**Soil Science and Technology**
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**Lecture – 49**
**Soil Survey**

Welcome friends to this 4th lecture of week 10 of Soil Science and Technology and in this lecture, will be covering a very very important topic that is Soil Survey.

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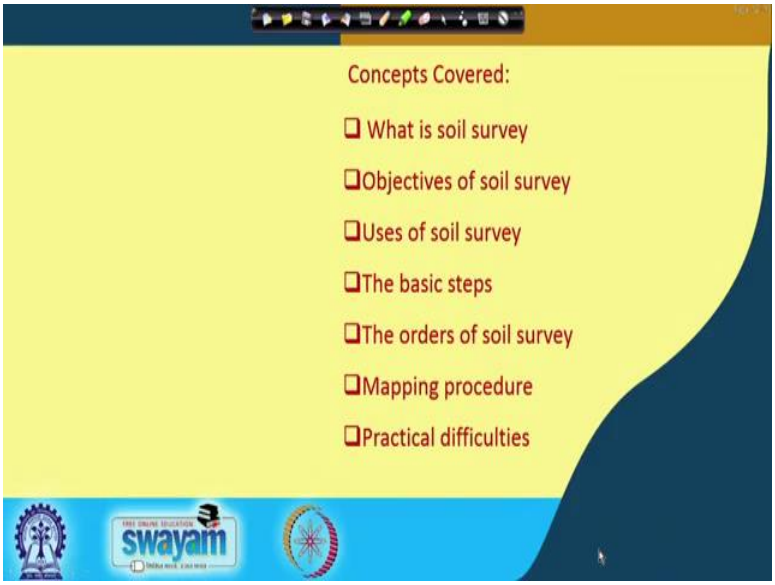


And will be covering this following concepts in the soil survey that is what is the first covering, what is soil survey and then what are the objectives of soil survey, what are the uses of soil survey and what are the basic steps of soil survey and different types, different orders of soil survey and then mapping procedure and practical difficulties which are present in soil surveys.

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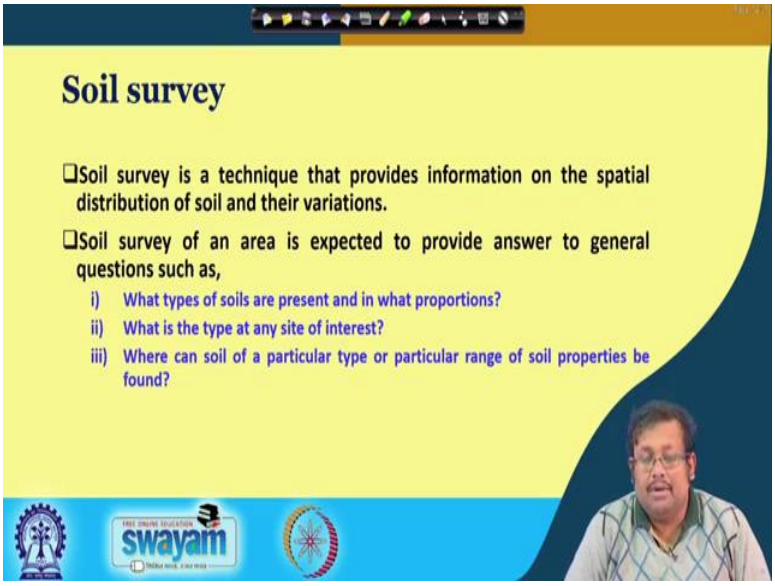


So, we talked about in our week 2, we have to it talked about the soil classification and how we can define difference soil in two different orders, suborder, about great group, subgroup, then family and series. And the soil survey is basically the practical application of the soil classification knowledge. And soil survey is a technique that provides information of the spatial distribution of soil and their and their variation; obviously.

And the soil survey of an area is expected to provide the answer to general questions such as you know what type of soil are present in what proportion. Secondly, what is the type at any site of interest and finally, where can soil of a particular type or particular range of soil properties be found.

So, these are some important questions which you require for better and effective management planning. So, for better and effective management of soil resources, you need to do soil survey. And remember that, whenever you plan anything whether you go for agricultural operation or whether you go for any engineering application, soil survey is must otherwise you cannot see we you know you cannot make a plan on which soil you are going to build anything or you can do some further you know agriculture operations are any other management planning. So, soil survey helps in getting this answers and we will see how this basically the soil survey works.

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So, the objectives of soil survey or you know or rather the broader, the broad general objectives of soil survey could be grouped as fundamental and applied. So, there are two aspects regarding the objectives of soil survey. First of all, let us you know see the fundamental objectives. The fundamentally is soil survey helps in gathering information about the properties genesis classification and nomenclature of the soil and applied aspect of soil survey includes interpretation of soil data for use in agriculture, forestry, recreational purposes, urban, industrial and pasture development, etcetera.

So, again fundamental aspects that is soil survey helps in gathering information about the soil genesis and it helps in classifying the soil and then name that particular soil. For example, if you want to name the soil of you know of any areas, say above say you know New Delhi area. So, we need to do a soil survey and then we need to properly identify the soil properties, then we have to give them a particular name which will be use for indicating the soil of that area.

