National Children's Science Congress 2016-2017

Focal Theme:
Science, Technology and Innovation for
SUSTAINABLE DEVELOPMENT :
A focus on Accessibility for persons with disabilities

ACTIVITY GUIDE

A Programme of
Department of Science and Technology
Government of India

Catalysed & Supported by
National Council for Science & Technology Communication (NCSTC)
Dept of Science & Technology, Govt of India
Technology Bhavan, New Mehrauli Road
New Delhi-110 016

Published by
Gujarat Council on Science & Technology (GUJCOST)
Dept of Science & Technology, Govt of Gujarat

Block B, 7th Floor, M S Building, Sector 11,
Gandhinagar – 382011, Gujarat, India

NCSC Themes covered so far

1993	Know Your Environment
1994 & 1995	Clean-Up-India
1996 & 1997	India is our Dream Let's go for it
1998 & 1999	Nature Let's Care, Share & Conserve
2000 & 2001	Indigenous Scientific Knowledge for a better tomorrow
2002 & 2003	Food System towards nutrition for all
2004 & 2005	Harness Water Resources for our Future
2006 & 2007	Biodiversity: Nurture Nature for our Future
2008 & 2009	Planet Earth: Explore, Share and Conserve
2010 & 2011	Land Resources: Use for Prosperity, Save for Posterity
2012 & 2013	Energy: Explore, Harness and Conserve
2014 & 2015	Understanding Weather and Climate
2016 & 2017	Science, Technology & Innovation for Sustainable Development

National Children's Science Congress
2016-2017
Activity Guide Book

Published by
Gujarat Council of Science & Technology (GUJCOST)
Dept of Science & Technology, Govt. of Gujarat
Block B, 7th Floor, M S Building, Sector 11,
Gandhinagar – 382011
Gujarat, India

Catalysed and Supported by
National Council for Science & Technology Communication (NCSTC)
Dept of Science & Technology, Govt. of India
Technology Bhavan, New Mehrauli Road, NEW DELHI-110 016
Email: ujjwala@nic.in
Telephone: 011-26535564/ 226590251.

This resource material compiled in this publication was developed during the Brainstorming Workshop held at Gujarat Science City, Ahmedabad during 21st – 24th Nov, 2015.

Core Working Group for Activity Guide Book development.

Advisor
Dr. B. P. Singh, Head & Advisor, NCSTC, DST, Govt. of India

National Coordinator, NCSC Programme
Dr. Ujjwala Tirkey, Scientist, F, NCSTC, DST. Govt. of India.

Working Group:

- Dr. Narottam Sahoo (Coordinator)
- Prof. H. C. Pradhan
- Dr. R. Gopichandran
- Er. Anuj Sinha
- Mr. T. P. Raghunath
- Shri B. K. Tyagi
- Dr. Pulin Behari Chakraborty
- Mr. Jayanta Kumar Sarma
- Prof. E. Kunhikrishnan,
- Dr. Lalit Sharma
- Er. U. N. Ravikumar
- Dr. P. Pramod
- Dr. Hemant Pande
- Dr. Bharat J Pathank, IFS
- Dr. Sudipto Chatterjee
- Dr. Swapan Kumar
- Shri Kathan Kothari
- Dr. Mani Subramaniam
- Dr. Satyendra N Bhandari

Designed and Illustrated by:
GUJCOST

FOREWORD

National Children Science Congress (NCSC) prompts children to ponder upon some significant societal problem, think over its causes and subsequently try and solve the same using the scientific process. This involve close and keen observation, raising pertinent questions, building models, predicting solutions on basis of models, trying out various possible alternatives and arriving at an optimum solution using experimentation, field work, research and innovative ideas. NCSC encourages a sense of discovery of child scientists.

National Council for Science and Technology Communication (NCSTC) aspire to popularise S&T among school students by exhibitions and demonstrations, training of resource persons particularly teachers, field projects etc. NCSC encourages children to observe, explore, experiment and wonder through a project activity and its associated ways of participation and evaluation rightly takes care of the guiding principles of next generation science learning.

The NCSC is unique programme that motivates children in the age group of 10-17 years, to take-up scientific research on local specific issues of their choice under broad themes, instead of imposing issues on them. NCSC programme is an activity towards promoting congenial team work, correlating science with everyday life situations.

The focal themeof NCSC for the year 2016 and 2017 has been finalized as "Science, Technology & Innovation for Sustainable Development". This has been very inspiring and engaging among children and the community, linking the socially relevant current research issue with the Sustainable Development Goals (SDG). The Activity Guide Book on this broad theme and sub-themes will be distributed widely among the organising and technical coordinators and guide teachers which will help them throughout the programme. Competition and recognition of merit is introduced at district, state and national level.

My best wishes to all of the Child Scientists and the teachers.

New Delhi

(Dr. Bhanu Pratap Singh)
Scientist ‘G/ Head (NCSTC)

Dated:

A Note from National Programme Coordinator

Ms. Ujjwala Tripti Tirkey
Scientist 'F/ Director, NCSTC & National Programme Coordinator.

The National Children's Science Congress (NCSC) is flagship programme initiated in 1993 has reached to 23 years with its great success. It is organised nationally every year from December 27-31. It is forum for 10-17 years age children from urban/ rural area of different state. NCSC programme is not necessarily a school-based programme but it is open to all non-formal systems of education besides out of school and disabled children. NCSC programme is not only limited to Government, Private and Public school but also extended to Kendriya Vidhyalaya Sangathan and Navodaya Vidhyalaya Samiti. All over the country about a million children take part in this unique event every year, from which about 650 projects come to national level. This programme is become popular in ASEAN countries with their participation by delegates.

NCSC programme has covered the topics like Environment, Nutrition, Clean-up India, Water Resources, Biodiversity, Land Resources, Energy, Weather and Climate during its 23 years of great success and also grow up with innovative ideas of Child scientist through their innovative Project work on a variety of highly relevant local issues of above topics.

NCSC has announced "Science, Technology & Innovation for Sustainable Development" as a focal theme for the year 2016 & 2017 with an expectation that the child scientist will be introduced to inquiry based learning approaches in project mode. Sustainable development (SD) is a process for meeting human development goals while maintaining the ability of natural systems to continue to provide the natural resources and ecosystem services upon which the economy and society depend. We are planning to engage child scientist and our teachers to work on Sustainable development goals to become change maker and to change their future.

The Activity Guide Book on (Science, Technology & Innovation for Sustainable Development as a focal theme for the year 2016 & 2017) is brought out with the great efforts of the Experts, Resource Persons, State Academic Coordinator and further involvement State Resource Person involved in the brainstorming session and participated in the National Orientation Workshop.

We hope that the Activity Guide Book will help the State and District Coordinators, Resource Persons, Teachers Guide and Evaluators to carry out the activity, resulting the valuable and potential project ideas that come up in different level of NCSC. Any suggestion with regard to improvement in the Activity Guide Book is always welcome.

My best compliments to all child scientists and heir guide teachers.

New Delhi

Dated:

(Ms. Ujjwala Tripti Tirkey)
Scientist 'F/ Director
National Programme Coordinator

ACKNOWLEDGEMENT

On behalf of Core Working Group for design and development of the Activity Guide Book for the National Children Science Congress 2016 and 2017, I am thankful to NCSTC, DST, Govt of India for considering the theme Science, Technology, Innovation for Sustainable Development, which is very inspiring and engaging.

I am extremely thankful to Dr. B. P. Singh, Head, NCSTC, DST, Govt of India and Mrs. Ujjwala Tripti Tirkey, Scientist F, and National Coordinator, NCSC Programme for their trust and confidence on GUJCOST for the design and development of the Activity Guide Book.

I express my sincere thanks and regards to the esteemed members of the Core Working Group who had attended the brainstorming session at Gujarat Science City during 21-24 November 2015 and contributed a lot in elaborating the focal theme and subthemes in terms of possible projects and activities.

My special thanks are due to NCSTC, DST for the catalytic support and guidance in making this activity guide book.

Last but not least, I express my sincere thanks and gratitude to DST, Govt of Gujarat, GUJCOST and Gujarat Science City for their constant support and encouragement in this programme.

On Behalf of National Academic Core Group

Dr. Narottam Sahoo
Coordinator, NAC

National Council for Science & Technology Communication (NCSTC)
Department of Science and Technology (DST)
Government of India

NCSTC is an apex Organization of the Department of Science and Technology of Government of India that endeavours to

- Communicate Science and Technology
- Stimulate Scientific and Technological temper
- Coordinate and orchestrate such efforts

Goals:

- to create excitement concerning advances in Science & Technology
- to enable informed decision-making at the grass roots level
- to encourage intelligent debate on developmental issues Important Activities
- Research in thrust areas of science and technology communication;
- Development of scripts, films, video and radio programmes, books, slide sets, etc., on selected areas of science and technology;
- Training (short term) for school teachers and activists of science & technology based voluntary organisations in science communication;
- Development of science journalists through University Courses in Science and Technology Communication;
- Awards and recognition for outstanding science communicators;
- Coordination with state councils and networks of S& T based organisations;
- Developing capacity through science communication
- Field programmes for demonstrating innovative ideas of science popularisation, outreach and extension activities including National Children's Science Congress, Science Day celebrations, promotion of voluntary blood donation programmes, environmental awareness and positive action, etc., and Promoting International Cooperation for mutual benefit.

For further details please contact

National Council for Science & Technology Communication
Dept of Science and Technology, Govt of India
Technology Bhavan, New Mehrauli Marg,
New Delhi 110016
Phones: 011-26521865/011-26590302
Fax: 011-26521865
Visit: http://www.dst.gov.in/scientific-programme/s-t_ncstc.htm

GUJARAT COUNCIL ON SCIENCE AND TECHNOLOGY
Dept of Science & Technology, Govt of Gujarat

The Gujarat Council on Science and Technology (GUJCOST) was established in September, 1986, to play a catalytic role in promoting the use of Science and Technology in the development process of the State. The S&T Council was constituted with a view to develop technologies appropriate to and in harmony with present conditions. The Council has been catalyzing interaction between developers and users of technologies, by bringing on a common platform to training Scientists and Engineers on the one hand and policy makers as well as administrators on the other.

Accordingly, the State Council is identifying the areas in which Science and Technology can be applied for development activities and achieve the goals of the State, with a particular emphasis to eliminate the prevailing backwardness, rural unemployment and poverty. It was also felt necessary to establish effective Communication and other links between, and Co-ordinate the activities of centres of Scientific and Technological Research, Government agencies and industries in order to promote the application of Science and Technology in the State.

The Council is an autonomous body registered under the Societies Registration Act from 1st February, 2000 and working under department of Science & Technology. Hon'ble Minister of Education is the Chairman of the Council. The Administration and Management affairs of the state Council is inducted by the Governing Board. The Board has constituted Executive Committee for fast Execution of work. The day to day affairs and administration of the State Council is looked after by its Advisor who is also Member Secretary of the Council. Presently GUJCOST is working at B/7, M.S. Building, Sector-11, Gandhinagar.

CONTENTS

About National Children's Science Congress (NNCSC)

1. NCSC- The Beginning

The seeds of the programme of National children's science congress (NNCSC), in the way of an exercise to carry out small research activities at micro-level were planned in Madhya Pradesh by an NGO called Gwalior Science Center. It was later adopted by National Council for Science and Technology Communication (NCSTC), Department of Science & Technology (DST), Government of India for carrying out national level activities through NCSTC-Network (a network of Non-Government and Government organizations working in the field of science popularization) as national organizer.

It was a time when many of the country's crusaders of science communication were experienced with massive science exercise of Bharat Jana Bigyan Jatha and Jana Gyan Bigyan Jatha. It was felt that the large scale activities for developing science awareness among the masses are to be continued as regular activity, so, this programme was launched nationwide in 1993, under nomenclature National Children's Science Congress (NNCSC), with an expectation that it would generate scientific temperament among the teachers and students, and spread among the various stakeholders of the society. The programme of NNCSC has been fruitfully conducted for the last 21 years.

2. NCSC: An overview

Children's Science Congress is targeted to spread the concept of the method of science among the children their project activities adopting the principle of learning through doing'. The mandate of participation is that, the children will carry out a project on a particular topic in relation to theme and sub-theme decided for the year. The study is to be carried out in the neighbourhood of the children where they live.

For this, the students form a group with their like-minded friends/classmates and the study is carried out under the supervision of a guide. It is noteworthy that, NCSC programme is not only for the school going children but is also open fort the children outside the formal boundary of schools, in the age group of 10 to 17 years (where 10 to 14 years is considered as junior group and 14 + to 17 years as senior group).

Further, it is not mandatory that a guide must be a school teacher; any persons with fair knowledge of dealing with children and method of science are considered eligible to guide the children, but should not be direct relative of any of the children.

The exercise of project activities, as thumb rule, encourages the children to explore, think, serve and wonder. It is capable to imbibe the following temperament/quality/skill of the children:

- Observation
- Making measurement
- Making comparison and contrasts,
- Classification,
- Estimation,

- Prediction,
- Interpretation,
- Critical thinking,
- Creative thinking,
- Drawing conclusion and
- Cooperative skill

Therefore it is ideally expected that any group of children will undertake a project work with a perspective of continuous effort of questioning and experimentation as shown in Fig-1. Here, observation incorporates anything the children observe in their daily life in the locality, in relation to the theme defined for the year.

The observation should be followed by relevant questioning such as "What? Where? When? Why? How? Whom?". In the search for finding out the answer to the question (s) one is required to review different literature concerning the issues in the study. Review of such literature basically and ideally helps in framing the steps towards the study and experimentation. In the process, one may also discuss with experts of the relevant fields to get information and advice. Initiatives for such activities must be encouraged by the guide associated with the project. These steps will help to frame assumption/ hypothesis.

Hypothesis is an assumption of some cause and its impact on the basic of observation, information collected from different literature and emerged from discussion with experts. After these phases, actual study through survey or experimentation or survey followed by experimentation would start. In the case of survey-based work, identification of respondent, their unit of observation, sample coverage, design of survey in relation to designing of interview schedule or questionnaire is supposed to be the most critical steps. Such decisions may vary with the issues of study. On the other hand, in case of experimentation, setting the objective of experimentation, defining different parameters, identification of ideal instruments, framing of procedures/ steps and control along with repetitive observation of the experiments are critical decisions, which will determine the path towards the result. Again in relation to issues of study, such experiment may be either laboratory experiments or field experiments.

It is expected that in course of time, the children's project will bring in lots of new information about problems and prospects of their locality along with innovative ideas to address these issues. Moreover, in the course of project work, the children may develop different new approaches of study along with the development of different instruments for their experiments. Such tools/instruments may be developed with the material in their access/available to them nearby. Another expectation was that the outcome of different studies will be communicated among the local populace, which in turn, helps in generating scientific temperament among the general mass.

In a nutshell, the NCSC projects are simple, innovative, concerned with local issues related with day to day life and are carried out with very nominal cost, where the focus is more on logical interpretation and analysis of issues, and finding out pragmatic solutions of generic nature to the possible extent, and not merely confined to the study topic and corresponding model making.

3. Objectives of NCSC

The primary objective of the Children's Science Congress is to make a forum available to children of the age-group of 10-17 years, both from formal school system as well as from out of school, to exhibit their creativity and innovativeness and more particularly their ability to solve a societal problem experienced locally using the method of science.

By implication, the NCSC prompts children to think of some significant societal problems, ponder over its causes and subsequently try and solve the same using the scientific process. This involves close and keen observation, raising pertinent questions, building models, predicting solutions on the basis of a model, trying out various possible alternatives and arriving at an optimum solution using experimentation, field work, research and innovative ideas. The Children's Science Congress encourages a sense of discovery. It emboldens the participants to question many aspects of our progress and development and express their findings in their vernacular.

4. Relevance of NCSC in the light of contemporary educational Initiatives

The basic approach of NCSC is the principle of learning through doing on the issues of children's immediate environment significantly caries the spirit and mandate of education for sustainable development (ESD) of UNESCO, National Curriculum Framework (NCF, 2005) and Right to Education (RTE, 2009).

The modalities and approaches of NCSC cater to the five pillars of learning of education for Sustainable Development vividly, viz. Learning to know, learning; to do, learning to live together and learning to be, learining to transform one self and society (Declaration of I SI) in the 57th meeting of the United Nations General Assembly in December 2002, which proclaimed the UN Decade Education for sustainable Development, 2005- 2014, refer www.desd.org and www.unesco.org)

The mandate of NCSC which encourages children to observe, explore, experiment and wonder through a project activity and its associated ways of participation and evaluation rightly takes care of the guiding principles of the NCF, 2005. Therefore, example of children's Science Congress has been rightly cited in the NCF documents under executive summary section, page ix (http://www.teindia.nic.in/Files/NCF 2005.pdf). Similarly NCSC activities also helps in materializing the approach of learning as framed in the Right of Children of Free and Compulsory Education (RTE)Act, 2005 particularly in relation to article 6.1, section C (ii, iii, iv, v)].

More over the NCSC activities, since 1993, has catered to many of the approaches and priorities of Science education visualized in the National Programme of Sarva Shiksha Abhiyan (SSA) (Ref: SSA framework, http// s s a k a r n a t a k a . g o v. i n / p d f s / a b o u t u s / ssa_framework%20.pdf) and Rashtriya Madhyamik Shiksha Abhijan (RMSA) (Ref:http://www.educationfor-allinindia.com/rastriya-madhyamic-shiksha-mission-RMSM.pdf).

5. Eligibility Criteria for Participants

It is open for children in the age of 10 years to14 years (lower age group) and from 14+ years to 17 years (upper age group) as on December 31 of the calendar year. A group of children not exceeding five can do the project study under a guide teacher. A child scientist, who had already presented as a Group Leader at the National Level in one age- group can act as a co-worker in the subsequent year, in the same age group (lower / upper). Parents, whose child would participate in the Children's Science Congress in the ensuing year, should not hold any portfolio in the organizing committee of the NCSC conducted at any level.

6. Modalities of Participation

Following are major steps involved for participations in the NCSC:

A social movement along the lines of the Children's Science Congress should be visualized in order to promote discovery learning across the nation, and eventually throughout South Asia" – National Curriculum Framework 2005, Executive Summary, Page (ix).

7. Nature of NCSC Project

NCSC projects are:

- Innovative, simple and practical;
- Representing teamwork;
- Based on exploration of everyday life-situations;
- Involving field based data collection;
- Having definite outputs, arrived through scientific methodology;
- Related directly to community work in the local community;
- Having follow-up plans.

8. Criteria of Good Projects

As per past experience it has been found that projects rated very good had the following elements while implementing and documenting the project:

- Proper understanding and definition of the problem undertaken.
- Quality and quantity of work, including team work, learning process, subject understanding and efforts to validate the data collected.
- Relevance of the proposal to the community/school problem and impact of project on schoolmates, neighbourhood community.
- Originality, innovation and creativity shown to understand the problem and find solution i.e. in methodology and experiment design.

The Project may follow the steps of SMART approach

S: Specific: The subject/issues of study must be specific.

M: Measurable: The issues of study must be measurable in quantitative /qualitative forms so that component of comparability is maintained.

A: Appropriate: The topic must be ppropriate to the focal theme and sub themes, along with field study area, methodology must be appropriate to nature of the issues considered for the study.

R: Realistic: The issues of the study must be realistic along with the methodology adopted for the purpose.

T: Time bound: Study must be carried out in a limited time frame. The project activities may not destabilize normal activity /schedule of the child.

9. Points to remember

The project work of NCSC must be carried out in a systematic way so that it can rightly reflect the method of science in the works. The issue of the study may demand experimental survey works or both. In case of experimental works design and principle of the experiments are very important factors which may help to get a better result in a rational way. In such case parameters of observation and verification through the experiment and its logical selection must be reflected vividly along with sets of control and approached of data validation. Similarly, in case of survey based projects universe of the study, criteria of

selection, sample coverage, design of questionnaire or interview schedule are very important along with approached of data compilation, validation, analysis and interpretation. Prototype model or functional models are only encouraged to be used in project presentation if issues and methods of study demands for it.

Log-Book. Proper work diary has to be maintained while carrying out the project works. The day to day activity has to be neatly noted in the form of a log-book and should be submitted with the project report at the time of submission. All the details, such as project title, name of the group leader etc. should be written clearly on the cover.

10. Structure of the Project Report

The structure of the project report of NCSC shall be as follows:

i. Cover page – must incorporate
- Title of the project
- Name and address of Group leader and coworkers
- Name and address of guide

ii. Form – A (Registration Form)

iii. Abstract – in 250 words for lower age group and 300 words upper age group (one copy in English) Please see Annexure VI for the Format for writing the Abstract.

iv. Contents- list of chapter with detail heading and sub-heading, list of table, chart, maps, etc. along with references against page numbers.

v. Introduction- description on background of the study

vi. Aims and objectives of the study

vii. Hypothesis

viii. Need statement & Relevance.

ix. Methodology:

i. Experimentation,
ii. Survey (if related to the project, neatly describe Survey methodology followed, sampling procedure, Sample size etc.) Remember that projects having only a Survey component do not qualify to be an NNCSC project and would be rejected. Survey can be an additional component of the methodology, to strengthen the project outcomes, to understand the Knowledge, Aptitude and Practices of the population).

x. Observations: By this we mean what we observe during the experiment, what outcomes are seen etc. Observation can be both qualitative as well as quantitative, but in NNCSC, we mean quantitative mode where we end up having specific data from the experiments. Please note that observing some phenomenon is different in scientific parlance where every observation leads us to better understanding of the phenomenon, where we generate specific information as to when something happened, why, under what conditions and what /how much the change occurred.

xi. Data analysis and interpretation: From the data that we generate /obtained from the experiments/observations, the data is processed for better understanding of the

phenomenon in a more structured manner. We can use many tools and methods to analyse the data where we try to understand the patterns that emerge from it to form results and later conclusions. We need to remember that the raw data that is generated is not the Results, rather we use the raw data and interpret the data using tools /methods (eg. Statistical methods).

xii. Results: Results are the output of our compilation of the data into meaningful outcomes /interpretations and sometimes, we may need to redo the experiments to get consistent results. If in case, we are not able to "repeat the experiments", we need to have adequate replicates so that adequate data is available for interpretation, and arriving at results.

xiii. Conclusions: This is the logical end of the project where the experimenter tries to arrive at specific conclusions from the observed phenomena. In a way, the whole objective of the project was to arrive at some conclusion, either positive or negative which would lead to a better understanding of the problem.

xiv. Solution to the problem: Once the problem is understood using the above steps, then we can attend searching for solutions to the problems. Most often, the correct understanding of the problem would lead us to one or many solutions.

xv. Future plan (Including any follow up plans): We can chalk out a future plan of action for taking the problem further, studying it deeper with more intensity and with more observations (replications, repeatations etc.)

xvi. Acknowledgement

xvii. References

The word limit for the written report for the lower age group is 2500 and that for the upper age group is 3500. The written report can be substantiated by including limited number of photographs, sketches, illustrations and / or drawings, etc.

11. Oral Presentation:

Oral presentation at the technical sessions of the congress is a very important component of the entire process. Effective communication during the briefing of the issues of study, its objectives, methodology adopted for the study, important observation and findings, vital aspects on the way and approach to solve the problem or addressing the problem is a very critical part of the exercise, since only 8 minutes' time is allotted for the purpose. Therefore, one has to plan pragmatically for this purpose. Children can use 4 different posters (which is mandatory) to make their presentation easier, clearer and richer. Posters must be prepared on 55 cm x 70 cm (21.6" x 27.5") drawing sheets (i.e. chart papers). If needed power point presentation may be used.

Your posters should contain bulleted points information on (1) The project title, (2) Names of the group members, (3) Objectives, (4) Map of the area, if any, (5) Methodology, (6) Results, (7) Conclusion, (8) Solution to the problem. Depending upon the nature of the project the poster may or may not have a map and/ or results.

12. Different levels of Congress

Children's Science Congress is organized in three levels where the child scientists and their project works are screened under common evaluation criteria. The evaluation of the project is done for its innovativeness, simplicity and practicality. On the basis of the merit of the project is selected for the next level. The three levels are as follows:

- Block /district level
- State level
- National level.

The District/Block level Congressis the first level in which projects compete with one another and are screened for presentation at the State level Congress, which is the second level. Projects as per State-wise quota (indicated at Annexure- I) are selected from the State level for the Grand Finale – the National Children's Science Congress. Seven to eight lakh child scientists participate at various levels from the States and the Union Territories.

13. Screening

(i) The selection ratio at District/State Level and at State/National Level should be as follows: State: District = 1: 15
(Out of 15 projects presented at District 1 will be screened for State Level.)

(ii) State to National As per State-wise quota indicated at Annexure-I. Projects qualified to take part in the National level are further divided in the ratio of 1:5, where the best projects at the State level are qualified for Oral Presentation at the National level, whereas the rest of the projects that come to the National level are qualified for Poster Presentations. (See AnnexureI for details).

(iii) The selection ratio of Lower age group (10 to 14 years of age) to Upper age group (14+ to 17 years) should be 40:60. For National level, the State Academic Committee can decide which is the best project that would qualify for Oral Presentation irrespective of age group or Rural/ Urban.

14. Tentative Activity Schedule
1) Selection of subjects and activity for registration of teams : June-July
2) Working on the project: Minimum two months
3) District level Congress: By September-October
4) State level Congress: By November
5) National level Congress: 27-31 December
6) Indian Science Congress – 3 to 7th January.
7) 'Kishore VaigyanikSammelan' (at Indian Science Congress) from 3rd to 6th January.

15. Approaches of Project Evaluation
The innovative ideas and scientific methodology are the basis of a good project but one has to prove his communication skills also to make others listen and understand his findings. For doing this, a total cooperation in the group is a must. Accept positive criticism within the group or even from outside and improve the work plan. This will bring award and recognition.

15.1. Evaluation Criteria
i. Originality of idea and concept:A unique or novel project idea which attempts to answer a specific question - (a hypothesis driven by curiosity to understand any concept related to focal theme). The idea should not be an exact replication of model project as printed in the Activity Guide. A proper explanation of origin of the idea may be demanded by the evaluator.

ii. Relevance of the project to the theme:This section focuses on how the project is relevant to the focal theme/sub-theme.

iii. Scientific understanding of the issue: Refers to the extent of knowledge the child scientist has in relation to the project idea.

iv. Data collection: Systematic collection of information using relevant tools/interviews/ questionnaire. Sample size should be sufficient to support the issues under study.

v. Analysis: This includes tabulation, categorization/classification, and simple statistics as applicable to the study.

vi. Experimentation/Scientific study/validation: Conducting of experiments/field study and validation applying simple methods of science. Experiment need not be every sophisticated or lab based, they could be simple, self developed and inexpensive too.

vii. Interpretation and Problem solving attempt: To what extent the team has addressed the
viii. proposed hypothesis and the issue of the locality through the project.

ix. Team work:It refers to work division, cooperation and sharing among and beyond the team members (the child scientists).

x. Background correction (Only for District level):In this case the background of the children is verified like geographical location of their school, village, town etc. in relation to infrastructure, information and other input related facilities available with them. The logic is that children from difficult geographical situation must get some weightage in comparison to the children from advantageous geographical location. Non-school going children should also get some weightage in this criterion.

xi. Report and Presentation: Written Report andOral Presentation are evaluated separately. Reports are evaluated for its systematic presentation, tabulation of data in support of the project idea and the clarity with which the study is documented and explained. A Log Book(actually a Daily Diary) is mandatory and should be authenticated over the signature of the guide teacher daily.The cover page of the Log Book should carry the names of the child scientists, the district and the Sate, in English. Marks awarded for the presentation covers question and answer with evaluators, presentation of charts/posters, illustrations and other visuals.

xii. Follow up Action Plan (Only for State level): The child scientists should try to find out scientific solution to the bothering problem. Has the team conveyed the message to the community? How it was communicated? Will effort continue to involve more people till the problem is solved? Was any action plan suggested? Credit shall be given for similar efforts.

xiii. Improvement from the previous level (Only for State level):This is to encourage the child scientists towards their continuous involvement with the project for its improvement. Improvements on the work from District to state level and then from State level to the national level will be given marks separately. The evaluators shall specify the areas of improvement on a separate sheet of paper.

xiv. Additional page(s): These must be there in the Project Report with detail description of works of improvement done after the previous level (particularly on the basis of the evaluators' suggestion in the previous level).

15.2. Evaluators

i. Evaluators may please note that the participating children are budding scientists from the age group of 10 to 17 years with limited access to knowledge centers and therefore require encouragement. Having understood their capabilities and capacities, the evaluators provide them with constructive inputs and positive feed-back.

ii. Evaluators appreciate and value the efforts, innovativeness and confidence of the participating child scientists and ensure that their honest assessment work as a guiding light for future endeavors of the child scientists and each one goes back motivated, intellectually richand more confident.

iii. Evaluators should evaluate the projects on the basis of subject matter and scientific content and are not influenced by the gadgetry or models used or oratory skills of the participants. They avoid unwarranted comments and also avoid comparing the works of the child scientists with those carried out by senior members or scientists.

iv. Evaluators should avoid being any source of distraction to the child scientists while presentation is going on and do not take the interactions with the participants as a test what the participating child does not know, rather, they make efforts to know what the child scientist know about the subject area.

15.3. Model consolidated Evaluation Sheet (For District level)

Sl. No.	Criteria	Max. marks	Written Report	Oral Presentation	Total
1	Originality of idea and concept	10			
2	Relevance of the project to the theme	10			
3	Understanding of the issue	15			
4	Data collection & analysis	15			
5	Experimentation/validation	10			
6	Interpretation and Problem solving attempt	10			
7	Team work	10			
8	Background correction	10			
9	Oral presentation/ written report (as applicable)	10			

Model consolidated Evaluation Sheet (For State level)

Sl. No.	Criteria	Max. marks	Written Report	Oral Presentation	Total
1	Originality of idea and concept	05			
2	Relevance of the project to the theme	05			
3	Understanding of the issue	15			
4	Data collection & analysis	15			
5	Experimentation/validation	10			
6	Interpretation and Problem solving attempt	15			
7	Team work	05			
8	Background correction	10			
9	Oral presentation/ written report (as applicable)	10			
10	Improvement over the previous level suggested	10			
Total		100			

Model consolidated Evaluation Sheet (National level) with effect from 2014 onwards

1. The same team of evaluators will evaluate each project for Oral, Written and Poster presentations at one stretch.

2. More time would be allotted for the project evaluation – roughly 20 to 25 minutes – including 8 minutes for Oral Presentation, evaluation of the written report and the posters followed by interaction with the Team leader. With increased time available, the entire screening process would be in a relaxed manner and also in a child-friendly environ.

3. The parameters and attributes under each parameter for the national level evaluation are given below.

Sl. No.	Criteria	Max. Points
A	Oral Presentation	
1	Originality of idea and concept	05
2	Relevance of the project to the theme	05
3	Understanding of the issue	05
4	Data collection & analysis	10
5	Experimentation/validation	10
6	Interpretation and Problem solving attempt	05
7	Oral Presentation	10
	Sub Total – A	50

Sl. No.	Criteria	Max. Points
B	Written Report	
1	Data Collection /Analysis, Graphical Representation etc	15
2	Methodology/Experimental design	15
3	Discussion /Conclusion	10
	Sub Total – B	40
C	Poster Presentation	10
1	Lay out	05
2	Logical Framework	05
	Sub Total – C	10
	Grand Total (A + B + C)	100

Thus each project would have total points of 100, out of which 50% would be for Oral presentation, 40% for Written Report and 10% for Poster presentation.

15.4 Modified Evaluation Criteria for national level NCSC

a. Every State Academic Committee need to be more proactive in the evaluation process at state level NCSC and for this all SACs need to take appropriate action to strengthen their State Academic Committees with subject related persons and also having experience of the programme much more in advance. The SACs will be responsible for proper orientation of the experts, state level evaluators and mentors.

b. Every project selected by the State Academic Committee for national will go through a quality mentoring process following which the State Academic Committee will evaluate the projects and grades to be awarded to each of the mentored projects. The grade sheet authenticated by State Academic Coordinator and State Coordinator is to be sent/ submitted to the National Academic Committee in a sealed confidential envelope. (sample of grade sheet is given in Annexure VII)

c. Out of the projects which will be selected/ recommended from the state to take part in the National event, each state should recommend the best projects in the ratio of 1:5 of their respective state quota, which will be evaluated at the national level for Oral Presentation. Projects selected to the national level should be mentored by the State Academic Committee and the Post Mentoring Score Card for selected projects should be sent to the National Academic Committee (or submitted in person at the NNCSC venue) at the time of the National evaluation process. (See Annexure VII for format). The rest of the projects would be qualified for Poster Presentations as is normally followed in professional scientific conferences /seminar.

d. The selected projects from the states should be endorsed by the State Academic Coordinator and the State Coordinator so that the responsibility of projects being selected to the national level does not rest with the national academic core group. (National Academic Core group would not be responsible in any way for any selection that is done by the respective State Academic Committee (SAC) or District Academic Committee (DAC) or Coordinators at the district or state level. Any query in this regard, would be attended by respective SAC or DAC).

e. Projects selected for oral presentation will be given certificate for Oral Presentation and the projects selected for poster presentation will be given certificate for Poster Presentation. Children who will qualify as outstanding after oral presentation will be given a 'Certificate of Merit'. However, all children irrespective of categories will be handed over medals/ mementos as has been done in the past.

f. The objective of this modified evaluation process is to identify the most 'outstanding' projects. Hence, it is to be noted that this system will be followed at National Level only. At district and state levels the existing methods of evaluation has to be followed.

It is MANDATORY for the projects selected for Oral Presentations at National Level to have the following;

i. The cover page of the project should be either in Hindi or English.
ii. Each project to have one page Abstract in English.
iii. Four numbers of Posters as per the instructions provided in the activity guidebook.
iv. Properly maintained Log book along with written report and posters.
v. Post mentoring Score sheet for all the projects selected for Oral Presentation at the national level with the scores/ grades awarded by the State Academic Committee. (See Annexure VII for details).

These instructions are to be followed strictly else the project would not be evaluated at national level.

16. Organizers

NCSC is organized by National Council for Science and Technology Communication (NCSTC), Department of Science & Technology, Government of India, with active support from NCSTC-Network, as a National Coordinating Agency.

NCSTC-Network is registered Society, comprising a network of 79 organizations, Governmental and Non-governmental, spread over all the States and Union Territories of India, who are working for science popularization.

To organize NCSC at the State Level, each State/Union Territory has a coordinating body viz. State Coordinating Agency, which is a member of the NCSTC-Network.

16.1. Role of District Coordinating Agency, District Coordinators and District Academic Coordinators

i. To agree in writing, on being selected, to act as a District Coordinating Agency and abide by rules and regulations prescribed in this Activity Guide Book and also by the State Coordinating Agency;

ii. To constitute a District Organizing Committee and a District Academic Committee consisting of not less than 7 (seven) teachers, activists, exchild scientists, government officials, officials of the local bodies etc. and send the lists to the State Coordinator by the date specified. The District Coordinators shall act as the Member Secretary of both the Committees;

iii. To register groups of children (not more than 5 in one group) in Form A (Annexure V)and provide them with necessary reference materials, kits and guidance. No. of group registered to be intimated to the State Coordinator by the date specified;

iv. While registering the District Coordinator should be assured that the age of the child scientist falls within the age as on 31st December of the calendar year. If need be a copy of the age certificate may be retained by the District Coordinator, to avoid any confusion at the later stages. Even while participating at the National Congress, the State Coordinator may also keep a copy of the certificate.

v. To select schools from rural and urban area in an equal ratio;

vi. To organize District level Teachers' Orientation Workshops with the help of the State Coordinators;

vii. To interact with local scientist and arrange for their periodic interaction with the registered group of children, if required;

viii. Try to involve at least 50 schools and 250 numbers of project in the district including those from informal education system;

ix. Organize District level Congress, Orientation of Evaluators in consultation with the State Coordinators;

x. To submit Feed-back Reports on all activities, containing names of schools and number of projects at district level and follow up action taken on projects likely to become part of community action, photocopies of all Registration/Attendance Sheets for all Workshops/Meetings, Evaluation Sheets in original, samples of certificates issued, mementos presented to child scientists, photo documentation etc. related to CSC at the District level to the State Coordinator in the manner and by the date specified;

xi. To maintain a Bank Account and maintain Accounts at the District level and submit an audited Receipts & Payment Account to the State Coordinators by the date and in the manner specified;

xii. To maintain infrastructural facilities, including electronic communication facility, such as internet connectivity, fax etc.

xiii. To arrange review and mentoring of the projects selected for presentation at the State level NCSC.

16.2. Role of State Coordinating Agency, State Coordinators and State Academic Coordinators

The State Coordinating Agency shall have the overall responsibility for the implementation of NCSC at the State level. The specific responsibilities shall be –

i. Constitute a State Organizing Committee (SOC) and a State Academic Committee (SAC) where minimum 7 (seven) members to be selected from teachers, activists, ex-child scientists, government officials, officials of the local bodies, Network members in the State and other nonNetwork organizations specifically active in a region in the State, where the State Coordinating Agency does not have a reach. Submit the list of SOC, SAC, DOC and DAC along with Project Proposal for districts and state. The State Coordinators shall act as the Member-Secretary of both the Committees;

ii. To constitute Regional Coordinators, if found necessary in case of big States and to involve SCERT, DIET, IRIS and organizations working with bhandicapped children/elder citizens and media representatives. Distribution of geographical area for organizational purposes etc. will be the prerogative of the State Coordinators;

iii. To locate individuals, schools specially interested in other curricular activities;

iv. To select District Coordinating Agencies and obtain consent letter from the respective organization, where they have to agree to abide by the guideline of CSC and willing to follow the guidelines of NCSTC-DST, NCSTC-Network and State Coordinating Agency of the State;

v. Organize Orientation Workshops of District Coordinators and teachers with the help of subject experts;

vi. To coordinate translation of the Activity Guide Book to be used by the children, in local language and make them available to the District Coordinators. To separately print/photocopy Activity Guide Book for participating child scientists and give them on cost to cost basis;

vii. To maintain a Bank Account and maintain Accounts at the State level and submit an audited Receipts & Payment Account to the funding agencies within three months of the date of event with a Project Completion Report and a Utilization Certificate in the manner prescribed;

viii. To submit Feed-back Reports on all activities, samples of certificates issued, mementos presented to child scientists, photo documentation etc. related to CSC at the State level to the funding agency in the manner and by the date specified;

ix. To remit funds to District Coordinating Agencies by account payee cheques;

x. To form linkages with Testing and Monitoring facilities available in the State (with NGOs as well as Government), Municipal Corporations and other local bodies etc. to help children in better implementation (information collection/sample testing) of their activities(Identity Cards may be issued to children registered for activities) through District Coordinators/State Coordinators;

xi. To arrange review and monitoring of the projects selected for presentation at the NCSC.

xii. To ensure that Evaluation sheets, both written and oral are forwarded to the next higher level, i.e. from district to State and from State to National level, else the district / State contingent might not be registered during State/National level CSC.

xiii. State Academic Coordinators should work in close association with the district/State Coordinators for arranging evaluation process and shall make an effort to send one member from State Academic Committee as an Observer to the district level CSC. His/her signature on the selection list is mandatory. The entire process of evaluation is to be supervised by the Observer. Decision of the State Academic Committee shall be final word on the selection.

