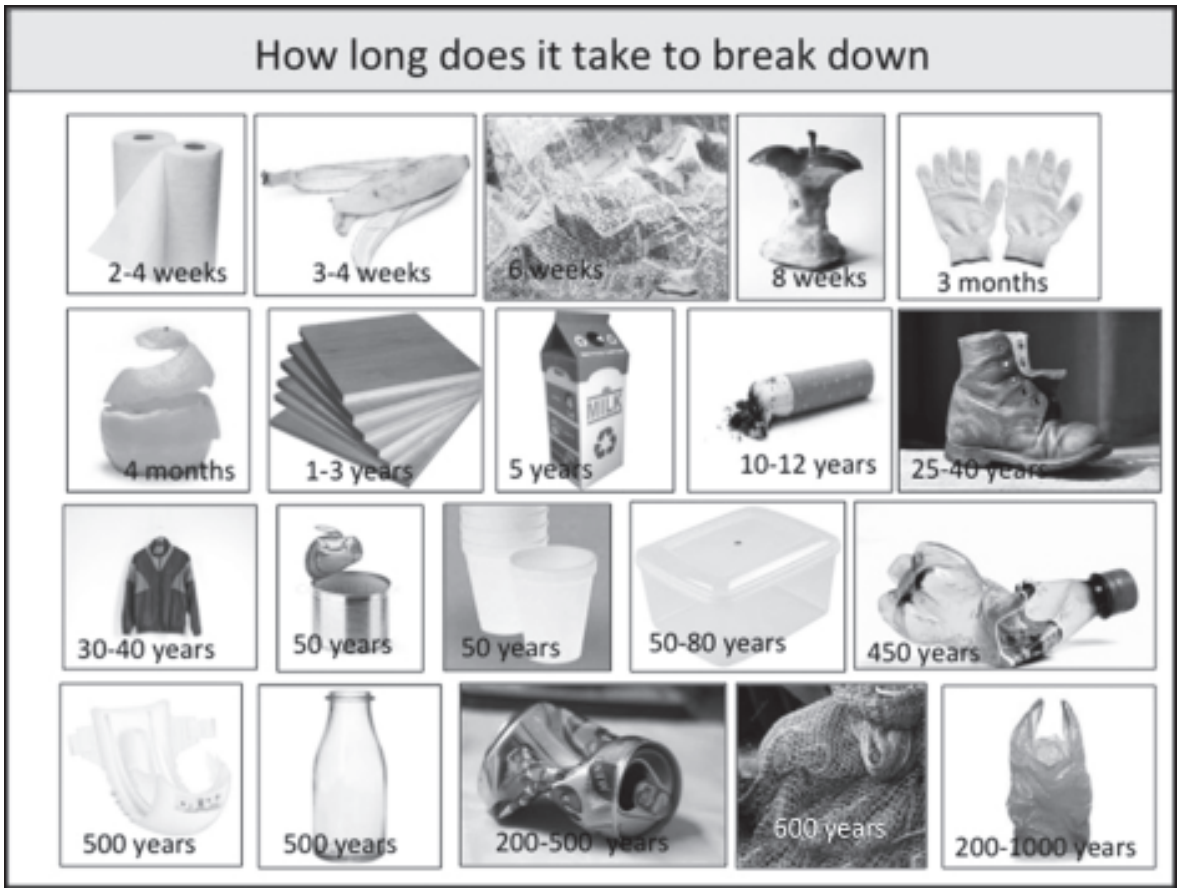
3.6. Waste management: An overview

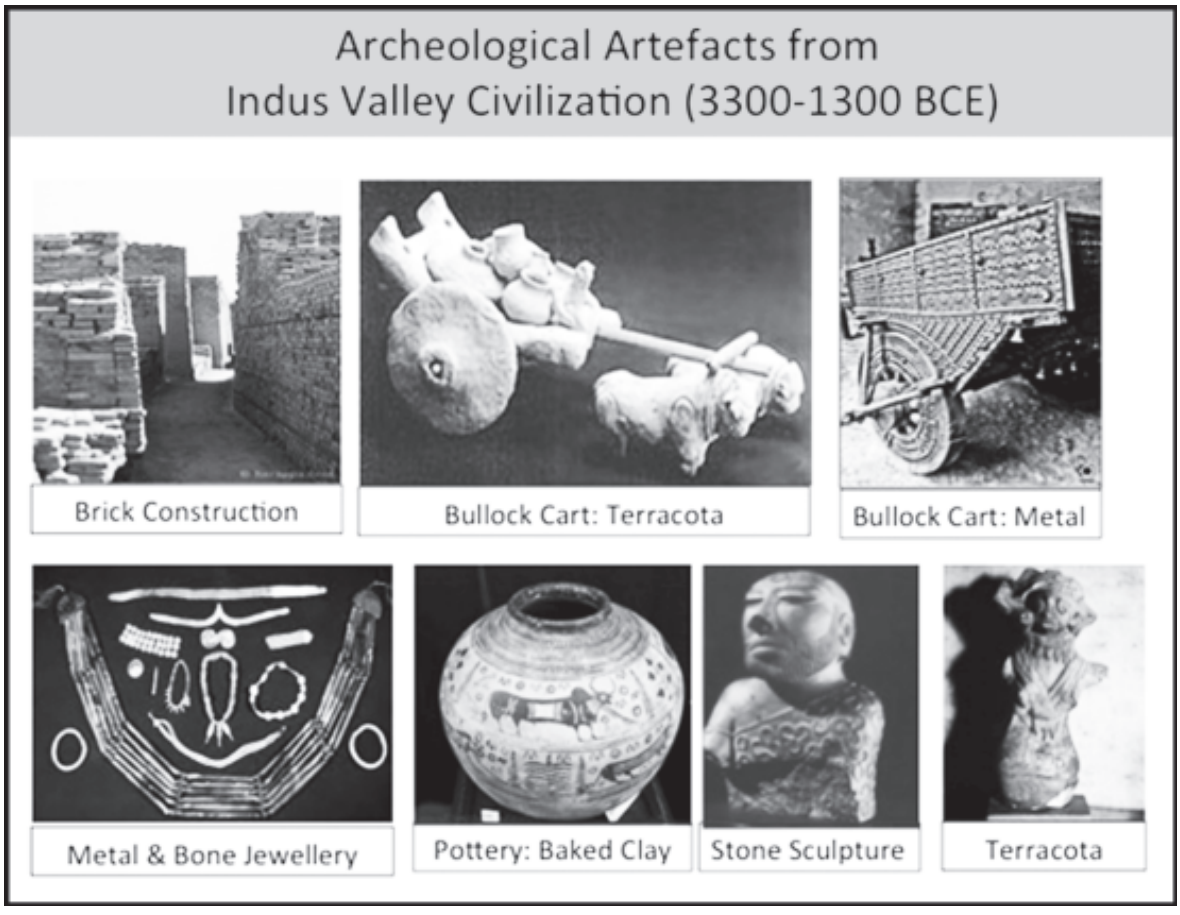
All of us generate immense waste on day-to-day basis without being conscious of the neighborhood and the escalation of the problem. Our daily dump includes plastic bottles, plastic/Styrofoam cups, plastic carry bags, metal cans, tetra packs, metal scraps and construction debris of all kinds.

Most of us do not realize that much of household waste is non biodegradable. We generate and dump this waste along with the biodegradable waste without realizing the hazards this action poses. Non biodegradable waste such as commonly used batteries, aerosols, bulbs, fluorescent tubes, polishes, adhesives, household cleaners, drain cleaners, solvents, broken thermometers, medicines, syringes, discarded wound dressings, surgical gloves, diapers, sanitary pads, etc. contain harmful chemicals and require careful, and often specialized, handling.

Waste Segregation: The treatment of waste depends upon its nature and decomposition properties. Hence handling of waste requires segregation at source. A simple practice is to identify wet and dry waste being generated in the household and discard these in separate containers. Many households and communities now convert wet kitchen waste into compost, a product used for enriching soil quality.

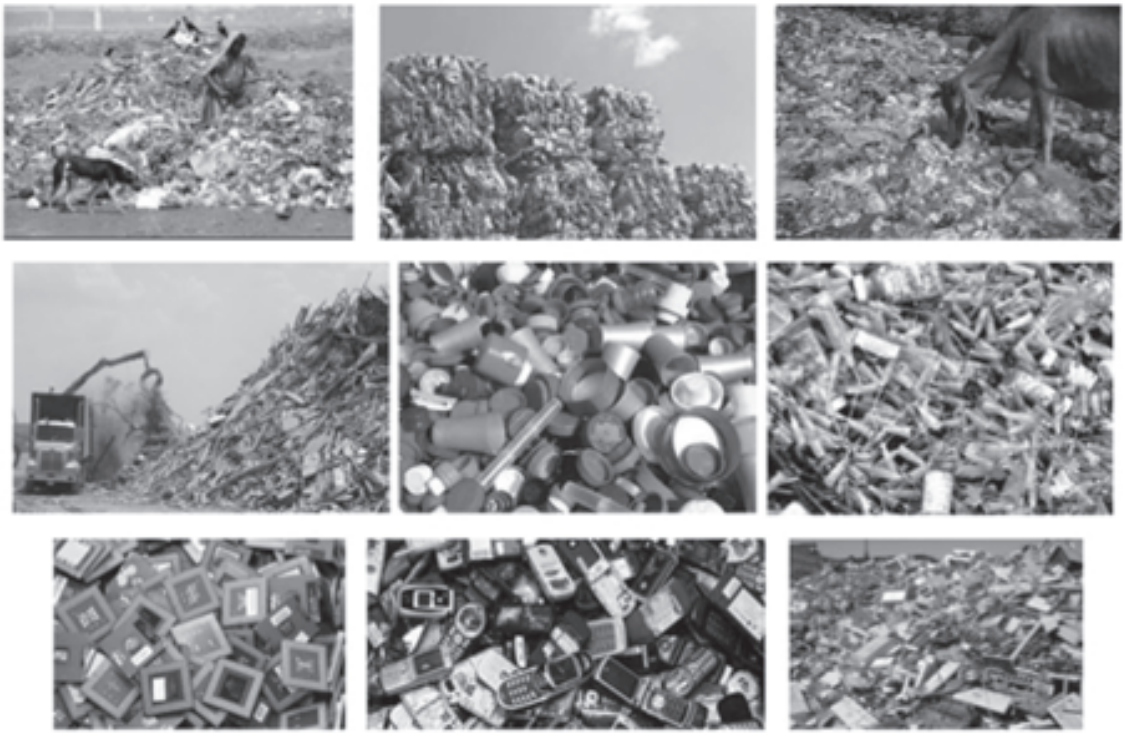
The above wet-dry categorization of waste is not adequate. Wet and dry household waste can include potentially hazardous waste materials that should be segregated more carefully


How long does it take to break down
2-4 weeks
3-4 weeks
6 weeks
8 weeks
3 months
4 months
1-3 years
5 years
10-12 years
25-40 years
30-40 years
50 years
50 years
50-80 years
450 years
500 years
500 years
200-500 years
600 years
200-1000 years


Archeological Artefacts from
Indus Valley Civilization (3300-1300 BCE)
Brick Construction
Bullock Cart: Terracota
Bullock Cart: Metal
Metal & Bone Jewellery
Pottery: Baked Clay
Stone Sculpture
Terracota

Society and Culture

Hazardous Garbage Dumps



Waste to Wealth: Crafting Useful Products

Amazing Construction From Recycled Materials

3.7. Waste Management

According to Central Pollution Control Board Report 2014-15, 51.4 million tonnes of solid waste was generated in the country. Of this, 91 per cent was collected, and 27 per cent was treated and remaining 73 per cent disposed of at dump sites. There is a critical need for developing sustainable wealth generating models for India's waste. The potential is immense. It is estimated that India will have a waste management market to the tune of US$ 13.62 billion by 2025. With the concerted efforts of the government, increasing interest and participation of the industry, academia, not-for-profit organizations, and communities, the nascent waste management industry in the country is poised for a major turnaround.

The emphasis has to be on 100 per cent collection and scientific processing/disposal/reuse/ recycling of municipal solid waste. To ensure the success of this vision, the government is focusing on providing all support to municipal bodies to come up with design, execution and operation plans for waste disposal systems. There is also an emphasis on private-sector participation and public-private-partnership (PPP) in capital expenditure and operation and maintenance costs for sanitary facilities. Industries are also increasingly cognizant about waste management, right from the point of production. Sustainable development sets the goal of redesigning the product to use non-hazardous materials.

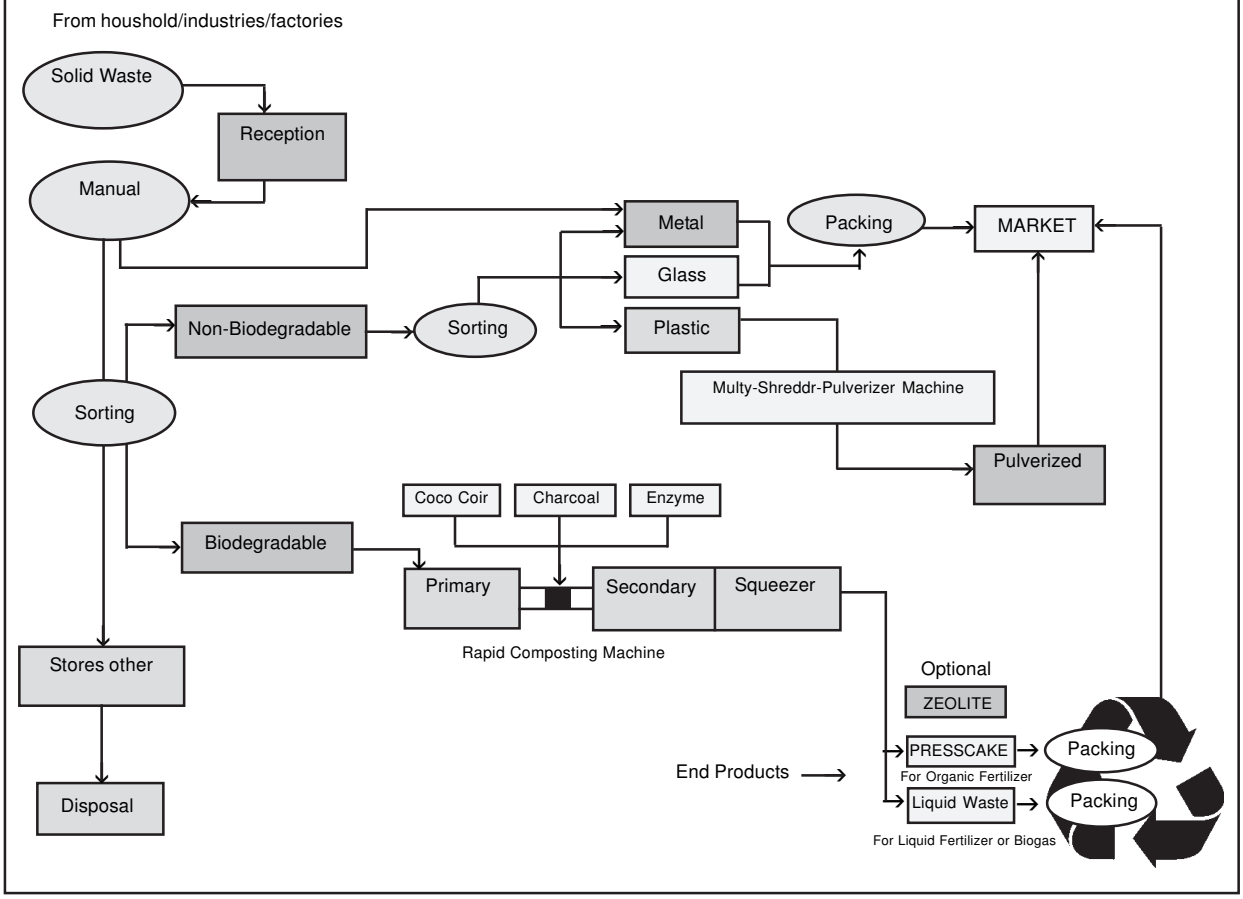
Waste can be recovered on-site, or at an off-site recovery facility, or through inter industry exchange. A number of physical and chemical techniques are available to reclaim a waste material such as reverse osmosis, electrolysis, condensation, electrolytic recovery, filtration, centrifugation etc. For example, a printed-circuit board manufacturer can use electrolytic recovery to reclaim metals from copper and tin-lead plating bath. However recycling of

hazardous products has little environmental benefit if it simply moves the hazards into secondary products that eventually have to be disposed of.

For anything to be a resource, it should be as clean and pure as possible. Therefore, to generate wealth, anything that is not useful in a particular location or for a person/s should be put away without contaminating it with other 'waste' or useless material. This is called 'source segregation'. For instance, to make compost from 'wet waste' generated in homes, markets, educational institutions, hotels and restaurants or religious places, it must be ensured that it is not contaminated with 'toxic waste' such as batteries, paints, pesticides, mercury lamps and other hazardous chemicals. The quality of the compost then is excellent and by carrying out bio-methanation and composting, huge revenue from both the solid and liquid wastes can be realized.

Installing more efficient process equipment or modifying existing equipment to take advantage of better production techniques can significantly reduce waste generation. New or updated equipment can use process materials more efficiently producing less waste. Modifying existing process equipment can be a very cost-effective method of reducing waste generation. In many cases the modification can just be relatively simple changes in the way the materials are handled within the process to ensure that they are not wasted.

Flow Chart of Solid Waste Process & disposal



BOX-I

Extracting Useful Products and Harvesting Energy from Non Recyclable Waste

Landfill

The steps to construct a landfill are:

- Scientific Research about location of the site, geology, underground water level, location of the bodies of the water such as river and the density of the waste.
- Clearing the landfill site of all ground cover.
- Excavation of the ground (the volume of the excavation depends on the results of the first step).
- Construction of the berm all around the landfill site.
- Construction of the liner and leachate management system.
- Construction of High Density Polyethylene (HDPE) which avoids leachate to escape into the environment from the landfill.
- Installation of the leachate and methane extraction pipe.
- Installation of the leachate tank for each landfill cell.
- Installation of power plant generator and flaring system (for generating electricity) or compressor station (for selling methane itself)

Incineration

An Incineration facility processes waste in the following steps:

- Waste is dumped into a waste pit by dump trucks
- An overhead crane picks up the garbage from the waste pit into a hopper which feeds a moving grate that passes through the incinerator furnace
- The waste is set on fire by using 10 to 12 GJ of fuel
- 70% of waste sludge is evaporated [1]
- An additional 1 GJ of fuel is used to reduce the production of hazardous compounds such as organo-chlorines
- Waste is transformed into solid ash and recycled for further application
- Energy is extracted from the toxic fumes produced by generating steam in a boiler
- Steam is used to turn a turbine to generate electricity
- Toxic gases pass through an electrostatic precipitator to allow the dust to settle
- The toxic fumes then go through flue gas and other cleaning systems before being released into the atmosphere through smoke stacks

Plasma Arc Gasification and Vitrification (Vitrification is the transformation of a substance into a glass, that is to say a non-crystalline amorphous solid)

A plasma arc facility processes waste in the following steps:

- Waste is received and weighed inside a containment building
- Large pieces of scrap metal and hazardous waste are separated from the waste stream
- Waste is shredded into small pieces and fed on a conveyor into a gasification vessel
- Process waste heat from the latter plasma arc conversion phase is used to gasify waste.
- Gas is fed into a plasma arc conversion vessel, where a plasma torch breaks the gas stream down at an elemental level, converting it to an energy rich synthesis gas.
- Fly ash is liquefied in a separate plasma vessel (vitrification process) and is cooled into a glasslike solid called slag.
- Synthesis gas is purified to separate toxic constituents
- Purified synthesis gas is used to fuel a reciprocating engine generator set.
- Excess process heat from the reciprocating engine and plasma arc vessels power a steam turbine to generate additional electricity

The 5Rs Principle: Refuse, Reduce, Reuse, Recycle, Recover

Problems with waste are as old as the human race. Generation of waste causes a loss of materials and energy. It increases environmental costs on society for its collection, treatment and disposal. *Every stage in the life cycle of a product – from its initial creation to its final disposal – can create waste and environmental residuals. The 5Rs Principle offers a sustainable, environment friendly alternative to deal with the enormous challenge posed by waste with its obvious impact on human health, environment and natural ecosystems. It looks at waste as a resource at every stage of its life cycle.* This defines waste hierarchy as a set of priorities for the efficient use of resources and underpins the objectives of waste management and wealth generation.

Refuse*: It encourages the community to* avoid unnecessary consumption and make informed life style choices by selecting items that use least packaging, require the least resources to produce, can be used multiple times. It promotes buying products that are recycled, recyclable, repairable, refillable, re-usable or biodegradable.

Reduce: *It costs much less to make processes more efficient and prevent wastes from occurring than to later consume more energy and materials to capture the wastes and then to reuse, recycle, or dispose of them.*

Reuse: *It involves using resources in their existing forms without further reprocessing thereby minimizing additional labor, material, water, and energy required for recycling.* For example, many household and industrial items can be repaired, re-used, sold or donated to charities, thereby keeping them in the productive economy

Recycle: *It involves transforming resources into a form that can be used as an input to a new process i.e. taking a product or material at the end of its useful life and turning it into a usable raw material to make another product. (e.g., recovering aluminum or plastic from drink containers, reprocessing a by-product from a chemical process, or processing wastewater for secondary use).*

Recover: Resource Recovery occurs after reduce, reuse and recycle have been attempted. It entails conversion of waste materials for the recovery of resources (such as electricity, heat, compost and fuel) or as metals, glass etc. through thermal and/ or biological means.

Disposal or treatment: Finally, the waste hierarchy recognizes that some types of waste, such as hazardous chemicals or asbestos, cannot be safely recycled and direct treatment or disposal is the most appropriate management option.

Circular Economy

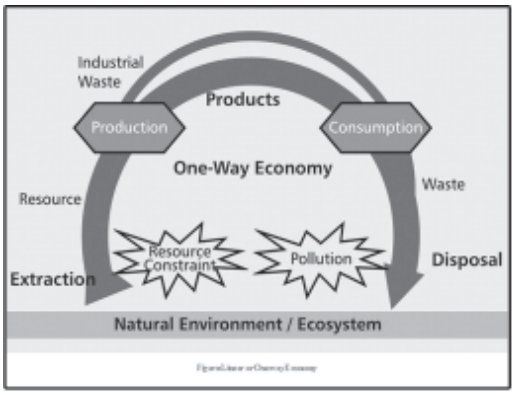


Figure: Circular or Closed Loop Economy

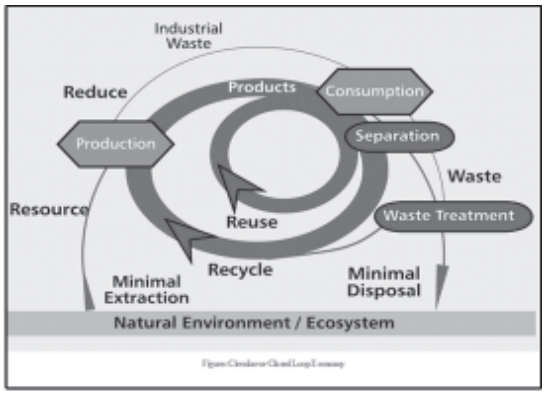


Figure: Linear or One-way Economy

Practicing resource efficiency involves using smaller amounts of physical resources and generating less waste to produce the same product or service. In a resource-efficient economy and society, traditionally 'valueless' wastes can be considered resources for a new tier of the economy. They can be recovered (or prevented from being lost) through greater efficiency and management at every stage of production and consumption. Even many hazardous or toxic materials may be recycled or re-refined for reuse. For instance, it is estimated that 10 million computers contain 135,000 metric tons of recoverable materials, such as base metals, silicon, glass, plastic, and precious metals.

This takes us from a linear economy based on 'take-make-waste' to a closed loop or circular economy whereby materials, components and goods have more than one useful life and are reused, repaired, reconditioned, remanufactured and ultimately cycled at different levels in the economy. There is greater resource efficiency, achieved by reducing consumption and waste of materials, and by reusing and recycling byproducts.

Mathematics of Waste Management and Sustainable Wealth Creation

Consider a typical community with 1 lakh population.

– Average waste produced is 50 tonnes per day with 70% wet waste, i.e. 35 tonnes

– If all of wet waste is composted directly or after producing methane gas, it reduces to 1/5th of its weight. Hence it will produce 7 tonnes of compost per day and 210 tonnes per month.

– If the compost is sold at Rs. 3/kg, it will yield Rs. 6,30,000 per month.

– Additionally about 3 tonnes of dry waste can be sold or converted into useful products everyday.

– The Urban Local Body can earn Rs. 7,50,000 per month or Rs. 90,00,000 annually.

On the other hand, for untreated waste, mixed solid waste management requires the municipality or corporation to spend about Rs. 700 per tonne, which is a minimum expenditure of Rs. 12,600,000 annually without any return on investment except pollution and ill health.

Box-II

Waste to Wealth: The story of a zero garbage hamlet on India's coast

Vengurla, a small municipality just half-hour drive from India's tourist hub of Goa is an example of how a community can effectively tackle waste. It recycles every bit of the 7 tonnes of waste generated each day by the community. Converting its waste to wealth, it earns a hefty income, which is ploughed back into municipal activities. The project is led by Ramdas Kokare, the chief officer of Vengurla municipality under the aegis of United Nations Development Porgramme (UNDP). According to him, Waste is not a problem. It is the mixed waste and its segregation that is the real challenge.The highlights of this achievement are:

- Waste is segregated at the primary source of generation by households.
- 3,000 households separate waste in up to four different coloured bins. Municipal collectors pick up waste six days a week and transport it to the municipal dumping ground. The waste collection centre, has lush green gardens developed using organic fertilizer. Here it is further segregated by 20 workers in to 23 categories.
- Wet waste is used to generate biogas, producing 30 units of electricity per tonne. This powers all the machines in the dumping ground.
- One of the machines powered by the biogas is a plastic shedding machine. It crushes up to 180 kg of light plastic everyday.
- Used with bitumen, shredded plastic is effective in helping build sturdier roads that are able to withstand more wear and tear. These roads offer greater resistance to inclement weather, and reduce costs. A one kilo metre stretch of road can use up to 1 tonne of plastic or 1 million carry bags, and save INR 10,000 per stretch.
- *Vengurla* has 12 km of 'plastic' roads and earns Rs.15 per kg of plastic sold to contractors for road building in nearby areas.
- A briquette machine helps process dry waste such as cloth, paper, cardboard into briquettes, which are sold to nearby industries as alternate fuels for boilers.
- Heavy plastic is sold to cement factories where it is melted at 3000 degrees Celsius.
- Each month, the municipality earns Rs. 150,000 which is used to improve solid waste management systems in the village.
- The facility has drawn 7000 visitors so far.

3.8. Waste to Wealth: Some Examples from the Field

3.8.1. Conversion of Waste Plastic into Liquid Hydrocarbons/Energy

Prof. Alka Zadgaonkar and Dr. Umesh Zadgaonkar invented the process to convert waste plastic into useful products like furnace oil and LPG. The process is based on the principle of random depolymerisation and involves selective breaking of C-C bonds. Both plastics and petroleum derived fuels are hydrocarbons. However, the plastic molecules have longer carbon chains than those in LPG, petrol and diesel fuels. Therefore, it is possible to convert waste plastic into fuels. The process is a thermal selective splitting reaction of the large molecular weight polymer carbon chains under an oxygen free environment and produces small molecular weight molecules.

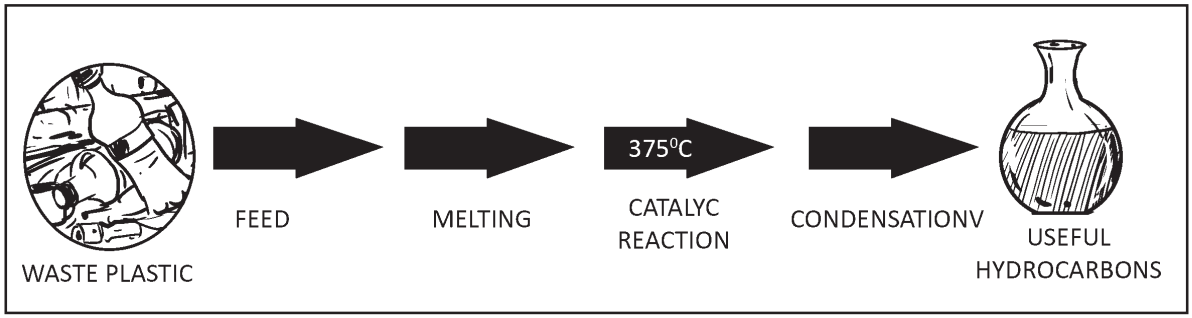
Output from 1 kg of Plastic

Name of End Product	Quantity	End Users
Liquid Hydrocarbons	600 - 800 gm	Agricultural pumps, D. G. sets, boiler fuel, marine fuel (bunker), input feed for petroleum refineries, Fuel oil
Coke	70-100 gm	Nearby industries using LPG, in-house consumption
Gas	Equivalent to produce net 2.25 units of electricity	Thermal power plants, metallurgical industries

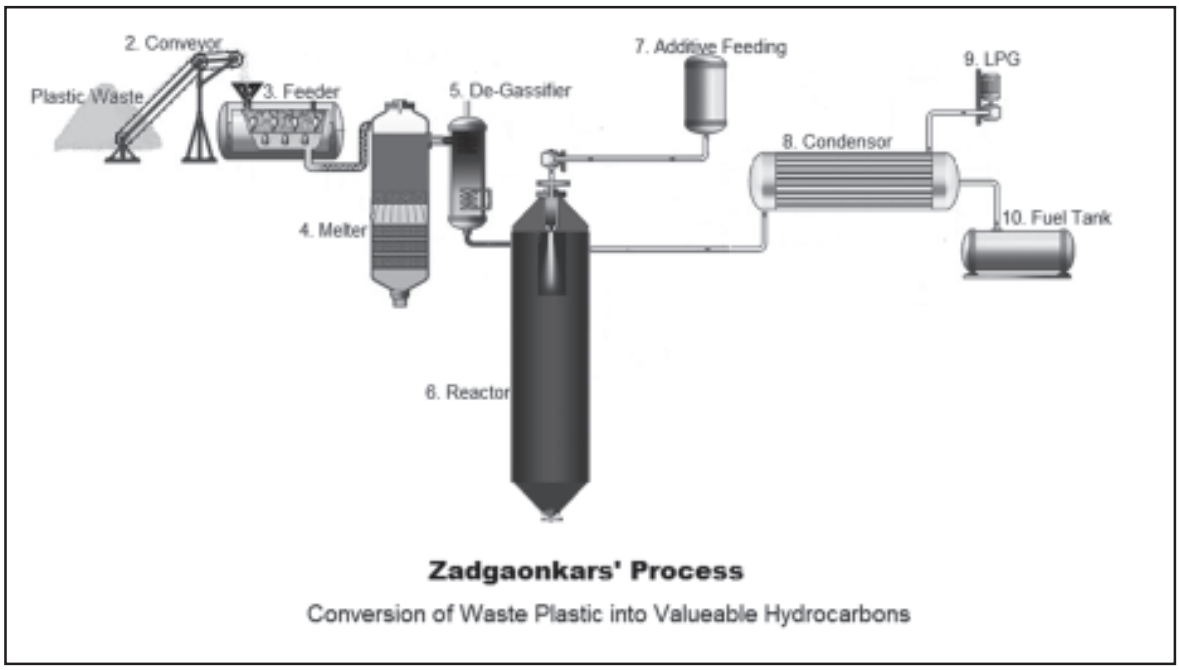
Input: Carry bags, broken buckets and chairs, PVC pipes, CDS, computer keyboards and other e-waste.

Advantages:

- 100% waste is converted into value added products.
- Solution to the waste plastic problem, can change global economic scenario by saving millions of dollars in import of crude oil
- No preparatory cleaning or segregation
- Easy transportation of bulky waste
- Sulphur content in the fuel generated is less than 0.002 ppm
- There is no emission in the atmosphere or liquid effluents
- High quality of Liquid Distillate, matches de-sulphuised crude oil



Source: http://www.ipiindia.org/recycling/item/plastic-fuel-alka-zadgaonkar-pdf (Retrieved on 27 June 2017)



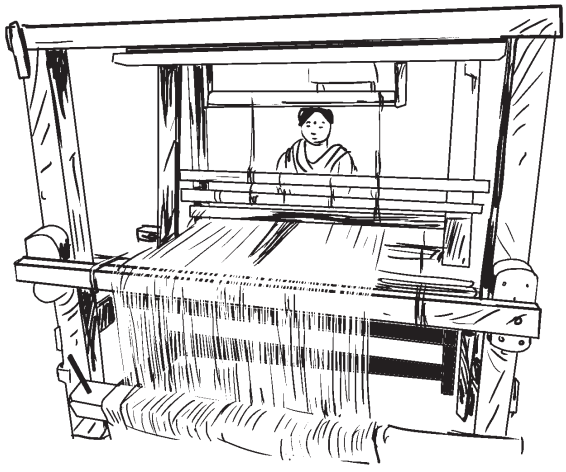
3.8.2. Bio-Methanation Plant at Koyambedu Wholesale Market

The Bio-Methanation plant was established in Koyambedu Wholesale Market Complex (Chennai, Tamil Nadu) as a unique national level demonstration project in order to utilize the organic waste generated from the perishables market for power generation. This project is a joint venture between Chennai Metropolitan Development Authority and the Ministry of Non conventional Energy Sources (MNES) of Government of India. The plant is designed to handle about 30 Metric Tonnes of perishable wastes per day and will generate on an average of 2375M^3 of gas through 'Bio gas Induced Mixing Arrangement' (BIMA digester) to produce 5000 units of electricity per day. The energy production is being fed into the TNEB grid. The plant is functioning since 4 September 2005.

Source: http://www.cmdachennai.gov.in/mmc.html (Retrieved on 28 June 2017)

3.8.3. Polythene Recycling Unit by CEE

Plastic recycling is an alternative method to prevent plastic from entering our environment and thus, reducing the menace. Centre for Environment Education (CEE) has developed the 'Polyloom' which is a plastic weaving handloom that helps reuse and recycling of discarded plastic bags (polybags). The Polyloom is used to produce plastic woven fabric with different designs, which is then used to tailor and create finished products like bags, pouches, bottle holders, etc.



Source: Zero Waste System booklet published by Centre for Environment Education (CEE)

3.9. Project Ideas

Project – 1:

Conversion of Leftover Mid-Day Meal to Animal Protein

Introduction

In a large number of schools across the country, mid-day meal is served to the school children. Out of the total amount of food cooked, an average of 10-15% is getting wasted. In a country like India where world's highest demographics of children suffering from malnutrition and under nutrition related diseases, these leftover or food scraps (considered as waste) may be reused as food for animal that will become the source of proteins which otherwise create negative impacts on the ecosystem through decomposition and environmental pollution.

