Geomorphology

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Lecture 6
Process Geomorphology-II

Ok, friends today in the class we are going to discuss about geomorphological modeling. Now the question arises, what is the geomorphological model? and first question is do you really need a model? and what are the different types of models? how they are prepared? and what is their utility? In this class, we will discuss in detail what are these geomorphological model and why really we need these geomorphological models. So, if you see here, we have different problems now a day the earth is facing.

The foremost problem is our global warming. So It is such a huge problem that is affecting our water affecting our vegetation affecting crops affecting soil affecting our day to day life affecting our day to day activities. So That is why though we have one problem what is affecting different aspects of life. Now the question arises how geomorphological model can solve this problem. Now you see applied geomorphologist equipped with techniques. So we have models we have knowledge. We have different techniques.

Now using the knowledge and techniques we have to solve this problem, but before solving the problem we must first understand the problem. So, problem understanding and problem solving in between this gap is the geomorphological model. So that means geomorphological model these are the bridges that interact or the bridge between this problem understanding and problem solving in between how this problem is behaving in between.

So that is the geomorphological model. So we have applied geomorphologist they are equipped with different techniques like areal mapping, then Remote Sensing then geographic information system GIS. Those can contribute from environmental management and programmed easily. So, using this knowledge using certain suitable material we prepare geomorphological models through these models we understand the problems and we predict for the solutions.
This is the main use of geomorphological model.

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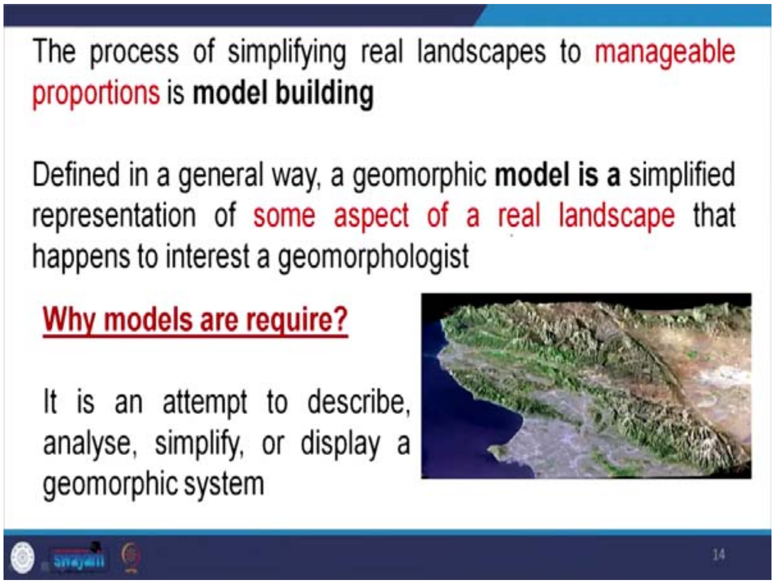

Here by definition we can say the process of simplifying real landscapes to manageable persons is called model building that is very important manageable proportion it is important. Suppose we want to prepare a model for the Himalayas or for example this figure given it is the model prepare for the San Andreas fault of America. Now you see if you are preparing a model here we are showing the fault here oceans, here the continents and different sharp faults they are arrest the hill slopes they are arrest all those things are there.

So that means what is in the real landscape that all those component should be reflected in our model. So, simply it is this model which is manageable proportion of this area, which is represented this San Andreas fault model. So if you are preparing a gigantic model large model we are not able to manage it. So, that is why definition geomorphic model it should be a miniature. It should be a replica of the real landscape, but it should be manageable.

So, defined in general way geomorphic model is a simplified representation of some aspects of real landscape that happened to interest of geomorphologist. Simplified aspects of real landscape that means here in this particular example if you see a real landscape, we have this San Andreas fault. We have this associated other faults. We have associated oceans and associated continents, the hills and whatever may be.

In the model all those component has to be reflected then it is called a model otherwise simply nothing its colour picture not a geomorphological model. So that means each and every components has to be precisely placed with proportional scale that is important with proportional scale. For example suppose preparing a model of the San Andreas fault and where only highlighting the fault and not their surrounding it is not the model.