16.3. Note for State Coordinators and District Coordinators

i. The age limits for participation must not be less than 10 years and more than 17 years on December 31 of the year.

ii. Relatives of District Coordinators, District Academic Coordinators, State Coordinators and State Academic Coordinators will not be selected for National CSC. They may leave the post for the year if participation of the ward is desired.

iii. A child will not participate more than twice in national CSC as Group Leader – once from each age group.

iv. Two selected projects (one from lower age group and the other one from upper age group) from each State are to be selected to participate in 'Kishore Vaigyanik Sammelan' of the Indian Science Congress session held every year during 3rd to 7th of January.

v. CSC projects meeting the following criteria may apply Technology Entrepreneurship Promotion Program selected for support–

- The idea should be new / novel,
- The idea should have potentiality for translating it into working model / prototype / process,
- The idea should be based on known scientific principle,
- The idea should have commercial feasibility/ technical viability.

vi. Proposals from individual innovators to convert an original idea / invention / know-how into working prototype / processes. These proposals can be made by individuals or jointly with any sponsoring organizations.

vii. Selected projects will be provided by financial support to undertake the above developments, patent support and guidance, scientific/technical consultancy, fabrication assistance, market information and networking with related research lab/ institutes as required. For detailed information you may contact:

Techno-entrepreneur Promotion Programme, Ministry of Science & Technology, Post Bag No. 66, HauzKhas, New Delhi 110016.

For further details please contact :
State Coordinator of your respective State / Union Territory. (See Annexure II)

Dr. B. P. Singh,
Scientist G & Head,
National Council for Science & Technology Communication (NCSTC),
DST, Govt. of India.

Dr. Ujjwala Tirkey
Scientist F & National Programme Coordinator of NCSC,
National Council for Science & Technology Communication,
Department of Science & Technology, Technology Bhavan, New Mehrauli Road
New Delhi-110016.
Email: <ujjwala@nic.in>; Telephone: 011-26535564 /26590251.

Some important points for Participation in the Indian Science Congress's' Kishore Vaigyanik Sammelan'

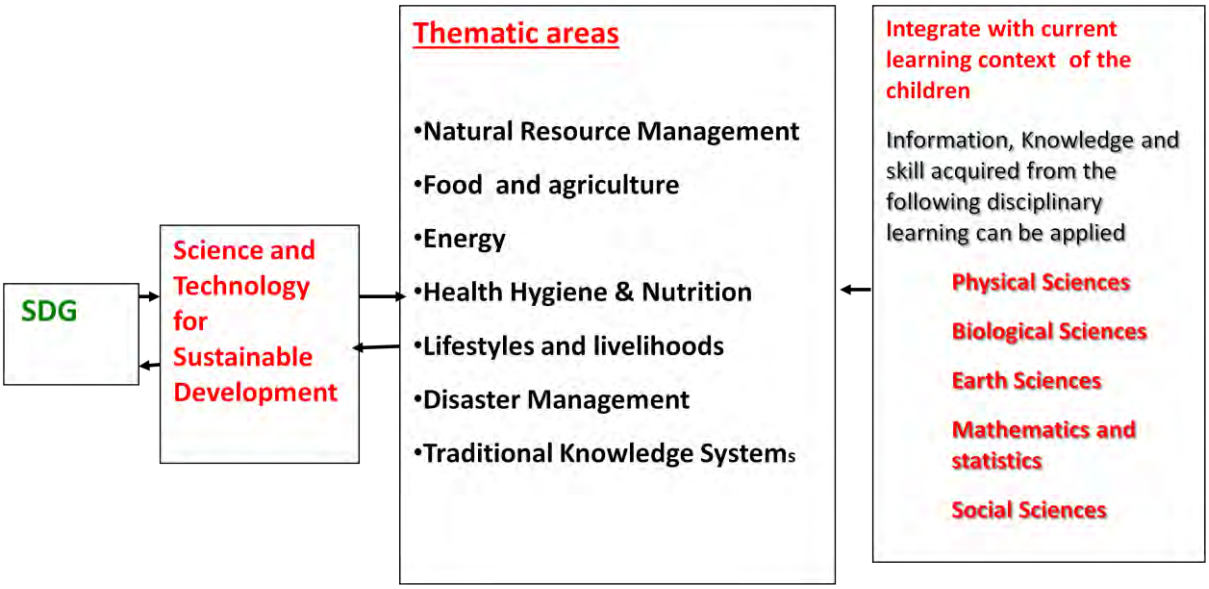
Any one of the co-workers (preferably the second in the team) of the selected two best projects of the State level Congress (one from lower age group and the other one from upper age group) will participate in this programme.

PART 2

Focal Theme:
SCIENCE, TECHNOLOGY & INNOVATION FOR SUSTAINABLE DEVELOPMENT

Introduction

In usual parlance, development stands for the situation where everyone gets food, shelter, clothing along with sound state of health and mind, gets opportunities for livelihood, having adequate energy to use, has good education, transportation and communication in a better environmental situation where cleaner air, water and soil exists.



In defining the concept of sustainable development Brundtland commission in 'Our common Future' (1997), mentioned that "Sustainable development is the development that meets the needs of the present without compromising the ability of future generations to meet their own needs", which not only raises the question of fulfilling the need for present, but also to cater to the need for the future. So, it pleads for rational and wiser uses of our natural resources, redesigning our different economic operations like production, transport and communication systems through optimum use of available resources and reducing its wastage. At the same time, it also demands for equal opportunities for everyone at present and for future. Moreover, it focuses on economic sustenance. Thus the entire principles of sustainable development insist upon environmental, economic and social balances and their inter-linkages.

In this context exploration and inquiry using Science and Technology approaches can help us to understand the dynamics of our planet as well as different components of its environment, ecosystems and resources that help one to look for the best means of optimum use without disturbing the functioning of the component ecosystems. Rather, this makes one able to achieve economic sustenance and cater intra and inter generational equality and

equity in society. Besides, in every aspect of the exploration and inquiry, innovative thinking and approaches helps one to find out solutions to address different problems or harnessing hidden opportunities.

In this perspective “Science, Technology and Innovation (STI) for Sustainable Development” has been decided as the focal theme for 24th and 25th National Children’s Science Congress, with an expectation that our Child Scientists will be introduced to inquiry based learning approaches in project mode exploring something from “known to unknown or ‘from unknown to known’. They will thereby come up with different new knowledge in relation to the focal theme following sub-themes

1. Natural Resource Management
2. Food and Agriculture
3. Energy
4. Health, Hygiene & Nutrition.
5. Lifestyles and Livelihoods
6. Disaster Management
7. Traditional Knowledge Systems
8. Accessibility for disabilities

Sub Theme I

Natural Resource Management

Sub-theme
Science Technology and Innovation for Natural Resource Management

Resource is function of living and non living components of the biosphere which, may perform an operation or be a part of a process i leading to human welfare without disturbing the ecology and ecosystems from which it is sourced. Resources include all material and non material means that helps in satisfying human's social, ecological and social needs. We should appreciate and be sensitive to fact that Earth's resources are meant not only for mankind but also for all life forms, i.e. biological diversity. Resources have two essential attributes: Utility and Function ability. Nature provides us with resources which are inimical for our survival. We called these as Ecosystem services and they can be regulatory, provisional and cultural.

Man's dependence on natural resources is as old as the history of civilization. He has since time immemorial extracted biotic and abiotic resources from terrestrial or aquatic eco-systems. The biotic comprises of the flora and fauna and abiotic constitutes the rocks, mineral, soil and water. Geo-environmental, socio-cultural and economic conditions plays a role in their abundance or rarity, availability, and use or misuse. Today, our demands for development put immense pressures on natural resources beyond the nature's capacity to restore and replenish. We understand that development is inevitable, for our economic and social wellbeing, however, we must insist on and contribute towards a planned development that emphasizes sustainable use of resources so that we have enough of these left for generations to come.

In the present parlance of environmental economics, the major utility of natural resources is interpreted as follows:

Direct use/benefits: like, **i.** minerals, **ii.** fuel, **iii**. food & medicine, **iv**. means/base of transport and communication, **v**. cultural uses

Indirect benefits: like, **i.** environmental regulating services: as sink, circulation, heat exchange, etc.; **ii.** aesthetic values and recreation

The natural resources can be also be classified as renewable and non renewable

Non-renewable are those which have a limited stock. Once the stocks are exhausted it may take thousands of years to be renewed or replenished. In case of such resources regeneration is lower than the rate of consumption. Coal and Petroleum are examples of non renewable resources. S&T and innovative initiatives and interventions can help develop appropriate management practices to control/curtail resource consumption wiser and efficient.

Renewable are those which get renewed or replenished.. Some of these are unlimited and are lesser by human activities, like solar and wind energy. But careless use of certain renewable resources like water, soil and forest can affect their stocks.

With increase in population there has been substantial increase on pressures on natural resources. In India we had a population density of 77 person / Km^2 in 1901, it was 117 in 1951, 216 in 1981 and 382 in 2011. Similarly arable land (hectares per person) in India also declined from 0.3hectres in 2009 to 0.13 in 2011.We had a forest cover of 70% in 1947 which reduced to 49.32% in 1992 and 21.23% in 2013. Resource scarcity leads to environmental, economic, soil and political crisis of different intensities. The scaffold of Sustainable Development, therefore, demands environmentally, economically and socially

defensible practices through the principle of Reduce, Reuse and Recycle; where sustainability represents sufficiency, safety, security, self-reliance in present as well as in future context too.

To achieve the aforementioned goal there is an urgent need of innovative S&T interventions to frame suitable management practices, where management practices covers exercises related to planning, depiction of future, decision making processes, quick response mechanism, crisis management, inventory management for alternative solutions, monitoring and impact assessment and corrective measures.

Coverage:

This sub-theme shall cover all the aspects of natural resource extraction, processing, value addition, or any other activity that leads to optimization of natural resource uses for different purposes. It also includes broadening of natural resources base or new/ better uses of already available natural resources for betterment of environment and human welfare. One can review an impact assessment of the existing technologies to address the negative impacts of resource management by suggesting appropriate modification in technology or developing alternative technology. Natural resource mapping and management planning, like watershed/micro-watershed planning, land use and land cover mapping, land use planning, mapping of biodiversity richness, undertaking population studies and developing conservation and management planning are also included under this sub-theme.

Design your project:

The first step in designing a project is to identify an area of your interest and concern; you need to do a situation analysis first before framing your project. Do not hesitate take help from your teachers or experts. Run through the flow diagram (framework) given below to identify the ecosystem(s) , issue(s) you would like to cover/include and highlight in your project. You must have clarity on what you want to work on, the intensity of the problem and rationale for your research. Develop your study following the above mentioned framework and exercise based on the table given below:

Framework

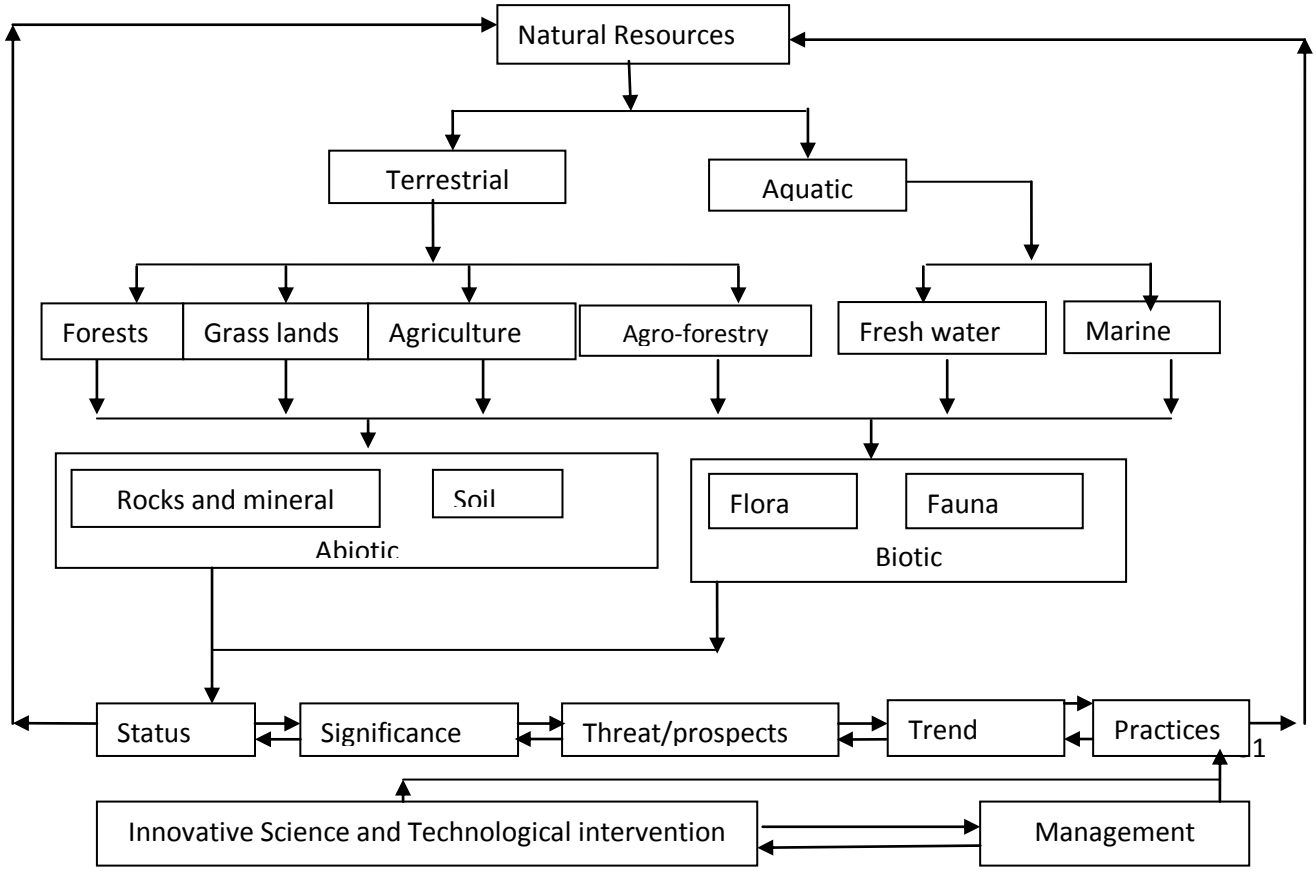
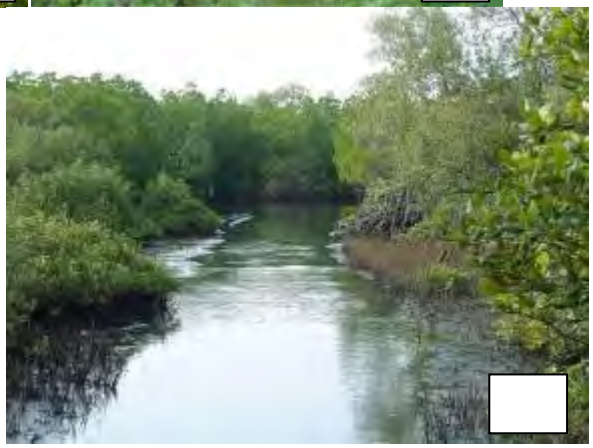


Image to ponder

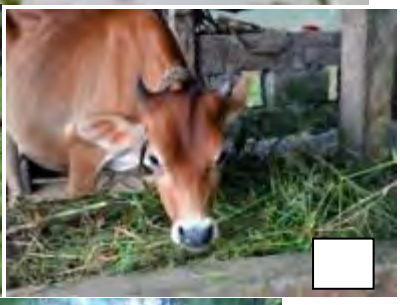
For an example observe the following situations and identify the subject/issues you need to study under this subtheme














All the photographs from **A** to **R** are some example where resources have an intricate linkage to local environment, economy and society. You need to observe and analyze the situation carefully, critically and completely with respect to its present status, ecological

significance, trends, threats/prospects. This will give you ideas for your involvement in sustainable management of natural resources..

Some project ideas are placed herewith:

1. Resource Mapping and Management Planning

Mapping of a region for the resources it provides, the pressures and threats it faces. Changes the area has been subjected to can help you with a situation analysis and designing an intervention for sustainable management of its resources:

Proposed activities could be:

- Identification of resources of the study area
- Understanding and analyzing its status, significance, threats/potentialities, trends and associated practices and their subsequent ranking
- Identification of the spatial pattern of the aforementioned and
- Preparation of a management plan

Methodological approaches:

- Specify /focus your study – identify Area od focus (AOI) to one resource, e.g. Surface water, wet land, soil quality, grass land, ground water, land use –land cover, etc
- Make transect walk in your study area ,identify sources, mark their location on the base map;
- Make thorough observations
- Undertake field base measurements- for assessing quality and quantity
- Hold discussions with relevant stakeholder
- Design a questionnaire and interview of the stake holders
- Develop a database, analyze and interpret

Expected out come

- Resource Map
- Resource Appraisal
- Identification of threat/potentialities
- Management plan

Box-1

How to prepare a map

A map is a systematic representation of location and associated features of a place in a diagrammatic form of a picture or drawing. It follows certain norms. Major elements of a map are – its scale, symbol, boundary, direction. Map scale is the ratio between the distance on a map and corresponding actual distance on Earth's surface. Boundary is the limit of the area represented in a map, usually line is draw to represent the boundary and size or pattern of line will change to represent different type of boundary. Every features of the area are represented in a map through some symbol; usually symbol can be a point, line and area. Usually residential location, pond etc are shown as point (but it may change with map scale), river, road, stream etc are represent as line symbol and information like area under area under forest, agricultural uses etc are shown as area with the help of shading or through colour.

Some important steps to prepare a map of a study area

I. You can prepare base map of your area from Topographical map. Identify the area in the topographical map and trace out the area where you carry out the study.

If access to internet is there go for Google map, put name of the area in Google map search option, it will show you the area (as in fig.1). Take a print out of the image. Then click to Google Earth shown in the left hand bottom corner of monitor screen, you will get the Google Earth Image (as in fig.2), take a print out of the image. Note down the year of the image as shown in the bottom of the image.

Fig.1

Fig.2

These maps, either from topographical map or from Google map and earth can be used as base map.

II. Now with reference to the base map you can observed the situation on ground in the area, marked the situation on the map using symbol or colour index. Based this new information, you can develop a new map to show the current situation.

III. Now in reference to scale of the map, you can calculate the length, area, density etc of different features, in the base map and current map. Based on this information able identify changes over the area over the period of time.

(For detail one can consult the followings:

- http://www.planetware.com/cartography-and-maps-for-beginners.htm
- http://www.walkingandhiking.co.uk/beginners-guide-map-reading-grid-references.html
- http://sseaep.org/reports/project_on_map_learning.pdf
- https://www.nh.gov/oep/resource-library/planning/documents/preparing-master-plan-existing-map.pdf
- http://www.wikihow.com/Make-a-Map
- " Introduction to Map Learning", SSEEP,Nagaon,Assam and ASTEC,Guwhati,Assam,
- Text book of Practical Geography, Md. Zulfequar Ahmad Khan)

Box-2

How to prepare a management and conservation plan

Management and conservation planning is an exercise through which goal of conservation/protection is identify along with agenda for action. The normal practices of planning includes different phases of works like situation analysis, identification of problem and prospects, identification of alternatives, setting goal and objectives, preparation of action plan and implementation, monitoring and impact assessment (fig-3) .

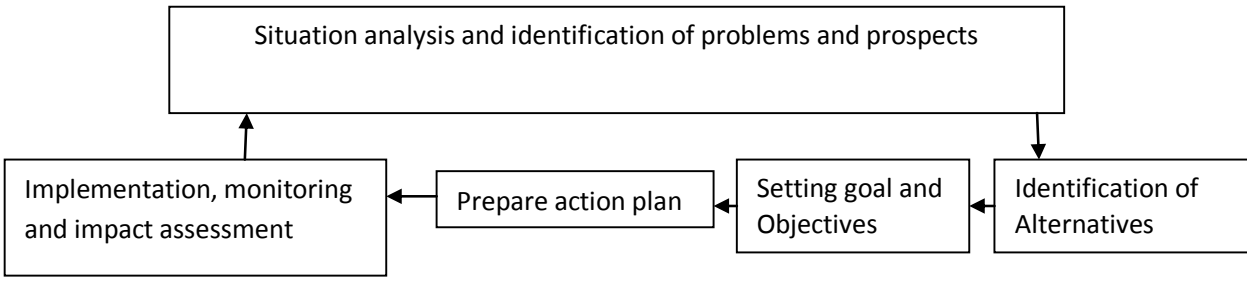


Fig3.

But in relation to natural resource management and conservation planning following process can be followed (fig.4.)

(for detail one can consult the followings-

Natural Resource Management Tools for participatory planning and implementation, http://www.crs.org/sites/default/files/tools-research/natural-resource-management-tools-for-participatory-nrm-projects.pdf; http://www.fao.org/nr/kagera/tools-and-methods/en/; http://www.fao.org/nr/kagera/tools-and-methods/community-active-planning/en/; http://www.fao.org/fileadmin/templates/nr/kagera/Documents/local_tools.pdf

http://www.fs.fed.us/psw/publications/documents/psw_gtr191/psw_gtr191_1213-1223_korschgen.pdf; http://www.ifad.org/pub/enviorn/EnvironENG.pdf

http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=52&ArticleID=58

http://www.ecologyandsociety.org/vol5/iss2/art17/figure2.gif

https://www.cbd.int/doc/meetings/mar/mcbem-2014-04/other/mcbem-2014-04-integrated-planning-decision-support-en.pdf)

Box-3

Focused group discussion (FGD)

FGD is method of data collection through a semi-structured group interview processes. Usually one or two person moderate the discussion, a homogenous group (may be by occupation, age, sex etc) participated in the discussion. Usually the data which cannot be collected directly through a face to face focused interview with individual are collected through FGD. Through FGD one can able discussed on "What? When? Why and How?" of any aspects which influences community life. Some of the important techniques used for the purpose are as follows

- Standard question put forwarded for group responses, followed by discussion on linked question for in-depth situation analysis; like which are the important natural resources available within the village which have direct link to livelihood activities of the villagers; responses to such question may emerged with list of resources; then next step will be as follows
- Filled up the table given below through more discussion
-

Sl no	Name of the natural resource	Depending livelihood practices (like animal rearing, fishing, paddy cultivation, horticultural practices)	Seasonality (is there any specific months or season of use of respective resources)	Present status (Good, Bad, Threaten, etc)	Any serious incidences group remember take place in the village due to uses of natural resources (like landslide, wild animal threat, conflict among the people)	Make ranking of resources (like 1,2,3, ...etc ; where 1 indicate most important for their livelihood , gradually importance reduces with 2,3, ... so on)

- Now, one can go for next step to gather their opinion in the following aspects

Sl no	Name of the natural resource	Probable risk	Strategy for mitigation/ conservation/ protection

These are the example only; with variation of issues of study similarly strategy can be developed.

- In case of documentation of such information it is better to use chart paper and note down the every information with the help of marker pen or sketch pen with large letter, so that everyone can get the information. Along with this one can go for audio recording of the discussion (use mobile phone recording facilities) and after discussion transcript the recorded discussion.
- Usually qualitative information is emerged through FGD, so classification of such information using appropriate coding through set of words is very important; which will help in analysis.

Methodological approaches:

- Specify /focus your study – identify AoI – focus to one resource,e.g. Surface water, wet land, Soil quality, Grass land, Ground water, Land use –land cover, etc
- Make transect walk in your study area ,identify sources, marked its location on the base map;
- Source base observation
- Field base measurement to assess quality and quantity (one can able to adopt quadrant method for quantification, particularly for identification distribution, but in such case better to select a small area like School campus. Homestead area,)
- Focused group discussion with stakeholder
- Interview of the stake holder based on predesigned questionnaire
- Data base development
- Data analysis and interpretation

Expected out come

- Biodiversity Map
- Biodiversity Appraisal
- Identification of threat/potentialities
- Management and conservation plan

3. Project title: Study of soil quality and mapping

Soil is an important resource which determines floral diversity to a large extent along with agricultural potentialities. So, soil quality analysis and mapping can help in agricultural planning, forest cover management planning, etc. Soil quality can be accessed through its texture, composition, chemical properties like acidity or alkalinity, etc. One can go for assessing soil quality through analysis of soil texture also. Many of the important soil properties are determined by its texture. Soil having high amount of sand is coarser or lighter in texture. On the other hand, soil having higher amount of clay is finer or heavy in texture. Coarse-textured soil (sand, loamy sand) is very permeable and less erosive. They can hold lesser amount of water and nutrients and as such they need to be irrigated and fertilised frequently. The fine-textured soil types (clay, sandy clay, silty clay) are less permeable and more erosive. They can hold large amounts of nutrients and water. The properties of medium-textured soil (loam, clay loam, sandy loam, silt loam) range between the above two categories.
Soil can be classified in the field on the basis of texture by its feeling on our fingers. The method is based on the differential feeling of moist soil. Sand particles feel gritty when the soil is rubbed in between fingers. Silt particles feel smooth and powdery. Clay particles feel smooth, sticky and plastic when the soil is moist. Different soil particles and textural class exhibit different degree of ball formation and ribbon formation. Based on observation on can identify soil textural variation in a locality, prepare a map and develop a plan for soil quality management. Such exercise is very much important for developing sustainable development plan for an area/locality.

Objective:

- To know about soil texture in different land use condition;
- Prepare a soil quality map in relation to its textural composition;
- Development of soil quality management plan.

Methodology:

A. Divide the area of your study in certain section /grid and perform following steps of works and records your final observation against each of the grid,
B. Feel the soil with fingers- follow the steps given bellow:
   Step 1: Collect soil samples from different from each of the grid and keep the record of the land use of respective grid,
   Step 2: Take about 5 g of each soil sample in your hand.
   Step 3: Moist the soil with few drops of water.
   Step 4: Feel the grittiness or smoothness of the soil by rubbing it in between fingers.
   Step 5: Press the moist soil in between your thumb and forefinger.
   Step 6: Observe whether it stains the fingers.
   Step 7: Observe whether balls or ribbons can be formed by rolling the moist soil in between thumb and fingers.
   Step 8: Name the soil textural class from the observations as given in the following table.
   Step 9: Write your interpretation.
   Step 10: Repeat the same procedure for other samples also.
   Step 11: Draw your inferences about the characteristics of land based on your observation.

Table: Observations for soil textures by feel method.

Textural class	**Feel of finger**	**Ribbon formation**	**Ball formation**	**Stickiness**	**Classify the grid into textural class**
Sand	Very gritty	Does not form ball	Does not stain finger	No	
Loamy sand	Very gritty	Forms ball but breaks very easily	Stains finger slightly	No	
Sandy loam	Moderately gritty	Forms firm ball but breaks easily	Stains finger vividly	No	
Loam	Neither very gritty nor smooth	Forms firm ball	Stains finger vividly	Slight ribbon forms with flaky surface.	
Silt loam	Smooth or sticky buttery feel	Forms firm ball	Stains finger vividly	On squeezing ribbon forms but breaks easily.	
Clay loam	Slightly gritty feel	Moderately hard ball when dry	Stains finger vividly	On squeezing ribbon forms with some flakes.	
Silty clay loam	Very smooth	Moderately hard ball when dry	Stains finger vividly	On squeezing forms long ribbons (2-5 cm)	
Clay	Very smooth	Hard ball, cannot be crushed by fingers when dry			

Based on the information gathered from the table mentioned above prepare the table given bellow

Table to showing grid wise soil textural quality, land uses, evolving problem and tools and techniques address the issues			
Grid no	**Textural class**	Observed problem and potentiality (take interview of owner of land of the particular land area under the grid)	tools and techniques to address the problem or harnessing potentialities (discussed with local experts, farmer and solution suggested by them are tried yourself and based on your observation put the suggestion here, kept the records of your own experimentation/trail)

4. Developing a good harvesting and management plan of Non timber forest products

May be you have studied and heard of many plants which are of high medicinal or commercial value. These are traded and often extractions from the wild are beyond the nature's ability to replenish. If you have observed, any such plant are being heavily collected from your region and you are also aware that that these species are declining rapidly from the wild. You feel that you should do a project for the Children's Science Congress with the support of your teachers and experts available in your region.

A good example of such a situation is the overharvest of lichens from the mountains of Uttarakhand. There is a diversity of lichens , which love to grow in pristine environments, are very good indicators of air quality. Some of the lichens are preferred in trade for preparation of *itra*, natural perfumes. The perfumes are exported to many countries.

Use of Rhodendrons in Himalayas is an another interesting example in Himalaya. In western Himalaya, *Rhododendron arboreum* is used for preparation of squashes while in Eastern Himalaya, in the state of Arunachal Pradesh for fuel wood. Conservation efforts are being directed to sustainable use of Rhododendrons. Your efforts in research in their distribution, usage, growth, abundance and other scientific studies can be huge contribution to S&T for Sustainable Development.

Methodology:

Data will have to be collated from available publications and websites that provide trade related data. You will work very closely with local communities who are engaged in harvesting of NTFPs. Local communities are most often very knowledgeable on the growth patterns of these and help you in formulating a plan. You may like to design a restoration plan and a long term monitoring programme at your school that could make valuable contribution to the sustainable use of natural resources in the long run.

Expected outcome:

1. You have mapped your location which are rich in NTFPs and the locations from where harvesting is more intensive
2. You will be able to prepare a baseline on the extent of extraction of select NTFPs of your region.
3. You will be able to come out with conservation plans and restoration strategy with local communities

Reference:

Community based Biodiversity Conservation in the Himalayas, Gokhale Y and Negi.A.K, 2011, The Energy and Resources Institute (TERI)

5. Assessing the status, usage and conservation of wild relatives of crop plants and underutilized plants and wild relatives of domesticated animals in India

Introduction and Rationale:
The staple crops that we enjoy as food and see being cultivated by the farmers often have their wild relatives surviving in the forests. These wild relatives are very important for us, for they possess many useful genes for traits and characters which we may need to have the same incorporated to deal with situations like infestation of a disease or adaptations to climate change. Rice that we eat in *Oryza nivara*, has its wild relatives in the forests. It is often difficult to preserve these species outside their natural habitats. There are wild relatives of other categories of food plants like vegetables, fruits, pulses and spices. There are365 such wild relatives of crop plants documented in India. Murali maize (Sikkim Primitive !) is a primitive variety of maize reported from selected locations from Sikkim. On similar lines there are wild relatives of domestic animals too. You must have heard about Charles Darwin and his famous book 'Origin of Species'. He talks about the Red Jungle Fowl of India as a progenitor of the domesticated chicken
You will realize that there are many plants which could be valuable source of nutrition but remain unutilized. These could be promoted for broadening our food base and nutritional security. You can plan with farmers and experiment on their cultivation and nutritional value

Methodology:

You have to go to the local farmers to get more information about such plants. Further you have to get in touch with an agriculture scientist. If you have decided to work on the Wild relatives of crop plants of India, you will have to visit a regional centre of the National Bureau of Plant Genetic Resources (NBPGR) of India. There are 5 such centres in India in addition to the Central NBPGR station New Delhi. You can learn referring to the herbarium and passport data sheets available at the herbariums of the NBPGR. You can get similar and relevant information from the offices of the National Bureau of Animal Genetic Resources at Karnal, Wildlife and Tree Genetic Resources at Coimbatore. Further you may need to consult and visit the National Bureau of Agriculturally Important Microorganisms near Varanasi in Uttar Pradesh.

Expected outcome:

1. You have mapped the distribution of wild relatives of crop plant and domesticated animals.
2. You will be able to come out with conservation plans of such species.
3. You have worked on the cultivation potential of some underutilized plants of India.
   Some references

- Setting Biodiversity Conservation Priorities for India : Summary of the Findings and Conclusions of the Biodiversity Conservation Proritisation Project, Volume 2 (2000), World Wide Fund for Nature.

.

- Wild relative of Crop Plants by R S Paroda and RoshniNayar. National Bureau of Plant Genetic Resources. New Delhi.

Box. 4.

Quadrat method

Quadrat is method of sampling; it is use to measure coverage and abundance of plants or animals.

A grid of known size is laid out and all the organisms within each square are counted (fig.5) .The usual sampling unit is a quadrat. Quadrats normally consist of a square frame, the most frequently used size being $1m^2$, but size varies with purpose of survey. Usually frequency, density, biomass, diversity, rareness can be assess through this method.

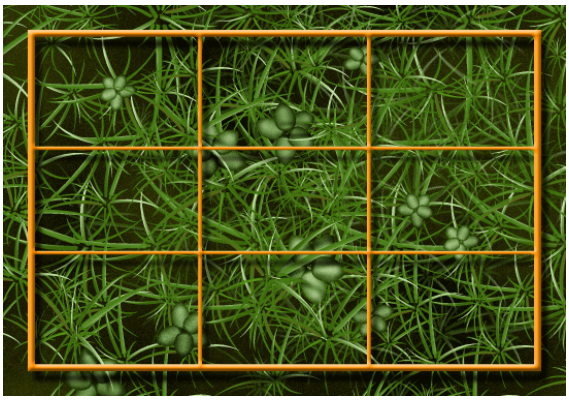


Fig.5

Box. 5. Example from the field – 'Converting agricultural waste to a craft product'

Jute stick, the remaining part after extraction of jute fibber is an agricultural waste. It is used for cooking as fuel but its thermal efficiency is very low. A group of children way back in 1995 take an initiative to use this waste to create wealth out of it. This sticks having a hole at its centre, which make it a cylinder. They utilize this property and made some pen putting riffle in to it, design accordingly. Now it is becoming a craft product and produces it under the banner of Nandanik. Later on they produce other product also from the waste generated from their pen production processes.

Box-6. Story from field – **"Community initiatives for water resource management"**

It is near the Sitabakow village of East Khasi Hills of Meghalaya, people designed and constructed a new water harvesting structure with community contribution (plate-10). These structures have been designed in such a way that it is maintained by vegetative covers at an altitude of around 1064 metres. Water reservoirs have been built at an altitude of around 962 metres with outlets to release water in a controlled way to the down slope areas. Village *darbars* (village council) play an important role in building consensus among the villagers to maintain the land use in the up slope so that the watershed principles are maintained. The water reservoirs are also used to rear fish. The water is also used for domestic purposes. Every individual of the village have the right to fish there but they have to pay a fee of Rs. 25 to the community each time they make a catch. The fee is deposited in the community corpus fund and used for maintenance of the structure, and also for other community related work if required.

List of project idea:

1. Population counts of select groups of species and collating information on trends
2. Ecological requirements of migratory species that come to your locality from distant locations for wintering/breeding.
3. Biological corridors which are essential for movement and passage of wildlife
4. Sustainable harvest of any plant species presently being collected unsustainably
5. Observing Social behaviour studies of wildlife and their interpretation
6. Wild relatives of crop plants Landraces and varieties and their status in your area and analyzing farmers approaches to preserve them
7. Changes in flowering and fruiting patterns
8. Understanding the ecological role of lesser known flora and fauna
9. Minimizing human wild life conflicts
10. Securing sacred groves, community conservation areas
11. A plan with the State Forest Department
12. Role of pollinators and their role in maintaining our ecosystems.
13. Role of aquatic plants and animals in maintenance of water bodies in your locality.
14. Water quality of fresh water lakes/wetland and its impact on fish
15. Ground water mapping of a locality (aquifer level identification and showing in map through iso-line preparation management plan)
16. Household water audit and management plan
17. Study the soil thickness in different terrain condition, mapping and development of land use plan
18. Study the land cover and its impact on soil quality and planning
19. Study impact of rainfall on soil erosion, mapping, identification of vulnerable location and management planning
20. Study traditional method of soil quality identification in your locality
21. Study the tilling practices and its impact on soil texture in the agricultural field
22. Study the impact of manure and fertiliser on soil organism and management planning
23. Study impact of harvesting practices of paddy and its impact on soil quality of paddy field and management planning
24. Study the impact of field bund on soil quality of agricultural field and management planning
25. Study impact of solid waste on soil quality and management planning
26. Study the impact of soil moisture on soil organisms and management planning
27. Document the traditional land use practices of your locality and preparation land use plan
28. Water audit in household sector
29. Water audit in agricultural sector
30. Water audit in cottage industries
31. Water audit in schools/colleges
32. Water audit in offices
33. Water audit in hotels and restaurants, etc
34. Comparative assessment of traditional vs modern water conservation techniques
35. Study the settlement pattern (spatial arrangement) its impact on transportation cost (including energy used for transportation);
36. Study the man-made drainage pattern of locality and its association with water logging or similar problems of the locality and management planning
37. Study the impact of wildlife on the settlement area and management planning
38. Study the home garden practices in the locality and management planning
39. study on environmental impact on settlement
40. Assess diversity of flora and fauna in your home garden
41. Assess diversity of wild edibles in local market.
42. Assess status of birds in your locality and prepare a check list
43. Assess the diversity of animal domesticated in your locality
44. Assess the diversity of medicinal plant of your locality.