So for achieving green and clean environment around the school as well as efficient use of such leftover food vis-à-vis of cooked food, the study has been planned to use this as feed for some domestic animal which may become a source of animal protein for the poor community.

Considering the fact that many a communities living below poverty line (BPL) rear pig for their livelihood; and hence, this particular domestic animal may be considered suitable for the study.

Hypothesis

The leftover mid-day meal will help in growth and increase in body-weight vis-à-vis source of animal protein.

Objective

1. To study impact of food type on rate of growth and body weight of the experimental animal.
2. To compare the nutritional values of food materials consumed by the animal.

Methodology

Step- I

(i) Keeping record of type and amount of leftover amount of mid day meal for at least one month, considering holidays.

(ii) Gathering information on type and amount of food of animal provided by the local grower.

(iii) Calculating the cost of food per month

(iv) Calculating the food needed per animal for normal growth

(v) Analyzing nutrient values of both the foods (this can be done from some laboratory

Step- II:

Experimentation

The domestic animal 'pig' (piglet) has been considered for conducting this experiment

Material Required

(i) 15 number of pigs of same breed and preferably of same age

(ii) 4 enclosures (2.5m x 2.5 m) with split bamboo to be constructed in some protected area (may be within school compound)

(iii) Food

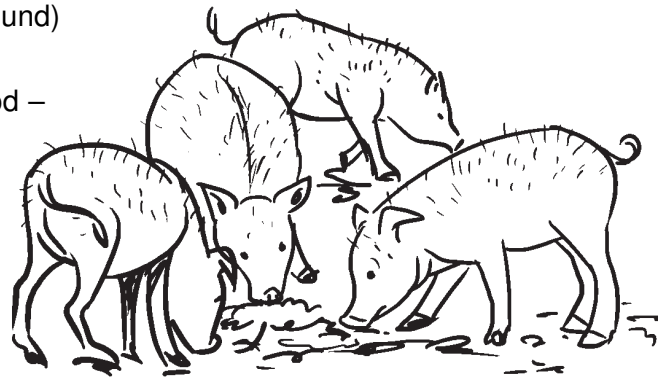
(iv) Tray (4 numbers) for providing food – one for each enclosing areas.

(v) 4 containers for providing drinking water

(vi) Measuring tape

(vii) Plastic tags and thread

(viii) Notebook, pen, etc.



Step- III

(a) 15 number of pigs of same breed and age, selected for study, are to be divided into 5 groups consisting 3 numbers in each.

(b) The groups to be assigned identification marks with tag as 'A', 'B and 'C', where

- Group A will grow on waste mid-day meal
- Group B will grow on Grower's food
- Group C is the control group of animal who will live on open field/range (*These groups are termed as 'Treatment'*)

To avoid error all the three members of each of the groups to be tagged with indicative mark as P1, P2 and P3

(c) The four cages are to be labeled randomly as A1, A2 and B1, B2.

(d) This is simply repetition of the treatment, known as replication.

(**Note:** For minimizing error in any experiment, the number of replication (or repetition) of the treatments should be minimum 3, but for convenience of the children and other constraints, here example has been given with two replications)

Step- IV

(i) At the beginning, children will put batches of 3 animals in each of the , leaving outside the rest 3 animals for control treatment.

(ii) Animals kept in the enclosures are to be allowed to stay within the enclosures with normal grower's food for 4-5 days with the aim to acclimatized/ adapt the artificial living condition.

(iii) Children will take measurements of girth and body length (from neck to base of the tail) and record it in tabular form given below:

Caution: The measurements must be taken in presence of some Veterinary Practitioner or some grower, having experience in handling the animal to avoid any harm to the children

Step- VI

(i) Provide food treatment wise in the cages for 5 working days (i.e. from Monday to Friday); then provide the animal with grower's food for 2 days (Saturday & Sunday).

(ii) Take measurements at the early hour on next Monday, followed by providing treatment wise food for next 5 working days.

(iii) After every day, similar measurements are to be taken as recorded in similar table.

Table 1: Initial information on girth (in meter) of the animals

Treatments		P1	P2	P3	Mean
A	A1				
	A2				
	Mean				Mean value of A
B	B1				
	B2				
	Mean				Mean value of B
C	C				Mean value of C

Step- VII

(i) Considering the information (data) noted in Table-1 & 2, children will calculate body weight using the standard formula given below:

$$W = (G^2 xL)/69.3 \text{ in kg}$$

Where , W = body weight in kg,

G = girth in mtr.

L = length of the body, in mtr.

Table 2: Initial information on body length (in meter) of the animals

Treatments		P1	P2	P3	Mean
A	A1				
	A2				
	Mean				Mean value of A
B	B1				
	B2				
	Mean				Mean value of B
C	C				Mean value of C

The value 69.3 is the conversion factor from FPS to MKS system

(ii) They will compare the growth pattern with respect to control.

(iv) Data will be presented using simple statistics and mathematics.

(v) The calculated values to be noted in the similar table (shown below) and then they will put the mean values as well.

(vi) Convert body mass into protein using conversion factor as per ICMR or WHO standard.

(vii) The data should be analyzed using simple statistics.

Table- 3: Initial information on body body weight (kg) of the animals

Treatments		P1	P2	P3	Mean
A	A1				
	A2				
	Mean				Mean value of A
B	B1				
	B2				
	Mean				Mean value of B
C	C				Mean value of C

Conclusion:

1. From the analyzed data, conclusion to be drawn if leftover mid-day meal is superior over grower's food with respect to nutritive value and if it really help in improving really has impact on growth and development of pig, which will indicate increment in protein availability for the community as well.
2. The leftover mid-day meal which is usually dumped nearby school compound acting as breeding ground for mosquito and other insects can be stopped through transforming it to source of animal protein.

Project – 2:

Organic Material to Compost

Food waste sealed in a plastic bag on a landfill site doesn't decompose properly. Instead, it produces methane, a greenhouse gas, which contributes to global warming, as well as a liquid, leachate, which can contaminate water supplies. But composting your kitchen food waste is easy and requires little time, effort or space, depending on which system you use. The compost is invaluable for the soil in your garden or potted plants. It's a complete and natural food for the soil, helping to improve its structure, water-retaining abilities and overall health.

Composting is simply the process of breaking down the organic matter (food waste) in the presence of air and water, using micro organisms and small insects present in nature. The end product is called compost which is rich in readily usable plant nutrients forming a part of healthy soil.

Materials which can be used for composting

- Vegetable and fruit peels
- Tea leaves and coffee grounds
- Crushed egg shells
- Grass cuttings and leaves
- Paper, paper towels and newspaper
- Leaves from non-coniferous trees and shrubs
- Wood
- Straw, hay, wool, sawdust and pets' bedding
- Vacuum dust

Note: Avoid meat, fish, and cooked food, weed seeds, diseased plant material, disposable diapers, glossy newsprint and coal ash. Also avoid citrus fruit and onion peelings (which cause acidic conditions), plant seeds, meat, fish, dairy products, dog and cat droppings, spent tissues, diseased plant material and anything in excess.

Composting organisms require 4 conditions to create compost

1. Carbon that comes from brown organic matter like dried leaves, sawdust, paper
2. Nitrogen that comes from fruit and vegetable waste
3. Oxygen which comes from air
4. Water in the right amounts

Steps to compost your kitchen waste

1. Separate your edible kitchen waste (vegetable peels, fruit peels, small amount of wasted cooked food) in a container
2. Collect dry organic matter (dried leaves, sawdust) in a small container
3. Take a large earthen pot or a bucket and drill 4 – 5 holes around the container at different levels to let air inside.
4. Line the bottom with a layer of soil.
5. Now start adding food waste in layers alternating wet waste (food scraps, vegetable and fruit peels) with dry waste (straw, sawdust, dried leaves).
6. Cover this container with a plastic sheet or a plank of wood to help retain moisture and heat.

Every few days, use a spade to give the pile a quick turn to provide aeration. If you think the pile is too dry, sprinkle some water so that it is moist.

Within 2 - 3 months, your pile should start forming compost that is dry, dark brown and crumbly and smelling of earth.

By segregating, recycling and composting, a family of 4 can reduce their waste from 1000 Kg to less than 100 kg every year.

1. You can calculate the amount and percentage of compost produced out of the total amount of organic matter used.
2. Effective composting should have Carbon- Nitrogen ratio (C : N) in the range of 30:1 to 40:1. Carbon and Nitrogen content in the compost can be assessed using simple Soil Testing Kits.
3. One can identify the type and number of macro-organisms harboured in the final product (Compost). This can be converted into per cent or in any other suitable forms.

Project – 3:

Efficacy of Natural Additives in Recycled Paper for Use as Shelf Liner for Prevention of Infestation by Household Pests

Introduction

A common household problem is invasion by pests such as cockroaches, silverfish, ants, moths et cetera. No household is completely bug proof. The problem can be equally intense in densely populated urban areas such as in apartment blocks and attached housing as well as areas with lot of open land.

The efficacy of most commercially available household pest repellants that are available off the shelf is doubtful. They are potentially toxic and often pose a health hazard when they

come in contact with kitchen utensils, food items, clothing and stationery items stored in open shelves and closed cabinets. Traditionally, Indian homes have used plant based repellants to control the menace. For instance, dried Neem leaves are spread under a paper liner in wardrobes; neem and clove sachets are tucked strategically in storage drawers, even in rice and grain bins; strong natural oil extracts are applied to drawer corners as repellants. However, efficacy of these practices is not scientifically proven. Preventing infestation remains a global challenge.

Objective

1. To prepare recycled paper using commonly occurring herbs and natural waste material such as Neem (Azadirachta Indica) leaves.
2. To explore qualitatively the effect of “Herbal” Paper on common household pests such as ants, cockroaches and silver fish.

Material Required

Discarded paper notebooks or scrap paper, bucket, hot water, arrowroot starch, alum powder, measuring spoons, kitchen mixer/grinder, scissors, weighing balance, wire gauge sheet (60cm x 60cm) fixed in a thin wooden frame, (60 cm x 60 cm) pieces of fine muslin cloth

Methodology

A. Preparing Neem Paper

1. Shred used notebook sheets or scrap paper into small pieces. Put the shredded paper into a bucket, cover with water, and stir till completely wet. Leave over night to soak completely.
2. Grind the paper finely using the mixer/grinder available at home in small lots to make paper pulp. About 600 g of paper pulp is needed to make 6 sheets of recycled paper.
3. Take Neem leaves and grind to make 200 g of pulp using the mixer/grinder.
4. Take six bowls labeled as C, A1, A2, A3, A4, A5. Bowl C will be the ‘control’ paper pulp with no additive. Add the ingredients as given below and mix well.

Ingredient (in g)	Bowl C	Bowl A1	Bowl A2	Bowl A3	Bowl A4	Bowl A5
Paper Pulp	100	100	100	100	100	100
Neem Pulp	Nil	10	20	30	40	50
Arrowroot Starch	05	10	15	20	25	30
Alum Powder	10	20	25	30	35	40

Now you have paper pulp with 5 different concentrations of Neem additive. Mix thoroughly.

5. Take the wire gauge strainer and spread the pulp from Bowl C evenly on it to make a sheet of paper. It helps to dip in a slightly bigger shallow trough of water to get an even

spread of pulp. Spread a muslin cloth slightly bigger than the size of the strainer. When the excess water has drained out, lift the paper sheet along with the cloth lining. Place on a hard surface (ply board or table) and press under a wooden board to smoothen the surface. Remove from under the board and leave it to dry hung on a clothes line in the sunshine. When dry, separate from the cloth lining.

6. Repeat the process to make paper sheets from the pulp containing Neem additive in the remaining bowls. It is also possible to place one sheet on top of the other along with the muslin lining and then press them all together to remove excess water. See figure.
7. When dry, label the sheets as C, A1, A2, A3, A4, A5. Trim the edges slightly to make these of equal size.

Table 1: Effect of Neem Additive in Recycled Paper on Insect Pest (Ants)

Label	% Neem Additive	Time spent by the pests on the paper (minutes)									
	(g)	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7	Day 8	Day 9	Day 10
C	None										
A1	10										
A2	20										
A3	30										
A4	40										
A5	50										

B. Investigating the effect on household pests

1. Collect pests such as ants, cockroaches and silver fish and place in a bottle.
2. Spread the sheet of paper C on floor or a table. Place a counted number of pests on it. Observe their behavior to record the time spent by the pests on the paper. Record your observations on the motion in the Table 1 given below for a specific pest, repeating the experiment for at least 10 days.
3. You may take a video of the motion using your smartphone.
4. Repeat this with each of the papers labeled A1, A2, A3, A4, A5.
5. The experiment can be carried out for a longer duration to test the duration for which the paper with additive retains its property.
6. Repeat with other pests, recording observations in similar tables.

C. Effect of other herbal additives

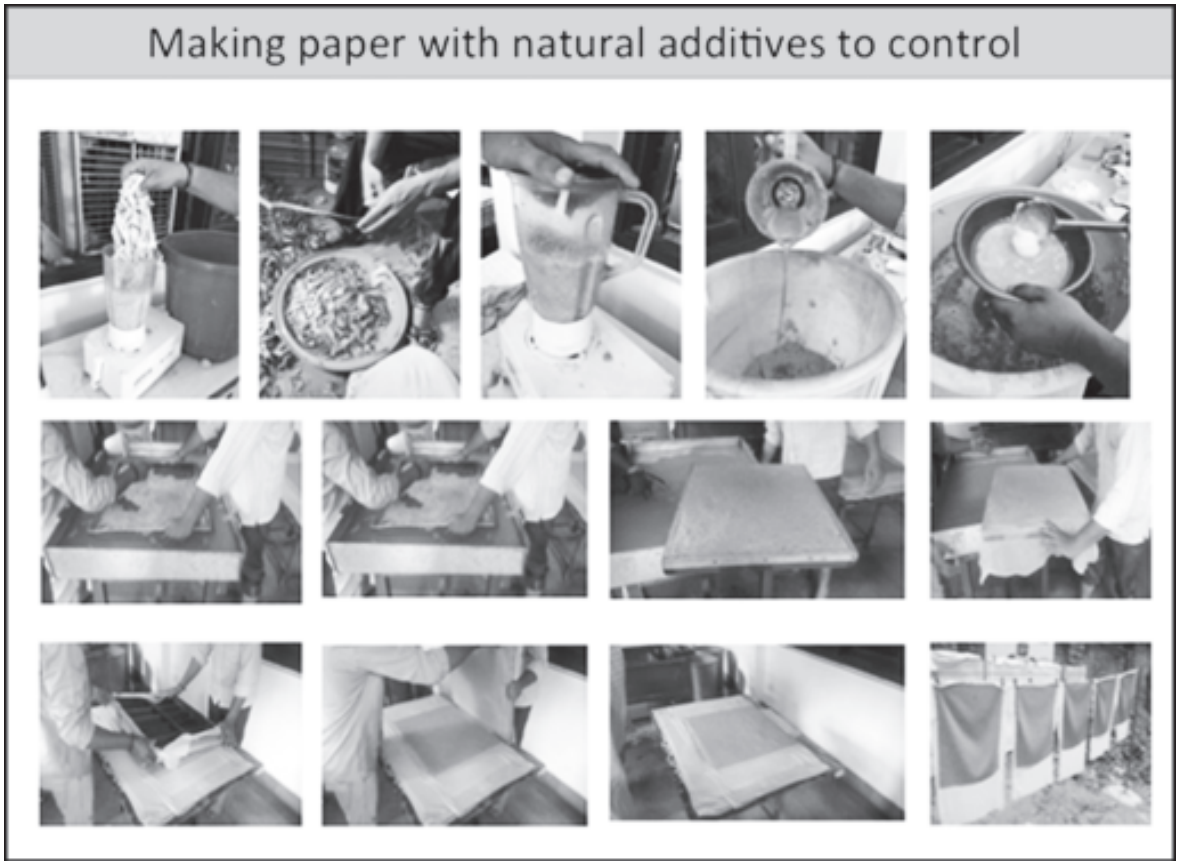
Repeat the experiment making paper with other additives such as *Pudina/ Mint* leaves (Mentha), *Ganjini/Malabar/Guchchh* (*Citronella* grass), *Haldi/ Turmeric* (*Curcuma longa*), Orange (*Citrus reticulata*) peels, Lemon (*Citrus limon*) peels, Cucumber (*Cucumis sativus*) peels.

Record your observations in tables similar to that given above, for different pests.

Conclusion

From the above data, draw conclusions about which herbal paper is the most effective in repelling household pests. Some questions to answer are

(i) how effective different herbal papers are in repelling household pests?
(ii) what is the effect of changing the concentration of the additive?
(iii) how long does the paper with additive retain its property?
(iv) does each additive have the same effect on different pests?
(v) which additive is most effective for a particular type of pest?
(vi) if instead of paper sheets, herbal balls are prepared from the mixtures in Bowls A1, A2, A3, A4, A, would they be equally effective in repelling the pests?



Project – 4:

Effect of Applying Different Waste Material as Mulches, on Population Density of Macro-Organisms

Introduction

Macro-organisms such as earthworms are regarded as farmer's best friend. They are responsible for soil development, recycling organic matter and form a vital component within many food webs. A mulch is a layer of material applied to the surface of soil for conservation of soil moisture, improving fertility and health of the soil, reducing weed growth and enhancing the visual appeal of the area. A mulch is usually, but not exclusively, organic in nature.

Objective

1. To identify different waste material that can be applied as mulch
2. To study about the effect of different material as mulch on earthworm population density

Materials Required

Seven sample plots of 1m x 1m in farm or garden soil; pegs and string, waste material to be used as mulch – coconut husk, fruit and vegetable waste, polythene bags – 1 kg per plot; weighing balance; spade, tray

Methodology

1. Identify the area where you will conduct the experiment- farm, kitchen garden, school garden.
2. Demarcate seven plots of 1m x 1m each keeping at least 1-2 m distance in between the plots.
3. Randomly label the plots as C, A1, A2, B1, B2 , D1, D2
4. Plot C will be the 'control' plot while plots A1, A2, B1, B2 , D1, D2 will be covered with different types of waste materials as mulch.
5. Each treatment will be replicated twice. (Note: The replication should be minimum 3 in numbers , but for convenience of the children and other constraints, here example has been given with two replications)
6. Begin by taking five random samples. Using a spade, dig upto a depth of 15 cm and collect the soil carefully along with all the macroanimals.
7. The collected soil is to be kept on a tray and of earthworms to be counted. Note their number in the given table 1. Reintroduce the soil back to the plot after the count.

Table-1: Initial information on earthworm population density

Sample collected	No. of Earthworms Present	Mean (Total no. of Earthworms/ No. of samples)

8. The plots will be now prepared for experiment. Apply coconut husk mulch to plot A1, A2. Apply vegetable and fruit waste mulch to plot B1, B2. Apply shredded polythene bag to plots D, D2.
9. Observations are to be taken over a period of one month. After each week, soil samples are to be collected from each plot for counting earthworm population and are to be recorded in Table 2.
10. The next step is to compare the population density with respect to control.
11. Data will be presented using simple statistics and mathematics.

Table 2

Treatments	No. of Earthworms present			Mean		
	Week 1	Week 2	Week 3	Week 4	Week 5	
A	A1					Mean value of A
	A2					
	Mean					
B	B1					Mean value of B
	B2					
	Mean					
D	D1					Mean value of D
	D2					
	Mean					
C						Mean value of C

Conclusion

From the analyzed data, conclusion to be drawn if different mulch has any effect on population density of macro organisms.

3.10. Additional Project Ideas

1. Fuel from Animal excreta such as cow dung, bio fuels
2. Handling of E-Waste
3. Identification, documentation & classification of the amount of electronic and electrical goods left unused in one's locality & look out for means for disposal and/or re-use.
4. Solid waste processing and disposal
5. Preparing Briquettes and checking efficient use for soil less plantation
6. Minimizing wastage of irrigation water through improving water retention in the soil using various wastes eg. wood shavings, briquettes, paddy husk, coconut choir, etc.
7. Bio remediation of waste water
8. Hydroponics using grey and/or black water
9. Treatment of kitchen waste water for removal of Fat, Oil Grease
10. Preparing natural dyes from leaves, flowers, fruits of weeds
11. Conversion of discarded flowers into useful products
12. Extracting oil from the seeds of weeds, to be used for illumination
13. Retention of soil moisture using wood shavings, briquettes, paddy husk, coconut husk, hyacinth in crop fields
14. Using paddy straw as substrate for mushroom cultivation
15. Use of Graphite from used batteries (dry cells)
16. Enhancing fertility of land using various wastes
17. Plastic decomposition by bacteria
18. Investigating properties of sponge for water retention and growing plants
19. Use of thrown away corrugated cardboard for making of tiles, panel boards, etc.
20. Preparing tiles and panel boards from tetra pack/ plastic bottles
21. Preparing fertilizer & other useful products from the carcasses
22. Innovative techniques for converting agriculture wastes into useful products

Survey based projects

1. Finding out the average waste generated per day at home. Extend the estimation to waste generated by the block, village, district, etc.
2. Study the packaging trend and estimate the associated wastage
3. Monitoring air quality around waste landfill and garbage dump areas
4. Diversity of organisms/ animals around land fill areas and linkage to vector borne diseases.
5. Impact of polluted water due to presence of waste dumping sites on public health

Information Sources

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Sub-Theme-IV

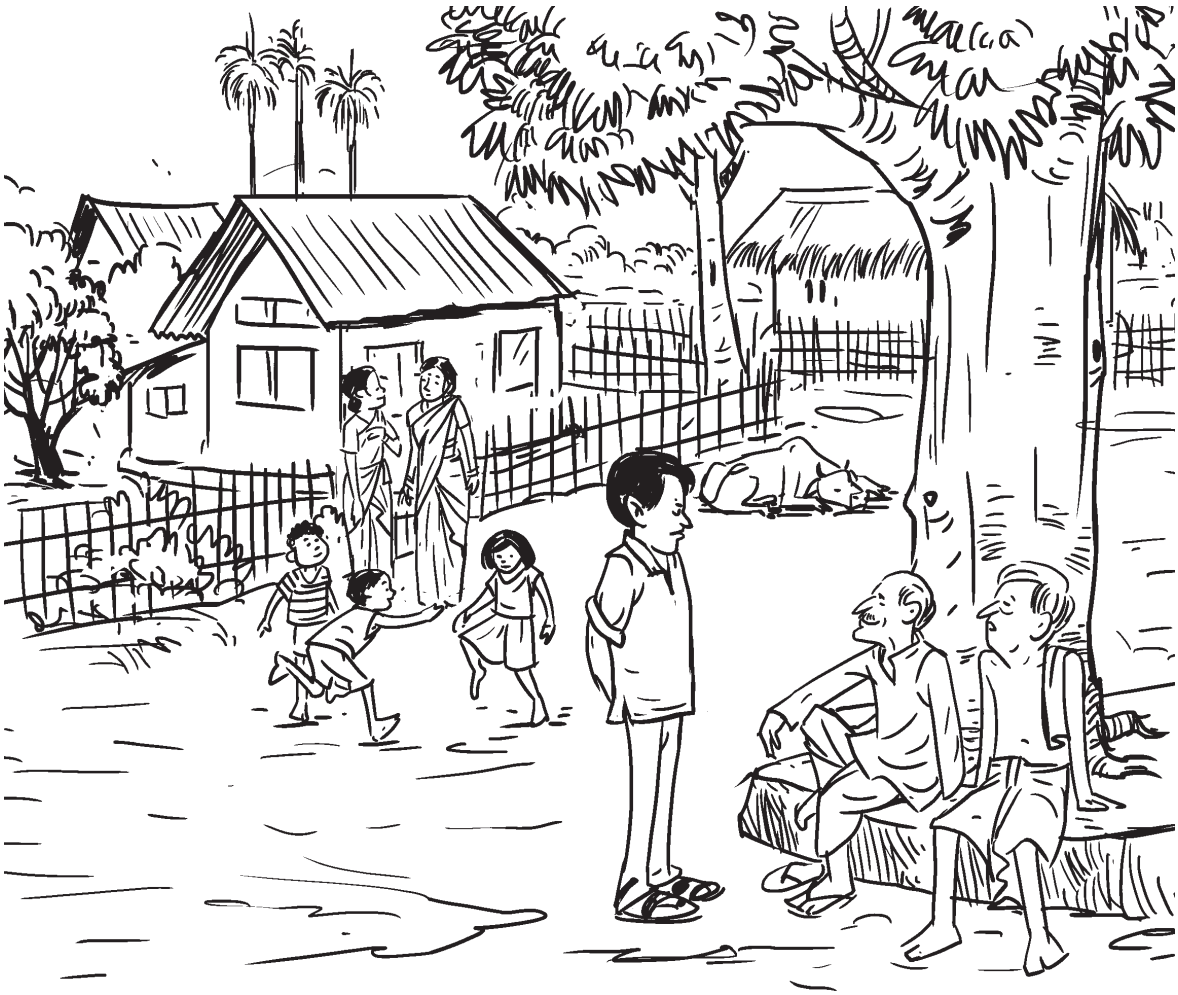
Society, Culture and Livelihoods

Society, Culture and Livelihoods

4.1. Background

Society is a total representation of intricate human relationships that grows out of action. It can be defined as collection of individuals united by certain relations or mode of behaviour which differentiate them from others who do not enter into these relations or who differ with them in terms of behaviour. It also refers to the complex organized associations and institutions within a community. Society can also be described as a group of people who interact based on a common culture; where 'Culture' is a pattern of ideas, customs and behaviours as well as the way of life shared by a particular people or society.

There are five basic components of a society, viz. *Population, Culture, Material Product, Social organization and Social institution.* Here, population represents demographic characteristics of a population which includes age, sex, skill, education, occupation etc. Material product includes objects or belongings of human being. Social organization is a pattern of relationship between and among individuals and social groups (social group means



when two or more people collectively have a sense of unity). Social institution is a system that ascribes role, responsibility, rights and reward approaches and mechanism of a society.

Culture incorporate values, norms, beliefs, knowledge, language and symbols where value denotes a principle or standard as a behavior that is considered as important or desirable. Norms are informal understandings that govern the behaviour of members of a society or an established orderly way that groups or individuals look at philosophical views. Knowledge represents know-how, skill and understanding about certain concepts, functions, relationships, etc. Language is the means of communication, symbol represents specific perceptions, ideology etc.

Livelihood means making a living and it covers fulfillment of basic necessities of life which incorporate security of food, shelter and clothing along with health and education. More specifically, a livelihood comprises the capabilities, assets and activities required for a means of living. A livelihood is sustainable when it can cope with and recover from stresses and shocks and maintain or enhance its capabilities and assets both in present and in the future, while not undermining the natural resource base.

Society, culture and livelihood are linked mainly through environmental context where people live. Ecological setting of a region, where people live in, is a factor that determines many aspects of social and cultural practices. The social group formation and its structural pattern vary from region to region with variation of ecological context. For example, small clan based groups have small number of people sharing the same roots living in a small area having a low population density. In such context, the ownership of natural resources also varies. Larger quantities of natural assets remain under village, community or clan ownership; village forest, community forest or clan forest which is most common in Himalayan regions of India. On the other hand, in an area where population concentration is high, the social structure is different. For

example, in densely populated river valley like Ganga –Brahmaputra basin area, social system of the villages are mostly defined by contemporary government system only and no specific institutions evolved because resources are mostly under individual ownership.

Scarcity of natural resources and other environmental stresses or threats like drought, flood, storm etc. promotes different social system or institutions, customs and livelihood practices which may help in developing resilience or disaster risk reduction strategies. In many water stressed areas, there are social institutions for community based management of water resources, like traditional *Dong* management committees among the Bodo communities of Northern Plain of Assam[1]. '*Pani Panchayat*'[2] which is a modern system developed under VO's initiatives for ground water management. Likewise, with variation of ecological contexts, different livelihood practices also vary. For example, in Himalayan highland there are nomadic herding practices among the *Gujjar* or *Bakarwals*[3] of Jammu and Kashmir, *Brokpa* nomadic herding occupational group of *Monpa*[4] tribes of Arunachal Pradesh. Similarly in coastal regions, river valley areas or in wetland areas there are many communities who earn their livelihood through fishing having different social groups and institutions in relation to their occupation. For example, *Pattanavars*[5] are the dominant fisher group residing along the Bay of Bengal coast, from the East Coast on the Krishna River in Andhra Pradesh to Nagapattinam, Tamil Nadu. They have their own internal governance system; every settlement has one or more headmen called '*Yejamanan/Nattamayi'*, who are assisted by *Thandakaran* and a *Paraiyan Chalavathi.* Basic function of these institutions is to maintain social security of the community, because they have different environmental threats being in a coastal environment.

In many circumstances, all the components of a society either discourage or promote social changes or development. Sometime, changes of ecological context in general or natural resource base in particular, changes the people's livelihood practices which in turn result in changes in the social aspects and cultural practices too. For example, there are migrations of people from flood or drought affected areas of the country to urban or industrial areas in search of alternative livelihoods as their original livelihood practices in rural areas are in danger under adverse environmental impact. In such contexts, when people migrate to urban or industrial area, occupational changes takes place which lead to social change in a larger context. Introduction of a certain technology and its adaptation by the community also influences the livelihood practices leading to social and cultural changes. Similarly following the impacts of natural disasters or environmental stresses like flood or drought, the male members of a family may migrate to urban settlements for alternate source of income. This can have an impact on the family structure and change of family leadership to women members of the family, eventually leading to changing social dynamics and cultural practices. So, multidimensional aspects are interlinked with society, culture and livelihood. However, in the present context this sub theme will focus on the understanding of the relations between the following components (table-4.1) given below and such relations can be tuned for sustainable development.

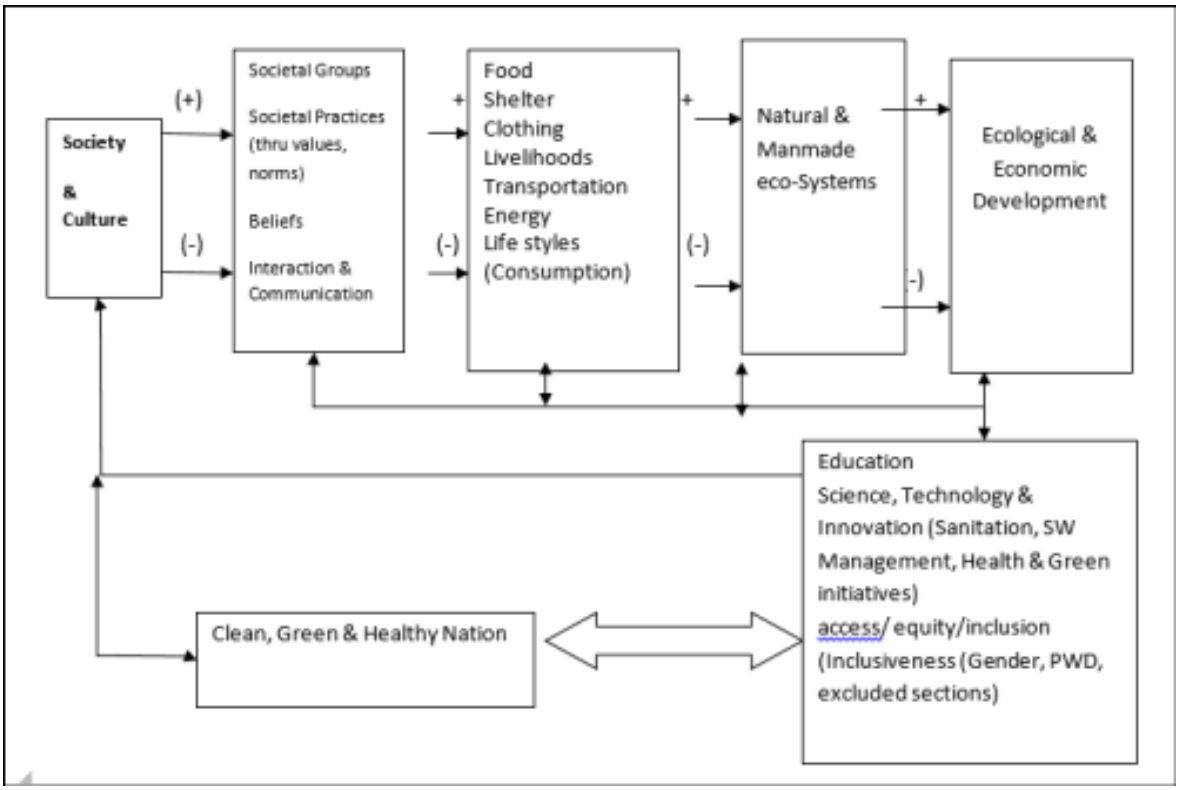
Table- 4.1. Relationship among Society, Culture and Livelihood

Society	Culture	Livelihood
Individual	Belief system (social / religious)	Primary (mining/agriculture /fishing/ animal husbandry etc.)
Family (Joint /nuclear)	Means of communication	Secondary (value addition activities)
Clan	Symbolism and motive	Tertiary (trade and commerce / miscellaneous services etc.)
Occupational group	Technology	
Cultural group	Means of economy	
Ethnic group	Food systems	
Interest group	Festivals	
Institutions related to NRM and Livelihood	Art and craft	

4.2. Focus of the Sub-theme

The primary objective of this sub-theme is to explore, document and analyze the role of all the components of a society and culture; how it promotes cogent living, quality and dignity of life or encourage sustainable lifestyles. At the same time, it will also focus on how the components of society and environmental opportunity of people promote livelihood practices which leads to sustainable lifestyle with security of ecosystem. One can explore critical linkages among society, culture and livelihood components and identify means to achieve sustainable lifestyles with a responsible production and consumption system with the objective of demystification of superstitions & myths and redefine cultural value systems.

4.3. Logical Framework



4.4. Scope

4.4.1. Natural resource management

In certain communities and societies, culture and traditions evolve around the livelihoods of people. Accordingly, these livelihoods and related exposure to its natural resource allow these communities to develop specific knowledge of managing the natural resources they have. For example, *Hira* communities of Assam are traditional potters and have specialized knowledge including what type of soil, where from the soil should be collected at what time of the year. Several customs, societal norms are practiced by these communities some of which are - only the women members make pottery items while male members collect the specific type of soil. The earthen pottery, *Hiramanu*[6] is not merely an occupation for them, but it also depicts their traditional knowledge, customs, creativity, craftsmanship and caste identity of *Hira* society apart from the knowledge on managing the required soil resources.