And secondly, the applied aspects is when we do it and when we map the soil; obviously, then it will be serving as a you know tool for selecting different land use patterns like whether we you want to use that soil, whether that soil is suited for agriculture purpose or forestry purpose or recreational purpose or industrial and pasture purpose. So, these all type of answers, you will get when you will have a map of soil survey. So, these are basically objectives you can say of soil survey.

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Now, what are the uses of soil survey; obviously, they provide the information for the development of land use plans for both arable and non-arable lands and for predicting the long term effects of a particular land use environment. Secondly, they help in predicting the adaptability of identified soil to various uses and also their behavior and productivity under defined sets of management practices. So, obviously, they also you know you know they also you know soil survey, also helps us to identify the adaptability of soils to various land uses.

And secondly, thirdly, soil resources inventory helps in recognizing the areas having constraints like salinity, alkalinity, acidity, erosion, waterlogging, flooding and also taking suitable measures for their management. So, it is very much important for identifying different problematic soils and their subsequent management. Finally, soil information generated through soil survey is useful for land settlement, tax appraisal, locating and designing highways airports and other engineering structures.

So, you can see both for arable and land and for non arable land, both for agricultural purposes and non agricultural purposes, engineering purposes, industrial purposes, you can use this soil survey and it has got a very very fast the you know application domain I would say.

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So, let us see, what are the basic steps in making the soil survey? The first step is mapping of the soil. So, this is very important. So, mapping of the soil is very very important is the first step. And obviously, characterization of the mapping units, we will discussing about the mapping units in a few slides and then, once we characterize the mapping units then we have to classify in classify the mapping units.

So, again the 1st step is the mapping of unit soil; 2nd is characterizing of the mapping unit; 3rd is classification of the mapping units; 4th is the correlation with other soil survey. So, basically once a team of soil scientists completed as soil map and the map is reviewed by other soil scientists to verify that the soil boundaries match those mapped and adjacent areas and that the characterization of the classification of mapping units are consistent with other soil survey. So, it is a kind of validation practice in the soil survey, And the 5th one is interpretation of the soil suitability for various land uses.

So, a report is written to accompany the soil map in order to describe the suitability of each mapping unit for various land uses and the interpretive tables of the report often reflect many person year of experience and observations as well as standard interpretation of measure soil properties. Now, this interpretation is very very important because it requires a long you know time dedication and as well as expertise for interpreting this type of soil as well as soil mapping units and then identifying what is the best suitable practice for that soil-mapping units. And organization obviously, of all this

soils information to make it available to users in the form of maps, tabular information and electronic data files. Obviously, most of these things have been already done main advanced countries like US and the work is on progress in India.

So, again this 6th steps first of all mapping of the soil, 2nd is characterization of the mapping units, 3rd is classification of the mapping unit, 4th one is correlation of the others with other soil surveys are kind of validation, 5th one is interpretation of soil suitability for various land uses and 6th one is the organization of all this soil information. So, these are the basic steps of making the soil survey.

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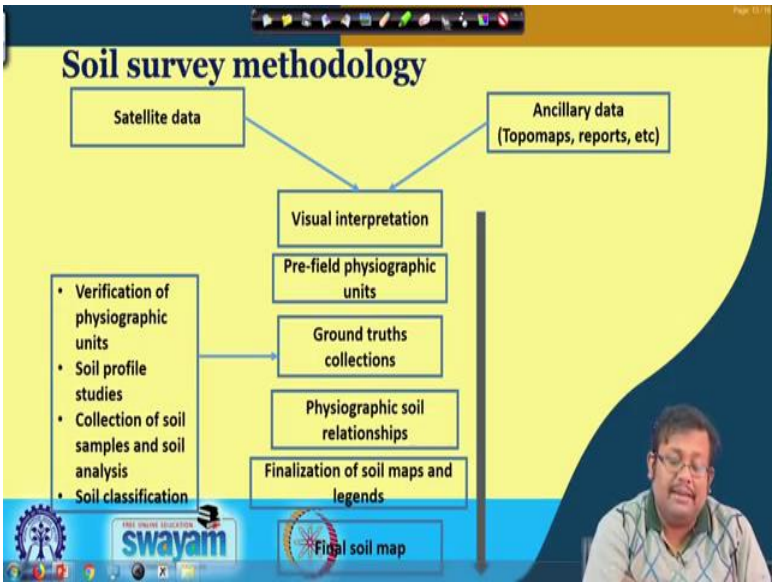


And if you see the diagrammatic view schematic view of soil survey methodology; obviously, starts with the different data sources. So, you can use either satellite data to create a base map and also you can use some ancillary data like Topomaps and reports, etcetera as a base maps. Topomaps also can be used as a base map and then you can use the visual interpretation.

After the visual interpretation, you know pre field physiographic units can develop. And from their ground truth collections and you know ground truth collection is mainly done for the verification of the physiographic units and soil profile studies and collection of samples and soil analysis and soil classification.

