NATIONAL CHILDREN'S SCIENCE CONGRESS (NCSC)

ACTIVITY GUIDEBOOK – 2022 & 2023

Catalysed & Supported by

National Council for Science & Technology Communication (NCSTC)

Department of Science & Technology (DST),

Government of India

Technology Bhavan, New Mehrauli Road

New Delhi-110016, India

FOREWORD

The National Children's Science Congress (NCSC) encourages the children to ponder upon societal problems in and around their surroundings or ecosystem, search for the possible causes and subsequently, explore possible solution by using the scientific process. This involves close and keen observation, raising pertinent queries, predicting solutions, trying out possible alternatives and arriving at an optimum solution using experimentation, field work, research and innovative ideas. NCSC encourages a series of exploration, discovery and innovative behaviour based on the learning of science through doing, using the method of science.

The Activity Guide Book (AGB) formalises the process by setting forth a programme guideline along with the explanation and exploration of focal theme and the sub-themes. A standardization in the understanding of the thematic areas leads to better and innovative project solution being thought of and implemented by the Child Scientists. This also aids the guide teachers to mentor their child scientists.

NCSC has been ensuring the delivery of instruction and transfer of knowledge in the vernacular languages, in line with NEP 2020, since its inception in 1993. The Child Scientists present their projects in their mother tongue. The projects are evaluated in different scheduled languages ranging from Assamese to Urdu.

It gives me immense pleasure to present the Activity Guide Book 2022-2023. I am hopeful that the stakeholders, child scientists, guide teachers, experts, and resource persons will find it useful and use the same to implement the Children's Science Congress in a better and effective manner.

I express my satisfaction and gratitude to the members of National Academic Committee, team of experts and other resource persons who have contributed to the compilation and shaping up of this document.

Sd/-
(**Dr. Parveen Arora**)
Scientist- G/Head, NCSTC
Department of Science & Technology (DST)
Government of India

New Delhi
Dated: 18 October, 2022

ABOUT THIS BOOKLET

The Children's Science Congress (CSC), a flagship programme of National Science & Technology Communication (NCSTC), Department of Science & Technology, Government of India, is now three decades young programme. Started in the year 1993, the journey of CSC has been pan-India covering from Kashmir in the North to Kerala in the South; Gujarat in the West to Assam in the East. CSC has gone not only to metros but also has been to smaller cities and remote areas of the country including Andaman & Nicobar Island and Lakshadweep.

The domain areas covered under CSC include the ones from the Sustainable Development Goals (SDGs) and others like Environment, Nutrition, Clean-up India, Water Resources, Bio-diversity, Land Resources, Energy, Weather and Climate. These thought provoking and challenging themes could energise the creativity in Child Scientists and motivated them to bring out innovative and research-based projects.

The Child Scientists of CSC belong to the age of 10-17 years, both from formal schooling and out of the school, including Divyangjans (children with special needs).

As the CSC enters its fourth decade of operation, its coverage of scientific content and outreach is being enhanced to suit the needs of the time.

This Activity Guide Book (AGB) which would be used for CSC 2022 and 2023, is culmination of the hard work of National Academic Committee (NAC), a body constituted to manage the academic part of the CSC. Initiation of the process started with an online discussion during 10-11 June, 2021, wherein thematic ideas received from across the stakeholders were discussed and deliberated upon. This was followed by series of discussions and National Brainstorming Workshop conducted at Science City, Ahmedabad during 18-20 May, 2022. Editing and finalisation of the AGB was done during a workshop of sub-committee of NAC along with the invited experts in Guwahati during 18-20 October, 2022.

I hope the AGB meets the expectation of all the stakeholders and is useful for the child scientists for whom and their guide it has been compiled.

Sd/-

New Delhi
Dated: 18 October, 2022

(Er Sujit Banerjee)
Scientist F, NCSTC
National Programme Coordinator, NCSC
Department of Science & Technology (DST)
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Expression of gratitude

Amidst the ongoing pandemic, during April – May 2021, the stakeholders across the country were requested to share their views on possible themes for the 30th and 31st Children's Science Congress (CSC). A variety of suggestions poured in through emails. Majority of these echoed the impact of pandemic on health and minds of the common man.

Subsequently, on 10 - 11 June 2021, the National Academic Committee (NAC) along with Dr Parveen Arora, Head, NCSTC, DST, GoI, met virtually to deliberate upon the probable thematic areas.

For the content development under the proposed focal theme and sub-themes, a brainstorming workshop was organized at Science City, Ahmedabad between 18 - 20 May, 2022. Finally, during 18 – 20 October, 2022, the NAC sub-committee along with the experts reviewed the content, designed and finalized the Activity Guide Book for 2022 and 2023, at Guwahati.

On behalf of the NAC, I hereby express deep sense of gratitude towards Dr Parveen Arora, Head NCSTC, DST, GoI, and Er Sujit Banerjee, National Program Coordinator, CSC, for giving us this opportunity to conceptualize, design, develop, and give a shape to this document which is an integral part of CSC, a flagship programme of NCSTC, DST, GoI.

The NAC is indebted to Dr Narottam Sahoo, Director, GUJCOST and his team, and Ms Kimnei Changsan, ACS, Director, ASTEC and her team for extending their wholehearted support and cooperation, and providing all necessary facilities for a smooth conduct of the workshops, respectively.

Our stakeholders, across the country, deserve a special thanks for their unstinted support extended all through the year to the NAC. I am extremely grateful to the NAC team without whose round the clock involvement and untiring efforts this Activity Guide Book would not have taken the present shape. A big thanks to all my colleagues.

Sd/-
(**Dr Lalit Sharma)**
Chairperson,
National Academic Committee, CSC

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 organisations working in the field of science popularisation) 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 launched as a nationwide programme in 1993. The expectation was that it would enhance scientific temperament, arouse scientific curiosity and improve the 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.

Like in the previous year, this year too we are bringing out an exclusive booklet on the Programme Guidelines and a separate Activity Guide Book which will deal with only the Focal and the Sub themes for the two years. This Activity Guide Book will deal with the specific Focal Theme for the years 2022 & 2023 which is "Understanding Ecosystem for Health and Ecosystem". 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.

Members who contributed in the preparation of the present Activity Guide Book

National Academic Committee

Dr. Lalit Kumar Sharma , Chairperson

D.r Pulin Behari Chakraborty, Co-Chair

Shri Raghunath T P	Shri Jayanta Kumar Sarma	Prof. E Kunhikrishnan
Er. U N Ravi Kumar	Shri Sandeep Bhattacharjee	Dr. Dinesh Kumar
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Ms. Megha Saklani	Ms. Seema Hardikar	Ms. Kalpana Nagathane

Invitees during Brainstorming Workshop at Ahmedabad

Dr. Narottam Sahoo	Dr. Dinesh Awasthi	Dr. Manoj Gumber
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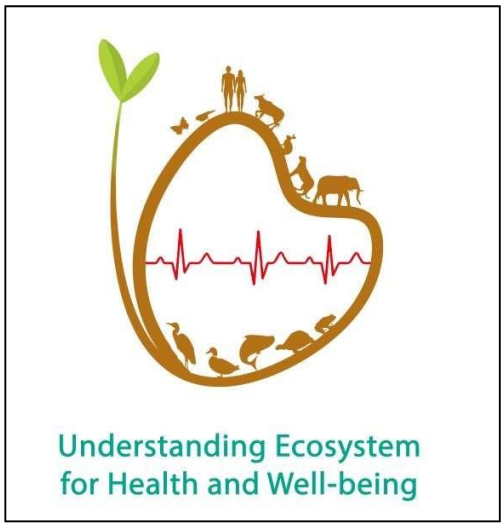
Invitees during Finalization Workshop at Guwahati

Ms. Kimnei Changsan, ACS	Dr. Jaideep Baruah	Dr. Dipak Kumar Sarma
Dr. Sadhan Mahapatra	Dr. Mantu Bhuyan	Dr. Namami Sarma

Contents

Focal theme



The ongoing pandemic has created a 'disjuncture' in our existence. 'Disjuncture' is a concept discussed in learning theory to interpret a phenomenon when people are confronted with an experience that conflicts with an individual's previous own understanding about the world[1]. The process compels us to find different information, acquire new knowledge and learn new ways of doing things[2]. This new learning tells us that "we must learn to listen to science"[3]. In this perspective, global focus on public health, scientific inquiry and education emphasizes on developing linkages to promote necessary collaboration, solidarity and collective action for common good to encompass fluidity as well as capillarity in the changing context of reality[4]. On the other hand, the experience of the pandemic and understanding about the origin of such a crisis with loss of human life, livelihood and biodiversity[5]. This led barriers to the 'old normal' and evolving fresh norms for a 'new normal'[6] focussing more on ecological security[7] and nurturing eco- literacy[8] to relook and reconnect with nature[9] for health security[10] and well-being[11]. In unison, recalling and considering its commitment to human well-being, biodiversity conservation and achieving Sustainable Development Goals, the UNO has declared 2021- 2030 as the UN Decade on '*Ecosystem Restoration',* within existing structures and available resources. This is done with the aim of supporting and scaling up efforts to prevent, haltand reverse the degradation of ecosystems worldwide and raise awareness on the importance of ecosystem restoration[12]. With this aforesaid perspective, 'Ecosystem', 'Health' and 'Well-being' are considered as the primary focus to develop the Focal theme of NCSC 2022-23 and it is-

"Understanding Ecosystem for Health and Well-being"

Ecosystems are the planet's life-support systems not only for humans but also for all other forms of life. Human survival has a fundamental need for food, water, clean air, shelter and relative climatic consistency. Other benefits that are derived include full complement of species, intact watersheds, climate regulation and genetic diversity. Stress of any form on ecological balance, biodiversity, freshwater sources, food-producing systems and climate regulation can cause major adverse health impacts[13]. Therefore, understanding an ecosystem as life-support-system in terms of its components, interrelationship among the components, role of abiotic and biotic factors and their functions, functional significance of food chain, energy dynamics, ecological services, biodiversity (genetic and species varieties) of any ecosystem are very important to develop ecological literacy. At the same time, understanding about human impact on ecosystems because of anthropocentric focus

of the human ways of life is also equally important[14]. It is essential to know how our activities disturb the ecosystem functions leading to negative environmental degradations. Hence, rectification and redesigning our daily activities at individual, family and community levels are required to reduce our negative impact on ecosystem[15] for developing positive environmental externalities[16] for achieving ecosystem sustainability, health safety and security as well as well-being for all.

Focuses

With the aforesaid background, the proposed focal theme will focus on the following aspects by engaging children for inquiry-based learning applying methods of science in their local contexts:

- To explore and understand ecosystem(s) in their neighbourhoods and to take initiatives for ecosystem restoration and conservation
- To make inquiry into the interlinkages of ecosystem with health, nutrition and well-being along with their implications
- To take initiatives for experimentation based on ecosystem approach for local level natural resource management, farm and non-farm based production, and to find out ways for food, nutrition and livelihood security, health safety, and also for developing resilience and adaptation towards climate change and disaster risk reduction.
- To ideate innovative S&T solutions for ecosystem conservation and restoration for nutrition and health safety.

For convenience of the teacher guide and children, focal theme has been divided into following five Sub-themes, which have been explained hereunder.

Sub-theme – I: Know your ecosystem

Sub-theme II: Fostering health, nutrition and well-being

Sub-theme III: Social and cultural practices for ecosystem and health

Sub-theme IV: Ecosystem based approach (EBA) for self-reliance

Sub-theme V: Technological innovation for ecosystem and health

These sub-themes will have the broad objectives of promoting inquiry-based experiential learning embedded with method of science. This will enable the children to understand issues about the ecosystem, its functions and implications for health and wellbeing. It also includes the focus for developing collective initiatives for ecosystem conservation and restoration, developing innovative approaches for fostering health, nutrition and wellbeing as well as exploring ways for self-reliance at local context.

I. Know your ecosystem

This sub-theme will, broadly, encourage the children to explore, identify ecosystem(s) in their neighbourhoods and carry out studies on them to know about its different components (abiotic and biotic), their interrelationship, functions, role of certain species in the ecosystem(s), association of biodiversity with ecological services, human dependency on the ecosystem(s) and impact of human activities on the ecosystem (s) etc. While doing so, based on the geo-ecological context, children may carry out their studies considering natural ecosystems (viz. wetland, grassland, desert, mountain, coastal, forest, river, wood land, estuaries, etc.) or man- made ecosystem (viz. fishery, agricultural field, agroforestry plot, garden, etc.) as their specific unit of observation and study. It is, thereby, desired that their study will find out the spatial and temporal perspectives of ecosystem components, its function. Children may also identify the status of the ecosystem in terms of its sustainability and find out strategies and paths for strengthening/ upgrading its suitability.

II. Fostering health, nutrition and well-being

The World Health Organization (WHO) defines health as 'a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity' [17]. This is in consistent with the bio-psycho-social model of health, which considers physiological, psychological and social factors in health and illness and interactions between these factors. Health and well-being are also related to our food and nutrition practices. A well-balanced diet with adequate nutrients and appropriate calories is a fundamental requirement for continued better health. An appropriate diet contributes to healthy development, ageing and greater resilience against disease. On the other hand, 'well-being' has been defined as the combination of 'feeling good' and functioning well. Over and above, experience of positive emotions such as happiness and contentment develop one's potential that evolve with a sense of purpose, and experiencing positive relationships. In reality, balanced nutrition, healthy mind and body and well-being are interconnected, which, in totality, reflects the status and situation of a community and society too. Well-being commonly covers the aspects of psychological, emotional, social, and physical aspects of human life and its connectionto nature. With these perspectives, this sub-theme basically focuses to inspire the children to make scientific inquiry in their own locality about situation and status of health, nutrition and well-being. Moreover, they will also be encouraged to make efforts to identify ways and means to fortify and foster the situation ensuring health safety and security, nutritional security and well-being at individual, family and community levels.

III. Social and cultural practices for ecosystem and health

Social situation of a society in relation to family structure, is different in different societies. Social groups and institutions develop a social make-up and create a social

foundation, where cultural beliefs and practices are embedded with many factors like spiritualism, food system, habitat development, occupational practices, traditional knowledge system, etc. By and large, these are interlinked with nature and the ecosystem as well as with health-related practices. Moreover, social and cultural practices have evolved around an ecosystemwith respect to social and cultural values. As a consequence, dependency on ecosystem and ecosystem services to fulfil social and cultural needs have gradually increased. On the other hand, in relation to health, there are social and cultural value-based perceptions which are sometimes linked to myth. Further, in certain cases there are practices linking health safety through specific food, herbal medicine, sanitation management, etc. All these aspects develop the local level prospects and challenges in different geo-ecological and cultural contexts. Therefore, the proposed sub-theme will inspire children to identify the prospects and challenges related to conservation of ecosystem and health, which will evolve through socio-cultural practices in their local contexts through systematic scientific inquiry and try to find out ways and means to tap the potentialities and overcome the challenges involving local communities.

IV. Ecosystem based approach (EBA) for self-reliance

Ecosystem based approach (EBA) is an integrated approach of planning and management that recognize the functional interaction of ecosystem with human activities focused to natural resource management, farm based activities like - sustainable agriculture, agroforestry, animal husbandry, sericulture, aquaculture, apiculture etc along with non-farm based activities like value addition of farm based products etc. EBA is also applied to develop local level landscape planning for climate change resilience, climate change adaptation, and disaster risk reduction etc. Such approaches aim to address bio-economic base through sustainable use and management of natural resources, developing natural resource-based livelihoods, local level food and nutrition and well-being for all. With these broader perspectives, the sub-theme will encourage the children to explore natural resource potentiality and challenges in their localities and will find out ways and means for local level natural resource management in sustainable way with the application of bio-economic principle based farm and non-farm activities. Thus, they will help to generate livelihood security, resource sufficiency and planning for climate change resilience, adaptation and disaster risk reduction.

V. Technological innovation for ecosystem and health

Technology has evolved much on the application of scientific principles in different activities of human being by improving efficiency to reduce resource consumption based on the principle of ‘low inputs to get high output’, reducing wastage of material, time and labour (drudgery), tapping renewable energy resources, tapping wealth from waste, mobilizing information and communication for effective management through appropriate

decision-making at appropriate time, adapting or modifying already existing technologies for local contexts and resources. Ideal design and development of technology can provide ways for ecosystem conservation, sustainable resource management, health safety, sanitation management, appropriate solutions for disease diagnosis (both physical and mental), on-time information communication for crisis mitigation, and long-term ecological monitoring. The post-pandemic world demands new technological interventions and innovations for ecosystem security, health security and overall well-being. With these broader perspectives the proposed sub-theme will encourage children to find local-level problems and take initiatives for developing local technological solutions from the perspectives of green technology, appropriate technology, information communication technology or improvising traditionaltechnology based on the principles of frugal innovation.

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Sub-theme I

Know Your Ecosystem

Introduction

Ecosystem is a structural and functional unit of ecology embedded to a particular spatial context. It is characterised by biotic and abiotic components, where interdependency and interrelationship of biotic and abiotic components functionally determines the flow and cycle nutrient and energy processes. This function nurtures the life forms in the systems, sustains the abiotic and biotic components and provides ecological services. These ecological services are one of the primary source to sustain life in the planet. It provides health security to human being and fosters wellbeing.

It is noteworthy that, the Convention of Biological Diversity (CBD) defines an ecosystem as a "*dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit*." Thus, ecosystems include biotic and abiotic factors that together interact with each other to form a functional unit. The biotic factors will include all living organisms and abiotic factors will consider non-living components (physical and chemical) like temperature, humidity, sunlight, water etc. Further, Biodiversity is recognised by species–a group of individual living organisms that can interbreed. Examples: Blue whales, White-tailed deer, White pine trees, Sunflowers, Bacteria and many more species

Table – 1.1: Levels of Biological Organism

<table>
<tr><th colspan="2">Species</th></tr>
<tr><td rowspan="11">Biosphere
Biome
Ecosystem
Community
Population
You are here Species
Organism</td><td>What is a Species?</td></tr>
<tr><td>A species includes all of the organisms that look similar and can interbreed to produce viable and fertile offspring. For example, all humans belong to one species, but a human and a dog belong to different species.</td></tr>
<tr><td></td></tr>
<tr><td>How is it different from an organism</td></tr>
<tr><td>An organism is just one living member of a species. A species includes many organisms, but not all organisms belong to the same species</td></tr>
<tr><td></td></tr>
<tr><td>How is it different from a population</td></tr>
<tr><td>A species includes all organisms in the world that can mate and have fertile offspring, but a population divides those organisms up by where they live. So, while all humans are one species. We can have one population of humans living in Pittsburgh, B second population of living in Philadelphia, and so on.</td></tr>
</table>

Species are the integral parts of an ecosystem and each ecosystem is unique to support a particular range of living species. Abiotic factors contribute significantly to the uniqueness of an ecosystem. Moreover, ecosystem diversity represents genetic and species diversity. Among the numerous ecosystems prevalent in our country, some terrestrial ecosystems are forest, grassland, desert, mountain ecosystem and aquatic ecosystems like marine and freshwater ecosystems.

We, human beings, are integral parts of the ecosystem. Ecosystems provide various services to us and many of us are fully dependent on ecosystems for our livelihood. Besides natural ecosystems, humans also produce some ecosystems which are termed man-made ecosystems viz, agro-ecosystem, urban ecosystem etc. Over time, human (anthropogenic) activities become threat to almost all ecosystems and the impact is visible in many ways. Many species living as an integral part of ecosystems disappears due to extensive pressure of anthropogenic activities. Therefore, abiotic components of most of the ecosystems get affected and changed, which are beyond restoration and resulting functional disruption of the said eco-system.

To understand the ecosystem, to measure the impact of anthropogenic activities on it and to formulate restoration strategies, it is very much essential to observe and study the ecosystem around us. It will help one to realize the role of the ecosystem on living organisms and environment as well. Children, under this subtheme, will be able to undertake their studies in one or various ecosystem(s) surround them.

Objectives

- Identify and explore an ecosystem in your surrounding,
- Recognize unique features of the ecosystem, i.e., biotic, and abiotic components, their independence and interrelationship
- Diagnose its contribution towards sustenance of lifeforms, human health and wellbeing
- Review the human impact on the ecosystem and try to find out pragmatic solution to curb the negative impacts

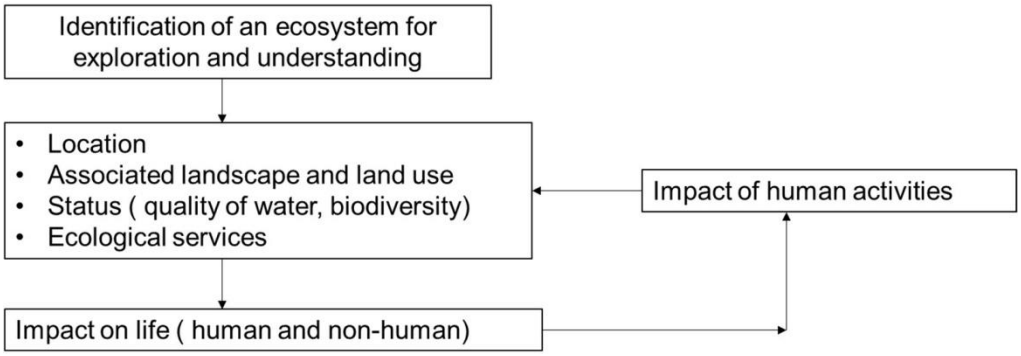
Children are supposed to explore the ecosystems around them and can identify flora and fauna in the ecosystems. They can also study the interactions among living and non-living components and among the different species in the ecosystem that make it a web of life. Children can identify various food chains and food webs as well as ecological pyramids of the ecosystems by studying different trophic levels.

Children can also document the extent of threats in the ecosystem from anthropogenic activities and how it affects various trophic (relating to feeding and nutrition) levels and also give them insight about maintaining healthy food chains and food webs. If it is a man-made ecosystem, children can note the land management system and its influence on the biotic and abiotic components of the ecosystem. Such a man-made ecosystem may be a model to study species adaptation in context of climate change or anthropogenic activities. Ecosystem restoration (if degraded) strategies may be formulated from local inputs.

Children can identify the ecosystem services provided by various ecosystems and can predict how people and biodiversity in general will suffer if the natural systems are hampered.

Framework

For developing strategic plan to carry out any study under this sub-theme better to follow the frame work as mentioned below



General methodology

Children can undertake studies related to their immediate ecosystem surrounding them through a variety of techniques including experimentations, field studies involving transect walks, quadrat-based studies, oral histories relating to the transformation of the system from past to present, mapping of various components. They can also include surveys on knowledge, aptitude and practices related to ecosystem practices (both qualitative and quantitative).

Survey: Children can explore the local ecosystem and landscapes and can document different species that live in ecosystems. The abiotic factors like temperature, humidity in different habitats of the ecosystem can also be recorded.

Field study: Study can be conducted by using appropriate methodologies in the local ecosystems in order to assess the biodiversity and species composition and also to assess the impact of human activities.

Observations: Seasonal variation, diurnal variation of ecosystem status can be observed in relation to variation in biotic and abiotic component. The information of the observations has to be documented. In such case, consideration of spatial location (latitude and longitude or relative location description, with map) and time frame (date, month, time) of observation is mandatory. In reference space and time observation information can be developed to a matrix for developing data base for further analysis.

Experimentation:

Quantification of ecosystem services and impact of anthropogenic activities can be documented. Ecosystem restoration plans for degraded ecosystems may be worked out. Moreover, while carrying out different project there will be requirement of documentation and assessment of biodiversity. Biodiversity refers to all different types of living organisms found on the planet. These include plants, animals and all different types of microorganisms present, including those in the soil or deep inside water as well. Presence of diversity of the living organisms in any ecosystem is a direct indication of the wellbeing of the same. Richness of Earth's biodiversity can be understood by

the fact that quite a large number of species have not yet been discovered and identified. Biodiversity can thus be studied under following categories:

A. Species Diversity
B. Genetic Diversity
C. Ecosystem Diversity

It is a known fact that interrelationship between different species in any community is highly complex, which makes the study and evaluation of biodiversity a little difficult. The easiest way to express or measure diversity is to just count the number of species present in an ecosystem. Species richness may simply be expressed as the number of species per 2 square meter area. However, when it comes to studying the relative presence of different species of any genera or organisms of different genera then study becomes complex. In general, quadrant method is used in such type of study.

Since diversity can be categorized at three different levels as mentioned above, the health of any ecosystem needs to be systematically studied. In the study of diversity, two components are very useful when identified; richness or variety of the diversity and the relative abundance or which is also referred to as apportionment of individual units among different kinds. In a functional ecosystem, the diversity is maintained from moderate to high indicating that the ecosystem can withstand various stresses like fire, drought, temperature changes etc. Children can appreciate through an example of the impact of human activity on two communities having the same number of species but one community has almost a similar number of individual species whereas the other community has one individual species as dominant and others represented as rare species. The earlier situation with a similar or uniform number of species is referred to as high evenness whereas the latter is designated to be with low evenness. Maintenance of moderate to high evenness is a parameter considered to be an indication of a sustainable ecosystem.

As the name indicates, species diversity refers to the presence of the number of each species in an ecosystem and its proportion also called relative abundance in comparison to other species. Therefore, in the present study, children may attempt to study the species richness of one or more organisms (either plant or animal) depending upon geographical area, locality, climate and other parameters.

In such ecological diversity study, many indices are considered for the purpose of representing species and apportionment. For a better understanding of the children, a few of the indices are mentioned hereunder;

(i) **Margalef Diversity Index (d)** can easily be calculated using the following equqtion-

$$d = (S - 1) / \ln N$$

Where S is the number of species, and N is the total number of individuals in the sample and ln indicates natural logarithm.

(iii) **Menhinick Diversity Index (M)** is used to compare samples of different sizes and also the effect of the number of individuals reduced.

$$M = S / \sqrt{(n)}$$

Where, M = Menhinicks Diversity Index; S = Number of Species Recorded; N = Total Number of Individuals in the Sample; ln = Natural logarithm

There are various ways and means to study species diversity through data collection and interpretation. As mentioned above, the study of species diversity, undertaken by children, will depend on geographical area, ecological conditions and habitat of the organism. Strategy for such a study for plants is comparatively convenient on a land or aquatic ecosystem whereas for animals, a different kind of strategy needs to be adopted to ascertain the number because of the obvious reason that animals move. Therefore, it is expected that children must adopt a method in which they can easily perform their studies depending on various limitations including access.

Sampling procedure: It is important to do the sampling in a scientific way. For the purpose of study of species diversity of an area, a small sampling unit needs to be ascertained. For larger trees and shrubs, a comparatively bigger unit area (may be 100 X 100 meter) needs to be selected. This may further be subdivided into smaller units for convenience (may be 10 X 10 or even 01 X 01 meter). For herbs, a comparatively smaller unit area will suffice as the number of different species would be sufficient in the said area to represent the locality.

Box 1.1: People's biodiversity register

The Biological Diversity Act, 2002 (No. 18 of 2003) was notified by the Government of India on 5th February, 2003. National biodiversity authority is the statutory body established to implement the provisions in this Act. People's Biodiversity Register (PBR) is a mandatory document prepared under the leadership of Biodiversity Management Committee (BMC) in each self-governing institution, as per the guidelines from the National biodiversity authority, which contains authentic information on the diversity of species of flora and fauna (both wild and cultivated varieties) in the locality, also the landscape and demography. The preparation of the People's Biodiversity Register through consultation with the local people, for comprehensive documentation of the availability and knowledge of local biological resources and uses associated with them. Because of the participation of the local community, PBR is a mechanism to create awareness among the people about the condition of plants and animals in the locality and their conservation and sustainable utilization. This mechanism can bring the people to participate in development planning which would be ecologically sustainable and socially justifiable. The traditional knowledge of millions of forest dwellers, fisherfolk, pastoralists, hunting community and traditional healers about the biodiversity in the locality and its utility are documented. PBR is the first step towards bridging the gap between intellectual property rights of local people and benefits derived from genetic resources and associated traditional knowledge and enabling them to share those benefits.

It is possible with consultation with BMC adopting the guideline and format of PBR. Children can participate in some PBR development exercises in their neighbourhood.

Similarly, for the purpose of sampling animals, different strategies would be required to be adopted. A few of the methods for the purpose of collection of insects and other small animals are pitfall traps (for insects and other terrestrial animals), malaise traps (for flying insects), light traps (for flying insects) etc. Collection of samples can be done at least for a period of 24 hour at each trap. However, there are a number of methods and keys available for the purpose of identification of plants and animals at family, genera and species level. It is further expected that children should explore these with the help of their guide teacher or mentor or from other offline and online resources.

In the methodology of the study of species diversity, it is important that children should identify different species of the specific genus and count the number of each species in the sampling area. The representative data would be more accurate if more than one sampling area is selected. These aspects should be planned appropriately in advance by the team in consultation with the guide teacher.

Data of the exploration can be represented in a table.

Box 1.2.The death of Aral Sea -one of the worst Ecological disasters

The shallow Aral Sea was once the world's fourth largest body of inland water.

The disappearance of the Aral sea is one of the worst ecological disasters that happened as a result of anthropogenic activities executed in the name of development without looking into long term impacts and also ignoring the dynamics of a waterbody.

Aral Sea was an endorheic lake (a drainage basin that normally retains water and allows no outflow to other external bodies of water) lying between Kazakhstan in the north and Uzbekistan.

The change resulted primarily because of the diversion (for purposes of irrigation) of the riverine waters of the Syr Darya (ancient Jaxartes River) in the north and the Amu Darya (ancient Oxus River) in the south, which discharged into the Aral Sea and were its main sources of inflowing water. Until the 1960s, the most-significant factors affecting the water balance of the Aral Sea were the rates of river inflow and water loss through evaporation, which formerly took out each year about the same amount of water that the rivers brought in. In 1960, the surface of the Aral Sea was 175 feet (53 meters) above sea level and covered an area of some 68,000 square km. Beginning about 1960, the Aral Sea's water level was systematically and drastically reduced, because of the diversion of water from the Amu Darya and Syr Darya rivers for purposes of agricultural irrigation. By the 1980s, during the summer months, the two great rivers virtually dried up before they reached the lake. The Aral Sea began to shrink quickly because of the evaporation of its now unreplenished waters. In 1987, it split into two lakes. By 1992, the total area of the two parts of the Aral Sea had been reduced to approximately 33,800 square km, and the mean surface level had dropped by about 50 feet (15 meters). By the end of the century, the Aral Sea had receded into three separate lakes: the Greater Sea had divided into a long, narrow, western lake and a larger, broader, eastern lake, with the remains of the Lesser Sea to the north. Almost no water from the Amu Darya and the Syr Darya ever reached the Aral Sea anymore. In the early 21st century, the eastern portion of the Aral Sea suffered the most drastic and immediate decline–diminishing by some four-fifths between 2006 and 2009. For periods of time after 2010, the eastern lobe dried up altogether. Satellite images by NASA in August 2014 revealed that for the first time in modern history, the eastern basin of the Aral Sea had completely dried up.

The change in water quality in the Aral Sea basin reduced the number of fish in the river and in the sea, and destroyed most of the fauna. The shrinking Aral Sea has also had a noticeable effect on the region's climate. The growing season there is now shorter, causing many farmers to switch from cotton to rice, which demands even more diverted water. The exposed bottom of the Aral Sea had a dry salt crust and numerous pollutants. The dust storms carried these contaminated salts and deposited them on land surfaces, reportedly causing several health issues like disability, reproductive problems and tumours to the people living in the Aral Sea region.

Box 1.3. Biodiversity Heritage sites

As per the provisions under Section 37(1) of Biological Diversity Act, 2002, the State Government may from time to time in consultation with the local bodies, notify in the Official Gazette, areas of biodiversity importance as “biodiversity Heritage Sites under this Act. “Biodiversity Heritage Sites" (BHS) are well defined areas that are unique, ecologically fragile ecosystems - terrestrial, coastal and inland waters and, marine having rich biodiversity comprising of any one or more of the following components: richness of wild as well as domesticated species or intra-specific categories, high endemism, presence of rare and threatened species, keystone species, species of evolutionary significance, wild ancestors of domestic/ cultivated species or their varieties, past pre-eminence of biological components represented by fossil beds and having significant cultural, ethical or aesthetic values and are important for the maintenance of cultural diversity, with or without a long history of human association with them.

India has 12 Biodiversity Heritage Sites in total and they have made it to the list because of their uniqueness and fragile nature.

One good example cited is Nallur Tamarind Grove near Devanahalli, some 40 km from Bengaluru Spread across 53.2 acres of revenue land; the grove is believed to have its origin during the period of Chola dynasty. Comprising 300 gigantic old trees, the carbon dating of wood samples has shown that 155 numbers of trees are 410 years old while the remaining are around 200 to 300 years old.

As per the research done by naturalists for Status of Karnataka Biodiversity and published in the Indian Institute of Science, Bengaluru newsletter, the grove is a habitat for a variety of 65 species ranging from slender loris, pangolins, porcupines, as also five varieties of owls and other avian species. An evaluation done by the team says the grove should be protected as it is a precious tamarind gene bank. Clearly these are unique and need to be preserved. The grove was declared a National Biodiversity Heritage Site, and attracted attention from the Nallur Biodiversity Heritage Management Committee for its management and conservation for posterity.

