## Lab 1 Introduction to Practical Ecology

Ecology is the study of an organism or organisms and their relationship to the

environment.

an organism's environment consists of physical, chemical and biological components

ABiotic factors (physical and chemical parameters) are the non-living components of the environment which include: Temperature -- Sunlight -- Water - Wind - Pressure -- Soil/substrate

## • Measurement of a biotic factors

Abiotic factors are easy to measure using simple instruments and equipment.

#### **First: Temperature measurements**

Temperature is a physical property of matter that quantitatively expresses the common notions of hot and cold, Quantitatively, temperature is measured with thermometers.

Temperature scales: Celsius scale (°C) -- Fahrenheit scale °F -- Kelvin scale K

(water freezes at 32 °F and boils at 212 °F. ---- water freeze at 273.15 and boils at 373.15 K.)

$t_C = \frac{5}{9} \left( t_F - 32 \right)$	Convert Fahrenheit to Celsius
$t_F = \frac{9}{5}t_C + 32$	Convert Celsius to Fahrenheit
$t_{K} = t_{C} + 273.15$	Convert Celsius to Kelvin
$t_{C} = t_{K} = 273.15$	Convert Kelvin to Celsius



Temperature is commonly measured by using the different types of thermometers such as :

#### a. Liquid thermometer

An instrument for measuring temperature, often a sealed glass tube that contains a column of liquid, as mercury, that expands and contracts, or rises and falls, with temperature changes.

- Liquid thermometer principle: relation between temperature and volume of a liquid

#### b. Maximum and minimum thermometer

**The purpose of use:** Thermometer that records the highest and lowest temperatures reached during a period of time.

Maximum-minimum thermometers are typically U-shaped parallel tubes of glass. One side registers the minimum temperature, while the other registers the maximum temperature since its last reading.

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## Second: Relative humidity

Relative humidity is defined as the ratio of the partial pressure of water vapor (in a gaseous mixture of air and water vapor) to the saturated vapor pressure of water at a given temperature.

Relative humidity is often determined by using the following:

#### a. Hair hygrometers

Hair hygrometers work on the fact that hair changes its length when humidity varies. This device usually consists of a number of human or horse hairs connected to a mechanical lever system. When humidity increases the length of the hairs becomes longer. This change in length is then transmitted and magnified by the lever system into a measurement of relative humidity.



#### b. Psychrometer

A psychrometer or sling psychrometer is a device used to measure relative humidity. It has two thermometers One thermometer is called a wet-bulb thermometer, The other thermometer is a drybulb thermometer and measures air temperature, The difference in temperature reading between the wet-bulb and dry-bulb thermometers indicates the amount of water vapor in the air.

#### c. Thermo-Hygrograph

A Thermo-Hygrograph is a chart recorder that measures and records both temperature and humidity (or dew point). Similar devices that record only one parameter are a thermograph for temperature and hygrograph for humidity.



#### d. Thermo-hygrometer

The thermo hygrometer measures both humidity of the air and temperature of the air. The thermo hygrometer measures different ranges of humidity and temperature depending on the model.

#### Other instrument to measure indirect humidity

- I. Dew point apparatus
- II. Rain gauge



# Lab 3 practical ecology

# Third: Atmospheric pressure

Atmospheric pressure, sometimes also called barometric pressure, is the pressure exerted by the weight of air in the atmosphere of Earth . Low pressure areas have less atmospheric mass above their location, whereas high pressure areas have more atmospheric mass above their location.

We can measure the pressure by the following:

#### a.Barometer

A barometer is a scientific instrument used in ecology to measure atmospheric pressure. It can measure the pressure exerted by the atmosphere by using water, air, or mercury. Numerous measurements of air pressure are used such as Water-based barometers, Mercury barometers and aneroid barometer .

## b. Barograph

A barograph is a recording aneroid barometer. It produces a paper or foil chart called a barogram that records the barometric pressure over time. Barographs use one or more aneroid cells acting through a gear or lever train to drive a recording arm that has at its extreme end either a scribe or a pen.



# **Fourth: Density**

The mass density or density of a material is defined as its mass per unit volume. In some cases density is also defined as its weight per unit volume; although, this quantity is more properly called specific weight. Different materials usually have different densities, so density is an important concept regarding buoyancy, purity and packaging.

Less dense fluids float on more dense fluids if they do not mix. This concept can be extended, with some care, to less dense solids floating on more dense fluids.