45. Assess the diversity rice cultivated in your locality.
46. Assess the diversity of insects in your house.
47. Assess the status of scavenging birds of your locality and their role in waste management.
48. Assess the diversity of fish of your locality
49. Assess the diversity of pulses cultivated in your locality and their status.
50. Assess the diversity of butterflies and moths of your locality.
51. Assess the status of nocturnal animals of your locality.
52. Assess the diversity of reptiles in your locality and their status.
53. Assess the diversity of life found in soil of different land categories.
54. Assess the diversity of minor forest product of your locality.
55. Assess the nesting sites of migratory birds in your locality and prepare protection action plan
56. To determine amounts for healthy nutrition, health, science and technology since it involves? Find it
57. Comparative Study about hygiene and health
58. Study malnutrition or diseases caused by food contamination
59. Solutions to the study of the diseases / damages on the basis of economic / cleanliness of the different areas of nutrition, in order to prevent it? If no mapping is available to implement the following suggestions into the world of modern methods / efforts for its dissemination
60. Various communities, tribes, allowing an average combined / nuclear family diet studies, who called balanced diet, what diet system diseases including diseases that evidence-two groups? The study
61. Diseases of the water quality, water purification, water-borne diseases and to study ways of preventing them
62. Preservation of health (diet) for costs and expenses arising from the disease, as well as ways of preventing them
63. What nutrients are found in a variety of diets of fruits, vegetables, herbs, meat, fish, milk, beans, grains, etc.? And how much food is needed per capita family? Etc. Practice
64. According to the study of traditional food from a particular region or community, family and study of diseases typical of the territory of the community
65. MDM or fortified foods given to study in private schools
66. Health check-up interval of information and awareness effort and health survey / study
67. to assess the needs of the poor, in particular, about their problems in daily life
68. to increase the awareness and sensitivity of the specialists involved in the project and also those responsible for programs designed to improve the basic need situation of the poor
69. Planning and preparation of the nutrition survey
70. Implementation of the nutrition survey

References

"Explore and understand your environment, people and their practices" series of Vigyan Prasar ,Noida, UP

http://www.nezine.com/info/The%20past%20can%20be%20the%20future
http://www.nezine.com/info/Small%20is%20beautiful,%20small%20is%20useful

http://www.nezine.com/info/Insect%20can%20be%20the%20buzzword
http://www.nezine.com/info/The%20benefits%20of%20a%20%E2%80%98bari%E2%80%99
http://www.nezine.com/info/Flats%20and%20fears
http://dolr.nic.in/dolr/downloads/pdfs/Impact%20and%20Effectiveness%20of%20WDP%20by%20LBSNAA.pdf
http://www.iwmi.cgiar.org/assessment/files_new/publications/ICRISATReport%2020.pdf
http://www.himachal.gov.in/WriteReadData/l892s/27_l892s/170028581212.pdf
http://tropicalgrasslands.info/index.php/tgft/article/viewFile/94/59
http://envfor.nic.in/divisions/csurv/WWD_Booklet.pdf

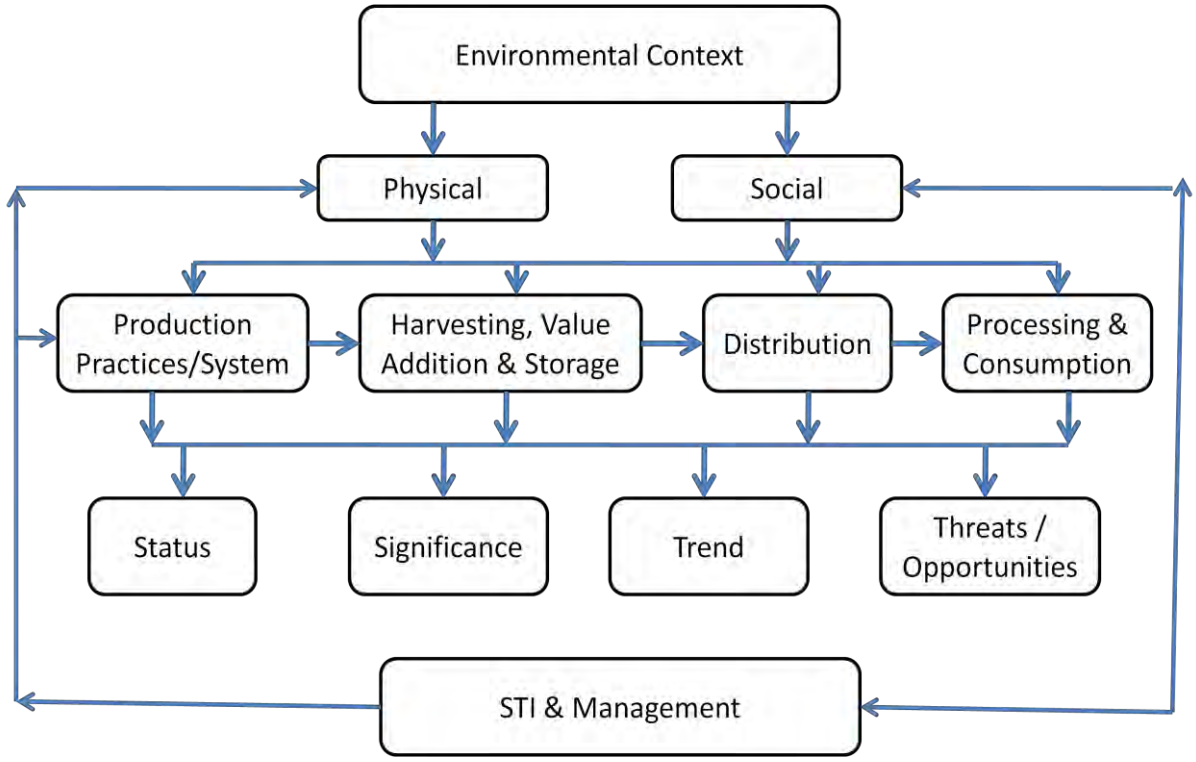
Sub Theme II

Food & Agriculture

Sub-theme - II:
FOOD & AGRICULTURE

Food and agriculture go hand to hand indeed, but are rooted in ecosystems which is the interaction of living organisms (biotic) and non living (abiotic) factors, where innumerable number of organisms, including humans, crop plants, livestock, insects, bacteria and fungi, are essential to our food supply.

Proposed Framework



Food and Food Web

Food is edible or potable substance (usually of animal or plant origin), consisting of nourishing and nutritive components such as carbohydrates, fats, proteins, essential mineral and vitamins, which when ingested and assimilated through digestion helps in sustaining life, generates energy and provides growth, maintenance, and health of the body. Its production, consumption and conservation mechanisms are very important while considering overall development of any country. The type, nature, variability and abundance of food of all organisms, including human being, is primarily determined by the existing food- web as well as functions of the specific ecosystem. In fact, food-web consists of a number of food chains meshed together and each food chain represents the flow of food energy from one feeding group of organisms to another.

Fundamentally, the feeding groups are referred as tropic levels. Basal species occupy the lowest trophic level as primary producer, the plants, which convert inorganic chemicals to generate chemical energy using solar energy. The second tropic level consists of herbivores, the first consumers who feed on plants. The remaining tropic levels include carnivores that consume animals at trophic levels below them. So, it is clear that the place of the primary producer, the plant, in the food web is at bottom i.e. on the ground level. In other words, soil is the place of habitation of plants, where many other organisms live and survive maintaining

food chains and webs, know as soil food web. The plants in general, however, interact with both above and below ground ecosystems; it not only survives on the functions but also regulates the services of eco-system. In above ground, energy moves from producers (plants) to primary consumers (herbivores) and then to secondary consumers (predators). In other words, the producers, consumers, and decomposers are the main trophic levels. This chain of energy transferring from one species to another can continue several times, but eventually ends. At the end of the food chain, decomposers such as bacteria and fungi break down dead plant and animal material into simple nutrients. In an ecosystem indirect interaction also occurs when two species do not interact with each other directly, but influenced by a third species.

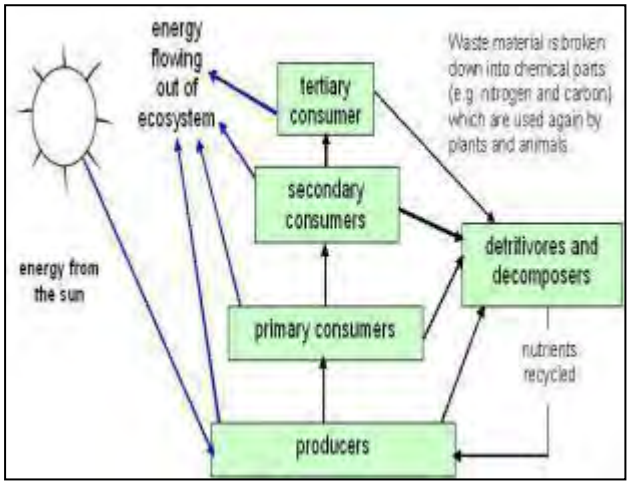


Fig-1: Flow of food energy at various levels

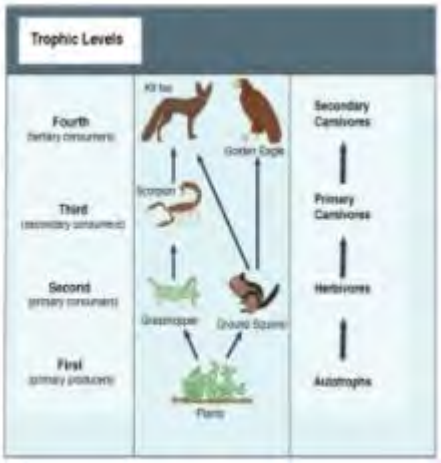


Figure 1: A simple six-member food web for representative desert grassland

Ecosystem Services

Ecosystem services are the benefits people obtain from ecosystems. The Millennium Ecosystem Assessment of the United Nations divides *ecosystem services* into four categories (MA 2005):

1. ***Provisioning services*** are the *products* obtained from ecosystems. Those are among others the production of food, timber, fibre and water.

2. ***Regulating services*** encompass benefits obtained from the regulation of ecosystem processes. Those are among others the control of climate, floods, wastes, water quality and disease. With regard to water and *sanitation*, the purification of water through the *decomposition* of *organic waste* introduced into inland waters as well as coastal and marine ecosystems is an important regulating service.

3. ***Cultural services*** describe among others spiritual and recreational benefits obtained from an ecosystem.

4. ***Supporting services*** are for example water cycles, nutrient cycles, *photosynthesis*, soil formation and crop *pollination*. These services are required to maintain the other three mentioned services.

So, alike other organisms the sources of our food is the product of ecosystem functions and services, which has been described through figure -3.

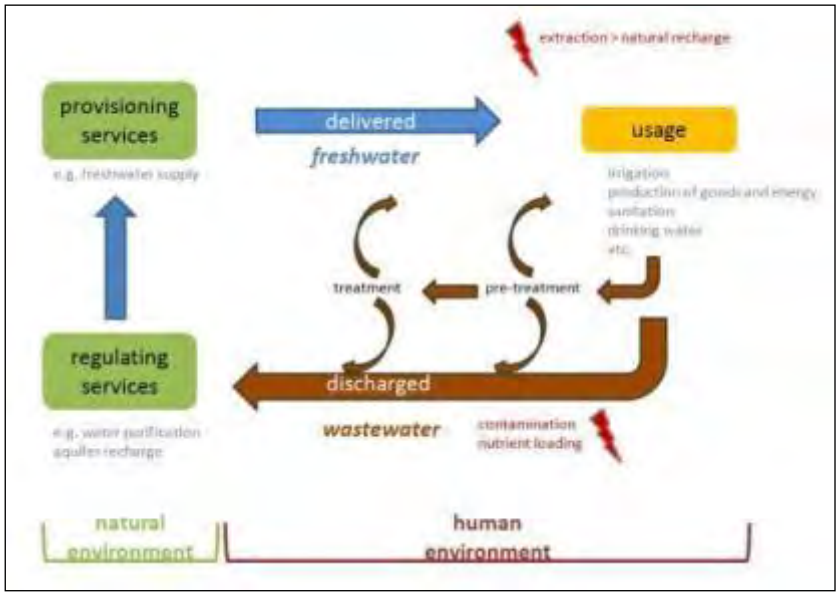


Fig.-3. Ecosystem functions and services

Agriculture: Our food production system

Most of our food supply originates from agriculture—the production of food and goods through farming. This practice relies on soil, climate, freshwater and other facets of ecosystems to cradle crops from seed to harvest. Soil being the foundation of agricultural ecosystems, we depend on it for most of our food supply. Our fertile soil is actually teeming with living organisms. A single teaspoon of soil can contain as many as a billion of bacteria. Arthropods, earthworms, fungi, nematodes and protozoa also inhabit soil, sustained by the energy and nutrients contained in organic matter, such as decaying leaves and other plant and animal materials. The soil food web offers many services that promote an abundant food supply and human health. Organisms break down dead plant and animal materials, cycling nutrients into forms that crops can use. Earthworms, for example, eat decaying leaves and release valuable nutrients in their waste.

The soil food web stores nutrients, releasing them slowly over time. It also stores water, suppresses plant diseases and, in some cases, purifies water by breaking down certain pollutants. In addition to fertile soil, a region's climate—its temperature, precipitation, humidity and other weather conditions over a long period—contributes to the suitability of the land for agriculture.

The favorable climate is essential to the immense productivity of agriculture in any region Freshwater Agriculture depends on a reliable supply of freshwater from streams, rivers, underground aquifers and other sources. Where rainfall is inadequate, farmers use irrigation to deliver water to fields. Moreover, biodiversity—the variety of organisms living in an ecosystem—plays a crucial role in agriculture. For example, farmers depend upon a varied assortment of bees, birds, butterflies and other pollinators that tend to 35 percent of the global food supply. Greater biodiversity within soil ecosystems may enhance the beneficial services offered by soil food webs. However, mankind is fundamentally dependent on the flow of *ecosystem services* to and from agriculture for their well-being (Fig.- 4).

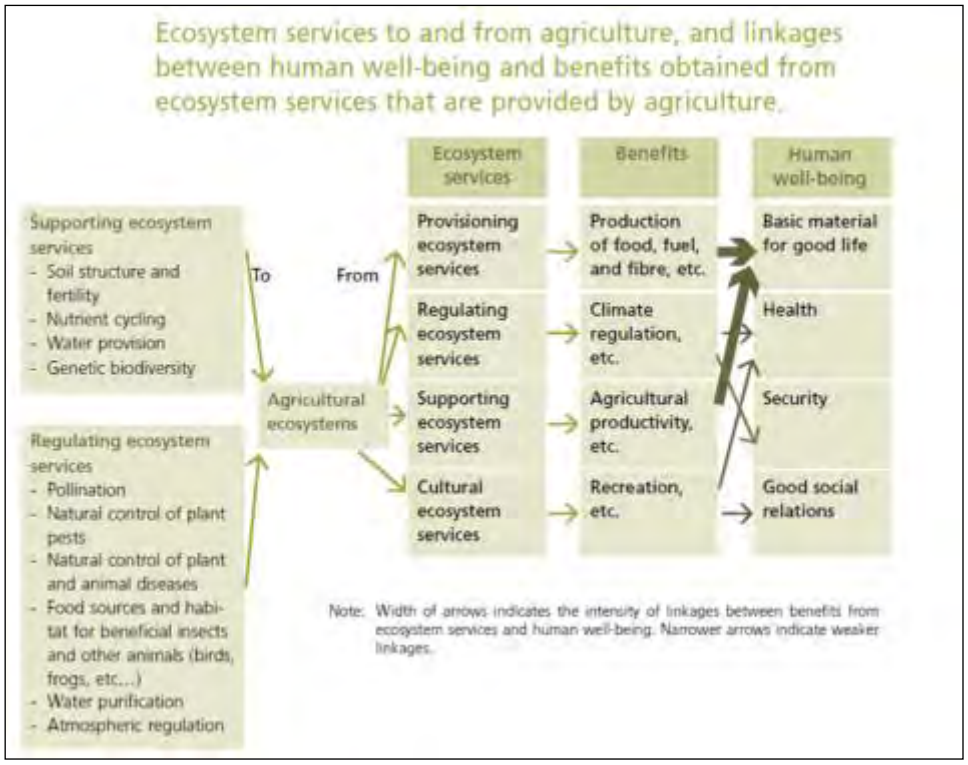


Fig.- 4. Ecosystem services to and from agriculture, and linkages between human well-being and benefits obtained from ecosystem services that are provided by agriculture.

Impacts of Agriculture

The impacts of human activities on ecosystems have increased rapidly in the last few decades due to growing demand for these services. While the majority thereof can be considered beneficial to human well-being today, viz. the overexploitation of water for agricultural purposes, there is growing evidences of adverse effects (the lowering of groundwater levels and the resulting difficulty to secure water for crops in the future).Humans have especially enhanced production of three ecosystem services: crops, livestock and aquaculture through expansion of the area devoted to their production, and through technological inputs.

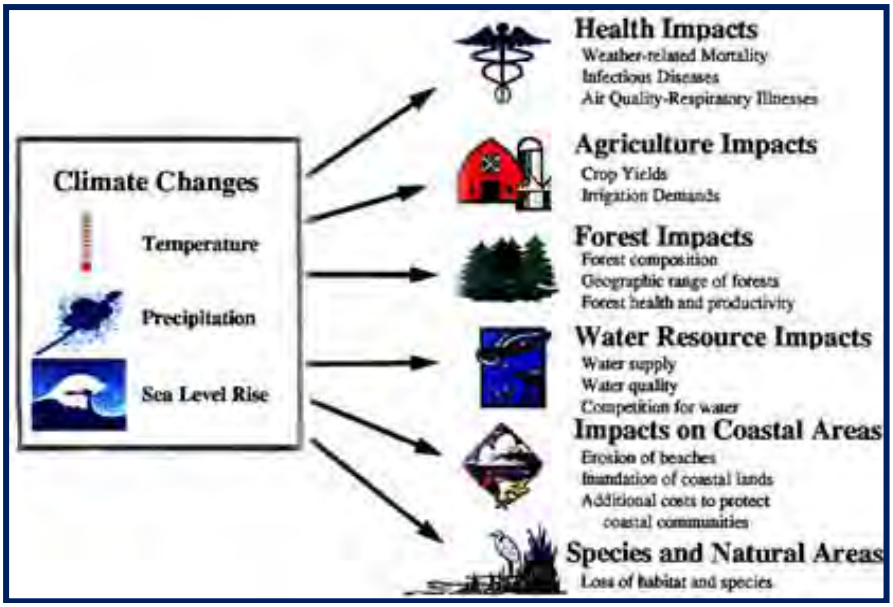
As agriculture remains a key sector in rural areas it continues to have great potential for reducing poverty and hunger in the rural sector. Through the update of modern agricultural technologies, India has moved from an era of chronic food shortages and “begging bowl' status up to 1960s to food self sufficiency and even food exports. The green revolution technologies along with several policy support measures adopted and implemented such as fertilizer subsidy and extension system helped to achieve self sufficiency in food grain production in staple crops such as rice and wheat. But the green revolution ensured food security at the macro level but not completely at the household level. Increase in population size, shrinking arable land resources, soil degradation and depletion of nutrients for the soil, poor water management and unsustainable use of the ground water, loss of momentum in the growth of food output, inefficient biological utilization of the nutrients consumed due to poor environment resulting in growth retardation and emergence of several diet related chronic diseases are some of the major problems the country may have to face in the long march towards human development.

Nutrition security is best defined as “physical, economic, social and environmental access to balanced diet and clean drinking water for all and forever. In India, a significant proportion of the families consume food that may not have enough micronutrients and are unable to afford fruit, vegetables and animal foods needed to provide balanced diet. The result is a devastating public health problem, referred as 'hidden hunger'. The effects of intensive agricultural practices, increasing population pressure, climatic changes, environmental pollution, loss of biodiversity, soil erosion, salinisation and water depletion are all threatening the sustainability of agriculture. Development of high yielding input efficient, resistant to abiotic as well as biotic stresses and better quality breeds can offset the cost of production to be globally relevant. Dynamically evolving biotechnological tools are being deployed to realize high productivity, profitability, quality and ecological sustainability to meet social as well as economic aspirations of farming and related communities. The present thrust is on ecological and economic access to food through poverty alleviation, higher profit to the farmers, and sustainability of resources, import substitution, quality and production for export.

Water contamination: Water is an important component of our land resource. The water which sustains the human life in the planet may become a source of diseases and a root cause of calamities if contaminated chemically or biologically. The quality as well as quantity of available water resource is regulated to a great extent by anthropogenic activities like industrialization, urbanization as well as by crop and livestock farming through unscientific disposal of solid and liquid wastes. The concentrations of heavy metals like, arsenic, lead, chromium etc in drinking water are in pockets due to a combination of geological and anthropogenic reasons. On the other hand a huge amount of harmful organic and synthetic effluents are leached to the surface and ground and surface water as farm land and urban wastes. The interrelation of water pollution with land use change must be analyzed for detailed understanding.

Biodiversity loss: The heavy application of insecticides (a type of pesticide intended to control insect pests) and other agricultural chemicals can have unintended impacts on biodiversity. Insecticide use can have harmful impacts to beneficial organisms, including pollinators and predators of pests. Recently, bee populations have been in dramatic decline. In places where monocultures are grown in place of a variety of flowering plants, pollinators may be left without enough forage (nectar) to survive. The extent to which agriculture specializes in producing a narrow range of crops and animals has lessened the genetic diversity of our food supply (domestic biodiversity Globally, 90 percent of the food supply is derived from only 15 plant and eight animal species. With farmers relying on only a few crop varieties, the stability of our food supply is more susceptible to pest invasions and other shocks.

Resource depletion: Natural resources, including fertile soil, groundwater, fossil fuels and phosphate (a mineral used in the manufacture of some chemical fertilizers), are being depleted at rates faster than natural processes can restore them. Many of these resources are nearing or have passed the point at which their rate of extraction begins to decline. In its current form, agriculture is dependent on all of these resources and is a major contributor to their decline. The possibility that they may no longer be easily acquired raises concerns about the long-term price and availability of food, which may disproportionately impact the poor. Arable land is another natural resource that calls for conservation efforts. Every minute, more than an acre of Indian agricultural land is lost to sprawling suburbs and other developments. Paving over farmland diminishes natural ecosystems, local economies, scenic and cultural landscapes, and the nation’s ability to supply ourselves and other nations with food. Well-managed agricultural land can offer many ecosystem services, including providing habitats for wildlife, helping to control flooding and maintaining air quality.

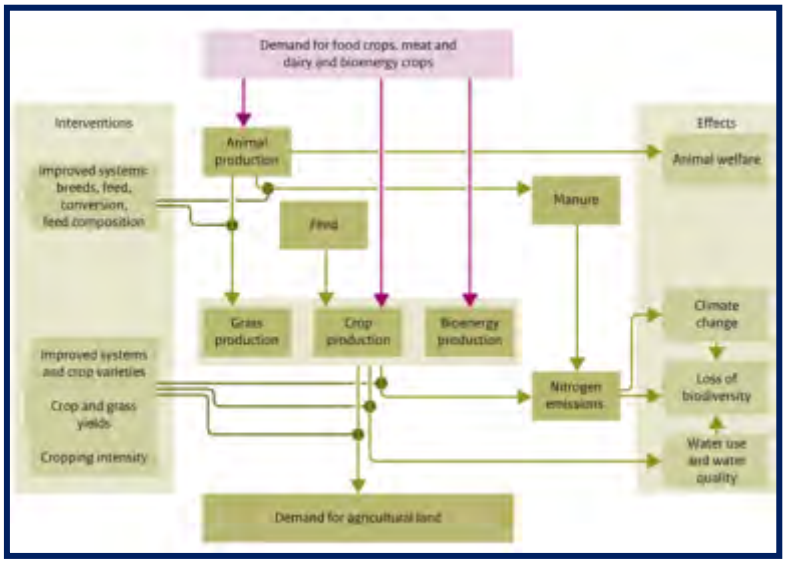


Food Security

The World Food Summit of 1996 defined food security as existing "when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life". Commonly, the concept of food security is defined as including both physical and economic access to food that meets people's dietary needs as well as their food preferences. In many countries, health problems related to dietary excess are an ever increasing threat, In fact, malnutrition and food-borne diarrhea are become double burden.

Food security is built on three pillars:

- Food availability: sufficient quantities of food available on a consistent basis.
- Food access: having sufficient resources to obtain appropriate foods for a nutritious diet.
- Food use: appropriate use based on knowledge of basic nutrition and care, as well as adequate water and sanitation.



Pictures depict various components and functions of Food Security

Sustainable agriculture:

Sustainability has been described as “meeting the needs of the present generation without compromising the ability of future generations to meet their needs.” Literally, “to sustain” means “to maintain,” “to keep in existence” or “to keep on going. It has been argued that it must be ecologically sound, practiced in ways that minimize harms to the natural environment; economically viable, allowing farmers to make an adequate living and produce sufficient food supplies; and socially just. In practice, sustainable agriculture deals with the practices that sustain ecosystem functions vis-a-vis services of agro-ecosystem and in other words, gives due consideration to the importance of long-term interests, such as preserving

fertile soil, biodiversity, freshwater and other resources. Soil erosion, for example, can be minimized by protecting soil from wind and rain. Crop rotations, cover crops, mulching, no-till farming and rotational grazing are farming practices that can reduce erosion.

What the children will do?

Keeping these in view, children will look for identifying the problem(s) related to food and food production systems (processing, preservation, conservation and consumption) in and around their locality and studying them in the form of research project to come up with viable and sustainable solution(s). It is to be made clear to them that impact of science and technology on *ecosystem services* is the most apparent in the case of food production. Much of the increase in agricultural output over the last 40 years has come from an increase in yields per hectare rather than expansion of cultivated area. Moreover, habitat change, overexploitation, invasive species, pollution and climate change are the most important direct drivers of change in ecosystems. For each ecosystem, other direct drivers may play an important role:

- For **terrestrial ecosystems** and their services: land cover change, mainly to cropland, and the application of new technologies. Both land cover changes and the management practices and technologies used on land may cause major changes in terrestrial *ecosystem services*. For marine ecosystems and their services: fishing, both in coastal areas and in open ocean has led to an overexploitation of commercial fish stocks.

- For ***freshwater* ecosystems**: modification of water regimes, invasive species and pollution, especially *nutrient* overloading. The introduction of invasive species is one reason for species extinction in *freshwater*. *Nutrients* such as *phosphorus* and *nitrogen* at high levels can cause *eutrophication* in water bodies and *lead* to high levels of nitrate in *drinking water*.

- For **coastal ecosystems**: change of coastal habitats, such as forests, wetlands and coral reefs, through coastal urban sprawl, resort and port development, *aquaculture* and industrialisation.

Framework

Following diagram (Fig.-5) shows the conceptual framework for developing project.

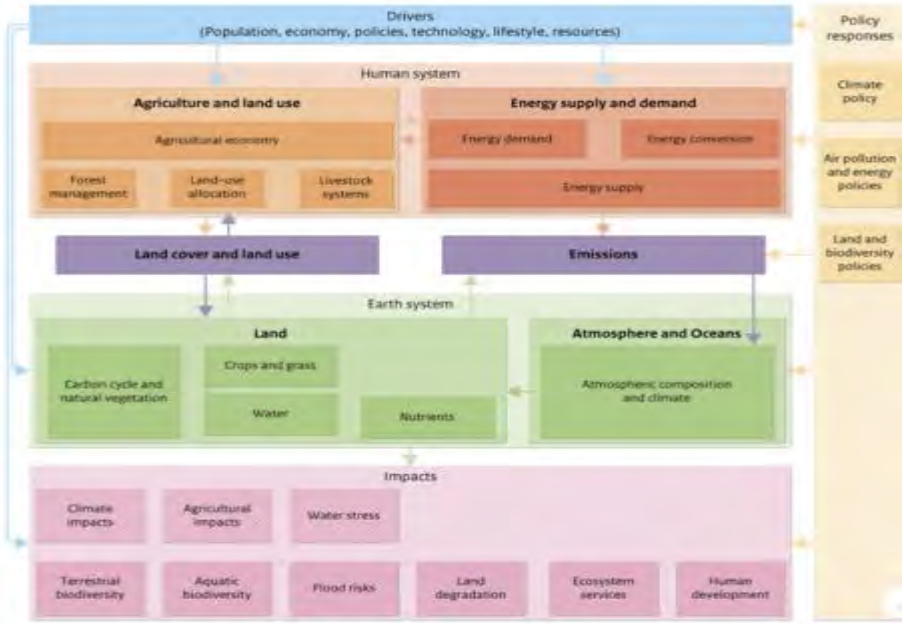


Fig. 5. Conceptual Framework

Ecosystem Function Categories and descriptions.

Ecosystem Function Category	Description
Regulating Functions	Maintenance of essential ecological processes and life support systems.
Supporting Functions	Providing habitat (suitable living space) for wild plant and animal species at local and regional scales.

Project Ideas

Project-1: Influence of vegetation cover on microclimate

The microclimate in simple term refers to the modified climate of a small area which is different in temporal and spatial scale from the climate of the region. The microclimate is modified by vegetation cover, industrialization, development of human settlement and any other intervention in the land use pattern. Tree plantation restricts incoming radiation and has a cooling impact on the microclimate. Trees also act as shelterbelts and reduce desiccating effect of wind. Vegetation cover greatly modifies the soil environment in long run which is a vital component of the microclimate. Modification of microclimate is the perceptible and immediate effect of anthropogenic intervention in land use system. A basic understanding of microclimate will help the students to conceive the possible impact of land use change.

Objective

0. To understand the microclimate
1. To study the impact of vegetation cover on microclimate
2. To have a comparative study of microclimate under different land use system

The experiment may be divided in two components

(A) Field study - monitoring microclimate of different land use system

(B) Development of workable model to understand the concept of microclimate

Part A: Field study - monitoring microclimate of different land use systems **Methodology**

Select different land use systems in the surrounding locality

a) Crop land
b) Barren land
c) Forest land/Orchard
d) Settlement areas and any other typical land use system.

Two simply measurable parameters: temperature and evaporation are selected. This can be improvised by incorporating additional indicators.

- Keep circular leak proof open pan of ½ m diameter and 50 cm depth at the representative place of each land use system. Fill with water up to 30 cm depth. Cover it with wire net.

- Keep the thermometers in suitable places to measure soil temperature, water temperature (of the pan) and air temperature in these sites. Care should be taken to avoid direct radiation on the bulb of the thermometer.

- Record the temperature observations three times daily at early morning (say, 7 am), mid day (say at 12 to 2 pm) and during evening (say, 6 pm) over a period of 4 months at weekly interval.

- Record the depth of water from these pans at weekly interval and add water as per requirement during the period of study

- Collect the soil samples from each site at 10 cm depth 3 days after each rain event. Take the fresh weight (immediately after collection) and again by drying the same sample at 105 ^{0}C for 24 hours in an oven. Calculate the moisture content as below

  Soil moisture content = (Fresh soil weight – Dry soil weight)/Dry soil weight

  The impact on soil evaporation can only be perceptible if soil types are same because the soil type (textural class) is a major driving factor for water release from soil for evaporation

Important note: It is a group activity. Time synchrony has to be maintained for observations at different field sites. Each student may be assigned one site for diurnal observation.

Relevance:

Note the difference in temperature and evaporation rate from each observation site. These parameters are easily perceptible but important indicators to define a microclimate of a place. Mark, how human intervention changes the microclimate. This will give help the students to understand the microclimate and in broad sense demonstrate how anthropogenic intervention is responsible for modification of the climate on the earth surface.

Part B: Understanding the concept of microclimatic

Materials required

- Earthen pot (6 Nos)
- Seedlings (Fast growing plant depending local suitability)
- Card board & Ply board
- Thermometer (2 Nos)
- Open pan of 20 cm diameter and 5 cm depth

Methodology:

- Take 6 earthen pots. Make a whole at the bottom of each pot.
- Fill the pots with one thin layer of small stones at the bottom and the rest with soil
- Plant one seedling in each pot and water regularly.
- Make two model houses using card board / ply board
- Place one model house in the middle of 6 pots and one house in open area
- Measure the temperature of the roof top of each house (using thermometer) at 15 days interval starting from the date of planting.
- Place the open pan near each model house and keep 2 cm depth of water in each pan. Add water to each pan after drying.
- Note the temperature difference between the two situations

- Note the time required to dry up the water from each pan

Relevance:

This project will give a direct experience to the students about how plantation helps in ameliorating the microclimate. Maintaining the plants from sowing to subsequent growth will induce the association of students with the plants and will help in understanding the concept of microclimatic modification at the same time. Hands-on learning process will be an interesting and effective method.

Note: These two exercises (part-A & part-B) may be considered complimentary to each other

Project 2: Soil is a Buffer Medium

Introduction

Soil has considerable buffering capacity. It helps to overcome the problems associated with various acidic or alkaline inputs which are frequently being added to the soils. An idea about how this buffering activities help to sustain the soil condition may be obtained through a simple experimentation.

Objectives

1. To study buffering action of soil
2, To assess the efficiency of soil organic matter influencing buffering capacity of soil

Methodology:

- Study will carried out using soil-column preparing in waste plastic drinking water bottle, the bottom of which will have to be perforated carefully with sharp nail. Number of perforation of all the bottles should be equal

- Organic matter (Farm yard manure or vermin-compost or decomposed cow dung etc.) in different proportions will be mixed well with the finely grindedsoils.

- A piece of blotting paper or filter paper should carefully insert and placed at the bottom of the bottles, so that the perforations do not get plugged with the soil particles

- The plastic bottles are to be filled-up with the soil with occasional tapering to attain natural density.

- Artificially prepared acidic solutions (pH around 5.0) will be used

- Different amount of acidic solution of same pH will be added to different soil column and the pH of soils as well as filtrate from the soil column will be analysed after stabilization of pH

Observation

Variation in pH of soils with or without organic matter as well as filtrates will be recoded

Relevance

Results of this experiment will help the student to understand how soils can resist the abrupt pH changes and other stresses imposed on soil by anthropogenic activities. This will also help the students to realize the role of OM.

Project 3: Land as a habitat of soil fauna

Introduction:

Land is one of the most diverse habitats on earth and contains one of the numerous assemblages of living organisms. Soil biota includes bacteria, fungi, protozoa, nematodes, mites, collembolans (springtails), annelids (earthworms), macro arthropods (insects, woodlice) etc. The primary role of soil biota is to recycle organic matter that is derived from the above ground plant based food web.

Objectives:

1. To observe and document some visible life forms present in the land.

2. To record the seasonal variation and the type of biodiversity present in the soils of varying productivity levels.

Methodology:

Soil sampling:

Sample should be taken from the root zone of plants. Collect soil samples with specific quadrat . Take sample from different locations within the area and mix together. Collect the soil and place it in a ziploc bag. It should not be touched with hands. Separate soil samples will be collected for some physico-chemical analysis viz. texture (feel method), colour, pH etc.

To see the organisms in the soil:

1. Larger animals can be easily separated(Earthworms, beetles, etc)
2. To catch small arthropods, take a Tullgren funnel. Set a piece of ¼ inch rigid wire screen in the bottom of the funnel to support the soil. Half fill the funnel with soil, and suspend it over a cup with a bit of anti freeze or ethyl alcohol in the bottom as a preservative. Suspend a light bulb (25 W) for about 4-5 days over the soil to drive the organisms out of the soil. Animals will move away from the light and heat and fall down in the cup placed below.

Observation:

Date
Time:
Weather: Sunny/ Rainy /Cloudy etc.
Sampling area:
Characteristics of the soil:

Sample no.	Type of organism	No. of individual	Remarks

Sample size:

Analysis:

1. Appropriate data sheet may be created for soil fauna.
2. Abundance of different species or relative density could be analyzed from the data collected using following formula.

$$\text{Abundance} = \frac{\text{Total no. of individuals of the species in all the sampling units}}{\text{No. of sampling units in which the species occurred}}$$

$$\text{Relative density} = \frac{\text{Total no. of individual species}}{\text{Total no. of individual in all species.}} \times 100$$

3. Seasonal variation of the animals could be noted under different soil conditions.

Conclusion:

1. Significance of habitat choice by the organism can be studied.
2. Dominant species and rare species can be shown.
3. Compare the result between or among the soils.

Relevance of the project:

A comparison of soil macro fauna in different types of soil like, forest, agricultural land, and urban, eroded, etc can be shown. The analysis of results may suggest remedies for eco-restoration of the degraded land.

Project 4.Evaluating filtration capacity of soil

Introduction:
Soil acts as a physical (sieving action), chemical (adsorption and precipitation) and biological filter (decomposition of organic waste materials). It has an important role in people's efforts to maintain a suitable environment, as a waste disposal site and to minimize pollution. In majority of area around cities and towns, municipal sewage water (which usually contains inorganic and organic pollutants) is used for irrigation to crops. In some situations, urban runoff and storm water carrying various chemical and pathogenic contaminants also finds its way into the land area. Unless filtered, these have the potential to contaminate water bodies.

Objective:
To estimate filtration capacity of soil
Materials required:
1. Industrial effluent and/or municipal sewage water
2. Copper sulphate
3. Nickel chloride
4. Empty mineral water bottle of one litre capacity
5. Note book
6. Soil from river bank, soil from dried pond bed, soil from cultivated land, and soil from forest area

Methodology:

1. Collect industrial effluent, domestic sewage from few sites of the city.
2. Prepare 16 soil columns: For this, cut one-third of the top portion of the bottle; make 3-4 fine holes with needle at the bottom of the bottle; put a thin cotton layer at the bottom. .
3. Pack the bottle with 500 g of soil and place it over a funnel.

4. Prepare solution of nickel chloride or copper sulphate (like: 10g salt/ 100 ml)
5. Add 200 ml of the salt solution, Industrial effluent and/or municipal sewage water in separate soil columns.
6. Collect the water leached through the soil column at the bottom of the funnel.
7. Note down the color of leached water

Observations:

Table:

Sl No	Name of the soil	Type of water added in the soil column	Colour of the leachate

Interpretation: If there is a colored leachate, the soil has poor filtration capacity. On the other hand, colorless leachate indicate high filtration capacity. In case, if a colored leachate is obtained for salt solution and colorless leachate is observed for industrial effluent or municipal sewage water, soil has good filtration capacity for particulate solids but poor filtration capacity for metals.

Relevance:
This experiment will help the student to understand which type of soil has good filtration capacity. By having information about the types of soil and industries in their area, they can predict the susceptibility of water bodies of their area from getting contaminated.

Project-5: Mitigate soil and water loss through runoff with suitable control measures.

Land degradation refers to the loss of inherent capacity of land to produce healthy and nutritious crops. It may occur with various forms – physical, chemical and biological. Soil erosion is the most important forms of land degradation as the vast area of our country suffers due to such process. It is, therefore, necessary to protect this shrinking valuable land resource to meet the demand of ever increasing population. Some of the common measures are practiced for preventing the loss of runoff water and soil particles from the sloppy land, which includes terracing, bunding, cover cropping, strip cropping, conservation tillage, cultivation along or across the slope etc.

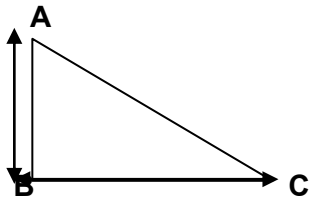
Objectives:
1) Quantify loss of soil and water through runoff.
2) Implement control measure to check the loss of soil and water.
3) Sustainable land use practice in areas prone to erosion.

Methodology:
1) Selection of a suitable sloppy land.
2) Divide the land into at least 3 parts along with the slope.
   (Minimum width of each part shall be 3m)
3) Treatments
   a) Keep fellow or undisturbed.
   b) Grow cover crops.
   c) Grow strip crop as per local practice.
4) Separate the adjoining parts by erecting suitable barriers with non porous inert materials

5) Place suitable notch at the middle part of the lower end through which runoff water and soil particle will pass.

6) Place a large bucket or suitable tank to collect the run off water and soil particles.

How to calculate slope of a land?



Suppose BC is the length of a land and AB is the height of the land;
So, **Slope, % = (BC/ AB)x 100**

Observation:

1) Length of slope
2) Percent of slope
3) Amount of water added at the upper end to initiate the runoff process
4) Measure the amount of water and soil collected in the tanks at lower end.

Follow-up:
1) Transfer the results of the experiments to the farmers and local people.
2) Demonstrate the experiment to other students of your school or area.

Project-6: Study of the influence of tillage on soil physical properties

Fifty per cent of the soil's compositions is void (occupied by air and water) which can be modified by anthropogenic activities like tillage, farm mechanization, etc. The void space is formed by both micro (small) and macro (large) pores. Water is easily drained out from the macro pores and is retained more in micro pores. Roots require water and air from soil for the growth which depends on how much water and air the soil can hold. When the soil gets compacted by traffic load, the total pore space is decreased which affects water retention as well as root penetration. Bulk density is the index that measures the compaction of soil. High bulk density value indicates high compaction and less pore space. It also implies the closer contact of the soil particles that increases the heat conduction within the soil. Tillage disintegrates soil particles, modifies soil pore spaces and slows down soil conduction in soil as compared to untilled or compacted soil. The modification depends on the intensity or frequency and types of tillage use. As for example, a tractor drawn ploughing differs in depth with country plough.

By looking comparison between tilled and untilled soil, the question of whether different intensity and type of tillage affect the physical properties of soil will be addressed. The question will be answered by comparing the bulk density, water holding capacity, presence of micro and macro pores and soil temperature.