In similar way, there many efforts are adopted for identification of Biodiversity Heritage Site (BHS) in the country, based on the guideline of BHS (http://nbaindia.org/uploaded/ut/Final%20BHS%20guidelines%20approved%20in%20the%2019th%20Authority.pdf).

Children can attempt for documentation of identification such BHS.

Box 1.4. Community Reserves and Conservation Reserves

These protected area categories were first introduced in the Wildlife (Protection) Amendment Act of 2002 − the amendment to the Wildlife Protection Act of 1972. These categories were added because of reduced protection in and around existing or proposed protected areas due to private ownership of land, and land use. Community Reserves and conservation reserves typically act as buffer zones to or connectors and migration corridors between established national parks, wildlife sanctuaries and reserved and protected forests of India. Such areas are designated as conservation areas if they are uninhabited and completely owned by the government but used for subsistence by communities, and community areas if part of the lands are privately owned. Community reserves are the first instances of private land being protected under the Indian legislature. Administration of such reserves would be through local people and local agencies like the Gram Panchayat, as in the case of communal forests.

These categories roughly correspond to IUCN Category V (conservation reserves) and VI (community reserves) protected areas. There are 218 existing Community Reserves in India covering an area of 1445.71 km , which is 0.044% of the geographical area of the country (National Wildlife Database, Dec. 2021)

Tiruppadaimarathur conservation reserve near Thirunelveli District of Tamil Nadu, declared in 2005, is the first Conservation Reserve in the country. In 2012, Rajasthan government in India declared "Jawai Bandh forests" as a conservation reserve forest. Akanasini conservation Reserve in Uttara Kannada district of Karnataka is aimed to protect Lion Tailed macaque, Myristica swamps and many rare amphibians and the entire landscape from impending threats .Keshopur-Miani Community Reserve is a dynamic freshwater ecosystem in the district of Gurdaspur, Punjab. It is the first-ever notified community reserve of India.

Kadalundi -Vallikkunnu community reserve in Kerala was established to protect the estuarine biodiversity. Many migratory birds visit this area in seasons.

Model projects

Project 1: Tree as a habitat

Systematic observation of a tree in the neighbourhood would give the child an idea how a single tree itself is an ecosystem. Tree is a sanctuary harbouring many kinds of plants and animals from insects to mammals. In an ecosystem there is interaction between the components. The child would wonder by making observations how the components interact and benefit through mutual dependence in the tree, in the vicinity and even far off.

Hypothesis: A tree is not a habitat for other organisms

Objective:

To understand the concept of habitat, niche and ecosystem

Methodology

Step1. Selection of area and trees for study: First the suitable area for the study is to be identified in the neighbourhood. The area should be suitable and safe for the children. A tree (better if

the species is known), cultivated or natural, can be selected and preliminary data like species, height, type of canopy, whether evergreen or deciduous and phenologic condition (whether it has buds, flowers, fruits, etc.) are recorded.

Step 2: Systematic observations are to be made on the different plants and animal species dwelling and visiting the tree. It is better to fix regular time for observation. (The birds will be vocal and active immediately after the sunrise. Butterflies may become active about two hours after the sunrise) There can be permanent dwellers like epiphytic plants attached to the tree bark throughout. Usually there will be algae, fungi, moss, lichen, parasites like Loranthes, early stage fig, epiphytic orchids, climbers and so on. Record all possible plants and the height at which and the position (like on trunk bark, branches, twigs etc.) also are to be noted. Likewise the creatures that are dwelling and visiting the various parts – trunk, branch, twigs, leaves, flowers, fruits, epiphytes etc. of the tree are to be recorded. It may include insects, spiders, amphibians, reptiles, birds and mammals. The role of each and every group of organisms can be recorded. All information collected should be tabulated in a suitable manner so as to make the analysis easy.

Step 3: The data collected systematically can be analysed and interpreted.

By recording the height at which the organism or the plant is seen, a vertical stratification of species and communities is possible. A graphical representation of the data would give more clarity and make it more scientific. This may give insight into the survival strategies operating in different species and communities in nature.

Since the children will be taking up a short term project, the dynamics in different seasons may not be possible. Still he/she can make particular observations in pre-monsoon, monsoon or post-monsoon seasons.

Expected Outcome

After the analysis of the data of observation for two or three months the children may be capable to understand the diversity of life even on a single tree and may be capable to identify many insects, spiders, birds, reptiles and mammals depending on the tree and the kind of interaction in a model ecosystem and also the intricacies in nature. If time and opportunity permits, children can compare the diversity of life on different species of trees whether standing alone or are in groves, small or large. Ultimately the children will be able to understand what is meant by ecosystem, habitat and niche. The children will have to come down to a decision whether the tree they studied is habitat in an ecosystem or by itself is an ecosystem.

Significance

The project has a pan India application and can be easily done in rural and urban areas.

Project 2: Study on insect - pest association with crop in an agroecosystem

Background

In an organic agro-ecosystem, biotic components almost remain balanced. Natural agriculture or regenerative agriculture encourages all biotic and abiotic factors to interact freely like a natural

ecosystem. Therefore, several natural factors influence the pest population below the Economic Threshold Level (ETL). Floral and faunal composition in organic agriculture is rich enough to continue healthy interaction among trophic levels and support more complex food webs. Strong association among trophic levels reduces pest population and crop infestation. Studying different factors that influence pest population will be helpful to understand an organic agro-ecosystem.

Objectives

1. To understand different insect-pest associated with crops in an organic agro-ecosystem (e.g. Kitchen Garden).
2. To document the population of insect-pests in different crops.
3. To document the insect-pest management agents.

Methodology

- Need to select a particular crop in a particular season
- For observational study one can select one or two crop land where that crop has been cultivated; if two plot are considered, better select them in two different locations
- Within the cropping area better to select some sampling /observational area, like in the plot of cropping is of 20 m x 20m, one can select 2m x 2 m area or 5 m x 5m within the larger area, which will be considered as the primary observation area. It will be ideal if more than 1 preferably 2 or 3 such primary observation area selected within same cropping field.
- It will be ideal to carry out the observation with the cropping cycle (like at the stage of germination, seedling sapling, flowering , seeding and ripening and harvesting etc); date and time of observation need to be consider in all cases.
- Based on every stage of observation against each of the primary unit of observation Qualitative measurement of insect-pest associated with each of the crop in the organic agro-ecosystem may be summarized in following table-

Sl No.	Crop	Stage of crop during infestation	Insect-pest identified	Local name of the pest (if any)	Plant part infested	Infestation stage of insect-pest
1	Brinjal					
2	Chilli					
3	Cabbage					
4	Cauliflower					
5	Bean					
6	Radish					
7	Turnip					
8	Coriander					
9	Tomato					
10	Knolkhol					

- The population of insect-pest may be counted physically in crops available within a square meter area. If the plant population of each crop is less, then individual plant may also be scanned for documentation of insect-pest species and may be represented in table as follows-

Sl No.	Insect-pest species	Host crop	No of insect-pest / sq m or / plant	ETL level (from reference)	Damage intensity (in 1-10 scale)	Existing pest management practice
1						
2						
3						
4						
5						
6						

- Several biological agents are involved in healthy interaction in the organic agro-ecosystem. A child scientist can document different natural biotic agents involved in pest management. A quadrate of 1 sq meter area may be randomly selected to document insect predators/parasitoids and spiders. For documenting other predators, the entire agro-ecosystem (kitchen garden) may be considered. The result may be presented in following table-

Sl No.	Type of biocontrol agent	Species	Generalist or Specialist biocontrol agent	Insect-pest target	Stage of the active biocontrol agents	Habit of agent
1.	Spiders	(a)				
		(b)				
		(c)				
		(d)				
2.	Green Lacewing					
3.	Lady bird beetle					
4.	Tiger beetle					
5.	Red tree ant					
6.	Potter wasp	(a)				
		(b)				
		(c)				
7.	Bird	(a)				
		(b)				
		(c)				
8.	Parasitoid (Cotesia, Bracon, Apanteles etc.)	(a)				
		(b)				
		(c)				
9.	Beauveria bassiana					
10.	Metarhizium anisopliae					

- Based on the above-mentioned table, possible to compare the situation against different cropping area under same crop.

Expected Outcome: Children would be able to Identify biocontrol - agents in agro-ecosystem and formulate strategies for their conservation. This will also be helpful to understand resourcefulness of the organic agro-ecosystem.

Project 3: Study on flower and pollinator association in a garden

Background

We are familiar with flowers with different colours. The colour and structure of flowers attract different kinds of insects and birds visiting to get nectar or other food materials and, in the process, they help in pollination. Pollinators are divided into different taxonomic groups like birds, bees, ants, wasps, dipterans and lepidopterans.

[**Note:** For images refer: https://courses.lumenlearning.com/wm-biology2/chapter/flower-structure/]

Hypothesis: Pollinators are not attracted by colours of the flower

Objectives: To see the relationship between flower colour and structure (e.g. Length of the floral tube) with composition of pollinators in the ecosystems.

Methodology

The flowers in the vicinity naturally occurring or planted can be chosen for observation. The colour choice can be four or five - yellow, white, pink, red /purple and blue/violet. The length of the floral tube in each species can be measured by using an ordinary scale. It would be better to observe the visitation in the morning hours by different birds and insects.

Usually, it is different species of Sunbirds that visit flowers in India. The visiting group can be classified into birds, butterflies (Lepidopterans), honey bees, wasps, ants, dipterans, other insects etc. Children should have a preliminary knowledge to identify these groups by looking into the external structure/ morphology.

The visitation of the flowers by various organisms can be recorded in a data sheet. The observation may continue for about a month. If the children can associate any group of organisms having preference of colour and structure then try to analyse it. If he/she finds some colour preferences and structure preferences in any of the pollinator groups, then try to analyze and interpret the intricate pathways present in nature.

Number of observations	Date	Time of observation	Lepdoptera/ Honey bee/ wasp/ Diperan/ ants/ bird/ Other	Length of the floral tube	Colour of the flower	Time spent
1						
2						

3						
4						

Expected Outcome

The outcome of the study may be helpful in predicting preferences of the pollinators towards certain flowers that can be used as tools to guide us to pick the right plant for the right pollinator. For example, the child can advise which kind of flowers are preferred by the honey bees to someone who has beehives.

Project 4: Diversity of butterfly in the local area

Background

Recent studies of biodiversity in relation to ecosystem functioning have suggested that species diversity sometimes enhances productivity and stability of an ecosystem. Positive relationships have been found between butterfly diversity and plant diversity. This relationship is particularly true in tropical regions, where insects show higher abundance with more species diversity.

Butterflies are economically very important insects. Besides providing vital pollination services, they also form an important food chain component of birds, reptiles, spiders and predatory insects. Butterflies are also good indicators of environmental changes, as they are sensitive to habitat degradation and climate changes. Caterpillars of some butterflies feed and develop on weeds instead of agricultural crops and thus become farmers' friends by controlling the weeds.

Objectives

- To study butterfly species in the locality.
- To study larval host plants and nectar plants diversity in the same area.
- To suggest strategies for conservation and enhancing butterfly diversity.

Methodology

I. Survey

Mapping the study area

Identify and map the study area with details like roads, pathways, buildings, open spaces, wooded areas, etc. Put 10 m X 10 m grid and identify 2 sample quadrats each from different site conditions like, garden, wooded area, around buildings, along the roads, etc.

Sampling

Carry out random surveys in the study area with a fixed frequency (may be twice a week) for the occurrence of butterflies. Choose sites based on their contrasting vegetation types and levels of disturbance. Surveys should be carried out only during good weather conditions and / or during active periods of butterflies (sunny days or from 08.00 hrs to 11.00 hrs and 14.00 hrs to 16.00 hrs).

Observations

Avoid collection of specimens. Make observations with the aid of binocular and digital cameras, and do only photographic documentation. Use local field guides and internet sites to identify the species. You can also get help from the local experts.

Modified Pollard Walk Method (MPWM)

Observations can be made through walking transects of 0.5 km to 0.7 km length with 2 m to 5 m on either side. Several walking transects can be made across different habitats of an ecosystem to count butterfly species.

Butterfly Line Transects

In this method permanent 500 m line transects need to be made at each study site. The transect in each habitat is slowly traversed at a uniform pace at each study site during good weather periods (no heavy rain or strong winds). Observations will be made during a fixed 4 transects each of 500 m length with 5 m on either side covered in an hour walking at a constant pace.

II. Identification

The recorded species need to be identified with the help of photographs by using reference books and various field guides and other available literature for information on species of butterflies, their classification, and ecological notes along with identification keys for Indian butterflies.

Prepare a preliminary checklist of butterflies based on the present study with families, genera and species.

Sl. No	Family	Total Identified Specimens	Identification of Specimens up to	
			Genus	Species
1	Papilionidae			
2	Pieridae			
3	Nymphalidae			
4	Lycaenidae			
5	Hesperiidae			
Total No.				

Expected Outcome

Try to correlate the observations with the site conditions. Which sites have maximum butterfly diversity and why?

Suggestions

Based on the observations and correlation, suggest plans to increase the diversity of the butterflies in the area. The abundance of butterflies depends on the availability of their food plants. Thus, planting of supporting vegetation and maintenance of water holes may help to conserve butterflies in the study area.

Further reading

- 'India - A Lifescape: Butterflies of Peninsular India' (Kunte, 2000)
- 'Red Data Book - Part II: Butterflies of India' (Gupta and Mondal, 2005)
- 'The Book of Indian Butterflies' (Kehimkar, 2008)
- 'Genera of Indian Butterflies' (Varshney, 1993)
- 'Butterflies of India' (Antram, 1986)
- 'The Dictionary of Butterflies and Moths in Color' (Watson and Whalley, 1983)
- Butterfly Sampling: Pollard Walk: https://www.wwu.edu/faculty/jmcl/Wildlife/bfly_walk.pdf

Project 5: Study of paddy field ecosystem

Background

Paddy is the staple crop grown in many parts of India and is mostly cultivated under rain-fed conditions. It is mostly grown in high rainfall areas and cultivated in specially prepared terraces called wet terraces on slopes. These terraces harbour several other species of plants, crustaceans, amphibians, insects, fishes, etc. which thrive along with the paddy and are an integral part of the paddy field. Even when the water recedes and the crop is harvested, there are many species which thrive in the residual moisture.

Objectives

1. To observe and study different living components (flora and fauna) of the paddy field over one season.
2. To observe and document various abiotic factors and elements related to the paddy field.
3. Try to correlate the biotic and abiotic factors and establish relations among them.
4. Compare diversity in paddy grown organically versus chemical farming.

Methodology

- Select more than one paddy field located in different location but having similar methods and process of cultivation.
- Put multiple quadrats of size 1m X 1m spread across the field. Fix these quadrats with wire and posts. The number of quadrats will depend upon the area of the field.
- Carry out observation in each quadrat in equal interval of time. It would be better to observe in the morning, afternoon and evening hours.
- If observation is carried out in an interval of 4 or 5-days in the cropping cycle of paddy, always keep records of date and time of observation which is to be referred in the data base.
- Count the number and species of plants in each quadrat and record in sheets
- observe fauna (birds, amphibians, reptiles, rodents, insects, etc.) in each quadrat and record in sheet
- You can photograph each species and identify with the help of local field guides. Local experts can also be consulted.
- Detailed data sheets for all the observations must be maintained for each quadrat.

- Species diversity and species richness and relative abundance can be evaluated from these observations. Make observations on the ecological role of each and every species and community in the field.

Along with the flora and fauna observations, other factors like soil characteristics (texture, structure, colour) and water parameters (pH, turbidity) can also be studied. Level of standing water in the field is also to be documented at every visit.Continuous observations may be made even after the paddy is harvested and till there is a residual moisture. Also note the amount of the harvest from each field.

Expected outcome:

Children are expected to observe and document all the species of plants and animals observed during the entire growing season. Correlation between the level of standing water and species of plants and animals can be checked. Compare the diversity among the organic versus conventional paddy fields.

Significance:

This study will lead to the documentation of one of the common agroecosystems in India i.e. paddy field. Children will be able to observe, identify and learn about many species of local flora and fauna in a relatively smaller area. The study will develop a habit of meticulous observations in the field and enhance children's understanding about their surroundings.

Project 6: Documentation of Bird Diversity of your locality

Bird watching or birding is a recreational activity involving the observation of birds. The scientific study of birds is known as ornithology. Globally, tens of millions of people are involved in bird watching.

Birds are almost everywhere. We do not need to visit a national park to watch birds. From mountains to deserts, from forests to the sea, one would even see birds in most of the urban areas. The renowned ornithologist Salim Ali said, "it is nearly impossible to imagine a sq km. of India without a few species of birds". One of the best things about bird watching is that it is very convenient. One can observe birds from their balcony or by simply visiting their backyard. Birding is also not limited by lack of equipment. Anyone can observe birds around them without any cost. Birding also gives us a wonderful opportunity to observe and reconnect with the natural world around us. Getting involved in bird watching may introduce you to the world the birds live in and give you a wonderful opportunity to learn about their habitat and other creatures who coexist with them.

Equipment for birding

The most important tools to observe birds are the simplest ones: your eyes, your ears, and some of your time. It is not just about looking at the birds, but how the bird moves, their feeding habits, is it calling from the ground or from the tree, which habitat type it prefers for foraging, their mating calls, alarm calls, etc. are some parameters that one can observe while watching birds. One has to be very patient if they want to observe birds. Binoculars, cameras, and telescopes are essential tools for birdwatchers. A field guide for bird identification, a notepad and a pen for keeping a record of birds are important accessories for the birdwatchers.

What to observe during bird watching?

A new birder may not know where to begin when they are birding for the first time. It's easy to watch a bird, but when it comes to proper identification, it will be a bit difficult for a new birder. Consider taking notes (using a pen, paper, or taking a picture) of at least one of the following features when you see a bird will be helpful for beginners.

A. **Size, shape, and structure:** We can note down if a bird is big or small in size. We can also take a familiar bird as a reference point to compare the size and shape of the unknown bird.
B. **Colouration and patterns:** We can observe and note down the color of birds. We can also look at bars, stripes, spots, markings on the birds. Their beak pattern is also important and helpful for identification.
C. **Behaviour:** Birds' behaviour can also be observed. Their foraging behaviour, call patterns can be noted down while observing birds.
D. **Sounds**: Bird calls are important for identification. We can record bird calls on the phone and other recording devices for identification.
E. **Habitat:** Identification of birds is often a matter of probability, so you can rule out species unlikely to be encountered at a particular time and place by taking location, habitat, and seasons into account.

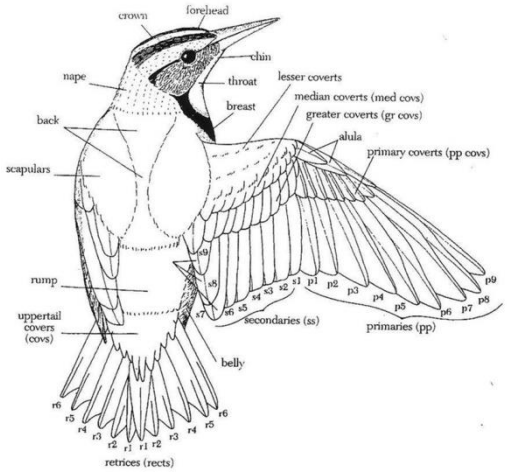


Figure 1.1: Different parts of body of bird which help in bird identification

Methodology

There is no particular method for bird watching if one takes it as a recreational activity. But to study birds in a scientific way, then one needs to follow some methodologies for a proper outcome. For a bird survey, firstly, we need to determine the survey area with boundaries. Depending on our objectives we can choose a habitat type such as forest, swamp or any geographical area. Next important thing we need to keep in mind is the sampling unit. For absolute or relative abundance study of birds, a proper number of birds' sampling units are necessary for getting an unbiased result. The most frequently used methods are random sampling and regular sampling. To conduct bird survey, predefined routes are decided within the survey boundary and these predefined routes are called transects. The most commonly used transects are line transect and point transects. With line

transects, bird records are continually taken, whereas with point transects, they are taken periodically along the route for a set duration at each point.

Based on the data collected one can go for the analysis

1. Identification of the species diversity
2. Species-wise population
3. Association with habitat without any disturbances and with disturbances
4. Time of observation and type of activity
5. Variation over season
6. Able to collect vernacular taxonomic information of identified birds, its meaning in local language and any association with local practices like totemic beliefs, bio-indicators of weather, etc.

Sample of documentation table (for transect base study)

Date:

Locality name:

Weather:

Species composition and behavioural activities of birds

Transect ID	GPS Way Point	Start/ End Time	Species Name	Photo ID (optional)	Altitude (m)	No of Ind	Activity	Habitat Type	*Canopy cover	Disturbances					
										Tree felling	Lopping Grass/ bamboo	Bamboo cutting	Human/ Domestic animal trail #	People's activity	Livestock grazing

Additional Project Ideas

1. Comparison of butterfly populations in urban and rural environments
2. Species diversity in the mangrove ecosystem
3. Diversity of aquatic plants in the local pond/wetland
4. Diversity of aquatic plants in the disturbed pond/wetland and intact pond/wetland in the locality
5. Impact of urbanization on the mangrove ecosystem
6. Impact of solid and liquid wastes on the mangrove ecosystem
7. Impact of solid and liquid wastes on the wetlands

8. Diversity of flora and fauna in the sacred grove
9. Comparison of soil organism in sacred grove and agricultural land/plantations in the neighbourhood
10. Studies on urban birds and their survival tactics
11. Probe into reasons for the disappearance of sparrows in urban/ rural environments.
12. Studies on pollinators in the home gardens.
13. Diversity of spiders in the paddy fields and their role in pest control.
14. Mixed hunting party of birds in rural areas and their dynamics
15. Birds in the paddy fields
16. Study of heronry and the dynamics
17. Fruit eating birds in the locality and their role in seed dispersal
18. Dragonfly and damselfly diversity in the locality
19. Dragonfly larvae and their role in mosquito larvae control
20. Bird flowers and flower birds
21. Ecosystem restoration of different mines areas
22. Coastal erosion and impacts
23. Choice of native and exotic plants in the home gardens and the transformations in the garden ecosystems
24. Change in riparian vegetation in different zones in a river
25. Analysis of change in the local landscape based on satellite images and land surveys
26. Riparian vegetation dynamics and its relation to diversity in aquatic fauna in the locality
27. Earthworm presence and density as an indicator of soil organic carbon content and soil health
28. Study of pollinators in the mustard field.
29. Pollinators and pollination

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Sub-theme II

Fostering Health, Nutrition, and Well-being

Introduction

"Health is a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity" (*World Health Organization)* Society often thinks health as biological and/or physical: the condition of our bodies, how healthy we eat, the physical exercise we do. However, a key component of health is missing from this list: mental wellbeing. Mental wellbeing encompasses our inner workings and the way we describe 'how we are' in our lives. It is also, linked to other positive lifestyle choices, it promotes good physical health and contributes to people's emotional and social wellbeing.

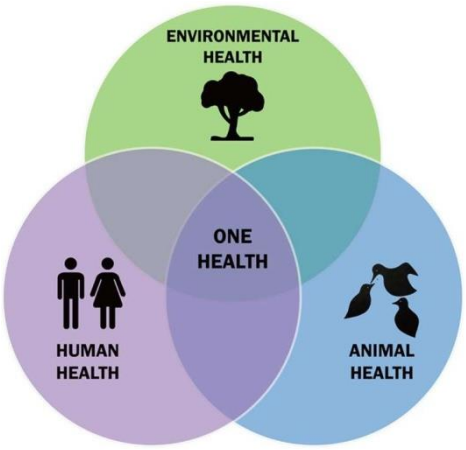
In addition to physical and mental wellbeing, a well-balanced diet forms a cornerstone of good health. Consuming a healthy diet helps to prevent malnutrition in all its forms as well as a range of non-communicable diseases (NCDs) and conditions, such as diabetes, heart disease, stroke and cancer, etc. Increased production of processed foods, rapid urbanization and changing lifestyles have led to a shift in dietary patterns across the globe. People are now consuming more foods high in energy, fats, free sugars and salt/sodium, and many people do not eat enough fruit, vegetables and other dietary fibre (e.g. whole grains).

Objectives

This sub-theme will inspire the children to make scientific inquiry, in their own localities, about status of health, nutrition and well-being of human, plants and animal and will also encourage them to make efforts to identify ways and means to fortify and foster the situation ensuring health safety and security, nutritional security and well-being at individual, family and community levels.

- To explore One Health concept
- To understand Mental Health and Well-being
- To know about Food and Nutrition
- To realise relationship of Health before, during or after disasters

Scope



What is One Health?

One Health is an approach that recognizes that the health of people is closely connected to the health of animals and plants and also our shared environment. One Health is not new, but it has become more important in recent years. This is because many factors have changed interactions between people, animals, plants, and our environment.

30. Human populations are growing and expanding into new geographic areas. As a result, more people live in close contact with wild and domestic animals (both livestock and pets). Animals play an important role in our lives for food, fibre, livelihoods, travel, sport, education, or companionship. Close contact with animals and their environments provides more opportunities for diseases to transmit between animals and people.

7. The earth has experienced changes in climate and land use, such as deforestation and intensive farming practices. Disruptions in environmental conditions and habitats can provide new opportunities for diseases to pass to animals.
8. The movement of people, animals, and animal products has increased from international travel and trade. As a result, there is possibility that diseases can spread quickly across borders and around the globe (Example: COVID-19).

These changes have led to the spread of existing or known (endemic) and new or emerging zoonotic diseases, which are diseases that can spread between animals and people. Every year, millions of people and animals around the world are affected by zoonotic diseases. Examples of zoonotic diseases include: Rabies, Salmonella infection, Anthrax, Brucellosis, Ringworm and the likes.

Animals also share our susceptibility to some diseases and environmental hazards. Because of this, they can sometimes serve as early warning signs of potential human illness.

What are common in One Health issues?

One Health issues include zoonotic diseases, antimicrobial resistance, food safety, and food security, vector-borne diseases, environmental contamination, and other health threats shared by people, animals, and the environment. For example:

F. **Antibiotic-resistant germs** can quickly spread through communities, the food supply, healthcare facilities, and the environment (soil, water), making it harder to treat certain infections in animals and people as well.
D. **Vector-borne diseases** are on the rise with warmer temperatures and expanded mosquito and tick habitats.
E. **Diseases in food animals** can threaten supplies, livelihoods, and economies.

F. The **human-animal bond** can help improve mental well-being.

G. **Contamination of water** used for drinking, recreation, and more can make people and animals sick.

Even the fields of chronic disease, mental health, injury, occupational health, and non-communicable diseases can benefit from a One Health approach involving collaboration across disciplines and sectors.

How does a One Health approach work?

It works among human, animal, environmental health, and other relevant partners (Fig. 2.2).

Fig. 2.1, The whole concept of 'One Health'

Successful public health interventions require the cooperation of human, animal, and environmental health partners. Professionals in **human health** (doctors, nurses, public health practitioners, epidemiologists), **animal health** (veterinarians, paraprofessionals, agricultural workers), **environment** (ecologists, wildlife experts), and **other areas of expertise** need to communicate, collaborate on, and coordinate activities. Other relevant players in a One Health approach could include law enforcement, policymakers, agriculturists, communities, and even pet owners. No one person, organization, or sector can address issues at the animal-human-environment interface alone.

The One Health approach can:

- Prevent outbreaks of zoonotic disease in animals and people.
- Reduce antibiotic-resistant infections and improve human and animal health.
- Protect global health security.
- Improve food safety and security.

By promoting collaboration across all sectors, a One Health approach can achieve the best health outcomes for people, animals, and plants in a shared environment.

Mental Health and Well-being

Mental health is a state of mental well-being that enables people to cope with the stresses of life, realise their abilities, learn well and work well, and contribute to their communities. It is an integral component of health and well-being that underpins our individual and collective abilities to make decisions, build relationships and shape the world we live in. Mental health is a basic human right. And it is crucial to personal, community and socio-economic development.

Mental health is more than the absence of mental disorders. It exists on a complex continuum, which is experienced differently from one person to the next, with varying degrees of difficulty and distress and potentially very different social and clinical outcomes. But, traditionally, games, festivals, and other community gatherings can be seen as a way of socializing reducing the stress levels. The advent of internet and spending more time on the "screen" has led to addiction, inwardly behaviours, depression, suicidal tendencies which are all related to less avenues for coping mechanisms. Various other addictions like substance, alcohol etc. also are manifestations of these.

Exposure to unfavourable social, economic, geopolitical and environmental circumstances, including poverty, violence, inequality and environmental deprivation – increase people's risk of experiencing mental health conditions. It is true that the risks can manifest themselves at all stages of life, but those occur during developmentally sensitive periods, especially early childhood, are particularly detrimental. For example, harsh parenting and physical punishment is known to undermine child health and bullying is a leading risk factor for mental health conditions.

Protective factors similarly occur throughout our lives and serve to strengthen resilience. They include our individual social and emotional skills and attributes as well as positive social interactions, quality education, decent work, safe neighbourhoods and community cohesion, besides others.

Mental health risks and protective factors can be found in society at different scales. Local threats enhance risk for individuals, families and communities. Global threats heighten risk for whole populations and include economic downturns, disease outbreaks, humanitarian emergencies, forced displacement and the growing climate crisis.

Each single risk and protective factor have only limited predictive strength. Most people do not develop a mental health condition despite exposure to a risk factor and many people with unknown risk factors still develop a mental health condition. Nonetheless, the interacting determinants of mental health serve to enhance or undermine mental health.

Impact on mental health was amplified during the lockdown situation, while Covid-19 pandemic occurred, for those who worked from home or the children, teenagers who took online tutorials and classes. Such a lifestyle with reduced exposure to outdoor activities, recreational activities. That influenced the mental health of people across the age groups, gender, regions in varied ways.

Exposure to nature and a clean green healthy environment plays a significant role in general health promotion, especially mental health. Studies have shown an increased exposure to forest environments can have a positive effect on psychological healing, recovering from stress, improving concentration and productivity, improving mental health, particularly for people from urban environments where the exposure to a green natural environment is less or negligible; e.g., Forest therapy in Japan.

Box-2.1 : Forest therapy in Japan

i. Forest Walking- Walking is the simplest rehabilitation method and whole-body exercise. Walking can prevent lifestyle related disease. In addition, individuals walking in the forest enjoy the landscape, fresh air, and natural environment.

ii. Relaxation- It is quiet and peaceful in the forest. Relaxation in the forest inspires natural peace in our body and mind. It adjusts our nervous system balance too.

iii. Rehabilitation- For clients after an operation, accident, and preparing to reintegrate with society, forest walking & working is one possible rehabilitation programme.

iv. Treatment and occupational activities in the forest- Carrying logs & branches, clipping trees & clearing weeds, and planting trees are typical examples of occupational therapy.

v. Counselling- counselling in the forest makes clients relax and sensitive. Forest amenities like landscape aesthetics, wind, fragrance, birds singing sometimes give useful hints to solve our problems and provide an ideal setting for traditional counselling approaches.

Negative mental health traits can be identified at an early stage by trained clinical psychologists and various interventions can be taken to correct those negative traits. These can include bio-psycho-social first aid by teachers (after they are trained for it), school based counsellors, group-based therapies through life-skill education and for severe cases referral to trained psychiatrists in renowned medical institutions. Example: Our Responsibility to Children Project being implemented by the Women and Child Department, Kerala.

Diet and Health

The exact make-up of a diversified, balanced and healthy diet will vary depending on individual characteristics (for example, age, gender, lifestyle and degree of physical activity), cultural context, locally available foods and dietary customs. However, the basic principles of what constitutes a healthy and responsible diet remain the same:

- Eat a well-balanced diet of natural foods.
- Choose fruits, vegetables, legumes, nuts and grains that were produced without harming the environment (this includes organic and biodynamic options).
- If you eat animal products, buy from sources that respect and promote animal wellbeing (this includes free-range, organic, biodynamic options).
- Avoid beverages containing high amounts of sugars or artificial sweeteners (this includes all types of carbonated or non-carbonated soft drinks, fruit or vegetable juices and drinks, liquid and powder concentrates, flavoured water, energy and sports drinks, ready-to-drink tea, ready-to-drink coffee and flavoured milk drinks).
- Limit consumption of industrially produced foods and pre-packaged snacks (this includes all types of fast food and ready meals, industrially produced cakes, cookies and salty snacks as well as all types of candies).

- Choose locally grown fruits and vegetables to reduce transportation related Green House Gas (GHG) emissions.
- Avoid single-use plastic water bottles and use a long-life, refillable drinking container instead.
- Avoid take-away foods and drinks to cut-down on single-use cups, plates and cutlery.
- Minimize food waste where possible.

Know Your Food

The effective management of food intake and nutrition are both key to good health. Smart nutrition and food choices can help to prevent disease. Eating the right foods can help our body cope more successfully with an ongoing illness. Understanding good nutrition and paying attention to what we eat can help us maintain or improve our health.

