DRAFT
ACTIVITY GUIDE BOOK FOR NCSC 2011 -2012

***Focal Theme*:**

LAND RESOURCES:
USE FOR PROSPERITY, SAVE FOR POSTERITY

***Sub-Theme*:**

1. **KNOW YOUR LAND**
2. **FUNCTIONS OF LAND**
3. **LAND QUALITY**
4. **ANTHROPOGENIC ACTIVITY ON LAND**
5. **SUSTAINABLE USE OF LAND RESOURCES**
6. **COMMUNITY KNOWLEDGE ON LAND USE**

Coordinators' Note

At the outset we thank Dr.R.N Ray and his team of NCSTC Network and Dr.D.K Pandey of RVPSP/DST, GOI for entrusting us with the task of organizing and conducting the brainstorming workshop for the preparation of activity guide NCSC 2011-12

This year a large number of renowned scientists, professors, researchers and teachers spent their valuable times for a couple of days in the National Brain Storming Workshop held at Kalyani Campus of Bidhan Chandra Krishi Viswavidyalaya, West Bengal as well as exchanged their views and enriched each and every session with their valuable contributions and suggestions. We have no words to express our sincere gratitude to all of the respected persons. We particularly thank the academic and technical staff of Bidhan Chandra Krishi Viswavidyalaya, West Bengal and the university authorities actually who were instrumental in giving the brainstorming session a shape to its desired destination. Rest of the scientists and academics were invited by RVPSP.

The focal theme for NCSC 2011–2012has been unanimously selected as "LAND RESOURCE: USE FOR PROSPERITY, CONSERVE FOR POSTERITY", with six subthemes, *viz.* (i) Know your land, (ii) Functions of land, (iii) Land quality, (iv) Sustainable use of land resources, (v) Anthropogenic activities on land, and (vi) Community knowledge on land use.

This guide book will provide a number of project ideas including few suggested areas of work with a brief background under each sub-theme. In addition, a detailed and informative note on the focal theme has also been included for ready reference. Moreover, a good number of related informations necessary for various types of calculations and measurements have also been incorporated for convenience of both teachers and children at large. The book has been designed in such a way that it can be preserved for ready reference for both privileged and unprivileged children of our country.

This is the first draft after incorporating not only the inputs emerging out of the session, but it has also incorporated the suggestions made by the group leaders after some rethinking and commands forwarded by various participants sent afterwards through e-mail. Cartoons, pictures and other technical instruments will be incorporated later on. However, we put forward the draft to the state coordinators to enable them to prepare for the National Orientation workshop, which will be held later on. We hope that this will also help the state coordinators to make preparations for its transformation into regional languages.

Once more we thank you all with the hope that you will feel free to send your comments and suggestions.

S.S Roy & P.B.Chakraborty

LAND RESOURCES:
USE FOR PROSPERITY, SAVE FOR POSTERITY

The soil is the great connector of lives, the source and destination of all.
-Wendell Berry

The most important natural resource, upon which all human activity is based since time immemorial, is land. Land resource is our basic resource. Throughout history, we have drawn most of our sustenance and much of our fuel, clothing and shelter from the land. It is useful to us as a source of food, as a place to live, work and play. It has different roles. It is a productive economic factor in agriculture, forestry, grazing, fishing and mining. It is considered as a foundation of social prestige and is the basis of wealth and political power. It has many physical forms like mountains, hills, plains, lowlands and valleys. It is characterized by climate from hot to cold and from humid to dry. Similarly, land supports many kinds of vegetation. In a wide sense, land includes soil and topography along with their physical features of a given location. It is in this context that land is defined closely with natural environment. However, it is also regarded as space, situation, and factor of production in economic processes.

India is well endowed with cultivable land which has long been a key factor in the country's socio-economic development. In terms of area, India ranks seventh in the world, while in terms of population it ranks second. With a total area of 328 million hectares, India is one of the big countries. Arable land includes net sown area, current fallow, other fallow and land under trees. Arable land covers a total area of 167 million hectares which is 51% of the total area of the country. However, the land-man ratio is not as favourable as in many other countries like Australia, Canada, Argentina, USA, Chile, Denmark and Mexico.

The physical features in India are diverse and complex. There are mountains, hills, plateaus and plains which produce varied human response to the use of land resources. About 30% of India's surface area is covered by hills and mountains. They are either too steep or too cold for cultivation. About 25% of this land is topographically usable which is scattered across the country. Plateau constitutes 28% of the total surface area but only a quarter of this is fit for cultivation. The plains cover 43% of the total area and nearly 95% of it is suitable for cultivation. Considering the differences in proportion of surface area, this allows us to conclude that taking the country as a whole, about two-third of it is topographically usable. Moreover, soils, topography, moisture and temperature determine the limits of cultivability and quality of the arable lands. As a consequence, half of the surface area is available for cultivation. This proportion is one of the highest in the world scenario.

Man's progress towards development has, however, considerably damaged our land resource base, probably since the dawn of civilisation. Out of the total land area, as many as 175 million hectares suffer from degradation. Land degradation is caused largely by soil erosion, but also by water logging and excessive salinity. The most serious threat to the land is posed by deforestation. Heavy rainfall during monsoon damages the soil too. Steep slopes encourage rapid run-off leading to soil erosion, especially on the southern slopes of the Himalaya and the western slopes of the Western Ghats. In fact, major portion of the Himalayas are prone to landslides and erosion. Wind erosion is prevalent in Rajasthan, gully erosion in the Chambal valley, Chotonagpur, Gujrat, Submontane Punjab Himalaya. Water logging and salinization which constitute the second major threat to soil have already claimed 23 million hectares and threatened many more. Land is also degraded due to mining operations in many parts of the country. The total land area is about 80 thousand hectares under mining. Urban encroachment on agricultural land is another burning problem by which the amount of land used for agriculture is readily declining. In other words, there is a tough competition amongst agriculture, urbanisation and industrial development.

The exponentially growing population in the country has placed immense pressure on the dwindling land resources, endangering the very survival of the biome as a whole. The high degree of degradation of existing land resources, the changing climate and increasing diversion of land from agricultural to non-agricultural uses have aggravated the problem. Consequently, the productivity of land has suffered to a great extent, sometimes beyond repair and per capita arable land is also decreasing with the progress of time. India, being a large agrarian society, has, therefore, an enormous task to meet the growing demands for food, fuel, fiber together with environmental security for its people in the coming years.

Land, the marvelous product of nature, without which no life would survive, is now at stake worldwide. The time has come to sustain it for our sustenance and its bridle must be handed over to our future generation, the children, who will unveil the thousands of wonders above and underneath this creamy layer. They will be amazed with the mystery of various branches of sciences in relation to the land mass on which they are growing and playing day to day. It will also be their prime duty to put into action the knowledge and wisdom acquired by their ancestors as regard various land uses.

For the sake of convenience, the whole aspect of land resources have been addressed in detail under six different sub-themes – (i) Know your land, (ii) Functions of land, (iii) Land quality of, (iv) Anthropogenic activities on land, (v) Sustainable use of land resources, and (vi) Community knowledge on land use.

Finally in the words of Feodor Dostoyevsky I too will say to the budding scientists, in particular, "*Love to throw yourself on the earth and kiss it. Kiss the earth and love it with an unceasing, consuming love*"

Sub- theme:I

KNOW YOUR LAND

We know we belong to the land, and the land we belong to is grand!

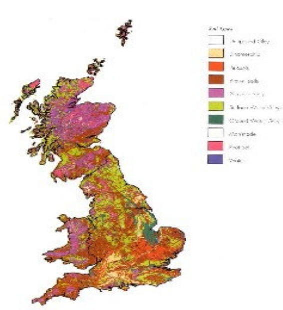
-Oscar Hammerstein

Understanding land resources, its potential, utilization and management of any area reflect the levels of development and standard of living of the locality. Improper use of land due to anthropogenic pressure has created many problems like shrinkage of arable land due to encroachment, decline in fertility due to over use of inorganic fertilizers without soil test information and land degradation. In land resource management approach, spatial distribution of land use, intervention of local and scientific decision support system and control and conservation measures are of primary importance.

Land may be defined as a physical environment consisting of relief, soil, hydrology, climate and vegetation in so far as they are determined by the land use. Value of land depends on its size, location, distance from the market and nature of potential use besides productivity. The sum total of characteristics that distinguish a certain kind of area in the earth's surface in contrast to other kind of areas to give it a distinguishing pattern is a landscape.

Soil is a dynamic natural body developed as a result of pedogenic processes during and after weathering of rocks, consisting of minerals and organic constituents, possessing definite chemical, physical, mineralogical and biological properties having a variable depth over the surface of earth and providing a medium for plant growth. Soils are formed by interaction of many factors, viz., climate, relief, organisms, parent materials and time etc. Soils are derived from their parent materials which are invariably derived from different rocks. There are three main kinds of rocks, viz. igneous rock, Sedimentary rock and metamorphic rock. Rocks are chemically composed of oxides of Si, Al, Fe, Ca, Mg, Mn, K, P etc. Chemical and physical disintegration and decomposition of rocks under different temperature, pressure and moisture condition results in the formation of parent material (C horizon or regolith) over which soil formation takes place. Afterwards both weathering and soil formation processes proceed simultaneously leading further development of soil.

Each soil is characterized by a given sequence of horizons. Combination of this sequence is known as soil profile i.e. a vertical section of the soil through its entire horizon. The layers or horizons in the soil profile which vary in thickness have different morphological characteristics. This includes colour texture, structure, etc. Horizons are generally designated as O (organic), A, E, B, C and R (regolith on which weathering processes act leading to soil formation). Therefore soil profile is taken as unit of study which helps the investigators not only to classify the soils but also to understand soil-moisture-plant-relationship. The soil profile in the



field therefore furnishes a base which has to be supplemented by physical, chemical and biological properties of soils.

Soil mapping

The physical properties of soil are important since this determine the manner in which it can be used either for agriculture, forestry etc., and non agriculture purposes like habitat, recreation site etc. Properties *viz*: infiltration rate, water holding capacity, aeration, plasticity and nutrient supplying ability are influenced by the size, proportion, arrangement and mineral composition of the soil particles. Four major components of soil *viz*. inorganic or mineral particles, organic matter, water and air vary with different regions. Based on soil water plant relation, the soil water may be classified as gravitational water, capillary water, hygroscopic water etc. Water mostly available to plant growth held as capillary water within -15 bars.

Soil chemical properties are mainly due to most reactive part of the soil namely soil colloids consisting of organic and inorganic phases. The organic phase consists of either fresh or decomposed residues of plants, animals, and microbes (fungi, bacteria, actinomycetes etc.) which may remain associated with inorganic phase or may be present in free form.

The life of mankind and almost all the flora and fauna on the earth is continuously influenced by an unending flux of water known as hydrologic cycle. In hydrologic cycle, soil act as a reservoir and water is always in transitory storage in soils. There are two interlocking cycles both starting with evaporation, from sea to atmosphere. The first shorter cycle is from rainfall into the soil and then as evaporation and transpiration back to atmosphere. This is sometimes called green water. The second cycle is blue water follows the longer part from rainfall through soil moisture, ground water and rivers to sea. It may be noted that hydrologic cycle is not always punctual and uniform in delivering precipitation to earth surface.

India is a vast country with a total area of 328.72 million hectare of which approximately 30 per cent is occupied by mountains and hills, 25 per cent by plateau and 45 per cent is occupies by plain valley. Out of the total geographical area forest covers an area of 69.02 m ha, area not available for cultivation 28.48 m ha, other uncultivated land including fallow land 53.38 m ha, cultivable wasteland 13.83 m ha, permanent pasture and grazing land 11.04 m ha, fallow land including current fallow 24.90 m ha, area not available for agriculture, forest etc. 50.19 m ha and net area under cultivation is 189.74 m ha. Out of the total geographical area, around 45 per cent of total geographical area is subjected to degradation problems. The area suffering due to water erosion, wind erosion, water logging, salinity/alkalinity, acidity and other complex problems are 93.6, 9.4, 14.3, 5.9, 16.0 and 7.4 million hectare, respectively.

Physiographically, the country can be put under seven regions, viz., northern mountains including the Himalayas and the mountain ranges in the north-east, Indo-Gangatic plain, Central Highlands, peninsular plateau, East coast, West coast and bordering seas and islands.

India has a diverse geology. Different regions of India contain rocks of various types belonging to different geologic periods. Some of the rocks are severely distorted and transmuted while others are lately deposited alluvium. Great variety of mineral deposits in huge quantity is found in the Indian Geological survey. India's geographical land area can be categorized into Deccan Trap, Gondwana and Vindhyan. The Deccan Trap covering almost the entire state of Maharastra, a part of Gujrat, Karnataka, Madhya and Andhra Pradesh. Indian soils are normally divided into four broad groups. These comprise of alluvial soil, black soil, red soil and laterite soil. Allivial soils are derived from the deposition led by diffirent tributaries of Indus, Ganges and the Brahmaputra system. It includes soils in deltic alluvium, calcarious alluvium and coastal alluvium. It covers 40 per cent of land area. Black soils are dark in colour gently calcarious low in organic matter, high in clay content, high in cation exchange capacity. They are sticky and plastic. It covers about 22.2 per cent of total land area. Red soil of India covers almost all the states. The colour of red soil is due to wide diffusion of iron. These soils are poor in nitrogen, phosphorus and humus. Kaolinitic type of mineral is prevalent in red soil. Laterite soils are highly weathered materials rich in secondary oxides of iron, aluminum or both. It contains large amount of quartz and kaolinite.

The land system of our country is affected by influences of man interventions well as various natural processes. The removal of top soil, deforestation and banned agricultural practices would, many a time, force us to live in environmentally adverse conditions. The environmental degradation of land makes our country stressful situations, which has become concern for us to think over and act for sustainable development. Our future generation is in stake as a result of interference with natural processes causing many situations unfit for our well being and also for the well being of future generation. Therefore, the database on the past and present land use practices will lead us to predict the future pattern of change which will enrich us towards sustainable development

Activity I: Agro-ecological mapping of a locality

Agro-ecological analysis is an important tool for management of farming system at village level. Agro-ecosystem mapping can help improve the location specific recommendation, technology adoption and dissemination based on resource base and socio-economic status of the community. Overlays of land type enterprise and socio-economic parameters highlight interaction for specific resource allocation, in addition to facilitating agriculture based developmental agencies (like social forestry, community development department, etc,) and target groups for implementation of site-specific technology intervention.

Objective:

1. To take stock of resource base of the neighbourhood/village
2. To identify opportunity and constraints for resource base of the area
3. To plan/intervene different developmental programmes of the village in team sprit

Materials required

1. Square data sheet for inventory documentation
2. Primary and secondary data sources from Agriculture offices of block, subdivision and district, panchayat, NGOs, farmers' club etc.

3. Large scale base map of the area

Methodology

1. **Collection of base map**

   Revenue map or village map can be obtained from the district revenue departments/ panchayat office or can be downloaded from Google Earth website.

2. **Map of topography and hydrology:**

   This map is prepared by eliciting every land type that they can distinguished and ascertaining spatial distribution can be a map of roads, homes, orchards and other land marks (temple, tank, etc.) Establishing land type boundaries requires considerable amount of walking around. Farmers can be requested to indicate flood and drainage direction and main water resources.

3. **Map of enterprises**

   This map is prepared by eliciting from farmers what enterprises they conduct or allocate on each land type. Major enterprises are crops, animals, fish, orchards, social forestry, etc. Special attention should be given to agriculture and non-agricultural activities like dwellings, rocky or stony areas, steep land or barren areas, etc.

4. **Map of social groups**

   This map is made by questioning farmers to name the castes or social group that live in the locality. Spatial distribution of houses can be drawn in the map.

5. **Transect of Agro-ecological zones**:

   This is prepared from a composite section through overlays on land type. For each land type local name, soil type, crops trees, livestock, fish, specific opportunities and constraints should be listed from the information collected from the local inhabitants.