So, we need to actually go to that area and collect some soil sample so that, we can verify whether we know we are correctly identifying the properties of the soil for that point. And then, once we do that, physiographic soil relationship will do and finally, finalization of soil maps and legends and ultimately producing the final soil maps. So, it starts again with the satellite data and ancillary data.

Then, we do the visual interpretation and then pre field physiographic units we develop and from there we do the different types of ground truth collection and then physiographic soil relationship, we have developed we develop and we then finalized the soil maps and legends and produce the final soil map for subsequent used by different stakeholders. So, these are basically steps of you know the of soil survey methodology and will discuss them in details letter on.

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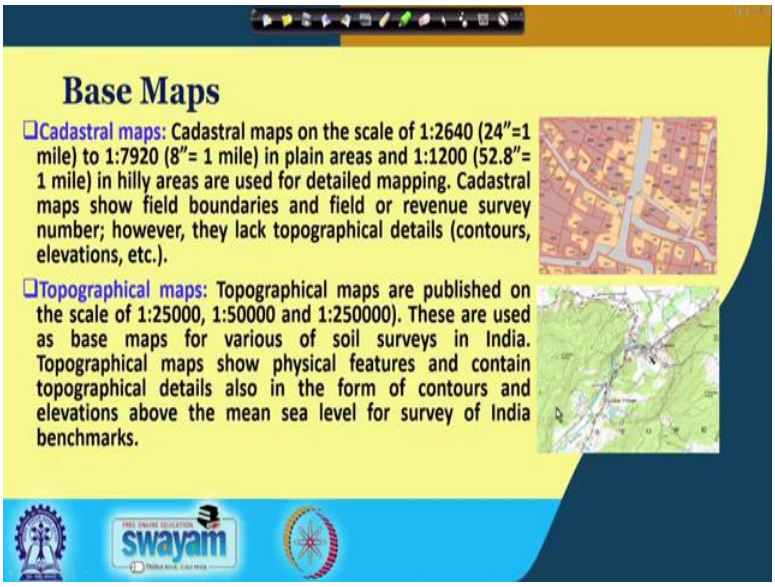


So, guys let us talk about the base maps. The base maps are the major we know at the starting points of soil survey, obviously. Now, there are four types of base maps will be talking about here. Let us start with the cadastral maps. Now, the cadastral maps on the are basically done on the scale of 1 is to 2 6 4 0 where 24 inch equal to represent 1 mile to 1 is to 7 9 2 0 where 8 inch represent 1 mile. In plain areas and 1 is to 1200 where 52.8 inches equals to 1 mile.

So, in hilly areas and used for detailed mapping and cadastral maps show field boundaries and field revenue survey number. However, we can see here these are the

cadastral map units and their basically shows field boundaries and field revenue survey numbers, we are getting some numbers or we are seeing some boundaries here. However, they lack topological details like contours alleviation etcetera. So, these information, we cannot get from cadastral maps. And we remember that these cadastral map can be used as a base map for doing the soil survey.

Second is topographical map. Now topographical maps are published on the scale of 1 is to 25000 or 1 is to 1 is to 50000 or 1 is to 200, 50000. So, these are basically used as base maps for various of soil surveys in India. And topographical maps or topo maps shows physical features and contain topographical details also in the form of contours and elevations above the mean sea level for survey of India benchmarks.

So, you can see these are the topograph, topo maps an you can see, the contours showing different types of topological feature different elevations and these are very very efficient base maps were creating the soil survey. So, we have discuss about these two important base maps again, the cadastral map as well as topographical map.

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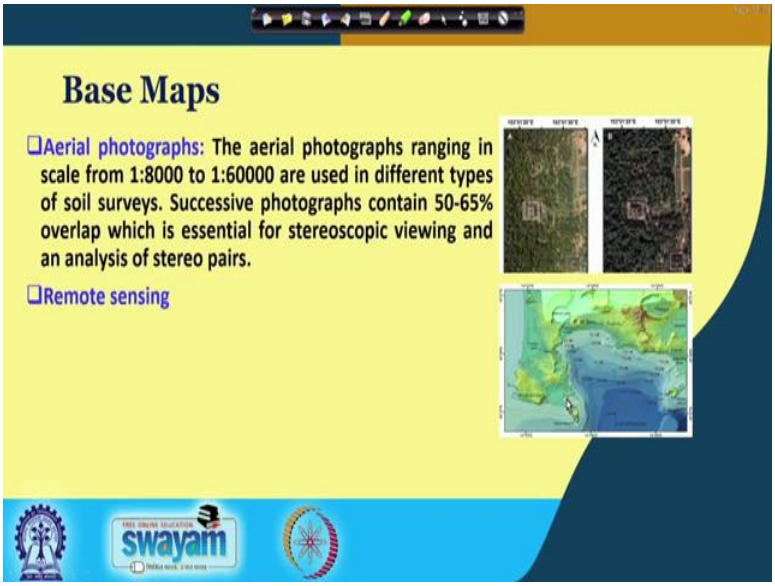


The third one is aerial photographs. The aerial photographs ranging in the scale from 1 is to 8000 to 1 is to 60000 are basically used in different types of soil surveys. And successive photographs contain 50 to 65 percent of the overlap which is essential for stereoscopic viewing and analyzing of the stereo pairs. So, basically what happens, with general you there are low altitude flights and this low altitude flights can take this images

from a certain distance above the earth surface and these are basically used in aerial photographs.