So model that means if you are considering a particular area particular features included in the area all those features and the total area has to be proportionated and finally reflected in the model. Then it is called a geomorphic model. So why a model is required that we have already discussed problem understanding and providing a solution to the problem geomorphic problem I am talking about.

So in between this gap is filled by geomorphic model. So that means proper understanding to your problem has to be understood properly proper understanding of the problem. The processes involved between the system to understand those process we need geomorphological modelling. And once a model is prepared that become easy for a geomorphologist to predict the behaviour of the system in future. Geomorphological modeling it is very much essential for predicting a geomorphological system for its future activities.

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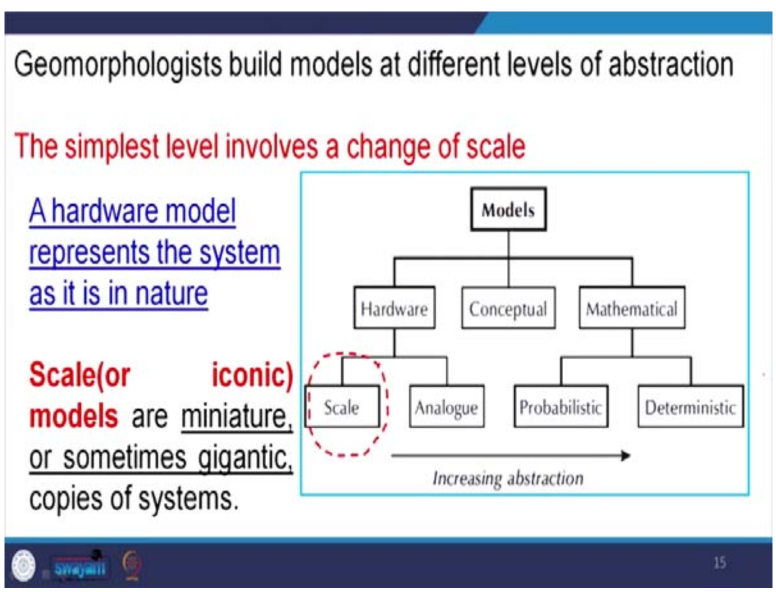

Now geomorphologist built models at different levels of abstraction for example if you see here models how we can classify you see model there are 3 it is classified into 3 different ways. one is called hardware model, then conceptual model, then mathematical model. Here Hardware model means here hard material here material is used. So that means last figure we are discussing. Suppose we want to prepare a model of the Himalayas we have to show this MBT, MFT, MCT the rivers, this peaks, the glaciers all those things and with proper scale.

So, in that case if you want to prepare a model using this cabinet place this beams using this clays and other material available we are preparing a model. So that is called hardware model that means we are using material. This material has to be choosed precisely that means in nature whatever the materials are there. For example, the Himalayas we have rocks sedimentary rocks and we have metamorphic, we have igneous rocks. So we choose the material its properties should be identical to those materials otherwise the model will fail that would not predict precisely.

Not the same material, but it should be identical property of that material which is present in nature. So, that means these are called hardware models, so that means we are using some material there. Then second type of model it is conceptual model that means concept it is only in our mind so a problem this problem with thought process started, so we could have model in the our mind that this could be that different. This could be the problem. This could be the possible causes and this will be the product.

So, to consider this problem to solve this problem there are different thoughts they different possible reasons that is going in your mind. So in conceptual model simply it is that means we will think for different concepts. This could be the concept. This could be the reasons in that is this is this problem this problem mix then you should be the solution of this will be another problem for like that. So, that means the conceptual model it is the concept, it is the solution which is different possible solution in between.

It is remains conceptual, this is conceptual model. Then mathematical model once we have a conceptual model to predict it, conceptual means it is always in your mind to come to mathematically prove it yes, whatever with you thinks your mind. It is true so to prove this conceptual concept we need some mathematical solution to it. That is mathematical model some quantified model. So there is 3 Types of model one is hardware model where material is used conceptual model material is not used mathematical model that when the concept to transform, to reflect in Real world with some quantity with some solution with some relationship.

With relationship that relation is expressed in mathematics, so that is mathematical model. So, in hardware model the first and foremost and simplest method is the scale model. Scale model means where decreasing or increasing scale. Suppose for example for your concept one scale is 1:50,000. Another is 1:10,000 which one is large scale it is 1:10,000 is a large scale. Scale model here as you consider scale model simply we are decreasing scale we are reducing scale.