If the average density of an object is less than water (1000 kg/m3 ) it will float in water and if it is more than water's it will sink in water.

The mass density of a material varies with temperature and pressure. (The variance is typically small for solids and liquids and much greater for gasses.)

Increasing the pressure on an object decreases the volume of the object and therefore increase its density.

Increasing the temperature of a substance (with some exceptions) decreases its density by increasing the volume of that substance.

#### a.Hydrometer

A hydrometer is an instrument used to measure the specific gravity (or relative density) of liquids; that is, the ratio of the density of the liquid to the density of water.

#### • The principle

Operation of the hydrometer is based on Archimedes' principle that a solid suspended in a fluid will be buoyed up by a force equal to the weight of the fluid displaced. Thus, the lower the density of the substance, the farther the hydrometer will sink.

## Fifth: Wind speed

Wind speed usually mean the movement of air in an outside environment. The wind speed are commonly measured by following:

Anemometer is a device for measuring wind speed, and is a common weather station instrument.

Anemometers can be divided into two classes: those that measure the wind's speed, and those that measure the wind's pressure; but as there is a close connection between the pressure and the speed, an anemometer designed for one will give information about both.

#### **Cup anemometers**

A simple type of anemometer consisted of four hemispherical cups each mounted on one end of four horizontal arms, which in turn were mounted at equal angles to each other on a vertical shaft. The air flow past the cups in any horizontal direction turned the cups in a manner that was proportional to the wind speed. Therefore, counting the turns of the cups over a set time period produced the average wind speed for a wide range of speeds.

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# Other instruments and devices are used in ecology for different purpose

#### 1. Van Dorn water sampler

The Van Dron water sampler (horizontal water bottle), desighnated for the sampling of open water (bottom of lakes, stearms). The sampler is made of sturdy transparent PVC(plastics) and has a double releaser, activated by a drop messenger.

#### 2. Ekman Bottom Grab Samplers

The Ekman Bottom Grab sampler is designed for sampling in soft bottomed lakes and rivers composed of muck, mud or fine peat.

#### 3. pH meter

A pH meter is an electronic instrument used for measuring the pH (acidity or alkalinity) of a liquid (though special probes are sometimes used to measure the pH of semi-solid substances). A typical pH meter consists of a special measuring probe (a glass electrode) connected to an electronic meter that measures and displays the pH reading.







#### 4. Sunshine recorder

A sunshine recorder is a device that records the amount of sunshine at a given location. The results provide information about the weather and climate of a geographical area.

This information is useful in meteorology, science, agriculture, tourism, and other fields.



There are two basic types of sunshine recorders: One type uses the sun itself as a times scale for the sunshine readings. The other type uses some form of clock for the time scale.

#### 5. The Secchi disk

The Secchi disk, created in 1865 by Pietro Angelo Secchi, it is a circular disk used to measure water transparency in oceans and lakes. The disc is mounted on a pole or line, and lowered slowly down in the water. The depth at which the pattern on the disk is no longer visible is taken as a measure of the transparency of the water. This measure is known as the Secchi depth and is related to water turbidity.



**Turbidity** is the cloudiness of a fluid caused by individual particles (suspended solids) that are generally invisible to the naked eye, similar to smoke in air. The measurement of turbidity is a key test of water quality.

Fluids can contain suspended solid matter consisting of particles of many different sizes (from large to very small particle).

#### 1. Electrical conductivity

An electrical conductivity meter (EC meter) measures the electrical conductivity in a solution. Conductivity is one way to measure of the inorganic materials including calcium, bicarbonate, nitrogen, phosphorus, iron, sulphur and other ions dissolved in a water body. It is measured by placing a conductivity probe (EC instrument) in the sample and measuring the flow of electricity between the electrodes. Conductivity is measured with a meter in micro Siemens per centimeter units ( $\mu$ S/cm).

#### 2. Spectrometer (spectrophotometer, spectrograph or spectroscope)

A spectrometer is an instrument used to measure properties of light over a specific portion of the electromagnetic spectrum, typically used in spectroscopic analysis to identify materials. A spectrometer is used in spectroscopy for producing spectral lines and measuring their wavelengths and intensities. Spectrometer is a term that is applied to instruments that operate over a very wide range of wavelengths, from gamma rays and X- rays into the far infrared.