These aerial photographs, you can see here these aerial photographs are basically use is the base map for further soil survey. And finally, remote sensing I can see this a remote sensing, remote sensing data we are these remote sensing photographs are basically taken by different types of satellite platforms and these are also this remote sensing maps are also produces a base map for creating the further soil survey. And remote sensing has become a very very important aspect of soil survey nowadays and we will discuss them in our next lectures also.

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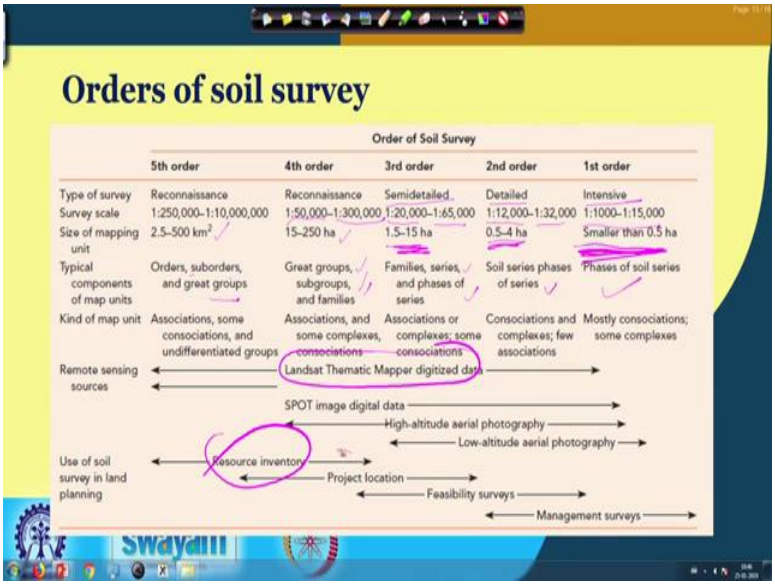


So, the soil survey can be divided into several orders. Actually, the soil survey can be you know can be different 5 difference orders starting from 1st order, then 2nd order, then 3rd order, 4rth order and 5th order. So, let us see them. So, type of survey scale is basically varying from 1st order to 5th order.

So, you can see first order is basically very very intensive and in generally takes the scale of 1 is to 1000 to 1 if 15000 and in the 2nd order is basically called detail where the survey scale is basically 1 is to 12000 to 1 is to 32000. Then, semidetailed is the 3rd water is the 3rd order and their the scale is 1 is to 20000 to 1 is to 65000. The 4rth order is called the reconnaissance soil survey which varies from 1 is to 50000 to 1 is to 300000. And in the reconnaissance, 5th order is also known as the reconnaissance where

we know the survey scaled varies from 1 is to 250000 and 1 is to kind of 10 million, you can say here 1 is to 10 million.

So, size of mapping units also vary from 5th order to 1st order. Obviously, in case of 5th order, the size area is quite large that varies from 2.5 to 500 square kilometer and in 4th order it varies from 15 to 250 hectare. In 3rd order, it varies from 1.5 to 15 hectare. 2nd order, it is more detail that is 0.5 to 4 hectare and in the 1st order smaller than 0.5 hectare. So, it is the more detailed, you know detail soil survey.

And typically, components of map units are basically in individual map units will be talking about the map units. Map units are the individual you know polygons, which are present in the map, in the soil map and these a polygons are map units are basically composed of these orders suborders and great groups in case of fifth order. In case of 4rth order, there mainly consists of great group subgroup and families. In the 3rd order is mainly consists of families series and phases of series and 2nd order is basically contain soil series phases and series.

Then, first order is basically contain phases of soil series will talk, will discuss what is the phase of soil series? And kind of map unit obviously, association in case of 5th order some consociation and undifferentiated group, will discuss this thing. And you know, in case of 4rth order, this association and some complexes consociation; in case of 3rd order, association or complexes. So, you can see in case of 1st order, it is mostly consociation and some complexes.

So, you can see as you are going from 5th order to 1st order, it is becoming more detailed and obviously, different types of remote sensing sources we are also using. Up to, you know up to 4rth order from up to 4 to 5th you know, up to 5th order 4, starting from the 2nd order to 5th order, we can use the Landsat Thematic Mapper digitized data for remote from you know from remote sensing sources.

Spot image digital data can be done up to 1st order and higher altitude aerial photography we can do from 1st order to 4rth order and low altitude aerial photography can be done only from 1st order to 3rd order. And use of soil survey land use planning; obviously, 5th order and 4rth order useful for resource inventory and from 4rth order to 3rd order are from project location. Feasible surveys are you know first feasible surveys

can be done from 3rd order and 2nd order and management surveys can be done using it 1st order and 2nd order.