Similarly many communities have such traditional institutions and management practices related to Common Property Resources (CPR) which provide them food, fodder, fuel, fiber etc. to sustain their livelihood. Best examples are seen among the *Khasi* of the Meghalaya, *Apatani* of Arunachal Pradesh, *Gond* tribes of Chhattisgarh and Jharkhand, etc. New and innovative approaches under the changing contexts of present day scenario may also contribute towards new livelihood opportunities by facilitating better nature resource management practices.

One may think on similar lines while conceptualizing project area in their respective geo-ecological regions.

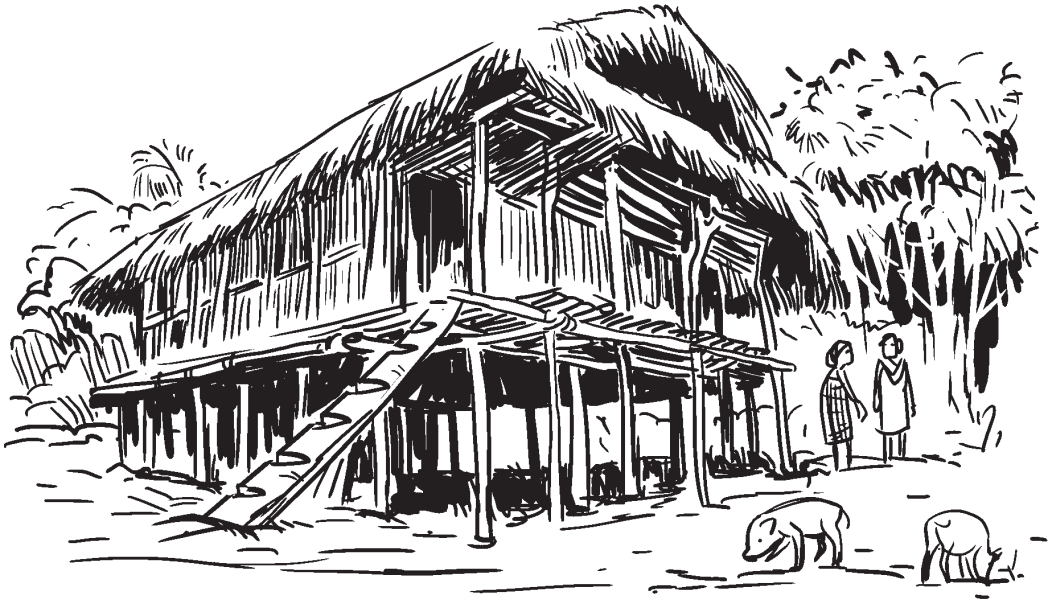
4.4.2. Biodiversity / Wildlife conservation

Traditional customs, norms and beliefs within a society that promote biodiversity conservation to a great extent ensures sustainable livelihoods for communities. From experiences and observation, indigenous communities living in harmony with nature have realized that conservation of biological resources are important for their life and livelihood and thus needs attention. Such realization has taken the form of conserving the agricultural crop diversity, fish diversity and has been integrated in the culture and folk traditions of the society. For example, restriction of fishing during the breeding season promotes conservation of local fish species available in natural environment and thus ensures the livelihood security of fishing communities. Similarly among the *Bodo* Community of Assam people with the surname *Mushahary* believe that they have certain relationship with tigers and hence killing of tiger is considered as a taboo among them. Similarly among the *Karbi* tribe people with surname of *Teron* think of them as descendants of Hornbill and hence killing of Hornbill among *Teron* is considered as a taboo. Similarly, safeguarding *Khejri* tree, Black buck and *Chinkara* are considered as sacred duty among the *Bishnoi* community in Rajasthan. The tradition of conservation of snake groves (*Sarpakkavu)* in Malabar and Travancore are some examples of the integral relationship between culture and biodiversity conservation.

In contemporary contexts also, cultural norms, societal traditions and conservation of biodiversity can give rise to new aspects of livelihoods like eco-cultural tourism. Community cultures and traditions, ethnic cuisines etc. are centered around biological diversity and have immense potential for modern day concepts like eco-tourism, photography etc. Concepts like home stay, village tour have opportunities for embedding cultural norms and practices with biological diversity and their conservation for better livelihood opportunities. So, a new and innovative approach towards these aspects can contribute towards achieving sustainable development.

4.4.3. Climate change resilience and / or disaster risk reduction

The indigenous communities have their own mechanisms of adaptation to any changes in their environment or any type of disasters. These knowledges or mechanisms are many a time part and parcel of their culture and social set up linked with their livelihoods. These customs, traditions within such groups and communities can help them in preparing efficient strategies for disaster risk reduction (DRR) as well contribute towards climate resilient development. These traditions or cultures are inherited or are acquired by the communities, sometimes with conscious interest towards its applicability or sometimes without. For example, *chaang ghar* (bamboo-platform house) is the traditional housing system of *Mishing* communities from Assam. *Chaang ghars* are considered integral to the social system of these communities and their cultural behavior, festivals, rituals are integrated to these housing patterns. However, it is important to know that these *chaang ghars* are important from the point of reducing the flood risk as they are built on bamboo poles maintaining a certain height above the maximum flood level which reduce the risks of damage from floods. Similar practices are available among other communities as well. A number of indigenous building practices that have prevented collapse of structures in seismic zones include *Koti Banal* architecture of Uttarakhand, *Dhaji Diwari* of Kashmir, *Bhongas* of Kutch, brick-nogged



wood frame (*Brick nog* is a construction technique in which *bricks* are used to fill the vacancies in a wooden frame) constructions in Himachal Pradesh and bamboo based *Ekra* constructions in Assam, India are examples of disaster risk reducing cultural techniques. Similarly, many such communities, who dwell by the rivers are prone to risks of flood, follow the strict norms of life skills swimming, riding a boat etc. These customs help them to manage disaster situations.

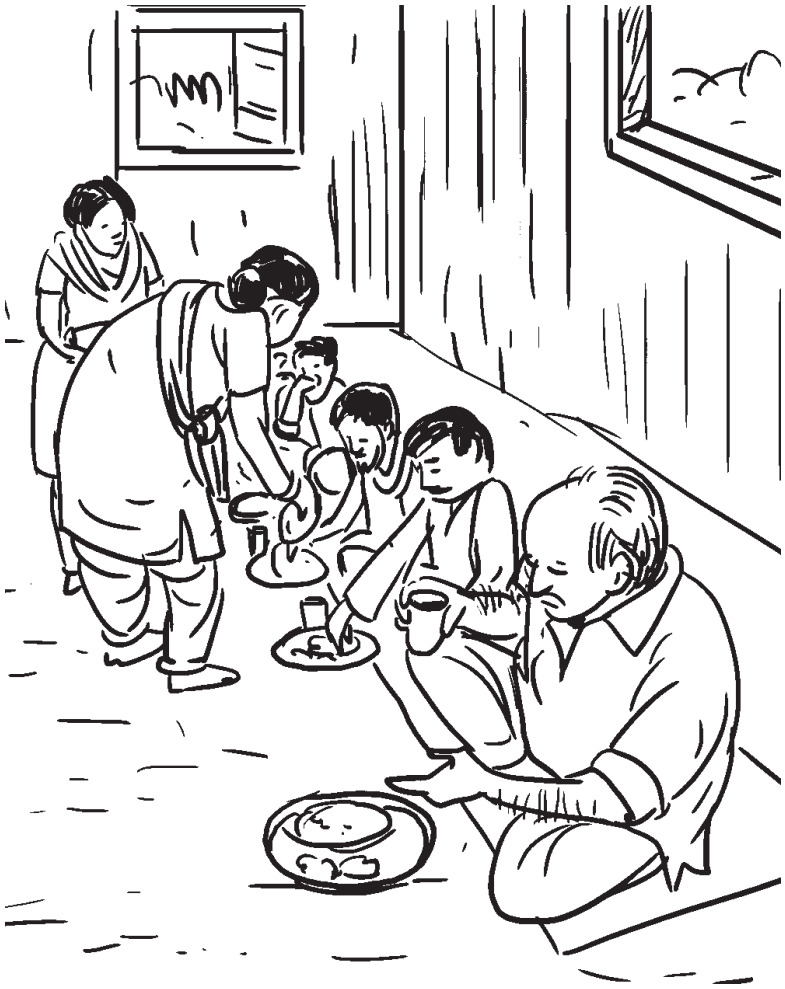
On the other hand, traditional culinary practices bear significant potential for using in a DRR strategy. Many communities have the tradition of sun-drying or smoke-drying of seasonal food items as a part of their traditional cuisine. These food items can serve many purposes viz. maintaining the traditional cuisine or culture, ensuring availability of food during flood or drought etc. Communities in desert areas of Rajasthan are reported to have their own wisdom of specific species, wild crops and plant, which can be grown and utilized during drought or famine like conditions[7].

In traditional societal systems of India, people tend to have more than one skill, thus making them more resilient to any impacts of disaster or climate related stresses. Studies have also indicated that forced migration is less among people or communities with multiple skills than among the specialized livelihood practicing communities. So, learning different skills like ploughing, bamboo artifacts making, boat making, implement making etc are considered important among the farming communities across India, so that people have scope for alternative income.

In contrary to these positive aspects, certain norms and traditions may also have negative impacts on developing climate resilient communities as well as in reducing disaster risks. In many Indian societal systems, women are not considered decision makers and are not exposed to outdoor conditions. They are forbidden from ploughing, rowing boats, climbing trees etc. Such restrictions and norms may push them to certain disadvantageous positions during a disaster. So, a careful exploration of such aspects is required to make everyone in the society resilient to climate induced or no-climatic disasters.

4.4.4. Energy conservation and management

Societies have their own culture and traditional methods for the energy conservation and sustainability. Sustainable livelihood involves relationship between the culture, nature and people. It is through culture that the society is able to innovate new technologies, skills and techniques for the conservation of the energy. For example, in rural parts of India, vast majority of the households are dependent on firewood for cooking. To conserve energy and manage the resources, they have alternatives like sun drying, pickling which provide them nutritious food while conserving energy. There are many examples of such practices in different geo-ecological regions of India among the mountain, coastal, river valley dwellers, which differ from each other in terms of food products and processes. Moreover, among many rural communities where joint family structures are prevalent, they have provision for common food preparation and dining for all the members. *Sanjha chulah* (community oven) as an outcome of community kitchen from northern India is a good example of this. Such cooking and dining practices also help in saving cooking energy because same number of people if they live in nuclear families may require more energy and human-hours for cooking. The same is also true in the case of energy for lighting, recreation, etc. in joint families.



Traditional housing systems practiced in rural areas of India, are based on local climatic and environmental situations, which help them to avoid excessive use of energy for cooling or warming the houses in summer or winter.

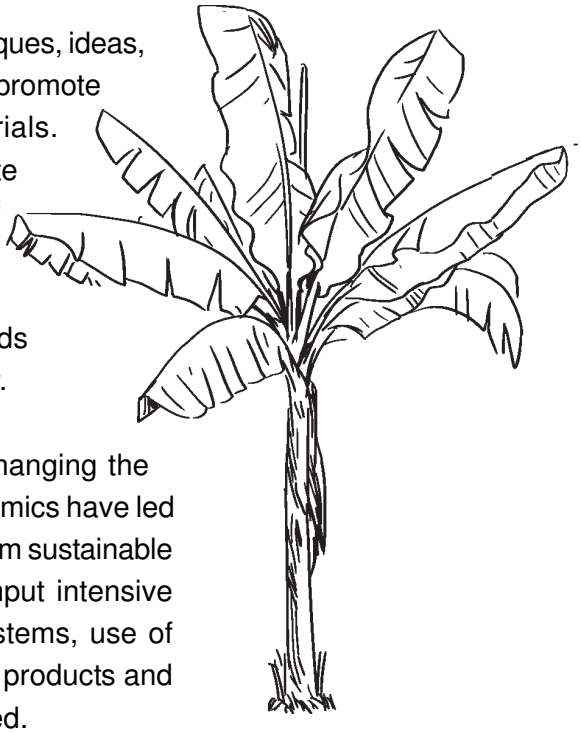
There is a need of scientific verification and documentation of such best practices of energy use or conservation as well as identifying and documenting the linkages to socio-cultural practices and traditions. At the same time, it is also important to identify livelihood potentialities in relation to domestic energy demand in rural context.

4.4.5. Sustainable production and consumption

Unsustainable production and consumption practices lead to an increased pressure on natural resources and long term impacts on the environment. In India, traditional practices that are sustainable and environment friendly continue to be a part of people's lives. India has a history of low carbon footprint and lifestyle[8].

Most indigenous communities prefer to use hand-made products that are made from locally available resources. Maximizing the use of resources available around is a cultural practice followed by most of them. A classic example of sustainable production and consumption in Indian tradition is the banana plant. Different parts of the plant are used for different purposes. While the fruits have immense food value, banana florescence or flower and also stem is consumed as vegetable in traditional cuisine. The leaves are used as food serving plates and for packing food items, before or after cooking. The outer sheath of the stem is used to make food bowls for community or religious rituals as well as to provide shade to the newly transplanted vegetable seedlings in the crop fields. Further, the underground part of the banana stem is used to prepare a natural bicarbonate by sun-drying and burning which have multiple uses like culinary use, as detergent and for medicines. Further, banana stem also yields fibre which is traditionally used to tie leafy vegetables and such other tender items for ease of carrying and now a days are used for making handicraft and handloom items. Rafts made of banana stems are in wide use in many cultures. It is a common practice to plant banana as part of a backyard/kitchen garden to safely manage the grey water. So, from the same plant, we are able to get many different products and services which make the production and consumption processes less waste generating and sustainable. In the states like Kerala, Tamilnadu, Karnataka, Assam etc., jackfruit trees have such multiple uses in traditional systems, thereby reducing the amount of wastage. Apart from that, we have many multi-purpose plant species which can cater to more than one needs.

Similarly, across India, we find various indigenous techniques, ideas, technologies, concepts and innovative approaches that promote reduce, reuse and recycling of products and materials. Colloquially known as *jugaad*, these systems are quite evident in rural and remote areas where availability of modern amenities are very less or sporadic. A careful observation and analysis of such indigenous techniques and technologies can give us a new outlook towards increasing sustainability of our consumption behaviour.



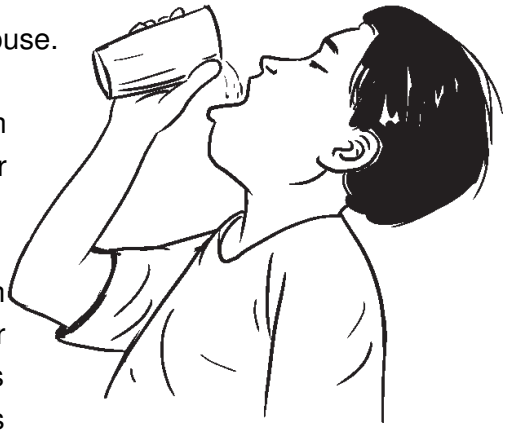
Simultaneously, we may also need to analyze how changing the developmental paradigm, social dynamics, socio-economics have led to a shift in our consumption and production behavior; from sustainable to unsustainable one. Shifting from traditional, less input intensive agriculture to high input requiring crop production systems, use of non-biodegradable items instead of naturally available products and associated impacts and dimensions can also be studied.

4.4.6. Sanitation and health

Society and culture have major impact on sanitation and health. In the society, traditional and cultural beliefs have certain sanitation practices that have major impact on the status of the health.

Traditional medicine and healing practices are integral part of Indian societies. From ages, people in India have learnt to use locally available medicinal plants for curing various diseases. Similarly many sanitation, hygiene and cleanliness related customs are in place across different communities. Every religion, culture and tradition had their own sanitation practices which are influenced by their cultural and religious beliefs. For example, in Indian culture there are various hygiene and sanitation practices that needs to be followed like-

1. Washing of feet and hands before entering the house.
2. Mode of drinking water without contact with lips
3. Washing of hands after urination or defecation with cow dung –ash or mud if they have no bad odour
4. Rinsing of mouth after waking up.



While some of such practices have positive health benefits like avoiding foods that can cause or aggravate certain ailment or can contribute towards reducing the health burden, many of these customs and traditional beliefs also have negative impacts. For example, among rural communities, new borne babies are not allowed to have the first milk or colostrum of the mother. Such practices are also followed in case of reared animals, though this deprives them from life-saving, nutrient rich colostrum which is beneficial for their health. Similarly, pregnant and lactating women are restricted to have some particular food items like sour foods (lemon or lime), which may have an impact on their nutrition. Practices like non construction of the toilet in the residential campus, which is followed by many Indian communities has led to open defecation and resulted in various health issues.

Sanitation and health related customs are also linked to gender dimensions of the society. Women, in traditional Indian households are bestowed with responsibilities of managing water for the family as well as cooking and cleaning of the houses. While doing so, such customs and practices increase the work burden on women (including girl children) with eventual negative impact on their health. Women generally do not get their proper share of food as they eat only after the male members of the family, thus are more prone to malnutrition. Similarly, menstruation related customs and taboos increase inconvenience of the women members in the family apart from increasing associated health risks. Use of unhygienic practices or items during menstrual cycle increase the possibilities of reproductive health disorders and can pose risks to their lives. In some parts of the country the traditional menstrual hygiene practice where post-puberty females have to live in isolation having restrictions on food habits. This has adverse effect on the physical and mental health. Thus women's health gets lesser priority under existing socio-cultural contexts and systems.

Under such circumstances, we need to identify and analyse the positive and negative aspects of sanitation and health related traditions existing in our society so that the best practices can be promoted and harmful ones can be avoided. Understanding and optimizing the societal practices on health and hygiene, and identifying the changes that needs to be made can pave the pathway for a clean and healthy nation.

4.4.7. Use of technology and impact on society

Traditionally the technologies and tools were developed by the communities using locally available material, skills based on local knowledge base to suit the local needs. Technology has both positive and negative impacts on economic, politic, social and cultural structures of modern society. In the late 1960s, Indian policy makers encouraged the use of western based technology to improve agriculture productivity and tackle prevailing food scarcity in the country. Such initiatives drastically changed the Indian agriculture scenario resulting in the introduction of green revolution based technologies in India. The success was however region specific and came at the cost of soil and water degradation, loss of crop diversity owing to use of extensive chemical inputs and introduction of Genetically Modified(GM) crops creating long term negative impacts on the entire ecosystem.

In traditional agriculture system the use of mechanised tools are very limited and practice of community involvement is common. Due to absence of mechanised tools/equipment such system needs collective effort of an entire community so that entire cycle can be accomplished within the specific season. Such existing traditional practices engage the entire community irrespective of gender with specific works being distributed among male and female members. For example, in the North Eastern part of India, ploughing land and sowing of seeds are done by male members whereas female members are associated with planting the saplings, weeding and harvesting. Such practices ensure a minimum employment opportunity to every household of a community. But, in recent times mechanised tools like power tiller, tractor, thresher etc. are being extensively used. No doubt, adaptation of such modern machinery

has improved the productivity and reduced human drudgery. One such technology we can site here is tractor. Due to its adaptability and multi functionality it has been widely used by farmers. Similarly, wide use of biotechnology including use of bio-fertilizers, genetic engineering, tissue culture etc. has brought new hope for farmers from developed as well developing countries. Another remarkable development is drip irrigation technology which helps farmers for effective use of water.

It also imparts the society negatively. One such negative side of use of such advanced technologies is the recent decline in opportunities for women. For example, introduction of mechanical weeders have taken away job opportunities of women having a negative gender role. Extensive use of big machinery in agriculture has led to the decline of invertebrates like snails, earthworms, ants etc., thereby disrupting the overall ecosystem.

Hence we need technologies which are economically, environmentally and socially sustainable so that we can improve the traditional system and at the same time keep the employment opportunities alive.

One may think on similar lines while conceptualizing project area in their respective geo-ecological regions.

4.4.8. New technologies and livelihood opportunities

New innovations in the field of renewable energy have brought many opportunities to rural areas. It has helped fight against climate change and at the same time are expected to create a large pool of jobs for unskilled youths in services related to sales, installation, maintenance etc., if proper skill based training is provided to them. Such employment will help in opening up opportunities in remote areas where agriculture is the key employment sector at present.

Advancement in solar technology will help connecting more remote villages with clean energy. Electrifying those rural villages will not only give them access to electricity but will help to extend their working hours, indirectly boosting their earning capacity. Improvements in the renewable energy sector like use of energy efficient stoves, conversion of waste into bio-gas etc. have resulted in the effective utilization of waste. Such stoves emit relatively very less smoke and thus lessen indoor air pollution and reduce greenhouse gas emissions. Better conversion efficiency of such

technologies ensure less fuel being burnt which will directly or indirectly help in fighting against climate change. It has a positive impact on women's health as well.

Advancement of electronics has been able to create more employment opportunities for the youth in particular. Electronic gadgets like smartphones have boosted the connectivity, better access to information and thus improving the quality of life. Manufacturing of various electronic parts and assembling them to the final product have emerged as a potential industry for livelihood creation in developing countries like India.

In the above mentioned perspective, one can assess the ground situation in their localities about the availability and use of technology in different walks of life which leverage for environmental safety, sanitation and health management; also having potentiality for sustainable livelihood generation. At the same time, it is possible to identify the gaps in technology services and assess the skilled manpower and skilling potentialities.

4.5. Project Ideas

Project – 1:

A Study on Traditional Homestead Garden of Your Locality with Its Potential for Climate Resilience

Introduction

In a traditional homestead garden, a self-sustaining micro-ecosystem can be observed which has different layers of plants as producer; livestock, poultry and fishes as primary and secondary consumers and at the top of the triangle is human being as the ultimate consumer. This ecosystem has its own mechanism of material cycling, waste management, food and nutritional management. Further, it has sufficient scope of providing alternative livelihood to the family, which can help them during climatic stress or disasters as well as help in maintaining the nutritional requirement of the family. So, an in-depth study on the tradition of homestead garden can be done under this sub-theme.

Objectives

1. To identify and document species diversity in a homestead garden
2. To find the seasonal pattern of species availability and its significance
3. To analyse and document the social, cultural and gender dimensions of the homestead garden
4. To document and analyze the potential/utility of the homestead garden under climate/ weather induced atrocities
5. To estimate the economic potential of a homestead garden under traditional management system and comparing with the potential under new/innovative approach of management

Methodology

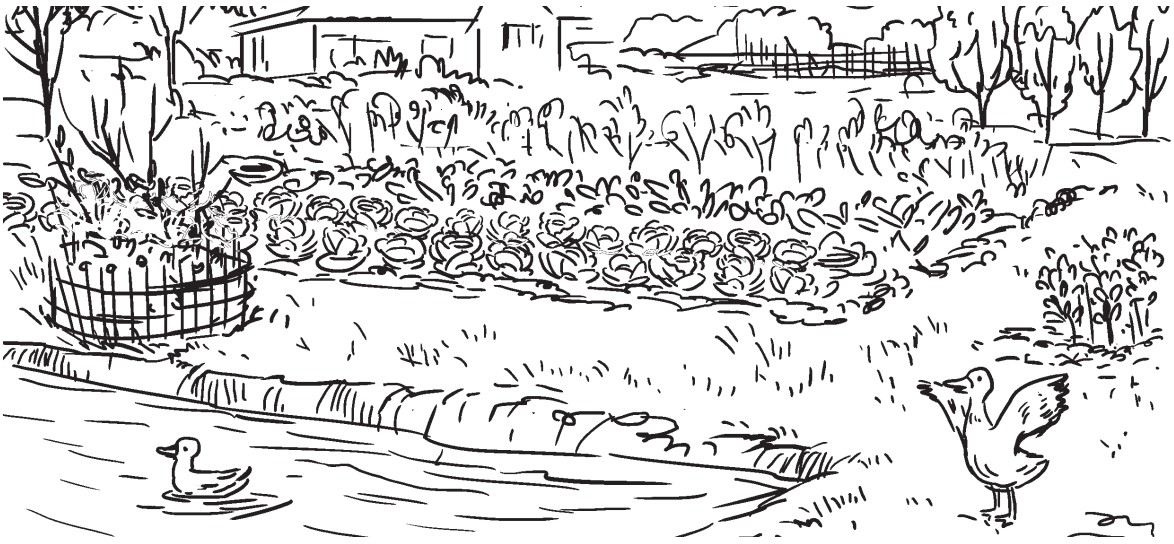
The suggested methodology for the study may include the following steps -

- Defining a study area
- Identification of plot for field observation
- Developing species diversity inventory
- Observation and documentation of seasonality
- Estimation of economic potential of different components
- Documentation of social , cultural and gender dimensions
- Observation and documentation of its potentialities/ adaptability in the context of varying weather and climatic conditions

Expected outcome

This study will help to find out –

- How the traditional homestead gardens sustain various species diversity and helps in maintaining a self-sustaining ecosystem
- How different components can give alternative livelihood options and generate income for the family under weather/climate related stress conditions
- How household level recyclable wastes are recycled into useful inputs for the homestead garden.
- Whether the traditional management system is sufficient to sustain the potential of the garden and can any innovative approach help in increasing the benefits of the same.



Project – 2:

Flood Induced Migration of Livelihoods of Specific Communities in Your Locality and Its Impact on Their Culture and Livelihood

Introduction

Regular floods are part of people's lives in various regions of the world, recurring with varying magnitudes and frequencies to which people have adapted for centuries. In disparity, flooding resulting from extreme hydro and meteorological events and taking place in unexpected magnitudes and frequencies can cause loss of lives, livelihoods and infrastructure.

Objectives

The study intends to find out how flood induced migration can impact the livelihood of specific communities (e.g. potter, fishermen, basket weavers, duck rearers etc.) on the following aspects –

- Impact on livelihood and income
- Traditional wisdom of the concerned livelihood and related knowledge
- Changing customs and societal impacts
- Community led innovations, if any and their verification

Methodology:

The study can be designed on the community through a focal group discussion (FGD). If any innovations or changing technologies are found, they may be compared to validate the applicability and prospects of such new techniques or concepts. The tentative steps of the study are –

- Defining the study area
- Selection of livelihood and related communities

- Identification of natural resources required for the livelihood and their charcteristics
- Documentation of related traditional knowledge, wisdom, cultural norms and societal structure
- Identification and documentation of disaster impacts, induced migration and related economic, social and cultural impacts
- Identification of impact of migration on the livelihood of the community as well as availability of the related natural resources
- Observation and documentation of any changes in the traditional techniques related to the livelihood or any alternative method adopted and associated impacts on culture and tradition as well as social dynamics of the community

Expected Outcome

The study may help to find out how migration has impacted the availability of quality raw material for the particular industry, whether that has changed their income potential as well as durability of the materials. It will also help to find out if there is any alternative method/ technique being used by the communities, whether that has forced people to adapt other livelihoods and does the same has any impact on the community or family structure etc.

Project – 3:

A Study on the Role of Multi-Purpose Tree Species (MPTS) in your Locality

Introduction

Multi-purpose tree species refers to the species of plants which have more than one economic/sustenance value. Such species are highly important in the context of achieving the goal of sustainable production and consumption. (For example, bamboo, banana, coconut, jackfruit etc.)

Objectives

The study may be taken with the following objectives –

- To identify and document various available MPTS in a certain locality
- To identify, analyze and document different uses of the available MPTS
- To observe and document different cultural and traditional practices and beliefs that are related to the use and management of these species
- To evaluate the economic as well as socio-cultural benefits of the MPTS
- To find out any management options/approaches needed for maintaining the MPT species along with any threats towards their avialbility

Methodology

- Selection of the study site/locality
- Transect walk based observation to identify various MPTS available in the study area
- Literature survey and inventorisation of available knowledge for scientific documentation of the species available

- FGD to document various uses of different MPTS available in the locality, associated management and cultural practices, traditional beliefs and norms associated with the MPTS
- Empirically calculate the economic value of the services provided by the MPTS and economic value of the products derived from them
- Observe, analyze and document various socio-cultural benefits of those MPTS
- Document any potential threat to the availability of these MPTS
- Experimentation for validation of traditional approaches of the MPTS
- Experimentation for innovative approaches for value addition, production system management etc.

Expected outcome

This study will help to identify various MPTS available in the specific locality along with various aspects of its uses, potential, benefits, socio-cultural impacts as well as management. Further, the study will also contribute towards identifying the potential threats of these species along with identification and validation of proper management approaches. This may also lead to some innovative approaches for management of these species which can increase their potential for sustainability.

Project – 4:

A Comparative Study on Firewood Used for Cooking in Nuclear Family and Joint Family: Issues of Conservation Management

Introduction

Due to the change of family system from joint families in the past to nuclear families at present, one of the major impacts could be an increase in the per capita energy consumption in a joint family being lower than that of a nuclear family.

Hypothesis

"Fuel wood use for cooking in joint family is less and provides scope for energy saving"

Objectives

1. To review and estimate fuel wood use for cooking in joint and nuclear family.
2. To identify and analyse the scope for energy saving.
3. To assess the contribution of social and cultural practices related to energy use and conservation.

Methodology

1. Selection of joint families and nuclear families for the experiment and divide them into two experimental groups; with adequate number of sample (minimum of 15 in each group) from both the groups for experimentation and observation
2. To record their total energy consumption per day for different seasons with adequate number of repetitive observations.
3. To calculate and derive per capita energy consumption in both types of households and see if there is any significant difference in the energy consumption.
4. Identify and document the social and cultural practices which contribute towards energy savings
5. Analyse and compare based on your collected data and draw conclusion and interpretation.

Expected Outcome

There may be significant difference in the energy consumption in both the types of households and there may be impact of traditional joint family system in the energy savings.

Project – 5:

Impact of Agri-Machinery on Employment Opportunities of Women in Rural Areas

Introduction

Adaptation of new machinery has brought many changes in the agriculture scenario of rural India. Such changes have both positive as well as negative impacts on the rural economy of the country. In India, women are affected by the recent technological shift. This study aims at analysing the impact of such agro-machinery on the socio-economic conditions and livelihood patterns of these women groups.

Hypothesis

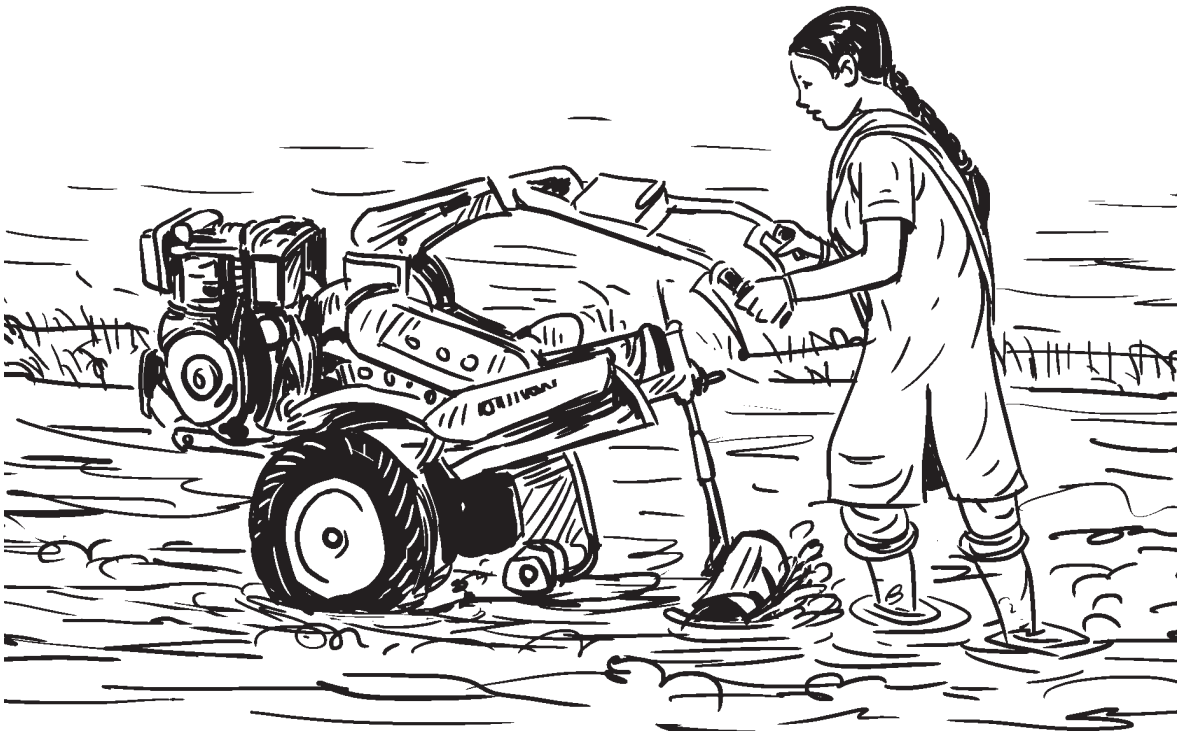
Use of modern agriculture machineries has displaced women from their traditional way of employment

Objectives

1. To study the adaptation and diffusion pattern of technology in the last 5-10 years
2. To study the changes brought by agro-machinery in employment pattern of women working groups
3. To study the socio economic changes brought by such technological changes

Methodology

- Identify a village for the study having minimum of 25 farming households. Both modern machinery users and non-user groups should be considered for the study



- Focus group discussion with male agriculture workers and female agriculture workers to understand the last 5-10 years' trend
- Key informant interviews based on pre-designed questionnaires are to be prepared
- Collection of data related to tools/ machinery used in agriculture for last 5-10 years
- Collection of Information related to employment of women working groups in agriculture for last 5-10 years (working hours, earnings per day, number of earning days in a season, type of work, presence of labour contract if any and its impact etc.)
- Collection of information related to employment of women working group other than agriculture for last 5-10 year
- Socio economic changes brought by change of pattern of employment

Expected results

- Crops cultivated year wise
- Year wise data related to tools/ machinery used for different activities
- Year wise Employment status for male and female members
- Male and female work share data year wise in different agriculture activities
- Year wise data related to economic status of each household
- Crop production costs and profitability analysis.
- Change in income levels of women groups and trend analysis.

Expected Outcomes

- The study will draw a picture on technological changes in agriculture in last 5-10 years
- Impact of new technologies on family income influencing overall socio-economic status of the society
- The study will give us information about change of pattern of employment opportunities for women workers.
- The will reveal the information regarding shifting of women employment to non-agricultural based works.