   Diagram of a typical transect Profile

LAND TYPE	UPLAND	MIDLAND	LOWLAND
(LOCAL NAME)	(LOCAL NAME	(LOCAL NAME)	(LOCAL NAME)
SOIL	TEXTURE – Alluvial	Alluvium	Alluvium
	Loam	Loam	Silty Loam
	SLOPE- 1-3%	Flat	Flat

HYDROLOGY	Rainfall: avg.1200mm Flood regime nil Duration nil Frequency nil Water table min 1m, max. 10m	avg.1200mm 0.25-0.45 15-20 days 2-3 times / yr. min 0.5 m, max. 7.5 m	avg.1200mm 0.50-0.60 20-30 days 2-3 times / yr. min 0 m, max. 5 m
CROPS & TREES	Big farmers: Rice, Wheat, mango, papaya etc. Small farmers: rice, wheat, sweet potato etc. Orchards: banana (homestead) Share croppers: wheat,maize Teak, Sal, Local species	Crops: wheat,maize,paddy,berseem Crops: wheat,maize,paddy & mung bean -Do-	Crops: paddy,mung bean,wheat, sugar cane Crops: paddy,mung bean,wheat/ fallow (after paddy,) -Do-
LIVESTOCK	Cattle, buffaloes, goats	Goats grazing	Bullock-ploughing
PROBLEMS	All farmers: Seed Big farmers: labour Small farmer: access to irrigation,non availability of grazing lands,plant protection problems	All farmers: Seed Big farmers: labour Small farmer: access to irrigation,non availability of grazing lands,plant protection problems	Seed Poor drainage(preventing planting of Rabi crops after late harvest of paddy) -Do-
OPPORTUNITY	Small farmers: timely supply of inputs(monetary- through credit facilities,improvement of live stock etc.		

Social Relevance

The project will help to gain insight on holistic interaction among the different segments viz., geomorphology, soils, hydrology, flora, fauna and the human population of the area for developing sustainable land use plan based on the existing agro-ecosystem. This knowledge can serve as a model for extrapolation in similar agro-ecosystems. Further, it will also educate on rational and group behavior and focus on constraints and opportunities of the study area.

Activity II: Land use pattern analysis

India covers a land area of 3,287,263 sq km. There are different types of land in India about 54.7% of it is cultivated land. The several types of land available in India are: Agricultural Land, Barren Land, Real Estate Land, Commercial Land, Farm Land and Residential Land. Indian people are mainly employed in Agricultural activities thus agricultural land is almost 54.7% of the total Land Mass. The agricultural lands are located on the outskirts of the Metro Cites. Usually the agricultural land shares space with the Industrial areas outside the city. There are Agricultural lands in almost all the States of India. Agriculture resources considered to be one of the most important renewable and dynamic natural resources. Comprehensive, reliable and timely information on land use pattern of an area would focus on its optimal use and development of an area in viewpoint to food security. A close study of the present land use and utilization patterns and land use history will help to suggest suitable land use plan with the farmers available knowledge.

Important terms :

Cropping pattern: The yearly sequence and special arrangement of crops orcrops and fallow of a given area.

Cropping Intensity : The ratio of gross cropped area to net cultivated area which is multiplied by hundred and represented in percentage.

Cropping intensity = Gross cropped area **/** Net cropped area x 100

Net cropped area : The area under cultivation.

Gross cropped area: The area of net area sown plus the area sown more than once.

Objectives

1. To study the land use pattern of the project area
2. To study the cropping pattern, cropping intensity in different land types.
3. To suggest alternate land use plan for the locality

Requirements

1. Square data sheet for inventory documentation
2. Primary and secondary data sources from Agriculture offices of block, subdivision and district, panchayat, NGOs, farmers' club etc.
3. Large scale base map of the area

Methodology

A. To collect data from primary/ secondary sources for the past few years on the following parameters.

- Total area under study
- Forests
- Area put to non agricultural uses
- Barren and uncultivable land
- Total cultivated area

- Area sown more than once
- Gross cropped area
- Cropping intensity (percentage)
- Irrigated area, if available
- Un-irrigated area
- Percentage of net irrigated area to net cultivated area
- Area under cereals, pulses, oilseeds, fibre crops, horticultural crops and others
- Share of area under different crops.

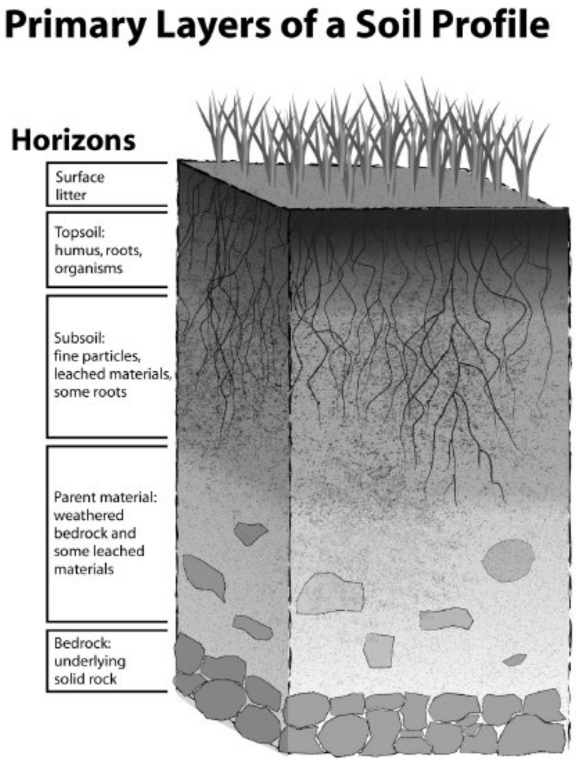
B. Analyze data for variation of present and past last 10 years) land use
C. Suggestion of optimal land use based on farmers needs
D. Graphical representation of change in parameters with time (years).

Relevance

The students can get an insight on the changes occurring in the land use patterns over the years due to a host of biotic and abiotic factors viz., climate change, land degradation, human interference, etc. and will help suggest ways for the planners, administrators and the end users to cope with the changing scenario.

Activity III: Know the vertical distribution of soil layers of your locality

Soils develop over long periods of geologic time and are an important part of the natural environment. Soil is formed by the weathering of rocks, the action of water, wind or ice which carries earth materials and by the living and once-living things (organic matter) that are found in it. As time goes on, soils become deeper and develop distinct layers or **horizons**. A soil profile is a vertical cross-section of the soil and is usually taken to a depth of a meter. Scientists use soil profiles to decide likely uses for soil in an area. The layers or horizons in the soil profile which vary in thickness have different morphological characteristics which includes colour texture, structure, etc. the horizons are generally designated as O, A, E, B, C and R.



Requirements
Spade
Pickaxe
Dagger/knife
Measuring tape
Colour chart
Wash bottle
Sieve set
Sample collection bags
Paper Tags/label
10% HCl solution
Magnifying lens
Agar agar solution

Methodology

Measure 1 square foot (0.9 square meters) of ground within the forested plot/ cultivated land/school ground (Corners can be marked with sticks.) Try to choose a site that closely represents the overall projected plot. For example, if your forest plot is mostly wet and covered with ferns, don't choose a spot that is dry and has no ground cover. Then dig a soil pit of 5 ft x 4ft x 5ft (dimension) taking care to keep the excavated soils on the two sides avoiding the east and west directions. Enter the pit and study the soil vertically. Demarcate the soil layers (if possible the layers may be separated based on differences in morphological properties viz., colour, texture, structure, nature and presence of roots, acid effervescence, etc.). Record physical/morphological properties of different layers standing in the soil pit through visual observation. Collect bulk soil samples (about 500g) from different soil layers starting from the top. Samples are collected in plastic bags and are taken to the school laboratory for air drying, grinding and sieving and stored in labeled bags for further analysis.

Observation

Observations may be recorded in a tabular form as shown below.

Table: Soil profile characteristics

Soil layer	Thickness	Soil colour	Soil structure	Soil texture	Soil porosity	Size of roots	Presence of gravels/stones	Effervescence (using 10% HCl solution)
1								
2								
3								
4								
5								

Other soil properties

Soil moisture: Determine moisture content level from soils at different depth from freshly collected samples. By feeling the soil, you can tell whether the soil is dry, good moisture or saturated soils. The depth of organic matter is an important factor influencing soil moisture. Measure how far the organic matter extends into the soil.

Soil Texture: Characterize soil texture in each soil layer depth as loam, sand, or clay. Use the "Soil Analysis Chart" as a reference.

Examine the soil for other characteristics such as color, smell, and the presence of glacial till and erratic.

Soil Texture Analysis Chart

Soil Type	**Soil Squeezed Dry**	**Soil Squeezed Moist**	**Feel of fingers**
Sand	falls apart when pressure is released	forms a cast (molds when formed) but crumbles when touched	Very gritty
Sandy Loam	forms a cast that will readily fall apart	forms a cast that will bear careful handling without breaking	Moderately gritty
Loam	forms a cast that will bear careful handling	forms a cast that can be handled quite freely without breaking	Powdery flour like

Silt loam	forms a cast that can be handled freely without breaking	forms a good cast that will not form “ribbon” but will give a broken appearance	Powdery flour like
Clay loam	breaks into hard clods or lumps	will form thin “ribbon” that will break readily, barel sustaining its own weight	Very smoot

Soil Microrganisms

Detect microorganisms in the soil by mixing a teaspoon of soil in 500 ml of water, then putting 0.5 ml (about 12 drops) of this diluted mixture on agar in a petri dish. Place the petri dishes in a dark place to incubate at room temperature. After one week, record the number and type of colonies that form on the agar. Compare microorganisms in samples taken at 3 inches (7.5 cm), 6 inches (15 cm), and 1 foot (30 cm).

Soil pH

Measure table spoon of soil from each depth and place into individual petri dishes, or any similar glass or plastic containers. Be sure to label each dish appropriately. Wet each soil sample with 2 table spoon of distilled water. Allow to sit for 3 to 5 minutes. Place one piece of pH paper on each soil sample. (Use pH paper with a range from at least 5-10.) Determine the approximate pH or acid/base level of your soil.

Soil Colour

Measure table spoon of soil from each depth and place into individual petri dishes, or any similar glass or plastic containers. Be sure to label each dish appropriately. Now compare the colour of the soil with the Munshell colour chart (may be collected from Soil/Agriculture department) and note their dominant colours (red,brown,grey,yellow,yellowish red etc.).Moisten the soil with few drops of water and record the moist colour also.

Relevance

The study of soil profile under natural conditions in three dimensions would help students to understand the processes of soil formation under a set of climatic and topographic conditions and depth-wise variation of soil properties.

Activity IV: How does organic component influence different Soil Properties?

Organic material is very important to agriculture. Farmers and gardeners use it to increase the nutrients in their soil. Organic matter retain higher amount of water and in turn supply it to the plants on which they grow. Moreover organic matter may influence various soil properties like soil color, pH, organic-carbon content etc. So by studying soils containing different level of inherent organic material in your soil will provide a relative idea of water availability, soil colour,organic-carbon content, soil pH etc. Organic material also supply nutrients into soil and plants can take both water and nutrient from soil. This assist better plant growth.

Objective

1. To study variation of organic matter content of soils under different land use
2. To determine the water retention capacity of soils under different land use
3. To determine the colour, pH, organic-carbon content of soils under different land use

MATERIALS-

• Spade/ Khurpi
• Colour chart
• Wash bottle
• Sieve set
• Sample collection bags
• Paper Tags/label
• Soil test kit for Organic Carbon
• Perforated container

Methodology

1. Prepare a land use map of your locality
2. Collect representative surface (0-15 cm) soil sample from each land type and land use (for example, forest land, grass land, barren land, steep land, soil under agricultural crops, orchards, etc.). Air dry the samples, grind and pass through 2mm sieve for studying the following parameters.

Water holding capacity

1. Take 500g soil sample in perforated containers. Add the soil slowly followed by tapping so that soil of the container comes to natural compaction
2. Place a plant saucer under each container to collect the leachate.
3. Pour measured volume of water from a measuring cylinder to each container and record the volume of water needed to completely saturated the column. Add approximately 100ml of water additionally to form a thin film of water over the soils of the container.
4. Wait for 12 hours
5. Measure the volume of water collected in the saucer, then substract this from total quantity of water added.
6. Repeat the experiment thrice for soils of each land type/use

Soil Colour

Measure table spoon of soil and place into individual petri dishes, or any similar glass or plastic containers. Be sure to label each dish appropriately. Now compare the colour of the soil with the Munshell colour chart (may be collected from Soil/Agriculture department) and note their dominant colours (red,brown,grey,yellow,yellowish red etc.).Moisten the soil with few drops of water and record the moist colour also. Repeat the experiment thrice for soils of each land type/use.

Soil pH

Measure table spoon of soil and place into individual petri dishes, or any similar glass or plastic containers. Be sure to label each dish appropriately. Wet each soil sample with 2 table spoon of distilled water. Allow to sit for 3 to 5 minutes. Place one piece of pH paper on each soil sample. (Use pH paper with a range from at least 5-10.) Determine the approximate pH or acid/base level of your soil. Repeat the experiment thrice for soils of each land type/use.

Soil Oxidizable Organic-Carbon (**KIT METHOD**)

Take 1 gram of soil in test tube. Add 2 ml of organic carbon reagent I (1N $K_2Cr_2O_7$) and 2 ml of organic carbon reagent II (conc. sulphuric acid) in the test tube. After 15 minutes stay determine the approximate Organic Carbon content of the soil under experiment from the colour chart matching. Repeat the experiment thrice for soils of each land type/use.

Colour	Oxidizable organic Carbon (%)	
Dark green	>0.75	High
Red	0.50 – 0.75	Medium
Orange	< 0.50	Low

Observations

Land use	Agricultural land	Forest land	Grass land

Replication	I	II	III	I	II	III	I	II	III
Observation 1 WHC Soil Colour	…	….	...	…	…	…	…	….	....

Soil pH Organic Carbon			
Observation 2 WHC Soil Colour Soil pH Organic Carbon			
Observation 3 WHC Soil Colour Soil pH Organic Carbon			
Mean value WHC Soil Colour Soil pH Organic Carbon			

Draw inference of the experiment

RESULTS

Water drained from the soil was measured exactly 12 hours after the water was initially added.

Relevance:

The study will throw light on the variation of water retention capacity, colour, pH,Organic Carbon content of soils under different land type and land use and gives an idea of importance of organic matter in controlling the availability of water, regulation of temperature due to colour, soil pH & organic carbon content thus nutrient availabity for plant growth.

Suggested Activity

1. **Knowing water holding capacity of soil of the locality**
2. **Know your land – soil, water and land-scape relationship**
3. **Study of soil profile under different land use**
4. **Fluctuation of water tables in any season of the year of the locality/region**
5. **Distribution & quantification of water bodies for water use planning**
6. **Delineation and characteriziation of local watershed based on topography, drainage network and local knowledge**
7. **Distribution and mapping of important minerals of the region**

Members: Prof. S.S. Sahu, Prof. M.C. Talukdar, Dr. K. Das, Dr. M. De Roy, Mr. A. Chanak

Sub theme: II

FUNCTIONS OF LAND

The only compensation for land is land.

-Winona LaDuke,

Land resources representing largely the soil and water phases contribute significantly to the development and sustenance of various living components in terms of flora and fauna. It is our basic resource alongside air and water. It is one of the marvellous products of nature without which there would be no life. It is a productive economic factor in agriculture, forestry, grazing, fishing, mining and various other industrial and social activities**.** Land systems function through general capabilities of soils that are important for various agricultural, environmental, nature protection, landscape architecture and urban applications.

Soil performs multiple functions starting from providing physical, chemical and biological support for plant growth. It provides habitat for variety of flora and fauna including human. Lives. It acts as natural filter and buffered media against abrupt changes occurring in it. It also acts as a sink of organic carbon and thus global CO_2 flux. It is the platform for manmade structure and perpetuates cultural heritage

The upper thin layer of land surface in the form of thin creamy layer of birthday cake is the most favourable medium for plant growth. Plant anchors and draws nutrients and water from this layer. Soil in this layer performs a number of ecosystem services like storage, decomposition, transformation, and detoxification and thereby provides right soil condition for crop/plant growth. Numbers of biogeochemical cycles like carbon, nitrogen, phosphorus and sulfur cycles are being operated and nutrients are being released for plant and soil organisms and thus biomass production are sustained in the earth.

Drivers, behind the lifeline activities maintaining soil fertility and ecosystem stability, are the frontier soil organisms. It is hard to believe that a single teaspoonful of soil contains over 4 billion micro-organisms, which is more than half of the planet's entire human population!! Can you even begin to imagine how many you would find in a garden, or even your nearest park? Soil is populated by an amazing variety of living creatures, ranging from tiny microbes such as bacteria and fungi to smaller insects such as centipedes, termites, ants, mites and other animals such as worms and larger animals such as moles and rabbits. Many of these organisms have very important functions. For example, certain microbes can break down

resistant organic matter such as lignin, or chemicals such as toxins and pesticides. Others perform a similar process on minerals, thereby releasing nutrients for the plant. Wide rages of soil micro-organisms are responsible for much of the decomposition of organic material in soils. They are usually present in top soils in very large numbers and play an important role in converting more inert forms of nitrogen to ones that can more readily be taken up by plants. Earthworms are another vital species, because they help in the decomposition of organic matter in the soil, as well as improving vital functions such as aeration, water infiltration, and drainage. In fertile soils they can number 2 million per hectare or more!