Understanding the whole Himalayas at a time it is not possible. That is why we reduce its size to a tabletop. Once you are reducing a size that means we are changing the scale and if it is hardware model, Scale model it is a part of hardware model so that we are using some material to prepare artificial Himalayas on our table top and showing all those features, whatever the feature we required to show all those features we show in this model and finally it is a scale model.

Scale model or miniature on sometimes gigantic copies of the system but once we say it is gigantic copies that again, I am saying it should be manageable until unless it is manageable scale manageable size it is not model.

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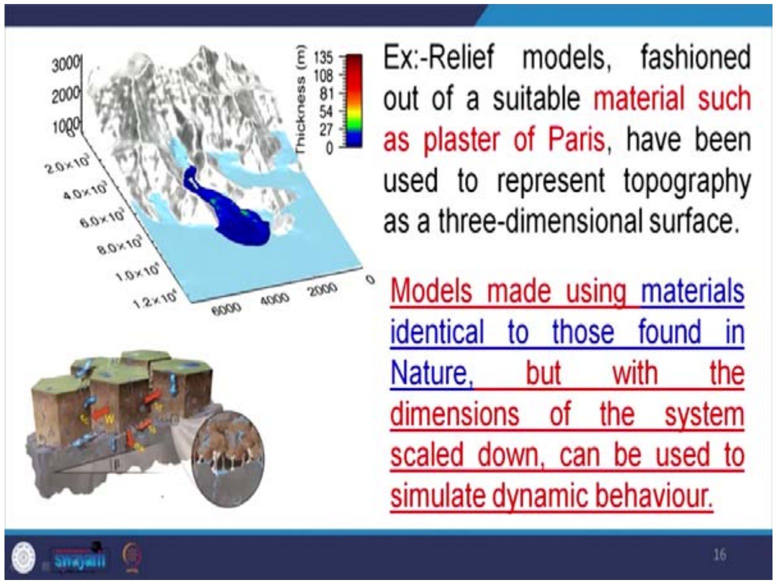

Example Relief model fashioned out to suitable material such as plaster of Paris, if you see in this figure we have a glacier system model of glacier system we have Plaster of paris prepared glacier system here. The mountains all this glacier erosional feature the sharps the carries this glacial valleys is and finally this movement of this glacier then Glacier melt here. These are glacier lakes and then the rivers.

So, that means in a glacial environment, whatever this features are those are model Pro artificial material with proper scale and this is called a scale model, scale hardware model. Models made using material identical to those found in nature. This is very much important model which is formed by identical materials not the same material but with the dimension of different scale down can we simulate the dynamic behaviour.

Because we want to understand the problems because we want to predict the future that means the model has to be dynamic because our geomorphic system is dynamic. So if you prepare a model and its throw it somewhere then it become a toy it is of no use. So that means model has to be dynamic like this geomorphic process a Glacier is moving. So, that means in a model whatever depicts whatever represents a Glacier that must also move in that particular rate where the glacier is moving.

So that means I want to say it is a scale model is a hardware model which uses the material identical that is representation of this nature but not the same material, but if we use this same material then we will put in problem, what are these problems? We will discuss here. The advantages of this type of scale model in which the geometry and dynamics of the model and the system are virtually identical these already have discussed.

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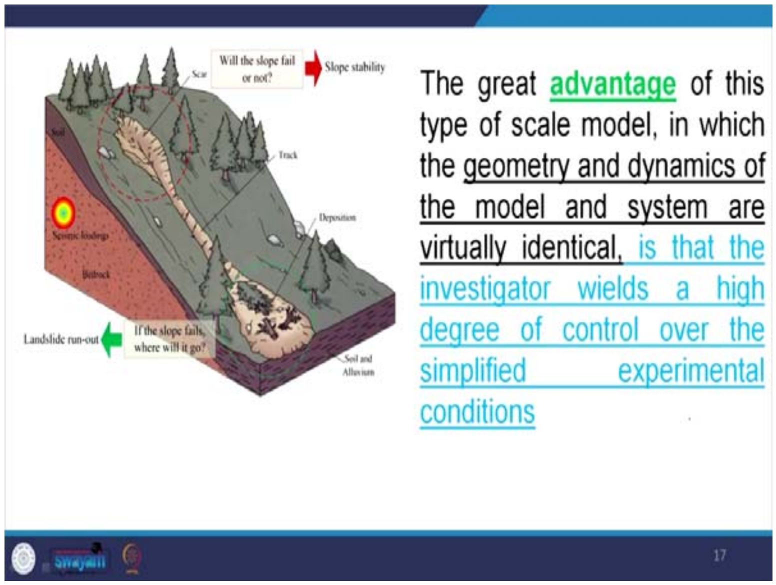