#### A diagram showed the Spectrometer principle

#### 3. Atomic absorption spectroscopy (AAS)

Atomic absorption spectroscopy (AAS) is a spectroanalytical procedure for the qualitative and quantitative determination of chemical elements employing the absorption of optical radiation (light) by free atoms in the gaseous state. In ecology the technique is used for determining the concentration of a particular element in a sample to be analyzed. AAS can be used to determine over 70 different elements in solution or directly in solid samples.

#### 4. Global positioning System (GPS)

The global positioning system (GPS) is a satellite-based system that can be used to located positions anywhere on earth. Its continuously transmit coded information, which makes it possible to precisely identify location on earth by measuring distance from the satellites.

Our position on earth is calculated by measuring our distance from a group of satellites in space. This calculation is done by timing how long it takes a radio signal to reach us from a particular satellite.

## **Remote sensing**

**Remote sensing is the technique of learning about ecosystems and the environment with out direct contact.** These methods involve the use of electromagnetic and sound waves, radiant energy and ionizing radiation.

Methods of remote sensing:

Aerial photography Black and white stereoscopic photos are used to determine the volume of **timber stand**, to count wild animals, to record vegetational and man made changes in the landscape and to prepare topographic maps.

**Colour photography** has been widely employed, for its visual contrast make the identification of tree species, insect damage, plant disease ,and details of aquatic environment.

**Infrared photography** is a newer and very useful technique in the study of vegetation because the molecules of pigments in plant do not absorb infrared wavelengths. Instead the infrared is either transmitted through the leaves or is reflected by the cell walls. Cells of one species of plant have a different reflectivity than abnormal ones. Therefor ,infrared photography has been used **to distinguish species and to detect unhealthy plants**. It is also used to detect differences in environmental temperature . Such pictures or thermographs in which differences in temperature appear as contrasting bands of colour, permit the detection of thermal pollution detection.

## Sampling in ecology

When collecting samples, one must follow predetermined sampling protocols (procedures and methods) which have been chosen bearing in mind:

- the sampling (collection) site
- the number of samples to be collected
- the timing of the sampling.

to meet the purpose of the survey, and which are appropriate to the media being investigated.

## 1. Water quality sampling

# 1.1 Sampling timing

Time the sampling trip and Take into account factors such as the **weather**, tides, currents, geography etc.

# 1.2 Sampling point

- For **rivers**, the primary sampling point is in the surface water layer (**0-5 cm** from the surface) at the centre of the main flow. However, the top **1-2 cm** of this surface layer should be **avoided** so as not to collect floating dust, oil, etc. In addition, further samples can be collected through the full depth of the water column if required to meet the purpose of the study.

- For lakes and the ocean, the sampling point will be selected after taking into consideration such factors as geography, whether there are freshwater (rivers or streams) or wastewater inflows, depth, tides, currents etc.

The simplest, sample for river and lakes is a "**grab**" sample, is taken at a selected location, depth and time. Normally, the quantity of water taken is sufficient for all the physical and chemical analyses that will be done on the sample.

- For **underground water**, the sampling site will be selected after taking into consideration such factors as water flow and geological structure (hydrogeology), and also site conditions such as factories or land use.

#### 1.3. Sampling tools and containers

The type of water sampling tool required will depend on the **sampling site** and the **type of sample** to be taken

The type of material of the tools should be made of will depend on the purpose (target analytes) of the study, but relatively inert materials such as stainless steel, synthetic resin such as polypropylene, polyethylene or pertetrafluoroethylene (PTFE), or glass are all acceptable.

The **size and type of sample** to be taken will determine the type of sample container required.

•For **volatile organic** compounds, use clear or brown bottles or vials with screw caps or stoppers lined with tetrafluoroethene resin films.

• For **semi-volatile or non-volatile organic** compounds, use clear or brown glass jars with a stoppers or Teflon lined screw caps.

• For inorganic compounds such as heavy metals, use polyethylene containers

#### 1.4 Sampling operation

Sample containers should be washed 3-4 times with water from the exact site of sampling prior to taking the sample.

• For **volatile organic compounds**, sample containers should be completely filled with bubble-free water and sealed tight.

• For **semi- and non-volatile organic compounds**, sample container should be completely filled with water that is as free as possible of air bubbles.