Soil is the hot-spot of biodiversity. Beneath feet they construct a wonderful world, called “Black Box” by soil ecologist. Each community of this world is working honestly for correcting the soil condition and making soil live so that above ground plant growth is ensured and thus biodiversity is maintained. Thus, belowground diversity influences the nature and makeup of above ground diversity.

Land acts as a reservoir of rich gene pool. But it is amazing to know that till date only 1-10% of total soil microorganisms can be isolated and characterized. So, there is a tremendous potentiality to explore and exploit rest of unknown soil residents for the benefit of human community.

Another amazing feature of soil is the way it acts as a 'filter' against many forms of harmful substances (pollutants).Research by soil scientists has shown that soil can have a major role in the transport of pollutants. Water in soil can transport substances such as nitrate, phosphorus and pesticides to water sources such as rivers, and whilst they are important to soil and plant life, these materials are generally considered harmful to humans and wildlife when they exceed certain quantities. However, land can also modify the impact of pollutants. For example, in wet conditions in the soil nitrate is converted into nitrogen gas, where it can be safely released into the atmosphere. Similarly, pesticides can be broken down into harmless substances by certain micro-organisms present in the soil. Phosphates are mostly filtered naturally during drainage of water as they become tied to soil particles, and are trapped in the soil. Soil is also effective at filtering ‘urban’ pollutants like oil and metals. Oil in particular is an organic substance which soil microbes can break down into carbon dioxide and water. Metals such as lead from petrol however cannot be broken down in such a manner, but the soil can often retain them until they can be absorbed into plants, which can then be disposed of safely. This filtering and buffering capacity of soil also help to sustain the quality of ground water at safe level. Porous soils with good vegetation encourage percolation of surface water, received through rainfall, irrigation or effluent discharge, clean it through filtration and add to good quality ground water. It needs to be emphasized that without this filtering activity of the soil, the quality of ground water might have been deteriorated to such a level that it would have become unsuitable for human population.

It is also one of the biggest reservoirs of organic carbon. Organic matter applied to cultivated land or dumped in low land for land filling is decomposed by soil microorganisms. During their course of decomposition process a portion of organic matter is converted into relatively hardy carbonaceous material resistant to microbial breakdown. Thus, carbon is buried and conserved for longer period. Thereby, CO_2 emission potentiality from that organic matter can be reduced and thus, environment is protected from GHG.

Soils provides a platform for manmade structures like buildings, road, highways, mall, multiplex etc.. It is the platform for civil and engineering works. Soil itself is a raw material for many small-scale industries like pottery, terracotta, tiles, brick etc. However, in many cases we are wasting much of our valuable land resources for various industrial uses. Time has come to assess the magnitude of damage we are causing our land resources through such activities and to find the alternative uses or remedies.

PROJECT I

Title: 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:

1. 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 size:

Sample no.	Type of organism	No. of individual	Remarks

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.
   Abundance = Total no. of individuals of the species in all the sampling units/ No. of sampling units in which the species occurred.
   Relative density = total no. of individuals species x 100/ total no. of individuals in all species.

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, urban, eroded, etc.can be shown. The analysis of results may suggest remedies for eco-restoration of the degraded land.

PROJECT II

Title: **Role of aquatic land system in reducing emission of CO_2**

Introduction:

The country has huge aquatic land resources which exhibit high status of organic matter in the bottom soils due to accumulation of dead tissues of various kinds of aquatic lives and transport of different kinds of organic materials from uplands.. These organic materials may release good amount of CO_2 to the environment. The living organisms in these ecosystems also add to the emission of CO_2 through their respiration. However, these aquatic lands have significant capacity to consume this CO_2 through photosynthesis of the phyto-organisms available in the system (algae, phytoplankton etc) and thus to reduce the magnitude of their release from the land system. The project will deal with the pattern of release of CO_2 in two aquatic land systems and also it's removal due to photosynthesis of various phyto-organisms.

Objectives:
1. To study the magnitude of release of CO_2 in two aquatic land systems.
2. To assess the effect of photosynthesis of soil and water flora on such release.

Methodology:
The study will be carried out in two fish ponds of the locality, one poorly productive and the other well managed. Fortnightly studies will be carried out on water properties of these two ponds.

Observation:

Diurnal variation (05.00, 11.00, 17.00,23.00 pm) on dissolved oxygen, carbon-di-oxide and gross or net primary productivity of water will be studied for three months.

Analysis:
CO_2: Acid- alkali titration.
Gross and net primary productivity to be calculated from
Dissolved oxygen values of water using light and dark bottle method.

Dissolved oxyzen: iodometric titration method.
Reagents:
- i) Manganous sulphate:Dissolve 120 g $MnSO_4,4H_2O$ in 250 ml distilled water by heating, if necessary.
- ii) Alkaline iodide: Dissolve 125 g sodium hydroxide and 37.5 g potassium iodide in 250 ml distilled water.
- iii) 0.025 N $Na_2S_2O_3$:Prepare a stock solution of 1 N $Na_2S_2O_3$ solution by dissolving 12.41 g $Na_2S_2O_3,5H_2O$ in 1 lit. distilled water. Dilute part of this stock solution to prepare 0.025 N $Na_2S_2O_3$ solution.
- iv) Starch indicator: Dissolve 1 g starch in 50 ml distilled water, warm at 80-90^{0}C, add 0.1 g salicylic acid as preservative.

Collect water sample in a 100ml bottle. Add 1ml each of $MnSo_4$ and KI .Close the bottle and invert it a few times to ensure thorough mixing of the water with the reagents. This will result in development of a flocculent precipitation which will gradually settle in the bottom. Add 1ml of conc. H_2SO_4 and invert the stoppered bottle a few times to dissolve the precipitate. Take 50 ml of the solution to a 250 ml conical flask and titrate with freshly prepared 0.025 N $Na_2S_2O_3$ till the colour of the solution turns fade. Add 0.5 ml of starch indicator to from blue colour and continue the titration carefully. At the end point, the blue colour will suddenly change to colour-less.
Concentration of dissolved oxygen in water sample (mg/litre) =ml. of 0.025N $Na_2S_2O_3$ used for titration x 4.

Determination of gross and net primary productivity (rate of photosynthesis) in water:

Take in water sample cautiously as well as uniformly in three bottles(initial, light and dark) from the desired depth of water. Add 1ml of manganous sulfate and alkaline iodide each in the initial bottle. Invert the stoppered bottle a few times. Take the other two bottles and dip them in the water under the depth from which water samples were collected. Incubate the water sample under water for some period which should not normally be less than 3hrs. After expiry of the time, take up both of the bottles and determine oxygen as stated before.

Calculation for gross and net primary productivity (GPP and NPP):

$$GPP = \frac{LB - DB}{T} \times \frac{0.375h}{1.2} \times 1000 \text{ mg } Cm^{-3}h^{-1}$$

$$NPP = \frac{LB - IB}{T} \times \frac{0.375}{1.2} \times 1000 \text{ mg } Cm^{-3}h^{-1}$$

Where---

LB	=	DO (ppm) in light bottle
DB	=	DO (ppm) in dark bottle
IB	=	DO (ppm) in initial bottle
T	=	Time (h) of incubation
0.375	=	ratio of the weight of C and O
1.2	=	Photosynthetic co-efficient.

Relevance:
Huge amount of CO_2 is being released from different aquatic land systems of the country. The study will indicate how much of these CO_2 may be retained in the pond environment through photosynthesis. This will also help them to understand how aquatic ecosystem reduce CO_2 load from the environment.

PROJECT III

Land is a site for waste disposal

Introduction:
Landsite is the first choice to dump the entire nuisance starting from farm wastes to nuclear wastes thus polluting the soil. Fortunately, soil has its own regulatory system and thereby surmounts all sorts of tortures imposed by anthropogenic activities either by decomposition or by transformation and so on by its living regiment. Thus, soil environment is protected and the sustenance of the planet earth is being ensured.

Objective:

1. To make understand how does soil digest/dispose waste materials?

Materials:
1. Filter paper -What man No.41/42
2. Flat iron rod
3. Brush to remove soil adhering to filter paper strip
4. balance

Methodology:
1. Take filter paper strip of 2 cm width (What man No.41/42) and weigh it
2. Insert an flat iron rod of 3 cm width into three different soils (collected from three different sites) in slanting way to create a slanting dug
3. Incorporate the pre-weighted filter paper strip into the dug
4. Fill up the dug with soil
5. Maintain the moisture of soil by periodic application of water
6. Keep the strip for 30 days
7. Remove the strip after 30 days very carefully
8. Remove soil adhering to filter paper strip
9. Weigh the strip

Observations:

Weight of filter paper strip during insertion into dug	Weight of filter paper strip after removing from the dug	Loss of weight of filter paper strip	Remarks

Relevance:

Results of such study will help the students to understand the capacity of soil to clear all the nuisance done in soil. This also makes them understand how does soil sustain time immemorial. This result will be valuable for the city planner to select dumping site for waste disposal.

Similar studies may be carried out with other materials like vegetable wastes by using nylon bag technique.

PROJECT-IV

Use of soil for brick preparation

Introduction:

Soil has multifaceted functions. In addition to its usual functions like promotion of plant growth, retention of water, transformation of nutrients, soil has industrial use where soil is a raw material for example, pottery. Manufacturing of brick is one of the potential soil-based industries where huge amount of good quality soil is utilized as raw material. Brick-field owner has their own perception about soil quality upon which they select soil for brick manufacturing. With this background a model project is suggested for the children to make them understand how we are using huge amount of good quality soil for brick preparation.

Objectives

1. To study the relationship between some soil properties and brick quality

Methodology

Soil samples to be collected from different brick fields and analysed for texture, pH and OC

Secondary data on brick quality of different brick field will be collected

Student will ask the brickfield owners the quality parameters of soil they generally prefer

Correlation will be studied on the influence of soil properties with brick quality.

Observation

No. Of Brick-field	Soil properties			Brick quality			Remarks
	Organic-C	Texture	pH	A-Grade	B-Grade	C-Grade	

Relevance:

Performing this study a student can realize the possibility of using the soils in industry and how quality of raw materials influence end product quality. The magnitude of large scale destruction of good quality of soil through other purposes can also be assessed.

PROJECT-V

SOIL IS A BUFFERED MEDIUM

Introduction:

Soil has considerable buffering capacity. It helps to overcome the problems associated with various acidic or alkaline inputs which are freque 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

Methodology:

Study will carried out using soil-column preparing in waste plastic drinking water bottle

Artificially prepared acidic solution (pH arround 5.0) will be used

Diff. Amount of acidic solution of same pH will be added to different soil column and the pH of soils as well as filtrate will be analysed after stabilization of pH

Different levels of OM (FYM) will be added to soils and similar study will be carried as stated earlier

Observation

Variation in pH in soils with or without OM 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 in such function of soil.

Suggested Projects:

1. **Discover Earthworm's habitat**
2. **Habitat disruption by androgenic activities**
3. **Restoration of microhabitat**
4. **Evaluation of plant biodiversity and preparation of herbarium**
5. **Exploring termite mould**
6. **Earthworm as a bio-indicator**

Members: Dr.G.N.Chattopadhyay, Dr.Niharendu Saha, Dr.G.C.Hazra, Dr. Chaitali Mukherjee Dr. Ipsa Bandyopadhyay

Sub-Theme- III

LAND QUALITY

Our land resources perform various functions like providing base for vegetation, water bodies, habitat for human, animals, birds and other organisms; producing food and fibre; maintaining or enhancing water quality; partitioning water flow and sequestering carbon. Land quality is defined as the capability of land to perform these functions without becoming degraded. Majority of these functions of land are, however, determined by the quality of soil. Maintaining and improving the quality of the Nation's soils can increase farm productivity, minimize use of nutrients and pesticides, improve water and air quality, and help store greenhouse gases.

Soil quality is defined as the continued capacity of soil to function as a vital living system, within ecosystem and land-use boundaries, to sustain biological productivity, promote the quality of air and water environments and maintain plant, animal and human health. In short, soil quality can be defined as the "fitness for use" or "Capacity of the soil to function".

There are several interacting processes occurring among the components of soil as well as with atmosphere. Soil is the storehouse of major, secondary and micronutrients required for plant growth and also for growth of soil micro-flora and fauna. Through different chemical, biochemical and microbial processes, these nutrient elements are released slowly as per the requirement of plant and other organisms. Plant is incapable to take up nitrogen directly from atmosphere even though it contains about 77% nitrogen. Some of the bacteria living in soil fix atmospheric nitrogen to make it available for higher plants. Similarly, soil contains significant amount of phosphorus, but in unavailable form. Various chemical and biochemical processes (mediated by phosphorus solubilizing bacteria) make this nutrient available to plant. Thus status of various nutrient cycling processes indicate the health status of soil.

Soils of the land area perform filtering action for water and therefore, its capacity to filter determines the quality of surface and ground water bodies. Concentration of carbon dioxide has been constantly increasing due to its emission from burning of fossil fuel, deforestation and large scale disturbance for urbanization. Soils also act as a sink for carbon. The vegetation including forests and agricultural crops fixes atmospheric carbon in leaves, shoots and roots through photosynthesis. These carbonaceous materials are temporarily locked in the soil profile on its decay and thereby help in reducing carbon-di-oxide concentration in the atmosphere and global warming. However, soils differ in such carbon storing capacity (Carbon sequestration) depending on their characteristics. Soils of the land also act as a sink for several toxic pollutants generated due to anthropogenic activities. Metals play an important role in our daily life. To meet out increasing demands, metals are continuously mined out from deeper layers of earth crust. After serving human purposes, these metals are ultimately disposed on the land surfaces in the form of industrial effluents, solid wastes etc. Each soil has a definite tolerable limit (loading limit) for pollutants. Once these limits exceeded, pollutants contaminate food chain and ground water bodies, affect adversely the plant growth and soil biota.

Thus the land care and soil quality management assume great significance for ensuring agricultural sustainability which is inevitable to feed the burgeoning population not only in India but across the world. In order to evaluate land quality, we need to identify the key attributes represent the health of land.

Indicators to assess land quality

Land use

Land use is an indicator reflecting how and to what extent society is responding to meet its changing needs and goals or to adapt to changing environmental conditions. Ideally, it is recommended that our geographical land area should have 33% forest cover. However due to increase in demographic pressure, the area under forests and agriculture is reducing continuously; consequently, area under dwellings and industry is increasing. Over the years, such interference of anthropogenic activities is considered as the major cause of land degradation. About 85 million ha of agricultural land are reported to be suffering from various degrees of soil degradation processes such as erosion, salinization, alkalization, water logging, desertification, loss of organic matter, loss of nutrients, soil compaction, entry of toxic pollutants etc.

About 45% of total geographical area of our country is affected by various kind of land degradation. In these degraded land area, erosion of soil caused by water flow contributes maximum to the degradation processes (about 63%) followed by acidification (about 11%), water logging (about 10%), erosion of soil by wind (about 6%) and salinization of soil (about 4%).

Information on aspects such as nature and density of vegetation or nature and productivity of crops; conditions of the land surface (slope, runoff, erosion rates and salinity); hydrological conditions (flooding incidence, groundwater dynamics); and physical, biological and chemical conditions (toxins, nutrients) of the soil helps in explaining various degradation processes. Such monitoring information, superimposed on a baseline soils and terrain database, will allow the estimation of potential productivity changes of land under different main uses and of suitability changes for different purposes such as conservation of native vegetation or animal populations.

Soil Quality

Since all agricultural activities are directly or indirectly, affected by how the “soil is handled”, its health becomes the prime concern before one can address human and livestock health issues. Managing soil is a formidable challenge to ensure productivity, profitability and national food security. Soil quality can be assessed by a number of physical, chemical and biological attributes / processes. Relevance of one or more unfavourable soils conditions for long periods leads to un-sustainability of agricultural system. Major issues of soil quality include:

i) *Physical degradation* – where, physical properties of soil such as bulk density, structure, water holding capacity, depth etc. are changed un-favorably. Physical degradation of soil are caused by compaction due to use of heavy machinery like combined harvester, tractor, laser leveller, intensive cultivation, puddling, water logging and soil erosion.

ii) *Chemical degradation* – where chemical properties like pH, electrical conductivity, soil organic matter content, available plant nutrient status, base saturation, cation exchange capacity, phosphate fixing capacity etc. are affected resulting in decline in soil fertility. Chemical degradation is caused by wide nutrient gap between nutrient demand and supply, imbalanced use of fertilizers, emerging deficiencies of secondary and micronutrients, limited / no use of organic manures, acidification and aluminium toxicity in acid soils, salinity and alkalinity. While salinity problems are often associated with irrigation, salinity problems can also occur in dry land areas where rainfall is insufficient to leach salts from the soil.

iii) *Biological degradation of soil* – where biologically mediated soil processes like nitrogen fixation, phosphate solubilisation, nutrient mineralization etc are affected. Biological degradation due to organic matter depletion caused by rise in soil temperature, loss of biodiversity due to agricultural chemicals like herbicides, pesticides, fertilizers etc. Biological degradation is perhaps the most serious form of soil degradation because it affects the life of the soil and soil may not be able to cycle nutrients and transform harmful chemicals or substances to nontoxic waste or to combat plant pests and diseases. The microbial community is continually adapting to the environment, and can function as indicators of changes in soil quality.

iv) *Soil pollution* from industrial wastes, excessive use of pesticides and heavy metal contamination resulting in deterioration of water and crop produce quality.