Food and Nutrition

Food and nutrition provide us fuel to energise our bodies. We need to replace nutrients in our bodies with a new supply every day. Water is an important component of nutrition. Fats, proteins, and carbohydrates are all required. Maintaining key vitamins and minerals are also important to maintaining good health. For pregnant women and adults over 50, vitamins (e.g. vitamin D) and minerals viz. calcium and iron are important to consider when choosing foods to eat, as well as possible dietary supplements.

A healthy diet includes a lot of natural foods. A sizable portion of a healthy diet should consist of fruits and vegetables, especially those which are red, orange, or dark green in colour. Whole grains, such as whole wheat and brown rice, also play a part in our diet. For adults, dairy products should be non-fat or low-fat and protein can consist of lean meat and poultry, seafood, eggs, beans, legumes, and soy products, as well as unsalted seeds and nuts.

Good nutrition also involves avoiding certain kinds of foods. Sodium is used heavily in processed foods and is dangerous for people with high blood pressure. Fried food, solid fats, and trans fats found in margarine and processed foods can be harmful to heart health. Refined grains (white flour, white rice) and refined sugar (table sugar, high fructose corn syrup) are also bad for long-term health, especially in people with diabetes. Figure -2.1 below indicates the percent of different food items required per day for maintaining a good health

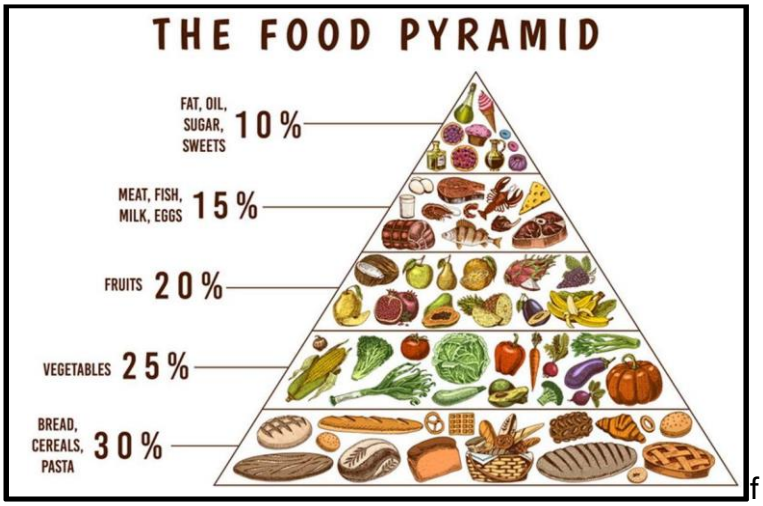


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Fig-2.1. Food Pyramid

Nutritional Deficiency

Even if we are getting enough to eat but do not eat a balanced diet; hence, we may still be at risk for certain nutritional deficiencies. Also, we may have nutritional deficiencies due to certain health or life conditions, or certain medications we might be taking, viz. high blood pressure medications. People who have had intestinal diseases or had sections of intestines removed due to disease or weight loss surgery, also may be at risk for vitamin deficiencies. Alcoholics are also at high risk of having nutritional deficiencies.

One of the most common nutritional deficiencies is iron deficiency leading to anaemia. Our blood cells need iron in order to supply our body with oxygen, and if we don't have enough iron, our blood will not function properly. Other nutritional deficiencies that can affect our blood cells include low levels of vitamin B12, folate, or vitamin C.

Vitamin D deficiency may affect the health of our bones, making it difficult for us to absorb and use calcium (another mineral that we might not be getting enough of). Although we can get vitamin D by going out in the Sun. Many people who concerns about skin cancer may end up with low levels of vitamin D by not getting enough sun.

Other nutritional deficiencies include:

- Beriberi: low levels of vitamin B1 (found in cereal husks)
- Ariboflavinosis: low levels of vitamin B2
- Pellagra: low levels of vitamin B3
- Paraesthesia: low levels of vitamin B5 leading to a "pins and needles" feeling
- Biotin deficiency: low levels of vitamin B7, which can be common in pregnancy
- Hypocobalaminemia H: low levels of B12
- Night blindness: low levels of Vitamin A
- Scurvy: low levels of vitamin C
- Rickets: severe vitamin D and/or calcium deficiency

- Vitamin K deficiency
- Magnesium deficiency: occurs with certain medications and medical problems
- Potassium deficiency: occurs with certain medications and medical problems

Eating a balanced diet can help prevent these conditions. Different types of vitamin supplements may be necessary for individuals, depending on age, gender, workability and others.

Health Conditions and Nutrition

Many health conditions are caused and/or affected by food and nutrition. Some are directly caused by food, such as "food poisoning" or bacterial infections from contaminated food. Some people can have severe allergies to foods like peanuts, shellfish, or wheat (celiac disease). Gastrointestinal ailments—such as irritable bowel syndrome, ulcerative colitis, and gastroesophageal reflux disease (GERD)—are also directly affected by the consumption of food. For other diseases and conditions, the type or quantity of food can influence the progress of the disease. Diabetes mellitus, for example, which results in inability of the body to regulate blood sugar, is drastically affected by the types and quantities of food eaten. Carbohydrate intake has to be carefully monitored if you suffer from diabetes, otherwise blood sugar can rise to dangerous levels. Other conditions affected by food and nutrition include:

- Hypertension: Salt intake affects blood pressure.
- Heart disease/high cholesterol: Fatty foods and partially hydrogenated oils can create plaque in arteries.
- Osteoporosis: Low calcium, low vitamin D and excess fat can result in fragile bones.
- Certain cancers: A poor diet and obesity are associated with increased risk of breast, colon, endometrial, oesophageal, and kidney cancers.

Our food choices and nutritional status can influence our overall health over the entire course of our life.

Sources of Food

It is of great importance that one understands where or what their source of food is. In fact, we know a balanced diet is a necessity if we want to lead a healthy life. This balanced diet involves different carbohydrates, minerals, vitamins, fats and so on. So, how does one ensure that a balanced diet is maintained?

The first step is to know where do they come from so that they can understand the different nutrients provided by that particular item of food. Let's have a glimpse of food sources, especially plant and animal products that we consume. The sources of food are broadly classified into two groups; plants and animals, and their related products.

(a) *Plant Sources*:

Plants are the source of a wide variety of nutrients required to keep the human body in perfect working condition. Humans consume everything from fruits, flowers, even I stem of some plants, leaves and stem-like lettuce, celery, roots of some plants like carrots, beetroot, and seeds like wheat, rice, etc. In fact, most of our food comes from plants, even animals

depend on plants. Hence, we obtain food from plants directly or indirectly. For this reason, one is advised to consume fruits and vegetables on daily basis for it is the source of rich nutrients.

Plants provide us with vegetables, coffee, cereals, pulses, fruits, sugar, spices, oil, etc. Different parts of the plants provide different food materials. Let us have a look at some of the food obtained from different parts of the plant.

Roots, leaves, and stem of some nutrient-rich vegetables. Radish, turnip, carrot, beetroot are some of the roots; potato and ginger are the stems; spinach, cabbage, lettuce are the leaves; broccoli and cauliflower are the flowers consumed as vegetables. Fruits are a healthy source of food from plants that includes orange, mango, apple, grapes.

Cereals include rice, wheat, maize, jowar, barley, etc. These are the rich sources of nutrients provided by the plants. Coffee and tea are widely grown in the southern parts of India. These are also obtained from the plants. Not just these, sugar is also obtained from the plants. It is processed from the sugarcane plants.

Oils are extracted from the seeds and leaves of the plants. Some of the plants producing oil are castor, mustard, and sunflower. Spices like Cinnamon, cardamom, pepper, clove, cumin seeds, and ginger are obtained from the plants and used for cooking purposes.

(b) *Animal Sources*:

Animal products are used as food directly or indirectly. Milk, eggs and meat are important examples of food from animals. Animal products too are rich sources of nutrients. The food chain is composed of exactly these animals starting with organisms that use the energy of the sun to the apex at which the organisms are predators and rely on producers.

Some of the foods obtained from the animals include milk, eggs, meat and the likes. Cows, buffaloes, sheep, goat, and camels are a great source of milk. Milk is also called an ideal food rich in vitamins, minerals, proteins, carbohydrates and fats.

Chickens, ducks, geese, and quails are raised for eggs and meat. The egg is a rich source of protein and vitamins. The yolk of the egg is mostly made up of fats, proteins, and essential nutrients, containing vitamins, phosphorus, calcium and iron.

Meat is of two types- red meat and white meat. The meat of cow, goat, sheep and pigs has a lot of fat and is called red meat. White meat contains less fat and is obtained from chicken and fish. White meat is healthier and can be easily digested as compared to the red meat. Meat is rich in proteins, vitamins, zinc, phosphorus and iron.

Health and Disasters

Disasters and other emergencies often result in significant impacts on people's health, including the loss of many lives. Every new threat reveals the challenges for managing health risks and effects of emergencies and disasters. Deaths, injuries, diseases, disabilities, psychosocial

problems and other health impacts can be avoided or reduced by health emergency and disaster risk management measures involving health and other sectors.

Disaster is a severe concern for the living. The impact of a disaster varies from small to large, depending on its types. In particular, disasters can happen for many causes. But in most cases, disasters can cause damage to material resources as well as life. Although they are unpredictable [like flood, drought and fire] and can be unconditional, but there are many reasons for which we are also responsible.

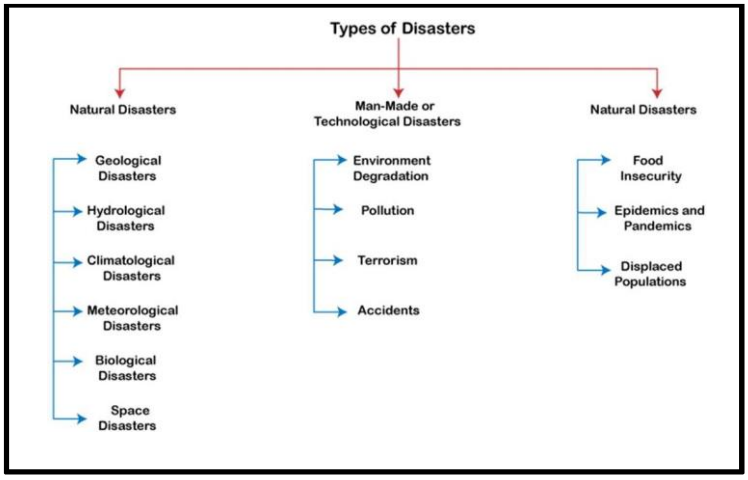
What is Disaster?

A disaster is an emergency of such severity and magnitude resulting from various uncertainties such as multiple deaths, injuries, illness, and property damage, and often not handled with routine procedures and resources. Such uncertainty can occur for several reasons. The causes can be natural, human error, equipment malfunction, disease, biological danger, etc.

The duration of disasters can range from a minute of disruption to an hour, day, or a week, and the effects can go from minor to large scale. These disruptions caused by various disasters can damage human resources, economic resources, environmental supplies, and even the lives of multiple species, including humans. Although any disaster type may occur for a specific period, it will have long-term effects that are usually beyond the affected society's tolerance capacity. Any disasters affecting ecosystems can lead to a cascade of events on the species, communities and to the society as a whole affecting lives, livelihoods, and natural resource base that support societies. e.g. landslides, earthquakes, volcanoes etc.

Types of Disasters

There are many types of disasters and can take different forms. However, all these can be broadly classified into the following three categories; Natural Disasters, Human-made or Technological Disasters, and Complex Emergencies



- ***Disaster Management, Prevention, and Mitigation***

Disaster management refers to the systems we use to deal with human, property, economic or environmental resources against disasters. It is how we prepare, deal, respond, and learn from disasters and their effects.

Disasters management mainly aims to:

- Prevention of threat of disasters
- Readiness to deal with disasters
- Saving lives of all living organisms
- Minimize sufferings to the maximum possible extent
- Protect and restore livelihoods
- Minimize the risks and uncertainties to societies affected by disaster

Proper planning and mitigation measures can play a leading role in risk-prone areas to prevent or mitigate the worst effects of many disasters, including cyclones, earthquakes, and floods. Besides, many disasters are predictable before occurrence, so we can prepare ourselves to reduce the damage caused by them. But there are many disasters like flash flood, landslide, drought are unpredictable.

- ***Disaster Preparedness***

Disaster preparedness or disaster management activities are aimed to minimize loss of life and damage in the event of a disaster. Disaster management forces can help by removing people and property from a threatened location and by facilitating timely and effective rescue, relief and rehabilitation at the place of disaster. Preparedness is the only way of reducing the impact of disasters as most of the disasters are unpredictable and even if predicted, there is not much time to act. Community-based preparedness and management should be a high priority in physical therapy practice management. Also, it should be the main agenda of the government to appoint a proper department dealing with disaster management and preparedness. Every municipality must have a disaster management plan as part of its Integrated Development Plans, according to the Municipal Systems Act. The local authorities should be empowered to act as soon as possible in the event of a disaster. It may take time to get relief and rescue operations to start, so in the meantime, it is the role of the Municipal disaster management team to provide rescue work as soon as disaster strikes. Disaster Management has four phases which are narrated below:

Mitigation: Mitigation can be defined as the effort to reduce the loss of life and property in the event of a disaster by minimising the impact of disasters. Mitigation is taking action now before the next disaster happens to reduce human and financial consequences later. Mitigation involves analysing risk, reducing risk and ensuring against risk. Personal mitigation is a key to national preparedness. Individuals and families need to be trained to avoid unnecessary risks. This includes an assessment of possible risks to personal/family health and to personal property. Effective mitigation at the time of disaster requires our understanding about local risks, address the hard choices, and invest for long-term community well-being. Without mitigation actions, we jeopardize our safety, financial security, and self-reliance. For effective mitigation, coordination, planning, and mock activities are very important. Disasters can happen at any time and place; their human and financial consequences are hard to predict, So, preparedness is the only solution.

Rescue: Disaster can strike any place at any time. The response phase of an emergency may commence with search and rescue but in all cases, the focus will quickly turn to fulfil the basic humanitarian needs of the affected population. The assistance may be provided by national or international agencies and organizations, but it is the role of local bodies to act as soon as possible.

Effective coordination of disaster assistance is often crucial, particularly when many organizations respond and local emergency management agency capacity has been exceeded by the demand or diminished by the disaster itself. Rescue operation involves providing medication to those hurt and taking people out of the affected area and debris in the events of earthquake and floods etc. There are various rescue teams at national and state level which come into action as soon as disaster strikes. But it is also better if local authorities are also trained as they have the best knowledge about the geographical location and other local conditions.

Relief: This is a coordinated multi-agency response to reduce the impact of a disaster and its long-term results. Relief operations starts as soon as disaster strikes and the main emphasis is laid on providing injured with medication and providing food as well as clean drinking water to the people. Relief activities include rescue, relocation, providing food and water, preventing disease and disability, repairing vital services such as telecommunications and transport, providing temporary shelter and emergency health care. It is very important to provide relief operations as soon as possible to minimize the number of casualties and to provide relief for injured. The relief workers are trained in basic first-aid and medication and are also given training on maintaining coordination even in the event of a crisis. The relief operation is best supported only when carried out as a teamwork and all the members of the team coordinate well with each other and also support one another without any discrepancy.

Rehabilitation: As soon as disaster strikes the first thing that comes to mind is relief and rescue operations. Once emergency needs are met and the initial crisis is over, the people affected and the communities that support them are still vulnerable and it is time to start rehabilitation activities. Rehabilitation activities include rebuilding infrastructure, health care, and other basic necessities. These should be blended with development activities, such as building human resources for health and developing policies and practices to avoid similar situations in the future. The immediate goal of the rehabilitation phase is to bring the affected area back to some degree of normalcy and to get back to the normal situation as soon as possible. During reconstruction, it is recommended to consider the location or construction material of the property and it should not be hurried rather reconstruction should be done properly and effectively.

Commonly followed methodologies

Under the present sub-theme, any or a combination of the following methodological approaches can be adopted.

Survey**:** This approach would ensure creating a baseline data to be substantiated by field or laboratory experimentation. However, while conducting the survey for collecting personal or sensitive information from an individual, one must adhere to the ethical norms.

Experimentation**:** While conducting either field or laboratory experiments, standard procedures are to be followed, including design of the experiment and having a control group along with the experimental group. Needless to say, replication for validation must adhere to simple statistical requirements.

Ethical guidelines for research on human participants

Research on human participants pertains to a broad range of scientific enquiry aimed at developing generalizable knowledge that improves health, increases understanding of disease and is ethically justified by its social value. Every research has some inherent risks and probabilities of harm or inconvenience to participants/communities. Therefore, protection of participants should be built into the design of the study. Do no harm (non-maleficence) has been the underlying universal principle guiding health care in all systems of medicine around the world. While conducting biomedical and health research, the four basic ethical principles namely respect for persons (autonomy), beneficence, non-maleficence and justice have been enunciated for protecting the dignity, rights, safety and well-being of research participants. These four basic principles have been expanded into 12 general principles, and are to be applied to all biomedical, social and behavioural science research for health involving human participants, their biological material and data.

Details on the guiding principles are available on ICMR_National_Ethical_Guidelines.pdf (https://main.icmr.nic.in/sites/default/files/guidelines/ICMR_Ethical_Guidelines_2017.pdf)

MODEL PROJECTS

Project 1: Water disinfection / treatment using solar energy

Background

Water in sufficient quantity and of good quality is essential for live. Solar Water Disinfection (SODIS) is a simple, environmentally sustainable, low-cost solution for drinking water treatment at household level for people consuming microbiologically contaminated water. Solar water disinfection is a simple method to improve the quality of drinking water by using sunlight to inactivate pathogens (E.coli and Coliforms) which cause water-borne diseases. Sunlight disinfects water through two effects:[i] Radiation in the spectrum of UV-A (wavelength 320-400nm) and [ii] increasing water temperature. If the water temperature rises above 50°C, the disinfection process only requires one hour of solar exposure.

Objectives

- To detect the bacteria by litmus paper test in water samples
- To investigate the effect of sunlight to inactivate microbial pathogens in contaminated drinking water.
- To record the data for solar water disinfection by various parameters

Methodology

Methodology consists of 3 steps. The first step is testing the bacteria before solar disinfection, second step exposing the water sample to solar disinfection and third step testing the bacteria after the solar disinfection.

Step 1:

1. In a glass beaker take 1000 ml of water sample from pond, lake, tap water.
2. Take a litmus paper which detect E.coli from the chemical store
3. Water sample testing before solar disinfection: Dip the litmus paper tip in the water sample and wait for a second before solar disinfection
4. If the paper changes the colour from yellow to pink, there are bacteria present in the water and no colour change indicates the absence of bacteria
5. Record the temperature with thermometer in water sample before exposing to sunlight and record your observations

Step 2:

1. Take a glass or PET [polyethylene terephthalate] bottle of 1000(ml) and fill the bottle with water sample
2. Close the lid of the bottle and expose the bottle to sunlight for 1,2,3,4,5,6 hours
3. Record the temperature with thermometer in water sample after exposing to sunlight for each hour and record your observations

Step 3:

1. After each hour of sample exposure to sunlight dip the litmus paper tip in the water sample and wait for 1-2 seconds till colour of the paper changes.
2. If the paper changes the colour from yellow to pink, there are bacteria present in the water and no colour change indicates the absence of bacteria and record your observations

Table-1: Data recording and observations for water samples treated with solar disinfection for inactivation of bacteria

S No	**Sample collection details (Place name, date, time, season)**	**Quantity of sample collected (ml)**	**Detection of bacteria before solar disinfection in water sample with litmus test paper**			**Solar disinfection exposure**		**Detection of bacteria after solar disinfection in water sample with litmus test paper**		
			Present	Absent	Temp (^{0}C)	Exposure Time (min)	Temp (^{0}C)	Present	Absent	Temp (^{0}C)

Expected outcome

- To identify the water quality problem in their local area
- Learnt sampling method, analysis and treatment of the samples
- Learn to interpret the data and observation, which will be useful for further problem solving.

Project 2: To study nutritional values of food and to carry out comparative analysis of different food items.

Introduction

The translation of human energy requirements into recommended intakes of food and the assessment of how well the available food supplies or diets of populations (or even of individuals) satisfy these requirements require knowledge of the amounts of available energy in individual food item.

Determining the energy content of foods depends on the following:

- The components of food that provide energy (protein, fat, carbohydrate, alcohol, polyols, organic acids and novel compounds) should be determined by appropriate analytical methods;
- The quantity of each individual component must be converted into food energy using a generally accepted factor that expresses the amount of available energy per unit of weight; and
- The food energies of all components must be added together to represent the nutritional energy value of the food for humans.

The energy conversion factors and the models currently used assume that each component of a food has an energy factor that is fixed and that does not vary according to the proportions of other components in the food or diet.

Objectives

- To observe and measure the amount of energy released from different food items.
- To calculate the amount of heat transferred in units of Calories
- To gain exposure to the concept of experimental error and discuss sources of error
- To practice mass and volume measurements
- Suggesting nutritional explanations for experimental results.

Methodology

It is known that the energy that keeps our brain and body functioning comes from the food we eat. Our digestive system and the cells in the body break down the food and gradually through a series of chemical reactions release energy that is used and stored in our cell.

So, it is important to learn the method for measuring how much chemical energy is stored in different types of food. This energy is expressed in Calories (denoted by capital "C"). To measure the chemical energy stored in food, children will oxidize the food by burning it in air. To do this, children will use a home-made Bomb Calorimeter that captures and measures the heat energy, released by burning food. The basic idea of a Calorimeter is to release all the stored energy at once and capture all the released heat with a reservoir of water. Measuring the temperature of the water at the beginning and at the end of the trial will allow the children to calculate the energy used for heating the water. As all this energy comes from the chemical reaction, the calculation will reveal the actual amount of energy released during the reaction, or the energy originally stored in the food. However, this is only true if *all* the energy released during the reaction is used to heat the water, and no part of it gets "lost."

Bomb calorimeters that are used by scientists are made in such a way that *all* of the energy released during the chemical reaction (like burning food) is captured by the water. The home-made version will not reach to that level of efficiency to catch the heat released while burning the food. But, only a fraction of energy stored in the food will be converted to energy that will be captured in the water of the calorimeter. For example, some of the energy might go into heating up the surrounding air instead of the water. Even catching half of the energy released (an efficiency of 50%) is acceptable for a home-made calorimeter, as it is very difficult to transfer all the chemical energy stored in the food and released during oxidation into the water of the calorimeter. Even with low efficiencies children will be able to rank different kinds of food from more calorie to less calorie and will allow them to predict, with reasonable accuracy, the ratio of calorie content of different types of foods.

Now, let us see how to calculate the energy stored in the water for a measured increase in the temperature (in °C). The temperature difference times the mass of the water (in grams) will give you the amount of energy captured by the calorimeter, in *calories*, a unit of chemical energy. We can write this in the form of an equation:

$$Q_{water} = m_{water} c (T_f - T_i)$$

where:

- Q_{water} is the energy in the form of heat captured by the water, expressed in calories (cal);
- m_{water} is the mass of the water, expressed in grams (g);
- c is the *specific heat capacity* of water, which is 1 cal/(g °C) (1 calorie per gram per degree Celsius); and
- $(T_f - T_i)$ is the change in temperature, or the final temperature of the water minus the initial temperature of the water, expressed in degrees Celsius (°C).

The unit calorie (cal) (Small "c") is defined by the heat capacity of water. One calorie is the amount of energy that will raise the temperature of 1 g of water by 1 °C.

When we talk about food energy, we use the word Calorie (Cal) (Capital "C"). It is the amount of energy needed to raise the temperature of 1 kilogram (kg) (which equals 1,000 g) of water by 1 °C. So, one Calorie (abbreviated as 1 Cal) is the same as 1,000 calories, also called 1 kilo calorie (kcal). In this project, for food Calories, the children will have to be careful to use capital "C".

Example of Calculation

Let us start with 100 millilitres (ml) of water in the calorimeter. Since 1 mL of water has a mass of exactly 1 g, so mass of 100 ml of water will be 100 g (m_{water} = 100 g). Let us consider that the initial temperature of the water is 20 °C. After burning up a small piece of food, we measure the water temperature again, and find that the final temperature is 24 °C. Now we have all of the information we need to calculate the amount of heat captured by the water in calorimeter, as given below-

$$Q_{water} = m_{water} \times C \times (T_f - T_i)$$

Given $m = 100$ ml = 100 g

$C = 1$ cal/g^{O}C

$T_i = 20^{O}$C

$T_f = 24^{O}$C

Now putting the values in the above equation we get

$$Q_{water} = 100 \text{ g} \times (1 \text{ cal /g}^{O}\text{C}) \times (24^{O}\text{C} - 20^{O}\text{C})$$

Or, $Q_{water} = 100$ g X (1 Cal/g^{O}C) X 4^{O}C

This can be written as

$$Q_{water} = 100 \text{ g} \times \frac{1 \text{ cal}}{\text{g}\,^{O}\text{C}} \times 4\,^{O}\text{C}$$

Or, Q_{water} = 100 X 1 cal X 4 = 400 cal

For expressing calorie to kilocalorie, which is expressed as capital c i.e.' C', it is to be divided by 1000.

So, 400 cal = (400/1000) Kcal = 0.4 Kcal or 0.4 C

Eating a balanced diet is fundamental for good health. This project will give the children a chance to learn about how much energy our body cells can extract from different types of food. It is important to remember that energy is only one measure of nutritional value.

Materials required for fabricating Calorimeter:

- One large (Approx. 6") cylindrical metallic can having no lid and no bottom
- One small (approx.. 3") metallic can having no lid, but must have the sealed bottom. The small can should be smaller in diameter than the large can
- Wooden stick to hook-in the small tin
- Clay mould or bottle cork
- A glass/ ceramic pan,

- 5-6 number of large size sewing needles/ pins
- 14 gauge craft wire, 6 inch length (2)
- Graduated cylinder, 250 mL
- Immersion thermometer

Children will also need to gather these items:

- Water, preferably distilled;
- *Long* matches or a multipurpose lighter
- Digital scale with 0.1 g increments. A digital scale that would be suitable is the Digital Pocket Scale, 500 g x 0.1 g;.
- Food items to test (dry items with a relatively *high oil content and air trapped in them* will generally work better), for example: Cashew nuts, peanuts, or other whole nuts, Pieces of popcorn, Dry pet food, etc.

Assembling the Calorimeter

Children may use the diagram below (Figure 1) as a guidance to build their calorimeter.

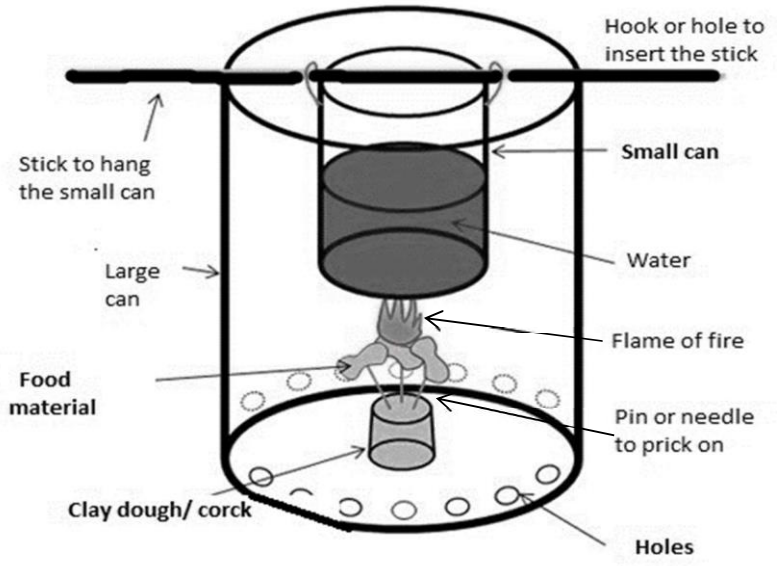


Figure 1. Diagram of homemade calorimeter

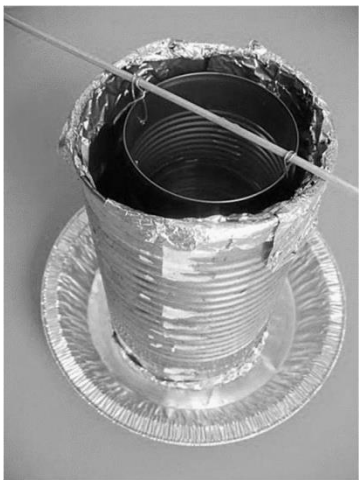


Figure 2. Arrangement of the cans and wrapping inside of the larger can with aluminium foil

Explanatory Note:

1. It is essential to be careful to place the smaller can so that the clay dough, needle, and food item can be placed well beneath it. The larger cylinder is to be open at both top and bottom. If this cylinder is not of aluminium, the inside of it is to be covered with aluminium foil and folding the edge of the foil over the edge of the cylinder, which will keep it in place. Then, make holes around one edge of that cylinder. Space the holes about 4-5 cm apart. Then make holes at the bottom side of the larger can to allow air to come in and sustain the flame. An arrangement is to be made at the brim of the smaller can to pass through the wooden stick to hold the can firmly. For this purpose, no glue to be used, as glue may melt down due to heat
2. Figure 3 shows how to place the needles/ pins in the mould. It is to be noted that the sharp ends to be used for piercing the food to be tested while the other end to be inserted into the dough.

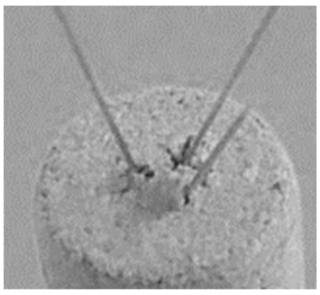


Figure 3. A clay dough with needles to hold the food items to be burned.

3. Extra care is to be taken while placing the dough with the food material, so that the food material should not be far away from the bottom of the smaller can
4. To construct the calorimeter:

i. Place the aluminium pie pan on a heat resistant surface.

ii. Put the cork with needles sticking up in the middle of the pan.

iii. Place the larger can over the cork on the aluminium pie pan.

iv. Hang the smaller can inside the big cylinder.

5. The smaller can will hold the water to be heated by burning the food samples. Use the graduated cylinder to measure how much water fills the can about half-full. Note this value (in millilitres) in your lab notebook.
6. Place the dough with food already pierced in the middle of the aluminium pie pan and light the food items with the long matches. Some food items will need to be in flames before being put under the calorimeter.
7. Calculate 'C' for each food item considered for study using the equation stated above.

Table ; Protein, Fat and Total carbohydrate contents of different food items

Food items	**Protein** kcal/g (kJ/g)§	**Fat** kcal/g (kJ/g)§	**Total carbohydrate** kcal/g (kJ/g)§
Eggs, meat products, milk products:			
Eggs	*4.36* (18.2)	*9.02* (37.7)	*3.68* (15.4)
Meat/fish	*4.27* (17.9)	*9.02* (37.7)	*
Milk/milk products	*4.27* (17.9)	*8.79* (36.8)	*3.87* (16.2)
Fats - separated:			
Butter	*4.27* (17.9)	*8.79* (36.8)	*3.87* (16.2)
Margarine, vegetable	*4.27* (17.9)	*8.84* (37.0)	*3.87* (16.2)
Other vegetable fats and oils	--	*8.84* (37.0)	--
Fruits :			
All, except lemons, limes	*3.36* (14.1)	*8.37* (35.0)	*3.60* (15.1)
Fruit juice, except lemon, lime#	*3.36* (14.1)	*8.37* (35.0)	*3.92* (15.1)
Lemon, limes	*3.36* (14.1)	*8.37* (35.0)	*2.48* (10.4)
Lemon juice, lime juice#	*3.36* (14.1)	*8.37* (35.0)	*2.70* (11.3)
Grain products:			
Barley, pearled	*3.55* (14.9)	*8.37* (35.0)	*3.95* (16.5)
Cornmeal, whole ground	*2.73* (11.4)	*8.37* (35.0)	*4.03* (16.9)
Macaroni, spaghetti	*3.91* (16.4)	*8.37* (35.0)	*4.12* (17.2)
Oatmeal - rolled oats	*3.46* (14.5)	*8.37* (35.0)	*4.12* (17.2)
Rice, brown	*3.41* (14.3)	*8.37* (35.0)	*4.12* (17.2)
Rice, white or polished	*3.82* (16.0)	*8.37* (35.0)	*4.16* (17.4)
Rye flour - whole grain	*3.05* (12.8)	*8.37* (35.0)	*3.86* (16.2)
Rye flour – light	*3.41* (14.3)	*8.37* (35.0)	*4.07* (17.0)
Sorghum – wholemeal	*0.91* (3.8)	*8.37* (35.0)	*4.03* (16.9)
Wheat - 97-100% extraction	*3.59* (14.0)	*8.37* (35.0)	*3.78* (15.8)
Wheat t - 70-74% extraction	*4.05* (17.0)	*8.37* (35.0)	*4.12* (17.2)
Other cereals – refined	*3.87* (16.2)	*8.37* (35.0)	*4.12* (17.2)
Legumes, nuts:			
Mature dry beans, peas, nuts	*3.47* (14.5)	*8.37* (35.0)	*4.07* (17.0)

	Soybeans	*3.47* (14.5)	*8.37* (35.0)	*4.07* (17.0)
	Vegetables:			
	Potatoes, starchy roots	*2.78* (11.6)	*8.37* (35.0)	*4.03* (16.9)
	Other underground crops	*2.78* (11.6)	*8.37* (35.0)	*3.84* (16.1)
	Other vegetables	*2.44* (10.2)	*8.37* (35.0)	*3.57* (14.9)

Note; * Carbohydrate factor is 3.87 for brain, heart, kidney, liver; and 4.11 for tongue and shellfish.