If you are modelling a landslide where preparing kaolin clay or something clay or whatever this material used for landslide means where is sliding 1 part of the land surface? Similarly in our model this type of land surface has to be slide down then it is a model and similarly sliding at a different rate than this actual then it is not a model. So that means scale has to be maintained and rate has to be maintained material properties has to be maintained.

That means If by considering those aspect we are using some material and preparing a model then it is called Scale model and hardware model. Other scale model use natural material but that has certain disadvantages. What are the disadvantages for example suppose we are modelling lacustrine environment a lake is there we are modelling it. And we have 7 metre of water for example we have 7 metre of water depth.

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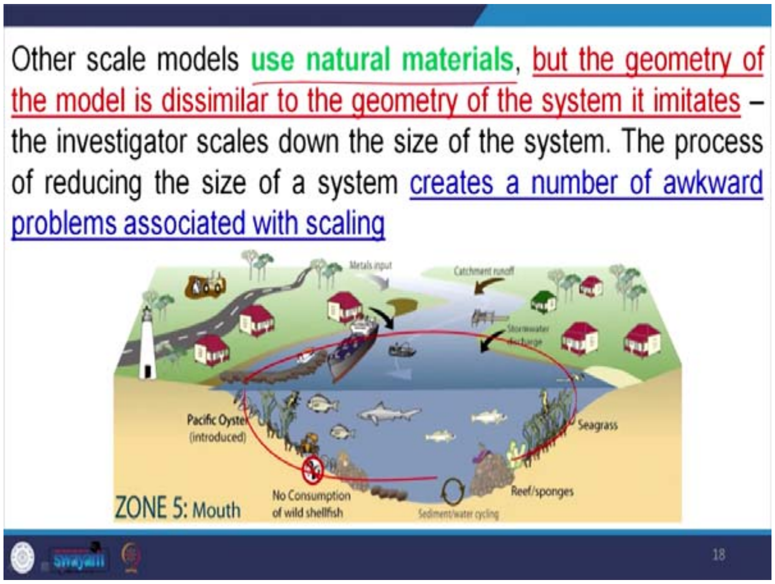

And we are creating a model of 1:1,000 scale so that means this water depth of 7 metre will be 0.7 mm so once 0.7mm depth water is there, if you are using sand representing the lake sediments this sand due to surface tension only float on the water. So that means our purpose is not solved. So, that means using material for geomorphic modelling it is also important. So, that is why we use identical material but not the natural material as it is.

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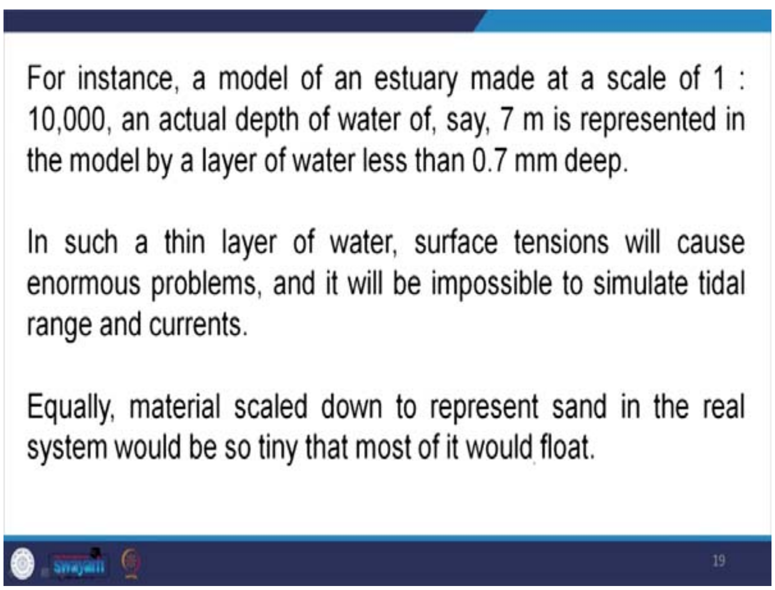