Remedial measures:

Remedial / corrective measures for degraded land could start after identifying the constraints. These can be broadly categorized as following:

Changes in land use pattern: Cultivation of crops having profuse foliage and cover can control soil erosion during rainy season. Plantation of trees and developing grassland with profuse deep root system on the barren and degraded land minimizes soil erosion and prevents degradation of water quality.

Modifying soil conditions by applying amendments: Management of acid soils should aim at raising pH through application of lime which improves nutrient availability and inactivated iron, manganese and aluminium toxicity. Alkali soils can be reclaimed by applying gypsum, which lowers down the pH and exchangeable sodium.

Salinity in the soil can be reduced by leaching down the salt with good quality of irrigation water. Sub-surface drainage technology can mitigate the twin problems of soil salinity and water logging. Growing green manures and addition of organic manures such as farmyard manure and compost improve soil properties.

Avoiding setting up of industries on a land with low fixing capacity for pollutants can prevent contamination of food chain and water bodies and protect crops, soil micro-flora and fauna.

Project 1: Determining maximum loading limit for copper in agricultural land

Introduction:

Copper is used for various purposes like utensils, electric wiring, fungicides etc. Repeated application of copper containing fungicides for long time, particularly in orchards has been found to enhance copper concentration to a toxic level. This element is known to have significant adverse effect on plant growth and soil beneficial microorganisms. Excessive copper can make people ill when ingested. Copper toxicity in humans takes the form of stomach upset, nausea, and diarrhea. Generally, metals are strongly immobilized (or inactivated) by soil constituents and thereby, their toxic effects are not expressed. However, each soil has a definite metal immobilizing capacity, depending on their characteristics; which is therefore, considered as an important soil quality indicator. Once, this immobilizing capacity limit (commonly known as, loading limit) is exceeded, metals start showing their toxicity effect and have potential to contaminate food and groundwater. Through this activity, children can estimate the loading limits of metal for the land area nearby their locality.

Objectives:

1. To estimate the loading limit of copper for a land
2. To understand symptoms of copper toxicity in spinach plant
3. To compare clayey soil and sandy soil for loading limit of copper

Materials required:

Pots of uniform sizes (4 – 5 litre capacity), spinach seeds, balance, wooden log, copper sulphate, data sheet, pencil

Methodology:

1. Collect about two bags of soil each from a cultivated land (preferably clayey or any heavy textured soil) and a sandy soil (or any light textured soil) from a river bank
2. Dry the soils under sun
3. Pulverize the soils with wooden log
4. Fill 10 pots with 3 kg of same type of soil. Apply graded doses of copper sulphate (ranging from 80 to 1200 mg/kg). So there will be a total of 20 pots.
5. Add sufficient amount of water to moisten the soil and keep the pots in shade for 3 days.

6. Mix the soil of the pot thoroughly on a polythene sheet and then refill the pot
7. Sow 15 to 20 seeds of spinach on each pot and apply water slowly with sprinkler to moisten the soil.
8. After a week of germination of seeds, keep only 5 seedlings and remove the rests.
9. Observe the seedlings growth and note down the yellowing of leaves if they appear.
10. The preceding dose of copper application where toxicity symptoms appears on the spinach plant is considered as maximum loading capacity of the soil
11. Compare the loading limits of these two soils and explain the reasons for the difference.

Relevance:

Knowledge on metal loading limits will help in decision making by policy makers for giving permission for new industries known to generate metal containing effluents and also for deciding upon waste disposal sites so that the metal does not contaminate food and water.

Project 2: Evaluation of groundwater for domestic and agricultural purposes

Introduction:

Ground water is being widely used in many parts of the country for drinking and irrigation purpose. However, there are reports of falling water quality from different states. The drought affected areas still depending on groundwater are facing serious problem. In many parts of the country, gypsum is used effectively in reducing the sodicity problem. Increasing concentration of salts due to heavy use of fertilizers over years is common. This project proposes to identify the problem and make student aware of its remedial measures.
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Objectives:

1. To gather information about change in ground water quality over a period of time
2. To examine the quality of ground water
3. To suggest remedial measures based on water quality

Methodology:

Project data base can be collected by using a questionnaire. Information can also be collected from local government organizations like ground water department. Questionnaire should include name, locality, source of ground water, level of ground water depth, color, taste, no of families using water and area under irrigation. Students can collect water samples and analyse for their physico-chemical properties like pH, EC, salinity, alkalinity using soil test kit. Finally water quality can be assessed,

Relevance:

Based on quality, salinity and alkalinity of the water can be grouped and probable reclamation measures can be suggested. Reclamation practices like placing gypsum at canal entry level or passing water through gypsum bed can be demonstrated.

Project 3: Suitability of soils for growing crops

Introduction:

Soil reaction (pH) indicates whether a soil is acidic, neutral or alkaline. A pH range of 6.5 to 7.5 is ideal for availability of most of the nutrients to plant. High pH of soil is due to the saturation of sodium which is responsible for deterioration of physical condition of the soil. Electrical conductivity (EC) of the soils indicates total soluble salt content of the soil. If the salt content in soil is above the permissible limit, then plants find it difficult to absorb nutrient and water from soil, thus their growth is poor. Therefore, measure of pH and EC of the soil gives an indication about chemical environment of soil around plant root zone.

Objectives:
1. To provide an idea about the suitability of soil for crop production.
2. To suggest corrective measures to improve soil quality.

Methodology:
- Visit your area and locate different types of the soils
- Collect a representative soil samples from each area
- Put the identification number to all the soil samples
- After drying, grind and sieve the soil samples
- Take a beaker of 50 ml and put about 10 g of soil sample in it
- Add about 25 ml of distilled water and keep it for 30 mts with intermittent shaking using glass rod
- Measure the pH of soil by using pH meter
- Measure EC in the same suspension by EC meter
- Record the reading of pH and EC of all the soil samples and interpret the results.

Interpretation

Soil Reaction (pH)

pH	***Interpretation***	***Recommendation***
< 5.5	Acidic	Requires addition of lime
5.5-6.5	Slightly acidic	Requires careful management
6.5-7.5	Neutral	Good for all crops
7.5-8.5	Slightly alkaline	Requires careful management
>8.5	Alkali soil	Requires addition of Gypsum

Electrical Conductivity

EC (dS/m)	*Interpretation*	*Recommendation*
< 1	Normal	Good for all the crops
1 – 2	Slightly saline	Injurious for germination
2 – 4	Moderately saline	Injurious for sensitive crops
> 4	Highly saline	Injurious for all crops

Relevance:

The proposed project could be easily carried out by students using simple tool. It will give an understanding about why some soil found in their locality is productive and some are not. They will be able to understand about the problems of their soil and could broadly sensitize the farming community to adopt the corrective measures like addition of lime and gypsum. This will have an overall impact on increase in soil productivity and a message to farmers how to care about their soils.

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 on the top of 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.

Additional project ideas:

1. How to prepare a soil health card?
2. How to reclaim saline and sodic soil?
3. How to minimize fluoride and nitrate toxicity in drinking water?
4. Organic farming for improving soil quality and food quality
5. Soil : source and sink of carbon.
6. Diagnosis of acid, saline and alkali soils for their better management
7. Evaluation of soil biological activity for assessing soil quality
8. Minimizing heavy metal pollution for protecting soil quality
9. Arsenic contamination in ground water
10. Influence of management practices on land quality
11. Recycling of industrial wastes for Agricultural use
12. Soil microbial population – Key to soil health
13. Waste disposal management and land quality
14. Balanced fertilization improves/maintains soil quality and enhances crop productivity
15. Soil pH and nutrient availability to crop
16. How soil quality affect human health
17. Pesticide effects on land quality
18. How pollutants affect soil biota?

19. Strategies / ways to improve soil organic matter
20. Eco-friendly compositing of agricultural wastes
21. Eco-friendly farming
22. Soil as a natural filter
23. Suitability of soils for growing crops
24. Evaluation of groundwater for domestic and agricultural purposes
25. Determining maximum loading limit for copper in agricultural land

Group Members:

Dr. J.K Saha, Dr. T.R. Rupa, Dr. G.V. Lakshmi, Dr. S.K. Singh, Dr. Tapan Adhikari, Mr. Nirmalendu Basak,

Sub-theme - IV

Anthropogenic activities on land

There is a sufficiency in the world for man's need but not for man's greed.
~Mohandas K. Gandhi

Anthropogenic (Greek word, meaning manmade) effects, processes or materials are those which are derived from human activities. Since all agricultural activities are directly or indirectly, affected by how the "soil is handled", its health becomes the prime concern before one can address human and livestock health issues. Managing soil is a formidable challenge to ensure productivity, profitability and national food security. Soil quality can be assessed by a number of physical, chemical and biological attributes / processes. Relevance of one or more unfavourable soils conditions for long periods leads to un-sustainability of agricultural system. Major effects of anthropogenic activities on land resources are summarized below:

***Land degradation*:** Land degradation, defined as lowering and losing of soil functions, is becoming more and more serious worldwide in recent days, and poses a threat to agricultural production and terrestrial ecosystem. Land degradation includes loss of top soil, physical changes like damage of soil structure (compaction), chemical changes like salinization, sodification, acidification, deposition of heavy metals and an overall declination of fertility and productivity of soil. It is estimated that nearly 2 billion ha of soil resources in the world have been degraded which includes approximately 22% of the total cropland, pasture, forest, and woodland. Though climatic and geogenic processes are major driving forces for land degradation, the impact of anthropogenic factors can not be overruled particularly when local situations are taken into consideration. Among the anthropogenic processes, agriculture, industrialization and urbanization all contribute significantly.

Agricultural activities like tillage disintegrates soil structure, causes organic matter depletion encourages soil erosion and nutrient loss. However, tillage practices improve soil air and modify temperatures for seed germinations and microbial activities. Heavy traffic load of tillage implements causes soil compaction. Over irrigation and application of poor quality of irrigation water lead to problems like water logging and soil salinization. Injudicious application of chemical fertilizers of nitrogen and phosphorus fertilizers and the concentration of livestock and their manures within small areas, have not only causes chemical degradation of agricultural land but also substantially increased the pollution of surface water by runoff and groundwater by leaching of excess nitrogen (as nitrate). Other agricultural chemicals like herbicides and pesticides causes contamination of surface as well as ground water.

The industrial wastes contribute largely to the chemical degradation of the valuable land resources. Improper waste management renders the surrounding areas vulnerable to heavy metal deposition in soil, water bodies, rivers as well as ground water. Rapid urbanization also aggravates the problem of land degradation still further.

Severe erosion of the productive top soil through wind and water action is aggravated by intensive mining, deforestation, improper range land management as well as injudicious tillage practices in agricultural fields. Besides that a sizeable amount of loss of top has been has been attributed to brick making and pottery affecting the livelihood of many traditional communities. It is important to note that it takes centuries to replenish 2.5 cm of top soil.

Loss of biodiversity: Biodiversity refers to totality of genes, species, and ecosystems of a region. India at present has 2.4% of land area of the world but contributes 8% species to global diversity. The Western Ghat, the Himalayas and the Indo-Burma regions are among the thirty four Hotspots identified worldwide as regards to vulnerable biodiversity resources. Biodiversity loss is a common phenomenon associated with land use and land cover change. When a natural forest land is transformed to farm land, the loss of tree species along with numerous associated flora, fauna and micro organisms is immediate and complete. Similarly, increasing grazing pressure on unmanaged pasture and rangelands causes severe damage to the biodiversity. Furthermore, the market driven intensive cropping system with overuse of chemicals leaves the agricultural biodiversity under severe threat. Even the so called eco- friendly technology of energy consumption like adaptation of bio-fuel when injudiciously followed has added tremendous pressure to the natural biodiversity of through dramatic shift in the land use pattern.

Green house gas load to atmosphere: Atmosphere is the mirror to our abuse to land resources. Every anthropogenic activity of concern to the precious land resources leaves an imprint in the atmosphere. There has been global ecological concern for increased concentration of carbon dioxide by 31%, methane by 151% and nitrous oxide by 17 % since 1750 which is incidentally coincided with the pace of land use change enforced by industrial revolution, urbanization, large scale live stock farming and by also modernization of agriculture. This has direct and indirect link with climate change and the problems associated with it. Though geological forces are assumed have big impact on increasing concentration of green house gases in the atmosphere, the human intervention can go a long way to ameliorate the adverse impact of increased GHG concentration. The soil-plant-animal system is an effective source of the important green house gases to the atmosphere. An efficient management of this system through judicious land use planning can increase the buffering capacity of the land resource.

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.

Hydrology: The hydrology refers to the study of water dynamics in surface and subsurface system. The natural catchments of watersheds are disturbed through rampant expansion of settlement areas. The technological intervention has made unimaginable geomorphologic changes possible at a faster rate. The large water bodies and hill tops are not spared. Even the natural river paths are modified by under man made projects. The rate of infiltration is impaired by rigorous anthropogenic activities enhancing the surface run off loss after each rainfall event. This has aggravated the water logging and flash flood in many urban and semi urban areas. On the other hand the ground water recharge is severely affected. This coupled with overexploitation of ground water to meet the demand from agriculture, industry and human settlement has made the situation worse day by day.

Although many of these problems are not solely from anthropogenic activities, these are certainly being aggravated by human activities. More over, it is the responsibility of every human being to sustain the land resources for the future generation through judicious land use planning. Nature is the school where the young minds are to be educated through participatory science activities.

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

1. To understand the microclimate
2. To study the impact of vegetation cover on microclimate
3. 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: <u>These two exercises (part-A & part-B) may be considered complimentary to each other</u>

Project-2: Changing trend in agricultural land use pattern

The changing cropping pattern contributes significantly to the land use change. As agriculture covers large part of our country's geographical area agricultural land use change study bears great relevance. With agricultural land use change there is remarkable change in biodiversity with respect to associated weed, pests and pathogens. The change in fertilizers and chemicals use has significant impact on soil and ground water contamination. Cropping system affects the farmer's economy as well as sustainability in long run. Land use mapping is part of the area feature mapping. While mapping agricultural land use crop practices over the year including fallow periods may be noted. Seasonal fallow and fallow for a period of more than one year may be indicated

Objective

1. To record agricultural land use changes over time (since last 20/40 years)
2. To analyze causes/drivers/pressure leading to these changes
3. To list out possible consequences and
4. To finally prepare a land use history of the chosen crop land

Methodology

- Select 50 respondent farmers aged above 50 years in the surrounding areas/region
- Identify and visit the cropland unit of each farmer

- Make the record of all crops and fallow in the following format and fill up three such formats for (a) present situation, (b) 20 years back, (c) 40 years back for each farmer through participatory approach

Sl. No.	Name of the farmer	Size of the land unit (acre)	Crop coverage						Remarks
			Pre-kharif		Kharif		Post-kharif		
			Crop	Area (acre)	Crop	Area (acre)	Crop	Area (acre)	
1									
2									
-									
-									
-									
-									
40									

Develop the timeline for agricultural land use pattern and write about a land use history for the chosen area

Identify the causes and effects of change in land use pattern

Relevance:

This project will help the students to understand the history of agricultural land use system of their locality along with related forcing functions like knowledge and economic standard of farmer, size of farm unit, resource availability, marked demand as well as other social factors.

Project 3: Influence of mulch on soil physical properties

Mulching is an effective erosion control practice, protecting soil surfaces from erosive action of falling raindrops and abrading wind. Mulches can also slow down water and wind movement at the surface. The mulches depending on colour of the mulching material increase or decrease the amount of absorbed radiation and also restrict the outgoing heat from the surface and thus change the energy balance. Mulches are used to keep soils warmer once temperature begins to drop in the winter. They also conserve water by restricting the soil evaporation. Mulching is an important component of many agricultural land use systems particularly in dry lands.