So, this shows this basically table shows how different order sub you know, what are the different orders of the soil survey and how they can catered, the you know different catered to the different leaves and how they are differing in their size, how their differing in their you know attention to details and what are their usefulness.

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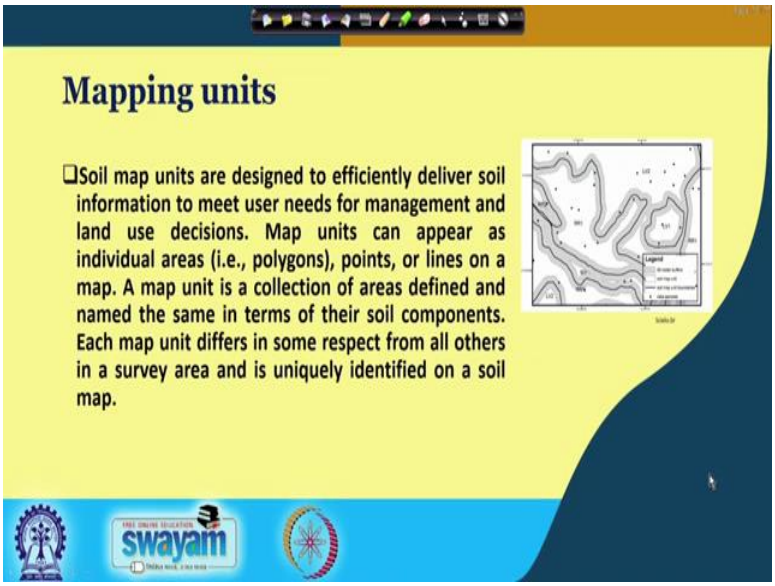


So, what is the mapping unit? So, soil map unit are designed to efficiently deliver soil information to meet user needs for management and land use decisions. So, map units can appear as individual areas like polygons, you can see it is an individual polygon here which is denoted by R R 1, then L V 2, then L V 1. So, these are individual map units and these are basically polygons points all lines on a map. So, a map unit is a collection of areas defined and named the same in terms of their soil components. So, each map unit differs in some respect from all others in a survey area and is uniquely identified on a soil map.

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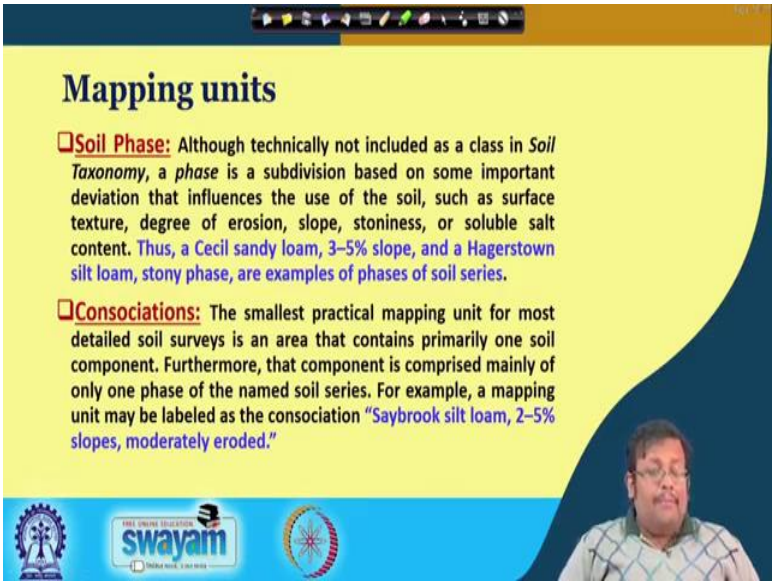


So, there are certain you know important you know terms which need to define. First of all soil phase; we talked about different soil phases while you know discussing these are different orders of soil survey. So, soil phase we know although technically not included in the class of soil taxonomy, as a class in soil taxonomy a phase is subdivision based on some important deviations.

That influences the use of the soil such as surface texture, degree of erosion, slope stoniness or soluble salt content etcetera. So, thus a Cecil sandy loam; for example, these a soil series. So, Cecil sandy loam 3 to 5 percent slope and you know Hagerstown silt loam, stony phase are example of phases of soil series.

So, where you are adding some more you know characteristics or more features in the soil series, then we are calling it soil phase because here you can see Cecil sandy loam 3 to 5 percent slope. So, adding with this 3 to 5 percent slope making it is a soil phase or phases of soil series. Now, the second important term is consociations.

The smallest practical mapping unit for most detailed soil survey is an area that contains primarily one soil component. Furthermore, that component is comprised mainly of only one phase of the named soil series. For example, a mapping unit may be labeled as the consociation like you know Saybrook silt loam, 2 to 5 percent slope moderately eroded, so, this is a consociations. So, now you differentiate between soil phases and consociation.