Objectives:

1. To study the influence of tillage on water holding capacity of soil
2. To find out the influence of tillage on bulk density
3. To identify the influence of tillage on soil porosity

Materials required:

- Agricultural fields in which a) ploughing is done through power tiller/tractor, b) ploughing is done through country plough c) Pasture/barren land where (no ploughing done)
- 9 GI pipes of 6 cm height and 5 mm diameter to be used as soil core
- Knife, Hammer, Wooden plank, Spade, Small cloth, Rubber band, Weighing Balance, Drier, Beaker, Thermometer
- Funnel fitted with a polythene pipe of 100 cm length
- A clump attached at 100 cm height

Methodology:

Study -1 : *Bulk density of soil* (g/ cm^3)

1. Scrap the soil surface with spade where the core is to be inserted
2. Insert a core with the use of a wooden plank and hammer
3. Pull the core from the soil with the help of a spade
4. Cut the extra soil present in the two open ends with knife and clean the soil from the outer of the core by hand
5. Weigh the empty can and put the excavated soil from the core and keep it in the drier at 105^o C for 24 hrs
6. Measure the volume of the core as: $\pi r^2 h$ ($3.17 \times 2.5^2 \times 6$)
7. After deducting the empty weight of the can from No 5, measure the dry weight of the soil in can.
8. Measure the bulk density of soil as-

$$\textbf{Bulk density (g/ cm}^3\textbf{)} = \left[\frac{\text{weight of the dry soil}}{\text{volume of the core}} \right]$$

Study - 2: *Water holding capacity* (%)

1. Same as from Sl No. 1 to 4 of Study 1.
2. A small piece of cloth is covered in one end of the core with the help of a rubber band
3. Place the core in a Petri dish and water is poured $1/3^{rd}$ in it
4. Keep this as such for 24 hrs, in that time the soil gets saturated
5. Take the core out of the Petri dish and keep it on the table for 10 min.
6. Collect 5 tea spoon moist soil from the core in an empty can
7. Weight the soil in can and keep it in the drier at 105^0C for 24 hrs
8. After deducting the empty weight of the can, measure the moist and dry weight of the soil in can
9. Calculate the soil moisture content in the soil core as:

$$Soil moisture(\%) = \left[\frac{\text{weight of the moist soil} - \text{weight of the dry soil}}{\text{weight of the dry soil}} \right] \times 100$$

10. The calculated value indicates the water holding capacity of the soil. As all the pores here are occupied by water, the calculated water holding capacity also indicates the total porosity of the soil.

Study - 3: Soil porosity (%)

1. Calculate percent total pore space (Micro and macro pores) present in a soil core using the following formula –

$$Total Porosity(\%) = \left[1 - \frac{\text{Bulk density}}{\text{Particle density}} \right] \times 100$$

2. The value of bulk density can be obtained from Sl. No. 8 of Study 1

3. The value of particle density (also known as True density) can be considered as 2.65 g/ cm^3, which is the average value considered for all practical purposes.
4. One can find out separately both micro and macro pores of the soil by other way too as given below

(A) Micro porosity

1. Same as from Sl No. 1 to 4 of Expt. 2
2. Clamp the funnel at 100 cm height
3. Place a beaker at the end of the pipe fitted in the funnel.
4. Keep the core on to the funnel for 24 hrs
5. Collect 5 tea spoon moist soil from the core in an empty can
6. Same as from Sl No 7 to 9 of Expt. 2..
7. The moisture content thus calculated indicates the moisture present in the smaller/micro pores i.e., micro porosity.

(B) Macro porosity

Deduct the values obtained in Sl No. 10 of Study- 2 and Sl. 7 of Study-3.

Study -4: Soil temperature (^{0}C)

- Insert thermometers in tilled and untilled soil up to a depth of 5 cm (2 inches) at the morning (8 hr) and record the soil temperature
- Compare the variations in soil temperatures

Relevance:

With the increase in intensity of tillage: (1) soil gets compacted i.e., bulk density is increased, (2) total pore space is reduced (3) micro pore space is decreased (4) water holding capacity is decreased (5) soil temperature is increased.

Note:
Density is the mass of an object per unit volume. It is expressed as gm/cm^3
Soil has got two densities – Particle density and Bulk density.

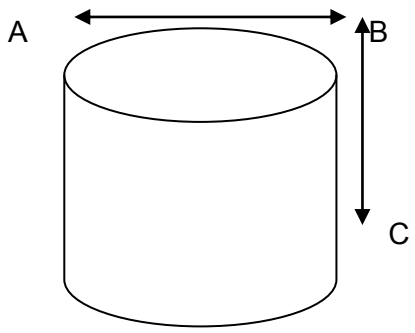
- **Particle density (pd)** is the density of the solid soil particles (sand, silt and clay). For all practical purposes and on-farm studies average particle density is considered as **2.65 gm/cm^3**

- **Bulk density (bd)** is the density for a volume of soil as it exists naturally, which includes any air space and organic materials in the soil volume. Science bulk density is calculated for the dried soil, moisture is not included in the sample. It is calculated using the following formula

bd = weight of soil/ volume of soil core

Volume of soil core = $\pi r^2 h$ (π = 22/7 = 3.14)

Where, **r** is the radious of the core = **d/2** (d is the diameter of the core)
h is the height of the soil core



Suppose, in the figure of the cylinder, AB is the diameter (d) and AB/2 or d/2 is the radius (r). BC is the height (h) of the cylinder.

Calculate (i) cross sectional area(A) of the cylinder ($A = \pi r^2$)

(ii) Volume of the cylinder (V) = A x h = πr^2 xh = 3.14 r^2 xh (π = 3.14)

Soil porosity, % = (1- bd/2.65)x100

Suggested Additional project ideas:

1. Minimize fluoride and nitrate toxicity in drinking water?
2. Organic farming for improving soil quality and food quality
3. Diagnosis of acid, saline and alkali soils for their better management
4. Minimizing heavy metal pollution for protecting soil quality
5. Arsenic contamination in ground water
6. Influence of management practices on land quality
7. Recycling of industrial wastes for Agricultural use
8. Soil microbial population – Key to soil health
9. Pesticide effects on land quality
10. Effect of pollutants on soil biota?
11. Eco-friendly compositing of agricultural wastes
12. Eco-friendly farming
13. Knowing water holding capacity of soil of the locality
14. Fluctuation of water tables in any season of the year of the locality/region
15. Delineation and characterization of local watershed based on topography, drainage network and local knowledge
16. Chemical farming to organic farming and the journey towards eco-resort sajivakhetithi study sujavatosansodhanatamka Agriculture
17. Comparative study of modern farming methods
18. Modern techniques of different resources (agricultural land, water damage, etc.); Side effects of the underground water and agriculture tulanatamka product / food nisatvikaranano study
19. Agriculture used to study changes in soil and water quality and measures / mechanisms to be refined again to undo the progress that has been a long-term consideration
20. Food, seeds, fruit, vegetables ityadimate quality production, studied traditional and modern ways of referring to their collection; There were no measures to increase selphalaipha mapping is available to study its design / technical information, etc.
21. Solutions for positive, long-term environmental protection is not commonly used in agricultural products, the maximum tolerance used in the second / agriculture

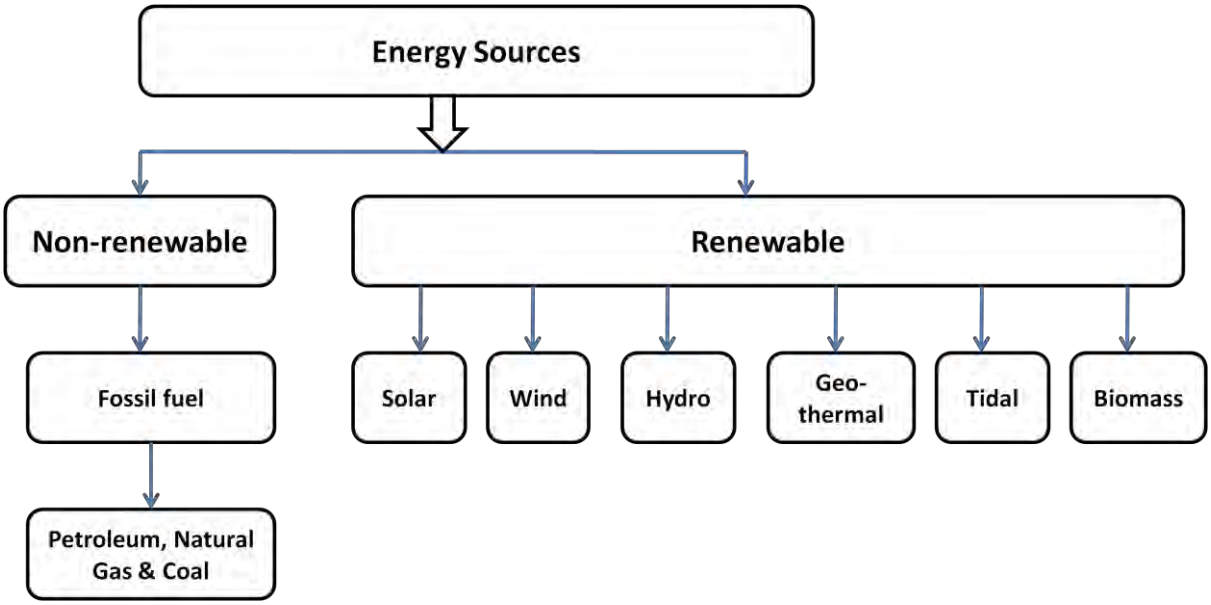
22. Whether increased agricultural tools / equipment or changes in functionality have been no other changes? The study
23. Farming Information (TV, Radio) of machines / media impact and ways to make it more efficient. Its spreading awareness about the study or the study of how many farmers
24. Traditional solutions / tools for food storage practice
25. Study innovative methods of soil analysis for crop cultivation
26. Industrial area polluted water found in soil chemical analysis and the study of its effects

Sub Theme III

Energy

Sub theme: Energy

Economic development of any region or a country largely depends on how its energy requirements are satisfied. Every production process has certain amount of energy requirement. Hence, availability of quality energy is crucial for overall scientific and technological progress of any country. Per capita energy consumption is one of the key deciding factors of the level of well-being of any society or for any country. It is also referred through the relationship between economic growth and energy consumption.



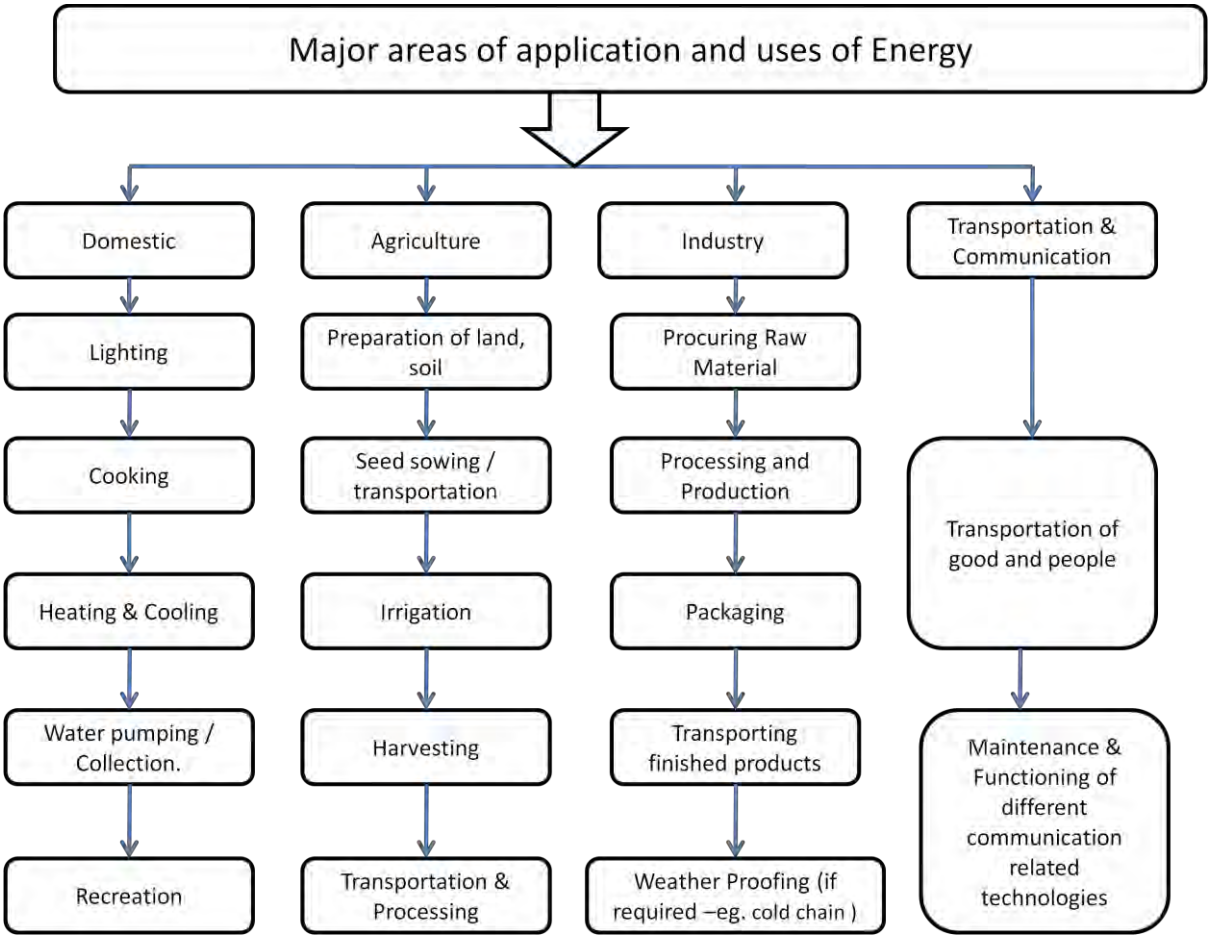
Energy is central to sustainable development and poverty reduction efforts. It affects all aspects of development - social, economic, and environmental - including livelihoods, access to water, agricultural productivity, health, population levels, education and gender-related issues. None of the Sustainable Development Goals (SDGs) can be met without major improvement in the quality and quantity of energy services in developing countries. Energy is mainly used in domestic, agriculture, industry, transport and communication sectors and they are interlinked. Efficiency of the technology in use and its purpose to produce services are important which determine the situation of energy sufficiency. In these perspectives, to achieve energy sufficiency and efficiency for suitability each one is interlinked through proper value setting, management principles, technological efficiency with policy measures

In the above perspectives Sustainable issues are reflected as follows:

Sustainable energy is the sustainable provision of energy that meets the needs of the present without compromising with the ability of future generations to meet their needs. Technologies that promote sustainable energy include renewable energy sources, such as hydroelectricity, solar energy, wind energy, wave power, geothermal energy, and tidal power, and also technologies designed to improve energy efficiency. Energy efficiency and renewable energy are said to be the twin pillars of sustainable energy.

“Dynamic harmony between equitable availability of energy-intensive goods and services to all people and the preservation of the earth for future generations”. And, “the solution will lie

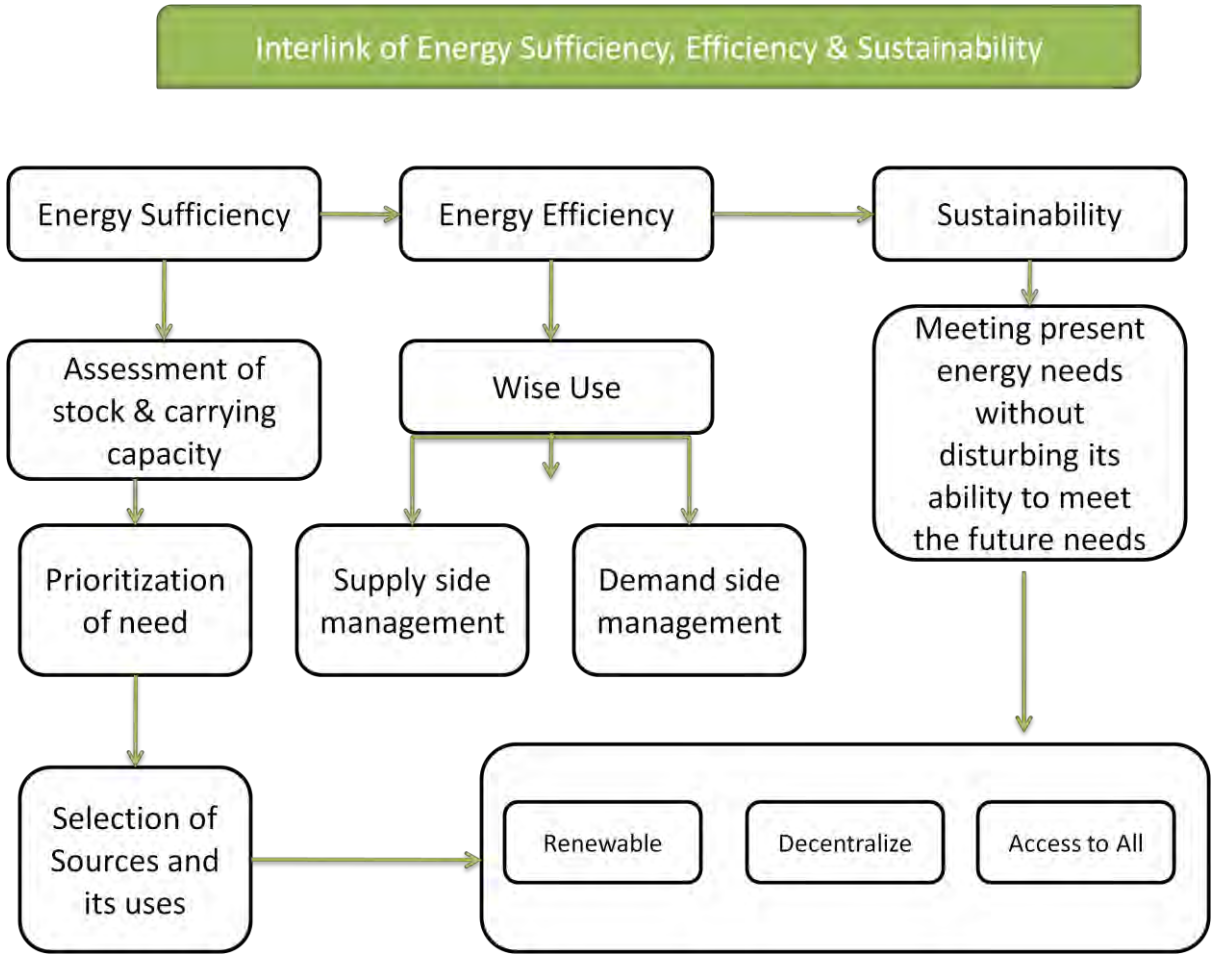
in finding sustainable energy sources and more efficient means of converting and utilizing energy".



Any energy generation, efficiency & conservations our where resources are available to enable significant portion of energy generation in long term. The growing concern for climate change and energy security now means that energy sufficiency is something that warrants serious consideration. It looks beyond technical energy efficiency measures and address the challenging issue of curbing consumer demand for energy services in an ethically acceptable fashion. It also implies a need to recognize limits and to establish acceptable minimum standards for energy services. Taking consideration of our required initiatives in this era of global climate change challenges, efficient energy use and replacement of carbon based fuel with non-carbon based fuel are the key areas by which we can reduce our carbon footprint to a large extent and undertake some pragmatic measures for mitigation and adaptation of climate change. It is noteworthy that awareness and understanding in such areas in many cases encourage us for taking self initiatives for conservation, rational uses and strategies for enhancing efficiency.

The last century witnessed an exponential growth of human population and it has altered the life style of the people from ecosystem based approach to a market base approach. In this context, the development index is controlled by GDP and associated with the pattern of consumption. As a result of which growth of different sectors like agriculture, industry etc is highly dependent on energy consumption. These processes create more demand for energy generation. Eventually to fulfil these demands now a days focus is given more on power

generation either from hydel or from thermal. But normally in planning and designing such project only economic perspectives is considered while ignoring the issues related to environment, human life and society. Such non-futuristic and unsustainable approach leads to the problems of global warming, developmental inequality, conflicts, and health and ecosystem damage.



It is essential to address issues to take care of all the evolving system related to development. If the development process has to be sustainable, it is necessary to increase the efficiency of energy utilities and processes, conserve energy and explore renewable sources of energy. From such perspectives, efficient and equitable energy access and supply system can create an ideal situation for energy sufficiency and provides energy security to all.

The energy connect of Sustainable development can be dealt at five levels: Production, Processing, Transmission, Consumption and Disposal. Energy production, let it be hydel, thermal, nuclear, fossil fuel, biomass or non conventional, has some impact on environment. Oil refineries pump a large quantity of GHS into the atmosphere. The high voltage transmission line and petroleum transmission pipes cause some mishaps in the environment. The greatest quantity of pollutants are emitted during the consumption of energy and fuels. The consumption of energy in industry, health care, cooking, agriculture, entertainment, housing, transportation, communication and in domestic domains have direct or indirect far reaching impact on life supporting systems like air, water, land and ecosystems like forests, wetlands, rivers, water sources, and biodiversity at large. Beginning of agriculture and industrial revolution are considered as landmarks in human civilization.

During the progress of civilization the demand on energy also increased. Energy consumption rate is considered an indicator of standard of living and development index of a country.
Energy is the driver of growth. International studies on human development indicate that India needs much larger per capita energy consumption to provide better living conditions to its citizens. But such growth has to be balanced and sustainable. Two important concepts here are energy management and conservation.

Planning commission of India has estimated that India has conservation potential at 23% of the total commercial energy generated in the country. India's energy requirement comes from five sectors; agriculture, industry, transport, services and domestic, each having considerable saving potential. For example, energy costs amount to 20 percent of the total production cost of steel in India which is much higher than the international standards. Similarly the energy intensity per unit of food grain production in India is 3 - 4 times higher than that in Japan. Sustainable growth also implies that our energy management and energy conservation measures are eco-friendly and accompanied by minimum pollution, in particular minimum carbon emission.

MODEL PROJECTS

PROJECT: 1

TITLE : Sustainability of the Energy Self-Reliance of a village / housing society

Any given village can be using a combination of renewable and non-renewable energy sources available to it. Probably the combination evolved in such a manner because of the different requirements came at different point of time. Now it might be necessary to relook the combination of different energy sources so that the village / society to be more of self-reliant and sustainable. This would help to make the future growth as sustainable in long term with the least carbon foot print.

OBJECTIVES

1. To identify the various energy sources available for the said village
2. To bring out the optimum energy usage pattern for the village leading to the maximum possible self reliance.
3. To suggest a various options for reducing the village level carbon foot print with more of renewable energy sources.

METHODOLOGY

Firstly the identify the various energy requirements for the most of the common facilities in the village/society like street lighting, water pumping station, sewage treatment plant, community cooking, public storage, energy for public buildings like schools, government offices, libraries, recreation clubs etc. Then the various energy sources readily available for the village/society need to be categorized under the ambit of renewable and non-renewable, cost-effective, long-term maintainability, reliability, less-polluting etc. Once these jobs are done, the whole data can be taken to meeting of village people and discuss the suitability of each source and requirements so as to make the village more self-reliant and hence it can be sustained for very long term. Points of discussion and suggestions of people and professionals can be noted down and a people participatory practical suggestions to make a energy self reliant can be worked out.

ANALYSIS

The water pumping can be done using solar or wind energy without any storage of energy. Simple and small storage systems can be made for the street lightings and energy can be stored in the day-time. The government offices work mostly in day-time, hence the energy requirements can be met by the solar power itself. Biogas or solar power can be used for community cooking. If the sources and requirements are matched by various factors the energy from various sources can be mixed in right proportion so as to make the village/society self-reliant and hence the future growth can be sustained. When the energy requirements increase in the village/society in future in a particular activity, the present fulfilment of all requirements should be looked afresh and appropriate reallocation should be done. A preparation of a model can be attempted with all the information collected and creative and synthetic ideas generated.

CONCLUSION & SIGNIFICANCE

If each and every village/ housing society is made self reliant, then the model can be replicated for wider area hence fuelling the future growth with sustainable activities and understandings.

PROJECT 2

TITLE: Equity and Distribution of energy in a locale and its effect on sustainable development.

The distribution of energy in a locale / village could have been evolved in a very non-uniform manner because of many socio-political and economic reason. In future, if the benefits of growth in terms of energy is not distributed uniformly and also by mitigating the present non-uniformity, then the sustainability of the growth can be disturbed by the social unrest due to the inequality. Distribution of energy usage can be documented and studied scientifically and can help to re-orient the distribution leading to sustainability.

OBJECTIVES

1. To identify the non-sustainable distribution energy in terms of economical, societal and ecological factors.
2. To suggest ways to redistribute the energy sources considering the sustainability of energy usage in future.

METHODOLOGY

Firstly, it is to identify the various sources of energy available in a locale/village and then to characterize them under the ambit of renewable and non-renewable sources. Then the pattern of the energy consumed in the locale needs to be mapped along the lines of per capita energy. Then the various reasons for the non-uniformity in the distribution, if any, need to be identified. After studying reasons scientifically, the same can be discussed with people of various background and steps for making the sustainable distribution can be identified. This needs to be done considering the present life style of people and future needs as well as new sources of energy.

ANALYSIS

The temporal and spatial patterns of energy consumption need to be studied scientifically. Then, with sustainability of growth in mind, the temporal and spatial requirements need to be matched with the characteristics of available energy sources. For example the solar energy can be tapped for all the day-time energy requirements and wind energy can be tapped to

the increased energy requirements during monsoon season. During monsoon it is imperative to eat the hot food all the time to avoid any virus/bacteria related diseases. Then the energy distribution can be done uniformly across the sub-locales keeping the growth in mind. If the redistribution is more uniform now, many potential social unrests can be avoided which is an important factor for the sustainability of any growth.

CONCLUSION & SIGNIFICANCE

The equitable distribution of energy to be consumed is an important ingredients for the sustainability of growth and that needs to tackled in terms of economical, societal and ecological factors.

PROJECT – 3.

TITLE: Assessment of wastage of energy and energy budgeting of festivals and social functions.

Lot of energy gets wasted though our carelessness and many ritualistic behaviours. Celebration of festivals in different parts of country witnesses increased energy usages. This may be by way of cooking, transportation, lighting and firecrackers so on. Students may be encouraged to explore the ways in which the celebration practices have changed over time and their impact on the health of the community and eco-system.

OBJECTIVES

1. To study the change in the pattern of energy uses in festivals
2. To find out the amount of energy consumed by a group of households during the festival days.
3. To compare the energy consumption pattern in the society during festival days and non-festival days.
4. To suggest ways to reduce the excessive/ unwanted use of energy during festival celebrations

***Methodology*:**

Sample: For the study the students should select, randomly, a group of households in their locality. A suggested sample size could be 25-40 households.

Tools: Students should prepare the following types of tools under the guidance of their teachers;

1. Check Lists of devices used, during the festivals, which consumes energy and the quantity of material / fuels etc. procured and consumed during festival days.
2. Interview Schedules to collect information from the Heads of households about the practices that require energy for celebrating festivals
3. Collection and analysis of electricity bills for the festival month(s) and non-festival month(s) to find out the difference in the energy consumption, if any.

Techniques:

1. The students should visit the households before the festival and after the festivals to collect relevant data and information.
2. If possible, they should collect the information from the field/ sample by observing the households during the festival.

Analysis and Interpretation of the Data:

The data/information so collected should be analysed in view of the objectives of the study and it should be interpreted to arrive at conclusions.

Expected outcome:

1. Suggestion of Eco-friendly efforts/ measures to be take nup by the society while celebrating the festivals
2. Awareness levels of public about energy saving techniques particularly for celebrating festivals 3. Examining people's sensitivity towards energy conservation while celebrating festivals

PROJECT IDEAS

1. Biofuels an alternative to our oil and energy needs. Children can study the availability and potential to use the biofuel as an alternative to the existing usage of fossil fuel or any other conventional fuels.
2. Village energy budget. A thorough analysis of existing village energy budget identifying the wastages and suggesting the corrections can be good project.
3. Changes in energy usages of people, Comparison of energy usage of different sections of people in the socio economic strata can be attempted.
4. Energetics of irrigation. Irrigation sector uses a very high energy. The practices of energy usages in this area can be studied in a village, identify the possibilities of energy saving and working modalities
5. Energy dynamics of dryland farming and irrigated farming. Children can think about a comparison of energy needs of dryland farming and irrigated farming in the same area.
6. Energetics of fast food culture: Energy needs of production, preservation, distribution and consumption of fast food as opposed to the traditional local foods can be compared and studied.
7. Energetics of building architecture. Every building needs energy for many aspects such as lighting, temperature maintenance and so on. There is a direct link with architecture and energy requirement. This can be compared.
8. Energetics of life stock. Different practices of livestock maintenance requires different levels of energy. Also the life stock give back energy a balance sheet of energy requirement and return can be attempted.
9. Energy demands of cooking. Cooking involve a significant energy usage of people everywhere. Energy demands of different cooking styles and be studied and compared.
10. Energy comparison of different mode of transportation. Sustainability of future transportation sector lies in how we are making it more and more energy efficient. A study of energy efficiency of different modes of transportation can be worked out focusing a specific city/town or even villages.
11. Storage of energy and sustainability. We may have to store energy for various purposes as in the batteries and so on. How much this is sustainable and the usage of such storage devices can be studied in the light of sustainability.
12. Waste of energy. We can see wastages of energy in all levels locations and contexts. Identifying the wastage of energy in different locations, practices etc can be taken as good study topic.
13. Effect of Energy policies on sustainability. Government takes various policies regarding energy usages such a electricity fare hike and so on. Effect of such policies on the usage pattern of energy can also be studied.
14. Using a solar module, calculate the maximum power output at different solar radiation and also try to evaluate the power output at different inclination angle of the solar module.
15. Measure the amount of gas output from different kinds of organic waste materials (cow dung, vegetable waste, food waste, municipal solid waste etc.).
16. Evaluation/estimation of energy supplied by cattle in the village ecosystem for the traction power
17. Cow dung as fuel etc and estimates the amount of other conventional energy sources required to substitute them.

18. Study the amount of fuel required to boil water/ cook a certain amount of food in different structured utensils and identify the most energy efficient one.
19. Study the components of energy systems supporting in maintaining a garden and relative roles.
20. Study the relative role of different energy systems in development of a green building.
21. Sustainability and food processing. Comparison of energy usage and energy system contributions in food processing.
22. Check the performance of chullahs in the village and rank them on the basis of performance in the light of availability and sustainability of firewood resources.
23. Sustainable energy conversion systems in a village. This need to include the energy source conversion devices, output work and kind of losses and try to rank them based on the work performance to develop a sustainable model.
24. Different refrigeration systems and their role in energy saving and management
25. Maintenance of room temperature – sustainable models. Record and analyse the room temperature inside the building with different types of roofs.
26. Charcoal production potential of different types of biomass and its role in the sustainable energy availability of a village.
27. Innovative energy efficient stoves to utilise locally available bio-residues as a source of sustainable cooking option for the village
28. Carbon sequestration through community initiatives
29. An investigation about the impact of energy availability on the change on lifestyle of the people
30. Traditional practice of backyard farming of the non-timber firewood species
31. Experimental study on conscious reduction in energy use in the household and role of awareness in the energy usage of people.
32. Reducing energy consumption through the use of energy transformation methods.
33. Comparative study of energy and resources required.
34. Biodiversity and energy.
35. Measuring and evaluating the cost of energy to stay healthy gymnastics.
36. Influence on the management of waste energy.
37. The impact on food and feed of energy.
38. Using solar energy is based on a new idea.
39. Related stove energy efficient new idea.
40. New ideas regarding the use of energy, protection of the planet.
41. Large-sized power plants impact on the environment.
42. Sight pastoral energy, evaluate the number of animals.
43. Social structure, gender - female - male, education and energy conservation, storage.
44. What is an acceptable solution to burn simply log for waste disposal?
45. As well as the evaluation of the energy produced by wind, sea mountain hill area.
46. Comparative study of the uses of farm animals, bulls, etc. as well as the machinery (tractor).
47. The use of solar cookers, When? Why ?
48. Electrical energy savings methods.
49. Enormous hydroelectric practice in your area.

References:

(http://www.undp.org/content/undp/en/home/ourwork/environmentandenergy/focus_areas/sustainable- energy.html).

Bureau of Energy Efficiency Guidelines; http:// www.beeindia.in/)

http://www.fao.org/forestry/17111/en

"The Twin Pillars of Sustainable Energy: Synergies between Energy Efficiency and Renewable Energy Technology and Policy". www.aceee.org.)

(http://www.undp.org/content/undp/en/home/ourwork/environmentandenergy/focus_areas/sustainable- energy.html).

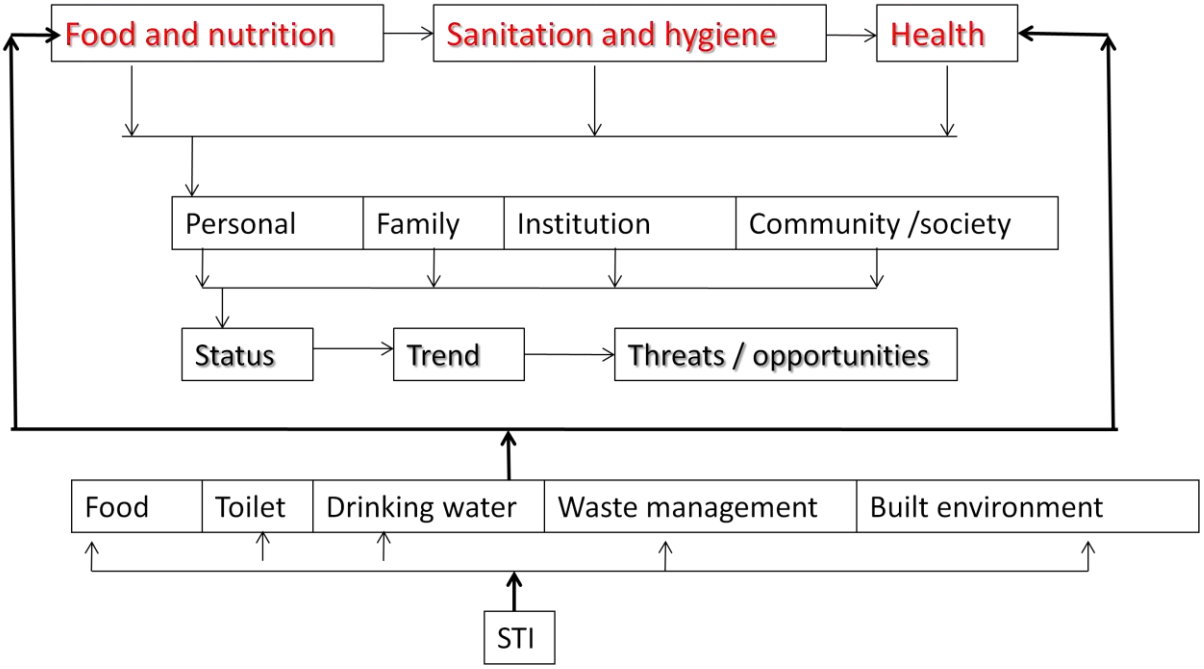
Sub Theme IV

Health, Hygiene & Nutrition

Sub-theme:
Health, Hygiene and Nutrition

Introduction:

On the surface, it is a common-sense argument. *Of course* the children of today and tomorrow are central to sustainable development and the future of our planet and all its inhabitants. All too often in practice, however, the issues of children and young people are relegated to being only a —socialll issue -- and their health, safety, education and rights are not seen as being inextricably linked to ensuring economic growth and shared prosperity, a protected natural environment and more stable, safer societies. Overlooking their role is to the peril of us all, the communities in which we live and to the planet.

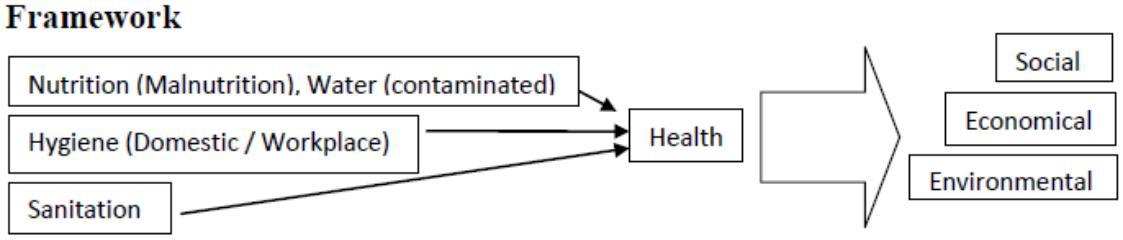


Children and young people are both shapers of and shaped by the world around them. When a child is not healthy, has compromised brain functionality due to chronic poor nutrition, does not receive a quality education, does not feel safe in his or her home, school or community, will that child be able to fulfill their potential and responsibilities as a parent, an employee or entrepreneur, a consumer, a citizen? In many cases, the answer is —noll and that denies the individual child his or her rights, *but also* deprives the entire human family of the intellectual, social and moral benefits that derive from the fulfillment of these rights.

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

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

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



Areas covered:
Key words: Health, Nutrition, Hygiene, Sanitation

People in general, and children in particular, are at the core of sustainable development. Individual wellbeing is essential to sustaining the inter-generational gains in health, productivity and social engagement that underpin the sustainable development agenda (OWG 2014). The choices that individuals are able and willing to make regarding foods to produce and market, the diets their families consume, and the care and nurture of nutritionally vulnerable people (particularly mothers and infants), all have a direct bearing on the success or failure of the Sustainable Development Goals (SDGs).

Reflecting this understanding in 2012, the World Health Assembly (WHA) endorsed a Comprehensive Implementation Plan on Maternal, Infant and Young Child Nutrition which included 6 targets based on their public health relevance; namely, child stunting, anaemia in women of reproductive age, low birth weight, childhood overweight, child wasting and exclusive breastfeeding for the first 6 months after birth (de Onis 2013). Alone, each of these targeted problems represents a challenge to most of the world's governments. Together, they combine to pose a significant threat to global development initiatives. Data from 2013 suggest that 161 million children under the age of 5 years were stunted (too short for their age), at least 51 million were severely or moderately wasted (weighing too little for their height), while another 42 million children were overweight or obese (Black et al. 2013; UNICEF, WHO, WB 2014). In addition, there are several billion children and adults who are deficient in one or more vitamins or minerals which can lead among others to anaemia, blindness, cognitive impairment, greater susceptibility to many diseases and higher mortality. Public and private investment in resolving and preventing each of these problems represents a commitment to development. In addition, actions to reduce low birth weight and/or small for gestational age (which can reflect in utero nutritional compromise and maternal under nutrition) and to increase exclusive breastfeeding help promote enhanced child nutrition early in life when future paths for growth, health and productivity are set in motion.

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

Nutrition in many ways represent a process by which individuals achieve their physical and mental growth potential; it is a characteristic of the quality of an individual's diet in relation to their nutrient needs; and it is a benchmark or metric against which the effectiveness of numerous development goals are assessed. It is also, not least, a fundamental right of all of

humanity. Without good nutrition, the mind and body cannot function well. When that happens, the foundations of economic, social and cultural life are undermined.

Nutrition must be understood as both an input to, and an outcome of, the SDGs as a whole. The many manifestations of malnutrition derive not just from a lack of sufficient and adequately nutritious and safe food, but from a host of interacting processes linking health, care, education, sanitation and hygiene, access to resources, women's empowerment and more. Good nutritional status leads to higher individual earnings and mental acuity, which in turn support macroeconomic and societal growth. Malnutrition (which includes several forms of under-nutrition as well as overweight and obesity) impairs individual productivity which acts as a drag on national growth. In this sense, malnutrition will represent a pernicious, often invisible, impediment to the successful achievement of SDG targets.