Objectives

1. To identify the influence of mulch on soil temperature
2. To identify the influence of mulch on soil moisture

Materials required

- Agricultural fields with mulching
    - Paddy / wheat straw may be used as a mulch material
    - Plastic (clear, white, or black) mulches or paper mulches
    - Any other type of mulch
- Agricultural field with no mulching
- Simple thermometers
- Spoon for soil collection
- Cans for sampling

Methodology:

Temperature study

- Find two crop fields of the similar soil types and crop, of which one has been mulched (with straw, plastic or paper) and the other one is without mulch.
- Insert thermometers in the mulched and unmulched soil up to a depth of 5 cm (2 inches) at 8, 12, 16 and 20 hrs and record the soil temperature
- Record the diurnal temperature variations and compare which soil condition will warm or cool more rapidly

Moisture study

- Weigh eight 250 ml empty cans
- Note the irrigation dates in mulched and unmulched fields
- In the same mulched and unmulched field, collect soil samples at a depth of 5 cm (2 inches) in cans with the help of a spoon at same time used in soil temperature 7 days interval after the date of irrigation
- Weigh the moist soils with can
- Dry the samples and measure soil moisture contents after subtracting can weight.

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

- Compare which soil condition will retains or conserves more moisture

Relevance:

The specific heat of water is 1.0 calorie per gram while the specific heat of soil is about 0.2 calories per gram. This means with the same energy input, the soil temperature will increase five times more than the water temperature. Mulched soils conserve water that contributes to slower warming.

Project 4: 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:

3. To study the influence of tillage on water holding capacity of soil
4. To find out the influence of tillage on bulk density
5. 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:

Experiment -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-

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

Experiment - 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^{0}C 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:

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

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.

Experiment- 3: Soil porosity (%)

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

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

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 Exp. 2 and Sl. 7 of Exp 3.

Experiment-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.

Project 5: Population pressure on land: quality of life

Human habitation is primarily influenced by availability of natural resources as well as climate and land features. In the modern age, however, the work/job facilities and economic conditions have become major influential force behind development of human habitation. With rapid progress of industrialization and urbanization along with population explosion during the last few decades, people concentrate on small piece of land for their living. As a result, people undergo certain stress on account of various social and family related issues in their living places. Hence, it is pertinent to assess the life style and living condition of people settled under different situations like, slums, colonies, rural areas, industrial belts etc.

Objectives:

1. To determine population density per unit area in selected slums/apartments of locality
2. To assess the quality of life based on parameters of living area

Methodology:

- Select at least 2 slums or 2 apartments in the locality.
- Visit the selected area and measure the area of living place.
- Fill up the questionnaire/data format through interaction with the head of each family and assign score values against each factor/item.

Name of head of the family	Male	Female	Children (<14 yrs)

Parameter	*Value*	*Score*
Area of living place (home)	$<20\ m^2 = 0$, $20\text{-}40\ m^2 = 1$, $40\text{-}60\ m^2 = 2$ and $>60\ m^2 = 3$	
Average number of persons per bed room	>4 persons = 0, 3-4 persons = 1 and ≤ 2 persons = 2	
Children (below 14 years) going to school	No = 0, Yes = 1	
Average distance of school from home	>5 km = 0, 2-5 km = 1 and < 2 km = 2	
Average distance of working place from home	>20 km = 0, 10-20 km = 1 and < 10 km = 2	
Drinking water facility	Community use = 0, and own use = 1	
Sanitary facility	Community use = 0, and own use = 1	
Drainage facility	Kuccha drain = 0, pucca drain =1	
Garden in own place	No = 0, Yes = 1	
Play ground/Pond in community area	No = 0, Yes = 1	
Medical facility	No facility = 0, Health centre = 1, Hospital/Nursing Home = 2	
Road within/adjacent community area	Kuccha road = 0, Pucca road = 1	
Common festival in selected area	No = 0, Yes = 1	
Community organization for development	No = 0, Yes = 1	
	Total	

- Calculate population density(PD) per unit area, which is expressed in percentage, using the equation as given below

$$\text{PD},\% = \left[\frac{\text{Total number of persons living in selected slums or apartment}}{\text{Total area of selected slums or apartment(sq meter)}}\right] x100$$

- Determine the quality of life on the basis of over all scoring:

Score <7 = low

Score 8-14 = medium

Score >14 = high.

- Compare between 2 slums/apartments in respect of population density and quality of life

Relevance:

This evaluation will help to understand various factors and their interaction influencing stress in living places. This project will generate some basic information that can be passed to local authority like panchayat/municipality for future development works.

Project 6: Effect of land use options on erosion loss of surface soil

Introduction:

The top soil is precious to all living beings. The top soil is being continuously eroded by the different natural agents like air and water. The vegetation cover checks the soil erosion in two ways. The canopy/leaves of the vegetation absorb the momentum of the falling raindrop where as the root system holds the soil particles against the erosive action of flowing water and wind. The erosion problem is more severe in the dry land areas where the vegetation cover is sparse. In hilly areas proper land shaping like, terracing, ploughing (across the slope) are some of the popular approaches to check soil erosion. Injudicious land use planning aggravates the erosion problem. The proposed experiment is aimed at assessment of erosion potentiality of different land use system.

Objective:

1. To monitor the quantity of soil loss under different cover vegetation
2. To analyze the role root system in binding soil particles to the land surface
3. To study the fate of rainfall on land as influenced by soil characteristics

Materials required:

- Leak proof tin tray 2´x3´x8´´ size
- Sample planting materials (seeds of fast growing herbaceous plants propagation materials- root cuttings of different grasses)
- Small funnels water collecting cylinders
- Typical soils collected from different locations (soils should be of different characters)
- Rose can

Methodology:

- Make wholes in the bottom of each tray at the both ends and middle of the bottom plate and one side of the tray
- Fit the funnel in each of the whole and seal the side of the funnels for leak proof.
- Fill the trays in each tray with different types of soil (make compact) leaving 1" from the top and place the trays side by side at slide inclination (1:20) sufficiently above the

ground surface so that water can be collected in receiving cylinders placed below the funnels at the bottom of each tray.

- Treat different trays by -

  a) Root cuttings of different grasses, b) Sow fast growing herbaceous plants like spinach, c) Barren (no vegetation) -compact, d) Barren- tilled (surface made loose using some hand implement), e) Barren- furrow and ridge along the slope, f) Barren- furrow and ridge accross the slope, g) Mulching with straw (or other materials)
- After setting the trays water was applied periodically at 7 days interval to each tray with help of rose can.
- Water collected in the cylinders is dried up and the dry weight of sediments is recorded after watering.
- Note the sediments collected under each system and find how it is related to the vegetation cover (that is gradually growing during the study period), tillage practice, furrow and ridge system along the and across the slope

Relevance:

Water is the main agent for soil erosion in sloppy lands. Vegetation cover as well as different land shaping practices can protect soil erosion due to water. This project will help the students understand the process of soil erosion by water and the ways and means to check the soil erosion due to flowing water.

Additional project ideas:

1. Monitoring of land use pattern influenced by human settlement
2. Shelterbelt impact of plantation – Natural forests and plantations
3. Soil characteristics influenced by Forest vegetation
   - Chemical, physical and biological
   - With support from local institutions (if feasible)
4. Study of water table through dug well monitoring
5. Assessment of top soil loss due to brick industries.
6. Change in rainfall pattern due to land use change inundated forest areas (under hilly region) – from historical records and secondary data source
7. Soil horizons study under different land use systems – To get the idea of soil formation process

Suggested Theme for some Specific Land Situations

- ***Urban and industrial areas***

1. Study of the air pollution (in industry peripheries)

i. Monitoring floating particles- dust, fog/smog

2. Influence of urban settlement on quality of nearby water body
    i. Chemical, physical and biological
    ii. With support from local institutions (if feasible)
3. Pollution load to rivers and water reservoirs on religious events like, Idol immersion, holy bathe etc.
4. Disposal of solid wastes and their fate in urban settlement areas – Heavy metals, polythene disposal,

- ***Low land ecosystem***

1. Assessment of alternate strategies of land use in low land eco system
    i Production potentiality (Economics)

    ii Sustainability and livelihood

2. Economics of fish production, land utilization efficiency
3. Seasonality of fish production and other related issues

- ***Dry regions***

1. Assessment of wind and water erosion,
2. Monitoring extreme weather events (from secondary database)
3. Assessing potentiality of community and individual water harvesting structures

- ***Rural and Agricultural systems***

1. Estimating biomass production capacity of different land use system
2. Estimating irrigation load of a crop land – Water received from rainfall, surface irrigation and ground water against crop water requirement
3. Waste disposal, sanitation, water quality and public health in rural settlements

Group Members:
Dr.M.K. Nanda, Dr M.C.Kundu, Dr.M. Ghosh, Dr.P.K. Bandyopadhyay,
Dr. E. Kunhikrishnan, Mr.K.Batabyal

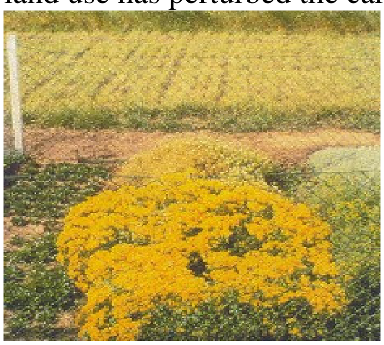
Sub-theme: V

SUSTAINABLE USE OF LAND RESOURCES

Laws Change; people die; the land remains.

-Abraham Lincoln

The world's land resources that include soil, water and vegetation are under great pressure to meet the food, fiber and housing needs of ever growing population. In addition, the land resources are also expected to provide services related to biodiversity, clean water and air and swallow vast amount of wastes produced by living beings. In nature different processes within the earth's surface generally occur in a cyclic manner thus maintaining a balance between different components of the ecosystems. For example, carbon cycles between soil, vegetation, ocean and atmosphere. However, human intervention through industrial activities and change of land use has perturbed the carbon cycle leading to increased carbon dioxide concentration in



the atmosphere. Not only air, human activities have also resulted in degradation of soil and water resources. Land degradation has threatened the livelihood of millions of people and future food security. Therefore, the greatest challenge before us today is to manage the land resources in a sustainable manner so that these are maintained without degradation for present and future generations

Major uses of land resource include forestry, pasture and grasslands, agriculture, housing and urban and industrial activities. The guiding principle for sustainable land management depends on ecological and economic interrelationships. The choice of land use and the practices for its sustainable management are site-specific and depend on local needs of the population. Soil is an important natural resource and its sustainable use is generally linked to agricultural management, though it performs multifarious functions. In relation to sustainable management one needs to know how agricultural management practices are influencing soil physical, chemical and biological parameters. Soil organic matter is considered a key constituent that influences most of the soil properties and governs the capacity of soil to perform ecosystem functions. The term soil organic matter is generally used to represent the organic constituents in the soil, including un-decayed plant and animal debris, their partially and completely decomposed products, and the soil microbial biomass. Soil organic matter, generally determined as organic carbon is taken as an index of soil fertility and crop productivity. Several factors, such as rainfall, temperature, vegetation and soil type determine the amount of carbon in soil. Due to land use changes such as deforestation, conversion of grasslands to agricultural land etc. soils have lost considerable amount of organic carbon. These losses of organic carbon from soils that are already of low fertility are clearly of concern in relation to future productivity. Sustainable management of soil requires that organic matter be maintained at an optimum level governed by soil characteristics and climatic conditions. Management practices or technologies that enhance carbon input to soil and decrease output/decomposition of carbon lead to net carbon storage in soils. Sources of carbon input include the amount of above ground and below ground biomass returned to the soil, and addition of bio-solids such as animal manure, compost, sludge etc. Technologies for enhancing carbon input to soil include i) intensification of agriculture ii) increasing area under forests, and iii) agro-forestry. Agricultural intensification implies adoption of recommended management practices on prime agricultural soils while restoring degraded and marginal soils to productive land uses.

Management options that contribute to reduced decomposition or losses of carbon from the soil include conservation agriculture, reduced or no-tillage practices, mulch farming, and reducing bare fallow or increased cropping intensity. Croplands under no-till systems have been shown to increase soil C compared to more intensive tillage operations. In some climatic regions, land dedicated to annual crops can be planted with a grass or legume cover crop after harvesting the cash crop to protect the soil during fallow period. This increases the residue inputs to the soil and hence soil carbon storage.

Deforestation of land

For providing sustainable fertilizer management practices to increase crop productivity and minimize environmental pollution, soil testing has an essential role. The basic aim of the soil-testing is to provide recommendations to the farmers for economic and balanced use of fertilizers. Soil testing involves the analysis of soil samples in the laboratory for estimating plant available nutrient status of soil. Based on soil test values, the soils are categorized as low, medium and high in supplying nitrogen, phosphorous and potassium to a growing crop. Analysis of other nutrients can also be carried out for diagnosing nutrient deficiencies. Fertilizer application based on soil testing usually leads to an increase in yields and profits by providing the correct and balanced amounts of nutrients. Without soil test based fertilizer recommendation, a farmer may apply excessive or inadequate amount of nutrient(s) required for optimum plant growth. This not only means an uneconomical use of fertilizers, but in some cases crop yields may be reduced and any excess application of fertilizer may also degrade the soil and groundwater. Besides fertilizer recommendations, soil testing also provides information on soil reaction (pH) and salt status (estimated from electrical conductivity) of the soil, which could be used to estimate lime or gypsum requirement for soil reclamation.

Water is another important natural resource that is becoming scarce day by day. It is not only the quantity but also the quality of water that is of concern. There is no single measure that constitutes good water quality since it depends upon several parameters. In some cases groundwater can be contaminated with chemicals or bacteria. Water quality is defined by analyzing it in terms of its i) chemical content such as hardness (calcium + magnesium), metals (iron etc), nutrients (nitrogen and phosphorus), chloride, sodium, organic compounds, etc. ii) physical content such as turbidity, color, odour, etc. and iii) biological content such as coliform, viruses, etc. Good quality (potable) drinking water is free from disease-causing organisms, harmful chemical substances and radioactive matter, tastes good, is aesthetically appealing and is free from objectionable color or odour. In India, the Central Pollution Control Board has identified water quality requirements in terms of a few chemical characteristics, known as primary water quality criteria. Further, Bureau of Indian Standards has also recommended water quality parameters for different uses.

There are different guidelines to evaluate quality of water for irrigation purposes. Based on electrical conductivity, sodium adsorption ratio and residual sodium carbonate irrigation water is categorized into different classes. Sustainable use of marginal quality groundwater is determined by soil characteristics, crop to be grown and the availability of good quality surface water for conjunctive use. In agriculture huge amounts of water are used for irrigation purposes especially for crops like paddy. This seriously impacts the aquifer and the availability of groundwater. Practices/technologies have been devised for efficient management of irrigation water. Some on-farm practices for efficient water management include weather based irrigation schedules, drip irrigation, soil matric potential based irrigation, bunding the field to check run-off and precise laser leveling of the field etc. Other practices include brick-lining of the irrigation channels, rain-water harvesting and groundwater recharge.

Project-1: Status of water quality and its impact on soil properties

Introduction:

Water is an important component of land resources. Steady increase in population leads an increasing demand of water for agriculture, industrial, domestic and other purposes. Besides quantity, the quality of water is also getting deteriorated. Therefore assessment of water quality and its impact on soil is necessary.

Objectives -

i) Identification and Characterization of water resources in the study area
ii) Grading of water quality
iii) Studying their impact on soil properties

Methodology

i) Selection, classification and demarcation of water resources in the study area
ii) Data collection and characterization of sources
iii) Collection of sample from identified sources and testing of water quality parameters
iv) Assess the water resource quality
v) Investigate the change of soil properties due to application tested water

Experimentation –

i) Collect water samples in polythene bottles.
ii) Find out the pH using pH paper (with 4-5 hrs of collection of sample)
iii) Find out the turbidity
iv) Find out the total hardness
v) Conduct any other tests
vi) Repeat the process after a gap of 15 days and take at least three sets.

vii) Data- the collected data are recorded in a tabular form.
viii) Analyses the data to find the water quality and recommend measures to improve it for proper uses.

Practical utility

The study will help to uncover the quality of soil and water resources and indicate the consequences of water qualities on soil properties

Follow-up

i) Monitoring of water quality parameters
ii) Adoption of measures to decrease water quality degradation
iii) Coming up with the process for suitable use of unsuitable water sources

Project-2: Screening suitable soil towards crop growth

Introduction:

Knowledge on soil is important as it provides support to dwell on, holding water and producing food for all living beings. Properties of soil differ from place to place. Studies of soil properties are necessary for its better management. All these ultimately help to restore the quality of land.