4.6. Additional project ideas

1. 'Society, culture and food system' its relation to sustainable production and consumption-case study of a community/tribe;
2. Natural Resource Management and Livelihood security – case study of area/community
3. "Society, culture and livelihood" its contribution towards climate change resilience or disaster risk reduction - case study of an area / a community
4. "Natural Disaster and livelihood security" – case study of an area
5. "Social institution and sustainable natural resource management" – case study of a community/ an area
6. "Society, culture and food system" - its impact of cooking energy consumption and management – case study of an area
7. "Impact of social and cultural practices on sanitation and health" – case study of an area
8. "Disaster induced migration and its impact of social, cultural and livelihood practices" – case study of a community

9. Social system, cultural practices its contribution to biodiversity conservation/ wild life conservation- case study of an area/ a community
10. Study on occupational hazard and its impact.
11. A study on menstrual hygiene related customs in your locality/community and analyze the positive and/or negative impacts of the same.
12. Identifying traditional customs in your locality that can be detrimental to health of the women in the family.
13. A study on changing livelihood structure, economic condition and associated impacts on production and consumption patterns of your locality
14. Study on impact of scientific intervention in optimizing the production of traditional handlooms.
15. Study on disappearing artisanal communities like blacksmiths with the advent of lathes etc.
16. Skill mapping and gap analysis in a particular community / area and correlation to local demand, local resources.
17. Local economy mapping with local natural resources and conducting a feasibility study for local value addition through appropriate technologies.
18. Eco-cultural mapping of a locality to develop eco-tourism operational plan.
19. Study on local festivals /rituals and its relationship with mapping of agricultural/animal husbandry practices and studying the underlying local knowledge base.
20. Analysis of local superstitions / myths and its impact on human development in a sociological perspective.

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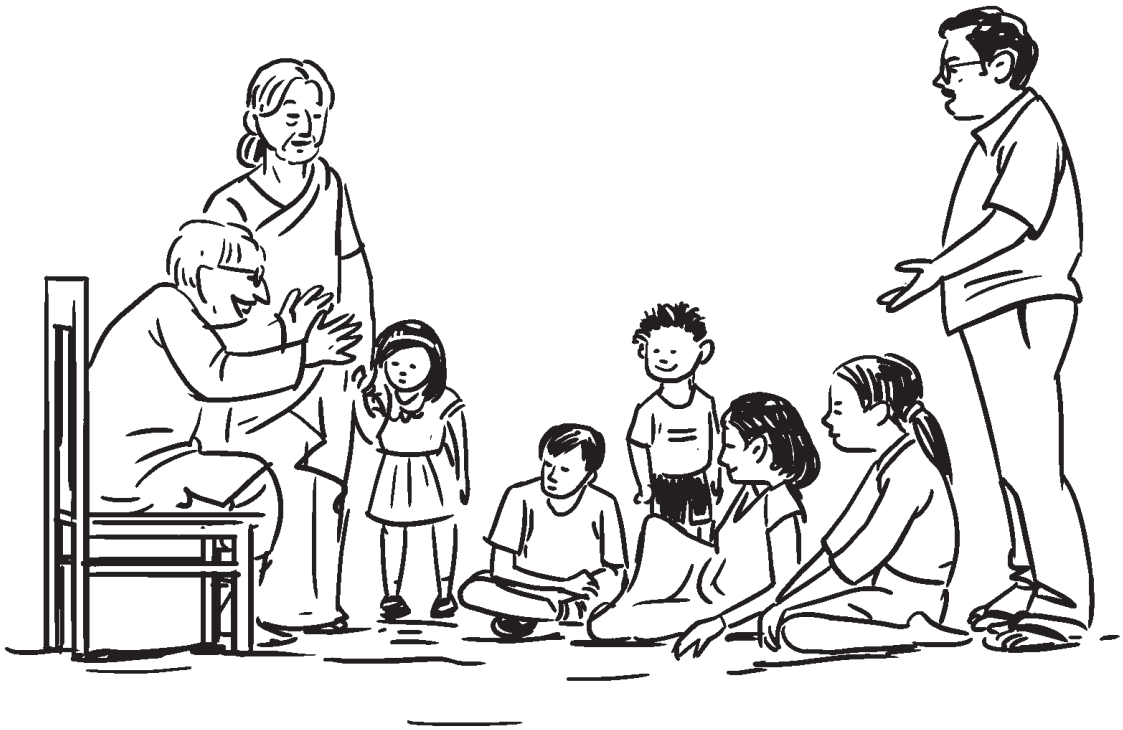
Sub-Theme-V

TRADITIONAL KNOWLEDGE SYSTEM

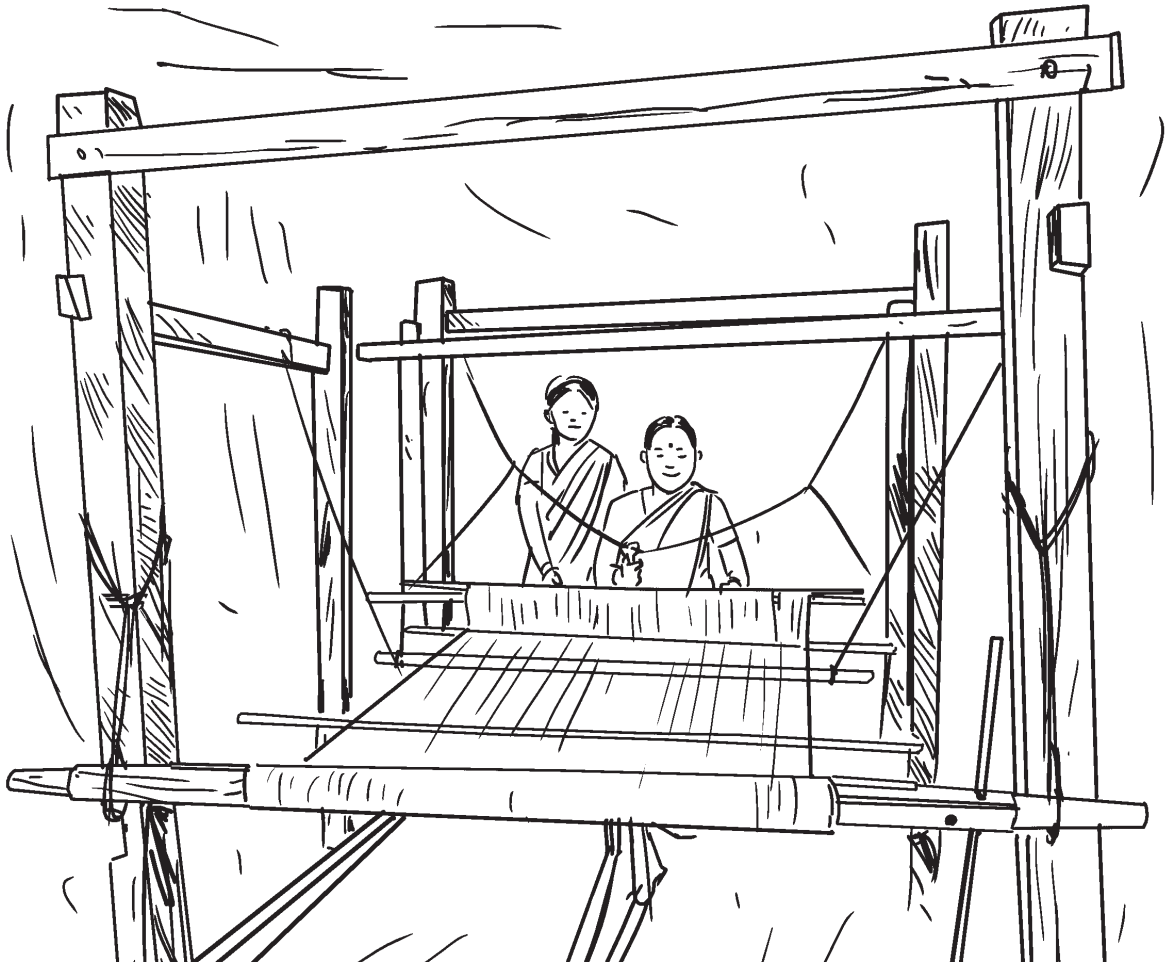


Traditional Knowledge System

5.1. Background

Traditional Knowledge System (TKS) is the know-how of the people, gathered through day to- day walk of life, to overcome the hurdles and tap the potentialities from their immediate neighbourhood. In fact, TKS evolved in a specific location within certain physical and socio-cultural environment, where it reflects people's specific knowledge, understanding as well as observational and experimental information about their dwelling environments, along with skill and technology to design a lifestyle in that specific environmental context.

TKS represents information, knowledge, skill and technology along with standard management practices, which are defined through the cultural systems. In the contemporary world when human civilization is facing the challenges of climate change, natural disaster, biodiversity loss, destabilized ecological services, food and nutritional inequality, problems of sanitation and health and many others , there is a need to give emphasis on TKS for searching alternative solutions or ways to face the challenges and design a sustainable lifestyle.



The international focus on TKS began in Rio-declaration of the Convention on Biological Diversity, which was the outcome of the World Summit on Sustainable Development, where it was described

> *"Traditional knowledge (TK) refers to the knowledge, innovations and practices of indigenous and local communities around the world. Developed from experience gained over the centuries and adapted to the local culture and environment, traditional knowledge is transmitted orally from generation to generation. It tends to be collectively owned and takes the form of stories, songs, folklore, proverbs, cultural values, beliefs, rituals, community laws, local language, and agricultural practices, including the development of plant species and animal breeds. Sometimes it is referred to as an oral traditional for it is practiced, sung, danced, painted, carved, chanted and performed down through millennia. Traditional knowledge is mainly of a practical nature, particularly in such fields as agriculture, fisheries, health, horticulture, forestry and environmental management in general."*[1]

Concurrently, different international forums started to focus on the relevance of TKS. Organizations like World Intellectual Property Organization (WIPO)[2], the International Labour Organization (ILO), especially its convention 169[3], the Food and Agricultural Organization (FAO)[4], World Health Organization (WHO)[5], United Nation Educational, Scientific and Cultural Organization (UNESCO)[6], United Nation Environment Programme (UNEP)[7], United National Development Programme (UNDP)[8], United National Commission on Human Right (UNCHR)[9] took initiatives to document the TKS and research for its validation along with developing different protocols for preservation , protection of rights, appropriate application as well as facilitating fair and equitable sharing of the benefits from their applications.

It is noteworthy that *the World Conference on Science*, organized by UNESCO and the International Council for Science (ICSU), in its *Declaration on Science and the Use of Scientific Knowledge*, *explicitly recognized the importance of TK and the need to respect and encourage its use for various forms of human endeavour* (ICSU 2002)[10]. Moreover, World Conference on Science (Budapest, June 1999), focussed on TKS, and recommended through 'Science Agenda: Framework for Action' (UNESCO, 2000), that, *"modern scientific knowledge and traditional knowledge should be brought closer together in interdisciplinary projects dealing with the links between culture, environment and development in such areas as the conservation of biological diversity, management of natural resources, understanding of natural hazards and mitigation of their impact. Local communities and other relevant players should be involved in these projects. Individual scientists and the scientific community have a responsibility to communicate in clear language the scientific explanations of these issues and the ways in which science can play a key role in addressing them."*[11]

In India, similar focus is also given on TKS by National Knowledge Commission for proper documentation and protection of Intellectual Property Right[12]. Different organizations and institutions have taken up activities for research and documentation and development of TKS application13**.** It is to be noted that the Indian Journal of Traditional Knowledge was

evolved to share such endeavour of research and documentation[14]. Moreover, legal instruments have also been developed like National Biodiversity Act (NBA), 2002[15].

There are many examples of TKS-based practices in the country on natural resource management[16], agricultural practices[17], medicine and health[18], housing and allied design and construction [19], which have the potential to act as leverage to sustainable development. In the fifteen different agro-climatic zones of India[20] there is diversity in terms of environmental and cultural practices, which nurture different traditional knowledge based practices to adjust way of life of the people to their respective environmental set-up. All these practices have some age-old history, progression and empirically tested observation, which essentially need not only documentation but also validation and applicability in contemporary context to meet the requirement for sustainable development.

5.2. TKS – Nature and Type

The evolution of TKS is very much local in nature and associated with a particular environmental and/or socio-cultural context. It is designed and developed by the local community through their constant observation, trial and modification/customization to match with its appropriateness. Therefore, TKS has the characteristics of local, empirical, time tested dynamisms. Moreover, TKS is always handed over or transferred from one generation to another and also between communities mostly orally and/or visually.

From its domain of application and associated management approaches, TKS can be categorised as (i) Traditional Ecological Knowledge (TEK), (ii) Traditional Technical Knowledge (TTK) and (iii) Traditional Value and Ethics (TVE).

TEK represents knowledge associated with natural resources and environmental management, TTK refers to knowledge associated with tools and appliances used and TVE refers to value, norm, institution and policy framework evolved with traditional knowledge based practices.

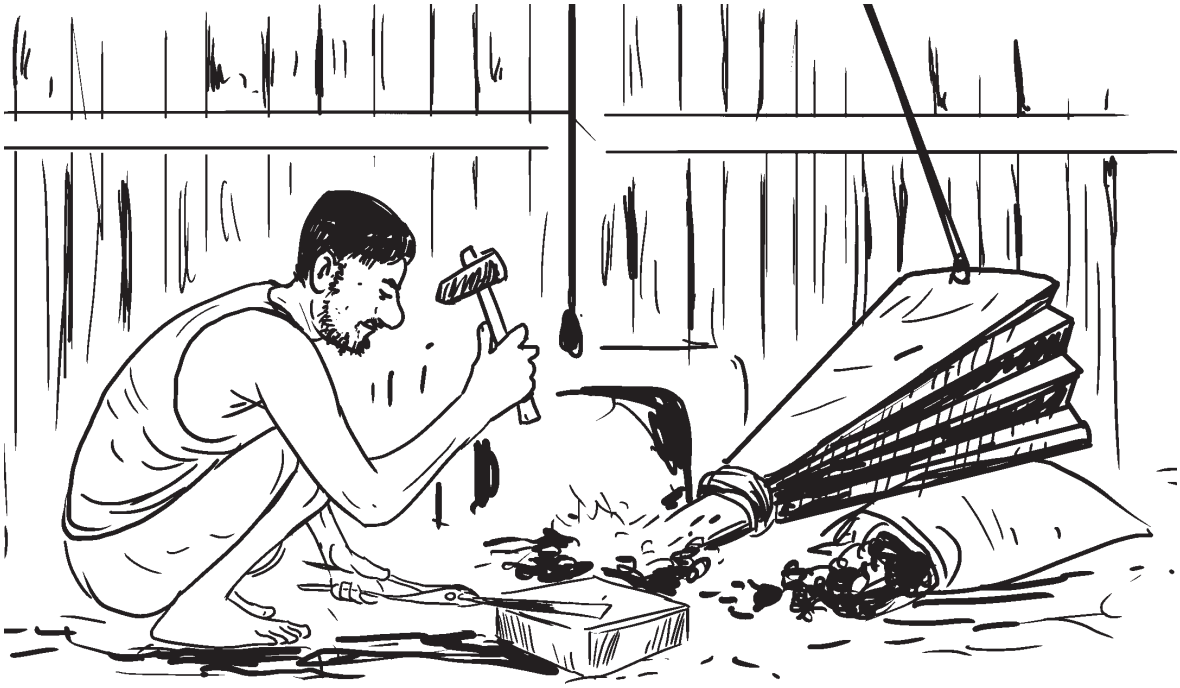
5.2.1. Traditional Ecological Knowledge (TEK)

TEK refers to the evolving knowledge acquired by indigenous and local people over hundreds or thousands of years through direct contact with the environment. This knowledge is specific to a location and includes the relationships between plants, animals, natural phenomena, and the landscape that are used for livelihood and sustenance of life, such as resource gathering through hunting, fishing, agriculture, livestock farming, forestry, agro-forestry, etc.[22] All these can be categorised as natural resource management[23], as these practices are linked with management of land, water, flora and fauna. Such practices are linked to prioritization of uses along the line of sustainable harnessing, wise use, equitable sharing of benefits, management of future stocks through conservation, defining threshold limits, etc. There are practices for weather forecasting too[24]. Such TEK considers natural landscape characteristics (topography, slope, soil and rock characteristics), weather and climate as well as types of flora and fauna. The community takes necessary decision based on abundance/ scarcity and seasonality of biotic and abiotic resources, natural disasters, and associated problems

It is a process of indigenous communities for observation, classification, analysis, interpretation and decision making for daily walk of life along with development of world views.[25]

5.2.2. Traditional Technical Knowledge (TTK)

TTK represents the knowledge related to design and development of tools, implements and gears for different application in the context of natural resource management by the indigenous communities[27]. Such practices are related to agriculture[26], fisheries[28], animal husbandry[29], forestry, handloom and handicraft etc. Moreover, TTK also represents the knowledge and skill about design and construction like housing[30], water harvesting structure[31], roads and bridges, etc.



5.2.3. Traditional Value and Ethics (TVE)

TVE is linked to traditional cultural practices which prioritize dos and don'ts in the aspects in relation to natural resource harvesting, conservation, and equitable sharing etc[32]. During the process, it evolves the concept of sacred species, space, forests, water bodies, etc. This involves seasonality based practices like restriction of fishing during breeding season, harvesting forest resources during flowering period, etc. Sometimes institutions are developed to manage human habitation, controlling human practices related to health and sanitation, like restriction of food in different seasons, restriction of waste disposal, norms for location of animal sheds, toilets etc

Exploration and documentation of such practices in local context will help in understanding these practices, creating a knowledge base and analysis and validation of its scientific base. This will help to identify the prospects for the future adopting lifestyles, habitat management, environment, natural resource management, wildlife protection, etc.

5.3. Framework

The approach starts with identification of traditional knowledge based practices along with its link to manage natural resources with the aim to maintain ecological services, management of food and fodder, augmenting nutritional inputs, health and sanitation, disaster risk reduction, climate change adaptation, etc. Such practices need to be documented with appropriate answer to the questions like: *"What it is? Where it is? Who practice it? Why it is in practice? From when this is being practiced? How does it function?"* In the process of documentation there is need to adopt the approaches of process documentation . If required one can adopt the tools like - flow chart with narratives, maps, photographs, etc. However, there is a need to mention what type of TKS is focused in the study,(viz. TEK, TTK or TVE).

It is equally important to validate these with appropriate interpretation in terms of its specific context, as well as in the universal contexts. For example, in water harvesting system from surface flows, it is required to verify, "Whether watershed perspectives are there? How

slope is considered? What are the catchment area treatment mechanisms followed in the practices?" These are very much contextual perspectives. On the other hand, verification of applicability of gravity flow of water is a universal aspect. Sometime, if such surface flow system is used only for irrigation, one can verify possibilities of harnessing energy from the flowing water, without disturbing the output of irrigation or one can think about applicability of pedal pumps or hydraulic rams with the system to increase its efficiency without disassociating TKS based practices. Such efforts can be part of an alternative, critical and creative thinking to strengthen the system under study.

From context to context, approach of validation may vary. However, it is essential to reflect the validation approaches, methods and tools in methodological approach of the study. Moreover, entire analysis and interpretation need to portray "how this particular TKS based practices help in sustainable/ wise use of resources and how it will contribute to clean, green and healthy nation along with its future prospects" (Fig.1).

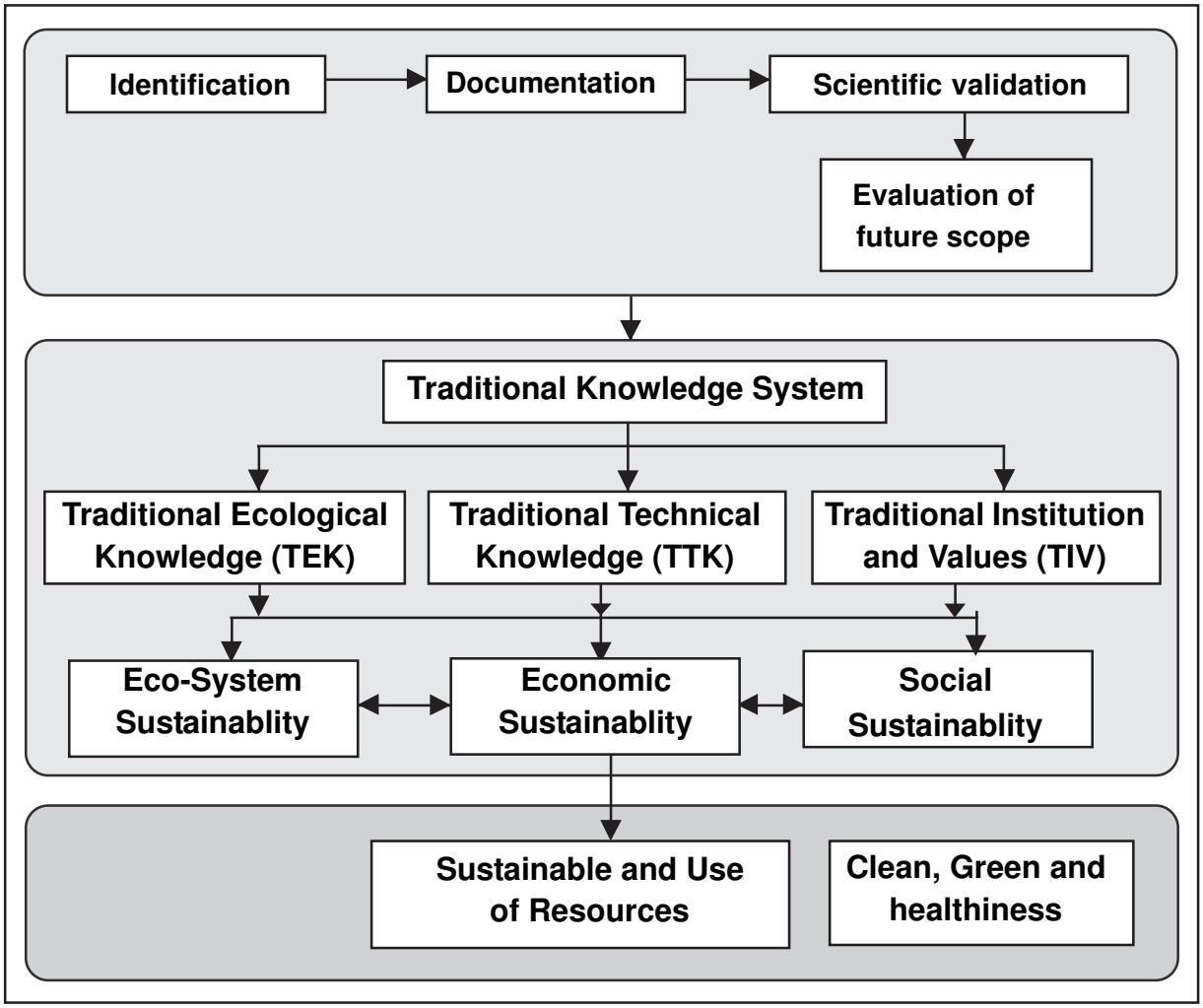


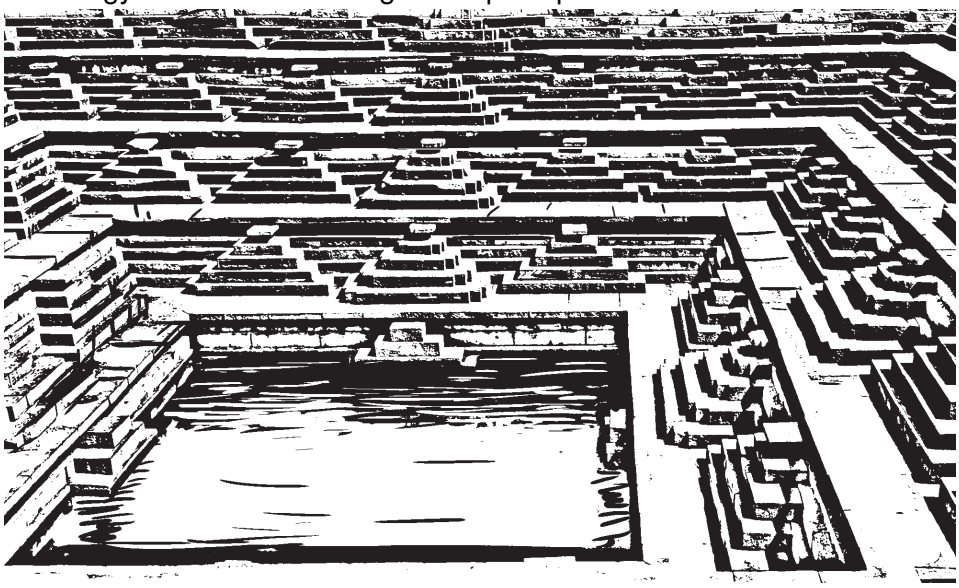
Fig.5.1. Framework of the sub-theme

5.4. Some examples of practices

All over the country many traditional knowledge based practices are followed by different communities; examples of some of the practices are presented below.

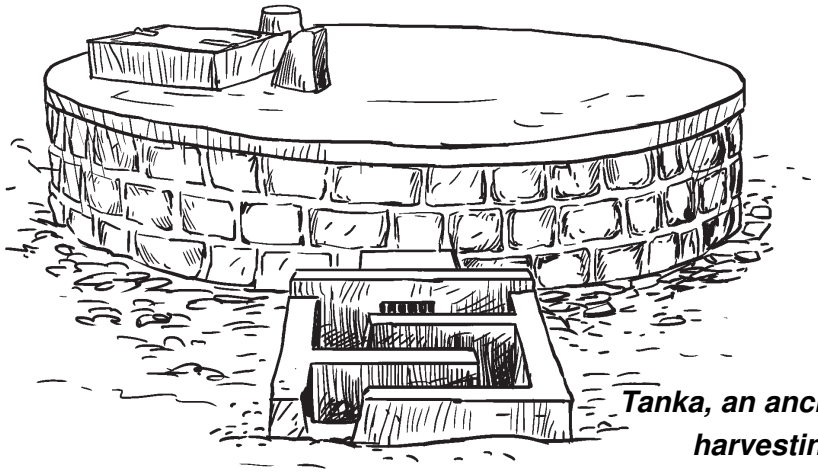
5.4.1. Traditional Water harvesting practices

There are many age-old-practices of harvesting water in the country, basically to collect rainwater, restore surface flow of water, ground water recharging, etc. These are based on simple technology and defined management principles.[33]



Step well, an ancient water harvesting structure

A **step well** is exactly what it sounds like- steps down to a well. The earliest step wells date back to about 550 AD were developed in India as a necessity for areas suffering from torrential seasonal rains.[34]



Tanka, an ancient water harvesting system

Though originally found in the desert towns, the system has since gained immense popularity in rural areas. The rural T**aanka**s found In Phalodi, Barmer and Balotra region, were of 6.1 m deep, 4.27 m long and 2.44 m wide. This technique of rainwater harvesting was perfected to a fine art in the arid regions of western Rajasthan.[35]

Johad, an ancient practice of Rajasthan

Johad is a dam that collects rainwater to replenish the supply of underground water table.[36]

Zabo a traditional practices among the Naga communities

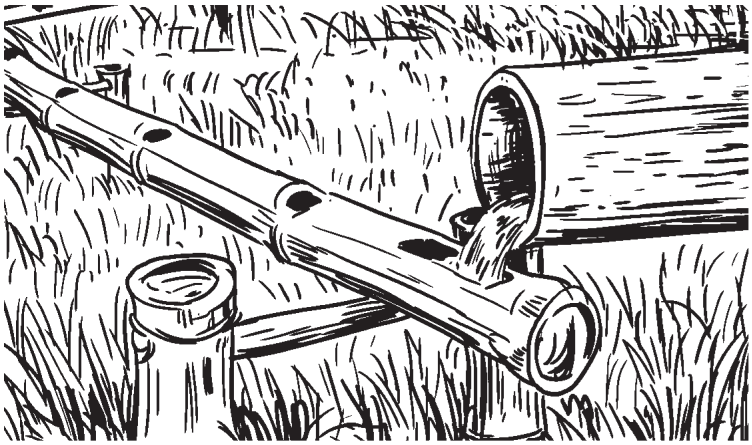
Zabo, which means 'impounding water', is an ingenious method of catching rainwater runoff from the mountains.[37] It **is** located at an altitude of 1270 m in Kikruma, a quaint village nestled in a rain-shadow area of Phek district of Nagaland. Centuries ago, the village evolved a self-organizing system to take care of its water, forest and farm management

Surangas continue to be one of the relatively less known and gradually disappearing traditional water harvesting systems of Kasargod district of Kerala. *Surangas* can be compared to a horizontal well or cave excavated in hard lateritic soil formations from which water seeps out, and flows out of the tunnel to be collected in open ponds. Despite their decline, they continue to be a lifeline for a large number of farmers in Kasargod, who depend on *surangas* to meet their drinking water needs.[38]

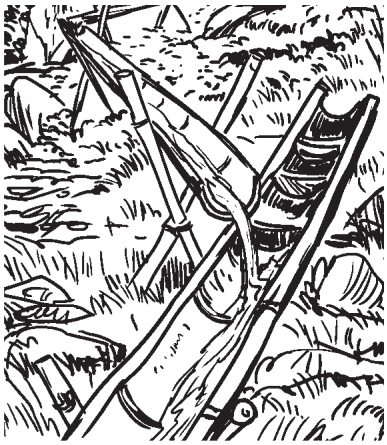
5.4.2. Bamboo drip irrigation

Surangas a traditional practice in Kerala

In different states of North-Eastern part of India Bamboo drip irrigation is a common practice. The design of the Bamboo pipe for irrigation varies with variation of rainfall, which reflects the uniqueness of traditional knowledge system of the local communities.[39]



(A) Bamboo drip irrigation of Karbi-Anglong, Assam



(B) Bamboo drip irrigation of Meghalaya

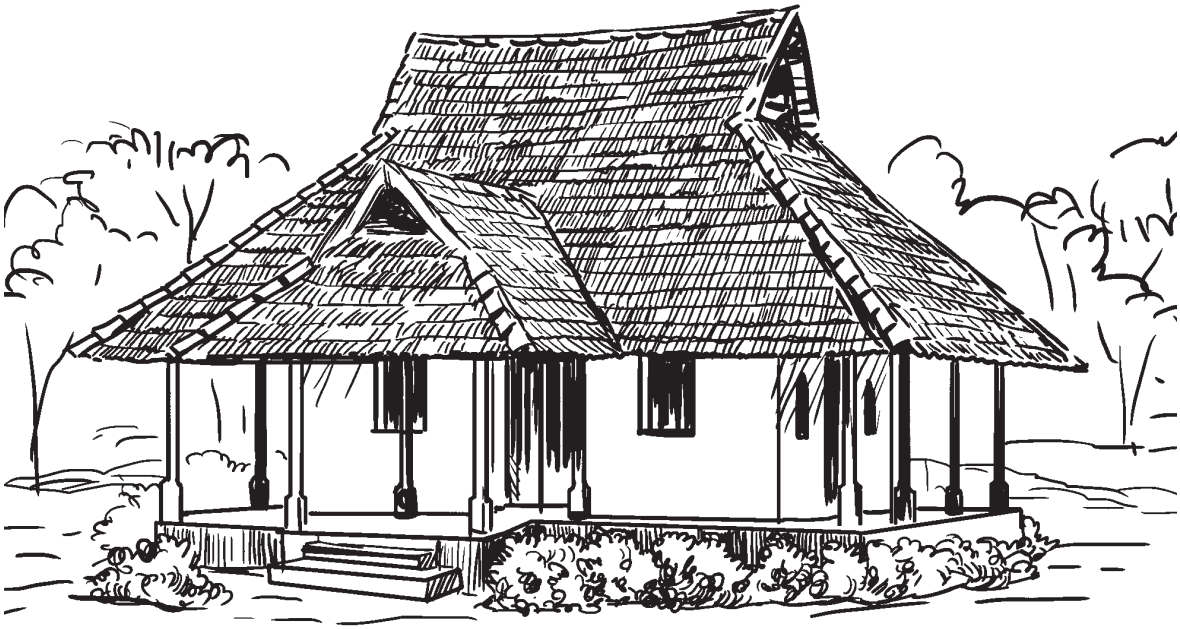
Picture (A) shows the Traditional Bamboo drip irrigation practiced by the Karbi communities (known as **Longsor** in Karbi) in the rain-shadow area of Karbi-Anglong, Assam. A different Traditional Bamboo drip irrigation (B) is practiced in high rainfall area of Meghalaya

Traditional Bamboo drip irrigation in intermediate rainfall area of on the northern plains and foothills of Assam-Aruanachal and Bhutan border area

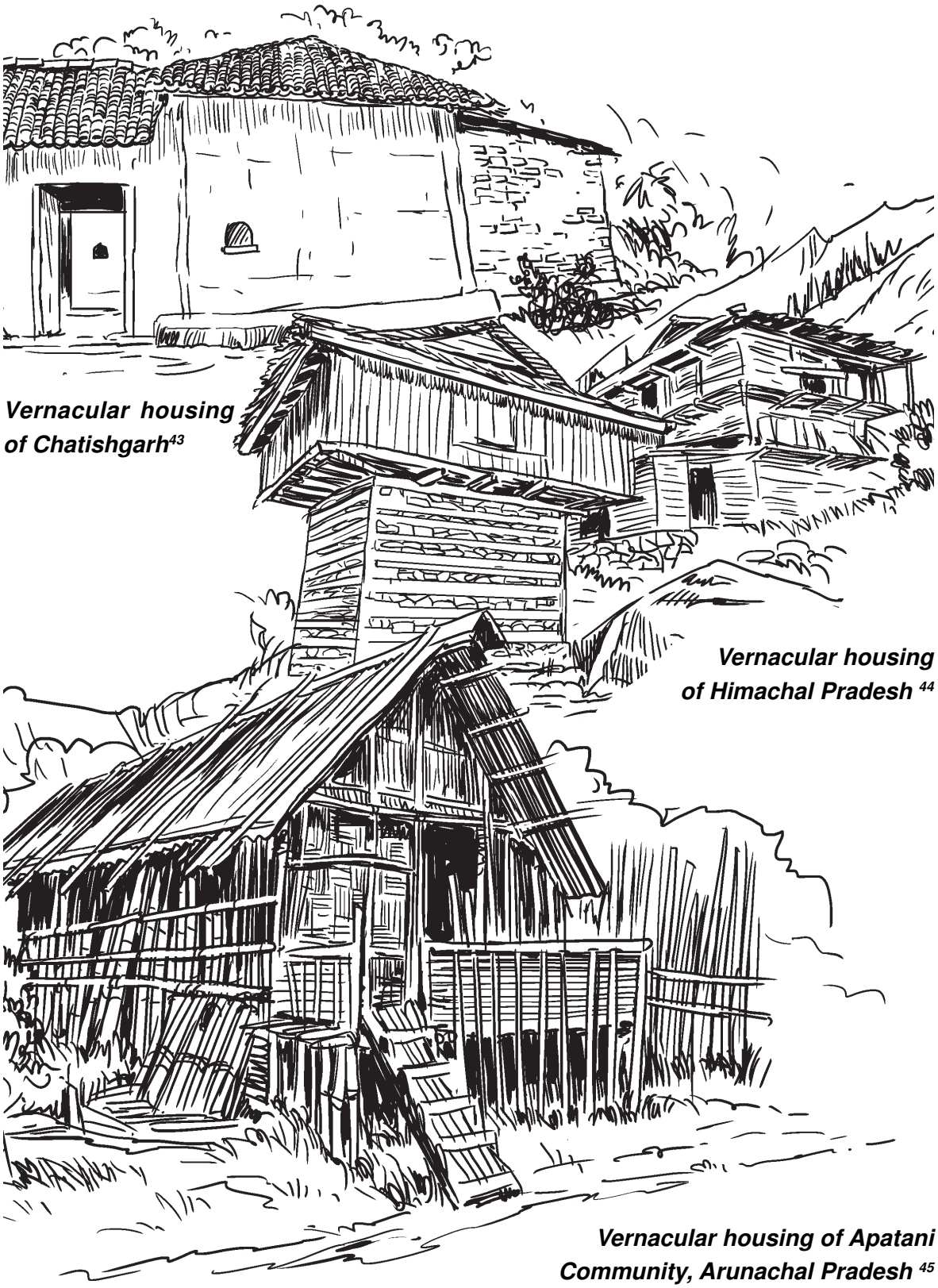
5.4.3. Traditional Housing - a reflection of STI

Usually these are called **Vernacular Architecture,** which is an architectural style and design based on local needs, availability of construction materials and reflecting local traditions. Originally, vernacular architecture relied on the design skills and tradition of local builders/ skilled labours. It tends to evolve over time to reflect the environmental, cultural, technological, economic, and historical context in which it exists.[40] In case of environmental factors major aspects are – geology, land and soil; weather and climate; availability of the building materials in the locality. On the other hand, family size, family structure (joint or nuclear), food habits, materials, cultural practices, belief system etc.[41] Based on the building materials used in wall construction it can be categorised as Adobe (mud blocks or whole walls), Masonry (stone, clay, or concrete blocks), Timber, Bamboo etc. Commonly a combination of materials is generally used. The layout of the building also varies, like Circular plan, Rectangular plan and linear plan. Similarly, there may be Single story or Ìulti-storied buildings.