Today, it is acknowledged that there are several distinct, albeit linked, facets of poor nutrition, and each carries its own implications for impaired human productivity, development and well-being. It has also come to be recognized that weight-for-age is not the only or best metric for representing the full array of nutrition conditions of concern.

Nutrition is intimately linked to nutrient sufficiency (relative to need) and diet quality, both in the short term and the long term. For health, care and other actions that are also needed to improve nutrition to gain traction, individuals must be well-nourished at all times. This requires efforts to enhance access to healthy diets, improved knowledge for food choices, stronger resilience of food systems to economic, climatic and human-made shocks, and remediation of food-borne threats to consumers.

Resolving all forms of under-nutrition and obesity would dramatically reduce the social burden of sickness and premature death, and the economic burdens of lost productivity and burgeoning health care costs that face virtually every country in the world. Appropriate investments in the first 1,000 days (from pregnancy through the first two years) will yield benefits not only for that child's lifetime, but across generations (Black et al. 2013).

The Global Nutrition Report (2014) argues that, ―improvements in human nutrition represent both a maker and a marker of sustainable development.‖ This Technical Note confirms that nutrition problems of many kinds manifest through the life-cycle affect, and in turn are affected by, each of the SDGs. The world as a whole did not meet the Millennium Development Goals (MDG) target relating to nutrition, and is currently not on track to meet the six global nutrition targets set by the World Health Assembly for 2025. As such, the nutrition community, and its natural allies in the food security, agriculture, WASH, gender and health communities, advocate for nutrition within the SDG framework. In the end, sustainable development will depend on it.

In calculating the relative contribution of various factors to the progressive decline in child stunting between 1970 and 2010, Smith and Haddad (2014) estimated that increased access to safe water accounted for 25 % of the change. The risks to nutrition derive from waterborne diseases, microbial contaminants that provoke enteric dysfunction, diarrhoea, and a lack of cleanliness that itself increases food safety risks and lack of hygiene-related nutritional compromise. Separately, Smith and Haddad (2014) calculated that roughly 14% of the total fall in stunting between 1970 and 2010 resulted from improved sanitation.

Today nearly 90 influential international organizations, including Action Against Hunger, called upon key United Nations decision makers to ensure that hygiene, a critical component of global health and development, be addressed as an indicator in the forthcoming SDGs.

Hygiene—specifically hand-washing with soap—is one of the most important interventions for human health and development and is a universal necessity. Fundamental to fighting

under-nutrition, reducing child mortality, overcoming antibiotic resistance, and advancing access to education, hygiene underpins the delivery of several other SDGs and ultimately advances gender equity, dignity, and human rights.

Hygiene is included alongside sanitation in Target 6.2 of the current draft of the SDGs. Given the massive role that hygiene plays in multiple areas of development, nearly 90 international corporations, non-governmental organizations, and coalitions have signed a letter asking the United Nations Statistical Commission and key Member States involved in determining proposed indicators to address this oversight.

“If hygiene is neglected in the Sustainable Development Goals at the indicator level this will be to the detriment of those populations who have the most to gain through global development— the poor and vulnerable”

According to Dr. Layla Mc Cay, Secretariat Director of the Global Public-Private Partnership for Hand-washing, “Failing to include a global, mandatory hygiene indicator means that the SDGs will also fail to fully capitalize upon this historic opportunity to bring better health, education, and economic opportunities to millions around the world. We ask those involved in determining the SDGs to not let this moment go by without taking action”

While rarely discussed alongside the —big threell attention-seekers of the international public health community—HIV/AIDS, tuberculosis, and malaria—one disease alone kills more young children each year than all three combined is diarrhoea (Boschi-Pintoet al, 2008]), and the key to its control is hygiene, sanitation, and water (HSW).

Much of the impact of water supply on health is mediated through increased use of water in hygiene. For example, hand washing with soap reduces the risk of endemic diarrhoea, and of respiratory and skin infections, while face washing prevents trachoma and other eye infections. A systematic review of the literature (Chant, 2008) confirmed that hygiene, particularly hand washing at delivery and postpartum, also helps to reduce neonatal mortality. It might be argued that water supplies also make flush toilets feasible, but this does not necessarily add to their health benefits, as we have seen no credible evidence that the health benefits of sanitation cannot be achieved by dry latrines, if they are properly built and maintained (Cairncross and Kolsky, 1997).

A balanced interpretation of the available evidence suggests that a reasonably well-implemented intervention in one or more of hygiene, sanitation, water supply or water quality, where preexisting conditions are poor, is likely to reduce diarrhoeal disease prevalence by up to a third. Still greater reductions (up to 63%) are associated with water piped to one or more taps on a property (Esrey et al, 1991). Such a major impact merits far more attention from health professionals and health systems than has been common in recent decades.

We are still learning about the role of HSW in disease control. For example, *Ascaris* and other intestinal worms are known to be associated with poor sanitation, but a recent review (Fung and Cairncross, 2009) found evidence that hand washing with soap can also help to prevent transmission of ascariasis. We know that trachoma is prevented by facial hygiene and hand washing, but recent research has also highlighted the role of latrines in controlling the *Muscasorbens* flies that carry the *Chlamydia* pathogen between children's faces (Emerson et al, 2004). Even regarding the effect of hygiene on diarrhoea among young children in poor communities, we still have much to learn. There is good evidence to justify promotion of hand washing with soap (Curtis and Cairncross, 2003), but for other aspects of hygiene behaviour, such as proper disposal of children's stools (Yeager et al, 1999), the epidemiological evidence is from observational studies, which are subject to confounding.

The most effective means of promoting behaviour change is also a fruitful research field. It has only recently become clear to health professionals that emotional levers (—Clean hands feel goodǁ) change people's health behaviours more effectively than cognitive statements (—Dirty hands cause diseaseǁ). Advertising agencies have known this for years. They also know the importance of Investing in formative research, testing, and evaluation, to tailor the messages to local people's beliefs and aspirations (Curtis et al, 2009). If health workers can divest themselves of the unsubstantiated belief that health considerations motivate behaviour, they can become a more effective force for hygiene behaviour change.

There are alternative ways to tackle some of the HSW-associated disease burden. The widespread introduction of oral rehydration therapy (ORT) in the 1980s, for example, contributed much to reducing mortality from diarrhoeal disease (Victoria et al, 1996). However, such interventions focus on mortality rather than morbidity and on secondary rather than primary prevention. Moreover, ORT does not address the problems of persistent diarrhoea and dysentery.

To improve the quality and accessibility of drinking water, the MVP supports the construction and rehabilitation of improved water sources; builds capacity of water committees to operate, maintain and financially manage water sources; and promotes point of use water treatment and safe storage. Water Safety Plans are also designed in close collaboration with the community, and are key tools to empower communities and local authorities to take the lead on these efforts. Generating demand for improved sanitation through community-led approaches and sanitation marketing is complemented by building the capacity of private sector actors to manufacture and supply sanitation Commodities. For schools, health facilities and the most vulnerable households, the MVP also subsidizes construction of improved latrines.

Hygiene refers to the science of the establishment and maintenance of (human) health. In everyday life, hygiene is closely associated with good housekeeping. This article will focus on home hygiene in relation to cleaning, on microorganisms, and on sustainable development of domestic technology. In domestic cleaning there are two beneficial effects: the aesthetic aspects of cleanness and the removal of microorganisms. In cleaning science substantial attention is paid to the interrelation between cleaning and removal of microorganisms. It appears that the parameters of the cleaning process and the detergent properties play a significant role in this interrelation. Changing technology to reduce the environmental impact of household cleaning not only influences the household activities and the functional performance of the cleaning processes but also has an impact on the level of hygiene. Results are presented of research in which the hygiene has been evaluated in relation to such changes. One option studied to reduce the environmental impact of households is the reduction of water consumption by water reuse. In such concepts water is used in successive steps for various processes before it is drained. The potential impact of such systems and of the use of rain water on the level of home hygiene is discussed. (Am J Infect Control 2001;29:211-7)

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

In short;

- Today more than 1 billion people are chronically undernourished and food insecure.
- Undernourishment compromises immune systems, which leads to a higher incidence of illness and disease that in turn contribute to lower productivity and life expectancies.
- Poor nutrition undermines economic growth. According to UNICEF, 195 million children younger than 5 are chronically malnourished. Chronic undernourishment in children creates a vicious cycle of compromised physical and cognitive development that reduces their economic productivity when they become adults, miring people in poverty that, in turn, leads to chronic undernourishment and poor health in the next generation.
- A massive disease burden is associated with deficient hygiene, sanitation, and water supply and is largely preventable with proven, cost-effective interventions.
- The total benefits of these interventions are greater than the health benefits alone and can be valued at more than the costs of the interventions.
- Hygiene, sanitation, and water supply are development priorities, yet the ambition of international policy on drinking water and sanitation is inadequate.
- Hygiene, sanitation, and water supply continue to have health implications in the developed world.
- The active involvement of health professionals in hygiene, sanitation, and water supply is crucial to accelerating and consolidating progress for health.

Model Projects:
Formulating nutritive food mix using locally available items

Objective: To use locally available items and formulate a food mix which is cost effective and has nutritive value for anytime usage

Methodology:

Locate items in the vicinity, known for its nutritive value, in the community
Analyze the nutrient levels present in the items from nearby food science institute or laboratory
Mix different items in such a proportion that maximizes the overall nutritive value
Formulate these items in powder or any other form that makes the assimilation easy
Analyze the nutrient content of the said formulation
Work out on stability and shelf life at room temperature
Compare nutrient composition at different intervals
Carry out cost-benefit analysis to assess economics of the formulation

Results:
An alternative, nutritive food mix can be formulated from locally available food items, and which is cost-effective too.

Personal hygiene – for not missing out on studies

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

Methodology:

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

Results

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

Improving quality of potable water

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

Methodology:

Collect 100 ml of water sample in a dry and clean (free from any kind of chemicals) bottle or container from the source

Analyze the sample collected for physical (color, smell, turbidity..), chemical (pH, metals…), and microbial (algae, bacteria…) properties, at school / college / research institute laboratory
Establish whether the sample water, based on properties analyzed, fit for consumption
If found unfit for consumption, use suitable mechanism / process, like bio-filtration (filtration through specific type of plant and the likes)
After processing, reanalyze for properties

Results:

Establish the efficacy of the bio-filtration

Suggested projects:

1. Nutritive value of traditionally consumed food in light of standards available from NIN and/or ICMR, for optimum health
2. Nutritive value of food items consumed during period of fasting (religious / recovery from illness)
3. Alternative food stuff available in a locality and their nutritive value
4. Balanced diet

5. Highly nutritive food (proteins / carbohydrates / fats) from nearby wild / forest area
6. Metals / heavy metals in potable water and its management
7. Quality of potable water
8. Biofilteration / bioremediation processes to make available water potable
9. Hygiene at personal / familial / community level and its impact on health
10. Assessment of hygiene maintained at regular basis
11. Level of hygienic conditions during different seasons
12. Occurrence of diseases due to breakdown in hygienic conditions and its management
13. Waste management (eg., hospital waste)
14. Diseases (microbial / parasitic) and their impact of social / economical / environmental parameters
15. Impact and management of zoonotic diseases
16. Impact and management of conditions arising out of vital nutrient deficiency / malnutrition
17. Comparison of sanitation before and after Swachch Bharat campaign, in terms of behavioral change
18. Epidemics and its management
19. Development of seasonal vegetables / fruits calendar of a particular locality
20. Role of kitchen garden in providing nutritive foodstuff
21. Health condition in post disaster scenario and its management
22. Impact of non-stick cookware used on health
23. Effect of Indoor Air Pollution on health
24. Maternal health and hygiene during pre and post-partum stages
25. Gender specific health and hygiene and its control / management
26. Food consumption pattern v/s health status in tribal and rural areas
27. To determine amounts for healthy nutrition, health, science and technology since it involves? Find it
28. Comparative Study about hygiene and health
29. Study malnutrition or diseases caused by food contamination
30. Solutions to the study of the diseases / damages on the basis of economic / cleanliness of the different areas of nutrition, in order to prevent it? If no mapping is available to implement the following suggestions into the world of modern methods / efforts for its dissemination
31. Various communities, tribes, allowing an average combined / nuclear family diet studies, who called balanced diet, what diet system diseases including diseases that evidence-two groups? The study
32. Diseases of the water quality, water purification, water-borne diseases and to study ways of preventing them
33. Preservation of health (diet) for costs and expenses arising from the disease, as well as ways of preventing them
34. What nutrients are found in a variety of diets of fruits, vegetables, herbs, meat, fish, milk, beans, grains, etc.? And how much food is needed per capita family? Etc. Practice
35. According to the study of traditional food from a particular region or community, family and study of diseases typical of the territory of the community
36. MDM or fortified foods given to study in private schools
37. Health check-up interval of information and awareness effort and health survey / study
38. to assess the needs of the poor, in particular, about their problems in daily life
39. to increase the awareness and sensitivity of the specialists involved in the project and also those responsible for programs designed to improve the basic need situation of the poor
40. Planning and preparation of the nutrition survey

References:

ACDI/VOCA (2015) Health and nutrition – Crucial investments for stability and economic growth

Action against hunger (2015) International Organizations Call for Hygiene in Sustainable Development Goals

Black R, Victora C, Walker S, Bhutta Z, Christian P, de Onis M, Ezzati M, Grantham-McGregor S, Katz J, Martorell R, Uauy R, and the Maternal and Child Nutrition Study Group (2013) Maternal and child undernutrition and overweight in low-income and middle-income countries. *Lancet* 382 (9890):427-51

Boschi-Pinto C, Velebit L, Shibuya K (2008) Estimating child mortality due to diarrhoea in developing countries. *Bull World Health Organ* 86: 710–717

Cairncross S, Kolsky PJ (1997) Letter: water, waste and well-being. *American J Epidemiol* 146: 359–360

Cairncross Sandy, Shordt Kathleen, Zacharia Suma, Govindan Beena Kumari (2005) What causes sustainable changes in hygiene behaviour? A cross-sectional study from Kerala, India *Social Science & Medicine* Volume 61, Issue 10, November 2005, Pages 2212–2220

Cairncross Sandy and Bartram Jamie (2010) Hygiene, Sanitation, and Water: Forgotten Foundations of Health. PLOS
Chant R (2008) The role of water, hygiene and sanitation in neonatal mortality [MSc dissertation]. London: London School of Hygiene & Tropical Medicine

Curtis V, Cairncross S (2003) Effect of washing hands with soap on diarrhoea risk in the community: a systematic review. *Lancet* Inf Dis 3: 275–281

Curtis V, Danquah L, Aunger R (2009) Planned, motivated and habitual hygiene behaviour: an eleven country review. *Health Educ Res* 24: 655–673

de Onis, M, Dewey K, Borghi E, Onyango A, Blössner M, Daelmans B, Piwoz E and Branca F. (2013) The World Health Organization's global target for reducing childhood stunting by 2025: rationale and proposed actions. *Maternal and Child Nutrition*, 9 (Suppl. 2): 6–26. DOI: 10.1111/mcn.12075

Emerson PM, Lindsay SW, Alexander N, Bah M, Dibba SM, et al. (2004) Role of flies and provision of latrines in trachoma control: cluster-randomised controlled trial. *Lancet* 363: 1093–1098

Esrey SA, Potash JB, Roberts L, Schiff C (1991) Effects of Improved Water Supply and Sanitation on Ascariasis, Diarrhoea, Dracunculiasis, Hookworm Infection, Schistosomiasis and Trachoma. *Bull World Health Organ* 69: 609–621

Euroconference —Hygiene and Health' (2001) The Correlation between sustainable development and home hygiene *American Journal of Infection Control* Volume 29, Issue 4, August 2001, Pages 211–217

Fung IC, Cairncross S (2009) Ascariasis and handwashing. *Trans R Soc Trop Med Hyg* 103: 215–222

Global Nutrition Report (2014) Draft report prepared by the Institute for Development Studies, Sussex University, for the Department for International Development, United Kingdom. Mimeo

http://sustainabledevelopment.un.org/focussdgs.html OWG (Open Working Group for Sustainable Development Goals) 2014. *Proposal for Sustainable Development Goals* (Outcome Document, Draft dated 19 July 2014)

Smith L and Haddad L. (2014) Reducing Child Undernutrition: Past Drivers and Priorities for the Post-MDG Era. *IDS Working Paper* 441.Brighton: U.K.

UNICEF (May, 2013) Sustainable development starts and ends with safe, healthy and well-educated children

UNICEF-WHO-The World Bank (2014) Joint Child Malnutrition Estimates: Levels &Trends in Child Malnutrition (updated September 2014). New York, NY.

United Nations System: Standing Committee on Nutrition (October 2014) Nutrition and the post-2015 SDGs A technical note

Victora CG, Olinto MT, Barros FC, Nobre LC (1996) Falling diarrhoea mortality in Northeastern Brazil: did ORT play a role? *Health Policy Plan* 11: 132–141

Water, Sanitation and Hygiene: Centre for Sustainable Development, Earth Institute / Columbia University

World Bank. 2013. Improving Nutrition Through Multisectoral Approaches. Washington, D.C.: World Bank

Yeager BA, Huttly SR, Bartolini R, Rojas M, Lanata CF (1999) Defecation practices of young children in a Peruvian shanty town. *Soc Sci Med* 49: 531–541

Case Study

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

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

via women or neighbours, underlining the need to direct interventions at men as well as women. The finding that hygiene behaviour persisted for years implies that hygiene promotion is a more cost-effective health intervention than previously supposed.

Calculating Body Mass Index (BMI)

BMI = weight (lb) x 703 / height^2 (inch^2)

BMI = weight (kg) / height^2 (m^2)

Estimating caloric value of food

A kilocalorie or food calorie is a unit of energy used to measure the chemical energy in food. It is generally defined as the quantity of energy needed to raise the temperature of 1 kilogram of water by 1 degree Celsius. You can estimate the caloric value of food from the amount of carbohydrates, fats, protein and dietary fiber that it contains. This value will be an estimate because the efficiency with which food is digested varies considerably.

Step 1 Read the nutritional label. Obtain the number of grams of fat, total carbohydrates, dietary fiber and protein in a serving of the food. You will also need to obtain the serving size of the food.

Step 2
Calculate the calories provided by fat. A gram of fat contains 9 calories so multiply the number of grams of fat by "9" to get the number of calories in a serving that come from fat.

Step 3
Determine the calories provided by protein. A gram of protein contains 4 calories so multiply the number of grams of protein by "4" to get the number of calories in a serving that come from protein.

Step 4
Establish the number of calories that come from non-fiber carbohydrates. Non-fiber carbohydrates have about 4 calories per gram. Subtract the number of grams of dietary fiber from the total grams of carbohydrates. Multiply this value by "4" to get the non-fiber carbohydrate calories.

Step 5
Compute the number of calories from dietary fiber. The digestibility of fiber may run the range from completely indigestible to almost completely digestible. Use the middle of this range (2 calories per gram) to estimate the calories from dietary fiber. Multiply the number of grams of dietary fiber by "2" to obtain the approximate number of calories that come from dietary fiber.

Step 6
Find the total number of calories that come from the serving of food. Add the calorie counts from Step 2 through Step 5 to find the total calories in the food.

http://www.livestrong.com/article/67787-determine-caloric-value/#sthash.YRn7E3xW.dpuf

International Year of Pulses 2016

The 68th UN General Assembly declared 2016 the International Year of Pulses (IYP) (A/RES/68/231)

The Food and Agriculture Organization of the United Nations (FAO) has been nominated to facilitate the implementation of the Year in collaboration with Governments, relevant organizations, non-governmental organizations and all other relevant stakeholders. Under the slogan „nutritious seeds for a sustainable future," the United Nations, led by its Food and Agriculture Organization (FAO), launched the IYP 2016 to raise awareness about the protein power and health benefits of all kinds of dried beans and peas, boost their production and trade, and encourage new and smarter uses throughout the food chain.

The IYP 2016 aims to heighten public awareness of the nutritional benefits of pulses as part of sustainable food production aimed towards food security and nutrition. The Year will create a unique opportunity to encourage connections throughout the food chain that would better utilize pulse-based proteins, further global production of pulses, better utilize crop rotations and address the challenges in the trade of pulses.

"Pulses are important food crops for the food security of large proportions of populations, particularly in Latin America, Africa and Asia, where pulses are part of traditional diets and often grown by small farmers," said FAO Director-General José Graziano da Silva. "They have been an essential part of the human diet for centuries," he further added, "Yet, their nutritional value is not generally recognized and is frequently under-appreciated."

Pulses are annual leguminous crops yielding between one and 12 grains or seeds of variable size, shape and colour within a pod, used for both food and feed. The term "pulses" is limited to crops harvested solely for dry grain, thereby excluding crops harvested green for food, which are classified as vegetable crops, as well as those crops used mainly for oil extraction and leguminous crops that are used exclusively for sowing purposes (based on the definition of "pulses and derived products" of the Food and Agriculture Organization of the United Nations).

Pulse crops such as lentils, beans, peas and chickpeas are a critical part of the general food basket. Pulses are a vital source of plant-based proteins and amino acids for people around the globe and should be eaten as part of a healthy diet to address obesity, as well as to prevent and help manage chronic diseases such as diabetes, coronary conditions and cancer; they are also an important source of plant-based protein for animals.

In addition, pulses are leguminous plants that have nitrogen-fixing properties, which can contribute to increasing soil fertility and have a positive impact on the environment.

According to FAO, pulses, including all kinds of dried beans and peas, are not merely cheap and delicious; they are also highly nutritious source of protein and vital micronutrients that can greatly benefit people's health and livelihoods, particularly in developing countries. There are hundreds of varieties of pulses grown throughout the world. Popular ones include all varieties of dried beans, such as kidney beans, lima beans, butter beans and broad beans. But also chickpeas, cowpeas, black-eyed peas and pigeon peas.

Speaking about their nutritional value, the FAO chief said that pulses have double the proteins found in wheat and triple the amount found in rice. They are also rich in micronutrients, amino acids and b-vitamins; Mr. Graziani da Silva underlined, and added that they are vital parts of a healthy diet.

FAO also added that as an affordable alternative to more expensive animal-based protein, pulses are ideal for improving diets in poorer parts of the world, where protein sources from milk if often five time more expensive than protein sourced from pulses. Pulses also offer a

great potential to lift farmers out of rural poverty, as they can yield two to three time higher prices than cereals, and their processing provides additional economic opportunities, especially for women.

“The International Year of Pulses 2016 is a great opportunity to raise awareness of the benefits of pulses as the world embarks on efforts to achieve the newly adopted Sustainable Development Goals,” said UN Secretary-General Ban Ki-moon. Mr. Ban added that pluses contribute significantly in addressing hunger, food security, malnutrition, environmental challenges and human health and also are a vital source of plant-based proteins and amino acids.

“Despite strong evidence of the health and nutritional benefits of pulses, their consumption of pulses remains low in many developing and developed countries. The International Year can help overcome this lack of knowledge,” said Mr. Ban.Further, he also said that pulses impact the environment positively due to their nitrogen-fixing properties, which increase soil fertility.

“Much work needs to be done to end hunger and provide food security and nutrition for all. One concrete, promising opportunity lies with pulses. Let us join forces to raise awareness of the benefits of pulses,” said the Secretary-General. The UN chief also called for collaborative commitment and concrete action by all relevant actors within the UN system, farmers‟ organizations, civil society and the private sector, to make the IYP 2016 a success.

Swachh Bharat Abhiyan (Clean India Mission)

A national campaign by the Government of India, covering 4,041 statutory cities and towns, to clean the streets, roads and infrastructure of the country.[1][2][3] The campaign was officially launched on 2 October 2014 at Rajghat, New Delhi, where Prime Minister Narendra Modi himself cleaned the road. Modi said that the best memorial to Mahatma Gandhi would be to achieve a "Clean India" by 2019, his 150th birth anniversary. It is India's biggest ever cleanliness drive and 3 million government employees and school and college students of India participated in this event.[4][5] It has been carried forward since then with people from all walks of life joining it.

Objectives

This campaign aims to accomplish the vision of a 'Clean India' by 2 October 2019, the 150th birthday of Mahatma Gandhi. Specific objectives are:[6]

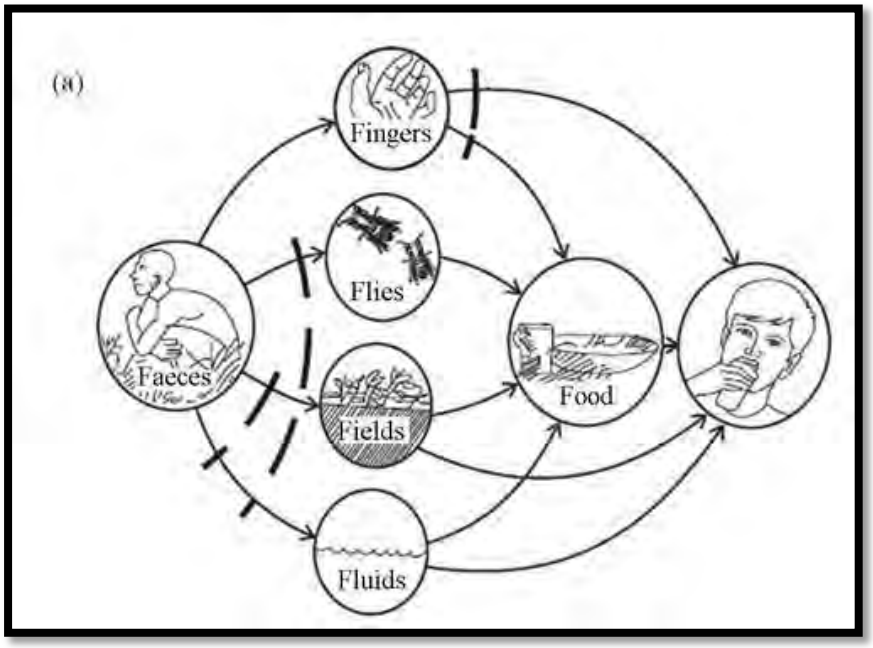
1. Eliminate open defecation by constructing toilets for households, communities
2. Eradicate manual scavenging
3. Introduce modern and scientific municipal solid waste management practices
4. Enable private sector participation in the sanitation sector
5. Change people‟s attitudes to sanitation and create awareness

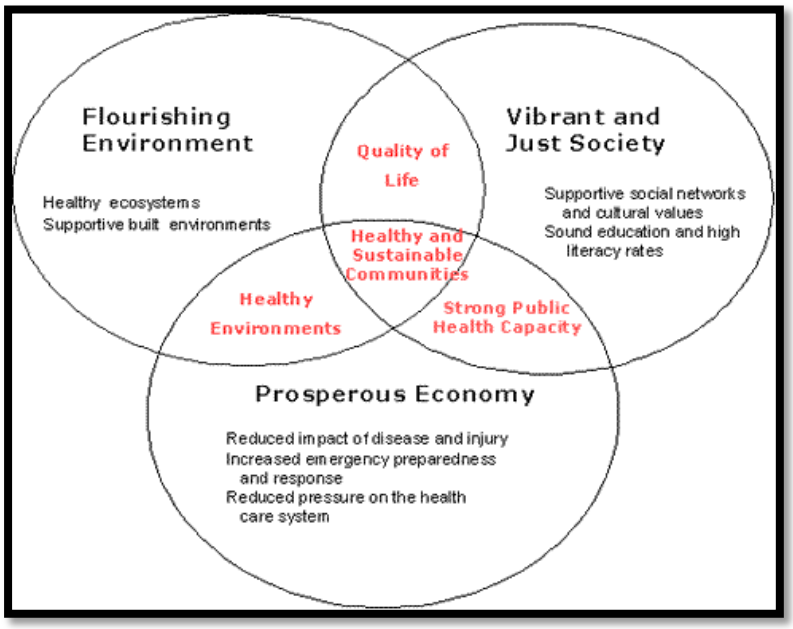
The program plans to construct 12 crore toilets in rural India by October 2019, at a projected cost of Rs 1.96 lakh crore (US$29 billion).[7]

References

1. "Swachh Bharat campaign should become mass movement: Narendra Modi". *The Economic Times. Retrieved 2 October 2014.*
2. "PM reviews preparations for launch of Mission Swachh Bharat". *Retrieved 7 October 2014.*
3. "Swachh Bharat: PM Narendra Modi launches 'Clean India' mission". *Zee News. Retrieved 2 October 2014.*

4. "Swachh Bharat Abhiyan: PM Narendra Modi to wield broom to give India a new image". *The Times of India. Retrieved 2 October 2014.*
5. "As it happened: PM Narendra Modi's 'Swachh Bharat Abhiyan'". *Retrieved 2 October 2014.*
6. Swachh Bharat Abhiyan: Is Modi's scheme a success one year later?, *Hindustan Times, 1 October 2015*
7. "Swachh Bharat Abhiyaan: Government builds 7.1 lakh toilets in January". *timesofindia-economictimes.*





Sub Theme V

Lifestyles & Livelihoods

Sub theme:
Lifestyle and Livelihood

"Young people around the world are well aware of environmental challenges, but the connection between such challenges and their lifestyles is not clear to them. There is a great need to translate these challenges into actions and opportunities at the local and individual level, as well as to create a holistic and pragmatic vision of what a sustainable society is."
— Fibenne Pierre, UNEP

The idea of this sub theme is to promote the concept of conscious and cautious involvement of science, technology and innovation to evolve a sustainable lifestyle & livelihood. The sub theme looks at several concepts related to the effect of occupational changes, cultural changes and environmental changes and its relation with lifestyle and livelihood. The subtheme not only tries to focus on the negative impacts but also positive impacts on lifestyle and livelihood and identifying them as opportunities to carry forward for developing a sustainable future.

Introduction:

Lifestyle and livelihood are few of the main factors which are associated directly with human lives and further mainly with sustainable development. The concept of Sustainable development consists of 3 main pillars which are People (Social), Planet (Environment) and Profit (Economy). All these three main pillars of Sustainable development are interwoven with Lifestyle and Livelihood and both have an effect on each other.

1. Scenario & Problems related to lifestyle and livelihood:

Change is a continuous process, it is ever evolving. The continuous evolving changes in the local, national and global scenarios has a direct impact on individual, families and community lifestyle and livelihood and vice-versa.

In the last few decades, several man made activities and interventions which are unsustainable, have accelerated the problems related to shelter, environment, food, health, society, culture and working pattern. These problems areas are also associated, linked and guided mainly in relation with lifestyle and livelihood.

The Modern lifestyles are unsustainable in many ways and are based on overproduction and overconsumption; putting too much pressure on our natural resources and imposing negative environmental, economic, (individual and collective) social and health impacts.

2. Conceptual understanding of lifestyle and livelihood:

Lifestyles define us; they are the way we live our lives, what we do, with whom, where, how and what we use to do earlier. This includes everything from the food we eat and how we interact with others to the way we get around. **Lifestyles also define our identity**; we express our social position, political preferences and psychological aspirations to others through our lifestyles.

Creating **Sustainable lifestyles** means rethinking our ways of living, how we buy, what we consume and how we organize our daily lives. It **is about transforming our societies and living in balance with our natural environment**. All our choices and

actions - whether at home or at work - on energy use, transport, food, waste and communication – contribute to sustainable lifestyles.

Sustainable lifestyles refer to patterns of action and consumption, used by people to affiliate and differentiate themselves from others, which: meet basic needs, provide a better quality of life, minimize the use of natural resources and emissions of waste and pollutants over the lifecycle, and do not put at risk the needs of future generations. Sustainable lifestyles reflect specific cultural, natural, economic and social heritage of each society *(Mont 2007).*

What do you think it means to live sustainably?

- Living within Earth's limits
- Reducing our impact on the earth's resources
- Making lifestyle and consumer choices to limit our use of resources
- Living more simply
- Reducing our footprints by our handprints
- Taking care of nature so nature can take care of us
- Meeting our needs without compromising the ability of future generations to meet their needs
- Creating a balance between our natural systems, our economic system and our social system

Livelihood and lifestyle are closely associated with each other. Livelihood is one of the very important factor impacting and defining the lifestyle as many of the activities of the daily life are associated with the economic factor.

A livelihood comprises the capabilities, assets and activities required for a means of living. Livelihood defines as a means of supporting one's existence, especially financially or vocationally.

A livelihood is sustainable which can cope with and recover from stress and shocks, maintain or enhance its capabilities and assets. It should provide sustainable livelihood opportunities for the next generation; and should contributes net benefits to other livelihoods at the local and global levels in the short and long term.

The concept of Sustainable Livelihood is an attempt to go beyond the conventional definitions and approaches to poverty eradication. It is also recognized that more attention must be paid to the various factors and processes which either constrain or enhance poor people's ability to make a living in an economically, ecologically, and socially sustainable manner.

3. Nature, extent and significance of problems:

India, located in South Asia, is the seventh-largest country in the world by area and the second-most populous country behind only China. As of 2014, it has a population forecast around 1.26 billion people, with the capital New Delhi estimated to be home to almost 17 million inhabitants. Despite the fact that India's population has grown steadily, the fertility rate in the country is on the decline.

When asked about the most polluted cities worldwide, most people usually name larger Chinese cities as being the worst air quality culprits. However, according to research published by the World Economic Forum, Delhi is actually twice as polluted as Beijing. The level of PM 2.5 (micrograms per cubic meter) in Delhi is six

times above the recommended World Health Organisation maximum. In fact, out of the world's 15 worst cities, ten are in Delhi. Pollution is one of the main factor related directly with livelihood and lifestyle.

On the national level as per the data of 2010, there are approximately 12 lacs new cancer cases every year in India. There are also almost 10 lacs cases of strokes every year. There are 50 lacs cardiac patients and 63 lacs diabetes patient. According to government data, the prevalence of heart failure in India due to coronary heart disease, hypertension, obesity, diabetes and rheumatic heart disease ranges from anywhere between 1.3 to 4.6 million, with an annual incidence of 491,600 to 1.8 million. Another important factor that should be highlighted is that every year 130,000 children in India are born with congenital heart disease.

As per the data of FAO 2002, though India has made significant progress in food production and sufficiency over last 50 years, most rural populations / communities have to deal with uncertainties of food security on daily basis, year after year. In aggregate one fifth of India's population suffers from chronic hunger. Almost 190 million people were under nourished in India as per the data of UN in year 2012-2014

Several similar problems have emerged and accelerated in the recent years due to the changes in lifestyle and livelihood. Such observations have been made in Health sector, cultural disturbances, economic sector, farming, etc.

4. Type of Areas:

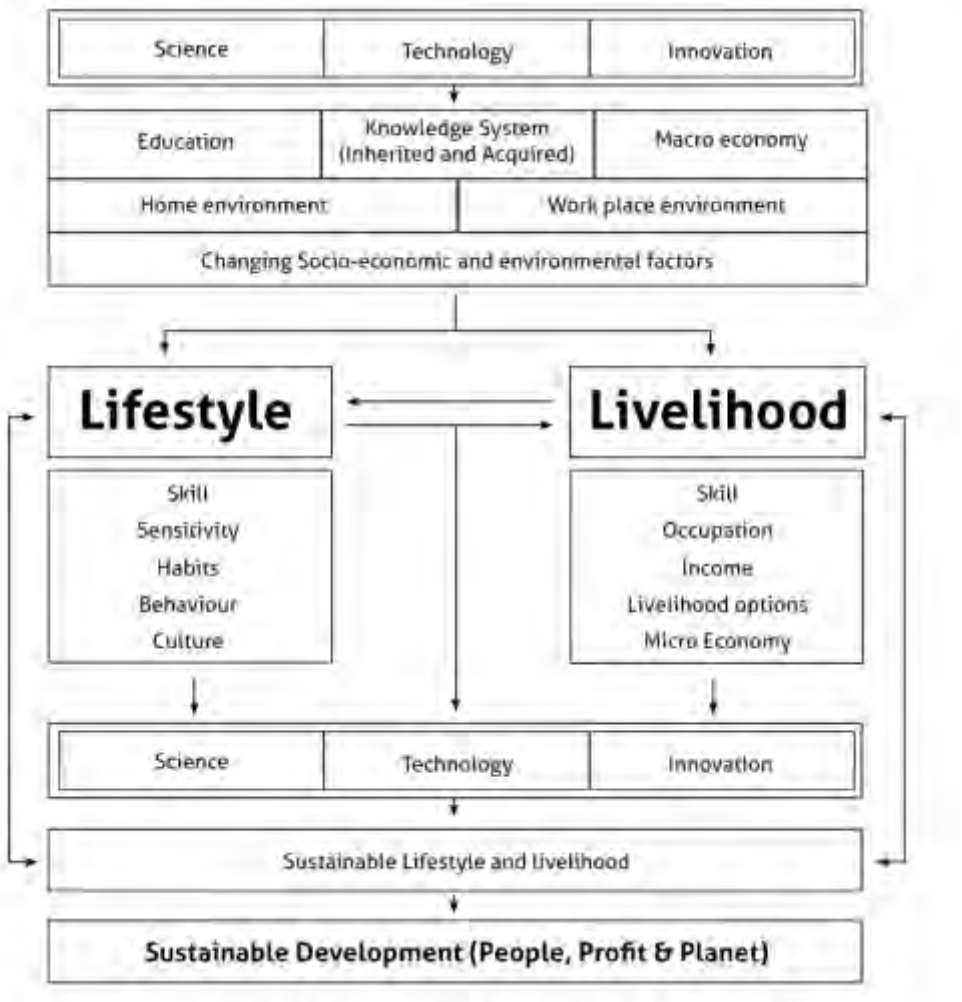
The lifestyle and livelihood is mainly driven by certain crucial factors such as Desires, Needs, Influencers and Motivators. These factors link and define an individual's living patterns, consumption patterns, migration patterns, travel patterns, health patterns and work patterns.

Sub Image reference: SPREAD project report

These changes in the patterns of livelihood and lifestyle further define the perception or actions of humans towards skills, sensitivity, habits, behavior, economy and culture.

Framework:

Framework for the approach of the sub theme of Lifestyle and Livelihood and how should a child see the sub theme for evolving their project.



Under this framework, we have tried to associate different areas of problems or opportunities:

Skill :

Skills play a major role in defining ourselves, our lifestyle and livelihood. They are responsible for what we know, what we do and how we do it? The skills over a period of time are transforming, the priorities of a human, families and community has been changing. Some of the areas are as under:

- Life skill (Ability & Requirement necessary for Daily life and living)
- Interpersonal Skill (Ability to maintain effective relationship with another individual belonging to different background or strata)
- Communication skill (Ability to express or present individuals thoughts, desires

and expressions)
- Occupational skills (Inherited or Acquired)

Sensitivity:

Sensitivity is one of the major concern in current era. By the change in the patterns in life and livelihood the priorities of human has been changing. Several new products and activities have become a part of life and which has further lead the individuals to defocus few of the main areas where the sensitivity is required. Some of the areas are listed below, they are categorized under Material and Non-material.