Objectives:

i) To identify easily measurable soil properties
ii) Characterization of soil bas by applying inorganic and organic fertilizers
iii) Selection of best soil of a locality for growing crops

Methodology:

1. Selection and collection of different kinds of soil from the agricultural fields of a locality
2. List out soil properties that could be easily measurable
3. Use of soil for growing plant/s in pot
4. Monitoring of plant growth characteristics
5. Selection of best soil type

Experimental:

1. Characterize soil for pH with pH Paper, water soluble salts, texture (feeling method), structure, color and Calcium Carbonate contents (Effervescence method)
2. Put 5 kg of each soil type in pots
3. Sow seeds of the test crop
4. Measure rate of germination, shoot growth (height / weight) etc
5. Compare crop growth with soil properties
6. Based on crop performance screen the rank of soil type

Practical Utility:

(i) Improve the understanding about soil for growing crops
(ii) Increasing awareness for sustainable use of soil

Future scope of Research:

(i) Assess performance of poor soil type with the addition of organics
(ii) Come up with the crops suitable for growing in appropriate soil type

Project-3: Identifying the cropping patterns appropriate for different land classes

Introduction:

The status of any land mass depends on its morphological, physical and chemical properties. Based on these properties we designate the capability classes of any land for its use in agriculture. Cropping intensity, type of crops in the sequence, irrigated or rainfed, fertilizer and tillage management depends on the land capability class. The cropping pattern also depends on the agro-climatic status of the region where the land is situated. Thus for effective production from any land mass we have to search for suitable cropping system.

Objectives:

i) Identifying the existing second crop and land type of any locality
ii) Grow all possible second crops feasible for a particular soil type.
iii) Screen the most suitable second crop

Methodology:

1. Selection of land area
2. Characterization of the area for agricultural use
3. Identify the existing crop pattern/s on the area
4. Select the group of second crops to be tested
5. Present yield level of second crops
6. Comparison of yield potential and the soil quality attributes
7. Establishing relationship between crop/s yield and different land characteristics
8. Develop criteria for crop selection

Experimental

(i) Collection of information about the study area, that includes land history, rainfall status, nature of cultivation, nature of soil, availability of water, groundwater status etc.
(ii) Explore the nature and type of vegetation on the existing system
(iii) Establish the criteria for crop selection
(iv) Grow various types of crops in the sequence after a common first crop
(v) Record the crop yield and compare it with various land characteristics
(vi) Select the second crop on the basis of yield and economic return

Practical Utility:

The project will help to establish criteria for selection of second crop for various land classes

Future scope of Research:

i) Specify the area of crop coverage under diversified cropping.
ii) Identify the cropping pattern appropriate for specific land classes.

Project 4: Conservation agriculture for sustainable land use

Introduction:

Conservation agriculture is application of modern agricultural technologies to improve production with concurrent protection and enhance the land resources on which the production depends. It promotes the concept of optimizing yield and profits with minimal disturbance of land resources along with balanced application of chemical inputs and careful management of crop residues and waste.

Objectives

- To promote minimal mechanical disturbance of soil through zero/minimum tillage.
- To maintain permanent soil cover with available crop residues and other wastes.
- Efficient nutrient management practices through balanced application of organic and inorganic source.
- Effective utilization of residual soil moisture.

Methodology

1. Selection of field
2. Selection of crop (Cereals/Oilseed/Pulse/ leafy vegetables)
3. Divide the field into two equal halves and mark as (a) and (b)
    a) Dig lines of 2" – 3" depths with equal distance between the lines, place the fertilizer, cover it with loose soil, place the seed on it and cover the lines.
    b) Plough the soil and apply fertilizer (as per local practice) and sow the seeds.
4. Doses of fertilizer, pesticides etc. will be as per practice followed by farmers.

Observation:

1. Record economic yield/ biomass data of the crops
2. Workout the economic benefit.
3. Determine bulk density of soil at the time of harvest of the crops from all the plots.
4. Find out porosity of soil and compare the differences.

Procedure to measure bulk density:

1) Cut 4-6" length pieces (core) from a G I Pipe with > 2" diameter
2) Place the core on the soil surface.
3) Place a wooden block (approximately 4" width, 5" length, 1" thickness) on the top of the core.
4) Hammer the wooden block to push the core into the soil
5) Cut the soil around the core with spade and take out the core with soil in it.
6) Cut the excess soil at both ends of the core with knife so that volume of the core will represent volume of the soil
7) Take the weight of core plus soil
8) Push the soil out, wash and clean the core and make it dry.
9) Take the weight of the core

10) Measure the inside diameter and length of the core, which will be used in calculating the volume of soil
11) Divide the mass of the soil by the volume of soil this will give the bulk density of the soil.

Follow up:

1) Show the crops condition to others.
2) Discuss the results with the farmers/ students.

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.

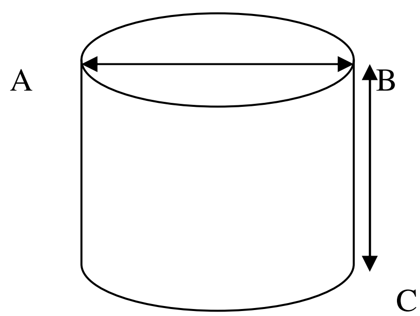
- **Particle density (pd)** is the density of the solid soil particles (sand, silt and clay). For all practical purposes and on-farm studies average particle density is considered as **2.65 gm/cm^3**
- **Bulk density (bd)** is the density for a volume of soil as it exists naturally, which includes any 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

Project 5: Influence of tillage on ground water recharge from rice field.

Introduction:

Puddling is a common phenomenon for transplanted rice. During puddling of rice field, particles of the top soil get churned and form a compact layer over the soil. The status of compactness of surface soil depends on the nature of the soil and the type of puddler. This layer reduces the rate of infiltration (entry of water into the soil through its surface) from the rice field. Farmers of a common locality use different puddlers drawn by animals, power tiller or tractor. Thus, regulating the degree of entry of water into the soil through puddling, this controls the recharge status of ground water of any locality.

Objective:

i) Quantification of infiltration rate
ii) Suitable puddling operation in terms ground water recharge

Methodology:

1. Partitioning a rice field
2. Number of partition depends on number of puddlers available in a locality
3. Collection of soil-water suspension just after puddling
4. Collect cylindrical container with 5 litre capacity at least
5. Cut the top and bottom plain of the container to make it open from both sides.
6. Make three to four holes on the side wall 1” apart from the middle part of container.
7. After puddling, insert the container into the soil till its middle part reached the soil surface, the holes will be thus 1’ above the soil surface.
8. Fix a plastic scale of 12’’ length attached to the side wall, insert 2’’ into the soil.
9. Measure the bulk density of the puddle layer at the end of the study period.

Observation:

1. Measure the height of water level inside the container in the morning.
2. Take readings consecutively for 2-4 days after puddling as well as at 15, 30, 45 and 60 days after puddling.
3. Measure the bulk density values after harvest of rice crop.

Follow-up:

1. Transfer the results of the experiments to the local Agricultural Development Officer (ADO) office or district office of the State Water Irrigation Department.
2. Demonstrate and explain the experiment and its results to the farmers of the area.

Project 6: Mitigate soil and water loss through runoff with suitable control measures.

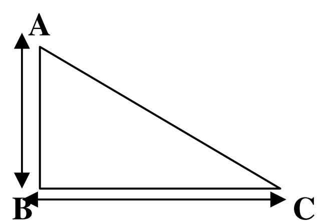
Introduction:

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 students of the area.

List of suggested projects

1. Innovative methods of testing soil at home
2. Impact of vegetation on soil
2. Impact of jhum cultivation on status of land
3. Vegetation and hums forms
5. Reclamation of salt affected soils
6. Impact of high sodium containing water on water movement in soil
7. Impact of saline water on soil properties like pH etc.
8. Germination of crop in soil with varying salinity level
9. Organic matter addition and crop growth
10. Human activities and soil erosion
11. Essential nutrients for plants
12. Management practices for soil conservation
13. Crop diversification and land suitability
14. Land utilization mapping
15. Rain water harvesting for irrigation

MEMBERS

Prof. D.K. Benbi, Dr. P.K. Tarafdar, Dr. Supradip Sarkar, Dr. Mrityunjoy Ghosh
Dr. J.C. Hazra, Mr. T. Vanlalngurzauva

Sub theme – VI

Community Knowledge on Land use

I am the earth. You are the earth. The Earth is dying. You and I are murderers.
~Ymber Delecto

Operational definition of Community and Community based Knowledge: Community is considered to be a group of people who live in close proximity, like the inhabitants of a village or of a locality in a town or city, the members of which interact with one another frequently on the basis of some common interests. A community need not always be a neighbourhood; people pursuing same or similar livelihood activity of an area and as a result interacting with one another frequently can also be described as community. Thus we can find a community of potters or blacksmiths inhabiting over a cluster of villages.

Community based Knowledge or CK can be described as a system of knowledge possessed by the members of a community in such a way that they themselves can put it to use, modify the same as and when required, and the knowledge is generally transmitted from one generation to another in verbal form.

Community based Knowledge vis-à-vis Indigenous and Traditional Knowledge: Often some terms like Indigenous Knowledge or Traditional Knowledge are also used to describe CK, as if those are synonymous. In the present context, however, we would prefer to use the term CK for certain reasons. The term indigenous is closely associated with a spatial dimension. Any idea or innovation that originated somewhere among some people and continued to be practiced by them for a considerably long period of time may be called indigenous. It, therefore, becomes essential to learn the history of the idea or innovation sufficiently before calling it indigenous. The term tradition again has a temporal connotation attached with it; one may ask how old a system should be so that it can be called 'traditional'? In case a knowledge system is not properly recorded or documented it becomes difficult to know about its antiquity. Moreover, in common parlance, tradition often denotes something that has not been mixed up with recent ideas and innovations; but who would vouch for its purity? CK is comparatively free from such complicated relationship with time and space dimensions.

Development and Transfer of Community based Knowledge: Community based Knowledge need not be invented or innovated by a specific group of people holding and practicing it, in fact a community borrows most of the knowledge they make use of from others. But in course of time the people assimilate the knowledge and use it on their own; often they conduct various experiments as well to modify the knowledge or its application. For example, they might have borrowed a particular kind of seed from others along with the associated knowledge of how to cultivate it. But one would often find that the knowledge has been fine-tuned to the local situation and internalised by the people so completely that it has become an indistinguishable part of their body of knowledge about agriculture. Such knowledge is generally transferred from one individual to another through material transfer (seed), method transfer (water conservation technique) and capacity transfer (skill learning under teacher/father/mother) mode.

Relevance for Research: There are a few common pitfalls associated with study of CK. There was a time when almost all kinds of CK were discarded as non-scientific or pseudo-scientific. This was largely because Indians educated in ‘western’ thoughts refused to see reasonability or rationality in anything ‘non-western’. Then, as if in reaction to the rejection of all things *desi* (local), some people started glorifying all kinds of CK. They kept on discovering significant scientific principles and astonishing cause-effect relationship in every part of CK denying the fact that a large part of *desi* knowledge is inherently irrational. It should be made amply clear at this point that neither unconditional rejection nor unqualified glorification of any system of knowledge is desirable. The Indian communities have developed elaborate systems of classifying and categorising the living and non-living components of their environment on certain empirical foundations, which are yet to be fully classified and categorised by the scientists. To know about the natural resource base available to our nation, we need to study these knowledge systems in every detail. On the other hand there are certain ideas and practices found in the Indian communities, like changing course of weather by performing religious or magical rites or like controlling effect of cosmic bodies on human life by wearing jewel stones, can never be glorified in name of any kind of science, *desi* or *phirangi*.

Any knowledge or its application needs to be adjudged only on basis of the universally accepted attributes of scientific methodology. It has to be remembered that CK is people’s science and technology, it would presumably be less sophisticated in its logic, it would sometimes fail to state the relationship between cause and effect in clear terms, the experimentations would often be simple trial and error without the support of scientific information. Under such circumstances only documentation of what the people think or practice would not be enough, it has been mentioned that CK in its crude form would contain many elements that cannot be called ‘science’. It would be extremely necessary to validate the principles used by CK through well-designed and repeated experiments.

Components for Research: We find community based knowledge systems in all spheres of life of the people. The spheres can broadly be divided into two types; the manifestation of some knowledge systems like philosophy, poetry and music are primarily intangible, having no direct material expression. Some other systems of knowledge are related to agriculture, pottery, metal works, animal husbandry, health, building houses and other structures, have tangible or material manifestations. **For the present purpose we would be dealing with the tangible ones only**. By Community based Knowledge we would mean only the latter type and would exclude the former one.

Examples of community based knowledge on land use: There is innumerable numbers of community based knowledge items scattered around us. A little proportion is till date documented. Some of the examples are furnished below to trigger your interest in this field.

i. Farmers of a village of Bangladesh classified their village soil into eight classes for cultivating different crops, and managing nutrient and irrigation water. It was later found appropriate through validation at laboratory level by the scientists.
ii. The potters use different mixtures of soil and other ingredients for making pots with variability in treatments.
iii. Farmers prefer specific plant species for preparing compost or use as mulch as they observed it efficient.
iv. Rural people have developed different scientific structures and methods to conserve soil and water which are unique to their situations.

Scope of the Research Projects: In our country as well as elsewhere in world Community based Knowledge is often threatened on two counts. As CK is often held and practiced by non-industrial or pre-industrial communities, in industrial societies CK finds little relevance for itself in day-to-day life of the people. Moreover, the mass-produced commodities produced in factories pose serious threat to the articles produced by small-scale production units run by the communities with help of CK. Weavers, blacksmiths, potters and many other artisans for example are losing jobs because their products are being replaced by factory-made substitutes; once a CK goes out of practice, it is lost.

Another kind of challenge is posed to CK by the formal educational institutions. CK is rarely a part of the curriculum these institutions follow, so the children are not taught anything related to CK at formal schools and colleges. Very few children of this country find the opportunity of learning the elaborate knowledge systems from the elders at home or from the community elders. As a result the knowledge steadily goes out of circulation and gets lost.

Generally the people handling and practicing CK control their own economic activities to a large extent. The gradual shift from CK to formal knowledge and industrial culture erodes the free and willing participation of the communities in economic activities as well as in the process of development. It must be acknowledged that there are many elements in CK that can offer us sustainable developmental alternatives. Even a miniscule effort of documenting CK and recognising its strength and weakness through experimentation and validation can help us to understand this important body of human knowledge in its right perspective and prepare the ground for its judicious use.

General guidelines for developing and carrying out project work: For implementing a project the children and their guide teachers might broadly follow the steps suggested below; but the final design has to be fine tuned to their own ideas and the prevailing local situation. Some reference books, journals and websites may be consulted for triggering the idea from documented community practices.

- They would identify the topic of the project after talking to members of community and collect generalised information on that issue. A tentative work design can be prepared at this stage.
- They would identify the knowledgeable persons on the subject in the community and collect specific information in some detail from them hands-on. The work design would be finalised at this stage.

- The children themselves would work hands-on and conduct experiments to verify and validate what they have learnt from the knowledgeable elders. Ideally, they would work under supervision of both the guide teachers and the community elders while carrying out the experiments.
- If the children think that they can make use of the material and ideas used by the community in a different / innovative way, they would experiment with that again under supervision of the guide teachers and the community elders.
- The data collected from all the above steps would be analysed and inferences would be drawn.

Resource:
Honey Bee http://www.sristi.org
Inventory Indigenous Technical Knowledge in Agriculture (Vol 1 & Vol 2): Published by ICAR (2002 & 2003)

Project 1: Community Knowledge about Classification of Land

Introduction:

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
- Select a field around your locality
- Collect a copy of the revenue map of the field and make a photocopy
- Meet with the some knowledgeable practicing farmers from the field and explain the purpose in details
- Ask the farmers about different types of land they have in the field

- Visit the different types of land and ask them the reasons for differentiation
- 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.
- Request the farmers to draw boundary lines of each homogenous type of land in the revenue map.
- Transfer the map to graph paper for quantification of area under each type of land
- 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 2: Changing Trend of Land Management through Time Trend Analysis

Introduction:

This exercise is intended to know the process of farmers' land management in different phase of time at their community land based on their perceivable criteria. This will also help the students to compare the practices, their effects and changes (positive and negative) over time in respect of crop choice, varietal choice, fertilizer use, irrigation scheduling, problem faced, conservation practices, yield etc. This project has two basic components. At first level a field survey should be made at a community adjacent to the locality of the students with participation of knowledgeable farmers. In the second level the community knowledge may be validated with consultation of research reports or with scientists who have been working in that particular region

Objectives:

- To identify the changes happened in the land over definite span of time
- To analyze the changes, causes/drivers/pressure leading to these changes
- To list out possible consequences
- To validate the farmers' Knowledge with secondary sources of information

Methodology:

***Requirements*: ** color pen and papers, secondary data on land use

Steps

- Select a field around your locality
- Meet some knowledgeable practicing farmers from the field
- Explain the purpose in details
- Consider minimum twenty years period as unit of changes
- Initiate discussion over the variables like crop, variety, fertilizer, irrigation, yield, problem faced in land management etc.
- Try to understand the changes happened to the land
- Ask the farmers the reasons for the changes
- Make an idea about the possible consequences from the discussion
- Finally prepare a comparative table for different phases with concluding remarks

Changing trend of soil management

Variable	1950-1970	1970-1990	1990-2010	Changes	Explanation	Consequences
Crop						
Variety						
Yield						
Many more variables						

Validation:

- Collect secondary data relevant to the exercise and analyze them over the definite periods
- Compare them with field findings

Conclusion:

Find out the strength and weaknesses of farmers' assessment technique

Relevance:

This project will help the students to understand the changes in land management through farmers' eyes and it will also promote respect towards the farming community

Project 3: Community practices / structures for rainwater harvesting

Introduction:

As the water availability is going down day-by-day due to population explosion, we have to think about artificial taping of water from the ground reserve. But this reserve is limited and becoming contaminated due to over exploitation. So the children can take up the project on the age-old practices of rainwater conservation techniques or structures in their own locality.