In Indian condition such vernacular housing are very common in rural context and its design, plan and building material vary with geographical regions.



Vernacular housing of Kerala[42]



Vernacular housing of Chatishgarh[43]

Vernacular housing of Himachal Pradesh [44]

Vernacular housing of Apatani Community, Arunachal Pradesh [45]

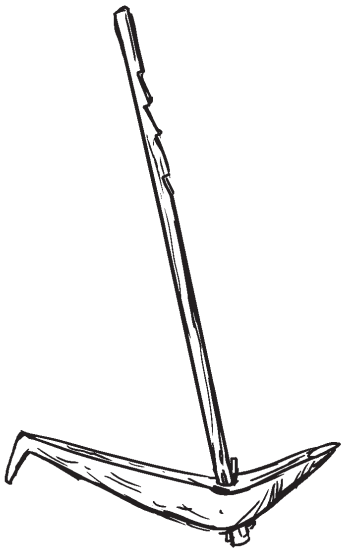
It is important to explore such practices with the objectives to identify merits and demerits of such practices and its usefulness in the context of climate change adaptation, earthquake resistance, environmental sustainability etc.

5.4.4. Traditional agricultural practices

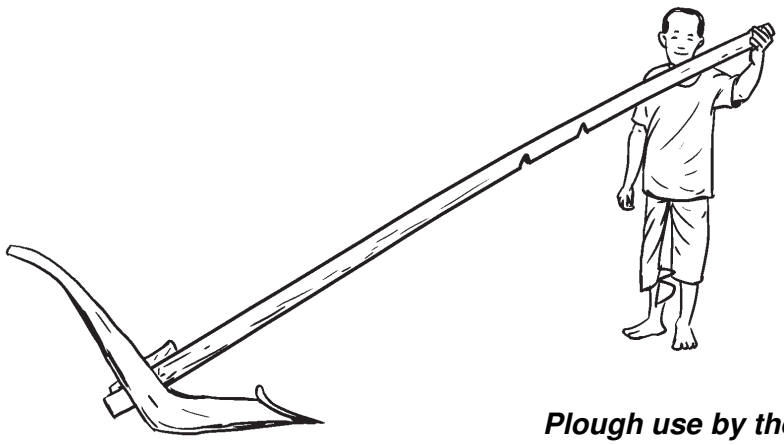
In many areas of the country, traditional agricultural practices are still considered important. These practices are followed in selection of crop varieties, land selection, land preparation, soil fertility management, pest and disease management, irrigation, harvesting, post-harvest management, seed preservation, etc. Moreover there are different tools and implements used for the purposes, some of which are mentioned below:

There are different shapes and sizes of ploughs and hoes used for tilling of soil in the country, which varies from region to region based on soil quality, terrain condition and the crop used for cultivation. Not only that, with variations in the crop varieties, the tools used for harvesting also changes .Best example is variations in the different shape and size of sickle used in different areas from time immemorial.

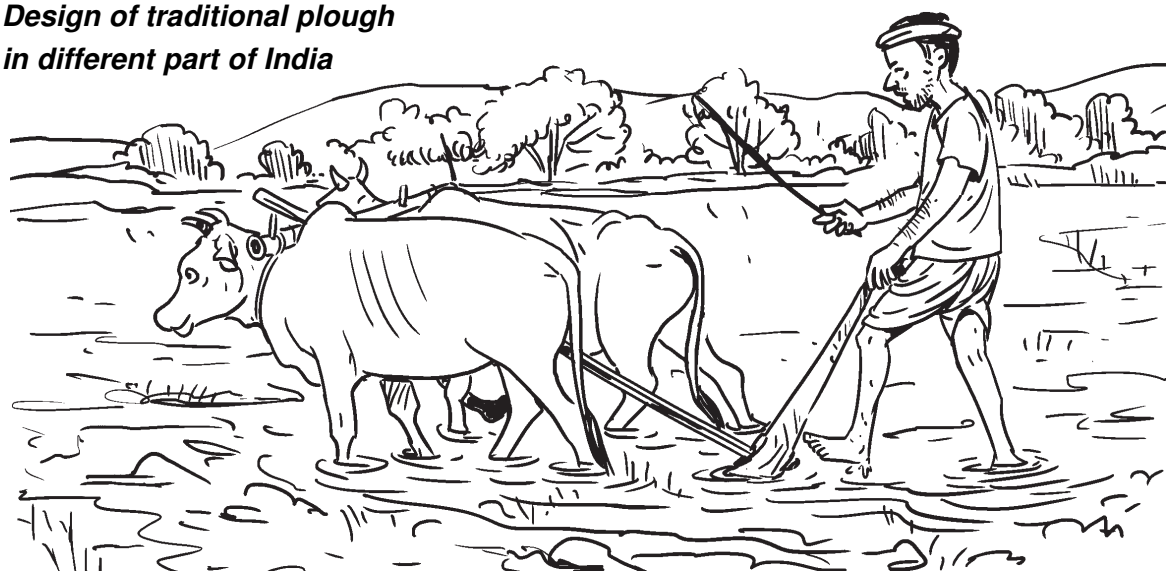
Similarly there are different types of land cultivar in different regions, which are potential source for climate change adaptation; because many of such crop varieties are either draught and/ or flood tolerant.



Design of traditional plough in different part of India



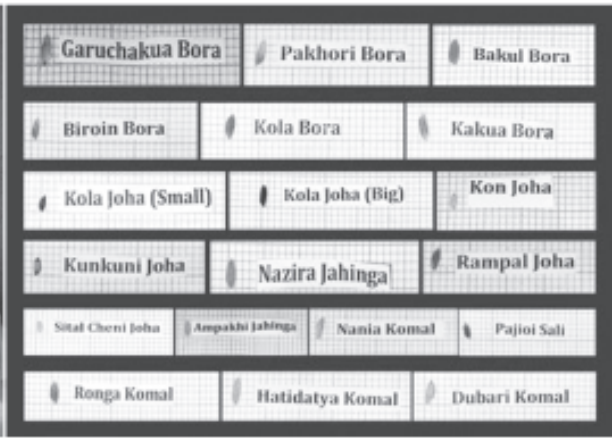
Plough use by the Tangsa Naga of Arunachal Pradesh



Varied design of Sickle used in different regions of India

Traditional rice land races

Variety most common in central part of North Eastern Region of India



Variety most common in Assam and northern India

Variety prominent in The Cauvery Delta near Thanjavur of Tamilnadu

Seed Preservation Technique

In different regions people adopt different methods of seeds preservation and storage, some of which are shown below:

Seed preserved by the Nyishi Women in Lower Subansiri ,Arunachal Pradesh

5.4.5. Weather Forecasting/ Prediction

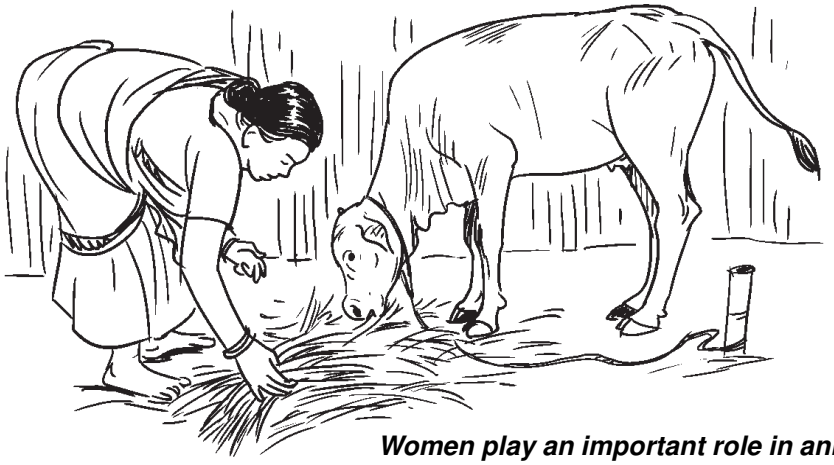
There are many methods of weather prediction practiced by the farmers in different parts of the country. For example, farmers in Himachal Pradesh believe that if the honeybee flies toward northern hill there will be no rainfall, if they fly towards south there will be good rainfall. On the other hand, in Rajasthan many local communities believe that appearance of many butterflies together indicate a good rain and get better crops.[46]

Similarly, Karbi Hill Tribes of Assam have a traditional calendar system which is used for agricultural planning. The months or periods are identified by a few conserved features of plants and animals and also physical factors. These indicators are so marked that there is a specific 'phrase' ascribed to each month or period. For example, the first month of the year is called ThangThang(February), which is noted with phrase *" ThangThang- ritlang"* , where *ThangThang* represents the month and ***rit*** means Jhum (shifting cultivation), *lang* means – cultivation of land; simply it is the time for preparing land for shifting cultivation. This month is characterised by flowering of Pharche (*Erythrina stricta* Roxb.;*Leguminoceae*) and Pharkong (*Bombax malabaricum* DC.; *Bombacaceae*). These are the most important indicators of this period, which reminds the people of the appropriate time to look for new jhum land. Similarly, for all the months they have some biological indicators, which acts as the link to agricultural activities. In most of the cases, such phenomenon are related with seasonality and in maintaining season-wise agricultural activities. Similarly, there are many such examples available in different agro-climatic zones of the country.

5.4.6. Traditional practices in animal husbandry

Traditional knowledge regarding animal husbandry can be considered as old as domestication of various livestock species. But these practices are in vogue throughout rural India and those are documented little and hence, there are possibilites of eroding out of these knowledge systems. For example, traditional practice of the feeding includes crop residues like straw, stalks, stovers, tops and crop thrush like wheat, paddy straw, etc as well as crop by-products that includes Bran, Husk, straw of Wheat, Rice, Bajra and Maize. Women have a very important role in the traditional method of integrating agriculture with animal husbandry. Traditional knowledge about treatment of the animal disease includes both preventive and curative practices based on local medicine using herbs. Women understand the importance of each herb and plant combination. They understand which leaves are best for which fodder; and their suitability for milching of the cattle and preparing highly concentrated feeds for the animals for improving milk yield.

Thus, it becomes very important to collect and document the practices and also to evaluate their validity.



Women play an important role in animal husbandry

Table-5.1. Treatments practised to cure disease of the animals.

Sl.no.	Ailments	Practice Followed
1	Wounds	Devadar Tree Oil
2	External Parasites	Cow Urine and Black Ash
3	Loss of Appetite	Dhania +Onion+Kalajeera+Curd
4	Fever	Kala Jeera Powder
5	De worming	Forest Leaves, Stem Peeling
6	Bloat	Kala Jeera + Dhania mix with the feed
7	Rumination	Kala Jeera
8	Treatment of minor injuries	“Bans” leaf pastel local name of some grass
9	Controls of Ticks in Animals	“Karoi” grass rubbed on the skin
10	Food and mouth disease	Animals with rotten foot are kept in mud, phenyl is applied to the foot and condition of sour mouth

Source: *Animal Husbandry Practices of Organic Farmers: An Appraisal. Subrahmanyeshwari B and Mahesh Chander, Veterinary World, 2008*

Fodder management for domesticated cattle is a challenge for many rural areas. Traditionally people adopted different techniques. For example, in Garo hills area of Meghalaya, successive vegetative growth of grassland abundant in Jhum plots is protected by Garo community as the source of fodder for their cattle. Usually, they shift their cattle shed near to this plot for easy grazing. With variations in such grass plot in abundant jhum they shift their cattle rearing sites. It is noteworthy that, shifting of cattle shed near to such plot also contributes addition of cow dung and urine to jhum plot. In many regions the provisions of cattle shed also varies with their environmental situation. For example, in Barpeta and Baksa districts of Assam, villagers keep their domesticated cattle in multi-storeyed cattle sheds, The first floor of the bamboo-steel multi-storeyed cattle shed is used for keeping the cattle. According to many villagers, these practices ultimately help them to maintain clean cattle sheds and make it easy to collect the dung. The clean cattle shed helps in maintaining cattle health, particularly from diseases that occur in the summer and monsoon season.[47]

Managing fodder plot in abundant jhum plot by Garo community in Meghalaya

(Photo-Jayanta Kr. Sarma)

Multi-storied cattle shed

(Photo –Jayanta Kr. Sarama)

Similarly there are many such traditional practices, their documentation along with assessment of scientific basis are important areas of study.

5.5. Coverage under the Sub-theme

The sub-theme will cover any subject related with traditional ecological and technological knowledge along with values and ethics. Such studies can be related with settlement system, housing, agricultural and allied practices, natural resource management, food systems, disaster management, mitigation of human and wildlife conflict, handloom and handicraft, traditional medicinal practices, etc.

It is expected that the study will cover the aspects of scientific documentation of the practices, its present status, management approach involved, along with scientific validation of the basic principles, techniques, material uses (if any) in the context of objectives of the said practices. In doing so, one may also be able to use secondary information and data with due references of sources only to establish the significance of the practices or to narrate the trends. However, some original primary data derived through survey, field experimentation or laboratory experimentation is mandatory to support core analysis and interpretation of the study.

5.6. Important aspects need to be focussed

Identification of traditional unique practices, its documentation, and verification of status of uses/application, measures of effectiveness and validation of its appropriateness along with scientific base are the important aspects involved in any project for study under these sub-themes. From these perspectives, it is better to follow the steps of work as mentioned below.

(i) Observation and identification of practices

Instead of randomly picking up a problem for the study, it will be ideal initially to conduct observation in the locality and observe local communities' daily life and approaches of work. Out of these, it is better to find out some traditional practices which is unique to the area and/or specific to the community. It is always better to note down the observational information in a systematic manner which will help in identification of specific study, as shown in table-1 .

Table-5.2. Compilation of observational information

House building	Preparatory activities	Design setting
	Midway activities	Building material selection and uses
	Final activities	Construction operation
	Application of tools and techniques	Type of tools and gears used for cutting/ fitting of building material and in other phases of construction
	Management principle	How it is focuses on minimizing material waste, minimizing cost of time, labour and money, how it helps the marginalized one
	Associated manpower	How efficiently manpower used for the purpose
	Uniqueness if any	Environment friendliness, seismic resistant, reflection of energy efficiency any other
	Remarks	At the time of observation, visit to all possible site of the locality, discuss with local practitioners involved with the work

Water management	Preparatory activities	Source identification
	Midway activities	Utilization approaches and purposes
	Final activities	End uses
	Application of tools and techniques	Tools and gears in use
	Management principle	Core management principle adopted for minimization of waste, safety, maintaining cleanliness, etc
	Associated manpower	Manpower involved in the process and their role & responsibilities
	Uniqueness if any	If able overcome certain constrains, achieved reliability in terms of quantity and quality
	Remarks	At the time of observation visit to all possible site of the locality, discuss with local practitioners involved with the work
Agriculture	Preparatory activities	Type of crop produced, land selectation and preparation for the purpose
	Midway activities	Selection of seed/ planting material selection, seed bed development (if required), soil nutrient management, water supply system, weed and pest management
	Final activities	Harvesting and post harvesting approach and process
	Application of tools and techniques	Tools and gears in use
	Management principle	Core management principle adopted for minimization of waste, safety of crops, maintaining cleanliness, etc
	Associated manpower	Manpower involved in the process, their role & responsibilities
	Uniqueness if any	If any constrains faced and overcome, if it is a unique product to culturally defined food system, if it has certain weather climate connection, if it has certain value addition potentiality
	Remarks	At the time of observation visit to all possible sites of the locality, discuss with local practitioners involved with the work
Food and medicine	Preparatory activities	What is for what and for whom?
	Midway activities	Identification and utilization of sources
	Final activities	Harvesting practices, final product preparation
	Application of tools and techniques	Tools and gears in use
	Management principle	Core management principle adopted for minimization of waste, safety of the product, maintaining cleanliness, etc
	Associated manpower	Manpower involved in the process, their role & responsibilities
	Uniqueness if any	If any constrains faced and overcome, if it is a unique product to culturally defined food and health system, if it has certain weather climate connection, if it has certain value addition potentiality, if it promotes sustainable consumption practices
	Remarks	At the time of observation visit to all possible sites of the locality, discuss with local practitioners involved with the work

Handloom and handicraft	Preparatory activities	What is for what and for whom?
	Midway activities	Design setting, sources of raw material
	Final activities	Harvesting practices of raw material, material processing, end products
	Application of tools and techniques	Tools and gears in use
	Management principle	Core management principle adopted for minimization of waste, safety of the product, maintaining cleanliness, etc
	Associated manpower	Manpower involved in the process, their role & responsibilities
	Uniqueness if any	If any local opportunities materialized, if it is a unique product to culturally defined way of life, if it has certain weather climate connection, if it has certain value addition potentiality, if it promotes sustainable consumption practices
	Remarks	At the time of observation visit to all possible sites of the locality, discuss with local practitioners involved with the work

(ii) *Detail documentation*

After initial observation and compilation of observational information, it is very much essential to document the practices in detail, covering all the aspects as it is mentioned in the above table. Such documentation need a process interpretation note explaining through the diagram, shown through figure- 5.2.

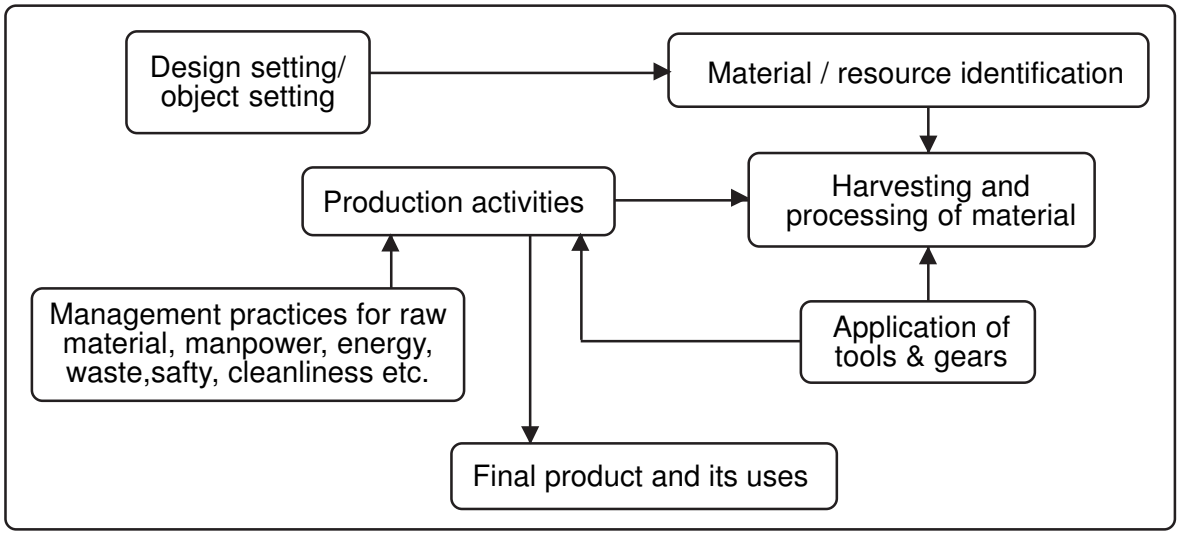


Fig.-5.2. An example of product base activities, that may vary with type of activities

(iii) Validation of core principle:

The important aspects of the chosen specific approach practiced by the community need to be validated with the application of method of science. If it is an approach that nurtures soil health, it requires testing of soil under such practices and validate the impacts. On the other hand, if it is related to weather it requires to validate with weather condition and seasonality. Similarly, if it is related herbal medicine, it is required to test to identify chemical content in the herbs and its impact on health or if it is water management it is necessary to find out how

such practices help in water conservation, assuring reliable supply system, maintaining perennial supply system, cleanliness of water etc. It is mentionable that with issues/subject of study the approach of validation will vary. However, without validation it is difficult to establish its appropriate utility; and in absence of that it may not help us to explore its applicability in future context or to undertake any initiatives for its improvement.

5.7. Project Ideas

Project – 1:

Biochemical Analysis of Nutritious Insects Eaten in Tribal Areas of India

Introduction:

The world faces huge challenges in terms of animal based proteins. This has become a major problem because of the increasing human population and environment degradation. Traditional societies have time immortals used insects as a source of protein. It's time to recognize the role of entomophagy(eating of insects as food) in traditional societies and also reduce ecological foot print in regard to the food production

Objectives:

1. To analyze the nutritious value of insects
2. To compare the nutritious value of the insects with other standard nutritious food

Methodology:

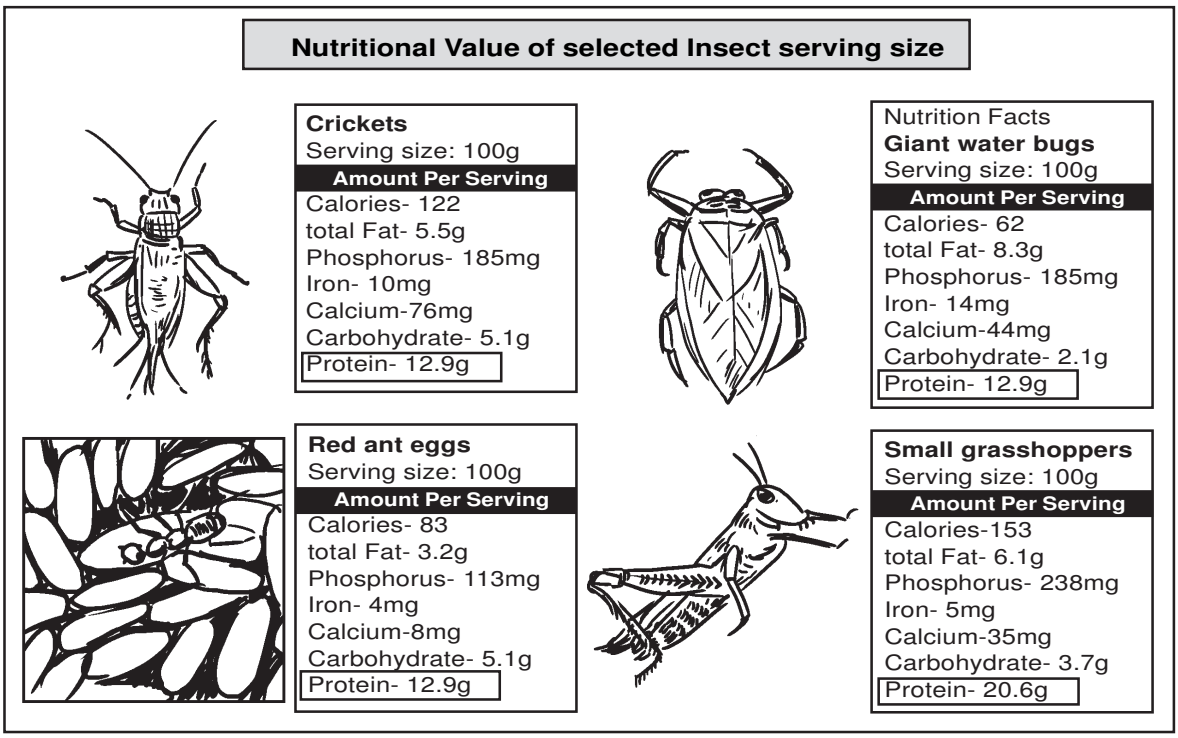
1. Collection of records of known edible insects in the locality
2. Identification regarding breeding seasons and other details about the insect
3. Note down important biochemical test (Starch, sugar and protein content)
4. Comparison of nutrient content with other nutritious valuable food

Parameters	Insect	Beef / Animal meat
Moisture (% of fresh weight)		
Protein		
Fat		
Metabolizable energy (Kcal/kg)		

5. To note down if there is a significant difference or comparable results with other nutritious food

Epected Result: To find out if there is significant nutritious value being provided by the insects.

Output: If the popular non vegetarian food could be substituted with insects, then there could be a balance in the ecosystem



Few examples of nutritious value of Insects, *Source: Internet*

Further Reference:

1. Edible Insects: Traditional Knowledge or Western Phobia by Alan L. Yen
2. Diversity of Edible Insects and Practices of Entomophagy in India: An Overview by Jharna Chakroborty

Project – 2:
Study of the Use of Herbal Medicine for the Treatment of Dengue Fever

Introduction:

Recent spurt in the incidence of dengue fever and an increasing number of deaths occurred due to the disease incidence triggered a re-look into the traditional Siddha medicine and its effectiveness for treatment of fevers, body ache, temperature control etc.. Documented work on the use of leaf extracts of Papaya, and/or Nilavembu (*Andrographis paniculata*) was revisited and validation of the same led to large scale adoption of this traditional practice. Now this has become a standard treatment protocol for treatment of dengue fever accepted by many state health departments leading to centralized preparation and administration of the herbal preparation to the affected population. Its effectiveness in control of the epidemic has been accepted by the modern system of allopathic medicine also.

Objectives

1. To do a review of literature of all available herbal medicine for treatment of body ache, fevers and associated difficulties.

2. To Study the disease incidence pattern of dengue fever in a location with refer to vector occurrence, breeding point mapping, study of socio-economic background of affected population.
3. To study the out of pocket (OOP) expenditure incurred by dengue patients before the introduction of the herbal medicine and compare with the expenditure incurred after the introduction of the herbal medicine.
4. To document, study, validate the traditional knowledge, attitude and perceptions (KAP) of affected population, related to dengue fever.
5. To study the disease profile with help from community health centre (with adequate precautions of not getting disease to oneself).
6. To study the loss of livelihood due to disease incidence to a sample population.

Methodology

1. Secondary reference to available documentation related to use of specific medicinal plants/plant parts.
2. OOPs study format (ref. National Health Systems Resource Centre, NRHM, New Delhi)
3. KAP study related to Objective No. 4.
4. Experimentation with sample population and disease monitoring using simple body thermometers, diagnostics procedures adopted by doctors (with help from PHC doctors)
5. Development of a protocol for disease reporting, procedures for treatment, dos, don'ts etc.
6. Looking at the source of vector multiplication as the problem and identifying solutions of avoiding water stagnation points, standard protocols, drainage mapping.
7. Community based action for awareness building, Solid waste management, health, hygiene etc. including schools, panchayats, civil society organizations, govt. infrastructure, media etc.
8. Use of modern communication technologies for effective health communication outreach.
9. To also look at control groups who have not taken other forms of medicine or no medicines at all and to see how far the herbal medicine is effective or not.
10. To look at the various preparations, protocols for preparation of the herbal extracts, their shelf life etc.

Expected Outcome

1. Understanding the intricacies of traditional knowledge and its modern application potential to newer challenges.
2. To mainstream, adopt, adapt and integrate the traditional knowledge systems to modern and changing socio-ecological and economic conditions
3. Understanding the economic impacts leading to loss of livelihoods, attendance in schools, negative impact to local production systems, and possible impact on developmental process, sustainability etc.
4. To understand the pattern of Out of Pocket (OOP) expenditure of various sections of the community / classes and the varied impact of the same disease on different socio-economic sections.

5. Effective and meaningful S&T/health communication strategies designed, implemented and adopted by the communities themselves can lead to sustainable livelihoods ,
6. To see if there are fake herbal products sold in the name of Traditional practices, commercialization of traditional knowledge if any etc.

Project – 3:

Ethno-Botanical Study of Various Important Medicinal Plants and their Important Phytochemical Properties

Introduction

Ethnobotany is the scientific study of the traditional knowledge and customs of people concerning with different uses of plants as medicine food etc. Human beings have collected rich experience with natural resources since time immemorial Plants have been used for ages as food, beverages, natural dye, natural additive and food preservative. The curative and prophylactic uses of medicinal herbs have been known since time immemorial. Indigenous knowledge is the main resource of ethno botanical investigations and it is mainly known as the traditional ethno botanical knowledge (TEK). The documentation of TEK is important for proper conservation and utilization of the biological resources. Proper experimentation should be carried out before these rich heritages are lost due to various reasons like anthropogenic.

Objectives

1. To identify important medicinal plants that have been used to treat diseases traditionally
2. Phytochemical analysis of important medicinal value of the plants.

Methodology

Study Area

Identification of geographical location(s) for analysis of traditional plants to be used for treatment.

Data Collection

Semi structured interviews can be carried out to gather information about the medicinal plants used in the study area. The information can include various data such as local names, ailments and disease treated, therapeutic effects, parts of the plant used and method of preparation can be obtained from the local people through individual and face to face interviews. At the end of the semi-structured interview the information's about the medicinal plants and usage can be carefully recorded.

Data Analysis and Quantitative study

A. Sample Collection

B. Preparation of Plant Extract

C. Phytochemical Analysis

Pholobotannins(a chemical constituent of the plant)

- Plant sample is mixed with distilled water
- 1% HCL (aqueous) is added.
- Plant sample is boiled with the help of hot plate stirrer
- Formation of red color precipitate denotes the positive result

Reducing Sugar

- 0.50 g of plant sample is taken
- 5 ml of distilled water is added
- 1 ml of ethanol is added
- Around 1ml of Fehlings solutions A + Fehlings solutions B is taken
- Solutions are boiled
- Addition of ethanol and development of positive result depicts positive results for terpenoids, alkaloids and other important plant properties

Expected Outcome

1. To create an inventory data base for the medicinal plants available and used in local community/traditions
2. To identify plants with important medicinal and nutraceutical properties that can be further researched and documented.

Phytochemical Analysis Data can be represented in the following manner

Test	A.n	B.b	D.r	P.e	T.a	Z.z
Alkaloids	-	+	-	+	+	-
Glycosides	+	+	+	+	+	+
Saponins	+	-	-	+	+	+
Terponins	+	+	+	+	+	+
Sterols	+	-	+	+	+	-
Resins	-	+	-	-	-	+
Carbohydrates	+	+	+	+	+	+
Balsam	-	+	-	-	-	+
Flavonoids	+	-	+	+	+	+
Anthraquinones	+	-	+	-	-	-

Key + = present, – = absent, A.n = A.nilotica, B.b = B.buonopozense,
D.r = D.rotundifolia, P.e = P.srinacsus,T.a = T.avicsnnioides, Z.z = Z.zanthoxyloides

Project – 4:

To Study Traditional Indigenous Knowledge Techniques in Coping with the Climatic Vulnerability

Introduction

Indigenous knowledge has been used in designing and implementing sustainable development projects but very less work has been done in incorporating it into formal climate change strategies. It is well known fact that climate change cannot be separated from sustainable development as it is the most important and crucial for climate mitigation. Although, incorporation of the climate change should be done integrated with the modern/ western knowledge. It should be aimed that indigenous knowledge should complement the global knowledge system. Villagers/farmers have since time immemorial used various cultivation, mulching, soil management techniques in conserving the resources and coping with the climatic vulnerability.

Traditional methods of reducing climate variability and extremes includes the following

- Development of early warning system for the prediction or forecast of event, wealth of knowledge has been based on predicting weather and climate changes
- Utilizing organic agriculture which is a holistic way of managing agro-ecosystem health.
- Organic agriculture prevents nutrient and water loss through high organic content and soil covers, thus soil is made more resilient to floods, drought and land degradation process.
- Increasing diversifying plant crops that are drought tolerant and/or resistant to temperature stresses which takes advantages of the available water and making efficient use of it Different architectural structures of houses to combat with different climate changes and variability

Objectives

1. To explore some of the ways in which society copes with the vulnerability of the climate
2. To integrate indigenous knowledge with the climatic change adaptation strategies

Methodology

1. Identification of particular local community
2. Identification of different parameters that help in coping up with climatic vulnerability which are (better to select one / two aspects only)
   Housing patterns
   Water conservation techniques
   Clothing pattern
   Agricultural farming
3. Preparation of questionnaires with structured and open ended questions
4. Sampling methods: stratified random sampling and purposive sampling techniques
5. Adopt focus interview based on questionnaire
6. Carry out field observation along with documentation
7. Carry out focused group discussion with community groups
8. Systematic compilation and tabulation of data
9. Scientific validation: Any particular parameter can be identified and scientifically validated, for e.g if study is on housing pattern and about how it is able to combat heat , rainfall, wind .

Expected Outcome

Identification of important traditional method of combating climatic variations and integrating with modern techniques

5.8. Additional Project Ideas

1. Evaluation of nutritional values of traditional food
2. Documentation of food fermentation techniques and its relation to food quality preservation
3. Study on biodiversity of a particular local community and developing people's biodiversity register
4. Different architectural structures and its importance in maintaining the ecosystem (e.g housing, bridges, water distribution canals)
5. Resource conservation methods and its sustainability
6. Various agricultural farming systems and its importance with the future scope
7. Traditional knowledge of various agricultural tools and its applicability in organic farming
8. Sustainable knowledge of various agricultural practices
9. Traditional knowledge of fisherman and its links to sustainable livelihoods
10. Study on community seed bank and its relation to food security
11. Traditional knowledge on Food Preservation Techniques and its importance as source of livelihood
12. Traditional knowledge on natural fiber and its uses in modern context
13. Study on traditional knowledge on ecological restoration mechanism its impact on ecosystem management
14. Design and development of appropriate technology based on traditional technological knowledge
15. Experiment on water harvesting based on traditional knowledge to verify its contemporary applicability

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h. https://www.macfound.org/media/files/CSD_Culture_White_Paper.pdf;
i. http://unesdoc.unesco.org/images/0021/002182/218270E.pdf;
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41. http://www.sathyabamauniversity.ac.in/uploads/notes/note_1461313899.pdf
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ANNEXURE - I

What Is an Experiment?