Unsweetened.

§ Original data were published in kcal/g; values for kJ/g have been calculated from calorie values. Hence, in this table, kcal values are given first, in italics, with kJ values following, in parenthesis.

Source: Modified from Merrill and Watt (1973).

Observation table:

Gender			
	Male	Female	
Age Group	0-10 years		
	11-20 years		
	21-50 years		
	Above 50 years		
BMI			
	Underweight		
	Normal		
	Overweight		
	Obese		
Education			
	No education		
	Primary		
	Higehr Secondary		
	Graduate & above		
Employment			
	Student		
	Full time		
	Part time		
	Unemployed		
	Homemaker		
	Retired		
	Unable to work		
	Other		
Marital status			
	Single		

	Married		
	Widowed		
	Divorced		
	Other		
Daily Activities	Sports/Exercise		
	Gardening		
	Walking		
	Office work		
	Labour work		
	No work		

Expected outcome

- They will learn about the balanced diet importance
- Learn about calorific value through calculating practically
- Learn importance of food chain

Additional Project Ideas

1. Correlation between junk food and obesity
2. Nutritive value of local / seasonal fruits / vegetables
3. Study of common / local zoonotic diseases
4. Evaluation of level of essential nutrients in food stuffs
5. Impact of climate change on the diseases of humans and/or plants and/or animals
6. Assessment of animal feeds on production
7. Study of food-system in tribal communities and its impact on their health and well-being
8. Role of public health system on societal well being
9. Study of deficiency diseases and approach to overcome at local level
10. Comparison of balanced diet across cultures
11. Study of methods adopted for physical / social well-being at school level
12. Companion animal health and impact on household well-being
13. Study of nutritional deficiency in the community and means to overcome
14. Analysis of nutritive values of plant-based versus animal-based food for specific ingredient

Sources of information

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Sub-theme III

Social and Cultural Practices for Ecosystem and Health

Introduction

Every society, across the globe, has its distinct social and cultural practices which have been transferred through the generations by various means. These practices are often reflected in the oral traditions and folk culture of the society. For instance, the cultural practice of celebrating the spring harvest in different forms across the societies of India viz. Vishu in Kerala, Bihu in Assam, Vaisakhi in Punjab, Poila Boishakh in Bengal and so on. This is also true with other festivals based on the lunar calendar like the Makar Sankranti. Changing dietary practices according to the seasons are not only integrated but are in sync with the local ecosystem as well as the weather / monsoon of that region. These time-tested practices are based on empirical, cultural and social practices leading to the upkeep and maintenance of health not only of human but also of livestock, including farming practices, dressing, food, housing, livelihoods etc.

The 101 herbs eaten during Bihu, the meal served during Vishu or Vaisakhi, are all said to trigger a robust immune system in human beings. Likewise, there are rituals in agricultural communities across states related to drought animal health. At the same time, only a healthy ecosystem can provide us with the ingredients to follow the rituals. Thus, one can infer that social and cultural practices that have an inherent connection with our ecosystem are responsible for good health.

There are many factors that influence our health. Among them, social, psychological and cultural environments have a big impact. The social fabric of a society, in relation to family structure, different social groups and institutions, develops a social make-up and creates a foundation. On the contrary, cultural beliefs and practices are knitted together with spiritualism, food system, occupational practices, traditional knowledge system etc. By and large, all these are interlinked with nature vis-a-vis ecosystem and health-related practices. Subsequently, social and cultural practices have evolved around an ecosystem with respect to social and cultural values. These collectively form the **intangible heritage** of societies.

Box 3.1. Intangible Cultural Heritage

Intangible cultural heritage includes traditions or living expressions inherited from our ancestors and passed on to our descendants, such as oral traditions, performing arts, social practices, rituals, festive events, knowledge and practices concerning nature and the universe or the knowledge and skills to produce traditional crafts.

While fragile, intangible cultural heritage is an important factor in maintaining cultural diversity in the face of growing globalization. An understanding of the intangible cultural heritage of different communities helps with intercultural dialogue, and encourages mutual respect for other ways of life.

The importance of intangible cultural heritage is not the cultural manifestation itself but rather the wealth of knowledge and skills that is transmitted through it from one generation to the next.

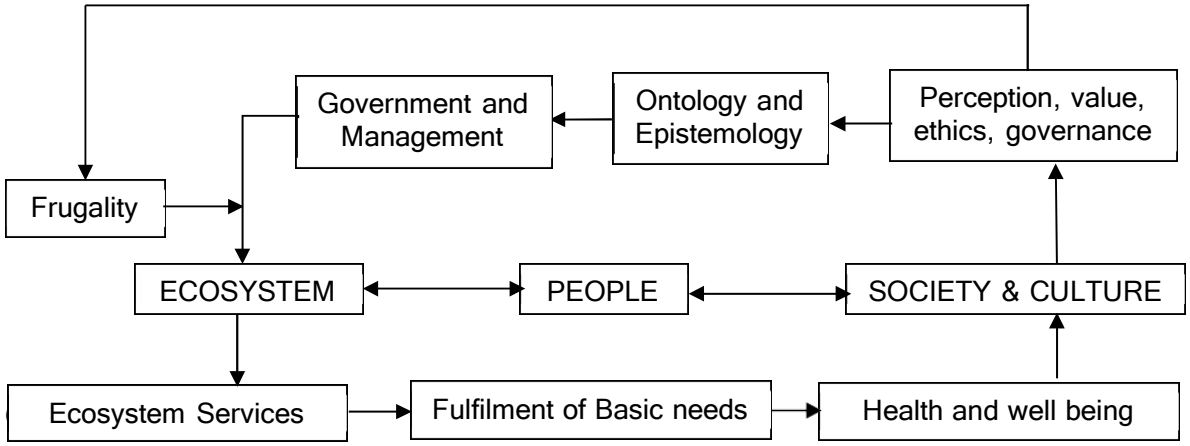
https://ich.unesco.org/en/what-is-intangible-heritage-00003

It is a fact that these practices evolved over the years, through generations, indicating that there was a rich traditional ecological knowledge system (TEK) embedded in these practices. Under this sub-theme, children will explore various social and cultural practices with reference to the health of ecosystems with respect to the wellbeing of human/anima/plants. Children can explore and validate the scientific content of TEK. The various sociological strata and their specific practices that exist in a society with respect to its ecosystem could be yet another point of enquiry.

Impact of migration on synthesis of social and cultural values

In a society, people often migrate from his/her homeland to other places in quest of livelihood and/or several other socio-economic and political reasons for leaving their traditional practices. Such migration often affects the prevailing socio-cultural practices. So, this can be the other interesting area of study to look into the impact of migration on such intangible culture, how much cultural and social values are retained when people migrate. Children can look into how those get integrated into their new habitat, following migration, leading to a synthesis of values/ethics of two entirely different agro-geological areas and entities. This may even be more interesting to study as migrant populations are there in almost all the states making this as a pan-India topic of research.

Logical Framework:



Objectives

1. To explore and document various social and cultural practices with reference to ecosystems and health in relation to various strata of the society and their differential interactions..
2. To validate empirically the Traditional Ecological Knowledge systems with respect to ecosystems and health.
3. To draw the connection between social and cultural practices of a community with the ecosystem services and health conditions.
4. To examine the societal and cultural belief and/or perceptions of communities on various aspects of ecosystem and/or health
5. To study the change in the social and cultural practices or coping strategies in tune with the

changing environment and climate, especially during disasters.

Methodology commonly followed

1. *Participatory Learning Appraisal* (PLA): It is a set of participatory methods which requires the participation of community members. The researcher would go into a habitation/village, mobilise the people and facilitate the tools of the PLA. The set of PLA tools can be accessed through the website mentioned below

   https://herproject.org/files/toolkits/HERproject-Participatory-Learning.pdf.

2. *Participants' Observation*: The young scientist would participate in the cultural process and make detailed in-depth observations of the process.
3. *Focussed Group Discussion* (FGD) The young scientist will mobilise people in the community and initiate a discussion on a relevant topic by asking pointed and specific questions related to the topic. The responses in the FGD will be noted down.
4. *Perception Scale*: The five point perception scale will contain markers that allow numerical measurements. For eg. *Fully Dissatisfied – Dissatisfied – Indifferent – Satisfied – Very Satisfied.* All these points are to be fit in a numeric scale [e.g. 0-5 or 0-10] to transform the responses into numeric values.
5. *Interviews*: The young scientist will prepare an interview schedule with open and close ended questions.

Scope

Our health, be it mental, physical, or psychological, and well-being are directly related to Social and Cultural practices. In addition to this, the traditional knowledge systems have indicated that these practices has a direct implication on the health of the ecosystem Thus, there is a need to understand the relevance of the socio-cultural practices in relation to health and ecosystem.

BOX-3.2. Social determinants frameworks

Social determinants frameworks focus on understanding the circumstances in which people live and work that shape their health outcomes [1]. These circumstances (social determinants) are believed to drive many deep-rooted world health inequalities, such as lower life expectancy, higher rates of child mortality, and greater burden of disease among disadvantaged populations [1]. Social determinants frameworks build upon the concept of the "social gradient"–that individuals with lower social status have greater health risks and lower life expectancy than those with higher status, and that the impact of social position can accumulate over time [2]. Observed differences in social determinants are thought to develop from unequal distribution of resources [3]; thus, they can be reduced through targeted social and economic policies and programs.

Source: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6181118/

Social Practices

Social practices are the habitual activities that structure the lives of communities and groups and are shared by many of their members. (UNESCO, n.d.)[2]. Social practices have a lot of significance in shaping the identity of societies. Few ways in which ecosystem features in the social practices of communities are in the form of Environmental Ethics, Resource management, Resource Distribution, Resource Use Pattern, and Traditional Ecological Knowledge.

Environmental Ethics	The conceptual foundations of environmental values which include societal attitudes, actions, and policies to protect and sustain biodiversity and ecological systems. [1]
Natural Resource management[2]	The management of supply and access to natural resources such as land, water, air, minerals, forests, fisheries, and wild flora and fauna by the community.
Traditional Ecological Knowledge	Evolving knowledge acquired by local communities over hundreds or thousands of years through direct contact with the environment.
Resource Use Pattern	The pattern in which different groups of people use the natural resource. e.g. a village pond may be used by the fishing community to fish, cattle herders to bathe the cattle, washing clothes by women etc.

It is important to note that certain social processes reflect the social stratification embedded in the society in the form of caste, class and gender. Children, while looking at the processes must also observe these strata. Social processes, if examined carefully, can illustrate the existing hierarchies in the society. At the same time, it may also reveal practices of assimilation, cooperation and accommodation.

Some examples

Communities often have rituals around any natural resource, such as Forest or a water body. It is also seen that the role of different social groups is different while following the rituals. The same is reflected in the use of the resource also. Is everyone in the village getting an equal share of the resource? If not, what are the reasons? Is there any gender specific role for women while conducting the rituals?

Another example could be the case of a village midwife having rich traditional knowledge. It was observed that with the coming of modern health systems and encouragement by the Government for Institutional births, the midwives are becoming irrelevant. Does this reduce the relevance of the Traditional Knowledge systems in this community? Will the people be less interested in the local medicines now? Or, does one see members of a particular class moving away from TEK?

Social Practices are observed in Local Governance Mechanisms and Natural Resource Management systems as well. In many villages of India, there are established grazing systems. Mesi

Lakhor is one such grazing system followed by the Rabha Community in Assam. One or two persons are entrusted with the responsibility of grazing and looking after the cattle. There is a common place where the cattle are kept in the summers to protect them from the heat. They provide the cattle with water. The appointed persons are compensated by rice per cattle. The important point to note here is who are these appointed grazers? The village collectively choses these persons form landless families. It's a social process which reflects the collective responsibility of the village towards the landless. [3]

In this manner, children can explore more such social processes and examine the intricacies.

Cultural Practices

Culture is defined as "a set of distinctive, spiritual, material, Intellectual and emotional features of society or a social group that encompasses, not only art and literature, but lifestyles, ways of living together, value systems, traditions and beliefs' (UNESCO, 2001).

India is a land of festivals. Each state is a part of colourful nation and joyous celebrations. Some are harvest festivals, some are based on religious beliefs. For instance, Makar Sankranti festivities are marked in different ways across North India such as through kite flying in Gujarat and parts of Rajasthan, Pongal in South India. People show gratitude to Mother Nature..Baisakhi, Lohri, Onam, Bihu, Nuakhai etc. are also harvest related festivals. Nuakhai is an important social festival in Western Odisha and neighbouring areas of Simdega in Jharkhand. It is celebrated at both domestic and community levels. Wangla (a post harvest festival of Garo tribe), Nabanna (West Bengal), Ka Pomblang (Khasi people of Meghalaya), Agera (Thanksgiving harvest festival), Dree Festival (Apatani tribe in Arunachal Pradesh celebrate three day long agricultural festival) are few examples. All these festivals bring social harmony, enrich social bonding, increase psychological well-being and also give a message for our environment and ecosystem.

Cultural practices involve the set of knowledge, beliefs, rituals and customs. It is often seen that the patterns in culture and science are related to each other. These are strongly associated with various life processes of the human being and can be examined from multiple angles.

Cultural practices provide good space to understand the intricate relationship between nature and human beings. These practices can be studied, validated and highlighted to further ecocentric ideal[4]. For example, in any worship within a polytheistic tradition[5],[e.g.Taoism, Hinduism etc.] one finds the use of several biotic components, including the use of Bel Patra (Leaves of *Limonia acidissima*), Durva grass (*Cynodon dactylon*), Mango leaves (Leaves of *Mangifera indica*), etc. All these plant species have a significant role to play in the ecosystem and in maintaining the health of human beings due to their known medicinal properties. Hence, communities are more cautious to preserve these plants for ecosystem security and wellbeing. In other words, certain cultural practices become the gatekeepers of Human and Ecosystem Health.

Cultural practices, on the other hand, can also reveal the stigmas and taboos associated with certain human health conditions. Several reports are available on the cultural practices followed

by certain communities to address mental health issues. The taboos associated with menstruating women in several societies are also to be taken note of. Cultural practices on menstruation reflect gender based discrimination such as they are not allowed to access public life during the menstruating days and thus gets excluded from crucial social gatherings/processes including key decision making processes. Same is also true for certain superstitions against vaccination which is irrespective of the economic status of a family and this was evident from the recent Covid pandemic as well where higher death rates were reported among those who were not vaccinated.

Looking at the culture objectively, one would be able to reveal values and beliefs held by members of the community from generation to generation. The repositories of traditional knowledge systems are reflected in cultural expressions of communities. Sustainable natural resource management is also driven by the beliefs and behaviours of human communities. Furthermore, cultures are strengthened by intimate connection to the natural environment (Rist *et al* 2003) and nature conservation is often seen as a cultural practice.

In Chamoli District of Uttarakhand, it is a standard practice that the newly married couple plant a sapling at the bride's house. This can be seen as a traditional way of forest conservation to prevent landslides and erosion.

Similarly sacred groves are protected, worshipped and invariably remain as a part of the culture, The limited access to sacred groves ensures protection to the small water bodies near the sacred groves which provide water during the drought months (Kandari et al, 2014).[6]

Presence of flora and fauna in different ecosystems /cultures and their management and use are important areas of study. For example, tribal cultures have specific ***totems*** (objects such as an animal or plant serving as the emblem of a family or clan and often as a reminder of its ancestry. In mythology, deities are associated with an animal/bird vehicle/accomplice which signifies Importance of animals in our societies and thereby signifies their conservation. In certain societies, some species has a totemic[7] significance.

Some areas of study that child-scientists could undertake are : What are the different totems? What is the significance? Does it have any role in the conservation ethic pertaining to the said species? What is the oral tradition (folklore, folksong) for the said totem?

BOX-3.3.Examples of Cultural Practices:

- Festivals and feasts
- Crop Management practices
- Fabrics and Textiles
- Housing and construction
- Religious and spiritual practices
- Medical treatment practices
- Forms of artistic expression
- Culinary systems
- Nature Resource Management systems

In the subsequent section, a few from the list are elaborated upon.

Fasting and Diet-related Practices

Religious fasting or intermittent fasting has been a part of various cultures. Various fasting styles can directly affect circadian biology, gastrointestinal microbiota and also lifestyle behaviour. Our lifestyle and nature of work has a direct impact on our health. Sometimes overeating leads to obesity; on the other hand, consuming less amount of food or improper balanced diet may lead to malnutrition and under-nutrition. Religious fasting is observed in cultural practices like the Ramazan, Chhath, Navratri, Easter and other festivals. The fasting practices reflect an effort of humans to connect to the tandem of nature. Additionally, the health benefits of fasting are well known.

Food is central to the cultural and religious practices of most communities. For this understanding and appreciating the food and food practices of another culture is a part of building our own cultural competence as food is directly related to what can be grown in the local ecosystem and closely related to lifestyle/health etc.. What people eat is also important to their long-term health.

Cultural cuisine

It is a specific set of cooking traditions and practices, often associated with a specific culture of a region. It is primarily influenced by climate, local agriculture and locally available ingredients. Food is often used as a means of retaining the cultural identity of any society. People from different cultural backgrounds eat different foods. What we consume, how we acquire it, who prepares it, has a rich cultural base besides local climate and ecosystem. Food apart from nourishing the body, what we eat and with whom we eat can inspire and strengthen the bonds between individuals, communities and even countries. Food reflects cultural connections between different societies as well. For example, there are several herbs consumed by communities in North east India which are common to south East Asian cuisine. The fish mint herb (*Houttiyniya cordata*) is one such example. Another example could be coconut oil being used in Kerala and mustard oil in north India etc. being linked to locally available sources and climatic conditions etc.

Food Preservation

The reason for food preservation is to use food or food products for prolonged /future use in order to prevent food from spoilage due to microorganisms. It also assures the availability of food in those areas and seasons where that particular food or vegetable is not grown. Preservation makes the off-season availability of vegetables, fruits, meat etc.. Some of the methods of food preservation are sun drying, refrigeration, and fermentation, smoking, pickling (use of salt/citrus fruits) and drying or a combination of these methods. Pickles, jams, jellies, jaggery (Gur) making are a few more examples of preservation.

Traditional dietary practices

It includes the centuries old “Thali” concept, emphasising the combination (grains, lentils, vegetables, dairy, spices, prebiotics and probiotics and fats) of local seasonal and predominantly plant based ingredients. These practices ensure that all the necessary food groups are provided and fit-well with the current evidence-based recommendation of ISPAD (International Society for Paediatric and Adolescent Diabetes 2018),. Techniques of preparation, cooking and preservation of food impacts gastrointestinal tract and nutrient availability and assimilation.

BOX-3.4. Sadhya: A feast of wellness

It is one of the finest formal meals of the Indian culinary book, Sadhya is an excellent presentation of not just the food of Kerala and its local produce, but also our traditional wisdom of well-being.

The feast was designed to showcase the produce of a new harvest, most dishes are simple with flavourings and techniques used only to enhance the quality of local produce. All 28 dishes come with its powerhouse of nutrients such as vitamins, minerals, antioxidants and proteins.

(https://www.traveldine,com/food-drinks/sadhya-onam-meal-feast-of-wellness)

Crop Management

Cultural practices in crop production and management techniques are utilised by farmers to maximise their crop productivity. It includes decisions on crops to be cultivated, time and ways of planting, tillage, field and crop sanitation, application of fertilisers, irrigation, harvesting time etc. The manipulation of these practices including reducing and/or avoiding pest damage to crops is known as cultural control of pests.

Management of pests by cultural practices include deep ploughing during summer leading to the expose of pupa in the field, pruning of twigs or branches to eliminate borers in mango and citrus, crop rotation, intercropping of trap crops (Marigold is a trap crop for Tomato) and many others. Clipping of tips of rice seedlings before transplanting avoids the chance of stem borer to lay eggs. Children can explore cultural practices pertaining to Nutrient management (e.g. high levels of nitrogen fertilisers increase the incidence of insect pests, water management, sanitation (e.g. de-trashing of dry sugarcane leaves reduces the attack of leafhopper etc. Furthermore, young scientists can also enquire into the gender role in crop practices.

BOX-3.5. GI Tag

Geographical indication (GI) is a sign used on products that have a specific geographical origin and possess qualities or a reputation that are due to that origin. e It is an intellectual property of that region. India has huge fame in the International Platform with around 365 GI Tags. GI Tags are given to food stuffs, handicrafts, agricultural products, and Industrial products. Few of the GI Tagged food products are Darjeeling Tea, Kashmiri Saffron, Bikaneri Bhujia, Bangalore blue grapes, Sirsi Supari, Silao Khaja, Gobindobhog Rice etc.

Fabrics and Textiles

The Indian handloom industry is deeply embedded in the socio-cultural tradition with a rich heritage of skill that needs to be preserved, perpetuated and promoted. These handloom fabrics and textiles are known from ancient times. We have regionally different varieties of handlooms like Ikats from Andhra Pradesh and Odisha, tie and dye from Gujarat and Rajasthan, brocades from Banaras, Pashmina from Kashmir and many more. In fact, Textiles of a country are a part of its social fabric, cultural and everyday life. Fabric pattern also symbolises socio-cultural identity. Vibrant colours and intricate techniques combined with environment-inspired motifs show the synchronisation of life with nature.

In some of the paintings, natural pigments obtained from flowers, leaves, barks of local trees and chemicals obtained from clay and river sands for the fabrics are still used. These textiles evolved over time according to resource availability and climatic conditions. Tribal textiles of India are a symbol of community bonding culture and legends for ages. On the other hand, indigenous textiles are an integral part of our culture. Indigenous garments are symbols of pride and depict our cultural richness. Natural dyes due to its unique character of natural origin are known to be eco- friendly. The synthetic mordanting agents (Salts of chromium, aluminium, copper, iron, tin, and cobalt) are not eco- friendly, some are toxic and harmful for the environment. Natural dyes can be of three types, as shown below (Table- 3.1)

Table- 3.1. Types of Natural Dyes .

Vegetable origin	It may be obtained from seed, root, stem, bark, leaves and flowers.Various examples are curcumin, Hina, Indigo, Madar, Morein (from jackfruit), Safflower, onion (Papery skin), Saffron etc.
Animal origin	From Cochineal insect and Lac insect
From minerals	Ochre (a kind of Iron ore used for yellow, brown and red colour), Malachite (used for green colour), Azurite (for blue colour),etc.

BOX-3.6 IKAT; Weave with a Mathematical twist

IKAT is an ancient weaving tradition that is at least thousand years old. The Ikat weave is very distinct and ranges from geometric patterns to abstract designs. A common element of this design is “fuzzy” or “blurry” effect, which is the signature element of the textile. Ikat employs mathematics to achieve its fantastic design symmetry. Although a craft, Ikat is also a precise science. The intricacy of the craft needs mathematical calculations and the design needs to be laid out on graph paper.

It is important to note that pigments and dyes traditionally derived from plants and minerals were used to dye the yarn. This includes the rich blue from the indigo plant, deep red from madar roots, blacks from pomegranate seeds, etc. It is also known by different names in the different parts of India- Bandha in Odisha, Patola in Gujarat and Paagadu Bandhu in Telangana.

The motifs of Ikat are also deeply inspired by nature and wildlife. The soft cotton fabric dyed naturally, is appropriate for the tropical weather conditions. It reinforces the interface between nature and human interactions.(https://www.livehistoyindia.com/story/living-history/ikat/)

There is a symbiotic relationship between habitats and culture and between ecosystem and cultural identity. Indian paintings, sculpture and decorative art is replete with themes from nature and wildlife reflecting love and reverence for nature. This resonates with the ethics of conservation embedded in the cultural practices. Example, Mithila painting, Suzani art, Applique work, Stone art etc.

Housing and Construction

Traditional methods of housing and construction are mostly eco-friendly and sustainable. The practice of living in an open space as "*aangan*" for multipurpose work has an important role in maintaining family harmony; so is the concept of *Nadu Mutram* (central courtyard) or *Thinnai* (Tamil architecture) etc. The open space can extend to a homestead space for local herbs and vegetables, which is known as 'kitchen garden'.. This concept of a small kitchen garden or a flower garden was in harmony with the ecosystem. We can say that proper design of housing and construction can keep us healthy. In places receiving heavy rainfall. Traditional water harvesting systems are a part of the architecture. Certain cultures have specific spaces in the house or the compound designated for specific purposes. Also, the knowledge system is concerned with the direction of sunlight and wind. For example, kitchen located in the south-east part attracts strong sun and keeps the space dry and germ free.

Children may explore the traditional architecture in their local areas and understand its significance with reference to the climatic conditions and wellbeing.

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4. Ecocentric approach refers to a nature-centered approach as opposed to a human-centered approach
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Model Projects

Project 1: Social and Cultural practices related to coastal fisheries and its impact on local marine resources

India has a long coast-line along the eastern and western sides.. More than half of these 6,000-km-long mainland Indian coast is under threat from coastal erosion and hence there is a large shift from small fishermen to organised trawler-based fishing community that needs rephrasing. Coastal marine ecosystems are unique and what is happening now in terms of ecosystem destruction calls for localised documentation and creating awareness among the stakeholders is of utmost priority and need of the hour.

Though coastal-ecosystems are prone mostly to local environmental changes, children can study the stability of the local coastal ecosystems especially fish availability, sustainable fishing, fish-processing techniques followed by traditional small-fishers, seasonality of catch across seasons and lean season for fishermen and coping mechanisms adopted by fishermen communities.

Objectives

1. Mapping of fishermen's dwellings available social spaces for net-drying, keeping boats, space for boat repair, fish drying etc. and see the interconnectedness and utility in terms of access/convenience.
2. To study a seasonal mapping of fish-catch, biodiversity and species wise quantum across months and assess the peak and lean seasons and correlate the same with festivals, family functions (marriage and other social gatherings).
3. To study the HTL(High tide lines) and LTL(Low tide lines) over a lunar cycle and study the variation as well as study historical information of any coastal erosion and damage to property etc. during cyclones.
4. To study coping mechanisms of fishers during disasters, extreme events in safeguarding the lives, assets (nets/boats/other valuables) and as well as during lean seasons.

Methodology

1. Selection of a fisheries hamlet and study the population/demography/literacy level/livelihoods profile etc. using a HH based questionnaire.
2. Mapping of the community space using easily available GPS apps (GPS Essentials) and map out residential areas, community spaces (storm-shelter etc.), common space for fish-drying, net-dis-entangling and drying cum repair, boat-parking and periodical maintenance etc. and see their utilitarian scope in terms of convenience, easy access, safety etc.
3. Through personal interviews as well as observing daily catches recreate an year-long calendar of fish-catch, which species are available in which seasons, biodiversity of catch, peak and lean seasons, price of each type of catch, market/trading mechanism for each type (local / state/interstate/international etc.)

4. Mapping of High and Low tide lines and tidal studies carried out a month (based on lunar cycle) and correlating this with the time at which fishers venture into the sea/ availability of fish etc.
5. Historical timeline study on coastal erosion if any using any existing building as a marker and also any major tidal incursions during the past 40-50 years based on oral history.
6. Study the coping mechanisms of fishers during lean seasons (access to credit / food/ alternative livelihoods / fish-vending by fisher-women etc.

Project 2: To study Dietary Regime of the area and its linkage with ecosystem

Background

Balanced diet plays an important role in keeping our health fit and fine. Our dietary habits change from place to place, person to person, gender wise, age wise, economic status wise, availability of food, festivals, types of crops grown. Sometimes misconception or food fad may lead to different dietary habits and affect our health.

Objectives

- To study the dietary regime of a community and see how balanced (or not) it is.
- To look at BMI as an indicator and correlate the same with the diet pattern mapped to those whose diet study has been carried out.
- To map the physical activity in terms of routine household activities / exercises / sports / games or other outdoor activities including physical labour.

Methodology

i) Choose a different group of people- it may be age specific, gender specific, economic status wise. This group may be even of your school or class.

ii) Ask them about the type of food consumed in the last 24 hours (Diet recall method). Calculate the nutritional value of food (in calories) consumed per day. Repeat the exercise every 15 days. Also assess how much of the diet is linked to local ecosystem/production and how much comes from outside the agro-ecological boundary.

iii) Assess the physical activity of the same group above - Categorise them as light, moderate, intense - and also time in each category.

iv) Assess the BMI of the same group and classify as obese, overweight, normal and below normal based on available scales for Indian population.

v) Correlate the BMI, diet and physical activity regime and also carry out a survey on existing knowledge of any NCDs (this is optional).

vi) Counselling of different BMI groups for appropriate interventions and review data after 3-4 weeks to see if there is any change in the data.

24 hours Diet Recall

S.no	Timings	Food items with quantity (e.g. 3 chapati/idly, 1 cup of dal/sambar, rice, vegetable, milk, egg, fruit etc.) Be specific!!
1	Early morning (time.....)	
2	Breakfast (time.....)	
3	Midmorning (time.....)	
4	Lunch (time.....)	
5	Evening (time.....)	
6	Dinner (time.....)	

Based on the above data: calculate the total calories consumed (refer calorific values of common indian dishes / cftri / national institute of nutrition).

Physical activity mapping

What type of physical activities are you engaged in? 1. Yes & 2. No

Sl. No	Types of physical activities	Time spent (hrs)	Light/ moderate/ intense
1	Skipping		
2	Cycling		
3	Running		
4	Walking (including coming to school)		
5	Swimming		
6	Yoga/martial arts / (specify)		
7	Other (including games/sports) other than school		

Do you have any hobbies/ recreational activities? 1.. Yes 2.. No

Sl.no	Types of recreational activities	Time spent (hrs.) Daily/ & weekly
1	Gardening	
2	Drawing /painting/ artworks	
3	Reading/music/others (specify)	
4	Caring for pet animals.	
5	Computer/mobile games/tv time	
6	Any other specify how much time do you spend on household work?	

Summarised data table

Day	Breakfast		Lunch		Dinner		Calories
	Protein	Carbohydrate	Protein	Carbohydrate	Protein	Carbohydrate	
1							
2							
3							
4							

(You may add one more column for snacks or extra diet and calculate calories)

Conclusion

i) From the data collected, we can learn about the existing diet followed by a community and also assess how much of the diet comes from local production and how much comes from outside (food-miles)

ii) From BMI we can conclude about the overweight, underweight or normal weight people and make them aware about various health issues.

iii) Follow up: Vulnerable groups like overweight / obese can be screened for NCDs (Non Communicable Diseases) - linkage with local PHC. Malnourished / undernourished can be advised for diet modification with inclusion of an additional fat/protein depending on affordability / or linking to existing govt. schemes by referring to PHCs/Health workers like ASHAs etc.

Project 3: Green glories for Health and Fitness and their linkages to local ecosystems.

Background

In Indian food, green leafy vegetables *GLVs), commonly known as,*'saag or 'saak"* (Keerai/Cheera/soppu etc in South India) hold a special place for both its taste as well as medicinal properties. It is an important part of a healthy diet. They are packed with vitamins, minerals and fibre but low in calories. Eating a diet rich in leafy greens can offer numerous health benefits including reduced risk of obesity, heart disease, high blood pressure etc.. In fact, through ages, most traditional recipes include *Saag*. The type and amount of the leafy vegetables, especially in rural areas, depend on seasonality and availability in the specific ecosystem. Moreover, at the beginning of the local calendar,the leafy vegetables become an essential part of a family's diet, which is a part of Indian culture..Consumption of green leafy vegetables somewhere reflects our tradition too. In this project, children will try to understand the role of the local ecosystem based on nutritious green leafy vegetables and their availability season-wise..

Hypothesis:

Green leafy vegetable has no relationship with culture and health

Objectives

1. To understand leafy vegetables as traditional food and its relation with the specific culture and society.
2. To identify the type and varieties of green leafy vegetables, their seasonal availability and their importance in the local ecosystem.
3. To study science behind inclusion of *Saag* in our regular diet in the light of health and nutrition
4. To study the interlinkages of the green leafy vegetables with tradition, festivals and health-practices.
5. To prepare a herbarium of the available green leafy vegetables in one's locality.

Methodology

1. Identify an area in the village where green leafy vegetables grow wild and/or are cultivated.
2. Using standard quadrant method find out density and frequency of different leafy vegetables
3. Classify the GLVs based on their seasonality / traditional festivals and prepare a seasonal calendar with GLVs availability, festivals, harvesting seasons, disease-occurrence etc. and establish correlation.
4. Classify as herbs, shrubs, creepers and runners and also prepare Herbarium
5. Document from elders the medicinal values/properties of the GLVs and their various plant-parts. the knowledge of the elders via-avis traditional knowledge, specific to GLVs and their benefits, is to be cross-checked with available research (secondary) data for validation.
6. Study impact of GLV-concentrates on children of low BMI with a control group. From a group of willing-to-participate/parental consented children, anthropometric measurements of height and weight are calculated and BMI values are arrived at. Based on the Indian Pediatricians Association's recommended values of age-specific standard, a group of same percentile children are selected and given GLV inputs and their condition is checked after about 8 weeks. Same BMI percentile control group is also maintained for cross-referencing.