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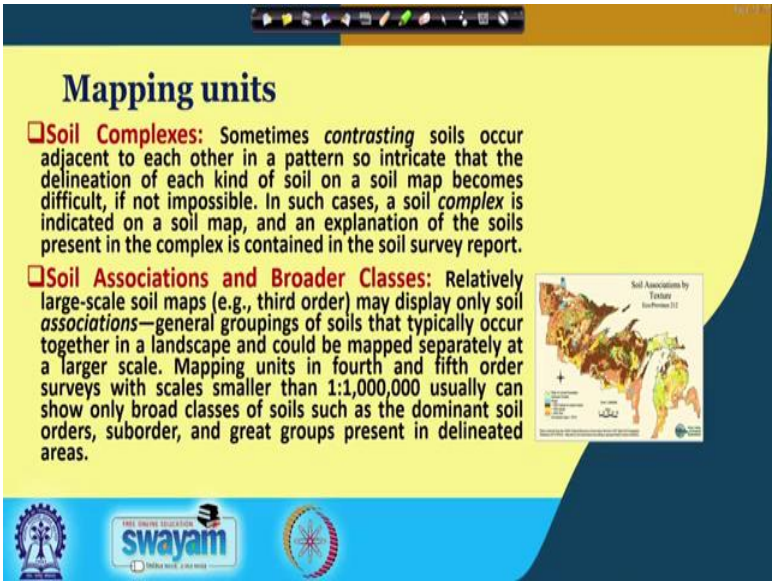


The third one is soil complexes. So, you know soil complexes you know sometime you know contrasting soils occur adjacent to each other in a pattern. So, intricate that the delineation of each kind of soil on a soil map becomes very very difficult. Again, some you know when the soil with contrasting you know characteristics occur side by side in a pattern. So, it is very difficult for us to differentiate the soils.

Then, we call it soil complexes and in such cases, a soil complex is indicated on a soil map and the explanation of the soil present in the complex is contained in the soil survey report; obviously, the soil surveys report we give the explanation. The fourth one is soil associations and broader classes; obviously, relatively large scale soil maps like third order maps may display only soil association.

So, basically these are general grouping of soil that typically occur together in a landscape and could be mapped separately at larger scales. And mapping units in 4rth and 5th order surveys with scales smaller than 1 is to you know 100000 usually can. So, 1 is to 1000000 an usually show only broad classes of soil such as the dominant soil orders suborder and great group present in delineated area.

So, you can see this picture, these are basically soil association by texture. And so, you can see these are you know the soil association is basically, sorry soil association is basically you know basically general groupings of soil that typically occur together in a landscape and could be map separately as a larger scale.

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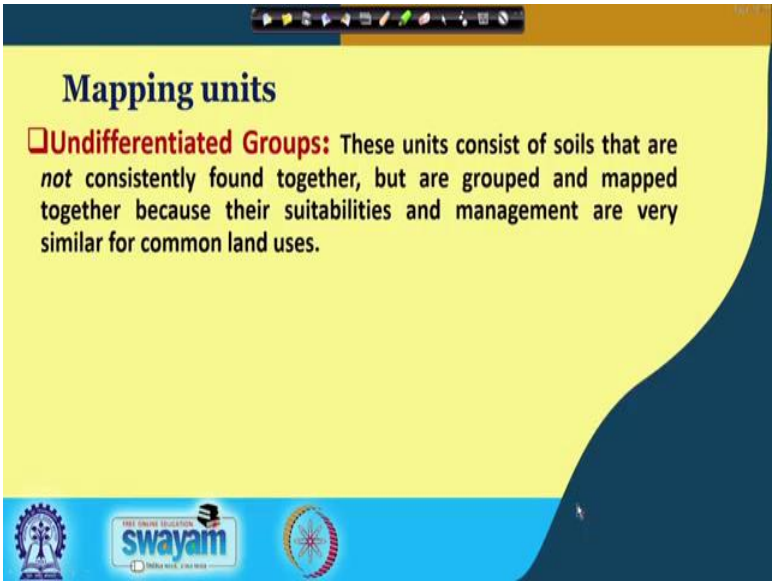


So, these are the 4 important point. So, another important point is undifferentiated group. Undifferentiated groups are these are the unit which consists of soil that are not consistently found together so, but they are grouped and mapped together because their suitabilities and management are very similar in common land uses. So, these are call undifferentiated groups.

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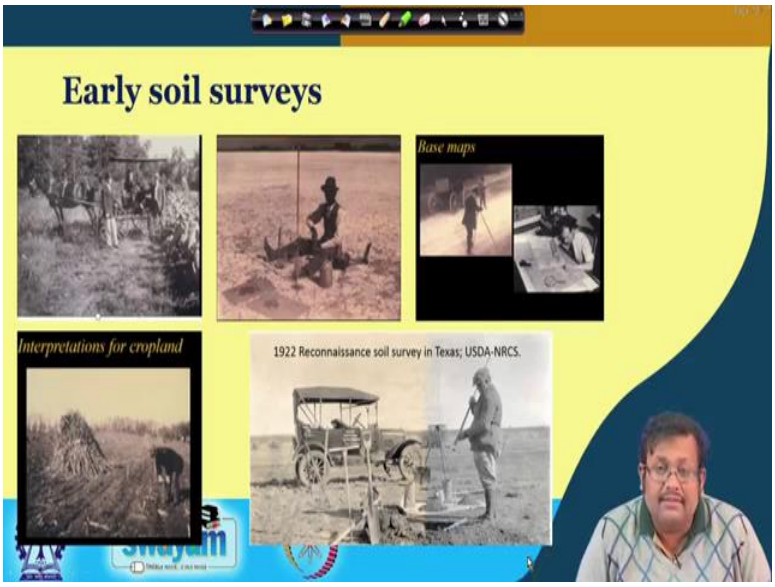