An experiment is a sort of test, designed to evaluate a hypothesis or theory. Science is concerned with experiments and experimentation, but do you know what exactly an experiment is? Here's a look at what an experiment is... and isn't!

What Is an Experiment?

In its simplest form, an experiment is simply the test of a hypothesis.

Experiment Basics

The experiment is the foundation of the scientific method, which is a systematic means of exploring the world around you. Although some experiments take place in laboratories, you could perform an experiment anywhere, at any time.

Take a look at the steps of the scientific method:

1. Make observations.
2. Formulate a hypothesis.
3. Design and conduct an experiment to test the hypothesis.
4. Evaluate the results of the experiment.
5. Accept or reject the hypothesis.
6. If necessary, make and test a new hypothesis.

Types of Experiments

- ***Natural Experiments***

A natural experiment also is called a quasi-experiment. A natural experiment involves making a prediction or forming a hypothesis and then gathering data by observing a system. The variables are not controlled in a natural experiment.

- ***Controlled Experiments***

Lab experiments are controlled experiments, although you can perform a controlled experiment outside of a lab setting! In a controlled experiment, you compare an experimental group with a control group. Ideally, these two groups are identical except for one variable, the independent variable.

- ***Field Experiments***

A field experiment may be either a natural experiment or a controlled experiment. It takes place in a real-world setting, rather than under lab conditions. For example, an experiment involving an animal in its natural habitat would be a field experiment.

Variables in an Experiment

Simply put, a variable is anything you can change or control in an experiment. Common examples of variables include temperature, duration of the experiment, composition of a material, amount of light, etc. There are three kinds of variables in an experiment: controlled variables, independent variables and dependent variables.

Controlled variables, sometimes called constant variables are variables that are kept constant or unchanging. For example, if you are doing an experiment measuring the fizz released from different types of soda, you might control the size of the container so that all brands of soda would be in 12-oz cans.

If you are performing an experiment on the effect of spraying plants with different chemicals, you would try to maintain the same pressure and maybe the same volume when spraying your plants.

The independent variable is the one factor that you are changing. I say one factor because usually in an experiment you try to change one thing at a time. This makes measurements and interpretation of the data much easier. If you are trying to determine whether heating water allows you to dissolve more sugar in the water then your independent variable is the temperature of the water. This is the variable you are purposely controlling.

The dependent variable is the variable you observe, to see whether it is affected by your independent variable. In the example where you are heating water to see if this affects the amount of sugar you can dissolve, the mass or volume of sugar (whichever you choose to measure) would be your dependent variable.

Steps of the Scientific Method

Experimentation is how you test a hypothesis in the scientific method. Experiments can be simple or complex. What matters is that you can control and measure your variables.

The scientific method is a method for conducting an objective investigation. The scientific method involves making observations and conducting an experiment to test a hypothesis. The number of steps of the scientific method isn't standard. Some texts and instructors break up the scientific method into more or fewer steps. Some people start listing steps with the hypothesis, but since a hypothesis is based on observations (even if they aren't formal), the hypothesis usually is considered to be the second step.

Here are the usual steps of the scientific method.

Examples of the Null Hypothesis

- Hyperactivity is unrelated to eating sugar.
- All daisies have the same number of petals.
- The number of pets in a household is unrelated to the number of people living in it.
- A person's preference for a shirt is unrelated to its color.

Examples of an If, Then Hypothesis

- If you get at least 6 hours of sleep, you will do better on tests than if you get less sleep.
- If you drop a ball, it will fall toward the ground.
- If you drink coffee before going to bed, then it will take longer to fall asleep.
- If you cover a wound with a bandage, then it will heal with less scarring.

ANNEXURE - II

Brief Guideline to Develop a Questionnaire for Social Science Research

A questionnaire is a technique for collecting data in which a respondent (the person who responds to the question) provides answers to a series of questions. Developing a questionnaire for collecting data (information) needs effort and time. However, by taking a step-by-step approach to questionnaire development, you can come up with an effective means to collect data that will answer your research question.

Step-1:

- Identify the goal of the questionnaire. Nature of information(s) you want to gather with your questionnaire aiming to your main objective is to be decided.
- Come up with a research question which may be one or more; but this should be the focal point of the questionnaire.
- Develop a hypothesis that is to be tested. The questions in the questionnaire should be aimed at testing the hypotheses which may be accepted or rejected following data analysis.

Step-2: Type(s) of question(s) to be chosen

Depending on the gathered information, there are several possible types of questions that may be included in the questionnaire, each with unique pros and cons. Here are the types of commonly used questions on a questionnaire:

Dichotomous question: This type of question generally become of "yes/no" question, but may also be "agree/disagree" . It is the quickest and simplest question to analyze, but is not highly sensitive.

Open-ended questions: These questions allow the respondent to respond in their own words. They can be useful for gaining insight into the feelings of the respondent, but can be a challenge when it comes to analysis of data. It is recommended to use open-ended questions to address the issue of "why."

Multiple choice questions: These consist of three or more mutually-exclusive categories and ask for a single answer or several answers. Multiple choice questions allow for easy analysis of results.

Rank-order (or ordinal) scale questions: Such types of questions are asked to the respondent to rank items or choose items in a particular order from a set. For example, the respondent may be asked to order five things from least important to most important.

Rating scale questions: These questions allow the respondent to assess a particular issue based on a given dimension. A scale that gives an equal number of positive and negative choices, like "strongly agree" to "strongly disagree."

NOTE: All these types of questions have both advantage and disadvantages with respect to data analysis. However, these limitations may be ignored by the children for CSC projects. They are free to choose either any one or better combination of questions for their conveniences.

Step- 3: Developing questions for the questionnaire

The questions for the questionnaire should be clear, concise, and direct. This will ensure to get the best possible answers from the respondents.

- The questions need be short and simple. Complex statements or using technical jargon should be avoided, as it will only confuse the respondents and lead to incorrect responses.
- Only one question is to be asked at a time.
- Beware of asking any question related to private or "sensitive" information.
- Determine if you will include an answer such as "I don't know" or "Not applicable to me." While these can give your respondents a way of not answering certain questions, providing these options can also lead to missing data, which can be problematic during data analysis.
- The questionnaire should begin with the most important questions. This will help in gathering important data even before the respondent may be distracted and/or impatient by the end of the questionnaire.

- Do not ask biased questions. Questions that encourage respondents to answer in particular ways are called biased. Avoid leading or highly inflammatory words

Step-4: Length of the questionnaire

- The questionnaire should be as short as possible as most of the respondents will prefer to answer a shorter questionnaire. So, developing a concise questionnaire without compromising the scope for collecting necessary information needs careful attention. Unnecessary and irrelevant questions must be avoided.
- Only questions that are directly useful to the research are to be incorporated. It may be noted that a questionnaire is not an opportunity to collect all kinds of information about the respondents.
- Asking needless questions to be strictly avoided.

Step-5: Writing your questionnaire

(i) Introduction of interrogator (the person who asks question): There should be an introduction of the interrogator (the person who asks question) explaining who is he or she. The interrogator should clarify if he/she works alone or as a part of a team. Name of the institution or organization he/she belongs to need be spelt out. Here are some examples:"My name is Shyam Sundar and I am one of the creators of this questionnaire. I belong to ABC institution/school".

(ii) Explain the purpose of the questionnaire. Many people will not answer the questionnaire unless understanding its purpose. Explanations need not be long; instead, a few concise sentences will do the trick. Here are some examples:

- I am collecting data regarding the attitudes of people towards organic farming in the area. This information is collected for my/our project.
- This questionnaire will ask you 25 questions about your farming practices and crop production. We will attempt to find relation between nature of farming practices and quality of crop for your healthy living.

(iii) Estimate how long the questionnaire will take: Before someone sits down to answer the questions, it may be helpful for them to know whether the questionnaire will take them 30 minutes or 1 hour. This will help the respondent to be mentally prepared to sit for.

Step- 6: A pilot study is a pre-requisite

Prior to starting the survey a test to be carried out with the questionnaire asking some people, known personally (they will not be included in any results stemming from this questionnaire), and be prepared to revise it, if necessary. Plan to include 5-10 people in the pilot testing of your questionnaire. Get their feedback on your questionnaire by asking the following questions:

- Was the questionnaire easy to understand? Were there any questions that confused you?
- Do you feel the questionnaire was worth your time?
- Were you comfortable answering the questions asked?
- Are there any improvements you would make to the questionnaire?

NOTE:

1. At the bottom of the questionnaire provision should be kept for signature with date of both Interrogator & Respondent
2. It is important to decide the sample size, which must be representative of the target population as well as proportionate for drawing conclusion.
3. During tabulation and subsequent analysis of the data gathered through survey, all the respondents should be assigned a number, so that no name of the respondent will appear in the table or analysis. Example: Mr. Ram- Respondent 1; Mrs. Kaveri - Respondent 2.. so and so forth.
4. Sometimes, it is a standard practice to get the consent of the respondent in a Consent Form where the respondent states that she/he agrees to provide the data and is willing to share the data for the purpose for which it was collected etc. It is better to consult a researcher to see if a written consent is required before the planning of the study.

ANNEXURE - III

List of Environmental Information System (ENVIS) centres and their weblinks

Name of ENVIS Centre	Web Address
Assam Science, Technology and Environmental Council	http://www.asmenvis.nic.in
Bihar State Pollution Control Board	http://www.bhenvis.nic.in
Bombay Natural History Society (BNHS)	http://www.bnhsenvis.nic.in
Botanical Survey of India (BSI)	http://www.bsienvis.nic.in
Central Arid Zone Research Institute (CAZRI)	http://www.cazrienvis.nic.in
Central Building Research Institute (CBRI)	http://www.cbrienvis.nic.in
Centre for Advanced Study in Marine Biology (CASMB)	http://www.casmbenvis.nic.in
Centre for Ecological Sciences - Indian Institute of Science (IISc)	http://ces.iisc.ernet.in
Centre for Environment Education (CEE)	http://www.ceeenvis.nic.in
Centre for Environmental Studies (CES), Forest & Environment Department, Government of Odisha	http://www.orienvis.nic.in
Centre for Media Studies (CMS)	http://www.cmsenvis.nic.in
Centre for Mining Environment (CME) IIT-Indian School of Mines	http://ismenvis.nic.in
Central Pollution Control Board (CPCB)	http://www.cpcbenvis.nic.in
Chhattisgarh Environment Conservation Board	http://www.chtenvis.nic.in
Consumer Education and Research Centre (CERC)	http://cercenvis.nic.in
CPR Environmental Education Centre (CPREEC)	http://www.cpreecenvis.nic.in
Department of Ecology, Environment and Remote Sensing, State Government of J&K	http://www.jkenvis.nic.in
Department of Environmental Sciences (DES), Kalyani University	http://deskuenvis.nic.in
Department of Environment - Chandigarh	http://www.chenvis.nic.in
Department of Environment and Forest - Andaman and Nicobar	http://as.and.nic.in/envis
Department of Environment & Forests - Arunachal Pradesh	http://arpenvis.org.in
Department of Environment & Forests - Kavaratti, Lakshadweep	————-
Department of Environment, Govt. of Tamil Nadu	http://www.tnenvis.nic.in
Department of Zoology - University of Madras	http://www.dzumenvis.nic.in
Directorate of Environment, Dept. of Forests and Environment, Govt. of Manipur	http://www.manenvis.nic.in
Directorate of Environment - Uttar Pradesh	http://www.upenvis.nic.in
Disaster Management Institute (DMI)	http://www.mpenvis.nic.in
Environment Management & Policy Research Institute (EMPRI)	http://karenvis.nic.in
Environment Protection Training and Research Institute (EPTRI)	http://www.eptrienvis.nic.in http://www.apenvis.nic.in
Forest Department (Wildlife Division), Union Territories of Dadra & Nagar Haveli and Daman & Diu	http://dd@envis.nic.in
Forests & Environment Department, Govt. of Jharkhand	http://www.jharenvis.nic.in
Forests, Environment & Wildlife Management Department, Sikkim	http://www.sikenvis.nic.in
Forest Research Institute (FRI)	http://www.frienvis.nic.in
Foundation for Revitalization of Local Health Traditions (FRLHT)	http://www.frlhtenvis.nic.in, http://www. envis.frlht.org
G.B. Pant National Institute of Himalayan Environment and Sustainable Development (GBPNIHESD)	http://www.gbpihedenvis.nic.in
Goa State Council of Science & Technology	http://www.goaenvis.nic.in
Gujarat Cleaner Production Centre (GCPC)	http://www.gcpcenvis.nic.in
Gujarat Ecology Commission (GEC)	http://gujenvis.nic.in

Indian Centre for Plastic in the Environment (ICPE)	http://www.icpeenvis.nic.in
Indian Environmental Society (IES)	http://www.iesenvis.nic.in
Indian Institute of Chemical Technology (IICT)	http://iictenvis.nic.in/
Indian Institute of Toxicology Research (IITR)	http://www.itrcenvis.nic.in
Indian Institute of Tropical Meteorology (IITM)	http://www.iitmenvis.nic.in, http://envis.tropmet.res.in
Institute of Forest Genetics and Tree Breeding (IFGTB)	http://www.envisindia.in/ifgtb
Institute for Ocean Management (IOM), Anna University	http://www.iomenvis.nic.in
International Institute of Health and Hygiene (IIHH)	http://www.sulabhenvis.nic.in
International Institute for Population Sciences (IIPS)	http://www.iipsenvis.nic.in
Kerala State Council for Science, Technology and Environment (KSCSTE)	http://www.kerenvis.nic.in
Mizoram Pollution Control Board	http://www.mizenvis.nic.in
Nagaland Institute of Health, Environment and Social Welfare (NIHESW)	http://www.nagenvis.nic.in
National Botanical Research Institute (NBRI)	http://www.nbrienvis.nic.in
National Environmental Engineering Research Institute (NEERI)	http://www.neerienvis.nic.in
National Institute of Occupational Health (NIOH)	http://www.niohenvis.nic.in
Puducherry Pollution Control Committee	http://www. pon@envis.nic.in
Punjab State Council for Science and Technology (PSCST)	http://www.punenvis.nic.in
Rajasthan State Pollution Control Board	http://www.rajenvis.nic.in
Salim Ali Centre for Ornithology and Natural History (SACON)	http://www.saconenvis.nic.in
School of Environmental Sciences Jawaharlal Nehru University (JNU)	http://www.jnuenvis.nic.in
School of Planning and Architecture (SPA)	http://www.spaenvis.nic.in
State Council for Science, Technology and Environment (SCSTE)	http://www.hpenvis.nic.in
State Council of Science and Technology for Sikkim (SCSTS)	http://www.scstsenvis.nic.in
State Environment Department, Maharashtra	http://www.mahenvis.nic.in
The Energy Resources Institute (TERI)	http://www.terienvis.nic.in
Tripura State Pollution Control Board	http://www.trpenvis.nic.in
Uttarakhand Environment Protection & Pollution Control Board (UEPPCB)	http://www.utrenvis.nic.in
Wildlife Institute of India (WII)	http://www.wiienvis.nic.in
World Wide Fund for Nature - India (WWF)	http://www.wwfenvis.nic.in
Zoological Survey of India (ZSI)	http://www.zsienvis.nic.in

Annexure-IV

Format of the Abstract

____TH NATIONAL CHILDREN'S SCIENCE CONGRESS 20__

STATE- _____ STATE CODE: _____

Language : _____ Category:Lower/Upper Area of Participation: Rural/Urban

Title : Project Title

Author's Name: Aaaaa, (Team Leader), Bbbbbb†

Name of School: .....
Address of School: .....
Distrct: ……..……..…… State: ……..…… PIN: …….
E-mail: ..... Contact No: .....

ABSTRACT

[TEXT]

Put your text here which will contain the Objectives, Objective wise Methodology & Work plan, Experiments carried out, Observation, Results and Analysis & Conclusion in short

(The Abstract should give clear idea as to what your project is, how it was carried out and also what has been the inferences and conclusion, follow up carried out etc.)

Maximum 250 words for projects in the Lower Age Group and 300 words for projects in the Upper Age Group

Name & Address of Guide Teacher: ……...
…… PIN…….
Phone.....

Note: 1. The write-up should be in New Times Roman in 12 point font in A4 size paper.

† 2. Write the names of both the members with the Group leader's name shown first & Underlined as shown above

Unit Conversion Table

LENGTH

Ordinary Units

1	foot	= 12 inches
1	yard	= 3 feet
1	mile	= 5280 feet
1	nautical mi	= 1.1516 statute mi
1°	of latitude at the equator	= 69.16 statute mi = 60 nautical mi
1	acre	= 208.71 ft on one side of square

Metric Units

1000	picometres	= 1 nanometre
1000	nanometres	= 1 micrometre
1000	micrometres	= 1 millimetre
10	millimetres	= 1 centimetre
100	millimetres	= 1 decimetre
10	centimetre	= 1 decimetre
1000	metres	= 1 netre
100	centimetres	= 1 metre
10	decimetres	= 1 metre
100	metres	= 1 hectometre
1000	metres	= 1 kilometre
10	hectometres	= 1 kilometre
1000	kilometres	= 1 megametre
1852	nautical metres	= 1 international nautical mile

Equivalents

1	inch	= 2.5400 centimetres
1	foot	= 0.3048 metre
1	statute mi	= 1.60935 kilometres
1	nautical mi	= 1.853 kilometres
1	centimetre	= 0.39370 inch
1	metre	= 3.28 feet
1	kilometre	= 3280.83 feet = 0.62137 mile

AREA

Ordinary Units

1	square foot	= 144 square inches
1	square yard	= 9 sq ft = 1296 sq ft in.
1	acre	= 43,560 sq ft = 4840 sq yds
1	sq mile	= 640 acres = 1 section of land (U.S.)

Metric Units

100	sq millimetres	= 1 sq centimetre
100	sq centimetres	= 1 sq decimetre
10000	sq centimetres	= 1 sq metre
100	sq decimetres	= 1 sq metre
100	sq metres	= 1 are
10	ares	= 1 dekare
10000	sq metres	= 1 sq hectometre = 1 hectare
100	ares	= 1 hectare
10	dekares	= 1 hectare
100	sq hectometres	= 1 sq kilometre
100	hectares	= 1 sq kilometre

Equivalents

1	square centimetre	= 0.155 square inch
1	square metre	= 10.76 square feet = 1.196 square yards
1	square kilometre	= 0.386 square mile
1	square inch	= 6.45 square centimetres
1	square foot	= 0.0929 square metre
1	square yard	= 0.836 square metre
1	square mile	= 2.59 square kilometres

VOLUME AND CAPACITY

Ordinary Units

1 cu ft of water at 39.1° F	= 62.425 lbs
1 United States gallon	= 231 cu in.
1 imperial gallon	= 277.274 cu in.
1 cubic foot of water	= 1728 cu in. = 7.480519 U. S. gallons = 6.232103 imperial gallons
1 cubic yard	= 27 cu ft = 46,656 cu in.
1 quart	= 2 pints
1 gallon	= 4 quarts
1 U. S. gallon	= 231 cu in. = 0.133681 cu ft = 0.83311, imperial gallon = 8.345 lbs
1 barrel	= 31.5 gallons = 4.21 cu ft
1 U. S. bushel	= 1.2445 cu ft
1 fluid ounce	= 1.8047 cu in.
1 acre foot	= 43,560 cu ft = 1,613.3 cu yds
1 acre inch	= 3,630 cu ft
1 million U. S. gallons	= 133,681 cu ft = 3.0689 acre-ft
1 ft depth on 1 sq mi	= 27,878, 400 cu ft = 640 acre-ft

Metric Units

1000	cu millimetres	= 1 cu centimetre
1000	cu centimetres	= 1 cu decimetre
1000	cu decimetres	= 1 cu metre
1000	cu metres	= 1 cu dekametre
1000	dekametres	= 1 hectometre
1000	cu hectometres	= 1 cu kilometre
1000	microlitres	= 1 millilitre = 1 cu centimetre
10	millilitres	= 1 centilitre
10	centilitres	= 1 decilitre
1000	millilitres	= 1 litre
100	centilitres	= 1 litre
100	litres	= 1 hectolitre
1000	litres	= 1 kilolitre = 1 cu metre
10	hectolitres	= 1 kilolitre

Equivalents

1	cu in.	= 16.387 cu cm
1	cu ft	= 0.0283 cu m
1	cu yd	= 0.765 cu m
1	cu cm	= 0.0610 cu in.
1	cu m	= 35.3 cu ft = 1.308 cu yds
1	litre	= 61.023378 cu in. (about 1 quart) = 0.264170 U. S. liquid gallon = 0.2201 imperial gallon
1	U. S. liquid quart	= 0.946 litre
1	U. S. liquid gallon	= 3.785 litres

WEIGHT (MASS)

Ordinary Units

1 pound	= 16 ounces (avoirdupois)
1 ton	= 2000 lbs
1 long ton	= 2240 lbs
1 lb of water (39.1° F)	= 27.681217 cu in. = 0.016019 cu ft = 0.119832 U. S. gallon = 0.453617 liter

Equivalents

1 kilogram	= 2.205 avoirdupois pounds
1 metric ton	= 0.984 gross or long ton = 1.102 net or short tons
1 avoirdupois pound	= 28.35 grams
1 avoirdupois	= 0.4536 kilogram

To Covert	***Multiply by***
ounces into grams	28.3495
pounds into grams	453.6
pounds into kilograms	0.4536
tons into kilograms	1016.047
tahils into grams	37.799
kati into kilograms	0.60479
grains into grams	0.0648

To Covert	***Multiply by***
grams into ounces	0.03527
grams into grains	15.4324
grams into tahil	0.02646
kilograms into pounds	2.2046
kilograms into tons	0.0009842
kilograms into katis	1.653
kilograms into stones	0.1575
kilograms into hundreweights	0.01968

NON-METRIC TO METRIC LINEAR

To Covert	***Multiply by***
inches into centimetres	2.540
inches into metres	$2{,}540 \times 10^{2}$
inches into millimetres	25.4
feet into metres	0.3048
yards into metres	0.9144
miles into kilometres	1.609344
miles into metres	1609.344
feet into centimetres	30.48

METRIC TO NON-METRIC LINEAR

To Covert	***Multiply by***
millimetres into feet	3.281×10^{3}
millimetres into inches	0.03937
centimetres into inches	0.3937
metres into feet	3.281
metres into yards	1.09361
kilometres into yards	1093.61
kilometres into miles	0.62137

VELOCITY

To Covert	***Multiply by***
miles per hour into kolometres per hour	1.609344
feet per second into metres per second	0.3048
feet per second into centimetres per second	30.48
centimetres per second into feet per second	0.03281
metres per second into feet per minute	196.9
metres per second into feet per second	3.281
kilometres per hour into miles per hour	0.6214

Glossary of Terms

[Arranged alphabetically]

A

Abiotic

Absence of living organisms.

Absorption of radiation

The uptake of radiation by a solid body, liquid or gas. The absorbed energy may be transferred or re-emitted.

Acid deposition

A complex chemical and atmospheric process whereby recombined emissions of sulphur and nitrogen compounds are re-deposited on earth in wet or dry form. See acid rain.

Acid rain

Rainwater that has acidity content greater than the postulated natural pH of about 5.6. It is formed when sulphur dioxides and nitrogen oxides, as gases or fine particles in the atmosphere, combine with water vapour and precipitate as sulphuric acid or nitric acid in rain, snow, or fog. The dry forms are acidic gases or particulates.

Acid Solution

Any water solution that has more hydrogen ions (H+) than hydroxide ions (OH-); any water solution with a pH less than 7.

Adiabatic Process

A thermodynamic change of state of a system such that no heat or mass is transferred across the boundaries of the system. In an adiabatic process, expansion always results in cooling, and compression in warming.

Additives

A substance added to something in small quantities to improve or preserve it

Aerobic

A life or process that occurs in and is dependent upon oxygen.

Aerosol

Particulate matter, solid or liquid, larger than a molecule but small enough to remain suspended in the atmosphere. Natural sources include salt particles from sea spray, dust and clay particles as a result of weathering of rocks, both of which are carried upward by the wind. Aerosols can also originate as a result of human activities and are often considered pollutants. Aerosols are important in the atmosphere as nuclei for the condensation of water droplets and ice crystals, as participants in various chemical cycles, and as absorbers and scatters of solar radiation, thereby influencing the radiation budget of the Earth's climate system.

Afforestation

Planting of new forests on lands that have not been recently forested.

Agro-ecology

Agro-ecology often incorporates ideas about a more environmentally and socially sensitive approach to agriculture, one that focuses not only on production, but also on the ecological sustainability of the productive system. This implies a number of features about society and production that go well beyond the limits of the agricultural field.

Agro-biodiversity

A fundamental feature of farming systems around the world. It encompasses many types of biological resources tied to agriculture, including:

- genetic resources - the essential living materials of plants and animals;
- edible plants and crops, including traditional varieties, cultivars, hybrids, and other genetic material developed by breeders; and
- livestock (small and large, lineal breeds or thoroughbreds) and freshwater fish;
- soil organisms vital to soil fertility, structure, quality, and soil health;
- naturally occurring insects, bacteria, and fungi that control insect pests and diseases of domesticated plants and animals;
- agro-ecosystem components and types (polycultural/monocultural, small/large scale, rain-fed/irrigated, etc.) indispensable for nutrient cycling, stability, and productivity; and
- 'wild' resources (species and elements) of natural habitats and landscapes that can provide services (for example, pest control and

ecosystem stability) to agriculture.

Agri-environmental indicator

Measures change either in the state of environmental resources used or affected by agriculture, or in farming activities that affect the state of these resources. Examples of sustainable agriculture processes monitored by such indicators are soil quality, water quality, agro-ecosystem, biodiversity, climatic change, farm resource management, and production efficiency.

Air pollution

One or more chemicals or substances in high enough concentrations in the air to harm humans, other animals, vegetation, or materials. Such chemicals or physical conditions (such as excess heat or noise) are called air pollutants.

Albedo

The fraction of the total solar radiation incident on a body that is reflected by it. Albedo can be expressed as either a percentage or a fraction of 1. Snow covered areas have a high albedo (up to about 0.9 or 90%) due to their white color, while vegetation has a low albedo (generally about 0.1 or 10%) due to the dark color and light absorbed for photosynthesis. Clouds have an intermediate albedo and are the most important contributor to the Earth's albedo. The Earth's aggregate albedo is approximately 0.3.

Alliance of Small Island States (AOSIS)

The group of Pacific and Caribbean nations who call for relatively fast action by developed nations to reduce greenhouse gas emissions. The AOSIS countries are concerned by the effects of rising sea levels and increased storm activity predicted to accompany global warming. Its plan is to hold Annex I Parties to a 20 percent reduction in carbon dioxide emissions by the year 2005.

Alien Species

An alien species is a species introduced outside its normal distribution. Species occurring in ecosystems to which they are not indigenous. The terms used include, 'exotic', 'foreign', 'non-indigenous', 'non-native', 'alien' etc. IUCN - the World Conservation Union uses the term 'alien' consistently to encompass all the above terms. CBD Subsidiary Body on Scientific, Technical and Technological Advice defines alien species as a species occurring outside its normal distribution.

Alkalinity

Having the properties of a base with a pH of more than 7. A common alkaline is baking soda.

Alternative energy

Energy derived from non-traditional sources (e.g., compressed natural gas, solar, hydroelectric, wind).

Anaerobic

A life or process that occurs in, or is not destroyed by, the absence of oxygen.

Anaerobic decomposition

The breakdown of molecules into simpler molecules or atoms by microorganisms that can survive in the partial or complete absence of oxygen.

Anaerobic lagoon

A liquid-based manure management system, characterized by waste residing in water to a depth of at least six feet for a period ranging between 30 and 200 days. Bacteria produce methane in the absence of oxygen while breaking down waste.

Anaerobic organism

An organism that does not need oxygen to stay alive. See anaerobic.

Animal Carcasses

The remains of a dead animal that's been slaughtered for food and other purposes.

Annex I Parties

Industrialized countries that, as parties to the Framework Convention on Climate Change, have pledged to reduce their greenhouse gas emissions by the year 2000 to 1990 levels. Annex I Parties consist of countries belonging to the Organization for Economic Cooperation and Development (OECD) and countries designated as Economies-in-Transition.

Antarctic "Ozone Hole"

Refers to the seasonal depletion of stratospheric ozone in a large area over Antarctica.

Anthracite

A hard, black, lustrous coal containing a high percentage of fixed carbon and a low percentage of volatile matter. Often referred to as hard coal. See coal.

Anthropogenic

Human made. In the context of greenhouse gases, emissions that are produced as the result of human activities.

Antibiotic Resistance

The ability of bacteria and other microorganisms

to reduce the effectiveness of an antibiotic which they were once sensitive to. Antibiotic resistance is a major concern of overuse of antibiotics. Antibiotic resistance is also known as drug resistance.

Arable land

Land that can be cultivated to grow crops.

Area search

The Area Search is a quantitative, habitat specific survey method that is widely applicable in most habitats. The method involves a time-constrained survey of a defined area, during which the observer records all seen or heard species, differentiating those detected inside, outside, and flying over the search area.

Aromatic

Applied to a group of hydrocarbons and their derivatives characterized by the presence of the benzene ring.

Ash

The mineral content of a product remaining after complete combustion.

Asphalt

A dark-brown-to-black cement-like material containing bitumen as the predominant constituent. It is obtained by petroleum processing. The definition includes crude asphalt as well as the following finished products: cements, fluxes, the asphalt content of emulsions (exclusive of water), and petroleum distillates blended with asphalt to make cutback asphalt.

Atmosphere

The mixture of gases surrounding the Earth. The Earth's atmosphere consists of about 79.1% nitrogen (by volume), 20.9% oxygen, 0.036% carbon dioxide and trace amounts of other gases. The atmosphere can be divided into a number of layers according to its mixing or chemical characteristics, generally determined by its thermal properties (temperature). The layer nearest the Earth is the troposphere, which reaches up to an altitude of about 8 km (about 5 miles) in the polar regions and up to 17 km (nearly 11 miles) above the equator. The stratosphere, which reaches to an altitude of about 50 km (31 miles) lies atop the troposphere. The mesosphere which extends up to 80-90 km is atop the stratosphere, and finally, the thermosphere, or ionosphere, gradually diminishes and forms a fuzzy border with outer space. There is relatively little mixing of gases between layers.

Atomic weight

The average weight (or mass) of all the isotopes of an element, as determined from the proportions in which they are present in a given element, compared with the mass of the 12 isotope of carbon (taken as precisely 12.000), that is the official international standard; measured in daltons.

Atoms

Minute particles that are the basic building blocks of all chemical elements and thus all matter.

B

Bacteria

One-celled organisms. Many act as decomposers that break down dead organic matter into substances that dissolve in water and are used as nutrients by plants.

Bacteriological

Relating to bacteriology or bacteria where Bacteriology refers to a branch of microbiology dealing with the identification, study, and cultivation of bacteria and with their applications in medicine,agriculture, industry, and biotechnology.

Bacillus thuringiensis(Abbreviation: Bt)

A bacterium that produces a toxin against certain insects, particularly Coloeoptera and Lepidoptera; a major means of insecticide for organic farming. Some of the toxin genes are important for transgenic approaches to crop protection.

Barrel

A liquid-volume measure equal to 42 United States gallons at 60 degrees Fahrenheit; used in expressing quantities of petroleum-based products.

Baseline Emissions

The emissions that would occur without policy intervention (in a business-as-usual scenario). Baseline estimates are needed to determine the effectiveness of emissions reduction programs (often called mitigation strategies).

Basic solution

Water solution with more hydroxide ions (OH-) than hydrogen ions (H+); water solutions with pH greater than 7.

Beach Erosion

Coastal erosion is the wearing away of land and

the removal of beach or sand dunes sediments by wave action, tidal currents, wave currents, drainage or high winds

Berlin Mandate

A ruling negotiated at the first Conference of the Parties (COP 1), which took place in March, 1995, concluding that the present commitments under the United Nations Framework Convention on Climate Change are not adequate. Under the Framework Convention, developed countries pledged to take measures aimed at returning their greenhouse gas emissions to 1990 levels by the year 2000. The Berlin Mandate establishes a process that would enable the Parties to take appropriate action for the period beyond 2000, including a strengthening of developed country commitments, through the adoption of a protocol or other legal instruments.

Bioaccumulation

A problem that can arise when a stable chemical such as a heavy metal or DDT is introduced into a natural environment. Where there are no agents present able to biodegrade it, its concentration can increase as it passes up the food chain and higher organisms may suffer toxic effects. This phenomenon may be employed beneficially for the removal of toxic metals from wastewater, and for bioremediation. See: biosorbents.

Bioassay

The assessment of a substance's activity on living cells or on organisms. Animals have been used extensively in drug research in bio-assays in the pharmaceutical and cosmetics industries. Current trends are to develop bio-assays using bacteria or animal or plant cells, as these are easier to handle than whole animals or plants, are cheaper to make and keep, and avoid the ethical problems associated with testing of animals. 2. An indirect method to detect sub-measurable amounts of a specific substance by observing a sample's influence on the growth of live material.

Bio-augmentation

Increasing the activity of bacteria that decompose pollutants; a technique used in bioremediation.

Bio-control

Pest control by biological means. Any process using deliberately introduced living organisms to restrain the growth and development of other organisms, such as the introduction of predatory insects to control an insect pest. Synonym: biological control.

Bioconversion

Conversion of one chemical into another by living organisms, as opposed to their conversion by isolated enzymes or fixed cells, or by chemical processes. Particularly useful for introducing chemical changes at specific points in large and complex molecules.

Biodegradable

Material that can be broken down into simpler substances (elements and compounds) by bacteria or other decomposers. Paper and most organic wastes such as animal manure are biodegradable.

Bio-degradation

Disintegration of materials by bacteria, fungi, or other biological methods.

Biodiversity

The variability among living organisms from all sources, including, inter alia, terrestrial, marine and other ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems. Synonyms: biological diversity, ecological diversity.

Bioenergetics

The study of the flow and the transformation of energy that occur in living organisms.

Biofiltration

Biofiltration is a pollution control technique using a bioreactor containing living material to capture and biologically degrade pollutants. Common uses include processing waste water, capturing harmful chemicals or silt from surface runoff, and microbiotic oxidation of contaminants in air.

Biofuel

Gas or liquid fuel made from plant material (biomass). Includes wood, wood waste, wood liquors, peat, railroad ties, wood sludge, spent sulfite liquors, agricultural waste, straw, tires, fish oils, tall oil, sludge waste, waste alcohol, municipal solid waste, landfill gases, other waste, and ethanol blended into motor gasoline.