Table- 3.1 Details about leafy vegetables

Sl No.	Common name	Scientific name	Relationship with Tradition/ Culture	Nutritional Value (Traditional vs secondary data)
1.	Noni Saag	*Portulaca deracea*	Jitia Festival	
2.	Kado Saag	*Limnophila rugosa*	Karma festival	

3.	Asaria	*Capparis zeylancia*	In rainy season (prevents from disease)	
4.	Munga Saag	*Moringa olefera*	Chaitra Sankranti	
5.	Poi saag	*Basella alba*	Nawa Khawa Chatth festival	
6.				
7.				

- Tabulate the data and critically look into it for a meaningful conclusion in relation to ecosystem,health and culture.

Relevance

Children will understand the values, importance and necessities of taking *saag* as one of the essential vegetables including their seasonalities.

Project 4. Study on soil loss during manual harvesting of many vegetable crops.

Background

It is known that soil erosion is a gradual process that occurs when the impact of water, wind or other mechanical processes detach and remove soil particles from its original position, causing deterioration of soil health. Besides natural processes, erosion is also caused and/or enhanced by human being in several ways. One of such activities is harvesting of vegetable crops, mostly root crops (e.g. potato, raddish, onion, etc,) and leafy vegetables (e.g. spinach, amaranthus, coriander, etc.). In large plots, erosion due to mechanical harvesting of crops by hand pulling is, although, not remarkable, but in small plots (kitchen garden)/ pots it matters a lot. Because even such a small amount will affect soil health in such a tiny plot or pot. However, since harvesting by pulling is a practice in our society, through this study children will be able to understand the loss of soil (erosion) from the place of its actual site and will also know its dependance on the root volume.

Hypothesis

Technique of crop harvesting does not affect loss of soil

Objective

1. To study the different methods of harvesting various vegetable crops from the field
2. To understand the amount of soil lost by methods harvesting, especially hand pulling, of different vegetable crops
3. To find out relationship between amount of soil loss and the volume of roots of different crops

Methodology-

[A] Growing of crops

Step-1. Choose 4-5 types of quick growing vegetable crops viz. Spinach, Amaranthus, Coriander, Lettuce and Mustard [as leafy vegetable].

Step-2. Collect good quality healthy seeds of the chosen crops

Step-3. Choose an area of 5x5 m, preferably in the kitchen garden

Step-4. Get help of an adult to till and clean the land for sowing the seeds

Step-5. Divide the big plot in 15 number of 1x1m plots [5 crops to be repeated three times]

Step-6. Sow five seeds, as per advice of the guide teacher,in 5 plots separately. Cover the seeds properly. Note down the date and time of seeding and also the amount of seeds per plot [this may be in number also].

Step-7. Irrigate as and when necessary

Step-8. Allow them to attain harvestable sizes [it may take 4-5 weeks]

[B] Soil loss and other studies

Step-9. Keep 2lit capacity bowl-shaped 3 containers [metallic/polyethylene] of same size. Weigh one bowl, which will be true for all if material and sizes are same; otherwise all the bowls have to be weighed separately and the values to be noted down accordingly

Step-10. Get another container to fill it with 1L of water [weight of 1L of water is 1 kg or 1000g]. So, the weight of the bowl (X g) + weight of 1L (1000 cc= 1000 g) will be the initial weight (Wi) or Wi = [1000 + X] g

Step-11. keep half of water (500 cc) in the bowl

Step-12. Start harvesting by hand pulling under the guidance of an adult. Preferably harvest one type of crop in a day during morning or evening. So, it will take 5 days to harvest all the five crops. Pull 3 plants from a plot and dip the plants with soil in the water kept in the bowl. Wash the soils thoroughly using the rest of the 500 ml of water. Thus total water used is 1litre..

Step-13. Keep the plants with proper labelling separately. Separate the roots just below the vegetative part using a knife. These are also to be kept apart with proper labelling.

Step-14. Weigh the bowls with water and soil. This will be the final weight (Wf)

Step-15. Calculate amount of soil by subtracting Wi from Wf and also calculate the amount of soil lost per plant, which is given by -

Soil loss per plant (Sl) = $[W_f - Wi]/3 = [W_f - (1000 + X)]/3$,

Where, X is the weight of bowl

Step-16. Use a graduated cylinder and measure the volumes of the dissected roots by displacement method. Get advice from the guide teacher, if necessary.

Step-17. Compare among the plants with regard to soil loss per plant and also calculate the amount of soil loss from farmers' fields who use such a process of harvesting.

Step-18. Find out empirical relation between soil loss and root volumes and explain through graphs.

Relevance

Children will visualise the loss of soil from a large area, which depends on the root volumes and surface areas

Project 5: Assessment of drinking water waste during social gathering/festivals

These days in most of the social functions drinking water is served in disposable plastic bottles. It is known that drinking water is precious and is increasingly becoming a scarce resource. It has increasingly become a habit to use packaged drinking water instead of drinking water from public taps or carry water from home. Our children and also most of the educated persons today instead of carrying water bottles from home, purchase bottled water from the market. Such a habit is in no way good or a sustainable practice. Also in social programmes, bottled water is served both in urban and rural functions replacing in most cases, dispensing of water from the jar. It is often seen that a large number of people do not consume the whole water in the bottle, but rather leave the unused water in the bottle which later is dumped in the waste bin. Keeping in mind the water price and availability, it is essentially required to take a stock of such sort of wastage, which is the prime objective of this project.

Hypothesis

No amount of drinking water is wasted during any social function.

Objectives

1. To determine the amount water consumed by the attendees in a gathering
2. To find out amount of water got wasted or left unused during the period of function.
3. To estimate the waste water in terms of money and carbon foot-print

Methodology

Study area/ site is the school of the children, where they study.

Step-1. Chose the children of a class having (say) 100 pupils if needed from multiple sections (with an equal mix of boys and girls)

Step- 2 (a) On the previous day of the study, instruct the children of the selected classes categorically not to bring any drinking water bottle from home and that they will be served drinking water by the project team/school on that very day.

(b) Also alert them not to drink water from the drinking water sources of the school

Step- 3. Arrange two different water dispensing systems in a safe place, easily accessible to the children (a) sealed bottled water and (b) a normal dispenser (control) along with dispensing glass with volume-gradation.. Maintain a reasonable distance between the two systems to make a note on their affinity towards the types used.

Step- 4. Provide marker pens at the side of both the sets. Make an arrangement to keep the markers in place after its use by each of the children and those should be available to the children at ease.

Step- 5. Use a board written on it 'This water is strictly for the students of class …'

Step- 6. Place two bins at the side of two system for putting the used bottle or glass separately

Step- 7. Deploy a responsible custodian to keep constant watch on the whole exercise.

Step- 8. Prior to beginning of the study the children should be given following instructions –

(i) They are free to drink water, whenever they feel thirsty

(ii) There are two dispensing systems, placed at ….. and they can drink from any one of the two.

(iii) Whether it is a bottle or a glass, at the bottom of the used bottle or glass, each and every one should put a mark at its bottom – '**+**' for the girls and '**–**' for the boys.

(iv) In the case of a bottle, it must be capped tightly and put in the bin after putting a mark. In case of glass, after putting the mark the used glass to be put in the bin with care so that no residual water is dropped outside the bin.

Step-9. The process will continue as soon as the child enters the school and will continue till the school is closed for the day. But, there should be kept some additional **bottles** and water jars to be provided in case the stock provided is finished; but a record on the number of bottles provided a second time and/or the amount of water in the dispensing system. These values will be added in the final calculation.

Step-10. (i) Take out the bottles and note down the number of '**+**' and '**-**' signs. And note down the reading in the log-book.

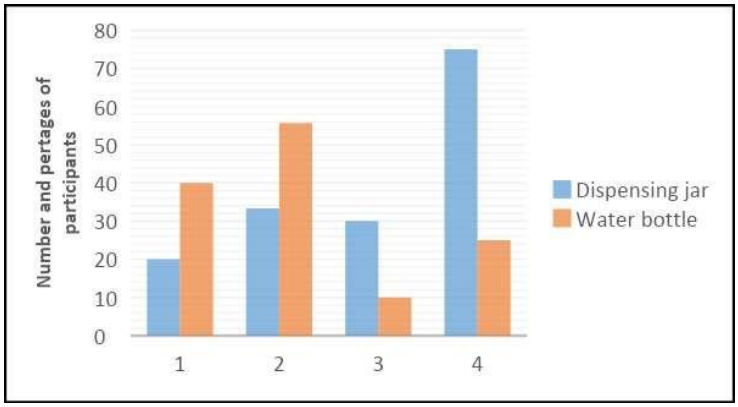
(ii) Carefully take out the glasses so that no water from the glass or bin gets spoiled. And then in a similar way count the marks and note down.

Step-11. Put the data in the following table. Here it is assumed that the total number of children are 100 with 60 boys and 40 girls for the sake of calculation. Use actual numbers while carrying out the study.

Water distribution system	**Male**		**Female**	
	Number of markings	**Percentage to the total male**	**Number of markings**	**Percentage to the total female**
Dispensing jar	20	33.33	30	75
Water bottle	40	66.67	10	25

Note- assumed that all the pupils of the class were present and took part

Step- 12. Data can be represented graphically and then compare the users by sex (male or female**)** and system.



Step -13. Using measuring cylinder measure the unused out water in both the system

Step- 14. Calculate the percentage of water wasted out of the total amount of water.

Example- Let 1L of water was allotted per head and it is considered that there are 100 number of pupils So, total amount of 100 L of water was made available in both the system Considering the fact that a child will not be able to use either 1 L or 500 ml bottle at a time, 200 ml bottles were used. So, 5 such bottles per head was made available.

- Let us say amount of water wasted in (i) dispenser = 5 L and (ii) bottle = 10L
- From the data above, 5L was wasted by 50 users (20 boys +30 girls) who used the dispensing jar and 10L was wasted by 50 users (40 boys +10 girls). Thus per-capita wastage of water in the dispensing system is 5L/50 users which is 0.1L or 100 ml. Similarly per-capita wastage of water in disposable bottles is 10L/50 users which is 0.2L or 200ml. Thus the per capita wastage is double in disposable bottles compared to the dispensing system.
- Calculate the amount of water wasted from using bottle over the dispensing system i.e. control in following way-

  Wastage of water (%) = [(ii) -(i)]/Total amount of water provided]*100
- Calculate the monetary value of the water wasted by taking into account the prevailing market price of drinking water.
- Calculate the carbon foot-print considering the standard norm 1.5 L of water equals to 200 g of CO_2.
- Prepare an appropriate table and present the data through a graph.

Step-15. A comparison will be drawn between the users (male and female) as well as between the delivery systems.

Note ; 1. The study should be repeated (**replicated**) at least thrice with the pupils of three different classes and then the average values may be calculated and used.

2. This study can be undertaken in different festivals and functions in the society besides the school premises.

Conclusion

From such studies children can conclude the amount of wastage of water, especially drinking

water which costs a lot in terms of money and energy. Also, they can suggest a better way of serving drinking water to the community with minimal waste.

Relevance

Through this project children will learn about the amount of precious drinking water wasted which is precious to any society. In addition they will understand the amount of money wasted due to such wastage of water. They themselves will be aware about it and make the people in the society aware so that appropriate measures can be adopted to minimise the wastage as much as possible.

Project 6: To study the use of toilets in rural households

Background

The rural sanitation programme in India was introduced in the year 1954 as a part of the First Five Year Plan of the Government of India. The 1981 Census revealed rural sanitation coverage was only 1%. [8] From 1999, a Total Sanitation Campaign was launched. The Nirmal Bharat Abhiyan was the successor programme to address the same objective in 2012. In 2014, the Swachh Bharat Mission was launched with the primary objective of a Open Defecation Free (ODF) country. The ODF is adding on the anthropogenic pressure on our ecosystem. However, despite the robust initiatives by the Government to build toilets and also to raise awareness on the importance of sanitation, reluctance to use the toilets is palpably seen in societies. What is the reason behind this? Despite having constructed pucca toilets with all support from the Government, why do people prefer defecating in the open? Does this behaviour have a cultural aspect?

Hypothesis

Toilets are culturally not accepted in many societies.

Objectives

1. To understand people's perception of using toilets.
2. To explore the social and cultural aspects of ODF.
3. To suggest ways to instil behaviour change

Methodology

1. Visit a village with a higher percentage of population opting for open defecation.
2. Find the total number of households in the village. This information can be gathered from the Panchayat office or the census.
3. Take 30% of the total households.
4. Prepare an interview schedule with both open and close ended questions.

   Examples of **close ended questions:**

   a) Do you have a constructed toilet in your house?

b) When did you construct it?

c) Which space did you use for sanitation/defecation purposes earlier?

d) Do you use the toilet now? What is the frequency? (everyday/less than 3 times a week/ more than 3 times a week/other)

e) How many family members do you have?

f) Which space do the women use? Frequency?

g) What is the source of water?

h) Do you feel comfortable using the constructed toilet? (very comfortable/ comfortable/ uncomfortable/ very uncomfortable/ unusable)

- Examples of open ended questions:

a) Why do you still go for open defecation? (habit)

b) How do you allocate the space for defecation? (behaviour)

c) How do you think these practices affect your surroundings? (perception)

5. Collect the information and make a table of the data.

6. Analyse the quantitative data from the closed ended questions and draw the percentages.

7. Place the qualitative responses from the open ended questions under themes such as habit, perception, behaviour and see the pattern. Draw inferences.

Additional Project Ideas

1) Agriculture related social and cultural practices leading to non-chemical farming with respect to biological pest and nutrient management.
2) Human animal conflict and linkage to local ecosystem degradation and coping mechanisms.
3) Land use changes causing ecosystem changes leading to flash-floods/land-slides including vulnerability mapping of potential landslide hotspots.
4) Cloud-burst and resultant flooding and its impact on agro-ecosystems.
5) Rain-gardening/farm ponds/soil erosion control measures / Continuous Contour Trenches/gabion etc. and study of regeneration of green cover over sloppy terrains.
6) Season watch – mango and other fruit orchards / other species / link to local marketing and study the process of flowering and its linkage to whether they have the same latitude/longitude etc.
7) Sacred groves and their importance / role in conservation and local traditions and ecosystem services.
8) Selective and controlled pruning of trees/fodder for cattle rearing / Jack tree leaves for goats etc. as a conservative measure.
9) Role of traditional games/sports and their linkage to health / Physical activity mapping/ seasonal games etc.

10) Food preservation/processing linked to seasonal availability of resources / fish/meat /vegetable process / in various agro-ecosystems.

11) Fisheries / Conservative measures leading to sustainable fishing.

12) Pest-predator balance in agro-eco systems and cultural pest control measures as opposed to conventional farming / comparative study / economics of input-based farming with natural farming systems

13) Study on sustainable menstruation as a means to avoid plastic waste.

14) To study role of rain garden in water recharge.

15) Study and compare lifestyle of different group/communities either in village or cities.

16) To study the effect of market force on changing pattern of festivals/dresses/food habits/Community celebration and its effect on ecosystem.[2]

17) To study the importance of our various festivals/traditional games/toys and their relation with our cultural aspects and mental health.

18) To study traditional biological control methods of pest management and its role in ecosystem.

19) Study on bio fencing plants of local area and its role in a)checking man animal conflict b)conservation of ecosystem.

20) Scientific study on traditional method of food storage processing and its role in ecosystem.

21) Study on land use and its role in ecosystem conservation by sea buckthorn (Hippophae) [In reference to local area of Leh- ladakh]

22) Study on local community knowledge of polyherbal medicine to control tick infection in Dairy Animals in eco-friendly way.

23) Study of machining Makhana (Fox nut / Gorgon nut) popping - a way to save health and improve the livelihood of makhana growers.

24) Impact of using Kulhad (earthen vessel) on local Ecosystem and Socio-cultural behaviour.

Sub-theme IV

Ecosystem Based Approach (EBA) for Self Reliance

Introduction

We, human beings , are an integral part of the ecosystem that surrounds us. There are many ways in which the other biotic and abiotic components of the ecosystem affect us and conversely we also have positive or negative impact on the surrounding ecosystem(s). Many times over exploitation of the resources from the surrounding ecosystem(s) leads to imbalance, extinction and ultimately affecting us. Keeping in mind short term gains, we tend to sacrifice long term sustenance.

The ecosystem approach is a strategy of the integrated management of land, water, environment and living resources that promotes conservation and sustainable use of these resources in an equitable way. It is based on the application of appropriate scientific methodologies focused on levels of biological organization which encompasses the essential processes, functions and interactions among organisms and their environment(s). It is admitted on all hands that humans, with their cultural diversity, being an integral component of ecosystems, aims to restore and/or strengthen the self-sustaining capacity of human-nature relationships and represents a framework of action under the Convention on Biological Diversity (CBD)[1] .

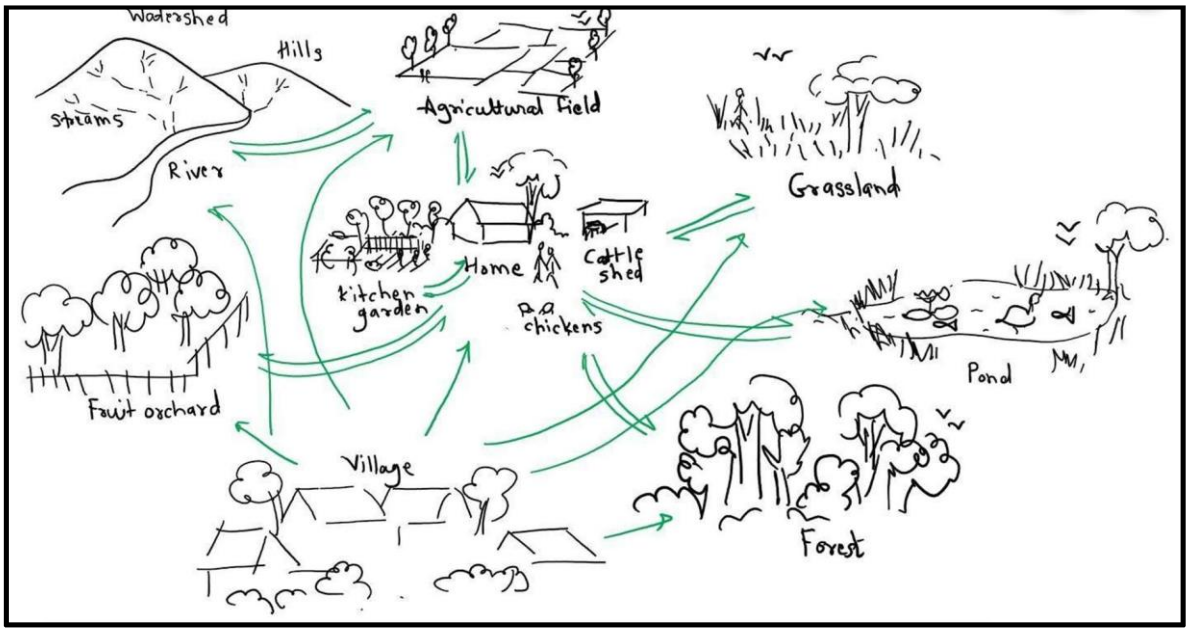


Fig.4.1. Ecosystems around us

Objectives

1. To understand various **s**ustainable uses, conservation of natural resources and restoration of ecosystems
2. To understand multiple social, economic and cultural benefits to local communities with maximizing ecosystem services using ecosystem principles .
3. Studying/documenting existing or innovative methods of Increasing resilience to climate change

Scope

Natural resources around us and their management

We depend on a number of natural resources around us including air, water, soil, under different ecosystems like wetlands, grasslands, forest etc. However, due to rapid urbanization and industrialization, we have lost direct connection with nature in our day to day lives. Most of our needs are fulfilled by the market. In current times though the majority of the population has access to the market, there are still many parts of the country where local communities are dependent on the surrounding ecosystems for fulfilling their needs for food, shelter, health, medicine, and the likes.

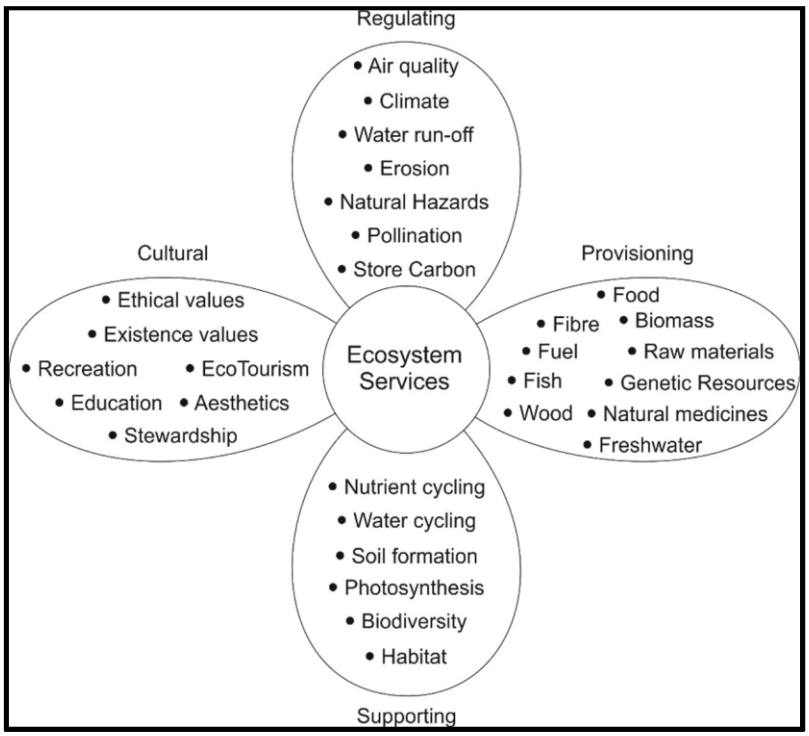


Fig.4.2. Ecosystem services

It is interesting to note how people define resources. Perception of a resource will change depending on region, culture, tradition, geo-climatic constraints, availability as well as access of the resource, etc. Management and sustainable use of resources can be looked at from the point of view of traditional approach as well as scientific approach. We will have to evaluate these management practices in terms of ease of doing, sustainability, cost, equitable sharing, etc. Further, satisfying our day-to-day household energy needs through a sustainable local resource base is also a dimension that can be explored.

Projects can be taken up by the children to study the dependence of the local community on natural resources in their surroundings based on criteria and indicators, assessment of current situation and availability of resources keeping in mind (i) how they can be restored, (ii) any traditional management practices associated with it and so on.

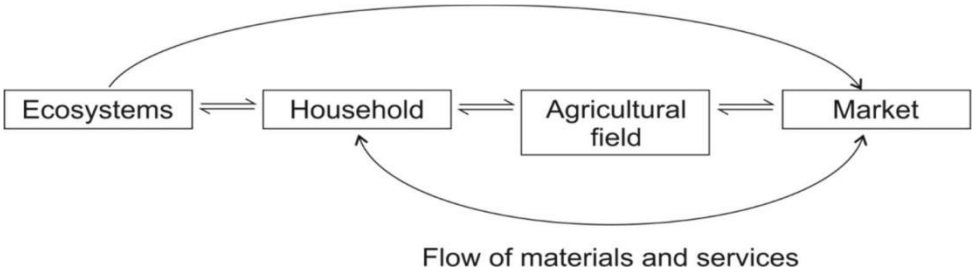


Fig.4.3

Agriculture and other ecosystem based livelihoods

Traditional agricultural systems and practices, even today, are mostly dependent on the resources available from the surrounding ecosystems. Earlier, these ecosystems were mostly intact in terms of soil formation, nutrient recycling, water infiltration, percolation, groundwater recharge, erosion control, pest control, etc and the resources were available almost free of charge. But, due to modern intensive agricultural practices, the land-use pattern has been changed and thereby people are becoming more and more dependent on the market for seeds, fertilizers, irrigation, pesticides and weedicides all of which could tamper with the health of flora and fauna and resulting in further degradation of the surrounding ecosystem(s).

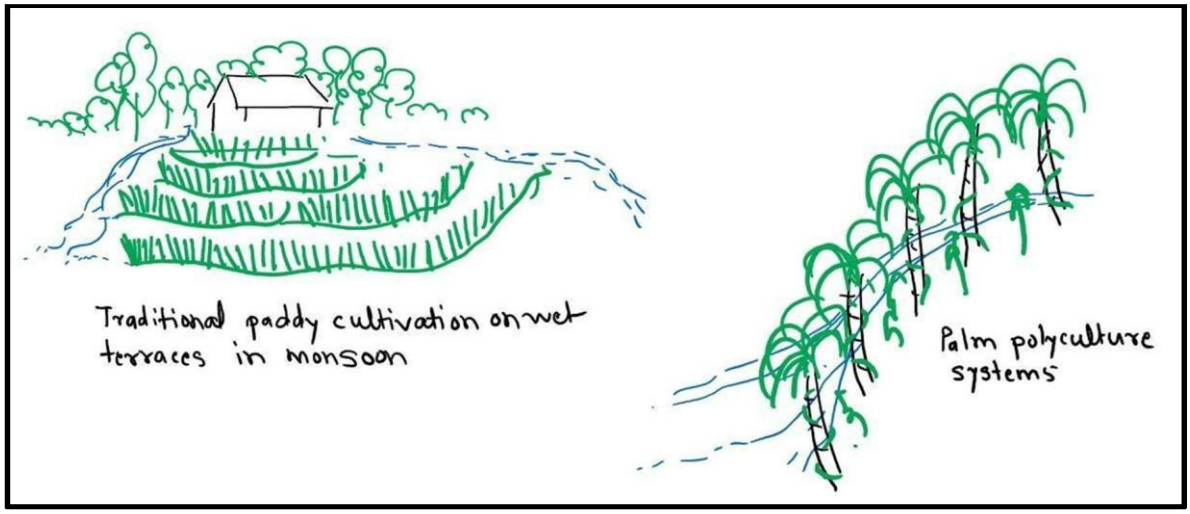


Fig. 4.4. Different agricultural systems

Livelihood pattern under different eco-systems

There are many livelihoods which are directly dependent on natural resources available in the surrounding area. In many parts of the country, there are communities who are specialized to work on these resources. Such livelihoods are local, have minimum ecological footprint, support local economy, skills and hence these are more sustainable. Due to modern education and the current economic models which make ecosystem people marginal, such specialized livelihood systems are getting eroded.

In coastal areas, fishing is the main occupation having a unique culture coupled with local traditions linked to their profession. . Health and productivity of the coastal ecosystems are of utmost importance to sustain these populations.

Many nomads and pastoral communities are dependent on livestock and other domestic animals for their livelihood. They graze these animals on common lands of villages, surrounding forests or other grassland patches. Grasslands either due to shrinkage like changing landuse or getting degraded due to overgrazing and frequent fires affect not only their livelihoods but also affect the ecosystem health adversely.. It is crucial to explore traditional pasture management practices in terms of sustainability of grasslands as well as livelihoods..

Projects can be taken up to study different traditional and modern agricultural systems, various farm and non-farm based activities- sustainable practices in agriculture, agroforestry, animal husbandry, sericulture, aquaculture, apiculture, processing, value addition to farm produce, circular production process, zero waste, diversified farming systems, agro biodiversity, etc.; impact of livelihoods on local resources; different nature based livelihoods to evaluate sustainability and self-reliance.

Food systems, nutrition and food security

The term food system describes the interconnected systems and processes that influence nutrition , health, community development and agriculture. A food system includes all processes and infrastructure involved in feeding a population: growing, harvesting, processing, packaging, transporting, marketing, consuming , distributing and disposal of food and food-related items.

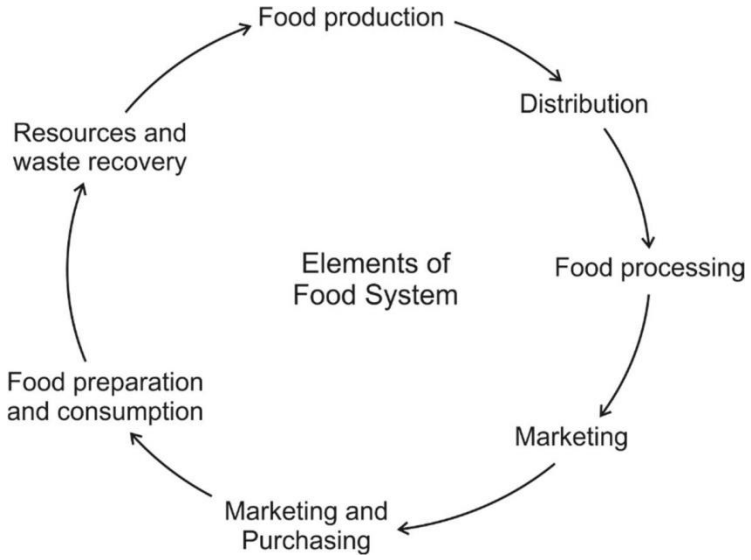


Fig.4.5. Food Systems

Global food system is facing a number of challenges due to global food security issues created by climate change and non-climate change stresses on the system. Transition to sustainable food systems is critical for addressing global challenges such as climate change, hunger, biodiversity loss, and deforestation.

Food systems are either conventional or alternative according to their model of food lifespan from origin to plate. Conventional food systems operate on economies of scale. These food systems

are geared towards a production model that requires maximizing efficiency in order to lower consumer costs and increase overall production. Alternative food systems are those that fall outside

Box 4.1: Homestead agroforestry Example (Adopted from Sarma, 2015)

A traditional house in Assam is incomplete without the component of a 'bari', or a backyard filled with a variety of useful trees, shrubs and herbs which can be called as "home garden".This ubiquity on the landscape of Assam, without many realizing it, has been an important factor in conserving the natural capital of the State. And if the model can be kept going in an organized manner, it can not only prove to be an important means of sustainable development -- key words to tame the tide of climate change gripping the country including Assam, but also can provide large-scale employment in the State. The practice of agroforestry has been in existence from time immemorial in the form of traditional homestead farming practices. It is common both in the plains and hills of the State, among all the indigenous communities, though they have a different name in different language and dialect. However, such areas are yet to be harnessed in a systematic manner to become a means of sustainable development. Conservation of biodiversity, control of land and soil degradation, regeneration of vegetation cover, generation of employment and creation of livelihood security are some of the important challenges of creating a path for sustainable development.

the scope of conventional agriculture, typically in order to create sustainable food systems. Examples of local food systems include community-supported agriculture, farmers markets and farm to school programmes [2]

Local level planning for climate change resilience, adaptation and disaster risk reduction

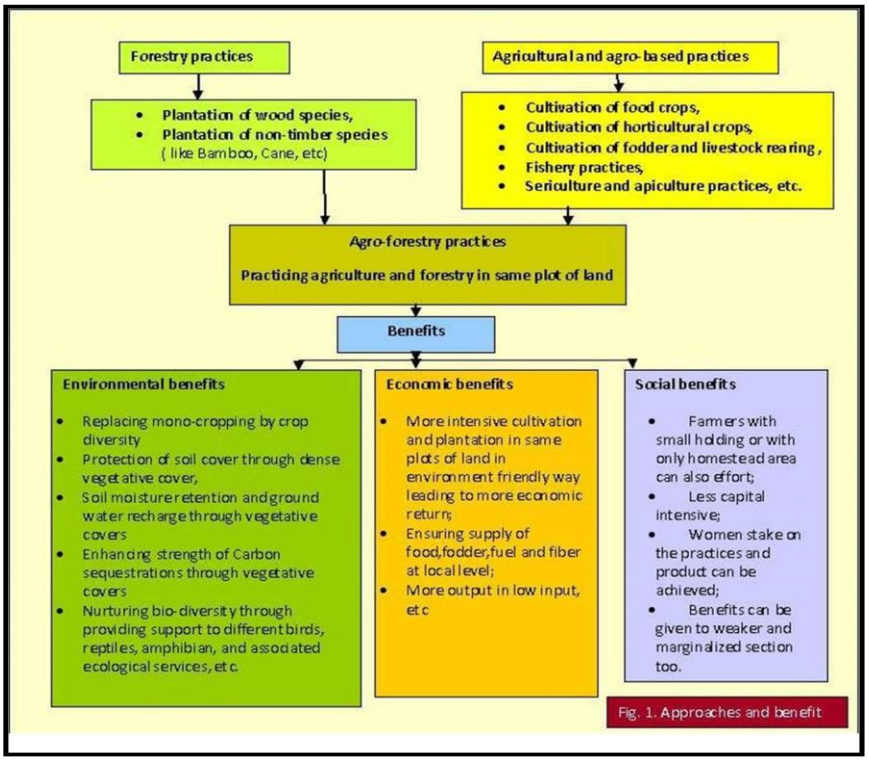


Fig. 1. Approaches and benefit

Human and natural systems are influenced by climate variability and hazards. Adaptation to climate change takes place through reducing vulnerability or enhancing resilience in response to climate change.Ecosystem-based adaptation is the use of biodiversity and ecosystem services as part of an overall adaptation strategy to help people to adapt to the adverse effects of climate change (*Convention on Biological Diversity,2009).*

Box 4.2. Schematic Diagram of Flowforms

Observe flowforms in ancient systems, to passively aerate the water in constant flow. There are stones placed in a series one below the other with a figure of eight horizontal turbulence effect, pulsing from the outfall from left to right and the opposite pulse in each basin. It is a beautiful pattern in motion to observe.