• For **inorganic compounds** such as heavy metals, the container should be approximately 80- 90 % filled with the water sample (the space above the surface of the water sample allows through mixing just befor analysis)

## 1.5 Field records

The sampling date, sample name (code), sampling site's name (code), an accurate position for the sampling site (map of G.I.S. position), general environmental conditions such as the nature of the surrounding landscape, the state of the tide or river flow, weather conditions such as cloud cover and air temperature, and general water conditions such as colour, water temperature, pH, and dissolved oxygen content, etc.

#### 1.6 Labeling of samples

- write on the sample bottle in water-resistant ink
- details of the name or code of the sample,
- the sampling date, the sampling site name etc.

- Finally, record on each sample and in the field record details of transport methods, storage methods, etc.

#### 1.7 Transport and storage of samples

Ideally all samples should be cooled in ice soon after collection, and then transported to the laboratory packed in ice.

If samples must be stored for a period of time, refrigerate or freeze samples as soon as possible after collection or arrival at the laboratory.

# 2. Plants Sampling

Is done by the use of small sampling units. These units may be in the form of area, line, or point, as has been employed in the quadrate, transect, and point sampling methods, respectively as follows:

## 2.1 Quadrate method.

It is a technique which is used when only a part of a large area is sampled. On the basis of this information, the total population of the area is estimated . The quadrate method is used to measure the population density of organisms such **as plants**, **planktons, carth worms, insects and also blood cell in the blood.** 

## 2.2 Transect method

A transect is across section of an area used as a sample for recording, mapping, or studying vegetation. Line transect method is commonly used for sampling of the forest and it consists of taking observations on a line or lines laid out randomly or systematically over the study area.





# **Animal Populations Sampling**

The ecological study of animal populations in the ecosystem involves more problems than the study of plants, because animals are harder to see and most are not stationary they are here one minute and gone the next.

The following methods furnish valuable information's regarding animal populations of different kinds:

## **3.1 Trapping and collecting animals:**

(I) Trapping and collecting flying insects:

- Aerial nets are used for the collection of **diurnal** insects.

- For **nocturnal** insects, traps containing ultra-violet light are used.
- For killing the insects, killing jars containing a layer of plaster of paris and potassium cyanide (KCN).

## (II) Trapping and collecting aquatic organisms:

- For collecting aquatic organisms **nets** are used for organisms in the water bottom.
- For aquatic collecting from the **shore**, aquatic **throw nets** are useful.
- For collecting **bottom organisms** in deep water, is used a **bag net** lowered from a boat.
- Fish, and large crustacean collected with seines (large vertical fishing-nets).

## (III) Trapping and collecting soil organisms:

For example the collection of **earthworms**, a **dilute solution of formalin** with special concentration is applied to a quadrate  $61 \text{ cm}^2$ . Within a few minutes worms will come to the surface.

## (IV) Trapping and collecting birds and mammals:

- Birds can be trapped for banding in specially constructed traps.

- For mammal live traps of wood or wire and snap traps are used. These traps can be baited with natural foods, dripping water, etc.

## ✓ Radioactive tracers:

The use of radioactive tracers in marking of animals, is a particularly **useful method for studying animals that are secretive in habits, live in dense cover, spend part or all of their lives underground, or that have radically different phases in their life cycle, such as moths and butterflies.** 

It is found that if animals are fed small traces of **gamma-emitting radioactive material** along with food, then the radio-active materials are metabolically incorporated into the tissues. The tracer becomes a part of the animal and is passed along to egg or offspring. This technique is **useful for studying dispersal, for the identification of specific broods or litters, for obtaining data on population dynamics and natural selection**.

# "Estimation of number of animals in population"

The numbers of animals in wild populations can be estimated by following three methods:

- 1. True census, a count of all individuals in a given area;
- 2. Sampling estimates, derived from counts on sample plots
- 3. **Indices**, in which the trends of populations from year to year or from area to area are obtained through roadside counts, animal signs, and the like.

#### **Estimates from sampling**:

This involves following methods:

#### (i) Sample plots:

Refer to quadrat sampling, strip sampling and similar methods under the general name of "plot sampling" generally plot sampling is a **useful method if it can be assumed that each survey will identify all of the animals in the sampled area, and that the animals will be distributed uniformly and independently** 

(ii) Mark-recapture method:

A portion of the population is captured, marked, and released. Later, another portion will be captured and the number of marked individuals within the sample is counted. an estimate of the total population size can be obtained by dividing the number of marked individuals by the proportion of marked individuals in the second sample