Objectives:

1. To find out the different local rainwater harvesting techniques/structures used by the local people
2. To estimate the harvestable rain water in different practices/structures
3. To state the uses of harvested water

Methodology:

- Select the area of your study
- Find the rainfall in your area from local meteorological office /from farmers' perception (seasonality and timeline of rainfall).
- Identify the age-old practices of water storage structure, techniques and their uses
- Compute the water collection (area x depth of storage) by these methods
- Observations are to be recorded as written in the table

Table: List of rainwater harvesting structures/techniques followed by the community/people

Name of Structure/technique	Details of Structure/technique	Storage capacity (m^3)	Utility/uses
i)			
ii)			
iii)			

Relevance

- This study will provide good information on rainwater harvesting that can be used for different land area also
- We can compare the storage ability of different techniques/structures

Project 4: Community knowledge on soil and water conservation

Introduction:

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.			
3.			

Relevance:

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

List of suggested projects on community knowledge

1. Community measures against river or pond bank erosion
2. Conservation of pasture and waste land in arid and semiarid areas
3. Conservation of soil and water in hilly terraces
4. Documentation of community knowledge having practical relevance from proverbs (Khanar Bachan, Folklores, etc.)
5. Comparative analysis of different soil for preparation of brick, pottery, dye, building material etc.
6. Comparative analysis of different soil for preparation of cricket pitch/tennis court/golf course/kabadi court etc

7. Medicinal use of soil
8. Cosmetic use of soil
9. Indigenous nutrient management (application of tank mud, different organic manures)
10. Uses of different mulch materials practiced by the farmers
11. Multiple uses of land and water by the farmers
12. Assessment of night keeping of animals in fields for soil nutrient enrichment
13. Solarization/inundation of land against diseases and pest/improving uptake of nutrient
14. Farmers' knowledge about flood water storage and utilization
15. Peoples' wisdom about utilization of wetlands for commercial purposes
16. Farmers' indicators about good/bad soil
17. Farmers' concept on multiple cropping (intercropping, mixed cropping, *paira* cropping etc)
18. Community knowledge about biological indicators of soil quality
19. Farmers' practices on conservation agriculture
20. Botanical insectides, fungicides, rodenticides and weedicides practiced by the farmers and its impact on soil
21. Participatory Appraisal Techniques for knowing the land and soil
22. Use of tank silt for agricultural and nonagricultural purpose
23. Use of soil for making idols
24. Use of soil as natural dye
25. Use of soil in cosmetics (*multani mitti* etc.)
26. Use of different kinds of soil by terracotta artists
27. Use of soil as preservatives
28. Economics of conservation agriculture /organic farming/ different cropping practices etc

Group Members

Dr.Debabrata Basu, Dr.Subhendu Goswami, Dr.Nitai Charan Das,
Dr.Kanchan Mukhopadhyay, Mr.Amrit Thapa

ANNEXURE - I

Pond Measurements:

Implementing pond management practices necessitates knowing the surface area and volume of the water impoundment. Aquatic herbicide applications, fish stocking rates and fertilization treatments are prescribed on the basis of area and/or volume of the pond.

you can measure your own pond by following the steps listed below. To assure accuracy, take all measurements carefully and carry all calculations to at least four or five decimal places (i.e., 0.11478 acres). After the final calculation has been performed, round the number to one decimal place.

Surface Area

Shoreline measurements are made with a tape measure or by pacing, and are then used in the appropriate formula below.

If the pond is **rectangular or square**, use the following formula:

$$\textbf{Surface area, in acres} = \frac{\textbf{Length, in feet x Width, in feet}}{\textbf{43,560 sq ft / acre}}$$

Example: (Figure A)

$$\frac{\textbf{80 feet X 140 feet}}{\textbf{43,560 sq ft / acre}} = \textbf{0.2571acre, or approximately 1/4 acre}$$

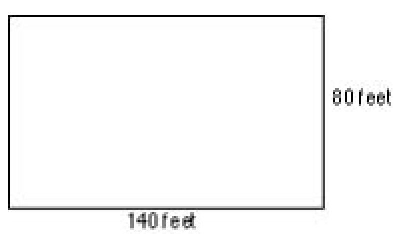


Figure A

If the pond is circular or nearly so, use this formula to determine surface area:

(total feet of shoreline) squared

Surface area, in acres = ------------------------------------

547,390

Example: (Figure B)

(520 feet) X (520 feet)
----------------------------- = 0.4939 acre, or approximately 1/2 acre
547,390

Figure B

Many ponds are **irregularly-shaped**, which makes the area measurements more difficult. In this case, approximate the pond shape as a square, rectangle or circle by measuring boundary lines that most nearly represent the actual shoreline.

Example: This pond shape can be approximated as a rectangle (Figure C).

$$\text{Surface area, in acres} = \frac{\text{Length, in feet x Width, in feet}}{\text{43,560 sq ft / acre}} = \frac{250 \text{ X } 120}{43{,}560}$$

$= 0.6887$ acre

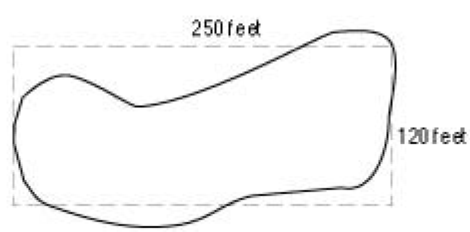


Figure C

Volume Measurements

Calculating the total volume of water in the pond is a two-step process:

Step 1: Determine average depth of the pond by taking uniformly-spaced soundings over the entire pond surface. This can be done from a boat, or during the winter when ice covers the entire surface. The measurements can be taken with a long pole, chain or weighted rope marked off in feet. At least 15 measurements should be taken. Add the measurements and divide by the number of measurements taken.

Example:

$$\textbf{Average depth} = (2+3+5+8+9+1+4+6+9+0+1+2+3+3+8)/\ 15$$

$$= \frac{64}{15} = 4.27 \text{ feet}$$

Step 2: Once you have determined average depth and surface area, acre-feet are determined by multiplying the two measurements:

Volume, in acre-feet = Surface area, in acres X Average depth, in feet

Example: A 1.5-acre pond has an average depth of 4.27 feet.

Acre-feet = 1.5 acres X 4.27 feet = 6.405 acre-feet

Measuring Small Areas Within a Pond

Some pond management activities involve the treatment of only a portion of the water impoundment. In these situations, the same formulas are used but the treatment area dimensions are much smaller.

Example: A pond owner desires to treat a 50' x 100' swimming area for algae, using a rate of 2.7 pounds (equivalent to 1 part per million) of copper sulfate per acre-foot (Figure D).

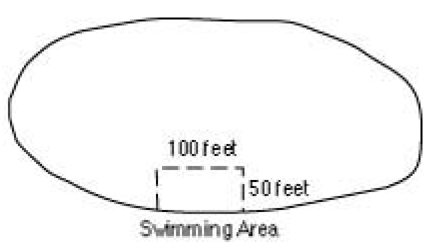


Figure D

$$\text{Surface area to be treated} = \frac{50 \text{ X } 100}{43{,}560} = 0.11478 \text{ acres}$$

$$\text{Average depth of swimming area} = \frac{1 + 2 + 3 + 5 + 2 + 3 + 4}{7} = 2.8571 \text{ feet}$$

Acre-feet in the swimming area = 0.11478 X 2.8571 = 0.32794 acre-feet

Amount of cooper sulfate to use = 0.32794 acre-feet X 2.7 lbs per acre-foot
= 0.88542 lbs of copper sulfate in swimming area
= 0.9 lbs

ANNEXURE - II

CONVERSION TABLES

Units of Length

	To calculate:						
Multiply measurement in: ↓	**inches**	**feet**	**yards**	**miles**	**centimeters**	**meters**	**kilometers**
inches by →	**1**	**0.08333**	**0.02777**	**0.0000158**	**2.54**	**0.0254**	**0.0000254**
feet by →	**12**	**1**	**0.33333**	**0.000189**	**30.5**	**0.305**	**0.000305**
yards by →	**36**	**3**	**1**	**0.000567**	**91.5**	**0.915**	**0.000915**
miles by →	**63,400**	**5,280**	**1,760**	**1**	**161,000**	**1,610**	**1.61**
centimeters by →	**0.394**	**0.0328**	**0.01093**	**0.00000621**	**1**	**.01**	**0.00001**
meters by →	**39.4**	**3.28**	**1.093**	**0.000621**	**100**	**1**	**0.001**
kilometers by →	**39,400**	**3,280**	**1,093**	**0.621**	**100,000**	**1,000**	**1**

Units of Area

	To calculate:					
Multiply measurement in: ↓	**sq. feet**	**sq. yards**	**sq. miles**	**acres**	**sq. meters**	**sq. kilometers**
sq. feet by →	**1**	**0.1111**	**0.00000003587**	**0.0000229**	**0.0929**	**0.0000000929**
sq. yards by →	**9**	**1**	**0.0000003228**	**0.0002066**	**0.8361**	**0.0000008361**
sq. miles by →	**27,878,400**	**3,097,600**	**1**	**640**	**2,589,988**	**2.59**
acres by →	**43,560**	**4840**	**0.0015625**	**1**	**4,046.856**	**0.0040469**
sq. meters by →	**10.76391**	**1.19599**	**0.0000003861**	**0.000247**	**1**	**0.000001**
sq. kilometers by →	**10,763,910.4**	**1,195,990**	**0.3861**	**247.1**	**1,000,000**	**1**

Units of Volume, cubes

	To calculate:				
Multiply measurement in: ↓	**cubic inches**	**cu. feet**	**cu. yards**	**cu. centimeters**	**cu. meters**

cubic inches by →	**1**	**0.0005787**	**0.000021433**	**16.387**	**0.000016387**
cu. feet by →	**1728**	**1**	**0.037037**	**28,316.85**	**0.028317**
cu. yards by →	**46,656**	**27**	**1**	**764,554.858**	**0.764555**
cu. centimeters by →	**0.0610237**	**0.0000353147**	**0.00000130795**	**1**	**0.000001**
cu. meters by →	**61,023.7**	**35.3147**	**1.30795**	**1,000,000**	**1**
ounces by →	**1.8047**	**0.0010444**	**0.00003868**	**29.5735**	**0.0000295735**
quarts by →	**57.75**	**0.03342**	**0.00123778**	**946.353**	**0.000946353**
pints by →	**28.875**	**0.01671**	**0.00061889**	**473.176**	**0.000473176**
gallons by →	**231**	**0.13368**	**0.00495113**	**3,785.41**	**0.00378541**
liters by →	**61.0237**	**0.0353147**	**0.00130795**	**1,000**	**0.001**

Units of Volume, containers

	To calculate:				
Multiply measurement in: ↓	**ounces**	**quarts**	**pints**	**gallons**	**liters**
cubic inches by →	**0.554113**	**0.017316**	**0.034632**	**0.004329**	**0.016387**
cu. feet by →	**957.5**	**29.922**	**59.844**	**7.48052**	**28.3168**
cu. yards by →	**25,852.7**	**807.896**	**1,615.79**	**201.974**	**764.555**
cu. centimeters by →	**0.033814**	**0.0010567**	**0.00211338**	**0.000264172**	**0.001**
cu. meters by →	**33,814**	**1,056.69**	**2,113.38**	**264.172**	**1,000**
ounces by →	**1**	**0.03125**	**0.0625**	**0.0078125**	**0.0295735**
quarts by →	**32**	**1**	**2**	**0.25**	**0.946353**
pints by →	**16**	**0.5**	**1**	**0.125**	**0.473176**
gallons by →	**128**	**4**	**8**	**1**	**3.78541**
liters by →	**33.814**	**1.05669**	**2.11338**	**0.264172**	**1**

Units of Weight/Mass

	To calculate:				
Multiply measurement in: ↓	**ounces**	**pounds**	**tons**	**grams**	**kilograms**
ounces by →	**1**	**0.0625**	**0.00003125**	**28.3495**	**0.0283495**
pounds by →	**16**	**1**	**0.0005**	**453.592**	**0.453592**
tons by →	**32,000**	**2,000**	**1**	**907,185**	**907.185**
grams by →	**0.035274**	**0.00220462**	**0.0000011023**	**1**	**0.001**
kilograms by →	**35.274**	**2.20462**	**0.0011023**	**1,000**	**1**

Units of Temperature

To convert between degrees Farenheit and degrees Celcius:

$$^{o}C = (^{o}F - 32) * (5/9)$$

$$^{o}F = (^{o}C * 9/5) + 32$$

ANNEXURE - III

SUGGESTED READINGS

Animal health and ecological implications

Land use

The intensification of livestock production as part of the development process may, if not properly carried out, contribute to land degradation through overgrazing, reduced soil fertility, erosion and desertification. This is particularly true in marginal areas unsuitable for agriculture, where most extensively managed ruminants are kept. Major animal health activities, such as vaccination campaigns or parasite (e.g. tsetse or ticks) control programmes, have positive impacts on productivity and size of animal populations that lead to increased animal population pressure and may contribute to land degradation unless correct land-use planning is implemented.

Proper land-use planning and utilization, taking into account the diverse agricultural, topographical and geographical aspects involved, is essential to reducing the risk of adverse ecological developments while increasing productivity and animal disease control. Therefore, it requires a multidisciplinary approach to ensure the correct planning and utilization of the land.

Pollution

In a similar way, the intensification of livestock production results in increased use of veterinary products, such as pesticides, and the production of different types of waste, like manure from feedlots. The pollution or contamination of the environment, especially water supplies, due to animal wastes (manure and liquid manure) is an increasing problem and must be foreseen when planning new animal housing, especially in the industrial production systems. Proper action has to be taken for the careful use or safe disposal of the slaughterhouse waste. These can be valuable by-products if appropriately processed. This should involve sterilization of contaminated material before further processing and release for use. Improper disposal of this type of waste can lead to an increase of predatory animal species (e.g. hyenas, rural dogs, etc., on land and sharks with disposal to sea).

Environmentally friendly methods of applying insecticides have the potential for reducing possibilities of contamination of the environment and should be utilized where practical. The use of pesticides may be minimized by using breeds or their crosses that are resistant to parasitic species, e.g. Trypanotolerant cattle or tick-resistant breeds.

Changing ecological equilibrium

Frequently the reduction of the population of one species in an area has unexpected consequences for the environment through its impact on non-target species. Occasionally the application of disease-control measures may have unpredicted consequences for the environment.

- The widespread and disproportionate use of antibiotics and parasiticides, such as anthelmintics and acaricides, has lead to the development of strains of pathogens that are resistant to the drug employed, thus complicating control.

• Poisoning coyotes (predators) to control rabies in Mexico resulted in such a dramatic increase in the Jackrabbit population that it became a pest in agriculture.
• Game parks in Africa may constitute a reservoir of infection of certain livestock pathogens, e.g. Foot-and-mouth disease and Trypanosomiasis.

These examples serve to emphasize the need for comprehensive planning of animal health interventions to take fully into account the possible ecological consequences.

Why Garden Organically?

There are many people who garden organically for many different reasons. Chief among these are the various philosophical reasons such as a desire to live in harmony with the Earth. Living within one's means so to speak, and attaining a balance in the garden.

I garden organically because of these reasons, and also because to me it seems easier ultimately. I grew up learning both organic and conventional methods, and have gradually switched over to wholly organic because when the soil is properly prepared and fed, it will in turn feed the plants in a way that will reduce insect and disease problems, and reduce weeding and watering chores. Every hour I spend mulching and composting probably saves me a couple hours of weeding and other work.