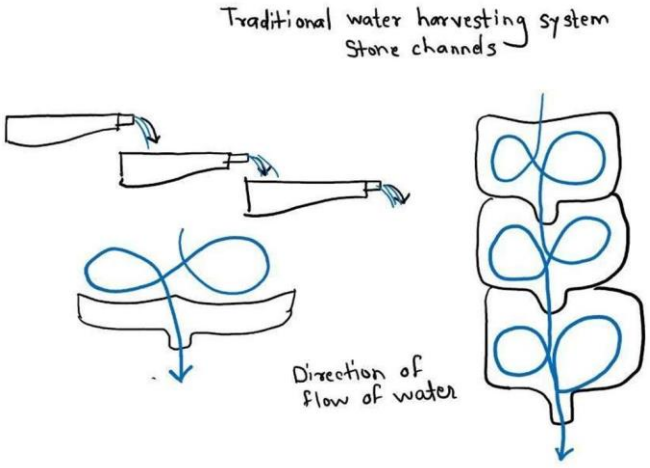


Fig. 4.6. Tradditional water harvesting system: Stone channels

Conservation, sustainable management, and restoration of ecosystems help people to adapt to the impacts of climate change - is gaining increasing attention. This approach includes coastal habitat restoration, agroforestry, polyculture systems in food production, integrated water resource management, livelihood diversification, and sustainable forest management interventions that use nature to reduce vulnerability to climate change[3] .

Commonly used Methodologies

Important methodology under this sub theme will be field study and experimentation.

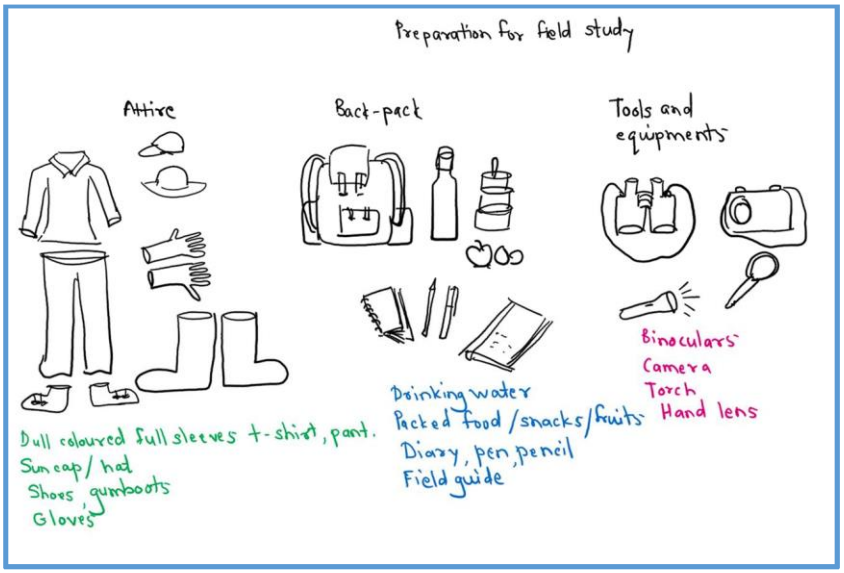


Fig. 4.7. Preparation for field study

Keeping detailed timely records is very important in field study and observations. Experiments can be designed to validate different parameters.

Quadrat sampling method to study the plant population density

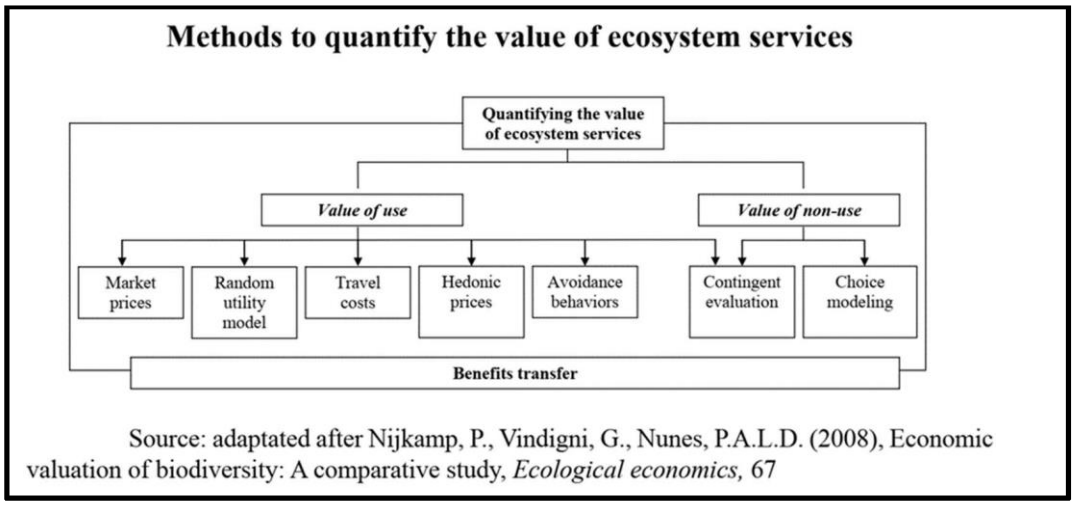
Using a series of quadrate (e.g.1X1 m for herbs and 10x10 m for tree) in habitat of interest and record the species. Quadrats are squares of a set size placed in a particular habitat. Plant and/or animal species within the quadrat are identified and their numbers recorded. If possible, photos of individuals along with the species information, form the baseline monitoring data are to be used to measure changes in species and habitats over time.

Fig. 4.8 quadrats commonly used to survey plants in the field

Tree survey method: A tree survey is done to collect objective information about trees in the area. The data are collected during a tree survey including the number, species, age and location of trees. Associated species are also recorded.

Methodology for quantifying Ecosystem services:

For quantifying Ecosystem services, the following framework is used:



Source: adaptated after Nijkamp, P., Vindigni, G., Nunes, P.A.L.D. (2008), Economic valuation of biodiversity: A comparative study, *Ecological economics,* 67

***Market Price Method*:** It is a method which estimates the value of ecosystem services that are bought and sold in the market. The method can be used to assess changes in both quantity and quality of an ecosystem service.

***Productivity Method*:** Productivity method is used to quantify the ecosystem services that contribute to the production of a good or service that is traded on the market. This method applied to the products or services provided by ecosystems, along with other inputs to the production of a commercial product.

Hedonic Price Method: Hedonic prices assign a value of ecosystem services by estimating the statistical relationship between system attributes evaluated and another good or service for which a market value exists.

***Travel Cost Method*:** It is a method designed to measure in monetary terms the benefits obtained by people visiting recreational areas. The travel cost is considered an approximation of the price that visitors are willing to pay for ecosystem services.

***Contingent Valuation Method*:** The method is applied when there is no market for ecosystem services assessed. In such situations, it uses an approximation, asking people if it is willing to pay to get a profit and how claiming to tolerate an expense.

***Choice Modeling*:** Choice modeling, also known as Contingent Choice. The premise is based on the method refers to the fact that any good can be described by attributes or characteristics and levels recorded. To apply, the respondents were presented a number of alternative options for the use of resources, and they are asked to choose your preferred option

***Random utility model*:** which allows the measurement of goods and services which do not have the market. Their value is calculated based on their attributes by applying probabilistic choice models between different combinations of attributes[5].

Case study

Hiware Bazar, Dist. Ahmednagar, Maharashtra

In the fast-developing urban growth of India, there are a few small villages that can teach us a lot about progress that is ecologically balanced! Hiware Bazar would certainly lead the list of these villages. About 17 km away from the city of Ahmednagar in the state of Maharashtra, this community of 1250 people has taken the reins of its future firmly in its own hands!

The village hosts a typical grassland ecosystem with thorny acacia species and neem trees. It is surrounded by small hills, on which many continuous contour trench (CCT) and nala bundings were made. The village conserves about 976.84 ha of forest, which is legally a reserved forest, under the jurisdiction of the forest department. In addition, the village has privately owned land and village common land.

The forest around the village was divided into four watershed zones. The villagers decided to construct various types of bunds and trenches, along with planting trees and constructing storage and percolation tanks. A number of check-dams were built in order to prevent loss of water by run-off. As the water table got recharged, water reappeared in open wells and seasonal ponds. The constant assured water has helped farmers to change their cropping patterns to grow crops that are more nutritious and lucrative. Not only do the villagers now grow enough to last them the entire year but are also able to generate substantial income by selling farm produce, particularly vegetables.

Since free grazing is not allowed and forests and grasslands are protected, people meet their fodder requirements mostly from their agricultural fields. Since 1994, villagers have been stall-feeding their cattle. Dairy is now a big business in the village, which is supported by fodder from the grasslands extracted in a regulated manner prescribed by the villagers. Milk production has reached 2200 litres per day, as compared to a mere 150 litres per day in the mid-90s.Fodder in the forest now is enough to meet all the village needs and those of the surrounding villages. Once the cutting season is declared, anyone can take one headload per day till fodder remains available on payment of Rs 100 for the entire season. Payment is made to the *gram sabha*.

Methodology for Ecosystem restoration

Ecosystem restoration is accomplished through management, protection, and re-establishment of plants by returning abiotic factors (e.g., soil chemicals , water content, disturbance etc.) and biotic factors (e.g., species composition, interactions among species) to historical/ earlier levels. Different methods are used in the restoration framework including survey, experimentation and modeling. Surveys can be used as preparation of baseline and monitoring. e.g. Survey of local flora, presence-absence of the species and thus it gives information about species composition. The experimentations are used to validate methods to be employed for different restoration approaches[6].

Model Projects

Project 1: Study of a wetland and its impact on the urban ecosystem

Background

Availability of land is a major constraint in urban areas. Due to change in land use, many times wetlands are neglected, encroached upon or dumped and leveled as a result of increasing anthropogenic pressures. In this project children will intend to study the ecosystem services provided by a wetland in an urban context. Children can choose any lake, pond, marshy area, mangrove around them for this study.

Hypothesis

Wetland has no impact on urban ecosystem

Objectives

1) To study the ecosystem services provided by the wetland.
2) To identify current status and threats to the wetland.
3) To derive measures for sustainable use and management of the wetland.
4) To study impact on human population around the water body

Methodology

Water quality assessment through:

- pH and KH testing (carbonate hardness)
- Measuring dissolved oxygen level
- Assessing turbidity and dissolved salts/ solids
- Recording water temperature

(A) Field study ()

Biodiversity

The existing biodiversity can be assessed by visiting the wetland periodically and identifying and listing the flora and fauna that is observed.

Date	Time	Plants-	Occurrence (Common/ Occasional/ Rare)	Activity (Feeding/ Breeding/ Nesting/ Perching, etc.)	Any other observation
		Animals-			
		Birds			
		Reptiles			

		Butterflies			
		Odonates			
		Bats			

Water quality

Water samples from the wetland can be collected from 4-5 different points and observations can be made for any smell, clarity of water, amount of sediments, pH. These observations can be related with existing flora and fauna observations.

Water spread area mapping for different seasons can be done. In wet season the area of the wetland expands and in dry season it shrinks. Parameters of this edge can be recorded.

Other wetland parameters like inlet of water, outlet, edges of the wetland can be observed. Is there any discharge of greywater or effluents in the wetland? Is there dumping of solid waste in the wetland? How do people residing in the surrounding area use the wetland? Is the wetland used for fishing, boating, or other recreation?

Depth of the wetland can be approximated with the help of local fishermen or authorities like Pollution Control Board. Methodology for restoration will depend on the kinds of interventions needed like purification of water, prevention of pollution, removal of weeds etc.

(B) Impact Assessment: This can be performed using questionnaires on wellbeing parameters

Expected outcome

- The current status of the wetland in terms of biodiversity, water quality, current use by locals, and role of edges can be understood.
- Alternate management plans for sustainable use of the resource can be prepared with the help of local community and authorities.

Significance

In urban areas, wetlands are reduced to tanks and are viewed only from the aesthetic angle. Understanding a wetland as an ecosystem and its management will help in retaining the ecosystem services we are getting from it as well as in disaster risk reduction as wetlands act as buffer, sink during extreme weather events.

Project 2: Study of intercropping system in coconut and arecanut palm cultivation in coastal areas

Background

Along humid coasts intercropping in palm cultivation is a common practice. Under this coconut and arecanut palms are primarily cultivated along with other spices like vines and different fruit crops as intercrops. Such polyculture helps in substantiating part of food and nutritional requirements as well as other needs of the local community.

Objectives

1. To study different crops grown as intercrops in the traditional palm cultivation area.
2. To study how this system helps in satisfying different needs of the local community.
3. To assess ecological and economic importance of the system.

(A) Field study

Periodical visits to different palm cultivation areas for taking observations, which are to be recorded in the table given below.

Table- 1:Observations on different parameters of the cropped area

Main crop	Number of plants/ ha	Yield/ ha/ year	Uses as food	Uses other than food	Approximate income/ year
Coconut					
Arecanut					
Intercrops					
Spices- Betelvine Nutmeg Cinnamon Black pepper Cardamom etc.					
Fruits- Pineapple Banana Papaya etc.					
Root crops- Turmeric Ginger Taro Yams etc.					

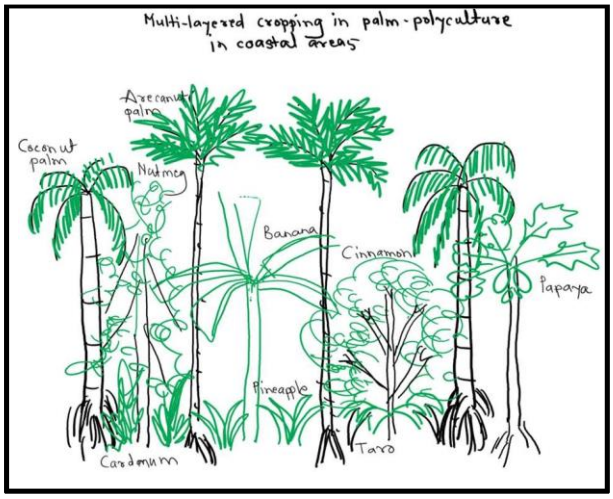


Fig. 4.9 : Multilayer cropping in Palm-polyculture in coastal areas

Observations regarding different layouts of main crop and intercrops, their combinations, associations will reveal optimum utilization of space and resources in a given area in polyculture practices. Study of multi-layered cropping is also interesting.

One can also compare this system with any system of monocropping in terms of productivity, sustainability, food security, etc. It will also be interesting to study how local food habits, cuisine, and recipes have evolved with products grown in that area.

Expected outcome

Understanding of different components of the polyculture system, their placement, arrangement, interactions in space and time, associations. Also the role of the polyculture system in food security, sustainability, optimum utilization of available resources like space, water, nutrients, etc. will be understood as well.

Significance

In the current scenario of changing climate, food security poses a great challenge and polyculture systems offer a sustainable option to tackle the problem.

Project-3: Study of wild varieties of cultivated crops

Background

Various crops that are cultivated today have evolved from selection of desirable traits from the varieties available in nature. In wild habitats around us, there are many species which are related to the crops that we cultivate today. These wild species are important from the point of view of natural habitats of these crops, their interactions and associations and for maintaining gene pool or genetic diversity of a particular group.

Objectives

1. To study wild varieties of cultivated crops in our surrounding.
2. Observing their natural habitat, growing season, propagation, associations and interactions.
3. To study if these plants are used by the local community.

Methodology

(A) Field Study

Visit wild/ natural habitats in your surrounding (wetland/ grassland/ scrub/ mountain/ forest, etc.) in different seasons and try to identify and list wild species that are related to the crops that we cultivate today with the help of local people and experts.

Note the habitat in which it grows, whether it is seasonal or perennial, how it can be propagated (seeds, food storage organ, cuttings, etc.). Also note your observations regarding the surrounding plant community, any insects or fauna observed visiting the plant to know the interactions and associations of that species. Observations regarding insect pest or disease occurrence on the wild as well as cultivated species can also be recorded. Wild species will be seen only during a particular season while a cultivated species may be grown round the year with irrigation.

Cultivated plant	Related species in the wild	Habitat	Plant community in the vicinity	Season of occurrence	Any associations or interactions	Propagation
Food-Cereals & millets						
Legumes & pulses						
Oil seeds						
Vegetables						
Leafy vegetables						
Spices & condiments						
Root & tuber crops						
Fiber-						
Timber-						
Fodder crops-						
Medicinal						

plants-						

Note; Size of the harvestable part can also be compared between wild and cultivated species.

Expected outcome

Database of the wild relatives of cultivated crops will help in understanding the importance of local biodiversity and its role in supporting our needs.Moreover this will act as a gene-bank if matured crops are harvested in proper time and preserved properly.

Significance

Database of the wild relatives of cultivated crops occurring in the surrounding natural habitats is important from the point of view of available alternatives in times of extreme events like severe drought, flood, loss of agricultural crops due to pests, diseases, etc.

It is of utmost significance for development of new varieties which adapt to changing weather patterns.

Project 4: Study of community-managed water harvesting system in a village

Background

Beautifully designed traditional water harvesting systems are still in vogue in some parts of rural India, These, where in operation, are mostly managed and maintained by the local community. But at present across India the village water supply systems are managed by local government authorities, and as a result, these age-old systems, although offer although more reliable and sustainable options for drinking and other purpose water resources, have been left unattended. It is admitted on all hands that these sort of structures are essentially required to be constructed at appropriate places/ locations for harvesting rainwater; so that utilization of groundwater can be minimized. Hence, this project has been suggested for the children to do

in-depth study of such structure(s) available to their vicinity.

Objectives

1. To study different components of the traditional water harvesting system.
2. To understand and evaluate the maintenance and management practices by the local community to run the system.
3. To identify threats and evaluate the importance of these systems for sustainable use.

Methodology

(A) Field study

Detailed documentation of different components of the system like tanks, their positions, usage, cleaning methodology, maintenance, channels, capacity, source of water, sink, etc. will help

in understanding the functioning of the system. It is advisable to draw a neat sketch showing detailed components of the structure.

At many places, water tanks are built successively for different purposes like drinking water, drinking water for domestic and wild animals, for domestic use like washing of clothes, etc. Every tank is filled by overflow from the tank above and drains into the tank situated below. Water is then supplied to orchards or plantations and then finally it is drained into a stream or a river. There are cultural associations of local communities with such systems.

(B) Experimentation: Water quality can be assessed for suitability for drinking water, agricultural use etc.

Expected outcome

- Understanding the functioning and maintenance of the system.
- Understanding the sustainability of the system in terms of local material, skill, maintenance, community responsibility, history, tradition, culture, bonding of the people to the life source, etc.

Significance

Instead of relying upon centralized water supply schemes, it is always better to retain and maintain traditional water harvesting systems as they are more reliable and sustainable in the current era of climate change.

Project-5: A study on land-use planning and land allocation

Background

Understanding land use is very important from an ecological planning perspective. A child can understand the importance of survey and mapping of a given site using ecological concepts like scale, landscape attributes for sustainable use of landscape.

Objectives

1. To make a survey and mapping of village/neighborhood boundary and forest, agricultural or urban land use zone
2. Preparation of basic maps through data collection and analysis
3. To give a set of suggestions/recommendation for preparation of sustainable land use plans

Methodology

Using Google map and freely available apps to map the land use type

Field study

Child scientists can use Google map or other freely available open-source tools to designate and map different land use attributes. Apart from that, child scientists need to visit sample points to validate those attributes. Students can take historical profile study using technology like observing

Google historical Imagery along with systematic point sampling for ground truthing. He/she can do key informant interviews or Household interviews for understanding the social perspective of land use drivers.

Expected outcome

At the end of the project, the student should understand land-use issues, challenges, and opportunities. The child scientist should also understand interdisciplinary issues like the role of social institutions in shaping the landscape.

Significance

Apart from ecological knowledge of landscape, the child scientist will be familiar with technology for land-use data analysis as well as ideas about zonation. It is expected that such a project can be helpful for creating a mindset to look at the bigger picture to better understand the landscape.

Project-6: Bioswale and Rain garden design and prepare models

Background

Groundwater recharge is a big issue not only in dry areas of India, but also it is critical for urban areas. Using vegetation cover, child can prepare bioswale as well as rain garden design to improve ground water recharge. Bioswales are vegetated, shallow, landscaped depressions designed to capture, treat, and infiltrate stormwater runoff as it moves downstream. The Rain Garden is an area that has been dug out and planted with native plants. These tend to be smaller than bioswales and can be placed near a drain pipe in one's house or another area where standing water is noticed.

Objectives:

Using native vegetation for conservation and recharge of ground water

1. To design and develop Bioswales and Rain Garden
2. To study the effectiveness of these in recharging ground water in the study area

Methodology:

1. Measure the rainfall
2. Delineate catchment area to find a location and find out what's below the ground also figure out size and slope
3. Type of plants: native grass and herbs with fine root systems

Field study:

Bioswales are not vegetated on the bottom and tend to be deeper basins where soil and rock filter the water, while rain gardens tend to be shallow and completely vegetated. Rain gardens are at times confused with bioswales. Swales slope to a destination, while rain gardens do not; however, a bioswale may end with a rain garden. The plants and soil in the rain garden or bioswale help to filter pollutants. Soils and plants have powers to clean unpolluted water by simply doing what they do naturally. Healthy soils and plant roots act like sponges, sopping up water and letting it slowly filter through. Through this activity child scientists Learn about the benefits of sustainable landscape

practices, And understand the environmental benefits that rain gardens and bioswales provide. Apart from these the child scientist can understand how to measure rainfall, sloping gradient, rain water runoff and role of plants in water filtration specially deep-rooted native plants are preferred for infiltration and reduced maintenance.

Representative Illustration

Expected outcome

Through this activity child scientists will learn about understanding the benefits of sustainable landscape practices, and understand the environmental benefits that rain gardens and bioswales provide.

Significance

This type of model activity helps to understand the importance of ground water recharge and give basic information on how the system buffers rainwater and allows it to infiltrate; thus minimizes overflow, improves the quality of surface water and prevents the ground from drying out.

Project 7: Invasive alien plant species management and mapping

Background

Invasive alien species have devastating impacts on native ecosystem biodiversity, causing decline or even extinctions of native species, and negatively affecting ecosystems. Invasive alien species are animals, plants, fungi and microorganisms entered and established in the environment from outside of their natural habitat.

Objectives·

1. To map Invasive alien species (IAS) in areas of interest
2. To use IAS for economic benefit and thereby controlling its negative impact

Methodology

Using quadrat method vegetation can be described and IAS mapped. For IA animal species point count, transect study to be done to map its impact on native biota. Transect lines can be used by a measuring tape or rope marked off at regular intervals. IAP can also be used for making furniture, natural dye etc for sustainable utilization.

Field study

Identification of the species is the first step, then the child scientist can take the quadrate method and map the invasive plants along with native vegetation. The most common way to measure plant cover in plant communities is to make a visual assessment of the relative area covered by the different species in a small circle or quadrate and the visual estimates of cover percentages is conducted. The student can also use mapping software like Google Earth to delineate the invasive species and prepare the zonation map. The child scientist can also think about preparation of useful household items. For e.g. *Lantana camara* is widely used for making furniture. *(Lantana- wood vinegar, Chromolaena- Dye)*

Expected outcome

Invasive alien species are one of the biggest threats to local biodiversity. There is a real need of proper mapping to understand its extent of distribution as well as creating an awareness amongst masses. The student can learn the mapping techniques along with the utilitarian perspective of the species.

Significance

The importance of the study is to create awareness of IAS amongst child scientists and make a study on them.

Additional Project Ideas

- Assessment of soil quality in different habitats in the surrounding area.
- Study of different practices in urban gardening to grow part of our food.
- Women's role in natural resource management.
- Restoration and management of grasslands for livestock and carbon storage.
- Study of traditional water management practices.
- Diversity of fishing discards and their usages
- Study of dependency of a village on the nearby forest.
- Documentation of the wild edibles from different habitats in the surrounding area.
- Assessment of current scenarios of different natural resources in the surrounding area of your school.
- Management of solid waste in urban areas- Reduce, Segregation, Collection (efficiency), Transportation, Resource recovery, Disposal.
- Study of impact of traditional agriculture on water harvesting system.
- Study of propagations techniques of different wild edibles.
- Study of vulnerable/ degraded resource areas in the surrounding.

- Study of restoration practices (indicative) for degraded ecosystems.
- Study of different man-made habitats like gardens and other open spaces and their role in urban areas.
- Study of aquatic flora to reduce water pollution.
- To study different practices of crop rotation, relay cropping, etc. for sustainable production (documentation, reflected in soil health, comparison between two patches).
- To study the diversity of birds in agriculture systems and their role.
- Study of mushroom cultivation.
- Study of beekeeping and its role in maintaining the ecosystem.
- Effect on food supply chain during pandemic.
- Study and documentation of food preservation practices for crisis period.
- Study of per capita water resource availability (domestic use) for a village or town.
- Study of salt tolerant and salt loving plants in coastal agroforestry and agriculture.
- Assessment of existing fish habitats and measures to improve them.
- Study of aquaponics cultivation.
- Study of different groundwater recharge practices.
- Study of role of vegetation in water percolation, retention,reducing runoff and erosion.
- Integrating plants and water for cooling and air conditioning within settlements and buildings.
- Micro watershed mapping.
- Carbon sequestration in your surroundings (Vegetation- Height, girth of trees-)
- Terraced cultivation in hilly areas
- Study on After effect of flash floods, storms, landslides.
- Water usages in packaged water bottle vs from Tap bottle water
- Study of road killed small vertebrates and invertebrates
- Survey and documentation of the biodiversity in the potential Biodiversity heritage sites
- Study on different Tree species in an Homestead Agroforestry systems
- Study of multipurpose tree species in the locality
- Study of traditional soil classification and based on that how land use classifications are made

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Sub-theme – V

Technological Innovation for Health and Well-being

Introduction

Biological diversity supports life on our planet - the air we breathe, the food we eat and the water we drink are only possible as long as we have healthy biodiversity with rich species and ecosystem diversity. Yet, this essential human lifeline is severely threatened, because our natural resource base has been misused by human societies for centuries, modifying 40% of the Earth's surface with catastrophic effects. Even though we represent just 0.01% of all life on the planet, our impact on our ecosystems has caused the loss of half of the world's plants and 83% of all wild mammals. When we lose species through extinction, the web of life is destroyed. This, in turn, affects the resilience of the ecosystems and nature's capacity to provide the services that are needed for all the living organisms. Hence, there is a need for urgent action to conserve our ecosystems protecting its biodiversity. Therefore, a shift to new, sustainable ways of production and consumption and reorient economic development towards an "economy within ecological boundaries" is gaining global recognition. At the same time, technological advancements are evolving at incredible speed and scale in relation to the said areas.

Technologies include tools such as artificial intelligence, machine learning, advancements in quantum computing, encoding DNA, virtual reality, biotechnology, and use of new materials. But, when it comes to biodiversity, there are areas like land use, including food production, conservation, restoration, as well as governance, communications, and community engagement – where these new technologies can be of great help.

New technologies could provide valuable support to conservation:

Hyperspectral imagery of landscapes, for example, could provide detailed information on a host of chemical and geological parameters and biological processes in both terrestrial and aquatic systems, with significant progress made in imaging techniques, data analysis, and modes of deployment. This type of remote sensing can help the conservation biologists to maintain healthy habitats and to protect the life they harbour, while offering the possibility of rapid alert systems for failing food webs or trophic systems, as well as for excessive human interference.

New technologies come with a range of associated risks and opportunities, and these can be used for good or worse. Hence, technology can be used to restore biodiversity as well as to destroy it, either intentional (e.g. resource extraction) or unintentional, through its unmanaged effects (e.g. some types of genetic engineering). Thus awareness and responsibility is the key when designing and utilizing any type of technology. Firstly, the awareness about the earth that it is a system of interconnected elements, and the man-made technologies are embedded in the larger natural system of the planet, and not the other way around; and secondly, to develop consciousness about human responsibility for maintaining the health of this fragile web of life of which we are only a part.

Technologies also have the potential to transform the way we approach ecosystem restoration:

Some agencies have started to use drones to determine what species are needed and where, and then use that data to reforest, replant, and restore. Bioremediation techniques, e.g. the use of plants and microbes to extract metal contaminants, have advanced to an extent that allows the use of natural processes to help "re-wild" damaged habitats. Research shows that even the most damaged landscapes can recover if human activities are limited and/ or restricted, for example, the area surrounding Chernobyl, Ukraine, has recovered remarkably following the nuclear disaster in 1986, with native fauna taking advantage of the absence of human activities to re-wild the exclusion zone.

Responsible innovations and technologies are readily available, affordable and scalable. Some countries are already harnessing these opportunities to fuse natural infrastructure with technology, for example, building infrastructure to enhance the adaptive capacity, strengthen resilience, and reduce vulnerabilities to climate change. In order to help safeguard life on our planet, Technologies will need to understand and learn from nature and align that learning with society's needs. Applied research and adaptive management are requirements to integrate the knowledge of ecosystems in technological design (e.g. biomimicry).

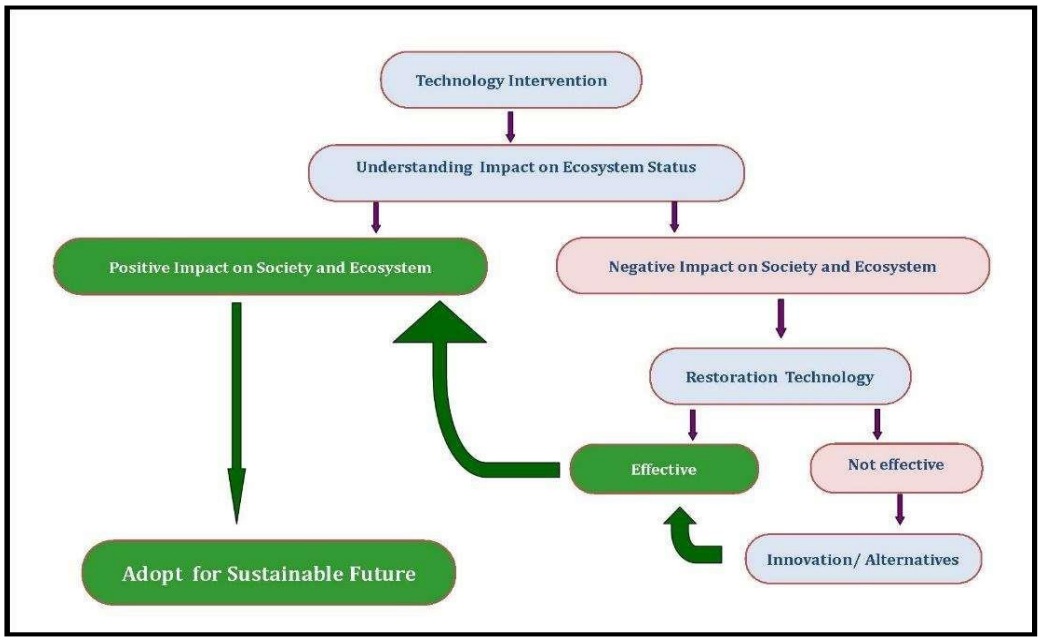
Traditional knowledge systems and community participation is crucial to innovation:

Traditionally used technologies have sustained us for generations through the knowledge acquired through millennia of interactions of the local people with their ecosystems and their land. Thus, we need to work together and co-create solutions not only for our survival, but for our equitable thriving on our planet. Technologies bring the possibility to engage not only amateurs and professionals, but also often overlooked communities when it comes to conservation, such as indigenous people as well as local communities.

Objectives

- To understand and appreciate the impact of technology on ecosystems, health and wellbeing.
- Use of appropriate technologies to restore and strengthen ecosystem health.
- To innovate tools /technologies / and processes to support sustainable living.

Flow Chart



BOX 5.1

Case Study 1

A venerating example of application of ITK against termite damage is reported from Kerala, India. In Thrissur district of this coastal state, marvellous antique wooden carvings and timber-in-service at Vadakkumnathan temple were under severe termite attack. This problem was confronted with the help of admixture of locally available plant-based products and oils (total eight ingredients), thus, obtaining good results to combat termite attack. Application of this traditional knowledge based termite management fetched the temple prestigious UNESCO Asia-Pacific Heritage Award for Cultural Heritage Conservation on 2015 (Times of India, TNN, September 15, 2015). Water containing decomposed fish, tobacco, salt and brackish water also worked better termite repellent in India.

Case Study 2

Indian farmers use salt and lime to control mites in various situations. Cow dung and urine have been used for termite control by farmers in India and elsewhere abroad. Most of the Indian villagers smear cow dung on walls and floors of their cottage to protect them from ant and termite attack. Sometimes fresh cow dung is put hither and thither on termite-prone fields, to lure them to the site, which can later be destroyed effectively.