So, in this slide, basically shows the early days of soil survey and obviously, remember that whatever soil survey, we are doing here in India, we are basically following the

United State Department of Agriculture or USDA soil survey which started long back in 18 you know in 19 centuries and you can see couple of pictures when there use the traditional methods of soil survey.

And obviously, at the time, more emphasis was given to the geological context rather than the soil characteristics and you can see how they were used different types of base maps you know they need some interpretation for cropland and the last picture shows that 1922, reconnaissance soil survey in Texas by USDA natural research conservation service which are responsible for this is the organization, this is the natural research conservation service who are responsible for delineating the soil survey or undertaking the soil survey in a united states and we are basically following there guidelines in India also.

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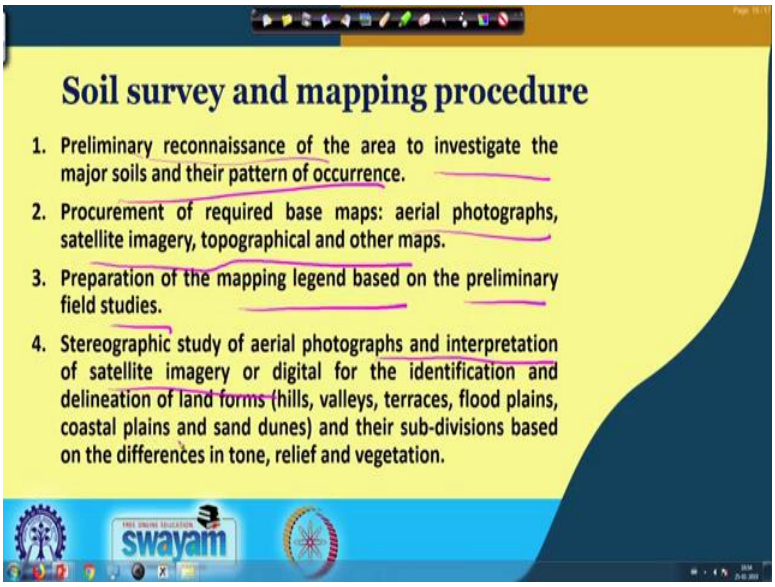


So, let us see, what are the you know several steps of soil mapping soil survey mapping procedure? So, preliminary in the first step, we do some reconnaissance of the area to investigate the major soils and their pattern of occurrence and you know this is the first step. The second step is procurement of required base maps like aerial photographs, we procure it from different sources, aerial you know satellite imagery topographical maps or other maps.

So, and then third you, we generally prepared the mapping legend based on the preliminary field studies. So, get first of all will do some preliminary reconnaissance of

the area to investigate the major soils of their pattern of occurrence. Second, we buy some base map like aerial photographs, satellite imagery, topographical and other maps. These are expensive and we buy from different sources. Third one is preparation of the mapping legends based on the preliminary field studies. So, after the preliminary field studies, we make them you know the mapping legends.

There we do the stereographic study of aerial photographs and interpretation of satellite imagery are interpretation of satellite imagery or digital for the identification delineation of the landforms and we want to identify these landforms like hills, valleys, terraces, floodplains, coastal plains and sand dunes and their subdivisions based on the difference of in the tone and relief and vegetation.

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So, this is the 4th step. The 5th step is basically so, these are the 4th step. The 5th step is basically the soils are examined at some standard interval along the traverse to locate important differences in their properties and then we further plot the soil boundaries. So, once you plot the soil boundaries, they we do classification of the soil and naming of the map units based on the morphological, physical and chemical properties of the soil forming the map unit and finally, we do the preparation of the final legends and finalization of the base map finalization of the soil map.

So, these are the some of the steps which are important for you know soil survey mapping procedure. Remember that, this is consists of several steps and each of the steps

for doing this, for executing this steps indicates you know long time experience and you know the people who do does this type of survey are called the pathologist and the soil survey experts and they have the capability of delineating each and every feature of the soil and they can they have the capability of preparation of the soil map in a most suitable way.

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And so, guys we know what are the different features we generally examine while describing the soil profile; obviously, each horizon, when we go and we collect the soil sample for ground truthing what are the parameters which we consider for classification of the soil and delineating the soil map units. These are the features we generally considered as a soil scientist. First of all, the horizon symbol, then the depth of the each horizon in layer or centimeter, then soil color under wet moist and dry conditions and also mottling.

So, mottling is basically soil when it indicates the periodic iron, reduction and reoxidation. So, that show some color here you can see you know the special mottle color of the soil. So, we it mottle soil and this mottling is an important feature in describing the soil profile and finally, the soil texture and then soil structure we have, we have already discuss this in our previous lecture and then soil consistence under dry moist and wet condition and then Cutans.