Biogeochemical Cycle

Natural processes that recycle nutrients in various chemical forms from the environment, to organisms, and then back to the environment. Examples are the carbon, oxygen, nitrogen, phosphorus, and hydrologic cycles.

Biological Control/Bio-control

Biological control is, generally, human's use of a specially chosen living organism to control a particular pest. This chosen organism might be a predator, parasite, or disease which will attack the harmful insect. It is a form of manipulating nature to increase a desired effect. A complete Biological Control program may range from choosing a pesticide which will be least harmful to beneficial insects, to raising and releasing one insect to have it attack another, almost like a 'living insecticide.

Biological oxygen demand

Amount of dissolved oxygen needed by aerobic decomposers to break down the organic materials in a given volume of water at a certain temperature over a specified time period.

Biomass

Total dry weight of all living organisms that can be supported at each tropic level in a food chain. Also, materials that are biological in origin, including organic material (both living and dead) from above and below ground, for example, trees, crops, grasses, tree litter, roots, and animals and animal waste.

Biomass energy

Energy produced by combusting biomass materials such as wood. The carbon dioxide emitted from burning biomass will not increase total atmospheric carbon dioxide if this consumption is done on a sustainable basis (i.e., if in a given period of time, regrowth of biomass takes up as much carbon dioxide as is released from biomass combustion). Biomass energy is often suggested as a replacement for fossil fuel combustion.

Bio-Methanation

Methanogenesis or biomethanation is the formation of methane by microbes known as methanogens.

Biosphere

The living and dead organisms found near the earth's surface in parts of the lithosphere, atmosphere, and hydrosphere. The part of the global carbon cycle that includes living organisms and biogenic organic matter.

Bioremediation

The use of either naturally occurring or deliberately introduced microorganisms to consume and break down environmental pollutants, in order to clean a polluted site.

Biosequestration

Biosequestration is the capture and storage of dead biota by biological/physical processes.

Biotic

Living. Living organisms make up the biotic parts of ecosystems.

Biowaste

These are the wastes (such as manure, sawdust, or food scraps) that are majorly composed of organic matter.

Bitumen

Gooey, black, high-sulfur, heavy oil extracted from tar sand and then upgraded to synthetic fuel oil.

Bituminous coal

A dense, black, soft coal, often with well-defined bands of bright and dull material. The most common coal, with moisture content usually less than 20 percent. Used for generating electricity, making coke, and space heating. See coal.

BOD (Biochemical Oxygen Demand)

The biochemical oxygen demand of wastewater during decomposition occurring over a 5-day period. A measure of the organic content of wastewater.

Boreal

Of or relating to the forest areas of the northern North Temperate Zone, dominated by coniferous trees such as spruce, fir, and pine.

Borehole

Any exploratory hole drilled into the Earth or ice to gather geophysical data. Climate researchers often take ice core samples, a type of borehole, to predict atmospheric composition in earlier years.

British thermal unit

The quantity of heat required to raise the temperature of one pound of water one degree of Fahrenheit at or near 39.2 degrees Fahrenheit.

Bunker fuel

Fuel supplied to ships and aircraft for international transportation, irrespective of the flag of the carrier, consisting primarily of residual and distillate fuel oil for ships and jet fuel for aircraft.

Bus

A rubber-tired, self-propelled, manually steered vehicle that is generally designed to transport 30 individuals or more. Bus types include intercity, school and transit.

C

Cadastral map

A cadastral map is a map defining land ownership. The land register cadastral map is further defined by the Act as a map showing all registered geospatial data relating to registered plots. The cadastral map consists of cadastralunits, each of which represents a single registered plot of land.

Carbon black

An amorphous form of carbon, produced commercially by thermal or oxidative decomposition of hydrocarbons and used principally in rubber goods, pigments, and printer's ink.

Carbon cycle

All carbon reservoirs and exchanges of carbon from reservoir to reservoir by various chemical, physical, geological, and biological processes. Usually thought of as a series of the four main reservoirs of carbon interconnected by pathways of exchange. The four reservoirs, regions of the Earth in which carbon behaves in a systematic manner, are the atmosphere, terrestrial biosphere (usually includes freshwater systems), oceans, and sediments (includes fossil fuels). Each of these global reservoirs may be subdivided into smaller pools, ranging in size from individual communities or ecosystems to the total of all living organisms (biota).

Carbon dioxide

A colourless, odourless, non-poisonous gas that is a normal part of the ambient air. Carbon dioxide is a product of fossil fuel combustion. Although carbon dioxide does not directly impair human health, it is a greenhouse gas that traps terrestrial (i.e., infrared) radiation and contributes to the potential for global warming.

Carbon dioxide equivalent

A metric measure used to compare the emissions from various greenhouse gases based upon their global warming potential (GWP). Carbon dioxide equivalents are commonly expressed as "million metric tons of carbon dioxide equivalents (MMTCDE)." The carbon dioxide equivalent for a gas is derived by multiplying the tons of the gas by the associated GWP.

MMTCDE = (million metric tons of a gas) * (GWP of the gas)

Carbon Equivalent

A metric measure used to compare the emissions of different greenhouse gases based upon their global warming potential (GWP). Greenhouse gas emissions in the U.S. are most commonly expressed as "million metric tons of carbon equivalents" (MMTCE). Global warming potentials are used to convert greenhouse gases to carbon dioxide equivalents - they can be converted to carbon equivalents by multiplying by 12/44 (the ratio of the molecular weight of carbon to carbon dioxide). The forumula for carbon equivalents is:

MMTCE = (million metric tons of a gas) * (GWP of the gas) * (12/44)

Carbon footprint

the amount of carbon dioxide released into the atmosphere as a result of the activities of a particular individual, organization, or community.

Carbon intensity

The relative amount of carbon emitted per unit of energy or fuels consumed.

Carbon pool

The reservoir containing carbon as a principal element in the geochemical cycle.

Carbon sequestration

The uptake and storage of carbon. Trees and plants, for example, absorb carbon dioxide, release the oxygen and store the carbon. Fossil fuels were at one time biomass and continue to store the carbon until burned. It has been proposed as a way to capture and slow the atmospheric and marine accumulation of Carbon dioxide through biological, chemical or physical processes.

Carbon sinks

Carbon reservoirs and conditions that take-in and store more carbon (i.e., carbon sequestration) than they release. Carbon sinks can serve to partially offset greenhouse gas emissions. Forests and oceans are large carbon sinks.

Carbon tetrachloride

A compound consisting of one carbon atom and four chlorine atoms. It is an ozone depleting substance. Carbon tetrachloride was widely used as a raw material in many industrial applications, including the production of chlorofluorocarbons, and as a solvent. Solvent use was ended in the United States when it was discovered to be carcinogenic.

Catastrophic

Involving or causing sudden great damage or suffering.

Chemical reaction

Interaction between chemicals in which there is a change in the chemical composition of the elements or compounds involved.

Chlorofluorocarbons

Organic compounds made up of atoms of carbon, chlorine, and fluorine. An example is CFC-12 (CCl_2F_2, used as a refrigerant in refrigerators and air conditioners and as a foam blowing agent. Gaseous CFCs can deplete the ozone layer when they slowly rise into the stratosphere, are broken down by strong ultraviolet radiation, release chlorine atoms, and then react with ozone molecules.

Climate

The average weather, usually taken over a 30 year time period, for a particular region and time period. Climate is not the same as weather, but rather, it is the average pattern of weather for a particular region. Weather describes the short-term state of the atmosphere. Climatic elements include precipitation, temperature, humidity, sunshine, wind velocity, phenomena such as fog, frost, and hail-storms, and other measures of the weather.

Climate change

The term "climate change" is sometimes used to refer to all forms of climatic inconsistency, but because the Earth's climate is never static, the term is more properly used to imply a significant change from one climatic condition to another. In some cases, climate change has been used synonymously with the term, global warming; scientists however, tend to use the term in the wider sense to also include natural changes in climate.

Climate feedback

An atmospheric, oceanic, terrestrial, or other process that is activated by direct climate change induced by changes in radiative forcing. Climate feedbacks may increase (positive feedback) or diminish (negative feedback) the magnitude of the direct climate change.

Climate lag

The delay that occurs in climate change as a result of some factor that changes only very slowly. For example, the effects of releasing more carbon dioxide into the atmosphere may not be known for some time because a large fraction is dissolved in the ocean and only released to the atmosphere many years later.

Climate model

A quantitative way of representing the interactions of the atmosphere, oceans, land surface, and ice. Models can range from relatively simple to quite comprehensive.

Climate modelling

The simulation of the climate using computer-based models.

Climate sensitivity

The equilibrium response of the climate to a change in radiative forcing, for example, a doubling of the carbon dioxide concentration.

Climate system (or Earth system)

The atmosphere, the oceans, the biosphere, the cryosphere, and the geosphere, together make up the climate system.

Coal

A black or brownish black solid, combustible substance formed by the partial decomposition of vegetable matter without access to air. The rank of coal, which includes anthracite, bituminous coal, sub bituminous coal, and lignite, is based on fixed carbon, volatile matter, and heating value. Coal rank indicates the progressive alteration, or coalification, from lignite to anthracite.

Coal coke

A hard, porous product made from baking bituminous coal in ovens at temperatures as high as 2,000 degrees Fahrenheit. It is used both as a fuel and as a reducing agent in smelting iron ore in a blast furnace.

Coal gasification

Conversion of solid coal to synthetic natural gas (SNG) or a gaseous mixture that can be burned as a fuel.

Coal liquefaction

Conversion of solid coal to a liquid fuel such as synthetic crude oil or methanol.

Coal bed methane

Methane that is produced from coalbeds in the same manner as natural gas produced from other strata. Methane is the principal component of natural gas.

Co-control benefit

The additional benefit derived from an environmental policy that is designed to control one type of pollution, while reducing the emissions

of other pollutants as well. For example, a policy to reduce carbon dioxide emissions might reduce the combustion of coal, but when coal combustion is reduced, so too are the emissions of particulates and sulphur dioxide. The benefits associated with reductions in emissions of particulates and sulphur dioxide are the co-control benefits of reductions in carbon dioxide.

Cogeneration

Production of two useful forms of energy such as high-temperature heat and electricity from the same process. For example, while boiling water to generate electricity, the leftover steam can be sold for industrial processes or space heating.

Cognitive

Mental processes of perception, memory, judgment, and reasoning, as contrasted with emotional and volitional processes.

Combustion

Chemical oxidation accompanied by the generation of light and heat.

Commercial sector

An area consisting of non-housing units such as non-manufacturing business establishments (e.g., wholesale and retail businesses), health and educational institutions, and government offices.

Compost

Partially decomposed organic plant and animal matter that can be used as a soil conditioner or fertilizer.

Composting

Partial breakdown of organic plant and animal matter by aerobic bacteria to produce a material that can be used as a soil conditioner or fertilizer.

Compound

Combination of two or more different chemical elements held together by chemical bonds.

Concentration

Amount of a chemical in a particular volume or weight of air, water, soil, or other medium. See parts per billion, parts per million.

Conference of the Parties

The supreme body of the United Nations Framework Convention on Climate Change (UNFCCC). It comprises more than 170 nations that have ratified the Convention. Its first session was held in Berlin, Germany, in 1995 and it is expected to continue meeting on a yearly basis. The COP's role is to promote and review the implementation of the Convention. It will periodically review existing commitments in light of the Convention's objective, new scientific findings, and the effectiveness of national climate change programs.

Coniferous trees

Cone-bearing trees, mostly evergreens, that have needle-shaped or scale-like leaves. They produce wood known commercially as softwood.

Conservation Tillage

Conservation Tillage is a term that covers a broad range of soil tillage systems that leave residue cover on the soil surface, substantially reducing the effects of soil erosion from wind and water. These practices minimize nutrient loss, decreased water storage capacity, crop damage, and decreased farmability. The soil is left undisturbed from harvest to planting except for nutrient amendment. Weed control is accomplished primarily with herbicides, limited cultivation, and with cover crops. Some specific types of conservation tillage are Minimum Tillage, Zone Tillage, No-till, Ridge-till, Mulch-till, Reduced-till, Strip-till,Rotational Tillage and Crop Residue Management.

Criteria pollutant

A pollutant determined to be hazardous to human health and regulated under EPA's National Ambient Air Quality Standards. The 1970 amendments to the Clean Air Act require EPA to describe the health and welfare impacts of a pollutant as the "criteria" for inclusion in the regulatory regime. Emissions of the criteria pollutants CO, NOx, NMVOCs, and SO_2.

Crop residue

Organic residue remaining after the harvesting and processing of a crop.

Crop rotation

Planting the same field or areas of fields with different crops from year to year to reduce depletion of soil nutrients. A plant such as corn, tobacco, or cotton, which remove large amounts of nitrogen from the soil, is planted one year. The next year a legume such as soybeans, which add nitrogen to the soil, is planted.

Crude oil

A mixture of hydrocarbons that exist in liquid phase in underground reservoirs and remain liquid at atmospheric pressure after passing through surface separating facilities.

Cryosphere

The frozen part of the Earth's surface. The cryosphere includes the polar ice caps, continental ice sheets, mountain glaciers, sea ice, snow cover, lake and river ice, and permafrost.

D

Deciduous trees

Trees such as oaks and maples that lose their leaves during part of the year.

Decomposition

The breakdown of matter by bacteria and fungi. It changes the chemical composition and physical appearance of the materials.

Deforestation

Those practices or processes that result in the change of forested lands to non-forest uses. This is often cited as one of the major causes of the enhanced greenhouse effect for two reasons: 1) the burning or decomposition of the wood releases carbon dioxide; and 2) trees that once removed carbon dioxide from the atmosphere in the process of photosynthesis are no longer present and contributing to carbon storage.

Demographics

Statistical data relating to the population and particular groups within it

Depolymerisation

Depolymerization (or depolymerisation) is the process of converting a polymer into a monomer or a mixture of monomers. All polymers depolymerize at high temperatures, a process driven by an increase in entropy.

Desertification

The progressive destruction or degradation of existing vegetative cover to form desert. This can occur due to overgrazing, deforestation, drought, and the burning of extensive areas. Once formed, deserts can only support a sparse range of vegetation. Climatic effects associated with this phenomenon include increased albedo, reduced atmospheric humidity, and greater atmospheric dust (aerosol) loading.

Detergent

Substance which lowers the surface tension of a solution, improving its cleaning properties.

Distillate fuel oil

A general classification for the petroleum fractions produced in conventional distillation operations. Used primarily for space heating, on and off-highway diesel engine fuel (including railroad engine fuel and fuel for agricultural machinery), and electric power generation.

E

Ecological characterization

Ecological characterization is a structured approach to the synthesis of human, physical, and ecological information for management purposes

Ecological Footprint (EFT)

The term introduced by William Rees in 1992. It is a measure of how much land and water is needed to produce the resources we consume and to dispose of the waste we produce. A calculation that estimates the area of Earth's productive land and water required to supply the resources that an individual or group demands, as well as to absorb the wastes that the individual or group produces.

Ecological niche

An ecological niche is the role and position a species has in its environment; how it meets its needs for food and shelter, how it survives, and how it reproduces. A species' niche includes all of its interactions with the biotic and abiotic factors of its environment.

Eco-rehabilitation

Restoration of damaged aquatic and terrestrial ecosystems, as a way to reduce further ecological deficits and economic losses

Economy

System of production, distribution, and consumption of goods.

Ecorestoration

Ecosystem Restoration is the "process of assisting the recovery of anecosystem that has been degraded, damaged or destroyed" (SER Primer, 2004)

Ecosystem

The complex system of plant, animal, fungal, and microorganism communities and their associated non-living environment interacting as an

ecological unit. Ecosystems have no fixed boundaries; instead their parameters are set to the scientific, management, or policy question being examined. Depending upon the purpose of analysis, a single lake, a watershed, or an entire region could be considered an ecosystem.

Ecotones

An ecotone is a transition area between two biomes. It is where two communities meet and integrate. It may be narrow or wide, and it may be local (the zone between a field and forest) or regional (the transition between forest and grassland ecosystems.

Electrons

Tiny particle moving around outside the nucleus of an atom. Each electron has one unit of negative charge (-) and almost no mass.

Electrostatic Precipitator

A Device that removes suspended dust particles from a gas or exhaust by applying a high-voltage electrostatic charge and collecting the particles on charged plates

Element

Chemicals such as hydrogen (H), iron (Fe), sodium (Na), carbon (C), nitrogen (N), or oxygen (O), whose distinctly different atoms serve as the basic building blocks of all matter. There are 92 naturally occurring elements. Another 15 have been made in laboratories. Two or more elements combine to form compounds that make up most of the world's matter.

El- Niño

A climatic phenomenon occurring irregularly, but generally every 3 to 5 years. El Niños often first become evident during the Christmas season (El-Niño means Christ child) in the surface oceans of the eastern tropical Pacific Ocean. The phenomenon involves seasonal changes in the direction of the tropical winds over the Pacific and abnormally warm surface ocean temperatures. The changes in the tropics are most intense in the Pacific region, these changes can disrupt weather patterns throughout the tropics and can extend to higher latitudes, especially in Central and North America. The relationship between these events and global weather patterns are currently the subject of much research in order to enhance prediction of seasonal to inter-annual fluctuations in the climate.

Emission inventory

A list of air pollutants emitted into a community's, state's, nation's, or the Earth's atmosphere in amounts per some unit time (e.g. day or year) by type of source. An emission inventory has both political and scientific applications.

Emissions

The release of a substance (usually a gas when referring to the subject of climate change) into the atmosphere.

Emissions coefficient/factor

A unique value for scaling emissions to activity data in terms of a standard rate of emissions per unit of activity (e.g., grams of carbon dioxide emitted per barrel of fossil fuel consumed).

Endemic

Species characteristic of or prevalent in a particular or restricted locality or region.

Energy conservation

Reduction or elimination of unnecessary energy use and waste.

Energy intensity

Ratio between the consumption of energy to a given quantity of output; usually refers to the amount of primary or final energy consumed per unit of gross domestic product.

Energy quality

Ability of a form of energy to do useful work. High-temperature heat and the chemical energy in fossil fuels and nuclear fuels are concentrated high quality energy. Low-quality energy such as low-temperature heat is dispersed or diluted and cannot do much useful work.

Energy

The capacity for doing work as measured by the capability of doing work (potential energy) or the conversion of this capability to motion (kinetic energy). Energy has several forms, some of which are easily convertible and can be changed to another form useful for work. Most of the world's convertible energy comes from fossil fuels that are burned to produce heat that is then used as a transfer medium to mechanical or other means in order to accomplish tasks. In the United States, electrical energy is often measured in kilowatt-

hours (kWh), while heat energy is often measured in British thermal units (BTU).

Energy-efficiency

The ratio of the useful output of services from an article of industrial equipment to the energy use by such an article; for example, vehicle miles travelled per gallon of fuel (mpg).

Enhanced greenhouse effect

The concept that the natural greenhouse effect has been enhanced by anthropogenic emissions of greenhouse gases. Increased concentrations of carbon dioxide, methane, and nitrous oxide, CFCs, HFCs, PFCs, SF6, NF3 and other photochemically important gases caused by human activities such as fossil fuel consumption, trap more infra-red radiation, thereby exerting a warming influence on the climate.

Enhanced oil recovery

Removal of some of the heavy oil left in an oil well after primary and secondary recovery.

Enteric fermentation

A digestive process by which carbohydrates are broken down by microorganisms into simple molecules for absorption into the bloodstream of an animal.

Environment

All external conditions that affect an organism or other specified system during its lifetime.

Environmental risks

Actual or potential threat of adverse effects on living organisms and environment by effluents, emissions, wastes, resource depletion, etc., arising out of an human activities.

Ethanol (C_2H_5OH)

Otherwise known as ethyl alcohol, alcohol, or grain spirit. A clear, colorless, flammable oxygenated hydrocarbon with a boiling point of 78.5 degrees Celsius in the anhydrous state. In transportation, ethanol is used as a vehicle fuel by itself (E100), blended with gasoline (E85), or as a gasoline octane enhancer and oxygenate (10 percent concentration).

Ethnobotanical

Ethnobotany is the study of a region's plants and their practical uses through the traditional knowledge of a local culture and people

Ethnozoological

Ethnozoology is the study of the past and present interrelationships between human cultures and the animals in their environment. It includes classification and naming of zoological forms, cultural knowledge and use of wild and domestic animals

Evapotranspiration

The loss of water from the soil by evaporation and by transpiration from the plants growing in the soil, which rises with air temperature.

Exponential growth

Growth in which some quantity, such as population size, increases by a constant percentage of the whole during each year or other time period; when the increase in quantity over time is plotted, this type of growth yields a curve shaped like the letter J.

E-Waste

Discarded broken or obsolete electronic components and appliances such as mobile phones, computers, televisions, motherboards etc.

F

Feedback Mechanisms

A mechanism that connects one aspect of a system to another. The connection can be either amplifying (positive feedback) or moderating (negative feedback).

Feedlot

Confined outdoor or indoor space used to raise hundreds to thousands of domesticated livestock.

Fertile

Capable of breeding and reproduction.

Fertilization

A term used to denote efforts to enhance plant growth by increased application of nitrogen-based fertilizer or increased deposition of nitrates in precipitation.

Fertilization, Carbon Dioxide

An expression (sometimes reduced to fertilization) used to denote increased plant growth due to a higher carbon dioxide concentration.

Fertilizer

Any substance that is added to soil in order to

increase its productivity. Fertilizers can be of biological origin (e.g. composts), or they can be synthetic (artificial fertilizer). Substance that adds inorganic or organic plant nutrients to soil and improves its ability to grow crops, trees, or other vegetation.

Flaring

The burning of waste gases through a flare stack or other device before releasing them to the air.

Flue Gas

Mixture of gases produced by the burning of fuel or other materials in power stations and industrial plants and extracted via ducts

Fluidized Bed Combustion (FBC)

Process for burning coal more efficiently, cleanly, and cheaply. A stream of hot air is used to suspend a mixture of powdered coal and limestone during combustion. About 90 to 98 percent of the sulfur dioxide produced during combustion is removed by reaction with limestone to produce solid calcium sulfate.

Fluorocarbons

Carbon-fluorine compounds that often contain other elements such as hydrogen, chlorine, or bromine. Common fluorocarbons include chlorofluorocarbons (CFCs), hydro-chlorofluorocarbons (HCFCs), hydro-fluorocarbons (HFCs), and per-fluorocarbons (PFCs).

Fog

Fine particles of liquid suspended in the air, such as of water in a fog chamber used for acclimatizing recent ex vitro transplants. See: mist propagation.

Food Circle

A dynamic, community-based and regionally-integrated food systems concept/model. In effect, it is a systems ecology. In contrast to current linear production-consumption systems, the food circle is a production-consumption-recycle model. A celebration of cycles, this model mirrors all natural systems and is based on the fact that all stable, biological and other systems function as closed cycles or circles, carefully preserving energy, nutrients, resources and the integrity of the whole.

Forcing Mechanism

A process that alters the energy balance of the climate system, i.e. changes the relative balance between incoming solar radiation and outgoing infrared radiation from Earth. Such mechanisms include changes in solar irradiance, volcanic eruptions, and enhancement of the natural greenhouse effect by emission of carbon dioxide.

Forest

Terrestrial ecosystem (biome) with enough average annual precipitation (at least 76 centimetres or 30 inches) to support growth of various species of trees and smaller forms of vegetation.

Fossil

The remains or impression of a prehistoric plant or animal embedded in rock and preserved in petrified form

Fossil fuel

A general term for buried combustible geologic deposits of organic materials, formed from decayed plants and animals that have been converted to crude oil, coal, natural gas, or heavy oils by exposure to heat and pressure in the earth's crust over hundreds of millions of years.

Fossil fuel combustion

Burning of coal, oil (including gasoline), or natural gas. This burning, usually to generate energy, releases carbon dioxide, as well as combustion by products that can include unburned hydrocarbons, methane, and carbon monoxide. Carbon monoxide, methane, and many of the unburned hydrocarbons slowly oxidize into carbon dioxide in the atmosphere. Common sources of fossil fuel combustion include cars and electric utilities.

Fugitive emissions

Unintended gas leaks from the processing, transmission, and/or transportation of fossil fuels, CFCs from refrigeration leaks, SF6 from electrical power distributor, etc.

G

Gasohol

Vehicle fuel consisting of a mixture of gasoline and ethyl or methyl alcohol; typically 10 to 23 percent ethanol by volume.

Gasification

Gasification is a process that converts organic- or fossil fuel-based carbonaceous materials into carbon monoxide, hydrogen and carbon dioxide

General Aviation

That portion of civil aviation, which encompasses all facets of aviation except air carriers. It includes any air taxis, commuter air carriers, and air travel clubs, which do not hold Certificates of Public

Convenience and Necessity.

General Circulation Model (GCM)

A global, three-dimensional computer model of the climate system which can be used to simulate human-induced climate change. GCMs are highly complex and they represent the effects of such factors as reflective and absorptive properties of atmospheric water vapor, greenhouse gas concentrations, clouds, annual and daily solar heating, ocean temperatures and ice boundaries. The most recent GCMs include global representations of the atmosphere, oceans, and land surface.

Genome

1. The entire complement of genetic material (genes plus non-coding sequences) present in each cell of an organism, virus or organelle.
2. The complete set of chromosomes (hence of genes) inherited as a unit from one parent.

Genus (pl.: Genera)

A group of closely related species, whose perceived relationship is typically based on physical resemblance, now often supplemented with DNA sequence data.

Geographical Information System (GIS)

A Computer software designed to store, retrieve, manage, display, and analyze all types of geographic and spatial data

Geology

The science which deals with the physical structure and substance of the earth, their history, and the processes which act on them

Geospatial

Pertaining to the geographic location and characteristics of natural or constructed features and boundaries on, above or below the earth's surface; especially referring to data that is geographic and spatial in nature

Geo-sphere

The soils, sediments, and rock layers of the Earth's crust, both continental and beneath the ocean floors.

Geothermal energy

Heat transferred from the earth's molten core to under-ground deposits of dry steam (steam with no water droplets), wet steam (a mixture of steam and water droplets), hot water, or rocks lying fairly close to the earth's surface.

Global Positioning System (GPS)

A system of Earth orbiting satellites, transmitting signals towards the Earth that enables the position of a receiving device on or near the Earth's surface. The receiving device is a hand-held instrument, which gives information of global position of itself based on satellite signals, in the form of X (Latitude), Y (Longitude) and Z .(Altitude). It also shows direction, time and speed in real time frame through receiving signals of minimum four satellites.

Global warming

The progressive gradual rise of the earth's surface temperature thought to be caused by the greenhouse effect and responsible for changes in global climate patterns. An increase in the near surface temperature of the Earth. Global warming has occurred in the distant past as the result of natural influences, but the term is most often used to refer to the warming predicted to occur as a result of increased emissions of greenhouse gases.

Global Warming Potential (GWP)

The index used to translate the level of emissions of various gases into a common measure in order to compare the relative radiative forcing of different gases without directly calculating the changes in atmospheric concentrations. GWPs are calculated as the ratio of the radiative forcing that would result from the emissions of one kilogram of a greenhouse gas to that from emission of one kilogram of carbon dioxide over a period of time (usually 100 years). The chart below shows the original GWPs (assigned in 1990) and the most recent GWPs (assigned in 1996) for the most important greenhouse gases.

GAS	GWP 1990	GWP 1996
Carbon Dioxide	1	1
Methane	22	21
Nitrous Oxide	270	310
HFC-134a	1,200	1,300
HFC-23	10,000	11,700
HFC-152a	150	140
HCF-125	NA*	2,800
PFCs**	5,400	7,850
SF6	NA*	23,900

* Not Applicable. GWP was not yet estimated for this gas.

**This figure is an average GWP for the two PFCs, CF_4 and C_2F_6.

Grassland

Terrestrial ecosystem (biome) found in regions where moderate annual average precipitation (25 to 76 centimetres or 10 to 30 inches) is enough to support the growth of grass and small plants but not enough to support large stands of trees.

Greenhouse effect

The effect produced as greenhouse gases allow incoming solar radiation to pass through the Earth's atmosphere, but prevent part of the outgoing infrared radiation from the Earth's surface and lower atmosphere from escaping into outer space. This process occurs naturally and has kept the Earth's temperature about 59 degrees F warmer than it would otherwise be. Current life on Earth could not be sustained without the natural greenhouse effect.

Greenhouse Gas

Any gas that absorbs infrared radiation in the atmosphere. Greenhouse gases include water vapour, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), halogenated fluorocarbons (HCFCs), ozone (O_3), per-fluorinated carbons (PFCs), and hydrofluorocarbons (HFCs).

H

Habitat

The natural home or environment of an animal, plant, or other organism. A habitat is made up of physical factors such as soil, moisture, range of temperature, and availability of light as well as biotic factors such as the availability of food and the presence of predators

Halocarbons

Chemicals consisting of carbon, sometimes hydrogen, and either chlorine, fluorine bromine or iodine.

Halons

Compounds, also known as bromo-fluorocarbons, that contain bromine, fluorine, and carbon. They are generally used as fire extinguishing agents and cause ozone depletion. Bromine is many times more effective at destroying stratospheric ozone than chlorine.

Hazardous

Dangerous

Heat

Form of kinetic energy that flows from one body to another when there is a temperature difference between the two bodies. Heat always flows spontaneously from a hot sample of matter to a colder sample of matter. This is one way to state the second law of thermodynamics.

Heat content

The amount of heat per unit mass released upon complete combustion.

Higher heating value

Quantity of heat liberated by the complete combustion of a unit volume or weight of a fuel assuming that the produced water vapour is completely condensed and the heat is recovered; also known as gross calorific value.

Histosol

Wet organic soils, such as peats and mucks.

Holistic

Characterized by the belief that the parts of something are intimately interconnected and explicable only by reference to the whole

Hydrocarbons

Substances containing only hydrogen and carbon. Fossil fuels are made up of hydrocarbons. Some hydrocarbon compounds are major air pollutants.

Hydro-chlorofluorocarbons (HCFCs)

Compounds containing hydrogen, fluorine, chlorine, and carbon atoms. Although ozone depleting substances, they are less potent at destroying stratospheric ozone than chlorofluorocarbons (CFCs). They have been introduced as temporary replacements for CFCs and are also greenhouse gases.

Hydroelectric power plant

Structure in which the energy of fading or flowing water spins a turbine generator to produce electricity.

Hydrofluorocarbons (HFCs)

Compounds containing only hydrogen, fluorine, and carbon atoms. They were introduced as alternatives to ozone depleting substances in serving many industrial, commercial, and personal needs. HFCs are emitted as by-products of industrial processes and are also used in manufacturing. They do not significantly deplete the stratospheric ozone layer, but they are powerful greenhouse gases with global warming potentials ranging from 140 (HFC-152a) to 11,700 (HFC-23).

Hydrological

The scientific study of the properties, distribution,

and effects of water as a liquid, solid, or gas on the Earth's surface, in the soil and underlying rocks, and in the atmosphere

Hydrologic cycle

The process of evaporation, vertical and horizontal transport of vapor, condensation, precipitation, and the flow of water from continents to oceans. It is a major factor in determining climate through its influence on surface vegetation, the clouds, snow and ice, and soil moisture. The hydrologic cycle is responsible for 25 to 30 percent of the mid-latitudes' heat transport from the equatorial to polar regions.

Hydrology

The branch of science concerned with the properties of the earth's water, and especially its movement in relation to land.

Hydropower

Electrical energy produced by falling or flowing water.

Hydrosphere

The part of the Earth composed of water including clouds, oceans, seas, ice caps, glaciers, lakes, rivers, underground water supplies, and atmospheric water vapour.

I

Ice core

A cylindrical section of ice removed from a glacier or an ice sheet in order to study climate patterns of the past. By performing chemical analyses on the air trapped in the ice, scientists can estimate the percentage of carbon dioxide and other trace gases in the atmosphere at that time.

Implications

The conclusion that can be drawn from something although it is not explicitly stated.

Incineration

A waste treatment process that involves the combustion of organic substances contained in waste materials.

Inclement Weather

Inclement usually refers to severe or harsh weather that is cold and wet. When packing for a trip to the Caribbean bring tank tops and shorts, but don't forget a raincoat in case of inclement weather.

Indigenous

Native and originating or occurring naturally in a particular place.

Industrialization

Development of industries in a country or region on a wide scale. It is a process that happens in a country or region when people start using machines to do works that was once done manually.

Industrial sector

Construction, manufacturing, agricultural and mining establishments.

Infestation

Presence of an unusually large number of insects or animals in a place that can typically cause damage or disease

Infrared radiation

The heat energy that is emitted from all solids, liquids, and gases. In the context of the greenhouse issue, the term refers to the heat energy emitted by the Earth's surface and its atmosphere. Greenhouse gases strongly absorb this radiation in the Earth's atmosphere, and radiate some back towards the surface, creating the greenhouse effect.

Inorganic compound

Combination of two or more elements other than those used to form organic compounds.

Intergovernmental Panel on Climate Change (IPCC)

The IPCC was established jointly by the United Nations Environment Programme and the World Meteorological Organization in 1988. The purpose of the IPCC is to assess information in the scientific and technical literature related to all significant components of the issue of climate change. The IPCC draws upon hundreds of the world's expert scientists as authors and thousands as expert reviewers. Leading experts on climate change and environmental, social, and economic sciences from some 60 nations have helped the IPCC to prepare periodic assessments of the scientific underpinnings for understanding global climate change and its consequences. With its capacity for reporting on climate change, its consequences, and the viability of adaptation and mitigation measures, the IPCC is also looked to as the official advisory body to the world's governments on the state of the science of the climate change issue. For example, the IPCC organized the development of internationally accepted methods for conducting national

greenhouse gas emission inventories.

Irreversibilities

Changes that, once set in motion, cannot be reversed, at least on human time scales.

J

Jet fuel

Includes both naphtha-type and kerosene-type fuels meeting standards for use in aircraft turbine engines. Although most jet fuel is used in aircraft, some is used for other purposes such as generating electricity.

Joint implementation

Agreements made between two or more nations under the auspices of the United Nations Framework Convention on Climate Change to help reduce greenhouse gas emissions.

Joule

The energy required to push with a force of one Newton for one meter.

K

Kerogen

Solid, waxy mixture of rock is heated to high temperatures, the kerogen is vaporized. The vapor is condensed and then sent to a refinery to produce gasoline, heating oil, and other products.

Kerosene

A petroleum distillate that has a maximum distillation temperature of 401 degrees Fahrenheit at the 10 percent recovery point, a final boiling point of 572 degrees Fahrenheit, and a minimum flash point of 100 degrees Fahrenheit. Used in space heaters, cook-stoves, and water heaters, and suitable for use as an illuminant when burned in wick lamps.