Material:

- Food habits
- Abuse (Smoking, substance abuse and drinking waste)
- Pollution (Biodegradable & Non degradable)
- Digital divide
- Sensitivity towards use of technology

Non-material:

- Physical fitness,
- Surroundings
- Society and community
- Environment

Habits and Behavior:

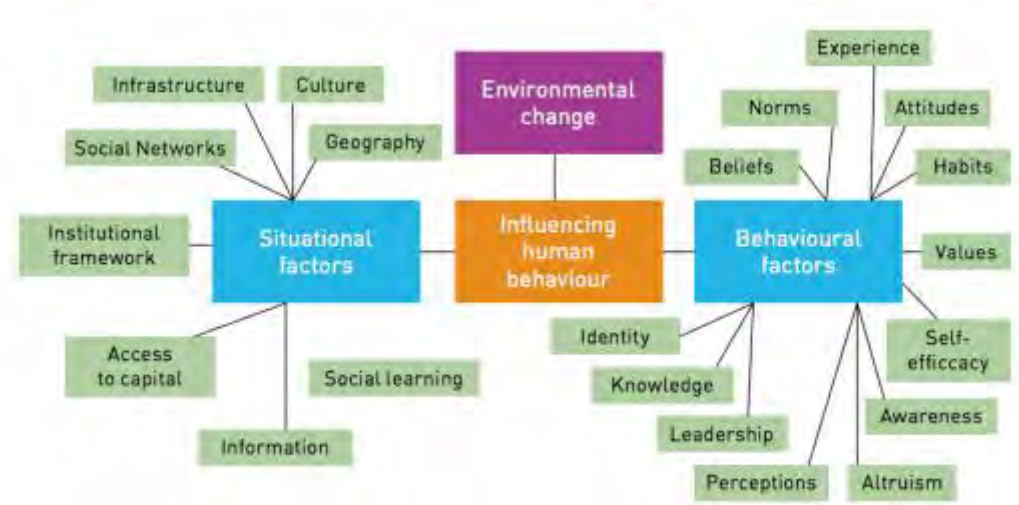
Habits could relate to most of the areas related to lifestyle. It could be linked with food, environmental sensitivity, health consciousness, abuse, technological interventions, etc. The continuous repetition of the habits gets converted to behaviors.

Culture:

India as a country was a culturally very strong country. Our family traditions, community knowledge and connections between different communities were one of the main keys to keep the activities in the country sustainable. With the passing of time and due to factors such as desires, needs and influencers there is a visible transition in the culture. There are several areas which can be looked upon, some of which are mentioned under:

- Socialization process
- Behavior of growing up child away from home and
- Nuclear family and Joint family
- Traditional knowledge
- Celebrations and festivals
- Lack of connections between different communities

Framework on effect of Environmental changes due to Manmade and natural changes on Human behaviour, lifestyle and livelihood.



Source: Defra, Sustainable Lifestyles Framework, 2011.

Why this sub theme?

- Current lifestyles and consumption patterns are unsustainable
- Our sensitivity towards environment has become more and more unsustainable.
- Human behavior is changing very rapidly which has been challenging the environmental factors and situational factors.
- There are several patterns of unsustainability observed in the health of humans and food security patterns at a national level
- Malnutrition and other diseases is a major area of concern at national level
- Our aspirations for prosperity are intrinsically linked to current patterns of unsustainable economic growth
- Due to the digital divide there is a great gap visible between the communities and families
- There is a massive cultural shift visible
- The occupational patterns have been changing rapidly and thus creating a great number of unemployment for unskilled members
- There are also great number of health hazards increasing due to changes in livelihood patterns
- The rural population is increasingly migrating from the rural areas to urban areas
- Meeting our individual needs and desires within the limits of available resources is our collective challenge

What all will it cover:

The subtheme Science, Technology and Innovation for Sustainable Development in relation to Lifestyle and Livelihood will mainly focus on the role of Science, Technology and Innovation for betterment of lifestyle and livelihood. It would also cover the areas which have been positively and negatively impacted due to the intervention of Science & technology. Some of the subject areas are as under:

Waste

(Human waste, food waste, bio waste, medical waste, industrial waste):

- Waste generation from lifestyle
- Waste generation from livelihood options

- Handling of waste produced through lifestyle and livelihood
- Management / disposal of waste produced through lifestyle and livelihood
- Innovative approaches towards efficient and sustainable waste disposal

Food
(Procuring, Preparation, Storage, Consumption, Wastage):

- Traditional / culturally imbibed food
- Organic food
- Fast / western food
- Packaged food
- Home cooked food
- Parceled food

Habits related to Lifestyle & Livelihood:

- Abuse (Smoking, Drinking, Substance)
- Biological clock of an individual
- Socialization process affecting habits
- Technology dependency habits
- Media sensitive lifestyle habits and its imbibing
- Food habits leading to lifestyle habits

Lifestyle and livelihood impacting culture and community:

- Demographic composition
- Migration
- Community culture
- Cultural diffusion / transition
- Impacts of Community activities & celebrations
- Impacts on Community values

Lifestyle & Livelihood diseases

Carbon footprints and impacts of handprints:

- Measuring of carbon footprints
- Value addition
- Innovative approaches
- Business entrepreneurship

Sensitivity towards Environment concerning lifestyle and livelihood
Occupations, economy and Environment:

- Occupational migration
- Occupational health hazards
- Occupational insecurity
- Digital divide in work
- Changes in work patterns in communities and its relation with culture and society
- Economic changes

Linkage with the focal theme and other sub themes:

The focal theme of the National Children Science Congress 2016 and 2017 is 'Science, Technology and Innovation for Sustainable Development'. One of the main concern of the focal theme is to promote the idea of Sustainable Development and the role and association of Science, Technology and Innovation with it.

Sustainable development in today's context is one of the most important issue addressed not only on national level but also on global level. Sustainable development has three pillars – People (Social), Planet (Environment) and Profit (Economy). If all the three pillars are addressed in a sustainable manner and several different steps can be planned tomake lifestyle and livelihood more sustainable.

The subtheme 'Lifestyle and Livelihood' mainly addresses the concept of Science, Technology and Innovation to develop and live a sustainable lifestyle and practice sustainable livelihood.

Model of Sustainable Development:

People (Social / society): The conscious or unconscious actions taken related to lifestyle and livelihood, by an individual, community, organization or entrepreneurial activity has a direct impact on the humans and further to the society. Similarly under this sub theme, it is planned to allow a child to evolve sustainable ideas and solutions which can be carried forward in the future, for the betterment of individuals and society.

Planet (Environmental): In the current scenario, there are several problems and challenges which our environment faces on regular basis. There have been macro and micro issues related to the planet and which need to be addressed. One of the factor for these problems is the unsustainable lifestyle and livelihood which can be further identified as an opportunity to support the planet and develop different innovative approaches to support the planet.

Profit (Economy): Occupation and economy defines us, it drives or guides us on several of our actions we take on daily basis. Lifestyle and livelihood are interconnected and have a direct link to the economy. Science, Technology and innovation plays a very major role in supporting to generate better economy.

The subtheme 'Lifestyle and Livelihood' is one of the only themes which has the maximum association with most of the other sub themes mentioned under this guide book. It is associated with Energy, Natural resource management, Health, Hygiene& Nutrition,

Traditional knowledge, Disaster management, Food and Occupation. It links with all these sub themes, in the association with the changes evolved in relation to lifestyle and livelihood.

Approach & Methodology a child should follow:

The sub theme 'Lifestyle and livelihood' is one of the very interesting aspects linked with sustainable development. The changes in the environment and several different human and manmade actions have brought many modifications in the Lifestyle patterns and Livelihood patters which are observed at every stage and place which has brought unsustainability in several aspects. As a child it would be very interesting to study these changes in the patterns of living and identify or suggest ideasfor living a supportive and sustainable lifestyle. While developing a project on the Sub theme of 'Lifestyle and Livelihood' it would be ideal for a child to follow the following approach and methodology:

- Observations
- Mapping
- Case studies
- Surveys
- Key informant survey
- Impact assessments
- Focus group Discussions
- Using media (Audio, visual)

The main idea of the subtheme is identify the involvement or the role of Science, technology and Innovation for Sustainable Development. It could be a product, process, system, ideas which a child can identify or suggest related to sustainability to lifestyle and livelihood and its impacts on Society, Environment and Economics.

Ideas for Projects:

Some of the ideas for the projects under the sub theme of Lifestyle and Livelihood are listed under few main subject areas. They are mentioned as under:

Waste (Human waste, food waste, bio waste, medical waste, industrial waste):

- Study and understand the Lifestyle waste generation, handling and management
- Understanding the impacts of human waste, food waste on city and village.
- Understanding the impacts of medical waste and industrial waste on city and rural lifestyle, its health hazards and impacts on environment.
- Mapping the innovations for waste management systems on village, city or state level.
- Conducting an analytical study of waste generation at different places and its relation with lifestyle and livelihood and designing a system for waste management on basis of the analysis.

Food (Procuring, Preparation, Storage, Consumption, Wastage):

- Study on Food and energy consumption pattern of your village or city.
- Studying the changes in the food consumption patterns and its relation with changes in lifestyle and livelihood
- Analytical study of impact of media on food consumption amongst adults, youth and children and its relation with health.

- Studying the occupational migration and the changes it has brought in food consumption patterns and its relation with health.

Habits related to Lifestyle & Livelihood:

- Study of relation of young children with technology and media and its effect on their lifestyle, health and education
- Observation and study on the effects of lifestyle and livelihood amongst youth in aspect of abuse like Smoking and Drinking.
- Changes in the work pattern and economy and it relation with abuse.

Lifestyle and livelihood impacting culture and community:

- Studying of natural lifestyle & organic lifestyle of a tribal community
- Comparing lifestyle of different groups / communities either in villages or cities
- Mapping of changes in community lifestyle& livelihood of a village or urban area
- Changing lifestyle of children with urbanization
- How the market force/ peer pressure has forced to change the pattern in celebration of festivals, occasions and community celebrations.
- Comparative study of the behavior of group of children growing at home and away from home
- How the traveling pattern has changed in communities and its impact (Socio-economic and political)?
- Use of social media and changing communication and interaction patterns. A behavioral study.
- Interface of formal education and livelihood
- Change in pattern of livelihood in relation with traveling
- Socialization process affecting habits in relation to peer pressure like purchasing new gadgets, toys, etc.
- Change in pattern of livelihood in relation with traveling
- Study of impact of media on cloth and consumption pattern (men's cosmetic market, cosmetic surgery, hair transplant)

Lifestyle & Livelihood diseases:

- Understanding and studying the disease due to the changes in food patterns
- Understanding and analyzing the diseases evolved due to changes in work pattern and its possible solutions

Carbon footprints and impacts of handprints:

- Measuring Carbon footprint of your own area, either in village, town or a city
- Documenting innovative approaches for reducing carbon footprints in your area and measuring its impacts and possible suggestions for replicating it in different areas
- Measuring the carbon footprints and looking at the handprints in your area
- Identifying the local hero's in your village, town or city and their impacts on individuals, communities or societies in relation with sustainable development
- Comparative study of joint family and nuclear family, in relation to their consumption pattern and cost analysis and carbon footprint and handprint

Sensitivity towards Environment concerning lifestyle and livelihood:

- Role of jugad on lifestyle and livelihood
- Positive and negative impacts caused on the environment due to expanding cities
- Study of effects on environment due to human migration
- Sensitivity of young children towards environmental protection, pollution and waste management
- Study of Sensitivity of industries and business towards environment

Occupations, economy and Environment:

- Application of S&T in traditional livelihood skills
- Occupational mobility
- Entrepreneurial orientation of young people
- Interface of skill training to livelihood
- Case studies on Sustainable lifestyles
- Impact of technology on lifestyle & Livelihood
- New business propositions and vocations and their impact on health, behavior and their sustainability.
- Economic and environmental of celebration of festivals in urban and rural areas.

Other combined areas of activities in relation with lifestyle and livelihood:

- Studying and analyzing change in Traveling, food, energy consumption, health issues, and migration patterns in relation to Social, Economic and Environmental context by assessing them in relation to sustainability.
- Study about the sensitivity and perception about the above the actual mentioned issues (Material and Non material) in relation to Gender, age, social / economic, demographic / geographical profile.
- Impact of media on young people and community
- Case study of lifestyle of children pear group children
- Designing of your festival / celebrations in sustainable way in relation to environment and culture conservation
- Use of social media and changing communication and interaction patterns. Do a behavioral study of humans in Villages, towns and cities.

Detailed Project ideas:

Project 1:
Mapping of Changes of Community Lifestyle and Livelihood in a Village

Objectives

1. To develop an understanding of changing community lifestyles of the families in a village
2. To explore livelihood of the villagers in historical perspective
3. To develop a comparative understanding of existing community lifestyles and livelihood in the village community
4. To present a comparative mapping of community lifestyles and livelihood of the village community.

Methodology

1. Base life survey of a village
2. Key informant interview of school master, Sarpanch, gramsevak, postman, etc.

3. Focus group discussion

Expected Results

1. Village Resource inventory
2. Village lifestyle Map
3. Village livelihood Map
4. Graphic comparative picture/ presentation of lifestyles & livelihood changes in the village
5. A report on village lifestyles and livelihood.

Project 2:
Lifestyle Waste Generation, Handling and Management at Household Level

Objectives:

1. To identify and describe lifestyle related waste generation among families
2. To study the perception about waste handling and waste management among the households
3. To explore actual handling of household level waste management practices
4. To study demerits and merits of household level waste management practices
5. To develop / suggest a suitable model for household level waste generation, handling and management.

Methodology

1. Interview of select households in a community
2. Review of secondary literature on household level waste generation, handling and management
3. Field visits to select successful waste management facilities in Co-operative Housing Societies.

Expected Results

1. A data based report on household level waste management
2. A comparative chart of select successful models of household level waste management practices
3. A suggested model / prototype of household level waste management.

Project ideas

1 To verify whether it is contributing to the study of the various livelihood and their environment and sustainable development for nirvaho
2 Nirvaho assets being raised through environmental paripeksamam observe / practice, often short-term studies lasting damage to development bahuja
3 Impact on a variety of essential utilities and media (demand from the market)
4 Was erected by the city maltipleksa / mol employment growth above the long-term study of their causes
5 Which has developed a new livelihood opportunities through new routes / stations with an overview of future plans for both a & b of the comparative study and the population
6 Livelihood changes in the name of advancement and the economic, physical, mental health of the above effects
7 Their society / area beautiful lifestyle / work practice effective lifestyle of living / inspirational individuals relevant to the community through
8 Exclusive lifestyle / system environment, health, society and the effects of its procedures (for groups) or a comparative study of the two communities would thus covering different issues

9 Ideal lifestyle pichanava village, city, should do in the big cities - to understand the current situation of the study
10 The study of diseases associated with lifestyle such as diabetes, hypertension, etc.
11 Country, region, community, according to the study of subsistence lifestyles
12 The study of employment and migration

Reference material:

Web reference:

https://sustainabledevelopment.un.org/sdgs
http://www.indiastat.com/default.aspx
http://www.statista.com/
www.academia.edu
http://www.unep.org/resourceefficiency/Consumption/EducationLifestylesandYouth/SustainableLifestyles/tabid/101304/Default.aspx

Publication& Reports:

Baseline Report of SPREAD Project
Sustainable Livelihood Report to Poverty Reduction by Sida
Food Insecurities in India- Causes and Dimensions
The State of Food Insecurity in the World
UNEP Guideline

Sub Theme VI

Disaster Management

Sub theme:
Disaster Management

Introduction

Over the past two decades, losses due to disasters are increasing in terms of life and property across the globe. Disasters apart, factors that enhance the gravity and severity of disasters include density and size of population, unplanned urbanization, environmental degradation, local and global impacts of climate change and ozone depletion etc.

The Global Assessment Report on Disaster Risk Reduction: Risk and Poverty in Changing Climate, 2009, identifies ecosystem decline as a key driver that will enhance the spread and depth of impacts of natural calamities, as we move into the future. This is further corroborated by the World Disaster Report. Unfortunately efforts to tackle disasters do not match the timing, frequency and the holism that pervades targets.

Definition of Disasters

Disaster is defined differently depending on the purpose of intervention.

- WHO defines disaster as “any occurrence causing damage, ecological disruption, loss of human lives, deterioration of health and health services on a scale sufficient to warrant any extraordinary intervention from outside the affected community” In fact, disaster is an event or series of events, that cause casualties and damage or loss of properties, infrastructures, environment, essential services or means of livelihood on such a scale which is beyond the normal capacity of the affected community to cope with.

- The Disaster Management Act of India, 2005 defines disaster as “a catastrophe, mishap, calamity or grave occurrence in any area, arising from natural or manmade causes, or by accident or negligence which results in substantial loss of life or human suffering or damage to, and destruction of property, or damage to, or degradation of, environment, and is of such a nature or magnitude as to be beyond the coping capacity of the community of the affected area”.

- The United Nations defines disaster as “the occurrence of sudden or major misfortune which disrupts the basic fabric and normal functioning of the society or community”. Disaster is also sometimes described as a “catastrophic situation in which the normal pattern of life or eco-system has been disrupted and extra-ordinary emergency interventions are required to save and preserve lives and or the environment”.

- As per Paho (1980) it is “an overwhelming ecological disruption occurring on a sufficient scale to require outside assistance”.

- According to Red Cross/Red crescent “A disaster is a sudden, calamitous event that seriously disrupts the functioning of a community or society and causes human, material, and economic or environmental losses that exceed the community’s or society’s ability to cope using its own resources. Though often caused by nature, disasters can have human origins as well.

Classification of Disasters

Disasters are classified differently using different criteria. They are classified on the basis of origin as natural or manmade or on the basis of severity as major or minor disasters.

- In India a high power committee was constituted in August 1999 by the government of India to prepare a comprehensive model plan for disaster management. This committee identified 31 disasters on the basis of their origin **(Natural Hazards or Technological** or **man-made**) and classified them into five categories, in tune with the classification given by Red Cross and Red Crescent. (//www.ifrc.org/en/what-we-do/disaster-management/about-disasters/definition-of-hazard/)

- Technological or manmade disasters are such events that are caused by humans and occur in or close to human settlements. The factors such as increasing population, degraded environment, unplanned urbanization and under-development/poverty etc. are some other factors which sometime play a role of key aggravating factor to increase the frequency, complexity and severity of the disaster.

Disasters as identified in India on the basis of origin. They include:-

I. **Hydrological and Meteorological Disasters (11 Types)**:-
Foods, Cyclones, Hailstorms, Cloudburst, Heat and Cold waves, Snow Avalanches, Droughts, Sea erosion, Thunder &Lightening**.**

II. **Geological Disasters (6 Types)**:-
Like landslides, Mud flows, Earthquake, Mines fires, Dam failure and General fire.

III. **Biological Disasters (4 Types)**:-
Epidemics, Pest attacks, Cattle epidemics and Food poisoning.

IV. **Nuclear & Industrial Disaster(3 Types)**:-
Chemical, Industrial and Nuclear accidents.

V. **Accidental Disaster (7 Types)**:-
Urban and forest fire, Oil spill, Mine flooding incidents, Collapse of huge building structures, Bomb blast, Air, road and rail mishaps, Boat capsizing and Stampede during large congregations.

Why this Sub Theme?

India, by her geography and climatic condition and high degree of soci-economic vulnerability is one of the most disaster prone areas in the world. She is vulnerable to wind storm spawned in the Bay of Bengal and Arabian Sea, floods, brought by monsoons and drought in the arid and several arid areas of the country, which are almost the annual features of the country besides the earthquake by the active crustal movement in the Himalayan region. In last few years Indian subcontinent is also witnessing the extreme weather phenomena in the form of unprecedented cold and heat weave. The vulnerability of India subcontinent could be well understood by the Bhuj Earthquake (about ten thousand deaths) and super cyclone (13805 Deaths) and Tsunami which accounted for many deaths and loss of property worth of several cores.

In fact out of 27 state and 7 UTs, about 22 are prone to one or the other type of natural disasters. As per the Vulnerability Atlas of India (www.nidm.nic.inn), 57% of the Indian land mass is vulnerable to earthquake (High Seismic zone – III-V) 68% to drought (Arid & Seismic arid zones) 8% to cyclone and 12% to food. The costal are of India has become vulnerable to Tsunami since 2004, the India ocean Tsunami. India has witness two major earthquake shocks in Gujarat (January 2001) and in J&K (October 2005) causing a severe danger to life

& property. The entre north eastern states, Andaman & Nicobar and six states in North/West states are in seismic zone V.

According to India's Tenth Five Year Plan, natural disasters have affected nearly 6% of the population and 24% of deaths in Asia caused by disasters have occurred in India. Between 1996 and 2001, 2% of national GDP was lost because of natural disasters, and nearly 12% of Government revenue was spent on relief, rehabilitation and reconstruction during the same period. As per a World Bank study in 2003, natural disasters pose a major impediment on the path of economic development in India*. (GOI-UNDP Disaster Risk Reduction Programme 2009-2012, Programme Document)*

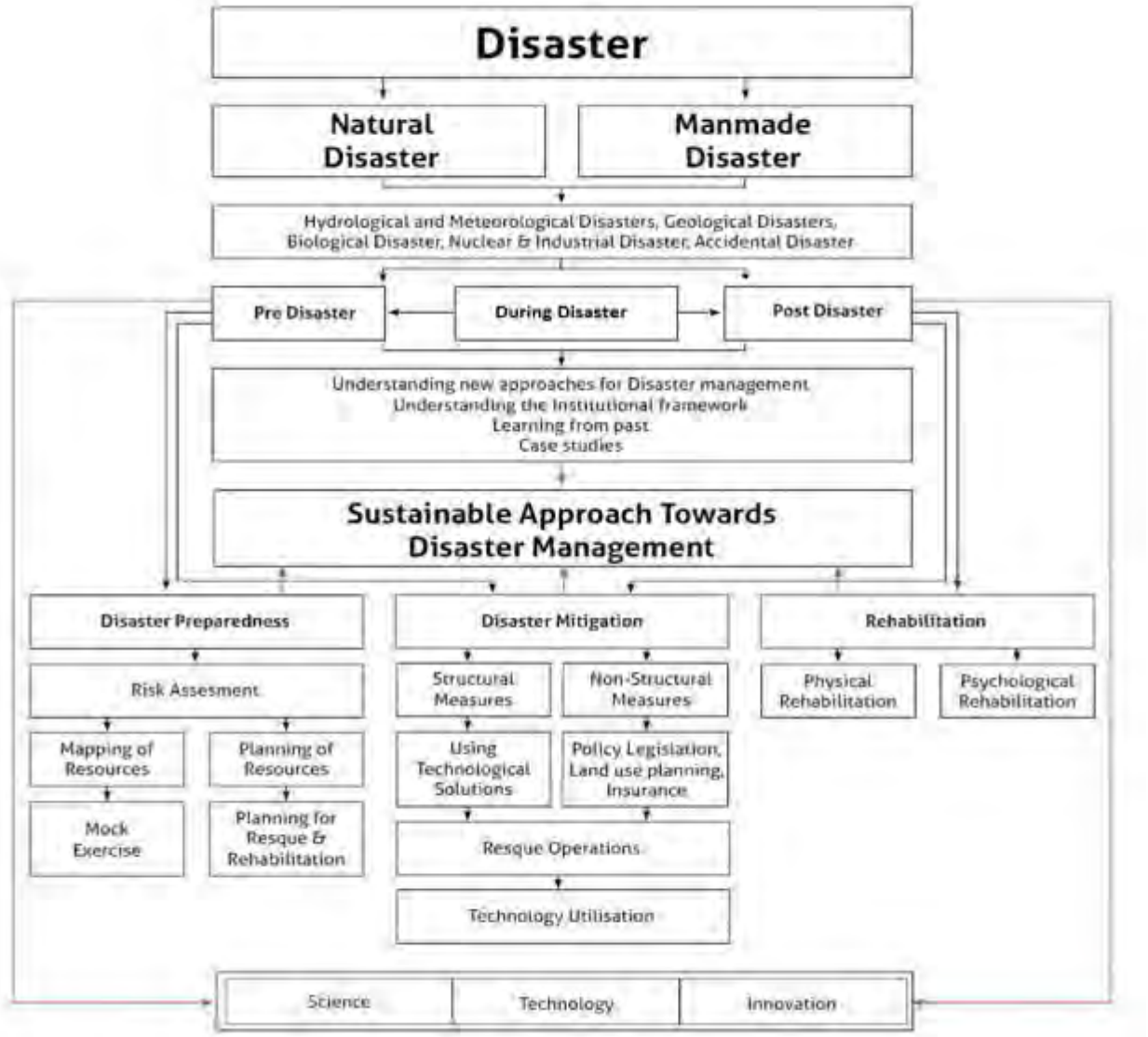
Whatever may be the origin or cause, it always affects people and halts overall development processes. Fortunately over the past 15 years, there has been a paradigm shift in managing the disaster at the global level which pleads a productive and preventive approach and integrate disaster management with ongoing development activities i.e. sustainable development. A shift in disaster management approach has evolved gradually since 1990's with the declaration of the International Decade of Natural disaster Reduction (1990-2000) by UN, General Assembly.

- In 2005, during the World Conference on Disaster Reduction, Hyogo (Japan) the Yakohama Strategy for disaster management was renewed*.("Yokohama Strategy and Plan of Action for a Safer World: guidelines for natural disaster prevention, preparedness and mitigation").* A three part document was the output of the World Conference on Natural Disaster Reduction, held in Yokohama, Japan, from 23 May to 27 May 1994. This document provides guidelines for natural disaster prevention, preparedness and mitigation. Yokohama Strategy also emphasized that disaster prevention, mitigation and preparedness are better than disaster response in achieving the goals and objectives of vulnerability reduction. Hyogo conference laid emphasis on some very crucial and so far neglected aspects of disaster management like governance and policy framework, risk identification and early warning, knowledge management, reducing risk factors and preparedness for effective response and recovery.

- As the outcome of the conference, a framework of Action 2005-2015 called "Building the Resilience of Nation and communities to Disaster was adopted by the member states of UN.

- In the backdrop of the above, the Disaster Management Act 2005 was passed by the Indian parliament to provide the legal and institutional framework for the disaster management in India at the national, State and district level. This Act defines Disaster Management as a continuous cycle and integrated process of planning, organizing, coordinating and implementing all necessary measures relating to prevention of threat of any disaster, capacity building, and preparedness to deal with any disaster, prompt response to disaster, assessment of the severity and magnitude of effects of disaster, evacuation, rescue and relief including rehabilitation and reconstruction.

Framework of the Sub theme:



Box-I
Understanding and Managing Disasters:

1. **New Approach in Managing Disasters**: (i) Shift from response and relief mode to integrate it with planning & Developmental process in the light of Yokohama Message
   (ii) International Decade of Natural Disaster Reduction (1990-2000)
   (iii) Hyogo framework of Action policy of India.
   (iv) Disaster Management in India
   (iii) Reference to 10 and 11th five- year plan document.
   (iv) Disaster management Act 2005.

2. **Classification of Disasters:-** (i) Different types based on severity or origin. Geological, Meteorological, Hydrological, Biological, Nuclear, Industrial & Accidental Disasters (as suggested by high-power committee in August 1999 and identified 31 disaster and categorized into five major group) (Reference to Red cross and Red Crescent organization.)

3. **Geological Disasters**: **- Earthquake**:- Earlier Theories, Tectonic plates, Scales and severity of Earthquake. Earthquake Prediction. Earthquake prone area of the world. Recent major earthquakes of the world.

4. **Earthquake profile of India**, Zonation. Major earthquakes in India and discussion on lesson learned. Do not Do not's. Institutional Framework for research and recent updates, Building designs and regulations

5. **Landslide, Mudflow and Snow Avalanches**:- Causes, Landslide , snow avalanches prone area of India. Prevention and Mitigation:- Role of Geological survey of India (GSI) in study of land contours and warning about landslide hazards & DRDO role in Avalanche warning.

6. **Tsunami:**- Causes, Tsunami of 1994 of India Ocean and losses in the coastal States and other part of the world. Measures & mitigating. Tsunami warning (INCOIS) Indian National Centre for oceanic Information system.

Hydrological Disasters:

7. **Floods**:- Causes and impact of Flood, Flood profile of India, (natural ecological system of India, its impact specially on poor people and & in rural area, outbreak of epidemics (Malaria, cholera) & scarcity of water , National flood control programme, Main flood porn area of the country, Damages by flood, Advantages of Floods, Flood management programme

8. **Droughts:-** Causes, droughts profile of India-mitigation:- Manual management Manual (Ministry of Agriculture in 2009) Rainfall forecasting system (IMD). Drought Prone Area & Desert Development programme. Water Conservation & Harvesting, Management of Drought

9. **Tropical Cyclones**:- Definition, causes, cyclone prone area of India, effect, cyclone & wind speed, super-cyclonic storm Forecasting and warning of cyclones (Role of IMD)

10. **Flesh Flood or cloud Bursting**:- Meaning, causes, effects and impact, mitigation:- Laddak, Uttarakashi flash floods,, warning system. Lesson Learned

11. **Thunderstorm, Hail storm & Dust storm** Definition, causes & effect, Impact, profile in India. Early warning systems, Dos and Do not's

12. **Heat & Cold wave:** Extreme weather phenomena, causes & Impact, preventive measures.

13. **Biological Disaster:-** Epidemics in India , meaning, types, causes, effect, impact, preparedness and mitigation i.e. meningitis, measles, dengue, polio, typhoid (Epidemic profile:- water born diseases :- mitigation, preparedness (Pest Attack, cattle epidemics and food poisoning) Manmade Disaster.

14. **Industrial Disaster (**oil and chemical):- Classification as chemical mechanical civilian electrical or other process failures due to accidents, negligence & incompetency in an industrial plant.
Bhopal gas tragedy: - Causes, Impact, Major accidents Hazards units mitigation preparedness in India.

15. **Fires & Forest Fire: -**Causes Impact, mitigation & preparedness (master plan on forest fire control), preventive and mitigation measures. Do & don't.

16. **Mine Disaster**: - Definition (Mine Act 1965), Major mining disasters, causes, (poisonous gas leak, asphyxiant gases, flooding etc.) preventive measures.

17. **Nuclear Disaster**:- Nuclear Material, Radiation its impact, possible causes, permissible limit of radiation, Nuclear emergency situations. Lethal diseases caused by radiation, Incidents in India in nuclear plants and Mayapuri Delhi in 2010, Russia (Chernobyl) and Japan (Fukushima)

Project Ideas:

1. Identification of potential disaster prone sites, locations, vulnerable target groups/population and developing a action plan by involving local community and authorities and creating awareness by organising mock exercises using locally available recourses . (*Efforts should be made to utilize locally available resources in an innovative way)*

Tips to Remember:

1. Make sure that your plan is cost effective, innovative and sustainable.
2. Make optimum use of locally available resources rather than depending on the external agencies for help and support.
3. Assess the existing capacities/resources (both externally/within community) that can assist in risk reduction to provide an element of novelty in your planning.
4. Suggest a mechanism how the risk reduced is measurable.
5. Involve villagers/community members to assess the local resources and drawing the map and plan.

Box-II

Types of Preparedness: It could be :-

1. Task oriented
2. Target Oriented
3. Disaster oriented

2. Identification of vulnerable target groups in your area/locality specifically those are prone to a particular disaster and making/developing a response plan involving vulnerable target group and community and testing of same by periodic mock exercises.

3. Formation of Disaster Management club and taking up some activities like preparing emergency preparedness and response plan for the school involving students, Parents ,Teachers and local authorities.

   (Activities may include awareness creation, mock drill, development of education material and creation of awareness, preparing volunteers and developing opportunities for leadership.)

(Activities may also include preparing students with basic lesson in tacking a fire outbreak, accident in a chemical laboratory, flood or even a bomb thread and terrorists attack and hostage crisis.)

The Disaster Management club could also work on assessing the impacts of few disasters in their region and the role of media which could be played by the media.

4. Developing community/school plan to tackle disasters and emergencies by risk assessment, hazards, vulnerabilities and contingency planning to bring back life to normalcy in shortest period of time.

(A community may be prone to various types of disaster due to factors like geological location, proximity to a chemical factory or nuclear plant etc. Accordingly a plan could be developed by involving vulnerable groups and communities.).

5. Study and developing a strategy for mitigating structural/material deficiencies prone to disaster like earthquake, fire, flood etc. through retrofitting or during on-going re-modeling in your locality, housing society and village.

6. Chemical hazard identification and risk analysis including awareness about basic information about the resources, demography, existing organizational set up, administrative facilities at the state, district and local levels. Describes preparedness and mitigation measures as well as response mechanisms.

7. Defines specific roles and responsibilities for various actors at different levels. Ensures networking/coordination with the media, NGOs, international agencies and other stakeholders.

8. Develop a disaster specific preparedness plan keeping in view the demography/topography and the disaster profile of your area.

9. Identification of hazard and risk analysis of your area by incorporating basic information about the resources, demography, existing organizational set up, administrative facilities at the state, district and local levels by developing a workable mechanism for preparedness and mitigation measures along with a response mechanisms.

(Also describe and defines specific roles and responsibilities for various actors at different levels. Ensures networking/coordination with the media, NGOs, international agencies and other stakeholders)

10. Develop a plan and create awareness in high-density settlements areas and develop information centre and watchdog committees to mitigate the impact of disaster.

11. Prepare a plan to protect the livestock of your village from flood by listing the appropriate measurement that could be undertaken keeping in view the demographic, topographic profile of your area.

(In project include mapping exercises to identify vulnerable places, resources available and safe places for taking shelter and Setting up of different Disaster Management Teams to perform specific tasks)

12. Plan to Reduce vulnerabilities and increase capacities of households and communities to withstand damaging effects of a specific disasters (Food, Earthquake, Storm, flash flood, etc)

13. Develop a Rescue plan for persons with special needs (like physically/visually disabled population and senior citizens) in relation to a particular disasters or emergencies (fire, flood, earthquake, etc) The project must have following components:-

a. Consultation with persons with special needs for resources needed during disasters/emergencies.
b. Identification of basic amenities (water sanitation etc.) required by them during/after the disaster takes place.
c. Existing schemes and institutes providing assistance devices.
d. Identification and listing of people/govt and non-govt institutes/agencies of the people who can provide the help to people of special needs.
e. Preparing the inventories of items required for rescue and relief operation.

14. Study of some traditional housing earthquake resisting technologies and to what extent same has been use in modern housing construction.

15. Study some historical/old dwelling structures (Houses, *hawalies* etc) which had withstood the previous disaster like earthquake, floods, etc. Find out the special feature of those structures and validate the same by scientific experimentation.

16. Study the legal and Intuitional framework emerged in your area as result of new approach to tackled potential disaster. Suggest new measure to make it operationally optimum by doing a series of mock exercises.

a. Case study can be taken with reference to a particular disaster (Natural or Manmade)
b. Create awareness and Suggest Alternative planning/strategies and mobilizing local and state authorities for the same.

17. Study the impact of disaster on the livelihood of affected population in recent past.

18. Develop a mechanism (including mathematical modeling) to estimate the loss of livelihood or environmental degradation in a hypothetical disaster situation of your area/ region or State.

19. Estimate the economic loss by collecting primary and secondary data in relation to Environmental Degradation / loss of livelihood in your area and propose a plan to reduce the same in relation to a particular disaster (flood, cyclone, earthquake)

20. Study the local and traditional consideration, taken into consideration while constructing houses or other dwelling units or systems in relation to a particular disaster and compare it with modern method of construction.

21. To visit the affected areas and collect information including the type of disaster frequency and photos

22. Any traditional remedies against a repeat of the disaster-equipment exercises

23. The study of the meteorological department forecast the disaster by other sources

24. Re-affected areas: habitat considerations of supply schemes (compensation) against quick solutions and permanent disability

Box
Approaches to Study Disaster
i) Geographical Approach
ii) Anthropological Approach
iii) Sociological Approach
iv) Development Studies Approach
v) Disaster Medicine & Epidemiology Approaches
vi) Technical Approach

Box:-
Learning from Disasters
i) Demystifying Myths
ii) The constant process of learning and Improve planning.

Detailed Project Ideas:

25. **Development of Hazards specific response procedure using existing local infrastructure /knowledge/capabilities, resource constraints.**

    Indicator of success:-

    How innovative resources/knowledge and capabilities has been used to develop and operationalize response procedure in term of attending medical emergencies, Emergency call system, evacuation etc. Response system can be with reference to Fire, Earthquake Terrorists Attack, Storm, Tsunami, Bomb threat, Gas leak, Hazard material release, , chemical or suspicious material spill.
    Children and youth could be engaged in child-participatory School Disaster Management planning inaction oriented activities in their own schools, and neighbouring communities

26. **Project:- School Earthquake safety & preparedness for school to prevent catastrophic consequences of earthquake**

    Relevance:- Many time the catastrophic consequences of earthquake is preventable as Death are not by Earthquakes but by collapse of buildings due to designed and material used and lack of awareness. The project is to equip student/teacher community to help themselves during disaster.

    Objective:- To assess the risk by building structure, material and design, equipment, window/doors settings that may cause injury to students.

    - To create awareness and trained students and teachers of life saving skill through lectures, demonstrations, training programmes, workshop, mock drills and first aid trainings.
    - To promote a culture of earthquake safety in school/housing society/village etc. .
    - To impart knowledge on disaster risk reduction focusing on earthquake safety.

Methodology:-
Risk assessment in relation to building, design, construction, material, equipment's etc installed, awareness creation followed by training in life saving skills specifically required at the time of disaster.

Development and compilation of literature explain the basics cause and effect of earthquake for creating awareness and equipping target group in life saving skill.

DID YOU KNOW?
Any disaster preparedness programme should essentially include:
Perceptions that need to be examined, and opportunities, which need to be created for people to modify their perceptions where necessary
Strategies that need to be created to rouse the curiosity of the members of vulnerable affected community, and instil in them a desire for change.

Individuals and communities that need to be helped to compare the existing practices with proposed innovations

Source:-
http://www.ignou.ac.in/upload/Disaster%20Preparedness%20and%20Mitigation.pdf

References:

Web Reference:

1. http://www.ndma.gov.in/images/guidelines/national-dm-policy2009.pdf
2. http://www.unisdr.org/2005/mdgs-drr/national-reports/India-report.pdf
3. http://www.newworldhope.org/School%20Safety.html
4. http://www.ignou.ac.in/upload/Disaster%20Preparedness%20and%20Mitigation.pdf

Sub Theme VII

Traditional Knowledge Systems

Sub Theme:
Traditional Knowledge Systems (TKS)

Introduction:

Traditional knowledge is the knowledge, innovations and practices of indigenous and local communities around the world. Developed from experience gained over centuries and adapted to the local culture and environment, it is transmitted orally from generation to generation.

It tends to be collectively owned and takes the form of stories, songs, folklore, proverbs, cultural values, beliefs, rituals, community laws, local language, and agricultural practices, including the development of plant species and animal breeds.

- ***Indigenous knowledge (IK)*** *system refers to the combination of knowledge system encompassing technology, social, economic and philosophical learning (**Hoppers, 2002**).*
- ***Indigenous knowledge (IK)*** *is the local knowledge – knowledge that is unique to a given culture or society. It is the basis for local-level decision making in agriculture, health care, food preparation, education, natural-resource management, and a host of other activities in rural communities (**Warren 1991**).*

Sometimes it is referred to as an oral tradition because, it is practiced, sung, danced, painted, carved, chanted and performed down through millennia. Traditional knowledge is mainly of a practical nature, particularly in such fields as agriculture, fisheries, health, horticulture, forestry and environmental management in general.