Source; Mahapatro, G.K. 2017. Indian Indigenous Traditional Knowledge (ITK) On Termites: Eco-Friendly Approaches to Sustainable Management. Indian Journal of Traditional Knowledge 16(2):333-34

MODEL PROJECTS

Project 1: Acid Rain and Aquatic Life in an aquatic ecosystem

Background

Acid rain occurs when pollution in the atmosphere (sulphur dioxide and nitrogen oxide) is chemically changed and absorbed by water droplets in clouds. When there is precipitation, the droplets fall to earth as rain, snow or sleet. The polluting chemicals in the water droplets form an acid by combining with the hydrogen and oxygen in the water. These acidic droplets can increase the acidity of the soil and affect the chemical balance of lakes and streams. "Acid rain is a serious environmental problem that affects large parts of the US and Canada," (EPA, 2006) and countries with concentration of industries. Acid rain accelerates weathering in carbonate rocks and accelerates weathering of buildings. It also contributes to acidification of rivers, streams, and forest damage at high elevations (Wikipedia contributors, 2006).

An acidic solution will donate hydrogen ions and usually taste sour, like lemon juice. Acids are the opposite of bases, which accept hydrogen ions and usually feel slippery, like soapy water. How do you tell if something is an acid or a base? You use a chemical called an indicator, which changes in color when it goes from an acidic to basic solution.

An indicator which is concentrated on little strips of paper, called "pH paper", may be used for the study. The color of the paper will indicate the pH of the solution. The pH of a solution is a numerical measure of how basic [alkaline] or acidic it is. pH 7 is neutral, and solutions become more acidic as the pH decreases below 7, and more basic as the pH increases above 7. Each one unit change in pH is a 10-fold change in the number of hydrogen ions in solution. The pH test strips have a colour chart that can be used to measure the pH of the solutions. This will give the measurement of acidity of the aquatic environments.

In this study, effects of acid rain on a simple aquatic environment, consisting of small aquatic organisms (specifically some plants and animals) will be studied. The effect of acidic water (toxic chemical) on organisms is called environmental toxicity. In this experiment, childrens are advised to use household vinegar to create different solutions of various acidities. Then it will be observed if there is any adverse effect in the experimental environment on viability of the organisms. Here, viability will be measured by counting the number of alive and dead organisms in each experimental set-up over time.

Hypothesis

The living organism will not be affected by increasing acidity of the aquatic environment

Objective

To test the effects of acidic water conditions on a simple aquatic environment containing animals and plants.

Materials Required

- Study Organisms:

(i) Small pond snails (at least 20 in number).or small fish. Whatever animals are to be used must be of the same variety and size. Otherwise the result will be erroneous.

(ii) Duckweed plants (40 healthy plants). Duckweed (Common name: Khudipana and scientific name is Lemna perpusilla

- Medicine droppers (glass made).
- pH paper
- Bottled distilled water, (10 - 15 liter.)
- 1 liter graduated cylinder or beaker or Measuring cup
- 4 plastic containers of 1 liter capacity with lids. All the containers must be of the same shape and size.
- Permanent marker
- White vinegar
- Clean spoon
- Lab notebook

Table – 5.1: pH – values of different water solution, achieved by using different amount of vinegar in drops

Container	Water	Drops of Vinegar	pH
1	1 litre	0 (Control)	6.5
2	1 litre	5	6
3	1 litre	10	5.5
4	1 litre	15	5

Methodology

1. Rinse each container thoroughly with water. Do not use soap because it may coat the plastic container and may be harmful to the experimental organisms. Label each container with a number, with the help of a permanent marker.
2. Pour 1 litre distilled water in each container with the help cylinder or beaker. Tap water should be avoided as it may contain chemicals, like chlorine, which may add to the error in the experiment.
3. Then, measure the pH of the water in Container No. 1 with the help of pH paper. Record the pH in the data table as shown in Table 5.1. Do not add Vinegar in Container 1 because this is the 'Control' of this experiment.
4. Pour water in Containers no. 2, 3 and 4 also. Add Vinegar drop wise to the water taken in containers 2-4 with a dropper very carefully. Put one drop in each container and one drop at a time. After adding each drop of vinegar, mix the water with the glass rod/clean spoon and measure the pH. The goal is to create four different pH solutions with increasing amounts of acidity, each one going 0.5 pH lower than the previous one. For example, if the distilled water has a pH of 6.5 (in container no. 1) then containers 2, 3 and 4 would have pH values 6.0, 5.5, and 5.0.

- Container- 2 will have the fewest drops of acid and thus be the least acidic (0.5 pH lower than the distilled water).
- Containers 3 and 4 will need more drops of acid.
- In the data table, the number of drops of acid and the corresponding final pH values for each container are to be recorded.

5. Place at least 5 numbers of snail/ fish into each container. Make sure that snails must be placed right-side-up at the bottom of the container.
6. Then, put at least 10 duckweed plants into each container. Make sure that each duckweed has a stem (the part sticking down) and exactly 2 leaves that must float.

   In your notebook, make data tables like Table 5.2. Record the number of snails/ fishes and the number of leaves (note that the total number for all plants in each container should be equal on the first day) on different days.

7. Record the number of snails/ fishes that are alive and the number of leaves on the duckweed in each of the containers are to be recorded in Table 2 on different days, as shown below.
   a. This procedure is called a viability assay because the number of things that are viable, or still alive are being counted.
   b. Write down any other observations you make in your lab notebook.

Table -5.2: Number of alive snails/fishes and leaves of duckweed under different levels of acidities in different days during the study

Number of alive snails/ fishes					
Container No.	**Day 1**	**Day 2**	**Day 3**	**Day 4**	Day 5
1					
2					
3					
4					
Average					
Number of leaves of duckweed					
Container No.	**Day 1**	**Day 2**	**Day 3**	**Day 4**	**Day 5**
1					
2					
3					
4					
Average					

8. It will be preferred that the values will be converted to percentage.
9. Make line graphs of your results, one for the living snails/ fishes and the other for the number of leaves on the duckweed over time. You can make a graph by hand and print out your graph.
   a. For the graph showing the snails living, the time (in days) on the x-axis (the horizontal axis) and the number of snails alive on the y-axis (the vertical axis) to be put. Make a different line for each container, being sure to also list the pH of the container.

b. For each graph showing the number of leaves on the duckweed, put the time on the x-axis and the number of leaves on the y-axis. Make a different line for each container, being sure to include the container's pH.

10. Analyze your results and try to draw conclusions based on them.
    - Did the aquatic organisms respond similarly or differently to the changes in pH of your environment?
    - What is the viable pH range for each organism?
    - Which organisms are the most sensitive or the most resilient (strong) when it comes to changes in acidity?

Relevance of the Project

In this experiment, children will understand the adverse effect of increasing acidity on the organisms in aquatic ecosystem. They will also understand the root causes of increasing acidity in the environment and will think over to take necessary precautionary measures for their living and wellbeing.

Project 2: Harvesting Dew with Dew-Trap in Desert and Arid Ecosystem

Background

Deserts are defined as landscapes that receive on average less than 10 inches (about 250 mm) of precipitation (either rain or snow) per year. The semi-arid regions also receive precipitation on average between 250 and 500 mm per year. So water is very precious for the people living in those zones/ areas. But water vapour in the air, also known as humidity, comes through evaporating (changing from liquid to gas) water from oceans, lakes, and other water bodies, and plants also add water vapour in the atmosphere through a process called evapo-transpiration. In these areas, water also exists in the form of dew which are small droplets of water that are formed on surfaces of the land mass during night. As the night-time air cools to a point where it cannot hold any more water vapour, the vapour condenses into liquid on exposed objects like grass, leaves, flowers, etc. Dew occurs when the water vapour condenses faster than evaporation. But when air temperature increases during day time, the dew evaporates.

In fact, some plants collect the dew that gathers on their leaves and use it for their growth. Like plants, humans also use to collect dew for hundreds of years using dew traps, and the collected water is used to quench the thirst of peoples, animals and plants.

Hypothesis: Harvesting of dew is a viable process of exploring water resources from air.

Objectives

i. To determine how the amount of water collected depends on the surface area of the trap
ii. To understand viability of the technique of harvesting dew

Materials Required

- Trenching shovel/ hoe
- Collector (2). The collectors can be aluminium/plastic bowl, pans, or food storage containers that cover the majority of the area at the bottom of the hole.
- Two transparent polyethylene sheets
- Measuring cylinder
- Few bricks
- Two small oval shape stones/rocks

Experiment

1. Children will have to select/choose an area in their backyards, or in another outdoor place that is undisturbed by other people and/ or animals. The area should be in a sunny location away from pedestrians.
2. Dig two round holes of different sizes with the help of some adults.
    i. The first round hole must have a diameter of 0.5 m and a depth of 0.5 m.
    ii. The second round hole must have a diameter of 1 m. and a depth of 1 m.
3. Put the dugout soil aside, which will be needed to construct the traps.
    i. Make the bottom of the holes flat so that the collector can be easily placed at the bottom.
    ii. Use the ruler to confirm that the holes are 0.5 m. deep each as shown in picture below
4. Place the collector at the bottom of each hole, once the holes are complete. The collector should cover most of the area at the bottom of the hole.
    i. The collectors must be identical. If they are not, you will be adding another, uncontrolled variable.
5. Open and spread out the plastic cloth. Using the scissors, the plastic sheet will have to be carefully cut into two circles, one for each of the holes. Be sure to position the circles carefully so that you get as many covers of both sizes as possible. The plastic must be larger than the hole for better and effective coverage.
6. Each piece of plastic is to be carefully centred over its hole and those are to be held in place with two or three bricks along the circumference of the holes or by piling the excess soil around the edges, as shown in the picture.
7. Then gently push each cover down as a cone so that the tip of the plastic is positioned a few inches above the collector at the bottom of the hole. As the dew condensed, it will

run down the inside of the plastic cover and will get deposited into the collector. For this a reasonably small sized rock/ stone in the tip of the cone canter directly over the collector. The purpose of the rock/ stone is to stabilize the cone shape.

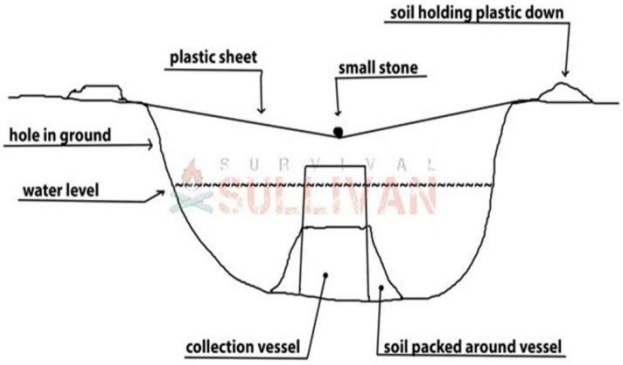
8. The edges of the plastic cover are completely sealed with soil. If the plastic is not sealed, the water can be evaporated from the trap.
9. It is to be checked that the insides of the plastic cover do not get in touch with any part of the rim of the container, since this would prevent some water from being collected.

Table 1. Collected water data

Hole	Trial	Starting		Ending		Total amount of water (ml)	Average amount of water (ml)
		Date	Time	Date	Time		
Small (0.5 m diameter)	1						
	2						
	3						
Large (1 m diameter)	1						
	2						
	3						

Experimentation

1. After three to four days, the plastic cover of each of the holes is to be taken off approximately at the same time of day, when the experiment was started.
2. Two disposable cups (marked as large and small with marker) are to be used to measure the water in each collector. The collected water is to be strained separately using filter paper to remove any soil/solids. The dew traps are now ready to collect water, which is to be continued for 3-4 days. During this time, monitor the conditions of the dew traps.
3. Precautions are to be taken so that too much dirt should not fall on the cover. Keep watch on the conical shape of the trap and the rock/ stone, these should be in the proper position at the tip of the cone.
4. If it rains, reading that very day should not be considered, else it will give wrong result. However, it should be repeated when the sky is clear.
5. After three to four days, the plastic cover of each of the holes is to be taken off carefully approximately at the same time of the day when the experiment was started.
6. Two disposable cups (marked as large and small with marker) are to be used to measure the water in each collector. The collected water is to be strained separately using filter/ muslin paper to remove any unwanted materials.
7. The amount of water collected to be measured with the measuring cylinder for each of the set-up separately and the data to be recorded in Table 1.
8. Repeat the Experiment at least for three times and take mean values of the data.



(a) (b)

Fig. 2.1. Showing the experimental set-up as it looks like (a) and its cross sectional diagram (b)

Data Analysis

1. Review the data in Table- 1. Average the data for each of the holes over the three trials. Record the average data in a table like Table 2 shown.
2. Calculate the approximate opening area of each hole (in m2) and record it in Table-2.
3. Following equation shows how to calculate the area of a circle (or top surface of dew trap).

$$A=\pi r^2$$

Where π = 3.1415; r = radius of the top surface of the dew trap

Divide the average amount of water collected (in millilitres) by the approximate area of the hole (in feet) to calculate the average amount of water collected per area (in millilitres per square foot) for each hole. Record this data in Table 2.

Table 2. Average water collected in two different holes.

Hole	Average Amount of Water Collected (ml)	Approximate Area of the Hole (m^2)	Average Amount of Water Collected per Area (ml/m^2)
Small (0.5 m diameter)			
Large (1 m diameter)			

4. Plot the data from Table 1 for each trial.
   - Label the x-axis Approximate Area of the Hole (feet squared) and use the values you calculated for Table 2. Label the y-axis Collected Water (millilitres) and use the data from Table 1. Were there many differences between the three trials?
   - For the second graph, label the x-axis Approximate Area of the Hole (feet squared) and label the y-axis Average Amount of Water Collected per Area (millilitres/feet squared). This graph compares the efficiency of the dew traps.
   - The total amount of harvested dew-water can be calculated for the whole season.

5. Children will also collect the secondary rainfall and temperature data for the season from meteorological department and can analyse the rainfall and temperature, which may be correlated with the information gathered from the experiment.

Relevance of the Project

This is an environmental engineering science project, in which children will build a dew trap to collect water and determine how the surface area of the trap contributes to the amount of water it collects. In this case, the trap will not strictly harvest dew, but the water that condenses on the inside of the cool trap covering. By this children of the arid or desert zone will be able to explore the natural resource in a sustainable way for their survival.

Project 3: Transportation system for carrying goods and products in hilly areas

Background

The topography of hilly mountain areas hinders the construction of transportation networks like roads etc. The rugged hilly mountains pose an obstacle to the mobility of the people and transport of goods and services. The isolated community faces serious problems in transporting their agricultural goods and products from fields to homes or markets and vise versa. The access to market due to the absence of proper and reliable means of transportation becomes a serious concern to commercialization of agriculture products. Development of an appropriate means of transportation is of utmost requirement for social development in these areas. Gravity Goods Ropeway as an alternative and complementary means of transportation in these areas. This type of system is inexpensive with low operational cost, and can reduce the transportation cost. The system can also be used to lift construction materials for high rise building construction.

A pulley is a mechanical device which contains a wheel with a crew and rope to lift the objects. The wheel of the pulley is generally fixed to a hinge and rotates on an axle or shaft. Rope is the driving element that moves over the wheel in a simple pulley system. The object is loaded at one end of the rope and from the other end the rope is pulled down lifting the object. An assembly of pulleys is used to lift large objects. These are also used to transfer power from one rotating shaft to another. The main advantage in the use of pulleys is that the effort becomes less as compared to the normal lifting of the weights. In other words, it reduces the amount of actual force required to lift heavy objects. It also changes the direction of the force applied.

Objective: To design and develop an efficient pulley-driven system for transportation goods and products in mountain or hilly areas

Experiment methodology

A pulley is a wheel on an axle or shaft that is designed to support movement or transfer of power between the shaft and cable. A rope and pulley system is characterized by the use of a single continuous rope to transmit a tension force around one or more pulleys to lift or move a load. The system of rope and pulley needs to be arranged at two different heights such as top of the hill and bottom of the hill. It also can be arranged using two different heights in a location, where loads or

materials need to be lifted to a higher location. The design needs to be optimized in terms of pulley support, pulley location, rope strength, diameter of rope and traction.

Children can test the carrying capacity of the rope by using simple tensile testing. The tensile strength is the load at which a rope, tested during experiments breaks. Children can use different diameter ropes with similar materials and hang it on a support. The diameter of the rope is measured minimum three times and cross sectional area of the rope is calculated. The load (weight in kg or gram) is fixed at the other end (as in Fig). Increase the loads slowly (say 250 grams) and find out at what weight ropes are broken. It is repeated minimum three times and mean is considered. This 'breaking point' indicates the tensile strength of the respective rope under study. This will provide the relation between rope diameter and tensile strength of the materials as shown in following Figures. The tensile strength can be estimated by dividing the failure load (kg) by the cross sectional area (m^2).

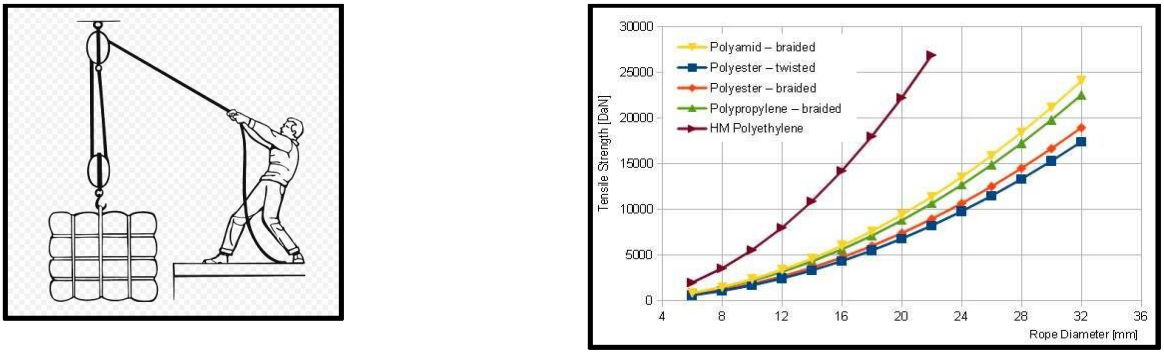


Figure 3.1. carrying capacity of the rope by using simple tensile testing

- Design a system of standard pulleys (used in garages in lifting loads) to enhance the mechanical advantage of the system.
- Apply trial and error method to decide the supporting frame. The advisable material is bamboo or wood based on local availability. For experimental purposes, make a frame and observe if it can withstand the required load. If not then redesign and apply trial and error method to optimize the design parameter (load withstanding capacity).

Pulley system: Mechanical advantage

Mechanical advantage is the force-amplifying effectiveness of a wheel or pulley. Mechanical advantage allows performing tasks such as lifting heavy objects much easier in terms of the force applied. The formula used to calculate the mechanical advantage of a pulley system is MA=2n

Where MA is the mechanical advantage of the pulley system and n is the number of movable pulleys in the system

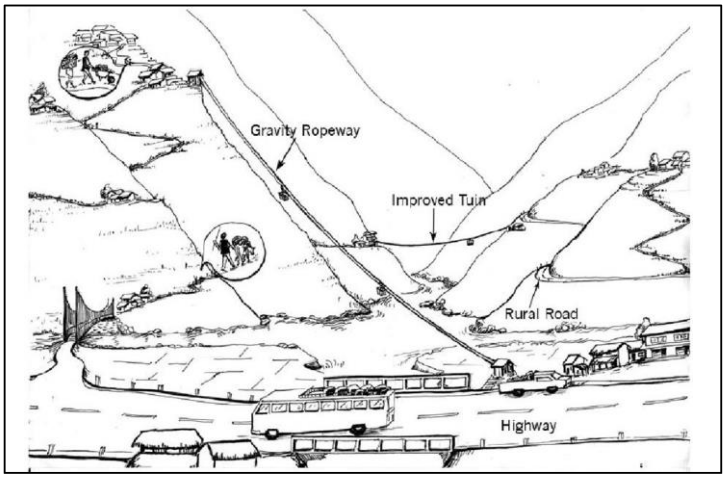


Fig.3..2. Different methods of carrying materials in a rural undulating area

Calculating force in a pulley-driven system of transportation on a slope

Newton's second law, **F (force) = M (mass) x A (acceleration**) assumes the pulley has no friction and the pulley's mass is ignored. Newton's third law says that for every action there is an equal and opposite reaction, so the total force of the system F will equal the force in the rope or T (tension) + G (force of gravity) pulling at the load. In a basic pulley system, if you exert a force greater than the mass, your mass will accelerate up, causing the F to be negative. If the mass accelerates down, F is positive. The tension in the rope using the following equation can be calculated using: T = M x A.

For example, if you are trying to find T in a basic pulley system with an attached mass of 9 g accelerating upwards at 2 m/s² then T = 9g x 2m/s² = 18gm/s² or 18N (Newton).

Calculate the force caused by gravity on the basic pulley system using the following equation: G = M x n (gravitational acceleration). The gravitational acceleration is a constant equal to 9.8 m/s². The mass M = 9 g, so G = 9g x 9.8 m/s² = 88.2 gm/s², or 88.2 Newton.

Insert the tension and gravitational force, you just calculated into the original equation: -F = T + G = 18N + 88.2 N = 106.2 N. The force is negative because the object in the pulley system is accelerating upwards. The negative from the force is moved over to the solution so F= -106.2N.

Expected outcome

A low cost transportation system for carrying products and goods in hilly areas or building construction sites.

Significance of the study

This study will yield a sustainable transportation system for goods which will address the barrier in transportation systems in hilly areas.

Project 4: Use of biochar to improve moisture and nutrient retention in soil

Background

Biochar (clean Charcoal) can be used as a soil amendment for improving its properties. It improves water retention capacity, soil fertility by capturing nutrients and preventing them from

leaching, increases the microbial population and ultimately improves the plant growth and productivity. Application of biochar in soil also leads to carbon sequestration, as carbon captured by the plants from the atmosphere is buried in the soil for a long time. Thus it has a potential for combating climate change by carbon capture and sequestration.

Biochar can be produced from any organic matter by a process called pyrolysis (which is heating in the absence of air). Suitable woody biomass can be selected and heated to a temperature of 300 to 400 Celsius in the absence of air or burnt in a pyrolyzer where all the volatile matter is burnt off; quenched (extinguish) with water to get clean charcoal (known as biochar) free from volatile oils, compounds and gases. This is powdered to a coarse grained structure and applied to the soil.

Simple top lit up flow stove can be constructed from used tin cans [ex- Garlington stove-google] This is powdered to a coarse grained structure, like sand (fine grains tend to get transported along with water), before applying it to soil. Wash the charcoal well by immersing it and rinsing it in water to clear it of any undesirable residue

Hypothesis

Biochar in sufficient quantity will improve the water holding capacity and the nutrient holding capacity of the soil.

Objectives

- To determine the relation between the quantity of biochar in the soil and change in the water holding capacity of the soil
- To determine the change in nutrient/salt retention property to assess the impact of charcoals on water and nutrient retention properties of the soil.

Materials required

- 12 Pots, required nos. to hold 1 to 2 kgs of soil each.
- Crushed biochar powder
- Ammonium sulfate fertiliser
- Weighing scale
- Jars for collecting and pouring of water
- Reagents for chemical analysis of water

Experiment

- There will be three trials of 2%, 4% and 6% biochar added, plus one control with no biochar addition - total 4 treatments. Each treatment will have three replicates making into a total of 12 pots.
- Fill each of them with 1 kg of clean washed and dried sand.
- Keep one set as control and in the remaining 3 sets add 2%,4% and 6% biochar (by weight) and mix well with the sand.
- For each pot add Ammonium sulphate at the rate of 6 g per litre of water dissolved in them.

- An arrangement to be made so that pots will be placed on an elevated place in such a way so that the drained out leachates can be collected in marked pots/ collectors from the bottom of the pots.
- Concentration of the salt solution (to be prepared as per farmers' practice) will be same for all the treatments. This is to be prepared before pouring into pots. An arrangements are to be made for collecting the leachates from the bottom of the pots. Measure the Collected water coming out of the pots carefully. Analyze it to determine the salt content. Find out the mean value of the replicates in each treatment including that of the control.

Data analysis

- Tabulate the results
- Draw graph of carbon content and water retained.
- Draw graph of Carbon content and salt retained.
- Interpret and explain the results,

Relevance

This project will demonstrate the influence of biochar on the water and nutrient holding capacity of the soil and will suggest as to what is the optimum quantity to be added to get good results. While improving the soil properties it also remains in the soil for a long time effectively achieving carbon sequestration or removal of carbon from the atmosphere.

Project 5: Simple solar dryer for crop drying

Background

The conventional sun drying of agricultural products has several limitations, such as crop loss due to inadequate drying, fungal attacks, dependence on environment, etc. On the other hand, electric powered dryers are not suitable due to inadequate supply of electricity, high initial investment and maintenance related issues, etc. Fossil fuel-powered dryers also have several limitations in the context of rural India, especially in the areas of heavy rainfall. Hence there is an urgent need to develop solar dryers which is appropriate, affordable, and sustainable for rural India.

Hypothesis

Drying agricultural goods will be better in a solar dryer as compared to open sun drying

Objectives

- To design and develop a solar dryer
- To test the productivity, effectiveness and efficiency of the dryer

Methodology

A systemic description of the dryer's working mechanism, evolution of the dryer is briefly discussed here. As shown in the figure 5.3 it consists of a box made up of easily available and cheap material

like cement, galvanized iron, brick, or plywood. The top surface of the dryer is covered by transparent single and/or double-layered sheets. To absorb the maximum incoming solar radiation, the inside surface is coloured black. The box is insulated with appropriate material. The air is ventilated through the small holes. As the inside air gets warm, it rises by the natural circulation process and carries the moisture with it from the agricultural products placed in trays inside the box. To fill the vacuum, fresh air comes in by a forced draught process and the process continues. A schematic view of the process is shown in the following Fig.5.3.

Objectives

1. To evaluate the performance of the dryer,
2. To find out drying time, drying rate, and effectiveness of drying

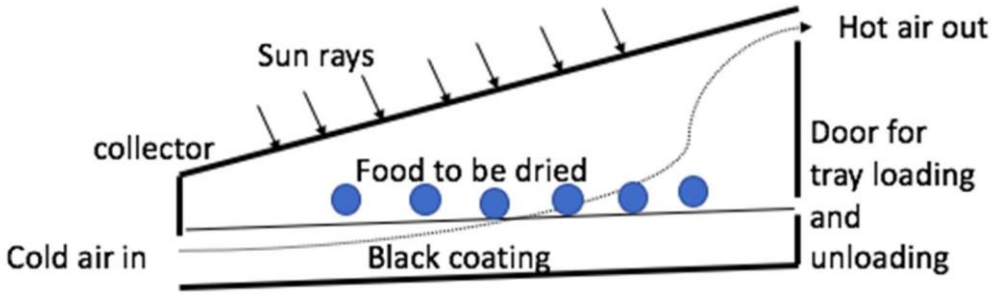


Figure 5.3. Schematic diagram of basic components of a solar dryer

Experimentation

Initial moisture content

A sample of 1 k g (wi) of the sample is subjected to drying, whose temperature was maintained at x °C. The weight of the sample is monitored every 1 h. When the change in the weight difference was negligible, the process was terminated, and the final weight (wd) of the sample was recorded. Then the moisture content is calculated using following equation:

$$M_i = (w_i - w_d) / w_d$$

- **Drying time**

The time taken to dry per kilogram of the sample is to be noted. A comparison is made to see the differences of time taken with sun drying and drying with the dryer.

- **Drying rate**

A graph is drawn using time [in x-axis] vs weight change in y-axis.

Conclusion

If the drying time is reduced and the process is found to be effective then we can conclude that the dryer is effective for improving drying quality.

Project 6: To explore different fruit and vegetable waste materials for extraction of value- added products such as pectin.

Background

Food processing industries generate a huge amount of waste that is now becoming a major global concern due to pollution problems associated with its disposal. Traditional measures like animal feeding, anaerobic digestion, pyrolysis, composting, incineration, land spreading and land filling etc have proved uneconomical with less environmental advantage in the past. Around 1.3 billion tons of food is wasted every year in the world and it is estimated to rise to 416 million tons in 2025 in Asian countries. Fruits and vegetables are on the top of waste food materials. Peels are the main source of proteins, carbohydrates, pectin, cold pressed oils, limonene and many phenolic compounds. Among all these products, pectin is one of the strongest components which can be retrieved from fruit and vegetable waste materials. Pectin, a polysaccharide, consists of about one third of the cell wall dry matter of higher plants. It is composed mainly of polymers of D-galacturonic acid, whose monomers are linked by (1, 4)- linkages and also contain arabinose and galactose units. Pectin is used in many food and pharmaceutical applications due to its various useful properties. It is used as a gelling, stabilizing and thickening agent in food industries for the preparation of jams, jellies and marmalades. Pectin is widely used for food biodegradable packaging. Its pharmaceutical value is due to its effectiveness in controlling blood cholesterol levels and gastrointestinal disorders.

Extraction of pectin from fruit and vegetable sources is a multi-stage physico –chemical process in which pectin from plant tissue is hydrolysed and extracted with the help of acids and then precipitated with the help of alcohols. Its solubilisation requires different factors, most important of which are type of acid, pH, temperature and time.

Hypothesis

Different physio –chemical parameters like type of acid, pH, temperature and time affect the process technology for extraction pectin from fruit and vegetable waste materials.

Objectives

1. To calculate the percent dry matter and percent moisture content (on dry and wet basis) in fruit and vegetable waste.
2. To determine the amount of pectin present in different fruit and vegetable waste materials.
3. To assess the effect of different physico-chemical parameters on the process technology for the extraction of pectin from fruit waste materials

Materials Required

- Beakers
- pH paper strips
- Measuring cylinder
- Funnel
- Weighing Balance
- Thermometer

- Filter paper
- Muslin cloth
- Concentrated Acids (citric acid or sulphuric acid or hydrochloric acid or nitric acid)
- Ethanol
- Stopwatch or any timer

Methodology

Part A: Collection and drying of fruit waste material (s)

1. Collect any fruit waste material e.g. Kinnow peels, orange peels, pomace, carrot waste etc. from the local market (like juice stalls) and weigh this wet material with the help of any balance. Record the reading as Wet Weight (Wi) as shown in Table 1. Children can collect more than one type of waste material to compare the results.
2. Dry the collected fruit waste under the sun for 72 to 96 hours until it is fully dried. Please keep the waste inside any room during night to avoid regaining of moisture.
3. Weigh the dried fruit waste and record as shown in Table 1 as Dried Weight (Wf).
4. Calculate the percent dry matter, percent moisture content on dry weight basis and percent moisture content on wet basis from the reading taken in step 1 and step 3 using simple equations as given hereunder:

$$\text{Dry matter (\%)} = \frac{Wf}{Wi} 100$$

$$\text{Moisture content (\%}MC_{dB}\text{) on dry basis (dB)} = \frac{Wi - Wf}{Wf} 100$$

$$\text{Moisture content (\%}MC_{wB}\text{) on wet basis (wB)} = \frac{Wi - Wf}{Wi} 100$$

Where, Wi is initial and Wf is the final weight in gram.

5. Ground to powder with the help of grinder and store the powder in a sealed container at cool place for further use in Part B

Table 6.1: Percentage dry matter and Moisture content (on dry and wet basis).

Sample No.	Type of waste Material	Wet weight of the sample (W_i)	Dried weight of the sample (W_f)	Dry matter (%)	% MC (wet basis)	% MC (dry basis
1						
2						
3						

Caution: Children should carry out this project only under the supervision of an experienced guide and adequate care/protective gears should be used while handing concentrated acids.

Part B:

Extraction of pectin

(Note: Children can use different variables in various experiments as suggested in step 1 to 6 and in Tables 2 to 7).

1. Take 10g of fruit waste powder obtained in Part A in distilled water (200ml) and mix it. Children can vary the Solid: Liquid ratio as shown in Table 2 and observe its effect on pectin yield.
2. Then, add any one concentrated acid like citric acid, sulphuric acid, hydrochloric acid, nitric acid, drop by drop with regular mixing with the help of glass rod to adjust pH of the mixture between 1.5 to 3.0. Add different acids in separate sets and observe the effect of each acid on pectin yield (Table 3). Use different pH values in different sets of each acid and observe their effect on pectin yield (Table 4)
3. 3. Heat the above mixture in a water bath at 90˚C for about 60 to 90 minutes. Children can use different time intervals in different sets and observe their effect on pectin yield (Table 5).
4. Filter the above mixture through muslin cloth to remove the fibre and water insoluble substances.
5. Take the filtrate obtained from step 4 in a beaker and cool to room temperature.
6. Add equal to double the volume of 100% ethanol (v/v) to the filtrate and then keep it undisturbed overnight in the refrigerator at 4˚C to achieve the precipitation of pectin. Add different volumes of alcohol in separate sets and observe its effect on pectin yield as shown in Table 6. Keep the solution undisturbed for variable time intervals also in different sets and observe its effect on pectin yield (Table 7).
7. Filter the mixture through filter paper for separation of pectin. Wash the pectin obtained with 55% and 75% ethanol to remove impurities.
8. Dry the pectin under shade and avoid the direct sunlight during drying. Then, weigh it to calculate yield. The yield (%) of pectin is calculated using following equation
9. Ground the dried pectin with pestle and mortars in to make pectin powder.