Kyoto Protocol

This is an international agreement struck by 159 nations attending the Third Conference of Parties (COP) to the United Nations Framework Convention on Climate Change (held in December of 1997 in Kyoto Japan) to reduce worldwide emissions of greenhouse gases. If ratified and put into force, individual countries have committed to reduce their greenhouse gas emissions by a specified amount.

L

Landfill

Land waste disposal site in which waste is generally spread in thin layers, compacted, and covered with a fresh layer of soil each day.

Leachate

Water that has percolated through a solid and leached out some of the constituents

Lifetime (Atmospheric)

The lifetime of a greenhouse gas refers to the approximate amount of time it would take for the anthropogenic increment to an atmospheric pollutant concentration to return to its natural level (assuming emissions cease) as a result of either being converted to another chemical compound or being taken out of the atmosphere via a sink. This time depends on the pollutant's sources and sinks as well as its reactivity. The lifetime of a pollutant is often considered in conjunction with the mixing of pollutants in the atmosphere; a long lifetime will allow the pollutant to mix throughout the atmosphere. Average lifetimes can vary from about a week (sulfate aerosols) to more than a century (CFCs, carbon dioxide).

Light-duty vehicles

Automobiles and light trucks combined.

Lignite

A brownish-black coal of low rank with high inherent moisture and volatile matter content, used almost exclusively for electric power generation.

Linear Economy

Economy where the raw materials are used to make a product, and after its use any waste (e.g. packaging) is thrown away.

Liquefied Natural Gas (LNG)

Natural gas converted to liquid form by cooling to a very low temperature.

Liquefied Petroleum Gas (LPG)

Ethane, ethylene, propane, propylene, normal butane, butylene, and isobutane produced at refineries or natural gas processing plants, including plants that fractionate new natural gas plant liquids.

Litter

Un-decomposed plant residues on the soil surface.

Long Wave Radiation

The radiation emitted in the spectral wavelength greater than 4 micrometers corresponding to the radiation emitted from the Earth and atmosphere. It is sometimes referred to as terrestrial radiation or infrared radiation, although somewhat imprecisely.

Low Emission Vehicle (LEV)

A vehicle meeting the low-emission vehicle standards.

Lower Heating Value

Quantity of heat liberated by the complete combustion of a unit volume or weight of a fuel assuming that the produced water remains as a vapor and the heat of the vapor is not recovered; also known as net calorific value.

Lubricant

A substance used to reduce friction between bearing surfaces or as a process material, either incorporated into other materials used as aids in manufacturing processes or as carriers of other materials. Petroleum lubricants may be produced either from distillates or residues. Other substances may be added to impart or improve useful properties. Does not include by-products of lubricating oil from solvent extraction or tars derived from de-asphalting. Lubricants include all grades of lubricating oils from spindle oil to cylinder oil and those used in greases. Lubricant categories are paraffinic and naphthenic.

M

Macroanimals

A large and usually polymorphic biological species markedly discontinuous from its congeners

Macroorganisms

Macroorganisms are large enough to be seen by an unaided eye. No optical instruments such as microscopes and lens are necessary to see them. For instance, macrobenthos such as crustaceans and mollusks in the sea floor and millipedes, snails and mites in soil

Malnutrition

Lack of proper nutrition, caused by not having enough to eat, not eating enough of the right things, or being unable to use the food that one does eat.

Manure

Dung and urine of animals that can be used as a form of organic fertilizer.

Mass balance

The application of the principle of the conservation of matter.

Mauna Loa

An intermittently active volcano (elevation: 13,680 feet; 4,170 meters) on the island of Hawaii.

Menstrual Hygiene

Menstrual Hygiene refers to the state of a women and adolescent girl's body when she can avail a clean menstrual management material to absorb or collect blood that can be changed in privacy as often as necessary for the duration of the menstruation period, using soap and water for washing the body as required, and having access to facilities to dispose of used menstrual management materials.

Methane (CH_4)

A hydrocarbon that is a greenhouse gas with a global warming potential most recently estimated at 21. Methane is produced through anaerobic (without oxygen) decomposition of waste in landfills, animal digestion, decomposition of animal wastes, production and distribution of natural gas and petroleum, coal production, and incomplete fossil fuel combustion. The atmospheric concentration of methane as been shown to be increasing at a rate of about 0.6 percent per year and the concentration of about 1.7 per million by volume (ppmv) is more than twice its pre-industrial value. However, the rate of increase of methane in the atmosphere may be stabilizing.

Methanol (CH_3OH)

A colorless poisonous liquid with essentially no odor and little taste. It is the simplest alcohol with a boiling point of 64.7 degrees Celsius. In transportation, methanol is used as a vehicle fuel by itself (M100), or blended with gasoline (M85).

Methanotrophic

Having the biological capacity to oxidize methane to CO_2 and water by metabolism under aerobic conditions.

Methyl bromide (CH_3Br)

An effective pesticide; used to fumigate soil and many agricultural products. Because it contains

bromine, it depletes stratospheric ozone when released to the atmosphere.

Meteorology

The science of weather-related phenomena.

Metric Ton

Common international measurement for the quantity of greenhouse gas emissions. A metric ton is equal to 2205 lbs or 1.1 short tons.

Microclimate

The climate of a very small or restricted area, especially when this differs from the climate of the surrounding area.

Microenterprise

A microenterprise is a small business that employs a small number of employees that usually operates with fewer than 10 people and small amount of capital.

Microfibers

Fine variety of synthetic yarn

Mineral

Any naturally occurring inorganic substance found in the earth's crust as a crystalline solid.

Mitigation

The action of reducing the severity, seriousness, or painfulness of something.

Model year

Refers to the "sales" model year; for example, vehicles sold during the period from October 1 to the next September 31 is considered one model year.

Molecule

Chemical combination of two or more atoms of the same chemical element (such as O_2) or different chemical elements (such as H_2O).

Monitoring

Act of Observing and checking the progress or quality of (something) over a period of time; keep under systematic review.

Montreal Protocol on Substances that Deplete the Ozone Layer

The Montreal Protocol and its amendments control the phase-out of ozone depleting substances production and use. Under the Protocol, several international organizations report on the science of ozone depletion, implement projects to help move away from ozone depleting substances, and provide a forum for policy discussions. In the United States, the Protocol is implemented under the Clean Air Act Amendments of 1990.

Mortality

The state of being subject to death.

Motor gasoline

A complex mixture of relatively volatile hydrocarbons, with or without small quantities of additives, obtained by blending appropriate refinery streams to form a fuel suitable for use in spark-ignition engines. Motor gasoline includes both leaded and unleaded grades of finished gasoline, blending components, and gasohol.

Mount Pinatubo

A volcano in the Philippine Islands that erupted in 1991. The eruption of Mount Pinatubo ejected enough particulate and sulfate aerosol matter into the atmosphere to block some of the incoming solar radiation from reaching Earth's atmosphere. This effectively cooled the planet from 1992 to 1994, masking the warming that had been occurring for most of the 1980s and 1990s.

Mulch

A protective covering, as of bark chips, straw, or plastic sheeting, placed on the ground around plants to suppressweed growth, retain soil moisture, or prevent freezing of roots.

Municipal solid waste (MSW)

Residential solid waste and some non-hazardous commercial, institutional, and industrial wastes. This material is generally sent to municipal landfills for disposal.

N

Naphtha

A generic term applied to a petroleum fraction with an approximate boiling range between 122 and 400 degrees Fahrenheit.

Natural gas

Underground deposits of gases consisting of 50 to 90 percent methane (CH4) and small amounts of heavier gaseous hydrocarbon compounds such as propane (C_3H_8) and butane (C_4H_{10}).

Natural gas liquids (NGLs)

Those hydrocarbons in natural gas that are separated as liquids from the gas. Includes

natural gas plant liquids and lease condensate.

Neurological

Related to the anatomy, functions, and organic disorders of nerves and the nervous system.

Niche

The function or position of a species within an ecological community. A species's niche includes the physical environment to which it has become adapted as well as its role as producer and consumer of food resources. In simple words it is the local address of a species's home in an ecosystem where it breeds, rests and perform lifecycle activities

Nitrogen cycle

Cyclic movement of nitrogen in different chemical forms from the environment, to organisms, and then back to the environment.

Nitrogen fixation

Conversion of atmospheric nitrogen gas into forms useful to plants and other organisms by lightning, bacteria, and blue-green algae; it is part of the nitrogen cycle.

Nitrogen Oxides (NO_x)

Gases consisting of one molecule of nitrogen and varying numbers of oxygen molecules. Nitrogen oxides are produced, for example, by the combustion of fossil fuels in vehicles and electric power plants. In the atmosphere, nitrogen oxides can contribute to formation of photochemical ozone (smog), impair visibility, and have health consequences; they are considered pollutants.

Nitrous Oxide (N_2O)

A powerful greenhouse gas with a global warming potential most recently evaluated at 310. Major sources of nitrous oxide include soil cultivation practices, especially the use of commercial and organic fertilizers, fossil fuel combustion, nitric acid production, and biomass burning.

Non-biodegradable

Substance that cannot be broken down in the environment by natural processess.

Nonlinearities

Occur when changes in one variable cause a more than proportionate impact on another variable.

Non-methane Volatile Organic Compounds (NMVOCs)

Organic compounds, other than methane, that participate in atmospheric photochemical reactions.

Non-point Source

Large land area such as crop fields and urban areas that discharge pollutant into surface and underground water over a large area.

Nuclear Electric Power

Electricity generated by an electric power plant whose turbines are driven by steam generated in a reactor by heat from the fissioning of nuclear fuel.

Nuclear energy

Energy released when atomic nuclei undergo a nuclear reaction such as the spontaneous emission of radioactivity, nuclear fission, or nuclear fusion.

O

Oil shale

Underground formation of a fine-grained sedimentary rock containing varying amounts of kerogen, a solid, waxy mixture of hydrocarbon compounds. Heating the rock to high temperatures converts the kerogen to a vapor, which can be condensed to form a slow flowing heavy oil called shale oil.

Ore

Mineral deposit containing a high enough concentration of at least one metallic element to permit the metal to be extracted and sold at a profit.

Organic

Production of crops, fruits and vegetables without the use of chemical fertilizers, pesticides, or other artificial chemicals

Organic compound

Molecule that contains atoms of the element carbon, usually combined with itself and with atoms of one or more other element such as hydrogen, oxygen, nitrogen, sulfur, phosphorus, chlorine, or fluorine.

Organic Farming

The term 'organic farming' was first used by Lord Northbourne in the book, Look to the Land in 1940. Lord Northbourne, who embraced the teachings of Rudolph Steiner and biodynamic farming, had a "vision of the farm as a sustainable, ecologically stable, self-contained unit, biologically complete and balanced--a dynamic living organic

whole. The term thus did not refer solely to the use of living materials (organic manures, etc) in agriculture although obviously it included them, but with its emphasis on 'wholeness' is encompassed best by the definition 'of, pertaining to, or characterized by systematic connection or coordination of parts of the one whole.

Organic fertilizer

Organic material such as manure or compost, applied to cropland as a source of plant nutrients.

Oxidize

To chemically transform a substance by combining it with oxygen.

Oxygen cycle

Cyclic movement of oxygen in different chemical forms from the environment, to organisms, and then back to the environment.

Ozone (O_3)

A colourless gas with a pungent odour, having the molecular form of O_3, found in two layers of the atmosphere, the stratosphere (about 90% of the total atmospheric loading) and the troposphere (about 10%). Ozone is a form of oxygen found naturally in the stratosphere that provides a protective layer shielding the Earth from ultraviolet radiation's harmful health effects on humans and the environment. In the troposphere, ozone is a chemical oxidant and major component of photochemical smog. Ozone can seriously affect the human respiratory system.

Ozone depleting substance (ODS)

A family of man-made compounds that includes, but are not limited to, chlorofluorocarbons (CFCs), bromo-fluorocarbons (halons), methyl chloroform, carbon tetrachloride, methyl bromide, and hydro-chlorofluorocarbons (HCFCs). These compounds have been shown to deplete stratospheric ozone, and therefore are typically referred to as ODSs.

Ozone layer

The layer of gaseous ozone (O3) in the stratosphere that protects life on earth by filtering out harmful ultraviolet radiation from the sun.

Ozone precursors

Chemical compounds, such as carbon monoxide, methane, non-methane hydrocarbons, and nitrogen oxides, which in the presence of solar radiation react with other chemical compounds to form ozone, mainly in the troposphere.

P

Particulate matter (PM)

Solid particles or liquid droplets suspended or carried in the air (e.g., soot, dust, fumes, mist).

Parts per billion (ppb)

Number of parts of a chemical found in one billion parts of a particular gas, liquid, or solid mixture.

Parts per million (ppm)

Number of parts of a chemical found in one million parts of a particular gas, liquid, or solid.

Pentanes plus

A mixture of hydrocarbons, mostly pentanes and heavier fractions, extracted from natural gas.

Per- fluorocarbons (PFCs)

A group of human-made chemicals composed of carbon and fluorine only. These chemicals were introduced as alternatives, along with hydro-fluorocarbons, to the ozone depleting substances. In addition, PFCs are emitted as by-products of industrial processes and are also used in manufacturing. PFCs do not harm the stratospheric ozone layer, but they are powerful greenhouse gases.

Petrochemical feedstock

Feedstock derived from petroleum, used principally for the manufacture of chemicals, synthetic rubber, and a variety of plastics. The categories reported are naphtha (endpoint less than 401 degrees Fahrenheit) and other oils (endpoint equal to or greater than 401 degrees Fahrenheit).

Petrochemicals

Chemicals obtained by refining (i.e., distilling) crude oil. They are used as raw materials in the manufacture of most industrial chemicals, fertilizers, pesticides, plastics, synthetic fibers, paints, medicines, and many other products.

Petroleum

A generic term applied to oil and oil products in all forms, such as crude oil, lease condensate, unfinished oils, petroleum products, natural gas plant liquids, and non-hydrocarbon compounds blended into finished petroleum products.

Petroleum coke

A residue that is the final product of the condensation process in cracking.

Photosynthesis

Complex process that takes place in living green

plant cells. Radiant energy from the sun is used to combine carbon dioxide (CO_2) and water (H_2O) to produce oxygen (O_2) and simple nutrient molecules, such as glucose ($C_6H_{12}O_6$).

Photovoltaic and solar thermal energy

Energy radiated by the sun as electromagnetic waves (electromagnetic radiation) that is converted into electricity by means of solar (i.e., photovoltaic) cells or useable heat by concentrating (i.e., focusing) collectors.

Plasma

An ionized gas consisting of positive ions and free electrons in proportions resulting in more or less no overall electric charge, typically at low pressures (as in the upper atmosphere and in fluorescent lamps) or at very high temperatures (as in stars and nuclear fusion reactors).

Plasma Arc

Plasma arc is formed between an electrode (which is usually but not always made of sintered tungsten) and the workpiece.

Point count

An ecological study method in which visual or auditory detection of the species is done within a fixed or unlimited radius plots

Point source

A single identifiable source that discharges pollutants into the environment. Examples are smokestack, sewer, ditch, or pipe.

Pollution

A change in the physical, chemical, or biological characteristics of the air, water, or soil that can affect the health, survival, or activities of humans in an unwanted way. Some expand the term to include harmful effects on all forms of life.

Polyloom

Weaving with strips of plastics

Polyvinyl chloride (PVC)

A polymer of vinyl chloride. It is tasteless, odorless and insoluble in most organic solvents. A member of the family vinyl resin, used in soft flexible films for food packaging and in molded rigid products, such as pipes, fibers, upholstery, and bristles.

Population

Group of individual organisms of the same species living within a defined area.

Post-Partum

Condition following child birth or the birth of young.

Precession

The tendency of the Earth's axis to wobble in space over a period of 23,000 years. The Earth's precession is one of the factors that results in the planet receiving different amounts of solar energy over extended periods of time.

Precipitation

Precipitation is water released from clouds in the form of rain, freezing rain, sleet, snow, or hail. It is the primary connection in the water cycle that provides for the delivery of atmospheric water to the Earth.

Prescribed burning

Deliberate setting and careful control of surface fires in forests to help prevent more destructive fires and to kill off unwanted plants that compete with commercial species for plant nutrients; may also be used on grasslands.

Primary oil recovery

Pumping out the crude oil that flows by gravity into the bottom of an oil well.

Psychological

Related to the mental and emotional state of a person.

Q

Quad

Quad stands for quadrillion, which is, 1015.

Quadrate

A sample plot of a specific size used in ecology and geography to isolate a standard unit of area for study of the distribution of an item over a large area. The shape of quadrate may be circular or square, depending upon the study needs

R

Radioactive

Emitting or relating to the emission of ionizing radiation or particles.

Radiation

Energy emitted in the form of electromagnetic waves. Radiation has differing characteristics depending upon the wavelength. Because the radiation from the Sun is relatively energetic, it has a short wavelength (ultra-violet, visible, and near infrared) while energy radiated from the Earth's surface and the atmosphere has a longer wavelength (e.g., infrared radiation) because the Earth is cooler than the Sun.

Radioactive Forcing

A change in the balance between incoming solar radiation and outgoing infrared radiation. Without any radioactive forcing, solar radiation coming to the Earth would continue to be approximately equal to the infrared radiation emitted from the Earth. The addition of greenhouse gases traps an increased fraction of the infrared radiation, radiating it back toward the surface and creating a warming influence (i.e., positive radioactive forcing because incoming solar radiation will exceed outgoing infrared radiation).

Rail

Includes "heavy" and "light" transit rail. Heavy transit rail is characterized by exclusive rights-of-way, multi-car trains, high speed rapid acceleration, sophisticated signalling, and high platform loading. Also known as subway, elevated railway, or metropolitan railway (metro). Light transit rail may be on exclusive or shared rights of way, high or low platform, multi-car trains or single cars, automated or manually operated. In generic usage, light rail includes streetcars, trolley cars, and tramways.

Rangeland

Land, mostly grasslands, whose plants can provide food (i.e., forage) for grazing or browsing animals.

Reconnaissance

Reconnaissance is a mission to obtain information by visual observation or other detection methods, about the activities and resources of an enemy or potential enemy, or about the meteorologic, hydrographic, or geographic characteristics of a particular area.

Recyclable

Substance or object tha can be recycled. (Recycle: It is the process of converting waste materials into new materials suitable for reuse)

Recycling

Collecting and reprocessing a resource so it can be used again. An example is collecting aluminium cans, melting them down, and using the aluminium to make new cans or other aluminium products.

Reforestation

Replanting of forests on lands that have recently been harvested.

Remnant patches

Remnant patches can be defined as the vegetation or bushland of native trees, shrubs and grasses that are still remaining

Remote Sensing

The scanning of the earth by satellite or high-flying aircraft in order to obtain information about it.

Renewable energy

Energy obtained from sources that are essentially inexhaustible, unlike, for example, the fossil fuels, of which there is a finite supply. Renewable sources of energy include wood, waste, geothermal, wind, photovoltaic, and solar thermal energy.

Residence Time

The average time spent in a reservoir by an individual atom or molecule. With respect to greenhouse gases, residence time usually refers to how long a particular molecule remains in the atmosphere.

Residential sector

An area or portion consisting only of housing units.

Residual fuel oil

The heavier oils that remain after the distillate fuel oils and lighter hydrocarbons are distilled away in refinery operations and is used for commercial and industrial heating, electricity generation, and to power ships. Imports of residual fuel oil include imported crude oil burned as fuel.

Resilient

Ability to withstand or recover quickly from difficult conditions.

Respiration

The process by which animals use up stored foods (by combustion with oxygen) to produce energy.

S

Secondary oil recovery

Injection of water into an oil well after primary oil recovery to force out some of the remaining thicker crude oil.

Scrubbing Technology

Technology that employs a diverse group of air pollution control devices that can be used to remove some particulates and/or gases from industrial exhaust streams.

Sector

Division, most commonly used to denote type of

energy consumer (e.g., residential) or according to the Intergovernmental Panel on Climate Change, the type of greenhouse gas emitter (e.g. industrial process).

Septic tank

Underground tank for treatment of wastewater from a home in rural and suburban areas. Bacteria in the tank decompose organic wastes and the sludge settles to the bottom of the tank. The effluent flows out of the tank into the ground through a field of drainpipes.

Sewage treatment (primary)

Mechanical treatment of sewage in which large solids are filtered out by screens and suspended solids settle out as sludge in a sedimentation tank.

Shale oil

Slow-flowing, dark brown, heavy oil obtained when kerosene in oil shale is vaporized at high temperatures and then condensed. Shale oil can be refined to yield gasoline, heating oil, and other petroleum products.

Short Ton

Common measurement for a ton in the United States. A short ton is equal to 2,000 lbs or 0.907 metric tons.

Sink

A reservoir that uptakes a chemical element or compound from another part of its cycle. For example, soil and trees tend to act as natural sinks for carbon.

Sludge

Gooey solid mixture of bacteria and virus laden organic matter, toxic metals, synthetic organic chemicals, and solid chemicals removed from wastewater at a sewage treatment plant.

Soil

Complex mixture of inorganic minerals (i.e., mostly clay, silt, and sand), decaying organic matter, water, air, and living organisms.

Soil amelioration

The improvement of poor soils. Includes the fungal and bacterial break down of plant organic matter, to form humus; the release of minerals - such as phosphates - to the soil, making them available to plants; the fixation of nitrogen. Can sometimes include an element of bioremediation

Soil carbon

A major component of the terrestrial biosphere pool in the carbon cycle. The amount of carbon in the soil is a function of the historical vegetative cover and productivity, which in turn is dependent in part upon climatic variables.

Soil-less culture

Growing plants in nutrient solution without soil. Synonym: hydroponics.

Solar energy

Direct radiant energy from the sun. It also includes indirect forms of energy such as wind, falling or flowing water (hydropower), ocean thermal gradients, and biomass, which are produced when direct solar energy interact with the earth.

Solar Radiation

Energy from the Sun. Also referred to as short-wave radiation. Of importance to the climate system, solar radiation includes ultraviolet radiation, visible radiation, and infrared radiation.

Source

Any process or activity that releases a greenhouse gas, an aerosol, or a precursor of a greenhouse gas into the atmosphere.

Special naphtha

All finished products within the naphtha boiling range that are used as paint thinners, cleaners, or solvents. Those products are refined to a specified flash point.

Stagnant

Water having no current or flow and often having an unpleasant smell as a consequence.

Still gas

Any form or mixture of gases produced in refineries by distillation, cracking, reforming, and other processes. Principal constituents are methane, ethane, ethylene, normal butane, butylenes, propane, propylene, etc. Used as a refinery fuel and as a petrochemical feedstock.

Stratosphere

Second layer of the atmosphere, extending from about 19 to 48 kilometres (12 to 30 miles) above the earth's surface. It contains small amounts of gaseous ozone (O3), which filters out about 99 percent of the incoming harmful ultraviolet (UV) radiation. Most commercial airline flights operate at a cruising altitude in the lower stratosphere.

Strip mining

Cutting deep trenches to remove minerals such as coal and phosphate found near the earth's surface in flat or rolling terrain.

Sub bituminous coal

A dull, black coal of rank intermediate between lignite and bituminous coal.

Sulphate aerosols

Particulate matter that consists of compounds of sulphur formed by the interaction of sulphur dioxide and sulphur trioxide with other compounds in the atmosphere. Sulphate aerosols are injected into the atmosphere from the combustion of fossil fuels and the eruption of volcanoes like Mt. Pinatubo. Recent theory suggests that sulphate aerosols may lower the earth's temperature by reflecting away solar radiation (negative radioactive forcing). General Circulation Models which incorporate the effects of sulphate aerosols more accurately predict global temperature variations.

Sulphur cycle

Cyclic movement of sulphur in different chemical forms from the environment, to organisms, and then back to the environment.

Sulphur dioxide (SO_2)

A compound composed of one sulfur and two oxygen molecules. Sulfur dioxide emitted into the atmosphere through natural and anthropogenic processes is changed in a complex series of chemical reactions in the atmosphere to sulfate aerosols. These aerosols are believed to result in negative radiative forcing (i.e., tending to cool the Earth's surface) and do result in acid deposition (e.g., acid rain).

Sulphur Hexafluoride (SF_6)

A colourless gas soluble in alcohol and ether, slightly soluble in water. A very powerful greenhouse gas used primarily in electrical transmission and distribution systems and as a dielectric in electronics. The global warming potential of SF_6 is 23,900.

Surface mining

Removal of soil, sub-soil, and other strata and then extracting a mineral deposit found fairly close to the earth's surface.

Sustainability

Development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Brundtland Report ,1987)

Symbiotic

Denoting a mutually beneficial relationship between different people or groups.

Synergy

The interaction or cooperation of two or more organizations, substances, or other agents to produce a combined effect greater than the sum of their separate effects.

Synthetic fertilizer

Commercially prepared mixtures of plant nutrients such as nitrates, phosphates, and potassium applied to the soil to restore fertility and increase crop yields.

Synthetic natural gas (SNG)

A manufactured product chemically similar in most respects to natural gas, resulting from the conversion or reforming of petroleum hydrocarbons. It may easily be substituted for, or interchanged with, pipeline quality natural gas.

T

Tailings

Rock and other waste materials removed as impurities when minerals are mined and mineral deposits are processed. These materials are usually dumped on the ground or into ponds.

Tar sand

Swamp-like deposit of a mixture of fine clay, sand, water, and variable amounts of tar-like heavy oil known as bitumen. Bitumen can be extracted from tar sand by heating. It can then be purified and upgraded to synthetic crude oil.

Temperature

Measure of the average speed of motion of the atoms or molecules in a substance or combination of substances at a given moment.

Terrestrial

Pertaining to land.

Terrestrial radiation

The total infrared radiation emitted by the Earth and its atmosphere in the temperature range of approximately 200 to 300 Kelvin. Terrestrial radiation provides a major part of the potential energy changes necessary to drive the atmospheric wind system and is responsible for maintaining the surface air temperature within limits of liveability.

Threatened Species

The IUCN has developed a set of peer-reviewed categories and criteria to assign the status to a

species in one of nine categories (Not Evaluated, Data Deficient, Least Concern, Near Threatened, Vulnerable, Endangered, Critically Endangered, Extinct in the Wild, or Extinct) of the threat. The threat category to which a species is assigned is based on a rigorous evaluation of a set of four broad criteria. These include an estimate of current population size, geographic range, reductions in population size, and the probability of extinction in the wild.

Topographical map

In modern mapping, a topographic map is a type of mapcharacterized by large-scale detail and quantitative representation of relief, usually using contour lines, but historically using a variety of methods. Traditional definitionsrequire a topographic map to show both natural and man-made features

Toxic Fumes

A fume or fumes refers to vapors (gases), dusts and/or smoke given off by a substance as a result of a chemical transformation such as reaction, heating, explosion or detonation. "Fumes" generally conveys the idea that the cloud is an irritating, hazardous and/or toxic substance

Toxic Waste

Chemical compounds produced by industry which, if they are ingested or breathed in by humans, can cause physiological damage

Trace Gas

Any one of the less common gases found in the Earth's atmosphere. Nitrogen, oxygen, and argon make up more than 99 percent of the Earth's atmosphere. Other gases, such as carbon dioxide, water vapour, methane, oxides of nitrogen, ozone, and ammonia, are considered trace gases. Although relatively unimportant in terms of their absolute volume, they have significant effects on the Earth's weather and climate.

Transboundary Migration

Wildlife habitats in two or more countries that are necessary to sustain populations of migratory species and involve some form of cooperation.

Transect

A transect is a path along which one counts and records occurrences of the species of study. It requires an observer to move along a fixed path and to count occurrences along the path and, at the same time (in some procedures), obtain the distance of the object from the path. This results in an estimate of the area covered and an estimate of the way in which detectability increases from probability 0 (far from the path) towards 1 (near the path). Using the raw count and this probability function, one can arrive at an estimate of the actual density of objects. In this method the observer cannot wander off the transect. Transects are often marked with colour flagging tape, or they may be along a compass bearing.

Transportation sector

Consists of private and public passenger and freight transportation, as well as government transportation, including military operations.

Troposphere

The lowest layer of the atmosphere and contains about 95 percent of the mass of air in the Earth's atmosphere. The troposphere extends from the Earth's surface up to about 10 to 15 kilometers. All weather processes take place in the troposphere. Ozone that is formed in the troposphere plays a significant role in both the greenhouse gas effect and urban smog.

U

Ultraviolet radiation (UV)

A portion of the electromagnetic spectrum with wavelengths shorted than visible light. The sun produces UV, which is commonly split into three bands of decreasing wavelength. Shorter wavelength radiation has a greater potential to cause biological damage on living organisms. The longer wavelength ultraviolet band, UVA, is not absorbed by ozone in the atmosphere. UVB is mostly absorbed by ozone, although some reaches the Earth. The shortest wavelength band, UVC, is completely absorbed by ozone and normal oxygen in the atmosphere.

Undernourishment

Supplied with less than the minimum amount of the nutritional foods essential for sound health and growth.

Unfinished oils

All oils requiring further refinery processing, except those requiring only mechanical blending. Includes naphtha and lighter oils, kerosene and light gas oils, heavy gas oils, and residuum.

United Nations Framework Convention on

Climate Change (UNFCC)

The international treaty unveiled at the United Nations Conference on Environment and Development (UNCED) in June 1992. The UNFCCC commits signatory countries to stabilize anthropogenic (i.e. human-induced) greenhouse gas emissions to "levels that would prevent dangerous anthropogenic interference with the climate system." The UNFCCC also requires that all signatory parties develop and update national inventories of anthropogenic emissions of all greenhouse gases not otherwise controlled by the Montreal Protocol. Out of 155 countries that have ratified this accord, the United States was the first industrialized nation to do so.

Unobtrusive

Not attracting attention.

Unprecedented

Never done or known before.

Urban

Relating to, or characteristic of a town or city. The urban biodiversity is explained as "the variety and richness of living organisms (including genetic variation and habitat diversity found in and on the edge of human (settlements" Muller et al. (2010)

Urban biodiversity

the urban biodiversity is explained as "the variety and richness of living organisms (including genetic variation and habitat diversity found in and on the edge of human (settlements" Muller et al. (2010)

V

Vehicle miles traveled (VMT)

One vehicle traveling the distance of one mile. Thus, total vehicle miles is the total mileage traveled by all vehicles.

Vitrification

Vitrification (from Latin vitreum, "glass" via French vitrifier) is the transformation of a substance into a glass, that is to say a non-crystalline amorphous solid. In the production of ceramics, vitrification is responsible for its impermeability to water

Volatile organic compounds (VOCs)

Organic compounds that evaporate readily into the atmosphere at normal temperatures. VOCs contribute significantly to photochemical smog production and certain health problems.

W

Wastewater

Water that has been used and contains dissolved or suspended waste materials.

Water Vapor

The most abundant greenhouse gas; it is the water present in the atmosphere in gaseous form. Water vapor is an important part of the natural greenhouse effect. While humans are not significantly increasing its concentration, it contributes to the enhanced greenhouse effect because the warming influence of greenhouse gases leads to a positive water vapour feedback. In addition to its role as a natural greenhouse gas, water vapour plays an important role in regulating the temperature of the planet because clouds form when excess water vapor in the atmosphere condenses to form ice and water droplets and precipitation.

Waxes

Solid or semisolid materials derived from petroleum distillates or residues. Light-colored, more or less translucent crystalline masses, slightly greasy to the touch, consisting of a mixture of solid hydrocarbons in which the paraffin series predominates. Included are all marketable waxes, whether crude scale or fully refined. Used primarily as industrial coating for surface protection.

Weather

Weather is the specific condition of the atmosphere at a particular place and time. It is measured in terms of such things as wind, temperature, humidity, atmospheric pressure, cloudiness, and precipitation. In most places, weather can change from hour-to-hour, day-to-day, and season-to-season. Climate is the average of weather over time and space. A simple way of remembering the difference is that climate is what you expect (e.g. cold winters) and 'weather' is what you get (e.g. a blizzard).

Weighing Balance

Spring balances or spring scales calculate mass by first measuring weight by balancing the force due to gravity against the force on a spring, whereas a balance or pair ofscales using a balance beam compares masses by balancing the weight due to the mass of an object against the weight of one or more known masses.

Wetland

Land that stays flooded all or part of the year with fresh or salt water, such that it takes on the characteristics of a distinct ecosystem

Wetlands

Areas regularly saturated by surface or groundwater and subsequently characterized by a prevalence of vegetation adapted for life in saturated-soil conditions.

Wood energy

Wood and wood products used as fuel, including roundwood (i.e., cordwood), limbwood, wood chips, bark, sawdust, forest residues, and charcoal.

Z

Zoonotic

Pertaining to a zoonosis: a disease that can be transmitted from animals to people or, more specifically, a disease that normally exists in animals but that can infect humans. There are multitudes of zoonotic diseases. Some examples include: anthrax

Zooplankton

Plankton consisting of small animals and the immature stages of larger animals. Plankton are organisms drifting in oceans, seas, and bodies of fresh water. The word "zooplankton" is derived from the Greek zoon meaning "animal", and planktons meaning "wanderer" or "drifter".

ANNEXURE - VII

___th National Children's Science Congress 20___

REGISTRATION FORM -A

Fill this form in Capital letters and submit to your District Coordinator

1. STATE

2. DISTRICT

3. TALUKA

4. TITLE OF THE PROJECT

5. SUB-THEME CODE

6. LANGUAGE USED

7. AREA [RURAL/URBAN]

8. NAME OF THE INSTITUTION

Address

PIN

9. NAME OF GROUP LEADER

Gender [Male/Female]

Date of Birth / / AGE Whether has disability (Y/N) Type of disability (see code)

Address

PIN Phone E-mail ID

10. NAME OF GROUP MEMBER

Gender [Male/Female]

Date of Birth / / AGE Whether has disability (Y/N) Type of disability (see code)

Address

PIN Phone E-mail ID

11. NAME OF GUIDE

Gender [Male/Female]

Address

PIN Phone E-mail ID

Name & Signature of District Coordinator

Name & Signature of Head of Institution

Date:

Sub Theme Codes : 01-Ecosystem and Ecosystem Services, 02-Health, Hygiene and Sanitation, 03-Waste to Wealth, 04-Society, Culture and Livelihoods, 05-Traditional Knowledge Systems

Types of Disabilities /Codes: Visual Impairment: VI, Low Vision: LV, Totally Blind: TB, Mental Retardation: MR Hearing Impairment: HI, Speech Impairment: SI, Multiple Disability : MI, Learning Disability : LD, Autism: AUT, Orthopedically Impaired: OI, Cerebral Palsy : CP

Age should be between 10-17 years as on 31st December of the current calendar year

District Coordinator to verify the age of all participants with Birth Certificates.

Copy of this form to be enclosed in the Project Written Report

NOTES