Cutans are basically ped coatings due to the process of eluviation and then pressure faces and slickensides. We have already covered the slickensides while we discuss the vertisols in our soil classification lecture and then different types of nodules and concretion of cementation, you can find different types of nodules and concretions specially form some carbonates and some other compounds also secondary accumulations.

Then, contents of carbonates and soluble salts we have you if you remember we have divided different types of subsurface horizons or indopedons based on this secondary accumulation of carbonates soluble salt like Salic, gypsy can all this thing we know calcic. So, if you remember those things, so this type of features we are also looking for wild describing this you know individual soil for ground truthing.

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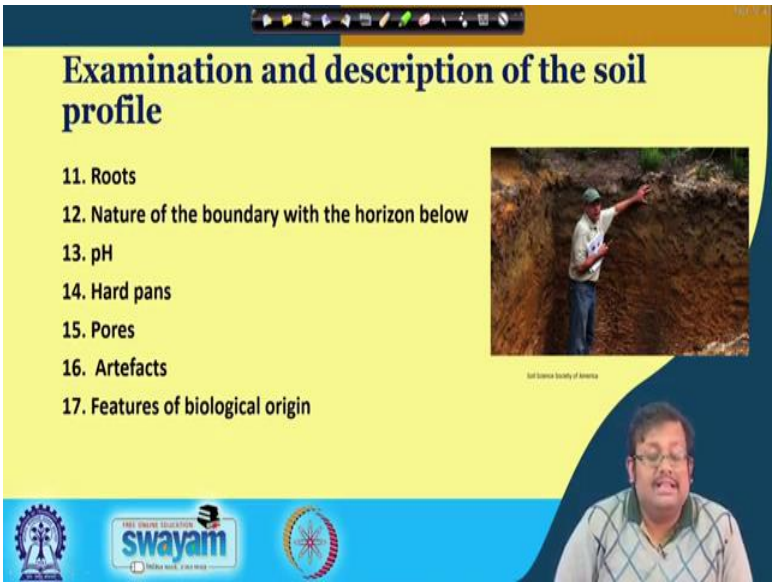


And also whether there is a presence of root where we know what are the nature of boundaries with the horizon below and then what is the pH what the hard if there is a formation of hard pans. Hard pans generally formed due to the movement of due to different heavy implements as well as you can other practices. Then pores, what is the percentage of pores, then is the presence of artefacts and then features of biological origin.

So, all these are taken into account wild describing any particular soil profile. You can see how a pathologist dig up a soil and actually define each and every layer and identify

what are the important properties of this each and every layer for proper validation of the mapping units and also based on this, they name that soil and they create the proper mapping units of that of the soil.

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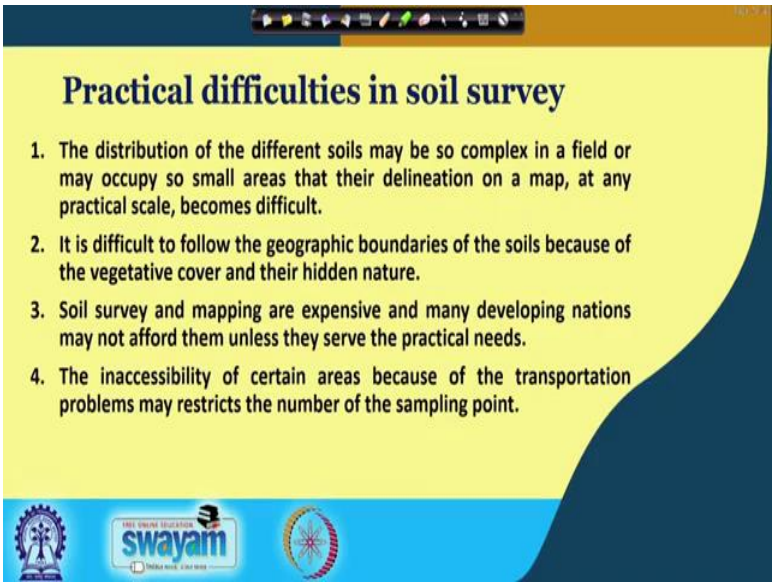


So, what are the practical difficulties of in soil survey; obviously, the distribution of the different soil may be so complex in a field or may occupy to so small areas that their delineation on a map at any practical scale become very difficult. And secondly, it is difficult to follow the geographic boundaries of the soil because of the vegetative cover and their hidden nature. Secondly, soil survey and map thirdly the soil survey and mapping are expensive and many developing nations, may not afford them unless they serve the practical needs.

And finally, the inaccessibility of certain areas because of transportation problem may restricts the number of sampling point. So, these are some practical problems are difficulties in the soil survey. So, guys I hope that you have learned about this soil survey. And let us wrap up this lecture here and will meet in the next lecture to discuss our final topic of week 10 that is the use of remote sensing in soil survey. So, thank you and let us meet and to discuss this thing in the next lecture, bye.