The yield (%) of pectin was calculated as under:

$$\text{Yield (\%)} = \frac{\text{Weight of dried pectin}}{\text{Weight of dry fruit waste powder taken}} \times 100$$

Table 6.2: Effect of Solid (g): Liquid (ml) ratio on pectin yield.

Sample No.	Solid (g): Liquid ratio (ml)	Pectin Yield (%)
1.	1:10	
2.	1:20	
3.	1:30	

Table 5.3: Effect of different acids on pectin yield.

Sample No.	Acid	Pectin Yield (%)
1.	Hydrochloric acid	
2.	Sulphuric acid	
3.	Nitric acid	
4	Citric acid	

Table 6.4: Effect of pH on pectin yield.

Sample No.	pH	Pectin Yield (%)
1.	1.5	
2.	2.0	
3.	2.5	
4	3.0	

Table 5.5: Effect of time of heating on pectin yield.

Sample No.	Time of heating, min	Pectin Yield (%)
1.	30	
2.	60	
3.	90	
4	120	

Table 6.6: Effect of volume of ethanol used on pectin yield.

Sample No.	Volume of ethanol	Pectin Yield (%)
1.	Half volume	
2.	Equal volume	
3.	One and half volume	
4	Double volume	

Table 6.7: Effect of settling time on pectin yield.

Sample No.	Settling time	Pectin Yield (%)
1.	6 h	
2.	12 h	
3.	18 h	
4	24 h	

Significance

Children will learn the concept of 'Waste to Wealth' using fruit waste materials for extraction of pectin using scientific concepts and methodology.

In addition, children will learn the significance and effect of different physical and chemical parameters used in the form of variables on the product yield during development of any technology.

Additional project ideas

- Biomass (Algae, Bio-residue, waste, etc.) as green energy
- Design and development of simple and economical devices for measuring water quality
- Appropriateness of water purifiers
- Technology for potable drinking water delivery during flood
- Design, development of a solar water still for coastal and brackish water areas
- To develop a simple tool for measuring water table depth in tube well
- Bamboo as a sustainable engineering material.
- Solar/ biomass based crop dryers for farmers
- Simple technology for weather monitoring (measurement of rainfall, wind, solar radiation duration, humidity, etc.)
- Technologies for person with disability
- Grey water treatment using plants and microorganisms.
- To study traditional fishing tools and gears and its modification to make it more efficient and productive
- Rain water harvesting accessories
- Comparative study of thermal performance of traditional and modern houses
- Exploring electric mobility

- Measuring specific heat of water and appreciating its role in microclimate maintenance in an ecosystem maintenance
- Information and communication technology (ICT) for decentralized healthcare delivery to develop a frugal process
- Application of artificial intelligence for estimating market demand for agri-products
- To study micro climate condition at the habitat level
- To develop solutions for stubble burning issue
- To explore the use of fruit and vegetable waste for extraction of value added materials like pectin or pigments

Annexure - I

TIPS FOR THE GUIDE TEACHERS

Birding ethics:

- Do not mimic bird calls in the natural habitats. It might disturb birds.
- Do not disturb birds when foraging.
- Do not go near the nest. It will disturb the birds as well as give clues to the predators.
- Nest photography is strictly prohibited.
- Do not use flash at night.

Ethics to be followed during field study:

- Do not litter
- Do not make noise.
- Stay on the designated trail.
- Do not trample vegetation
- Do not eat anything in the wild unless cross checked with the experts.

Few other information:

- The project taken must be carried out within a limited timeframe (2 and half month)
- Study must be done in a scientific way following the steps of science.
- Methodology should be appropriate like experimentation, survey, case study, mapping etc.
- Project must include Data collection, Analysis, Results (in the form of bar graph, pie chart, graphical) and conclusion.
- Bibliography / References must be enlisted properly.
- Duly acknowledge people, including the parents and teacher, who helped during conducting the project.

Check list:

- If a suitable project title has been chosen according to the theme and subtheme
- If proper observation/documentation done properly
- If logbook has been authenticated by the guide teacher
- if the project report has been written properly according to the CSC guidelines
- check size and layout of the posters as per CSC guidelines

Annexure – II

How to calculate Pearson correlation co-efficient

To examine the relationship between two variables, a formula is used which produce a value known as the **co-efficient value** (commonly known as **Correlation Co-efficient**), an unit of less value denoted by 'r'. The co-efficient value ranges between 1 and -1. If the value is negative (-) it means the relationship between the variables is **negatively** correlated, or as one value increases, the other one decreases. But, if the value is positive (+), it means the relationship between the variables is **positively** correlated, or as one value increases/decreases, the other one also increases/decreases. The Pearson correlation coefficient value is calculated by the following formula.

$$r_{xy} = \frac{N\sum XY - \sum X . \sum Y}{\sqrt{\{N\sum X^2 - (\sum X)^2\}\{N\sum Y^2 - (\sum Y)^2\}}}$$

r_{xy} = Product moment coefficient of correction between X and Y variables

$\sum$ = Symbol of summation

$\sum XY$ = Sum of product of X and Y

$\sum X$ = Sum of scores of X variables

$\sum Y$ = Sum of scores of Y variables

$\sum X^2$ = Sum of squre of X

$\sum Y^2$ = Sum of squre of Y

Note: The sign sigma (∑) used in the equation indicates summation or simply addition.

Step – 1: Make a chart with your data for two variables, labelling the variables (x) and (y), and add three more columns labelled as (x^2), (y^2) and (xy).

Step – 2: Let us take an example to study the correlation between Age of child and their scores. Here y is the dependent and x is the independent variables.

Step – 3: Let's put the above information in the table below-

Child	Age (x)	Score (y)	(xy)	(x^2)	(y^2)
1					
2					
3					

• More data would be needed. Here, only three samples have been shown for the purposes of example, but the ideal sample size to calculate a Pearson correlation co-efficient should be more than ten.

Step – 4: Complete the chart using basic square and multiplication procedures to get the values as depicted in the following table.

Child	Age (x)	Score (y)	(xy)	(x^2)	(y^2)
1	20	30	600	400	900
2	24	20	480	576	400
3	17	27	459	289	729

Step – 5: After completion of all the values, add all of the columns from top to bottom and put in the table as Total.

Child	Age (x)	Score (y)	(xy)	(x^2)	(y^2)
1	20	30	600	400	900
2	24	20	480	576	400
3	17	27	459	289	729
Total	61	77	1539	1265	2029

Step – 6: put these values in the formula to find the Pearson correlation co-efficient value.

Step – 7: Once you complete calculation using the formula above, the result is your co-efficient value. If the value is a negative number, then there is a negative correlation of relationship. If the value is a positive number, then there is a positive relationship between the two variables.

REMEMBER More closely the r-value is to ± 1, more is the strength of relationship between the two variables. Of course there are methods to test its strength more accurately. But, for you people, as a rule of thumb, value e" 0.8 may be considered as existing 'very good' strength between the variables.

Annexure – III

Conversion Table

Linear Measure (Length/Distance)			
Imperial	**Metric**	**Metric**	**Imperial**
1 inch	25.4 millimeters	1 millimeter	0.0394 inch
1 foot (= 12 inch)	0.348 meters	1 centimeter (=10 mm)	0.3937 inch
1 yard (= 3 feet)	0.9144 meters	1 decimeter (=10 cm)	3.937 inchs
1 (satute) mile (=1760 yards)	1.6093 kilometers	1 meter (=100 cm)	1.0936 yards
1 (nautical) mile (=1.150779 miles)	1.852 kilometers	1 decameters = 10 m)	10.936 yards
		1 hectameter (=100 m)	109.36 yards
		1 kilometer (=10 cm)	0.6214 miles
Square Measure (Area)			
Imperial	**Metric**	**Metric**	**Imperial**
1 squre inch	6.4516 sq. centimeters	1 square centimeter	0.1550 sq. inch
1 squre foot (= 144 inch)	9.29 sq. decimeters	1 square decimeter (=10000sq. cm)	1.1960 sq. yards
1 squre yard (= 9 squre yard)	0.8361 sq. meters	1 are (=100 sq. meter)	119.60 sq. yards
1 acre (=4840 squre yard)	0.40469 hectare	1 hectare (=100 ares)	2.4711acres
1 squre mile (=640 acre)	259 hectare	1 sq.kilometer	0.3861 sq.mile
Cubic Measure (Volume)			
Imperial	**Metric**	**Metric**	**Imperial**
1 cubic inch	16.4 cubic centimeters	1cubic centimeter	0.0610 cubic inch
1 cubicfoot (= 1728inch)	0.0283 cubic meters	1 cubic meter (one million cubic cm)	1.308 cubic yards
1 cubic yard (= 27 feet)	0.765 cubic meters		
Capacity Measure (Volume)			
Imperial	Metric	Metric	Imperial
1 (Imperial) fl.oz (=1/20 Imperial pint)	28.41 ml	1 millilitre	0.002 (imperial) pint

1 (US liquid) fl.oz (=1/16 US pint)	29.57 ml	1 centilitre (=10ml)	0.018 pint
1 (Imperial) gill (=1/4 Imperial pint)	142.07 ml	1 decilitre (=100ml)	0.0176 pint
1 (US liquid) gill (=1/4 US pint)	118.29 ml	1 litre (=1000ml)	1.76 pints
1 (Imperial) pint (=20ft Imperial oz)	568.26 ml	1 decalitre (=10l)	2.20 (imperial) gallons
1 (US liquid) pint (=16ft US oz)	473.18 ml	1 hectolitre (=100l)	2.75 (imperial) bushels
1 (US dry) pint (=1/2 quarts)	550.61 ml		
1 (Imperial) gallon (=4 quarts)	4.546 litters		
1 (US liquid) gallon (=4 quarts)	3.785 litters		
1 (Imperial) pack (=2 gallons)	9.092 litters		
1 (US dry) pack (=8 quarts)	8.810 litters		
1 (Imperial) bushel (=4packs)	36.369 litters		
1 (US dry) bushel (=4packs)	35.239 litters		
Mass (Weight)			
Imperial	**Metric**	**Metric**	**Imperial**
1 grain	0.065 grams	1 milligram	0.015 grain
1 dram	1.772 grams	1 centigram (=10 mg)	0.154 grain
1 ounce (=16dram)	28.35 grams	1 decigram (=100 mg)	1.543 grain
1 pound (=16ounces = 7000grains)	0.45359237 kilogram	1 grams (=1000 mg)	15.43 grains
1 stone (=14pounds)	6.35 kilograms	1 decagram (=10 g)	5.64 dram
1 quarter (=2stones)	12.70 kilograms	1 hectogram (=100 g)	3.527 ounces
1 hundredweight (=4quarter=112lb.)	50.80 kilograms	1 kilograms (=1000g)	2.205 1 pounds
1 (long) ton (=2240lbs)	1.016 tonnes	1 ton (=1000kg)	0.984 (long) ton
1 (short) ton (=2000lbs)	0.907 ton		

Annexure - III

Glossary of relevant terminologies and Definitions

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 hydrolysis- A reaction in which acid is used to catalyse the breaking of chemical bond of a molecule with the addition of water

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.

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

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.

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.

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.

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 (polyculture/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.

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.

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 colour, while vegetation has a low albedo (generally about 0.1 or 10%) due to the dark colour 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.

Alcohol precipitation: It is commonly used for concentrating, desalting, and recovering nucleic acids. Precipitation is mediated by high concentrations of salt and the addition of either isopropanol or ethanol.

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.

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.

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

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.

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

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.

Anthropocene: The current geological age, viewed as the period during which human activity has been the dominant influence on climate and the environment.

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.

Anxiety: A feeling of fear, dread, and uneasiness that might cause sweating, feeling restless and tense, with a rapid heartbeat.

Appropriate technology: Technology which is simple, make use of local material and skills, responsive to local needs and contexts, needs little capital, can be used and owned by individuals and small communities.

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.

Attention deficits: A condition that affects how a person pays attention, sits still, and controls own behaviour. It is common in children and teens and can continue into adulthood

Avian influenza (or Bird Flu): An infectious disease caused by avian (bird) influenza (flu) Type A viruses. These viruses naturally spread among wild aquatic birds worldwide and can infect domestic poultry and other bird and animal species, but not humans

B

Bacillus thuringiensis (Abbreviation: Bt): A bacterium that produces a toxin against certain insects, particularly Coleopteran and Lepidoptera; a major means of insecticide for organic farming. Some of the toxin genes are important for transgenic approaches to crop protection.

Bacteria: Single-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.

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.

Bio sequestration: Bio sequestration is the capture and storage of dead biota by biological/physical processes.

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: bio sorbents.

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.

Biochar- It is the solid charcoal like material obtained from the thermochemical conversion of biomass in an oxygen limited environment

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. Biodiversity or 'Biological diversity' is a term which describes every living organism within a single ecosystem or habitat, including numbers and diversity of species and all environmental aspects such as temperature, humidity, oxygen and carbon dioxide levels and climate. Biodiversity can be measured globally or in similar settings, such as in ponds.

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 micro biotic 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 sulphite 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 Factors - These include genetic influences, brain chemistry, hormone levels, nutrition and gender.

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 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.

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.

Bio-methanation: Methanogenesis or bio methanation is the formation of methane by microbes known as methanogens.

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.

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.

Bioswales: A vegetated, shallow, landscaped depressions designed to capture, treat, and infiltrate stormwater runoff as it moves downstream

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-sulphur, 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.

BMI: Body Mass Index (BMI) is an approximate measure of whether someone is over- or underweight, calculated by dividing their weight in kilograms by the square of their height in metres. BMI is more often correlated with total body fat. This means that as the BMI score increases, so does a person's total body fat.

BMR: **Basal metabolic rate (BMR)** is a measurement of the number of calories needed to perform your body's most basic (*basal*) functions, like breathing, circulation and cell production. BMR is most accurately measured in a lab setting under very restrictive conditions. But, there are some empirical relations which may be used to calculate approximate BMR of someone.

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 cadastral units, 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 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.

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 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 formula for carbon equivalents is:

Carbon Footprint: the amount of carbon dioxide released into the atmosphere as a result of the activities of a particular individual, organization, or community. The amount of carbon dioxide released into the atmosphere as a result of activities like use of electricity, transportation, cooking etc. by an individual, organisation 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 storage of carbon dioxide in vegetation such as grasslands or forests, as well as in soils and oceans is known as carbon sequestration.

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.

Carrying Capacity: The maximum number of people or individual of a particular species that a given part of the environment can maintain indefinitely.

Catastrophic: Involving or causing sudden great damage or suffering.

Catchment area: The area from which rainfall flows into a river, lake or reservoir

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.

Circadian Biology- The natural cycle of physical, mental and behavioural changes that the body goes through in a 24-hour cycle. Circadian rhythms are mostly affected by light and dark.

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.

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.

Cluster random sample: The population is first split into groups. The overall sample consists of every member from some of the groups. The groups are selected at random.

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.

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: 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.

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.

Collagen: It is the most abundant protein in the human body, found in the bones, muscles, skin, and tendons.

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.

Conventional (chemical) farming: Conventional farming makes use of pesticides, fungicides and herbicides to protect plants and fertilizers to enhance their growth and fertility.

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 SO2.

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.

Dementia: Dementia is the loss of cognitive functioning — thinking, remembering, and reasoning — to such an extent that it interferes with a person's daily life and activities.

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.

Depression: It is a mood disorder that causes a persistent feeling of sadness and loss of interest, affecting how someone feels, thinks and behaves, and can lead to a variety of emotional and physical problems.

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.

Dew point – It is the temperature to which air must be cooled to become saturated with water vapour when cooled below the dew point, the moisture capacity is reduced and air borne water vapour will condense to form liquid vapour called dew.

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.

Dynamism: Quality of being characterized by vigorous activity and progress.

E

Ecological characterization: Ecological characterization is a structured approach to the synthesis

of human, physical, and ecological information for management purposes

Ecological Economics: Ecological concept applied to economy, the capacity of the natural environment to absorb wastes, to generate replenished resources etc.

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.

Ecological restoration: Recovery of disturbed or destroyed land or water ecosystems with the aid of supporting practices.

Ecology: A branch of science concerned with the interrelationship of organisms and their environment; the study of ecosystem.

Economic threshold level: The population density of insect-pest at which control measures should be determined to prevent an increasing pest population from reaching the Economic injury level.

Economy: System of production, distribution, and consumption of goods.

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

Eco-restoration: Ecosystem Restoration is the "process of assisting the recovery of an ecosystem that has been degraded, damaged or destroyed" (SER Primer, 2004)

Ecosystem approach: The ecosystem approach is a strategy for the integrated management of land, water and living resource that promote conservation and sustainable use in an equitable way. The ecosystem approach places human needs at the centre of biodiversity management. It aims to manage the ecosystem, based on the multiple functions that ecosystem performs and the multiple uses that are made of these functions. The ecosystem approach does not aim for short term gains, but aims to optimise the use of an ecosystem without damaging it.

Ecosystem Management- It is an approach to natural resource management, which ensures long term sustainability OR It is a way of conserving ecological services and biological resources. It is important for the functioning of ecosphere processes and for the wellbeing of biotic and abiotic components of the earth.

Ecosystem Services: Ecosystem services are the direct and indirect contributions of ecosystems to human wellbeing. They support directly or indirectly the survival and quality of human life.

Ecosystem: An ecosystem includes all living things in a given area, as well as their interactions with each other and with their non-living environments (weather, earth, sun, soil, climate, atmosphere). Each organism has a role to play and contributes to the health and productivity of the ecosystem as a whole. 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.

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.

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.

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 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).

Emissions: The release of a substance (usually a gas when referring to the subject of climate change) into the atmosphere.

Empirical: Verified by observation or experience rather than on theory

Empowerment: The process of becoming stronger and more confident

Endemic: Species characteristic of or prevalent in a particular or restricted locality or region.

Endogenic Factors- With reference to health, these are the factors produced by an organism or cell, like biological, cognitive etc.

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 Ethics - It is the philosophic study that examines the ethical relationship of humans and the environment.

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.

Epistemology: Theory of knowledge, especially with regard to its methods, validity, and scope, and the distinction between justified belief and opinion is termed as Epistemology.

Ethanol (C2H5OH): 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).

Ethics: A set of moral obligations that define right and wrong in our practices and decisions.

Ethnobotanical: Ethnobotany is the study of a region's plants and their practical uses through the traditional knowledge of a local culture and people

Ethno-medicine: It is the traditional ***medicine*** based on bioactive compounds in plants and animals and practiced by various ethnic groups, e.g., indigenous peoples.

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.

E-Waste: Discarded broken or obsolete electronic components and appliances such as mobile phones, computers, televisions, motherboards etc.

Exhaustion and Fatigue: Exhaustion is a state of extreme physical or mental tiredness, while fatigue is extreme tiredness resulting from mental or physical exertion or illness

Exogenic Factors- With reference to health. Any material that is present and active in an individual organism or living cell but that originated outside the organism.

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.

F

Fauna: All of the animals found in a given area.

Fecundity: The ability to produce an abundance of offspring or new growth i.e. fertility.

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, Carbon Dioxide: An expression (sometimes reduced to fertilization) used to denote increased plant growth due to a higher carbon dioxide concentration.

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.

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.

Flagship species: A flagship species is a species selected to act as an ambassador, icon or symbol for a defined habitat, issue, campaign or environmental cause.

Flaring: The burning of waste gases through a flare stack or other device before releasing them to the air.

Flora: The term flora in Latin means “Goddess of the Flower.” Flora is a collective term for a group of plant life found in a particular region. The whole plant kingdom is represented by this name. All of the plants found in a given area.

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 sulphur dioxide produced during combustion is removed by reaction with limestone to produce solid calcium sulphate.

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 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.

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: The remains or impression of a prehistoric plant or animal embedded in rock and preserved in petrified form

Frugal: Frugal can be termed as an effective solution in a resource-constrained environment. It is a matter of redesigning products and processes to cut out unnecessary costs to make it more affordable and sustainable. It can be defined as an innovation manifestation which aims at redesigning products, processes and services for substantial cost reduction, to concentrate on core functionalities, and to optimize performance level as per needs/aspirations of billions of poor in the emerging economies. It aims to deliver appropriate, easily accessible, affordable and locally adoptable products/processes/services to socially and economically excluded population and solve their complex problems in day-to-day life."

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

Gasification: Gasification is a process that converts organic- or fossil fuel-based carbonaceous materials into carbon monoxide, hydrogen and carbon dioxide

Gasohol: Vehicle fuel consisting of a mixture of gasoline and ethyl or methyl alcohol; typically 10 to 23 percent ethanol by volume.

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 vapour, 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 analyse 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 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.

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.

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 (CO2), methane (CH4), nitrous oxide (N2O), halogenated fluorocarbons (HCFCs), ozone (O3), per-fluorinated carbons (PFCs), and hydrofluorocarbons (HFCs).

H

Habitat: A place or type of site where an organism or population naturally occurs. **It is t**he natural home or environment of an animal, plant, or other organism. A habitat is made up of physical factors such as soil, moisture, 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.

Handprint: It is an innovative approach to facilitate the measurement, evaluation and communication of the ecological, economic, and social sustainability impacts of products.

Hazardous: Dangerous

Heat content: The amount of heat per unit mass released upon complete combustion.

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.

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

Holozoic animals: Animals that obtain nourishment by feeding on plants or other animals,

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).

Hydrologic cycle: The process of evaporation, vertical and horizontal transport of vapour, 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.

Hydrological Cycle: Water Cycle

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

Hydrology: The branch of science concerned with the properties of the earth's water, and especially its movement in relation to land.

Hydrolysis- A reaction used to break a molecule into two smaller parts using water.

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.

ICT: Information and Communication Technology

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.

Indicator species: An organism (mostly plants and microorganisms) whose presence, absence or abundance reflects a specific condition of an environment and/or ecosystem is termed as **indicator species**. An indicator species is an organism whose presence, absence or abundance reflects a specific environmental condition. Indicator species can signal a change in the biological condition of a particular ecosystem, and thus may be used as a proxy to diagnose the health of an ecosystem.

Indigenous: Native and originating or occurring naturally in a particular place.

Indirect benefit: Invisible gains

Industrial sector: Construction, manufacturing, agricultural and mining establishments.

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.

Infestation: Presence of an unusually large number of insects or animals in a place that can typically cause damage or disease

Infiltration: The process by which water on the ground surface enters the soil

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.

Intangible benefit: Invisible gains

Intercropping: Intercropping is the practice of growing two or more crops in proximity.

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.

Intermediate technology: It is a kind of technology which is in between complex, large, high-cost technology and small-scale traditional technology.

Invasive species: The species which are introduced – intentionally or unintentionally – to an ecosystem in which they do not naturally appear and which ultimately compete for nutrients with the local species thereby threatening habitats, ecosystems or native species.

Irreversibility: 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 vapour 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 illuminate when burned in wick lamps.

Keystone species: A keystone species is a species that plays an essential role in the structure, functioning or productivity of a habitat or ecosystem at a defined level (habitat, soil, seed dispersal, etc.).

Kiosks: Small booth that displays information

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

Land use: Land use refers to how a specific piece of land is allocated: its purpose, need or use (e.g. agriculture, industry, residential or nature).

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

Leaching of soil – Leaching occurs as excess water removes water soluble nutrients out of the soil be runoff or drainage.

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 (sulphate 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 vapour and the heat of the vapour 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

Macro animals: A large and usually polymorphic biological species markedly discontinuous from its congeners

Macro-organisms: Macro-organisms 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 molluscs 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.

Mechanical advantage – It is a measure of force amplification achieved by using a tool, mechanical device or machine

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.

Meteorology: The science of weather-related phenomena.

Methane (CH4): 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 (CH3OH): A colourless poisonous liquid with essentially no odour 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 CO2 and water by metabolism under aerobic conditions.

Methyl bromide (CH3Br): An effective pesticide; used to fumigate soil and many agricultural products. Because it contains bromine, it depletes stratospheric ozone when released to the atmosphere.

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.

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

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

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.

Moisture content- the amount of water present in particular substance usually expressed as a percent per cent of weight

Molecule: Chemical combination of two or more atoms of the same chemical element (such as O2) or different chemical elements (such as H2O).

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.

Mood disorders: It is a mental health condition that primarily affects emotional state that can cause persistent and intense sadness, elation and/or anger.

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 sulphate 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 suppress weed growth, retain soil moisture, or prevent freezing of roots.

Multi-storied: Having many storeys

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.

Native species: Flora and fauna species that occur naturally in a given area or region is known as native or indigenous species.

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.

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 (C3H8) and butane (C4H10).

Natural Resource Management: Natural Resource Management (NRM) refers to the sustainable utilisation of major natural resources such as land, water, air, minerals, forests, fisheries, and wild flora and fauna.

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 (NOx): 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 (N2O): 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 processes.

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

Occupational Practices- A practice related to occupation is called occupational practice. It requires knowledge, skills and abilities.

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 vapour, which can be condensed to form a slow flowing heavy oil called shale oil.

Ontology– it is a science of philosophical study of being and related concepts such as existence, becoming and reality.

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 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, sulphur, 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.

Organic: Production of crops, fruits and vegetables without the use of chemical fertilizers, pesticides, or other artificial chemicals

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 (O3): A colourless gas with a pungent odour, having the molecular form of O3, 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 (O_3) 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.

Pasture land: Area covered with grass or other plants suitable for the grazing of animals.

Pectin- A polysaccharide composed mainly of D-galacturonic acid units and found in middle lamella of terrestrial plants

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 fibres, paints, medicines, and many other products.

Petroleum coke: A residue that is the final product of the condensation process in cracking.

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.

pH (Potential of hydrogen)- used to measure the concentration of hydrogen ions in a solution in terms of negative log of the hydrogen ion concentration. This is used to measure the acidity or alkalinity of a solution.

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 Arc: Plasma arc is formed between an electrode (which is usually but not always made of sintered tungsten) and the workpiece.

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).

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.

Policy framework: A document that sets out as a set of procedures on goals, which might be used in negotiation or decision making to guide a more detailed set of policies.

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.

Poly-loom: Weaving with strips of plastics

Polysaccharide- Long chain carbohydrates composed of several monosaccharide units bound together by glycosidic linkages

Polyvinyl chloride (PVC): A polymer of vinyl chloride. It is tasteless, odourless and insoluble in most organic solvents. A member of the family vinyl resin, used in soft flexible films for food packaging and in moulded rigid products, such as pipes, fibres, 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 one.

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.

Pulley system- A pulley is a collection of wheels looped over a rope that is used to lift loads. A pulley system is an easy way to lift heavy objects, as compared to lifting the object barehanded. A single pulley only serves to change the direction of the applied force. When two or more forces are used in a system, then the pulley not only changes the direction of applied force for but also multiplies the input force. If one fixed and one movable pulley is applied in a system, the system almost doubles the amount of force applied by a person.

Q

Quad: Quad stands for quadrillion, which is, a thousand raised to the power of five (10^{15}). A quadrillion is one followed by fifteen zeroes. If you're looking for a mnemonic, the root word, quad, "four" from the Latin Quadric, refers to the number of groups of three zeroes that follow one thousand.

Quadrat: Each of a number of small areas of habitat, typically of one square meter, selected at random to act as samples for assessing the local distribution of plants or animals.

Quadrate method of survey: Survey of plant or animals in a definite size of square area.

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

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).

Radioactive: Emitting or relating to the emission of ionizing radiation or particles.

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 than 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.

Resource-constraint environment: Situation where lack of access to natural resources, skill and capital can become limiting factors.

Respiration: The process by which animals use up stored foods (by combustion with oxygen) to produce energy.

Rotation Per Minute (RPM): Number of rotations a wheel complete within a minute time.

S

Sacred Groves: A patch of vegetation mostly protected by the society /family due to various faiths and sentiments.

Sampling: Sampling is the process of selecting a representative group from the population under study. The target population is the total group of individuals from which the sample might be drawn.

SARS CoV: It is a viral respiratory disease caused by a SARS (Severe Acute Respiratory Syndrome)-associated coronavirus.

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.

Secondary oil recovery: Injection of water into an oil well after primary oil recovery to force out some of the remaining thicker crude oil.

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).

Seismic: Related to earthquakes, other vibrations of the earth and its crust.

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.

Simple random sample: Every member and set of members has an equal chance of being included in the sample.

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.

Social Enterprise: Organisation that applies commercial strategies to maximize social impact alongside profits

Societal Ideation: The process of bringing ideas to life by collaborating, commenting, etc.

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: Complex mixture of inorganic minerals (i.e., mostly clay, silt, and sand), decaying organic matter, water, air, and living organisms.

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.

Solvent extraction- A method used to separate compounds present in solution based on their relative solubility in two immiscible solvents

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.

Species: A group of organisms capable of interbreeding freely with each other but not with member of other species.

Sporadic: A disease which occurs only infrequently, haphazardly, irregularly or occasionally from time to time in a few isolated places with no discernible temporal or spatial pattern, as opposed to a recognizable epidemic or endemic pattern, is considered as sporadic.

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.

Strain- Strain is the amount of deformation experienced by the body in the direction of force applied, divided by the initial dimensions of the body. The deformation or elongation of a solid body due to applying a tensile force or stress is known as tensile strain

Stratified random sample: The population is first split into groups. The overall sample consists of some members from every group. The members from each group are chosen randomly.

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.

Stress- Stress is defined as force per unit area within materials that arises from externally applied forces. The external force per unit area of the material resulting in the stretch of the material is known as tensile stress.

Stress-strain curve- A stress-strain curve is a graphical way to show the reaction of a material when a load is applied. It shows a comparison between stress and strain. The stress-strain diagram provides a graphical measurement of the strength and elasticity of the material. Also, the behaviour of the materials can be studied with the help of the stress-strain diagram, which makes it easy to understand the application of these materials.

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 (SO2): A compound composed of one sulphur and two oxygen molecules. Sulphur dioxide emitted into the atmosphere through natural and anthropogenic processes is changed in a complex series of chemical reactions in the atmosphere to sulphate 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 (SF6): 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 SF6 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)

Sustainable Development Goal: Sustainable Development Goal (SDGs) are a set of 17 global goals adopted by the United Nations General Assembly in 2015 with a vision of ending poverty, protecting the planet and ensuring that all people enjoy peace and prosperity by 2030.

Sustainable Development: The development that meets the needs of the present without compromising the ability of future generations to meet their own needs, according to the World Commission on Environment and Development (WCED).

Sustainable Living: Sustainable living is a lifestyle that attempts to reduce an individual's or society's use of the earth's natural resources and personal resources. Practitioners of sustainable living often attempt to reduce their carbon footprint by altering methods of transportation, energy consumption, and diet.

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.

Systematic Random Sample: Individuals are selected at regular interval from the sampling frame for ensuring an adequate sampling size.

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.

Tangible benefit: Visible gains

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.

Tensile strength- Tensile strength is the ability of a material to withstand a pulling (tensile) force and refers to the breaking strength of a material when applying a force capable of breaking at a constant rate of extension/load. It is customarily measured in units of force per cross-sectional area.

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.

Terrestrial: Pertaining to land.

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 map characterized by large-scale detail and quantitative representation of relief, usually using contour lines, but historically using a variety of methods. Traditional definitions require a topographic map to show both natural and man-made features

Toxic Fumes: A fume or fumes refers to vapours (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.

Tradition: A practice (evolved by the society) of doing something commonly by the various sects of society from the remote past.

Traditional Ecological Knowledge: The evolving knowledge related to plants, animals and natural phenomena acquired by local people over hundreds or thousands of years through direct contact with the environment.

Traditional Knowledge System: 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.

Traditional Value and Ethics: The traditional cultural practices which prioritise dos and don'ts in the aspects in relation to natural resource harvesting, conservation, and equitable sharing.

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 kilometres. 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 (UV) radiation: 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.

Umbrella species: Species that have either large habitat need or other requirements whose conservation results in many other species being conserved at the ecosystem or landscape level.

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, happened or existed before

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

Urban habitat: Urban habitats are essentially altered or transformed by human use. Land may be predominantly occupied by construction or infrastructure and the ecosystems and species assemblages that occurred there previously, may be completely or almost completely lost.

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)

V

Vehicle miles travelled (VMT): One vehicle traveling the distance of one mile. Thus, total vehicle miles is the total mileage travelled by all vehicles.

Vernacular name: A common name of a plant or animal in the local language or dialect.

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 footprint: Quantity of fresh water used directly or indirectly by a person or community.

Water mill: A mill operated with the help of kinetic energy of flowing water

Water Vapour: The most abundant greenhouse gas; it is the water present in the atmosphere in gaseous form. Water vapour 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 vapour in the atmosphere condenses to form ice and water droplets and precipitation.

Waxes: Solid or semisolid materials derived from petroleum distillates or residues. Light-coloured, 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 of scales 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.

Wild species: Organisms captive or living in the wild that have not been subject to breeding to alter them from their native state.

Wood energy: Wood and wood products used as fuel, including roundwood (i.e., cordwood), limb wood, wood chips, bark, sawdust, forest residues, and charcoal.

Z

Zoonotic: Pertaining to a disease that is naturally transmissible between the vertebrate animals and human beings. There are number of zoonotic diseases. Some examples include: rabies, anthrax, tuberculosis.

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".