A properly compost amended soil will have good air and water penetration as well as good water retention. The high air flow within the soil will reduce rot and disease problems. But the high water retention will result in reduced watering chores as well as ensuring a steady supply of water to the plant when it needs more moisture.

How does compost perform this seemingly 'too good to be true' task? It all is due to the unique properties of compost, that is it's high surface area. In short, water clings to the surface of soil particles such as clay and sand.

Clay particles are very thin wafer-like particles that stack like cards on a table. This is why clay soils are so hard to get wet, the water likes to roll off the surface, and has a hard time overcoming the soil chemical and physical resistance and sink into the soil. But once it becomes wetted, it's high surface area causes it to be resistant to drying, in addition it's tight packing features cause the airflow between the particles to be nearly non-existent resulting in reduced drying by airflow. There is one benefit to the high water holding capacity of clay though, it means that the nutrients in the soil which are water soluble are not going to be taken away by water easily and transported beyond the reach of the roots.

A sand soil is very difficult to keep wet due to the fact that sand particles tend to be of a rounded or jagged shape, and they do not fit tightly together, this results in a smaller surface area that does not hold much moisture, also the loose soil texture causes massive amounts of air to flow between the particles, this airflow can wick much moisture from the soil particles. Sandy soils have the additional ability to loose moisture through them during periods of high irrigation and rainfall. This moisture going quickly through the soil and into the groundwater can take with it many of the soluble nutrients that were in the soil either naturally or by being added.

So there you have the major types of soil, sandy and clayey. Most soils are some extreme of one or the other, or a mixture to one degree or another of both. Now the big question is, how does compost make such a large change in either type of soil? Well, imagine a tiny piece of compost, residue of some type of animal or plant that has rotted to a great degree, this high carbon state of being results in a very porous material, it may have many holes all through it, this feature gives it

a very high ratio to surface area to which water will cling, this means that compost can hold many times it's own weight in water. It’s open and cellulose structure makes it capable of absorbing much water.
Think if you will of the flat platelets of clay particles, laying flat on a table top. When water is poured over them it runs off the surface. Now if you took the sponge, tore it into many smaller pieces and lifted the clay particles and put pieces of the sponges between them you will have a surface physically lifted up and made more 'fluffy' and able to readily accept water. This lifting action will result in greater airflow and quicker water acceptance. Using this method the compost will ensure less water runoff and wastage, quicker water acceptance and greater airflow and reduced rot. The good benefits of clay are retained though, the soils will not tend to run water through it too fast to be absorbed, and digging compost in a shovel depth or two will not cause the water to run beyond the root area overly quickly taking vital nutrients.
The sandy soil is likewise helped by compost. Picture sandy soil as marbles in a bag, when water is poured into the bag it will quickly run through the marbles. The compost if pictured as a torn up sponge placed between marbles makes it easy to see how it would trap much water. The high surface area of the compost dug into the sand will trap much more of the soil moisture than would be trapped by the sand alone. Also the overly high airflow rates of the sandy soil are reduced by the compost wedging itself between the sandy particles. Water is retained by the compost along with many of the water soluble nutrients.
Now compost can do all these things and more, it can help to reduce weeding chores due to the fact that it loosens soil so well. When you pull on a small weed it will come out easier because the soil is loosened by the compost.
When you walk on the soil it will be a little less likely to pack down tightly because of the springy action of the sponge like compost.
The compost will cause a reduction in the amount of soil erosion. Clay soils will accept more moisture and reduce erosive run off. Sandy soils will be held a bit tighter together and cause a reduction in wind erosion.
So with all these benefits it is easy to see why an hour of composting saves several hours of other types o work.

Land Pollution Comprises Of: Solid Waste and Soil Pollution

Solid Waste: Semisolid or solid matter that are created by human or animal activities, and which are disposed because they are hazardous or useless are known as solid waste. Most of the solid wastes, like paper, plastic containers, bottles, cans, and even used cars and electronic goods are not biodegradable, which means they do not get broken down through inorganic or organic processes. Thus, when they accumulate they pose a health threat to people, plus, decaying wastes also attract household pests and result in urban areas becoming unhealthy, dirty, and unsightly places to reside in. Moreover, it also causes damage to terrestrial organisms, while also reducing the uses of the land for other, more useful purposes.

Some of the sources of solid waste that cause land pollution are:

<u>Wastes from Agriculture:</u> This comprises of waste matter produced by crop, animal manure, and farm residues.

Wastes from Mining: Piles of coal refuse and heaps of slag.

Wastes from Industries: Industrial waste matter that can cause land pollution can include paints, chemicals, and so on.

Solids from Sewage Treatment: Wastes that are left over after sewage has been treated, biomass sludge, and settled solids.

Ashes: The residual matter that remains after solid fuels are burned.

Garbage: This comprises of waste matter from food that are decomposable and other waste matter that are not decomposable such as glass, metal, cloth, plastic, wood, paper, and so on.

Soil Pollution: Soil pollution is chiefly caused by chemicals in pesticides, such as poisons that are used to kill agricultural pests like insects and herbicides that are used to get rid of weeds. Hence, soil pollution results from:

- Unhealthy methods of soil management.
- Harmful practices of irrigation methods.

Land pollution is caused by farms because they allow manure to collect, which leaches into the nearby land areas. Chemicals that are used for purposes like sheep dipping also cause serious land pollution as do diesel oil spillages.

What are the Consequences of Land Pollution?

Land pollution can affect wildlife, plants, and humans in a number of ways, such as:

- Cause problems in the respiratory system
- Cause problems on the skin
- Lead to birth defects
- Cause various kinds of cancers

The toxic materials that pollute the soil can get into the human body directly by:

- Coming into contact with the skin
- Being washed into water sources like reservoirs and rivers
- Eating fruits and vegetables that have been grown in polluted soil
- Breathing in polluted dust or particles

How can Land Pollution be prevented?

- People should be educated and made aware about the harmful effects of littering
- Items used for domestic purposes ought to be reused or recycled
- Personal litter should be disposed properly

- Organic waste matter should be disposed in areas that are far away from residential places
- Inorganic matter such as paper, plastic, glass and metals should be reclaimed and then recycled

Thermal pollution

Thermal pollution is the rise or fall in the temperature of a natural body of water caused by human influence. A common cause of thermal pollution is the use of water as a coolant by power plants and industrial manufacturers. When water used as a coolant is returned to the natural environment at a higher temperature the change in temperature impacts organisms by (a) decreasing oxygen supply, and (b) affecting ecosystem composition. Thermal pollution can also be caused by the release of very cold water from the base of reservoirs into warmer rivers. This affects fish (particularly eggs and larvae), macroinvertebrates and river productivity.

Ecological effects — warm water

Warm water typically decreases the level of dissolved oxygen in the water . The decrease in levels of dissolved oxygen can harm aquatic animals such as fish, amphibians and copepods. Thermal pollution may also increase the metabolic rate of aquatic animals, as enzyme activity, resulting in these organisms consuming more food in a shorter time than if their environment were not changed. An increased metabolic rate may result in food source shortages, causing a sharp decrease in a population. Changes in the environment may also result in a migration of organisms to another, more suitable environment, and to in-migration of fishes that normally only live in warmer waters elsewhere. This leads to competition for fewer resources; the more adapted organisms moving in may have an advantage over organisms that are not used to the warmer temperature. As a result one has the problem of compromising food chains of the old and new environments. Biodiversity can be decreased as a result.

Component	Bituminous	Subbituminous	Lignite
SiO_2 (%)	20-60	40-60	15-45
Al_2O_3 (%)	5-35	20-30	20-25
Fe_2O_3 (%)	10-40	4-10	4-15
CaO (%)	1-12	5-30	15-40
LOI (%)	0-15	0-3	0-5

Chemical composition and classification

It is known that temperature changes of even one to two degrees Celsius can cause significant changes in organism metabolism and other adverse cellular biology effects. Principal adverse changes can include rendering cell walls less permeable to necessary osmosis, coagulation of cell proteins, and alteration of enzyme metabolism. These cellular level effects can adversely affect mortality and reproduction.

Primary producers are affected by warm water because higher water temperature increases plant growth rates, resulting in a shorter lifespan and species overpopulation. This can cause an algae bloom which reduces the oxygen levels in the water. The higher plant density leads to an increased plant respiration rate because the reduced light intensity decreases photosynthesis. This is similar to the eutrophication that occurs when watercourses are polluted with leached agricultural inorganic fertilizers.A large increase in temperature can lead to the denaturing of life-supporting enzymes by breaking down hydrogen- and disulphide bonds within the quaternary structure of the enzymes. Decreased enzyme activity in aquatic organisms can cause problems such as the inability to break down lipids, which leads to malnutrition.

In limited cases, warm water has little deleterious effect and may even lead to improved function of the receiving aquatic ecosystem. This phenomenon is seen especially in seasonal waters and is known as thermal enrichment. An extreme case is derived from the aggregational habits of the manatee, which often uses power plant discharge sites during winter. Projections suggest that manatee populations would decline upon the removal of these discharges.

The added heat lowers the dissolved oxygen content and may cause serious problems for the plants and animals living there. In extreme cases, major fish kills can result. Warm water may also increase the metabolic rate of aquatic animals, as enzyme activity, meaning that these organisms will consume more food in a shorter time than if their environment was not changed. The temperature can be as high as 70 degrees Fahrenheit for freshwater, 80 degrees Fahrenheit for saltwater, and 85 degrees Fahrenheit for tropical fish.

Ecological effects — cold water

Releases of unnaturally cold water from reservoirs can dramatically change the fish and macro invertebrate fauna of rivers, and reduce river productivity. In Australia, where many rivers have warmer temperature regimes, native fish species have been eliminated, and macro invertebrate faunas have been drastically altered and impoverished. The temperatures for freshwater fish can be as low as 50 degrees Fahrenheit, saltwater 75 degrees Fahrenheit, and Tropical 80 degrees Fahrenheit.

Fly ash is one of the residues generated in the combustion of coal. Fly ash is generally captured from the chimneys of coal-fired power plants, and is one of two types of ash that jointly are known as **coal ash**; the other, bottom ash, is removed from the bottom of coal furnaces. Depending upon the source and makeup of the coal being burned, the components of fly ash vary considerably, but all fly ash includes substantial amounts of silicon dioxide (SiO_2) (both amorphous and crystalline) and calcium oxide (CaO). Toxic constituents include arsenic, beryllium, boron, cadmium, chromium, chromium VI, cobalt, lead, manganese, mercury, molybdenum, selenium, strontium, thallium, and vanadium, along with dioxins and PAH compounds.

In the past, fly ash was generally released into the atmosphere, but pollution control equipment mandated in recent decades now require that it be captured prior to release. In the US, fly ash is generally stored at coal power plants or placed in landfills. About 43 percent is recycled, often used to supplement Portland cement in concrete production. It is increasingly finding use in the synthesis of geopolymers and zeolites.

Fly ash material solidifies while suspended in the exhaust gases and is collected by electrostatic precipitators or filter bags. Since the particles solidify while suspended in the exhaust gases, fly ash particles are generally spherical in shape and range in size from 0.5 µm to 100 µm. They consist mostly of silicon dioxide (SiO_2), which is present in two forms: amorphous, which is rounded and smooth, and crystalline, which is sharp, pointed and hazardous; aluminium oxide (Al_2O_3) and iron oxide (Fe_2O_3). Fly ashes are generally highly heterogeneous, consisting of a mixture of glassy particles with various identifiable crystalline phases such as quartz, mullite, and various iron oxides.

Fly ash also contains environmental toxins in significant amounts, including arsenic (43.4 ppm); barium (806 ppm); beryllium (5 ppm); boron (311 ppm); cadmium (3.4 ppm); chromium (136 ppm); chromium VI (90 ppm); cobalt (35.9 ppm); copper (112 ppm); fluorine (29 ppm); lead (56 ppm); manganese (250 ppm); nickel (77.6 ppm); selenium (7.7 ppm); strontium (775 ppm); thallium (9 ppm); vanadium (252 ppm); and zinc (178 ppm).

Fly ash reuse

The reuse of fly ash as an engineering material primarily stems from its pozzolanic nature, spherical shape, and relative uniformity. Fly ash recycling, in descending frequency, includes usage in:

- Portland cement and grout
- Embankments and structural fill
- Waste stabilization and solidification
- Raw feed for cement clinkers
- Mine reclamation
- Stabilization of soft soils
- Road subbase
- Aggregate
- Flowable fill
- Mineral filler in asphaltic concrete

- Other applications include cellular concrete, geopolymers, roofing tiles, paints, metal castings, and filler in wood and plastic products.[7][9]

Environmental problems

Contaminants

Fly ash contains trace concentrations of heavy metals and other substances that are known to be detrimental to health in sufficient quantities. Potentially toxic trace elements in coal include arsenic, beryllium, cadmium, barium, chromium, copper, lead, mercury, molybdenum, nickel, radium, selenium, thorium, uranium, vanadium, and zinc. Approximately 10 percent of the mass of coals burned in the United States consists of unburnable mineral material that becomes ash, so the concentration of most trace elements in coal ash is approximately 10 times the concentration in the original coal. A 1997 analysis by the U.S. Geological Survey (USGS) found that fly ash typically contained 10 to 30 ppm of uranium, comparable to the levels found in some granitic rocks, phosphate rock, and black shale.

In 2000, the United States Environmental Protection Agency (EPA) said that coal fly ash did not need to be regulated as a hazardous waste. Studies by the U.S. Geological Survey and others have concluded that fly ash compares with common soils or rocks and should not be the source of alarm. However, community and environmental organizations have documented numerous environmental contamination and damage concerns.

What do we know about the impacts of global warming?

A large body of scientific studies, exhaustively reviewed, has produced a long list of possibilities. Nobody can say that any of the items on the list are certain to happen. But all the world's climate experts, virtually without dissent, agree that the impacts listed below are *more likely than not* to happen. For some items, the probabilities range up to almost certain.

The following are the likely consequences of warming by a few degrees Celsius — that is, what we may expect if humanity manages to begin restraining its emissions soon, so that greenhouse gases do not rise beyond twice the pre-industrial level.

*** Most places will continue to get warmer,** especially at night and in winter. The temperature change will benefit some regions while harming others — for example, patterns of tourism will shift. The warmer winters will improve health and agriculture in some areas, but globally, mortality will rise and food supplies will be endangered due to more frequent and extreme summer heat waves and other effects. Regions not directly harmed will suffer indirectly from higher food prices and a press of refugees from afflicted regions.

*** Sea levels will continue to rise for many centuries.** The last time the planet was 3°C warmer than now, the sea level was roughly 5 meters higher. That submerged coastlines where many millions of people now live, including cities from New York to Shanghai. The rise will probably be so gradual that later generations can simply abandon their parents' homes, but a ruinously swift rise cannot be entirely ruled out. Meanwhile storm surges will cause emergencies.

* **Weather patterns will keep changing** toward an intensified water cycle with stronger floods and droughts. Most regions now subject to droughts will probably get drier (because of warmth as well as less precipitation), and most wet regions will get wetter. Extreme weather events will become more frequent and worse. In particular, storms with more intense rainfall are liable to bring worse floods. Mountain glaciers and winter snowpack will shrink, jeopardizing many water supply systems. Each of these things has already begun to happen in some regions.

* **Ecosystems will be stressed,** although some managed agricultural and forestry systems will benefit, at least in the early decades of warming. Uncounted valuable species, especially in the Arctic, mountain areas, and tropical seas, must shift their ranges. Many that cannot will face extinction. A variety of pests and tropical diseases are expected to spread to warmed regions. Each of these problems has already been observed in numerous places.

* **Increased carbon dioxide levels will affect biological systems** independent of climate change. Some crops will be fertilized, as will some invasive weeds (the balance of benefit vs. harm is uncertain). The oceans will continue to become markedly more acidic, gravely endangering coral reefs, and probably harming fisheries and other marine life.

* **There will be significant unforeseen impacts.** Most of these will probably be harmful, since human and natural systems are well adapted to the present climate.

The climate system and ecosystems is complex and only partly understood, so there is a chance that the impacts will not be as bad as predicted. There is a similar chance of impacts grievously worse than predicted. If the CO_2 level keeps rising to well beyond twice the pre-industrial level along with a rise of other greenhouse gases, as must inevitably happen if we do not take strong action soon, the results will certainly be worse. If emissions continue under a "business as usual" scenario, recent calculations give even odds that global temperature will rise 5°C or more by the end of the century — causing a radical reorganization and impoverishment of many of the ecosystems that sustain our civilization.