Understanding what is traditional knowledge

Traditional knowledge* refers to the knowledge, innovations and practices of indigenous and local communities around the world. Developed from experience gained over the centuries and adapted to the local culture and environment, traditional knowledge is transmitted orally from generation to generation. It tends to be collectively owned and takes the form of stories, songs, folklore, proverbs, cultural values, beliefs, rituals, community laws, local language, and agricultural practices, including the development of plant species and animal breeds.

** for the purpose of this paper, the terms traditional knowledge, indigenous knowledge and local knowledge are used interchangeably*

Source: THEMATIC PAPER towards the preparation of the 2014 World Conference on Indigenous Peoples- INTER-AGENCY SUPPORT GROUP ON INDIGENOUS PEOPLES' ISSUES

Why this Sub Theme?

Traditional knowledge is valuable not only to those who depend on it in their daily lives, but to modern industry and agriculture as well. Many widely used products, such as plant-based medicines, health products and cosmetics, are derived from traditional knowledge. Other such valuable products include agricultural and non-wood forest products as well as handicraft. Traditional knowledge can make a significant contribution to sustainable development.

Most indigenous and local communities are situated in areas where the vast majority of the world's genetic resources are found. Many of these over a period of thousands of years have been brought under cultivation. . Some of the practices of the indigenous and local communities have proven to enhance and promote biodiversity at local level and aid in maintaining healthy ecosystems.

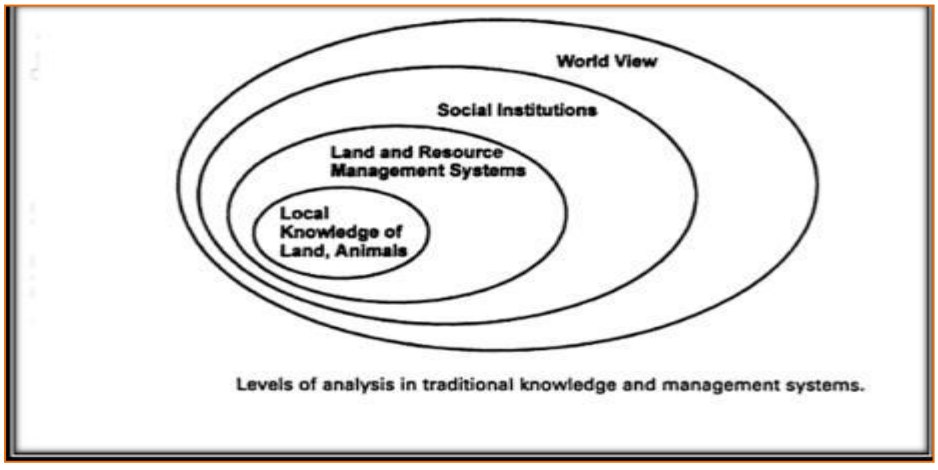
It is pertinent to mention here that, the contribution of indigenous and local communities to the conservation and sustainable use of biodiversity goes far beyond their role as natural resource managers. As on-site communities with extensive knowledge of local environment, they are directly involved with conservation and sustainable use. Their skills and techniques provide valuable information to the global community and useful models for enabling policies on biodiversity conservation..

Traditional knowledge issues cross-cut across many domains in relation to global environmental issues, from biodiversity conservation and natural resource management, to use of genetic resources and to climate change observations, mitigation and adaptation Work on indigenous knowledge provides support to understanding the role of customary livelihoods within sustainable development and the links between environmental management, science and well-being. Recognition of the links between traditional knowledge, sustainable and customary use of biological resources has led to global issues on soverign rights to ones own resources, access and benefit sharing.

The Convention on Biodiversity (CBD) provides the clearest recognition of these links through work on the following two Articles that:

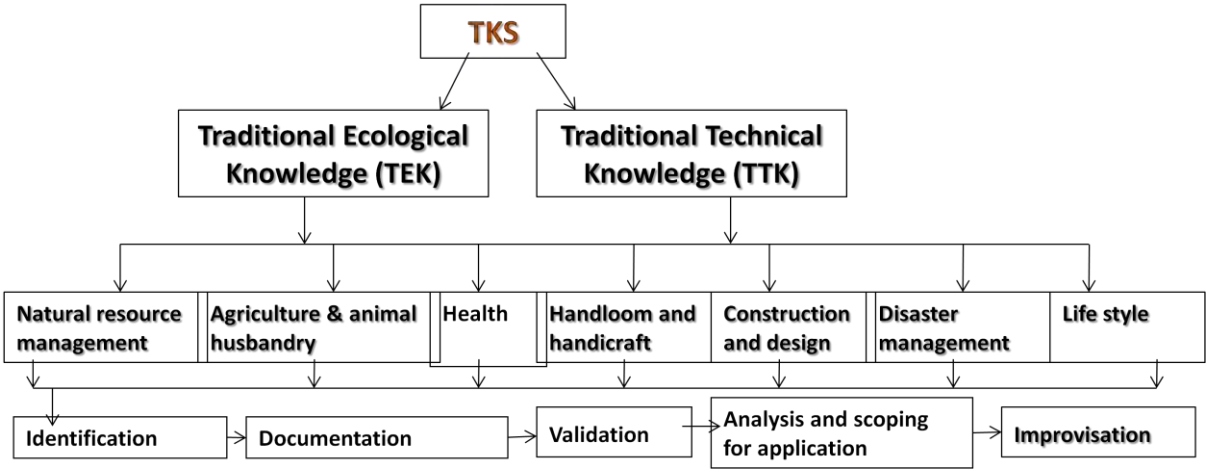
'...respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and promote their wider application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of the benefits arising from the utilization of such knowledge innovations and practices' (Article 8(j)) and 'protect and encourage customary use of biological resources in accordance with traditional cultural practices that are compatible with conservation or sustainable use requirements.' (Article 10(c))

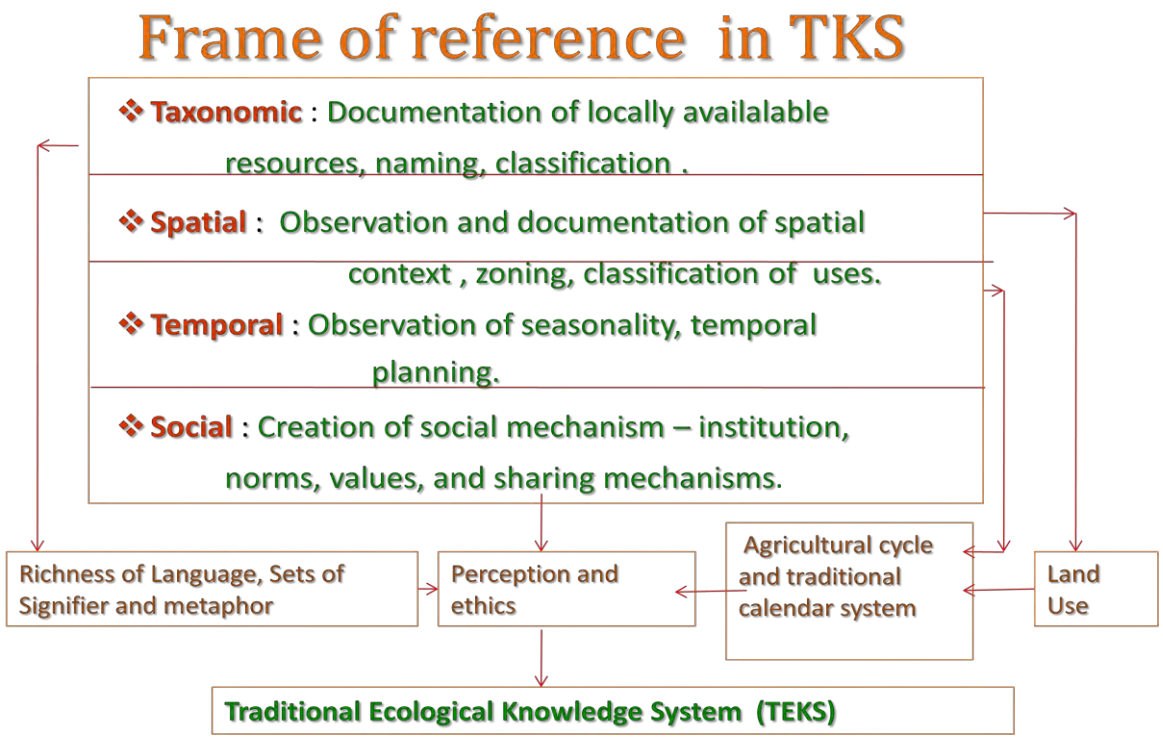
The larger holistic Frame work.



Levels of analysis in traditional knowledge and management systems.

Source : Sacred Ecology: Traditional Ecological Knowledge and Resource Management,- By : Fikret Berkes,





Coverage under the sub-theme:

Most commonly accepted is the role of Traditional Knowledge) TK in the "traditional" or primary sectors of the economy: agriculture and pastoralism, forestry, fisheries, water, and products made from natural resources such as crafts, furniture, housing, and so on (Posey 1999). Given the fact that a majority of the world's population remain dependent on these sectors for their survival and livelihoods, and for various aspects of shelter, the contribution that TK makes and can continue to make towards sustaining billions of people is quite clear (though not necessarily acted upon in policies and programmes of most countries).

However, the role of TK in the secondary and tertiary sectors of the economy too is becoming clearer. A whole range of industrial products are dependent on or use TK in varying ways. This is true for sectors like textiles, pharmaceuticals, household good, and so on. Health care, through all systems of medicine, is to varying degrees of extent dependent on TK, or on combinations of TK and modern knowledge. According to the World Health Organization (WHO), the majority of the world's population (in areas like Africa, up to 80 per cent of the population) is dependent for varying degrees on medicinal plants through traditional health care systems (www.who.int/mediacentre/factsheets/fs134/en/). Numerous studies have demonstrated the contribution that TK also makes to the modern pharmaceutical industry and modern health care, a contribution that may only increase as people in the western world (including westernized people in the "developing" countries) become more conscious of plant-based cures. The World Health Organization (WHO) estimates that 25 per cent of modern medicines are made from plants first used traditionally.

Services like food distribution, education, climate forecasting and warning, and community care also continue to be performed through institutions using traditional means, and in some cases even modern institutions of the government or corporate sector are discovering the value of this. In a Food for Work programme in Nepal, significant losses of food in the distribution system were reduced when the programme switched to the use of local technologies and networks (Gorjestani 2004). Rates of maternal mortality at childbirth were reduced significantly when traditional institutions (including the traditional birth attendant) were used in combination with modern communications (Musake 1999, cited in Gorjestani2004).

The trade sector too has seen a significant and continuing contribution of TK related products and services, as recognized by institutions such as UNCTAD (Twarog and Kapoor 2004).

Though much more recent, there is now a growing recognition of the role that TK could play in humanity's response to the gravest threat it now faces: climate change. The fact that communities have for centuries and millennia adjusted their behaviour and strategies and knowledge systems to changes in their surrounds, is central to this realization. Communities adjust their agriculture/pastoralism/fishing and hunting-gathering to subtle or not-so-subtle changes in climate, to threats from other communities or invasions, to disease and epidemics, and so on.

Traditional systems appear to be static, but they are indeed dynamic in making such adjustments. Such adaptability could be a key factor in the response that we give as a species, to the impacts of climate change and TK's role in all the sectors named above could provide the alternatives needed to build towards a more sustainable way of dealing with our atmosphere. As an example of the potential of this (as yet considerably under-utilized), researchers, government agencies, and indigenous peoples of Canada are collaborating in research and action related to climate change that brings together TK and modern knowledge (see http://www.itk.ca/environment/climate-change-index.php; and Birkes and Jolly 2001). Parties to the CBD are also beginning to highlight this issue, as pointed out by its Executive Secretary Ahmed Djoghlaf at the "International Expert Seminar on Indicators Relevant to Indigenous Peoples, the Convention on Biological Diversity and the MDGs" (Banaue, Ifugao, Philippines, 5 March 2007) **(**http://www.biodiv.org/doc/speech/2007/sp-2007-03-05-ind-en.doc).

On the Demarcation of Pseudo-science from Traditional Knowledge

(From ICSU Series on Science for Sustainable Development No. 4, Science, Traditional Knowledge and Sustainable Development)

The demarcation of pseudo-science from traditional knowledge is fairly straightforward. As noted earlier, traditional knowledge is a cumulative body of knowledge, knowhow, practices and representations maintained and developed by peoples with extended histories of interaction with the natural environment. Thus, it has typically originated independently of science in a particular cultural setting, and critically, independently from Western culture. Traditional knowledge is therefore neither intended to be in competition with science, nor is such a competition the necessary result of their interaction. O n the contrary, traditional knowledge has informed science from its very beginnings and it continues to do so today. If competition between science and traditional knowledge arises at all, then the initiative typically comes from people w h o want science to replace these other forms of knowledge. Pseudo-science, on the other hand, tries at least partly to de-legitimize existing bodies of scientific knowledge by gaining equal epistemological status. The existence of pseudo-science as an enterprise in competition with science is thus invariably bound to the existence of science itself whereas traditional knowledge is independent of science.

The Way Forward

It is acknowledged in the introductory note to the Science Agenda - Framework for Action of the World Conference on Science (Annex 1) that modern science does not constitute the only form of knowledge available to further the development of humankind. Traditional knowledge systems harbor an enormous and, for the most part, untapped wealth of information that is acquired and constructed within a wide range of cultures. It is also acknowledged that these unique knowledge systems are increasingly weakened in the face of globalization and the growing dominance of a single view of the natural world as espoused by science.

The valuable contribution to science that has been made by traditional knowledge systems was recognized at the World Conference on Science. Further, the need to preserve, protect, research and promote this empirical knowledge was advocated. To assure mutually beneficial and enriching exchanges between these two distinct knowledge systems requires the development of a way forward that is based on two lines of action. The first concerns recommendations for action within the scientific community to raise awareness about the unique values of traditional knowledge systems. The second area of action that must be predicated on the first, concerns establishment of a foundation upon which to build partnerships that can constructively couple science and traditional knowledge.

Measures to be taken by the Scientific Community

Scientists and scientific institutions should promote dialogue and build awareness and understanding within the scientific community about traditional knowledge and its relationship to science. Specifically, they need to:

- Recognize that science does not constitute the only form of empirical knowledge about the world;
- Encourage research into the history and philosophy of science to identify and highlight the tangible contributions that traditional knowledge systems have made to the development of science;
- Raise awareness of the important distinctions between traditional knowledge, science and pseudo-science;
- Recognize that traditional knowledge systems offer unique and valuable approaches to the acquisition and construction of knowledge, processes that can only be addressed by acknowledgement of the specific cultural milieu within which they are reproduced;

- Recognize that scientists are also influenced by their own cultures in which they learn, work and research;
- Promote and support research into traditional knowledge systems that represent considerable stores of, as yet "undiscovered", knowledge and potential for mutually beneficial exchanges with science.
- Actively support and strengthen the systems of acquisition, transmission and maintenance of traditional knowledge in the societies that are keepers and developers of that knowledge. Specifically with respect to building appropriate bases to articulate equitable exchanges between traditional knowledge and science:
- Understand that knowledge in traditional societies, contrary to an often held perception, is also dynamic and constantly evolving;
- Recognize that there also exist traditional processes of transmitting and acquiring traditional knowledge, and that these processes deserve to be maintained and supported;
- Recognize, support and encourage research into the role of women's traditional knowledge that has often been neglected.

Possible initiatives.

- Creating sensitization and awareness on traditional knowledge systems and best practices;
- Developing information and data base through the means of Heritage Register, People's Biodiversity Registers; Technology Register; (write in Indian Journal of Traditional Knowledge)
- Promoting inquiry based learning in curriculum framework;
- Participatory action research;
- Training in vocational area (IGNU experiments traditional drum making in NER)
- Identify appropriate means of communication, etc.
- Mainstreaming TKS through validation, adaptation to modern lifestyles, proper packaging, value addition,

Project ideas

i. Title of the project : Study of the use of herbal medicine for the treatment of dengue fever.

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

iii. Objectives
1. To do a review of literature of all available herbal medicine for treatment of body ache, fevers and associated difficulties.
2. To Study the disease incidence pattern of dengue fever in a location with refer to vector occurrence, breeding point mapping, study of socio-economic background of affected population.

3. To study the out of pocket (OOP) expenditure incurred by dengue patients before the introduction of the herbal medicine and compare with the expenditure incurred after the introduction of the herbal medicine.
4. To document, study, validate the traditional knowledge, attitude and perceptions (KAP) of affected population, related to dengue fever.
5. To study the disease profile with help from community health centre (with adequate precautions of not getting disease to oneself).
6. To study the loss of livelihood due to disease incidence to a sample population.

iv. Proposed methodology

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

v. Expected outcome

1. Understanding the intricacies of traditional knowledge and its modern application potential to newer challenges.
2. To mainstream, adopt, adapt and integrate the traditional knowledge systems to modern and changing socio-ecological and economic conditions
3. Understanding the economic impacts leading to loss of livelihoods, attendance in schools, negative impact to local production systems, and possible impact on developmental process, sustainability etc.
4. To understand the pattern of Out of Pocket (OOP) expenditure of various sections of the community / classes and the varied impact of the same disease on different socio-economic sections.
5. Effective and meaningful S&T/health communication strategies designed, implemented and adopted by the communities themselves can lead to sustainable livelihoods ,
6. To see if there are fake herbal products sold in the name of Traditional practices, commercialization of traditional knowledge if any etc.

Project 2: Community Knowledge about Classification of Land

This exercise is intended to know the process of farmers' classification of their land based on their perceived criteria. This will also help the student to understand the farmers' decision making process in respect of land management especially crop choice, fertilizer use, irrigation scheduling, etc. This project has two basic components. At first level a field survey and mapping will be made at a community field adjacent to his/her locality with the participation of knowledgeable farmers and in the second level the community knowledge may be validated in school laboratory or agriculture laboratory nearby.

Objectives:

1. To identify different categories of land in farmers' field according to farmers' own criteria
2. To understand the rationale behind the farmers' classification system and its affect on land management.
3. To validate the farmers' classification process with some simple analytical techniques.

Methodology:

***Requirements*:** Photocopy of the revenue map of the field, colour pen and paper, soil testing kits

Steps

1. Select a field around your locality
2. Collect a copy of the revenue map of the field and make a photocopy
3. Meet with the some knowledgeable practicing farmers from the field and explain the purpose in details
4. Ask the farmers about different types of land they have in the field
5. Visit the different types of land and ask them the reasons for differentiation
6. Take a note while visiting each type of land about the land type, soil type, slope, vegetation, nutrient management and irrigation management practices, water table, yield, cost of land, revenue etc.
7. Request the farmers to draw boundary lines of each homogenous type of land in the revenue map.
8. Transfer the map to graph paper for quantification of area under each type of land
9. Make a comparative table for different types of land based on their attributes

Experiment:

- Collect appropriate sample of soil from each type of land
- Assess the pH, electrical conductivity, NP K status of each type of land with the help of soil testing kits
- Compare the results with farmers' classification technique for validation

Conclusion:

- Find out the strength and weaknesses of farmers' classification technique

Relevance:

This project will help the students to understand the farmers' land classification system, and their relevance in land management and it will also promote respect towards the farming community.

Project-3 : Community knowledge on soil and water conservation

Topsoil of land surface is the outcome of weathering process, which encompasses a variety of physical, chemical, and biological processes acting to break down the rock. Topsoil is more vulnerable to erosion by water and wind. High intensity rainfall on the bare soil causes soil detachment and transport of finer particles elsewhere. Ultimately soil is eroded and become unfit for any use, especially agriculture. There are several mechanical and biological measures to check the soil erosion. Mechanical measures like bunding, terracing, stone bunding, check dam involve huge monetary cost, whereas biological measures like strip cropping, cover cropping, grass cover cost less. Cover crops like black gram or sweet potato are grown over the surface soil and are mostly used for smothering the land surface to protect the land from the beating action of rain and to increase infiltration of rainwater by checking the run-off water. *Vetiver* grass is grown across the slope for same purpose. People try number of location specific mechanical and biological measures to conserve the soil

Objectives:

1. To record soil and water conservation practices in your locality practiced over the years
2. To analyse the causes/reasons behind such practices
3. To assess the benefits of such practices followed by the farmers/community

Methodology:

- The children have to survey the locality where the farmers/ people practice soil and water conservation
- Identify the conservation practices against soil erosion and water run off
- Observe the details of practices as mentioned in the table
- Identify some easily measurable parameters by which the efficacy of the practices can be measured

Table: List of practices followed to conserve land and soil

Name of practice	Details of practice	Farmers' logic	Validation with simple innovations
1.			
2.			

Relevance:

This study will provide good information on land and soil conservation practices practiced by the farmers

Additional Project Ideas

1. Scientific study of pottery based products and its potential impact on reduction of non-bio-degradable wastes.
2. Traditional methods of preservation of food items using pottery products, coolers, their economics compared to refrigerators etc.
3. Traditional granaries, pest protection practices using herbs in comparison to chemical methods of pest protection in seeds, their germination % etc.
4. Assessment, study and validation of traditional weather forecasting techniques used by tribal communities and its linkage to sustainable lifestyles.
5. Study of traditional housing in terms of climate adaptability, cultural practices, cost, life of the buildings, maintenance costs, energy efficiency etc.

6. Study of traditional food processing techniques and its comparison to new forms of modern food preservatives, carbon footprints etc.
7. Traditional crop calendars and use of indigenous seeds and cropping systems and their adaptability to pests and diseases, climate and weather extremes like flooding, drought, cyclones etc.
8. Study of sacred groves in relation to sustainability, preservation of biodiversity and eco system services.
9. Traditional water harvesting systems, their sustainability, transfer of knowledge from one generation to another etc.
10. Traditional festivals and their interconnectedness to health, energy, food, weather, agriculture, biodiversity etc.
11. Documentation, Validation of Traditional knowledge practices in your area in differentiation to superstitions/pseudoscience based practices.
12. Peoples' wisdom about utilization of wetlands for commercial purposes.
13. Farmers' indicators about good/bad soil
14. Farmers' concept on multiple cropping (intercropping, mixed cropping, *paira* cropping etc)
15. Community knowledge about biological indicators of soil quality

References:

1. Sacred Ecology: Traditional Ecological Knowledge and Resource Management., Fikret Berkes. Taylor and Francis, Philadelphia. 1999
2. http://www.un.org/en/ga/president/68/pdf/wcip/IASG%20Thematic%20Paper_%20Traditional%20Knowledge%20-%20rev1.pdf
3. Traditional Knowledge and Sustainable Development - DRAFT FOR DISCUSSION, Ashish Kothari, September 2007
4. Posey, D (ed). 1999. *Cultural and Spiritual Values of Biodiversity.* United Nations Environment Programme, Nairobi, and Intermediate Technology Publications, London.
5. Gorjestani, N. 2004. Indigenous knowledge for development: Opportunities and challenges. in Twarog and Kapoor, op. cit.
6. Twarog, S. And Kapoor, P. (Eds.). 2004. *Protecting and Promoting Traditional Knowledge: Systems,National Experiences and International Dimensions.* United Nations Conference on Trade and Development.
7. Berkes, F. and D. Jolly. 2001. Adapting to climate change: social-ecological resilience in a Canadian western Arctic community. Conservation Ecology **5**(2): 18. [online] URL: http://www.consecol.org/vol5/iss2/art18/
8. *ICSU Series on Science for Sustainable Development No. 4, Science, Traditional Knowledge and Sustainable Development*

Sub Theme VIII

Accessibility for children with disability

Sub Theme:
Accessibility for children with disability

Introduction:

Almost 10 percent of the world's population — 650 million people — live with some type of disability. A disability is any physical, sensory, or cognitive impairment that makes daily activities more difficult. Many people are born with a disability. Others acquire a disability later in life, from an accident, an illness, or the aging process. Many older individuals are diagnosed with chronic conditions that lead to functional or cognitive disabilities. Education is one of the most effective ways to break the cycle of discrimination and poverty that children with disabilities and their families often face.

According to the World Report on Disability approximately one hundred crore people in the world are living with a disability, with at least 1 in 10 being children and 80% living in developing countries. India has an alarming statistics of children with disabilities and with an increase order in rural urban ratio. Children with disabilities are one of the most marginalized and excluded groups of children and remain invisible to the mainstream population.

Disability is recognized as one of the least visible yet most potent factors in educational marginalization. Reaching the marginalized, children with disabilities remain one of the main groups being widely excluded from quality education as per the EFA Global Monitoring Report 2010.

The National Children Science Congress programme attempts to take a bold step by inspiring the physically challenged children to participate with their creative and innovative projects along with the mainstream students.

It is essential that the state coordinators and state academic coordinators of each state adapt their methodologies to ensure that all children, irrespective of age, gender and disability, can engage in the NCSC programme without discrimination of any kind. This applies to engagement and enrollment which need changes and new, innovative approaches to fit the specific needs of children with disabilities.

The challenge:

- Between 93 million and 150 million children are estimated to live with disabilities. (GEM Report 2015)
- An estimated 90% of children with disabilities in the developing world do not go to school (UNICEF. Global Initiative on Out-of-School Children)
- Poverty, malnutrition, poor health, illiteracy, and lack of access to proper sanitary conditions or clean water aggravate the consequences of existing disabilities.
- Millions of children with disabilities are left out of education sector plans due to poor data collection and a lack of knowledge on how to include them in education planning and implementation. (UNICEF. Children and Young People with Disabilities Fact Sheet)
- Children with disabilities are often overlooked in humanitarian action and become even more marginalized as fewer resources are available in the midst of an emergency.

How the children with disabilities can be enrolled in NCSC programme?

Children with disabilities enrolled in school but excluded from learning because the curriculum has not been adapted to their needs or teachers do not have the capacity or time to make the needed adaptations, and/or they do not have access to assistive devices necessary for their learning needs.

Example: Children with low vision are unable to see the board without eye glasses.

Children who are not enrolled in school but who could participate if schools had the capacity in terms of knowledge, skills and equipment to respond to their specific needs.

Example: Children with physical disabilities who cannot access the classrooms or children with learning difficulties who may require a slightly different method of teaching or extra hours of instruction.

Children with severe disabilities who require additional specialized support, whether in school or not. This group is relatively small (2-3% of all children with disabilities).

Example: Children with limited speech or communication, children with a need for support in major life activities or children with multiple disabilities.

Towards Inclusive Education

For over a century, the prevalent model for offering education to children with special needs has been the special school. This system had major drawbacks – it is expensive and has only limited reach. Moreover, segregating children based on disability was discriminatory and violation of the human rights. Subsequently, the philosophy of 'integration' emerged which advocated education of children with mild and moderate disabilities in general schools along with others with adequate resource support. But children under integration method were still treated separately in schools and integration or mainstreaming was only partial.

This led to the emergence of the new concept called Inclusive Education (IE) which argues that all children irrespective of the nature and degree of the disability should be educated in general schools with normal children. More and more experts in special needs education are now advocating inclusive education not only on educational grounds but also on social and moral grounds. Inclusive education is all about making classrooms responsive to the needs of the learner. It stresses on child centered pedagogy using peer tutoring, co-operative learning and group learning.

Inclusive education has been introduced in the schools in the project areas of DPEP on a limited scale. Success of IE depends on teachers and good classroom practices. A beginning has been made in this area, but a lot more has to be done. Inclusive education may be the *mantra* to provide education to all children with special needs in the country. Then only the country will be able to achieve the elusive goal of Universal Elementary Education (UEE).

Encouraging children with disabilities for NCSC programme:
Improving access and quality

This Activity Guide Book discusses on how to engage, motivate and provide access and quality for children with disabilities. It gives an overview of the global context, provides best practice case studies and clearly signposts practical tools and resources.

"Ensuring inclusive and equitable quality education and promote lifelong learning opportunities for all" is the Sustainable Development Goals will be impossible without improving access to and quality of education for children with disabilities.

Poverty is both a cause of consequence of disability.

In 1999 the World Bank estimated that people with disabilities may account for as many as one in five of the world's poorest people. A 2005 World Bank study also tentatively concluded that "disability is associated with long-run poverty in the sense that children with disabilities are less likely to acquire the human capital that will allow them to earn higher incomes", but stressed the need for more research in this area. People in developing countries are more likely to be affected by disability caused by communicable, maternal and prenatal diseases and injuries than people in developed countries. These disabilities are largely preventable. Furthermore conflict often occurs in poorer countries which increases the number of people with disabilities and invariably worsens the delivery of basic services which is likely to impact those with disabilities to a greater degree than others.

Educating children with disabilities is a good investment.

It has been reported that by educating and empowering the children with disabilities reduces welfare costs and future dependence. It reduces current dependence and frees other household members from caring responsibilities, allowing them to increase employment or other productive activities. It also increases children's potential productivity and wealth creation which will in turn help to alleviate poverty.

Education can reduce discrimination against children with disabilities and tackle poverty. Education, particularly inclusive education, is able to reduce discrimination through enabling children with and without disabilities to grow up together. Education gives children with disabilities skills to allow them to become positive role models and join the employment market, thereby helping to prevent poverty.

The best way to improve education for children with disabilities is to improve the education sector as a whole. In countries where teachers are untrained, working with large class sizes and few resources in structurally unsafe classrooms, pragmatic context-specific and cost effective decisions are necessary.

Inclusive education is primarily about restructuring school cultures, policies and practices so that they respond to the diversity of students in their locality. It sees individual differences not as problems to be looked, but as opportunities for enriching learning and for education systems to embrace change. It is a dynamic, continuing process of facilitating the participation of all students, including those with disabilities

The between integrated and inclusive education relates to access and quality. Save the Children notes that integrated education tends to focus more on children with disabilities attending school whereas inclusive education focuses more on ensuring children with disabilities are learning. Save the Children argues that inclusive education is about restructuring the cultures, policies and practices in schools so that they respond to the diversity of students in their locality. This means that all children, including children with disabilities, not only have access to schooling within their own community, but that they are provided with appropriate learning opportunities to achieve their full potential. However, it is also essential that parents, children and communities are supported to change their attitudes and understanding of why inclusion matters, as this is what will sustain change.

UNESCO's policy guidelines for inclusion state that in order to move systems towards greater inclusion, there needs to be:

- A recognition of the right of children with disabilities to education and its provision in non-discriminatory ways

- A common vision of education which covers all children of the appropriate age range
- A conviction that schools have a responsibility to meet the diversity of needs of all learners, recognizing that all children can learn.

NCSC and quality of education for children with disabilities

There are a range of interventions which can be explored, examined and experimented as Children Science Congress project and the consequence results and observations could improve the quality of teaching and learning for children with disabilities. The extent to which these can be implemented will be dependent on the overall education context in terms of school resources, teacher training, curriculum development.

For much of history, many people with disabilities have had to rely on technologies that were designed for the nondisabled community. Even technology specifically designed for people with disabilities—such as Braille text for people with a visual impairment or text telephones (TTY) for people with a hearing disability—could require a high learning curve, be limited in availability, or have a high cost because of its specialized nature.

Recently, however, the shift from analog technology to digital technology has eliminated many of these barriers. The reason is simple: digital information can easily be converted into voice, text, or even physical patterns (e.g., Braille), allowing the development of many more low-cost, readily available general purpose devices that also can be used by people with disabilities. The digital era has led to many advances in technology that have directly improved the quality of life for the disabled community. As discussed below, technology that improves accessibility for people with disabilities generally falls into three categories:

- **Assistive technology** (technology designed specifically to improve a disabled person's functional capabilities)

- **Adaptive technology** (technology that provides a mechanism that allows people with disabilities to use technology that would otherwise be inaccessible to them)

- **Accessible technology** (technology that has many broad applications but helps remove barriers and make the world more accessible for people with disabilities)

ANNEXURE - I

What Is an Experiment?

An experiment is a sort of test, designed to evaluate a hypothesis or theory.
ex·per·i·ment /ikˈsperəmənt/- *noun, verb*

Science is concerned with experiments and experimentation, but do you know what exactly an experiment is? Here's a look at what an experiment is... and isn't!

What Is an Experiment?

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

Experiment Basics

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

Take a look at the steps of the scientific method:

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

Types of Experiments

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

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

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

Variables in an Experiment

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

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

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

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

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

Examples of Things That Are *Not* Experiments

- Making a model volcano.
  Making a poster.
  Trying something, just to see what happens. On the other hand, making observations or trying something, after making a prediction about what you expect will happen, is a type of experiment.

Steps of the Scientific Method

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

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

Here are the usual steps of the scientific method.

Scientific Method Step 1: Make Observations - Ask a Question

You may think the hypothesis is the start of the scientific method, but you will have made some observations first, even if they were informal. What you observe leads you to ask a question or identify a problem.

Scientific Method Step 2: Propose a Hypothesis

It's easiest to test the null or no-difference hypothesis because you can prove it to be wrong. It's practically impossible to *prove* a hypothesis is correct.

Scientific Method Step 3: Design an Experiment to Test the Hypothesis

When you design an experiment, you are controlling and measuring variables.

Scientific Method Step: Take and Analyze Data

Record experimental data, present the data in the form of a chart or graph, if applicable. You may perform a statistical analysis of the data.

Scientific Method Step 5: Accept or Reject the Hypothesis

Do you accept or reject the hypothesis? Communicate your conclusion and explain it.

Scientific Method Step 6: Revise the Hypothesis (Rejected) or Draw Conclusions (Accepted)

These steps also are common:

Scientific Method Step 1: Ask a Question

You can ask any question, providing you can devise a way to answer the question! Yes/no questions are common because they are relatively easy to test. You can ask a question where you want to know whether a variable has no effect, greater effect, or lesser effect if you can measure changes in your variable. Try to avoid questions that are qualitative in nature. For example, it's harder to measure whether people like one color more than another, yet you can measure how many cars of a particular color are purchased or what color crayon gets used the most.

Scientific Method Step 2: Make Observations and Conduct Background Research

Scientific Method Step 3: Propose a Hypothesis

Scientific Method Step 4: Design an Experiment to Test the Hypothesis

Scientific Method Step 5: Test the Hypothesis

Scientific Method Step 6: Accept or Reject the Hypothesis

Revise a Rejected Hypothesis (return to step 3) or Draw Conclusions (Accepted)

What Are Examples of a Hypothesis?

A hypothesis is a prediction of what you expect will happen in an experiment.

A hypothesis is an explanation for a set of observations. Here are examples of a scientific hypothesis.

Although you could state a scientific hypothesis in various ways, most hypothesis are either "If, then" statements or else forms of the null hypothesis. The null hypothesis sometimes is called the "no difference" hypothesis. The null hypothesis is good for experimentation because it's simple to disprove.

If you disprove a null hypothesis, that is evidence for a relationship between the variables you are examining. For example:

Examples of the Null Hypothesis

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

Examples of an If, Then Hypothesis

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

Improving a Hypothesis To Make It Testable

While there are many ways to state a hypothesis, you may wish to revise your first hypothesis in order to make it easier to design an experiment to test it. For example, let's say you have a bad breakout the morning after eating a lot of greasy food. You may wonder if there is a correlation between eating greasy food and getting pimples.

You propose a hypothesis:

Eating greasy food causes pimples.

Next you need to design an experiment to test this hypothesis. Let's say you decide to eat greasy food every day for a week and record the effect on your face. Then, as a control, for the next week you'll avoid greasy food and see what happens. Now, this is not a very good experiment because it does not take into account other factors, such as hormone levels, stress, sun exposure, exercise or any number of other variables which might conceivably affect your skin. The problem is that you cannot assign *cause* to your *effect*. If you eat french fries for a week and suffer a breakout, can you definitely say it was the grease in the food that caused it?

Maybe it was the salt. Maybe it was the potato. Maybe it was unrelated to diet. *You can't prove your hypothesis.* It's much easier to disprove a hypothesis. So, let's restate the hypothesis to make it easy to evaluate the data.

Getting pimples is unaffected by eating greasy food.

So, if you eat fatty food every day for a week and suffer breakouts and then don't breakout the week that you avoid greasy food, you can be pretty sure something is up. Can you disprove the hypothesis? Probably not, since it is so hard to assign cause and effect. However, you can make a strong case that there is some relationship between diet and acne.

If your skin stays clear for the entire test, you may decide to accept your hypothesis. Again, you didn't prove or disprove anything, which is fine.

Elements of a Good Hypothesis

Propose a hypothesis you can test in a safe, ethical experiment. Just because you can test a hypothesis on yourself, it doesn't mean you should. Andrew Rich, Getty Images

A hypothesis is an educated guess or prediction of what will happen. In science, a hypothesis proposes a relationship between factors called variables. A good hypothesis

relates an independent variable and a dependent variable. The effect on the dependent variable *depends* on or is determined by what happens when you change the independent variable. While you could consider any prediction of an outcome to be a type of hypothesis, a good hypothesis is one you can test using the scientific method.

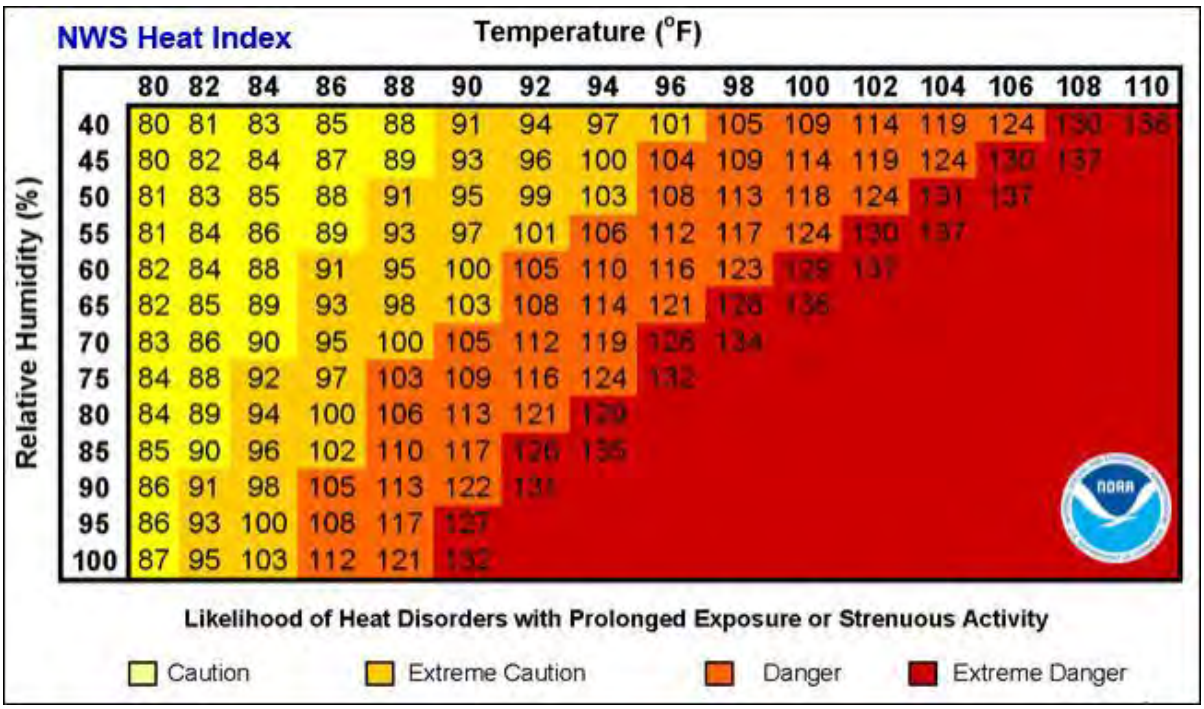
In other words, you want to propose a hypothesis to use as the basis for an experiment.

ANNEXURE – II

HEAT INDEX

The Heat Index is a measure of how hot it really feels when relative humidity is factored in with the actual air temperature. To find the Heat Index temperature, look at the Heat Index Chart above or check our Heat Index Calculator. As an example, if the air temperature is 96°F and the relative humidity is 65%, the heat index--how hot it feels--is 121°F. The red area without numbers indicates extreme danger. The National Weather Service will initiate alert procedures when the Heat Index is expected to exceed 105°-110°F (depending on local climate) for at least 2 consecutive days.

NWS also offers a Heat Index chart for area with high heat but low relative humidity. Since heat index values were devised for shady, light wind conditions, **exposure to full sunshine can increase heat index values by up to 15°F**. Also, strong winds, particularly with very hot, dry air, can be extremely hazardous.



ANNEXURE - III

International Year of Pulses, 2016

The 68th UN General Assembly declared 2016 the International Year of Pulses (IYP), the Food and Agriculture Organization of the United Nations (FAO) has been nominated to facilitate the implementation of the Year in collaboration with Governments, relevant organizations, non-governmental organizations and all other relevant stakeholders. Under the slogan „nutritious seeds for a sustainable future," the United Nations, led by its Food and Agriculture Organization (FAO), launched the IYP 2016 to raise awareness about the protein power and health benefits of all kinds of dried beans and peas, boost their production and trade, and encourage new and smarter uses throughout the food chain.

The IYP 2016 aims to heighten public awareness of the nutritional benefits of pulses as part of sustainable food production aimed towards food security and nutrition. The Year will create a unique opportunity to encourage connections throughout the food chain that would better utilize pulse-based proteins, further global production of pulses, better utilize crop rotations and address the challenges in the trade of pulses. "Pulses are important food crops for the food security of large proportions of populations, particularly in Latin America, Africa and Asia, where pulses are part of traditional diets and often grown by small farmers," said FAO Director-General José Graziano da Silva. "They have been an essential part of the human diet for centuries," he further added, "Yet, their nutritional value is not generally recognized and is frequently under-appreciated."

Pulses are annual leguminous crops yielding between one and 12 grains or seeds of variable size, shape and colour within a pod, used for both food and feed. The term "pulses" is limited to crops harvested solely for dry grain, thereby excluding crops harvested green for food, which are classified as vegetable crops, as well as those crops used mainly for oil extraction and leguminous crops that are used exclusively for sowing purposes (based on the definition of "pulses and derived products" of the Food and Agriculture Organization of the United Nations). Pulse crops such as lentils, beans, peas and chickpeas are a critical part of the general food basket. Pulses are a vital source of plant-based proteins and amino acids for people around the globe and should be eaten as part of a healthy diet to address obesity, as well as to prevent and help manage chronic diseases such as diabetes, coronary conditions and cancer; they are also an important source of plant-based protein for animals. In addition, pulses are leguminous plants that have nitrogen-fixing properties, which can contribute to increasing soil fertility and have a positive impact on the environment.

According to FAO, pulses, including all kinds of dried beans and peas, are not merely cheap and delicious; they are also highly nutritious source of protein and vital micronutrients that can greatly benefit people"s health and livelihoods, particularly in developing countries. There are hundreds of varieties of pulses grown throughout the world. Popular ones include all varieties of dried beans, such as kidney beans, lima beans, butter beans and broad beans. But also chickpeas, cowpeas, black-eyed peas and pigeon peas. Speaking about their nutritional value, the FAO chief said that pulses have double the proteins found in wheat and triple the amount found in rice. They are also rich in micronutrients, amino acids and b-vitamins; Mr. Graziani da Silva underlined, and added that they are vital parts of a healthy diet. FAO also added that as an affordable alternative to more expensive animal-based protein, pulses are ideal for improving diets in poorer parts of the world, where protein sources from milk if often five time more expensive than protein sourced from pulses. Pulses also offer a great potential to lift farmers out of rural poverty, as they can yield two to three

time higher prices than cereals, and their processing provides additional economic opportunities, especially for women.

“The International Year of Pulses 2016 is a great opportunity to raise awareness of the benefits of pulses as the world embarks on efforts to achieve the newly adopted Sustainable Development Goals,” said UN Secretary-General Ban Ki-moon. Mr. Ban added that pluses contribute significantly in addressing hunger, food security, malnutrition, environmental challenges and human health and also are a vital source of plant-based proteins and amino acids. “Despite strong evidence of the health and nutritional benefits of pulses, their consumption of pulses remains low in many developing and developed countries. The International Year can help overcome this lack of knowledge,” said Mr. Ban. Further, he also said that pulses impact the environment positively due to their nitrogen-fixing properties, which increase soil fertility.

“Much work needs to be done to end hunger and provide food security and nutrition for all. One concrete, promising opportunity lies with pulses. Let us join forces to raise awareness of the benefits of pulses,” said the Secretary-General. The UN chief also called for collaborative commitment and concrete action by all relevant actors within the UN system, farmers‟ organizations, civil society and the private sector, to make the IYP 2016 a success.

Unit Conversion Table

LENGTH

Ordinary Units

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

Metric Units

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

Equivalents

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

AREA

Ordinary Units

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

Metric Units

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

Equivalents

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

VOLUME AND CAPACITY

Ordinary Units

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

Metric Units

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

Equivalents

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

WEIGHT (MASS)

Ordinary Units

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

Equivalents

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

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

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

NON-METRIC TO METRIC LINEAR

To Covert	***Multiply by***
inches into centimetres	2.540
inches into metres	2.540 x 10^{-2}
inches into millimetres	25.4
feet into metres	0.3048
yards into metres	0.9144
miles into kilometres	1.609344
miles into metres	1609.344
feet into centimetres	30.48

METRIC TO NON-METRIC LINEAR

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

VELOCITY

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

ANNEXURE –V

Glossary of Terms

(Source: Environment Protection Agency (EPA), 2006)

A

Abiotic
Nonliving. Compare biotic.

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

Acid deposition
A complex chemical and atmospheric process whereby recombined emissions of sulfur and nitrogen compounds are redeposited on earth in wet or dry form. See acid rain.

Acid rain
Rainwater that has an acidity content greater than the postulated natural pH of about 5.6. It is formed when sulfur dioxides and nitrogen oxides, as gases or fine particles in the atmosphere, combine with water vapor and precipitate as sulfuric 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.

Acidic
See acid solution.

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. See methanotrophic, anaerobic.

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. See climate, particulate matter, sulfate aerosols.

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

Air carrier
An operator (e.g., airline) in the commercial system of air transportation consisting of aircraft that hold certificates of, Public Convenience and Necessity,
issued by the Department of Transportation, to conduct scheduled or non-scheduled flights within the country or abroad.

Air pollutant
See air pollution.

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

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

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. See Annex I Parties.

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

Alternative energy
Energy derived from nontraditional sources (e.g., compressed natural gas, solar, hydroelectric, wind).

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

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

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

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

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. See ozone, ozone layer.

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

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

Arable land
Land that can be cultivated to grow crops.

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.

Atmospheric lifetime
See lifetime.

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.

Aviation gasoline
All special grades of gasoline for use in aviation reciprocating engines, as given in the American Society for Testing and Materials (ASTM) specification D 910. Includes all refinery products within the gasoline range that are to be marketed straight or in blends as aviation gasoline without further processing (any refinery operation except mechanical blending). Also included are finished components in the gasoline range, which will be used for blending or compounding into aviation gasoline.

B

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

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. See acid solution, alkalinity.

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. See United Nations Framework Convention on Climate Change, Conference of the Parties.

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. See nonbiodegradable.

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

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

Biological 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. See BOD5.

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

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

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.

Biotic
Living. Living organisms make up the biotic parts of ecosystems. See abiotic.

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

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.

BOD5
The biochemical oxygen demand of wastewater during decomposition occurring over a 5-day period. A measure of the organic content of wastewater. See biological oxygen demand.

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. See ice core.

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

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

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

Carbon dioxide
A colorless, odorless, 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. See global warming.

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

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

See greenhouse gas, global warming potential, carbon equivalent.

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

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

See greenhouse gas, global warming potential, metric ton, carbon dioxide equivalent.

Carbon intensity
The relative amount of carbon emitted per unit of energy or fuels consumed. See energy, energy-efficiency.

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

Carbon sequestration
The uptake and storage of carbon. Trees and plants, for example, absorb carbon dioxide, release the oxygen and store the carbon. Fossil fuels were at one time biomass and continue to store the carbon until burned. See carbon sinks, fossil fuel.

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. See carbon sequestration.

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. See ozone depleting substance.

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 (CCl2F2, 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. See ozone depleting substance, fluorocarbons.

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. See weather.

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

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. See climate, climate change, radiative forcing.

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. See climate, climate change.

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. See General Circulation Model.

Climate modeling
The simulation of the climate using computer-based models. See climate model, General Circulation Model.

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

Climate system (or Earth system)
The atmosphere, the oceans, the biosphere, the cryosphere, and the geosphere, together make up the climate system.

Coal
A black or brownish black solid, combustible substance formed by the partial decomposition of vegetable matter without access to air. The rank of coal, which includes anthracite, bituminous coal, subbituminous 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. See anthracite, bituminous coal, subbituminous coal, lignite.

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.

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

Co-control benefit
The additional benefit derived from an environmental policy that is designed to control one type of pollution, while reducing the emissions of other pollutants as well. For example, a policy to reduce carbon dioxide emissions might reduce the combustion of coal, but when coal combustion is reduced, so too are the emissions of particulates and sulfur dioxide. The benefits associated with reductions in emissions of particulates and sulfur 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.

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. See decomposition.

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. See compost.

Compound
Combination of two or more different chemical elements held together by chemical bonds. See element, inorganic compound, organic compound.

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. 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. See United Nations Framework Convention on Climate Change, Berlin Mandate.

Conifer
See coniferous trees.

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

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. See petroleum.

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. See coniferous trees.

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

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.

Degradable
See biodegradable.

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.

Distillate fuel oil
A general classification for the petroleum fractions produced in conventional distillation operations. Included are products known as No. 1, No. 2, and No. 4 fuel oils and No. 1, No. 2, and No. 4 diesel fuels. Used primarily for space heating, on and off-highway diesel engine fuel (including railroad engine fuel and fuel for agricultural machinery), and electric power generation.

E

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

Ecosystem
The complex system of plant, animal, fungal, and microorganism communities and their associated non-living environment interacting as an ecological unit. Ecosystems have no fixed boundaries; instead their parameters are set to the scientific, management, or policy

question being examined. Depending upon the purpose of analysis, a single lake, a watershed, or an entire region could be considered an ecosystem.

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

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. See compound.

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 interannual fluctuations in the climate.

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

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

Emissions coefficient/factor
A unique value for scaling emissions to activity data in terms of a standard rate of emissions per unit of activity (e.g., grams of carbon dioxide emitted per barrel of fossil fuel consumed).

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

Energy conservation
Reduction or elimination of unnecessary energy use and waste. See energy-efficiency.

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 traveled 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. See greenhouse gas, anthropogenic, greenhouse effect, climate, global warming.

Enhanced oil recovery
Removal of some of the heavy oil left in an oil well after primary and secondary recovery. See primary oil recovery, secondary oil 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.

Ethanol (C_2H_5OH)
Otherwise known as ethyl alcohol, alcohol, or grain spirit. A clear, colorless, flammable oxygenated hydrocarbon with a boiling point of 78.5 degrees Celsius in the anhydrous state. In transportation, ethanol is used as a vehicle fuel by itself (E100), blended with gasoline (E85), or as a gasoline octane enhancer and oxygenate (10 percent concentration).

Evapotranspiration
The loss of water from the soil by evaporation and by transpiration from the plants growing in the soil, which rises with air temperature.

Exponential growth
Growth in which some quantity, such as population size, increases by a constant percentage of the whole during each year or other time period; when the increase in quantity over time is plotted, this type of growth yields a curve shaped like the letter J.

F

Feedback Mechanisms
A mechanism that connects one aspect of a system to another. The connection can be either amplifying (positive feedback) or moderating (negative feedback). See climate feedback.

Feedlot
Confined outdoor or indoor space used to raise hundreds to thousands of domesticated

livestock. See rangeland.

Fertilization
A term used to denote efforts to enhance plant growth by increased application of nitrogen-based fertilizer or increased deposition of nitrates in precipitation.

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

Fertilizer
Substance that adds inorganic or organic plant nutrients to soil and improves its ability to grow crops, trees, or other vegetation. See organic fertilizer, fertilization.

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

Fluidized bed combustion (FBC)
Process for burning coal more efficiently, cleanly, and cheaply. A stream of hot air is used to suspend a mixture of powdered coal and limestone during combustion. About 90 to 98 percent of the sulfur dioxide produced during combustion is removed by reaction with limestone to produce solid calcium sulfate.

Fluorocarbons
Carbon-fluorine compounds that often contain other elements such as hydrogen, chlorine, or bromine. Common fluorocarbons include chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), hydrofluorocarbons (HFCs), and perfluorocarbons (PFCs). See chlorofluorocarbons, hydrochlorofluorocarbons, hydrofluorocarbons, perfluorocarbons, ozone depleting substance.

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. See radiation, infrared radiation, radiative forcing.

Forest
Terrestrial ecosystem (biome) with enough average annual precipitation (at least 76 centimeters or 30 inches) to support growth of various species of trees and smaller forms of vegetation.

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. See coal, petroleum, crude oil, natural gas.

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.

Freon
See chlorofluorocarbons.

Fugitive emissions
Unintended gas leaks from the processing, transmission, and/or transportation of fossil fuels, CFCs from refrigeration leaks, SF6 from electrical power distributor, etc.

G

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

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. See air carrier.

General Circulation Model (GCM)
A global, three-dimensional computer model of the climate system which can be used to simulate human-induced climate change. GCMs are highly complex and they represent the effects of such factors as reflective and absorptive properties of atmospheric water vapor, greenhouse gas concentrations, clouds, annual and daily solar heating, ocean temperatures and ice boundaries. The most recent GCMs include global representations of the atmosphere, oceans, and land surface. See climate modeling.

Geosphere
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 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. See climate change, greenhouse effect, enhanced greenhouse effect, radiative forcing.

Global Warming Potential (GWP)
The index used to translate the level of emissions of various gases into a common measure in order to compare the relative radiative forcing of different gases without directly calculating the changes in atmospheric concentrations. GWPs are calculated as the ratio of the radiative forcing that would result from the emissions of one kilogram of a greenhouse gas to that from emission of one kilogram of carbon dioxide over a period of time (usually 100 years). The chart below shows the original GWPs (assigned in 1990) and the most recent GWPs (assigned in 1996) for the most important greenhouse gases.

GAS	GWP 1990	GWP 1996
Carbon Dioxide	1	1
Methane	22	21
Nitrous Oxide	270	310

HFC-134a	1,200	1,300
HFC-23	10,000	11,700
HFC-152a	150	140
HCF-125	NA*	2,800
PFCs**	5,400	7,850
SF6	NA*	23,900

* Not Applicable. GWP was not yet estimated for this gas.
**This figure is an average GWP for the two PFCs, CF4 and C2F6.

See radiative forcing, carbon equivalent, carbon dioxide equivalent.

Grassland
Terrestrial ecosystem (biome) found in regions where moderate annual average precipitation (25 to 76 centimeters 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 vapor, carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), halogenated fluorocarbons (HCFCs), ozone (O3), perfluorinated carbons (PFCs), and hydrofluorocarbons (HFCs). See carbon dioxide, methane, nitrous oxide, hydrochlorofluorocarbons, ozone, hydrofluorocarbons, perfluorocarbons, sulfur hexafluoride.

H

Halocarbons
Chemicals consisting of carbon, sometimes hydrogen, and either chlorine, fluorine bromine or iodine.

Halons
Compounds, also known as bromofluorocarbons, 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. See ozone depleting substance.

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. See temperature.

Heat content
The amount of heat per unit mass released upon complete combustion.

Higher heating value
Quantity of heat liberated by the complete combustion of a unit volume or weight of a fuel assuming that the produced water vapor is completely condensed and the heat is recovered;

also known as gross calorific value. See lower heating value.

Histosol
Wet organic soils, such as peats and mucks.

Hydrocarbons
Substances containing only hydrogen and carbon. Fossil fuels are made up of hydrocarbons. Some hydrocarbon compounds are major air pollutants. Seefossil fuel.

Hydrochlorofluorocarbons (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. See ozone depleting substance.

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 vapor, condensation, precipitation, and the flow of water from continents to oceans. It is a major factor in determining climate through its influence on surface vegetation, the clouds, snow and ice, and soil moisture. The hydrologic cycle is responsible for 25 to 30 percent of the mid-latitudes' heat transport from the equatorial to polar regions.

Hydropower
Electrical energy produced by falling or flowing water. See hydroelectric power plant.

Hydrosphere
The part of the Earth composed of water including clouds, oceans, seas, ice caps, glaciers, lakes, rivers, underground water supplies, and atmospheric water vapor.

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.

Industrial sector
Construction, manufacturing, agricultural and mining establishments.

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. See radiation,

greenhouse effect, enhanced greenhouse effect, global warming.

Inorganic compound
Combination of two or more elements other than those used to form organic compounds. See organic compound.

Inorganic fertilizer
See synthetic fertilizer.

Intergovernmental Panel on Climate Change (IPCC)
The IPCC was established jointly by the United Nations Environment Programme and the World Meteorological Organization in 1988. The purpose of the IPCC is to assess information in the scientific and technical literature related to all significant components of the issue of climate change. The IPCC draws upon hundreds of the world's expert scientists as authors and thousands as expert reviewers. Leading experts on climate change and environmental, social, and economic sciences from some 60 nations have helped the IPCC to prepare periodic assessments of the scientific underpinnings for understanding global climate change and its consequences. With its capacity for reporting on climate change, its consequences, and the viability of adaptation and mitigation measures, the IPCC is also looked to as the official advisory body to the world's governments on the state of the science of the climate change issue. For example, the IPCC organized the development of internationally accepted methods for conducting national greenhouse gas emission inventories.

Irreversibilities
Changes that, once set in motion, cannot be reversed, at least on human time scales.

J

Jet fuel
Includes both naphtha-type and kerosene-type fuels meeting standards for use in aircraft turbine engines. Although most jet fuel is used in aircraft, some is used for other purposes such as generating electricity.

Joint implementation
Agreements made between two or more nations under the auspices of the *United Nations Framework Convention on Climate Change* to help reduce greenhouse gas emissions.

Joule
The energy required to push with a force of one Newton for one meter.

K

Kerogen
Solid, waxy mixture of rock is heated to high temperatures, the kerogen is vaporized. The vapor is condensed and then sent to a refinery to produce gasoline, heating oil, and other products. See oil shale, shale oil.

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, cookstoves, and water heaters, and suitable for use as an illuminant when burned in wick lamps.

Kyoto Protocol

This is an international agreement struck by 159 nations attending the Third Conference of Parties (COP) to the United Nations Framework Convention on Climate Change (held in December of 1997 in Kyoto Japan) to reduce worldwide emissions of greenhouse gases. If ratified and put into force, individual countries have committed to reduce their greenhouse gas emissions by a specified amount. See United Nations Framework Convention on Climate Change, Conference of the Parties, Berlin Mandate.

L

Landfill
Land waste disposal site in which waste is generally spread in thin layers, compacted, and covered with a fresh layer of soil each day.

Lifetime (Atmospheric)
The lifetime of a greenhouse gas refers to the approximate amount of time it would take for the anthropogenic increment to an atmospheric pollutant concentration to return to its natural level (assuming emissions cease) as a result of either being converted to another chemical compound or being taken out of the atmosphere via a sink. This time depends on the pollutant's sources and sinks as well as its reactivity. The lifetime of a pollutant is often considered in conjunction with the mixing of pollutants in the atmosphere; a long lifetime will allow the pollutant to mix throughout the atmosphere. Average lifetimes can vary from about a week (sulfate aerosols) to more than a century (CFCs, carbon dioxide). See residence time, greenhouse gas.

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. Also referred to as brown coal. See coal.

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
Undecomposed plant residues on the soil surface. See decomposition.

Longwave 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. See infrared radiation.

Low Emission Vehicle (LEV)
A vehicle meeting the low-emission vehicle standards.

Lower heating value
Quantity of heat liberated by the complete combustion of a unit volume or weight of a fuel assuming that the produced water remains as a vapor and the heat of the vapor is not

recovered; also known as net calorific value. See higher heating 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

Manure
Dung and urine of animals that can be used as a form of organic fertilizer. See fertilizer, 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.

Methane (CH_4)
A hydrocarbon that is a greenhouse gas with a global warming potential most recently estimated at 21. Methane is produced through anaerobic (without oxygen) decomposition of waste in landfills, animal digestion, decomposition of animal wastes, production and distribution of natural gas and petroleum, coal production, and incomplete fossil fuel combustion. The atmospheric concentration of methane as been shown to be increasing at a rate of about 0.6 percent per year and the concentration of about 1.7 per million by volume (ppmv) is more than twice its pre-industrial value. However, the rate of increase of methane in the atmosphere may be stabilizing.

Methanol ($CH_{33}OH$)
A colorless poisonous liquid with essentially no odor and little taste. It is the simplest alcohol with a boiling point of 64.7 degrees Celsius. In transportation, methanol is used as a vehicle fuel by itself (M100), or blended with gasoline (M85).

Methanotrophic
Having the biological capacity to oxidize methane to CO_2 and water by metabolism under aerobic conditions. See aerobic.

Methyl bromide (CH_3Br)
An effective pesticide; used to fumigate soil and many agricultural products. Because it contains bromine, it depletes stratospheric ozone when released to the atmosphere. See ozone depleting substance.

Meteorology
The science of weather-related phenomena. See weather, climate.

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. See short ton.

Mineral
Any naturally occurring inorganic substance found in the earth's crust as a crystalline solid.

Model year
Refers to the "sales" model year; for example, vehicles sold during the period from October 1 to the next September 31 is considered one model year.

Molecule
Chemical combination of two or more atoms of the same chemical element (such as O2) or different chemical elements (such as H2O).

Montreal Protocol on Substances that Deplete the Ozone Layer
The Montreal Protocol and its amendments control the phaseout 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. See ozone depleting substance, ozone layer.

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. See hydrocarbons.

Mount Pinatubo
A volcano in the Philippine Islands that erupted in 1991. The eruption of Mount Pinatubo ejected enough particulate and sulfate aerosol matter into the atmosphere to block some of the incoming solar radiation from reaching Earth's atmosphere. This effectively cooled the planet from 1992 to 1994, masking the warming that had been occurring for most of the 1980s and 1990s.

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. See landfill.

N

Naphtha
A generic term applied to a petroleum fraction with an approximate boiling range between 122 and 400 degrees Fahrenheit.

Natural gas
Underground deposits of gases consisting of 50 to 90 percent methane (CH4) and small amounts of heavier gaseous hydrocarbon compounds such as propane (C3H8) and butane (C4H10).

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.

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.

Nonbiodegradable
Substance that cannot be broken down in the environment by natural processess. See biodegradable.

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. See point source.

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. See nuclear energy.

Nuclear energy
Energy released when atomic nuclei undergo a nuclear reaction such as the spontaneous emission of radioactivity, nuclear fission, or nuclear fusion.

O

Oil shale
Underground formation of a fine-grained sedimentary rock containing varying amounts of kerogen, a solid, waxy mixture of hydrocarbon compounds. Heating the rock to high temperatures converts the kerogen to a vapor, which can be condensed to form a slow flowing heavy oil called shale oil. See kerogen, shale oil.

Oil
See crude oil, petroleum, fossil fuel, hydrocarbons.

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, sulfur, phosphorus, chlorine, or fluorine. See inorganic compound.

Organic fertilizer
Organic material such as manure or compost, applied to cropland as a source of plant nutrients.

Oxidize
To chemically transform a substance by combining it with oxygen. See chemical reaction.

Oxygen cycle
Cyclic movement of oxygen in different chemical forms from the environment, to organisms, and then back to the environment.

Ozone (O3)
A colorless gas with a pungent odor, 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. See atmosphere, ultraviolet radiation.

Ozone depleting substance (ODS)
A family of man-made compounds that includes, but are not limited to, chlorofluorocarbons (CFCs), bromofluorocarbons (halons), methyl chloroform, carbon tetrachloride, methyl bromide, and hydrochlorofluorocarbons (HCFCs). These compounds have been shown to deplete stratospheric ozone, and therefore are typically referred to as ODSs. See ozone.

Ozone layer
The layer of gaseous ozone (O3) in the stratosphere that protects life on earth by filtering out harmful ultraviolet radiation from the sun. See stratosphere, ultraviolet radiation.

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. See troposphere.

P

Particulate matter (PM)
Solid particles or liquid droplets suspended or carried in the air (e.g., soot, dust, fumes, mist). See aerosol, sulfate aerosols.

Particulates
See particulate matter.

Parts per billion (ppb)
Number of parts of a chemical found in one billion parts of a particular gas, liquid, or solid mixture. See concentration.

Parts per million (ppm)

Number of parts of a chemical found in one million parts of a particular gas, liquid, or solid. See concentration.

Pentanes plus
A mixture of hydrocarbons, mostly pentanes and heavier fractions, extracted from natural gas. See hydrocarbons.

Perfluorocarbons (PFCs)
A group of human-made chemicals composed of carbon and fluorine only. These chemicals (predominantly CF4 and C2F6) were introduced as alternatives, along with hydrofluorocarbons, 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: CF4 has a global warming potential (GWP) of 6,500 and C2F6 has a GWP of 9,200. See ozone depleting substance.

Petrochemical feedstock
Feedstock derived from petroleum, used principally for the manufacture of chemicals, synthetic rubber, and a variety of plastics. The categories reported are naphtha (endpoint less than 401 degrees Fahrenheit) and other oils (endpoint equal to or greater than 401 degrees Fahrenheit).

Petrochemicals
Chemicals obtained by refining (i.e., distilling) crude oil. They are used as raw materials in the manufacture of most industrial chemicals, fertilizers, pesticides, plastics, synthetic fibers, paints, medicines, and many other products. See crude oil.

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. See crude oil.

Petroleum coke
A residue that is the final product of the condensation process in cracking.

Photosynthesis
Complex process that takes place in living green plant cells. Radiant energy from the sun is used to combine carbon dioxide (CO2) and water (H2O) to produce oxygen (O2) and simple nutrient molecules, such as glucose (C6H12O6). See carbon sequestration.

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.

Point source
A single identifiable source that discharges pollutants into the environment. Examples are smokestack, sewer, ditch, or pipe. See non-point source.

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.

Polyvinyl chloride (PVC)

A polymer of vinyl chloride. It is tasteless, odorless and insoluble in most organic solvents. A member of the family vinyl resin, used in soft flexible films for food packaging and in molded rigid products, such as pipes, fibers, upholstery, and bristles.

Population
Group of individual organisms of the same species living within a defined area.

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.

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. See enhanced oil recovery, secondary oil recovery.

Q

Quad
Quad stands for quadrillion, which is, 10^{15}.

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. See ultraviolet radiation, infrared radiation, solar radiation, longwave radiation, terrestrial radiation.

Radiative Forcing
A change in the balance between incoming solar radiation and outgoing infrared radiation. Without any radiative 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 radiative forcing because incoming solar radiation will exceed outgoing infrared radiation).

Rail
Includes "heavy" and "light" transit rail. Heavy transit rail is characterized by exclusive rights-of-way, multi-car trains, high speed rapid acceleration, sophisticated signaling, 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. See feedlot.

Recycling
Collecting and reprocessing a resource so it can be used again. An example is collecting aluminum cans, melting them down, and using the aluminum to make new cans or other aluminum products.

Reforestation
Replanting of forests on lands that have recently been harvested.

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. See hydropower, photovoltaic.

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. See lifetime.

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 that conform to ASTM Specifications D396 and D975. Included are No. 5, a residual fuel oil of medium viscosity; Navy Special, for use in steam-powered vessels in government service and in shore power plants; and No. 6, which includes Bunker C fuel oil 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. See crude oil, hydrocarbons.

Respiration
The process by which animals use up stored foods (by combustion with oxygen) to produce energy.

S

Secondary oil recovery
Injection of water into an oil well after primary oil recovery to force out some of the remaining thicker crude oil. See enhanced oil recovery, primary oil recovery.

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). See Intergovernmental Panel on Climate Change.

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 kerogen 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. See kerogen, oil shale.

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. See metric ton.

Sink
A reservoir that uptakes a chemical element or compound from another part of its cycle. For example, soil and trees tend to act as natural sinks for carbon.

Sludge
Gooey solid mixture of bacteria and virus laden organic matter, toxic metals, synthetic organic chemicals, and solid chemicals removed from wastewater at a sewage treatment plant.

Soil
Complex mixture of inorganic minerals (i.e., mostly clay, silt, and sand), decaying organic matter, water, air, and living organisms.

Soil 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.

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. See solar radiation.

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. See ultraviolet radiation, infrared radiation, radiation.

Source
Any process or activity that releases a greenhouse gas, an aerosol, or a precursor of a greenhouse gas into the atmosphere. See point source, non-point source.

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.

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, butylene, propane, propylene, etc. Used as a refinery fuel and as a petrochemical feedstock.

Stratosphere
Second layer of the atmosphere, extending from about 19 to 48 kilometers (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. See ozone layer, ultraviolet radiation.

Stratospheric ozone
See ozone layer.

Strip mining
Cutting deep trenches to remove minerals such as coal and phosphate found near the earth's surface in flat or rolling terrain. See surface mining.

Subbituminous coal
A dull, black coal of rank intermediate between lignite and bituminous coal. See coal.

Sulfate aerosols
Particulate matter that consists of compounds of sulfur formed by the interaction of sulfur dioxide and sulfur trioxide with other compounds in the atmosphere. Sulfate aerosols are injected into the atmosphere from the combustion of fossil fuels and the eruption of volcanoes like Mt. Pinatubo. Recent theory suggests that sulfate aerosols may lower the earth's temperature by reflecting away solar radiation (negative radiative forcing). General Circulation Models which incorporate the effects of sulfate aerosols more accurately predict global temperature variations. See particulate matter, aerosol, General Circulation Models.

Sulfur cycle
Cyclic movement of sulfur in different chemical forms from the environment, to organisms, and then back to the environment.

Sulfur dioxide (SO_2)
A compound composed of one sulfur and two oxygen molecules. Sulfur dioxide emitted into the atmosphere through natural and anthropogenic processes is changed in a complex series of chemical reactions in the atmosphere to sulfate aerosols. These aerosols are believed to result in negative radiative forcing (i.e., tending to cool the Earth's surface) and do result in acid deposition (e.g., acid rain). See aerosol, radiative forcing, acid deposition, acid rain.

Sulfur Hexafluoride (SF_6)
A colorless gas soluble in alcohol and ether, slightly soluble in water. A very powerful greenhouse gas used primarily in electrical transmission and distribution systems and as a dielectric in electronics. The global warming potential of SF_6 is 23,900. See Global Warming Potential.

Surface mining
Removal of soil, sub-soil, and other strata and then extracting a mineral deposit found fairly close to the earth's surface. See strip mining.

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. See organic fertilizer.

Synthetic natural gas (SNG)
A manufactured product chemically similar in most respects to natural gas, resulting from the conversion or reforming of petroleum hydrocarbons. It may easily be substituted for, or interchanged with, pipeline quality natural gas.

T

Tailings
Rock and other waste materials removed as impurities when minerals are mined and mineral deposits are processed. These materials are usually dumped on the ground or into ponds.

Tar sand
Swamp-like deposit of a mixture of fine clay, sand, water, and variable amounts of tar-like heavy oil known as bitumen. Bitumen can be extracted from tar sand by heating. It can then be purified and upgraded to synthetic crude oil. See bitumen.

Temperature
Measure of the average speed of motion of the atoms or molecules in a substance or combination of substances at a given moment. See heat.

Terrestrial
Pertaining to land.

Terrestrial radiation
The total infrared radiation emitted by the Earth and its atmosphere in the temperature range of approximately 200 to 300 Kelvin. Terrestrial radiation provides a major part of the potential energy changes necessary to drive the atmospheric wind system and is responsible for maintaining the surface air temperature within limits of livability.

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 vapor, 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.

Transportation sector
Consists of private and public passenger and freight transportation, as well as government transportation, including military operations.

Troposphere
The lowest layer of the atmosphere and contains about 95 percent of the mass of air in the Earth's atmosphere. The troposphere extends from the Earth's surface up to about 10 to 15 kilometers. All weather processes take place in the troposphere. Ozone that is formed in the troposphere plays a significant role in both the greenhouse gas effect and urban smog. See ozone precursors, stratosphere, atmosphere.

Tropospheric ozone (O3)
See ozone.

Tropospheric ozone precursors
See ozone precursors.

U

Ultraviolet radiation (UV)
A portion of the electromagnetic spectrum with wavelengths shorted than visible light. The sun produces UV, which is commonly split into three bands of decreasing wavelength. Shorter wavelength radiation has a greater potential to cause biological damage on living organisms. The longer wavelength ultraviolet band, UVA, is not absorbed by ozone in the

atmosphere. UVB is mostly absorbed by ozone, although some reaches the Earth. The shortest wavelength band, UVC, is completely absorbed by ozone and normal oxygen in the atmosphere.

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. See Conference of the Parties, Berlin Mandate, Kyoto Protocol, Montreal Protocol.

V

Vehicle miles traveled (VMT)
One vehicle traveling the distance of one mile. Thus, total vehicle miles is the total mileage traveled by all vehicles.

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. See non-methane volatile organic compounds.

W

Wastewater
Water that has been used and contains dissolved or suspended waste materials. See sewage treatment.

Water Vapor
The most abundant greenhouse gas; it is the water present in the atmosphere in gaseous form. Water vapor is an important part of the natural greenhouse effect. While humans are not significantly increasing its concentration, it contributes to the enhanced greenhouse effect because the warming influence of greenhouse gases leads to a positive water vapor feedback. In addition to its role as a natural greenhouse gas, water vapor plays an important role in regulating the temperature of the planet because clouds form when excess water vapor in the atmosphere condenses to form ice and water droplets and precipitation. See greenhouse gas.

Waxes
Solid or semisolid materials derived from petroleum distillates or residues. Light-colored, more or less translucent crystalline masses, slightly greasy to the touch, consisting of a mixture of solid hydrocarbons in which the paraffin series predominates. Included are all marketable waxes, whether crude scale or fully refined. Used primarily as industrial coating for surface protection.

Weather

Weather is the specific condition of the atmosphere at a particular place and time. It is measured in terms of such things as wind, temperature, humidity, atmospheric pressure, cloudiness, and precipitation. In most places, weather can change from hour-to-hour, day-to-day, and season-to-season. Climate is the average of weather over time and space. A simple way of remembering the difference is that climate is what you expect (e.g. cold winters) and 'weather' is what you get (e.g. a blizzard). See climate.

Wetland
Land that stays flooded all or part of the year with fresh or salt water.

Wetlands
Areas regularly saturated by surface or groundwater and subsequently characterized by a prevalence of vegetation adapted for life in saturated-soil conditions.

Wood energy
Wood and wood products used as fuel, including roundwood (i.e., cordwood), limbwood, wood chips, bark, sawdust, forest residues, and charcoal.

GLOSSARY
Abiotic: Absence of living organisms.
Agro-ecology: Agro-ecology often incorporates ideas about a more environmentally and socially sensitive approach to agriculture, one that focuses not only on production, but also on the ecological sustainability of the productive system. This implies a number of features about society and production that go well beyond the limits of the agricultural field.
Agro-biodiversity is a fundamental feature of farming systems around the world. It encompasses many types of biological resources tied to agriculture, including:

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

Agri-environmental indicator measures change either in the state of environmental resources used or affected by agriculture, or in farming activities that affect the state of these resources. Examples of sustainable agriculture processes monitored by such indicators are soil quality, water quality, agro-ecosystem, biodiversity, climatic change, farm resource management, and production efficiency.
***Bacillus thuringiensis*(Abbreviation: Bt):** A bacterium that produces a toxin against certain insects, particularly Coloeoptera and Lepidoptera; a major means of insecticide for organic farming. Some of the toxin genes are important for transgenic approaches to crop protection.
Bioaccumulation: A problem that can arise when a stable chemical such as a heavy metal or DDT is introduced into a natural environment. Where there are no agents present able to biodegrade it, its concentration can increase as it passes up the food chain and higher organisms may suffer toxic effects. This phenomenon may be employed beneficially for the removal of toxic metals from wastewater, and for bioremediation. See: biosorbents.
Bioassay : The assessment of a substance's activity on living cells or on organisms. Animals have been used extensively in drug research in bio-assays in the pharmaceutical

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

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

Biocontrol: 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.

Biodegrade: The breakdown by micro-organisms of a compound to simpler chemicals. Materials that are easily biodegraded are colloquially termed biodegradable.

Biodegradable: Capable of being biodegraded.

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

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

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.

Carbon Sequestration: It is the process through which agricultural and forestry practices remove carbon dioxide (CO_2) from the atmosphere. The term 'sinks' is also used to describe agricultural and forestry lands that absorb CO_2, the most important global warming gas emitted by human activities. Agricultural and forestry practices can also release CO_2 and other greenhouse gases to the atmosphere. Sequestration activities can help prevent global climate change by enhancing carbon storage in trees and soils, preserving existing tree and soil carbon, and by reducing emissions of CO_2, methane (CH_4) and nitrous oxide (N_2O).

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**.

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

Ecological Footprint (EF):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.*

Fertile: Capable of breeding and reproduction.
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).
Food Circle is 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.

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.

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.
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 connexion or coordination of parts of the one whole.

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.

Soil-less culture: Growing plants in nutrient solution without soil. Synonym: hydroponics.

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

Reference

Carbon Dioxide Information Analysis Center, website at http://cdiac.esd.ornl.gov, Oak Ridge National Laboratory, U.S. Department of Energy, February 26, 1999.

Cooper's Comprehensive Environmental Desk Reference, Arthur R. Cooper, Sr., Van Nostrand Reinhold: New York, 1996.

Davis, Stacy, *Transportation Energy Data Book*, Oak Ridge National Laboratory, U.S.

Department of Energy, Edition 17, 1997.

Energy Information Administration, *Annual Energy Review 1997*, DOE/EIA-0387(97), U.S. Department of Energy, Washington, DC., July 1998.

Energy Information Administration, *Emissions of Greenhouse Gases in the United States 1997*, DOE/EIA-0573(97), U.S. Department of Energy, Washington, DC. October 1998. [See http://www.eia.doe.gov]

Intergovernmental Panel on Climate Change, *Climate Change 1995: The Science of Climate Change*, Cambridge University Press: New York, 1996

Miller, G. Tyler, Jr., *Living in the Environment, An Introduction to Environment Science*, sixth edition, 1990.

Resources for the Future, Weathervane website, http://www.weathervane.rff.org/glossary/index.html, February 26, 1999.

United Nations Framework Convention on Climate Change. [See http://www.unfccc.de]

U.S. Environmental Protection Agency, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 – 1998*, EPA 236-R-00-001, April 2000.

U.S. Environmental Protection Agency, *Ozone Depletion Glossary*, http://www.epa.gov/ozone/defns.html, February 26, 1999