The same thing we have discussed for instance a model of a estuarine made of scale of 1:10000 and actual depth of water 7 metre is represented by the model by layer of water 0.7 mm deep. In such the layer water surface tension will cause anonymous problem it is impossible to simulate tidal range and currents also because in lake we have from tides we have some currents with 0.7 mm depth of water it is not possible to simulate those features. So It is not a model.

Similarly the sand that we have discussed this sand will float on the surface of water it is due to surface tension. So, that means identification of material and choosing a scale both are equal important for preparing geomorphic model of hardware nature.

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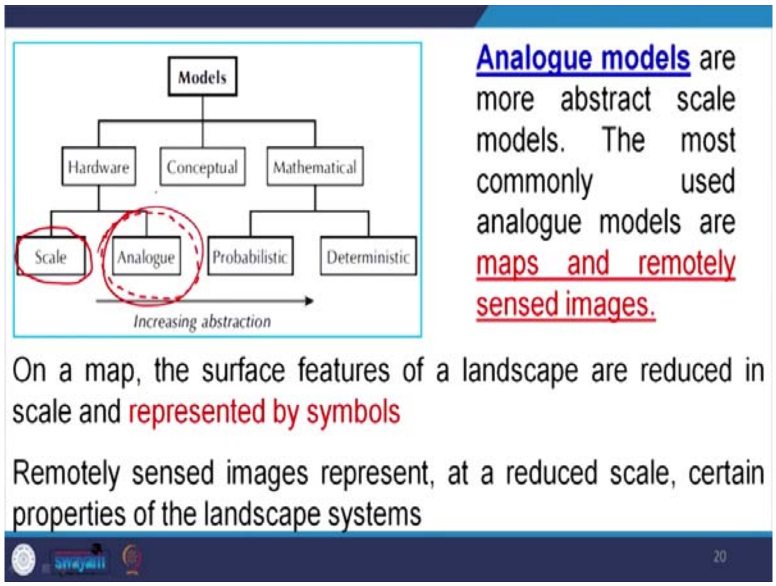

Another type of model is analogue model. Analogue model are more abstract scale models. The most commonly used Analogue models are Maps and Remote Sensing images. Similarly here there are 2 subdivision 1 called static model and another called dynamic model. Suppose geological map or toposheet of any area. This is static model. Static model means suppose for example, we are using a toposheet mapped on in 1965 for a example, so that means whatever the information available in 1965 those are embedded in this map.

And after 1965 to 2019 whatever the changes has been taken place in that area those changes are not reflected on this map. So, though we have a geological map or a toposheet that is static model, we cannot predict anything on that but if you have dynamic model, dynamic model means it is changes can be predicted. Change can be detected by showing a change detection we need dynamics in the system.

So, that toposheet can be used as a dynamic model if a series of toposheet is available. For example for a particular area for example in this area, we have it toposheet of 1965. We have a toposheet of 1970 we have a toposheet of 1980 to 2000 and 2010 for example A particular area we concentrate we consider, in that area whatever this features available in 1965 if we compare with 1970 then there will be a change. In 1990 there will be another change, in 2000 there will be another change in 2010 there will be another change.

So that means the changes can be detected through a series of map in a particular area and those models they are called dynamic models. Similarly in case of remote sensing image, suppose you have only one image that means during this image acquisition whatever the material was there whatever the information available in the land that is embedded there that is static model. But in LANDSAT series or in IRS series after a particular day of a particular time interval there will be same image will be acquired from a same area.

So if you compare those images and information is extracted from that, preparing a model or detecting the change that can be called dynamic model, so that means I want to say here static model they cannot be used for prediction propose, they that cannot say anything what will happen in future, but in a dynamic model it always predict for the future that this is the change and this is the rate of change that is important to say.

Change is not enough the rate of change that is quantification. If you are quantifying the system properly that means we can precisely modelling we can precisely predict for the future. On the map surface features of a landscapes are reduced scale and represented by symbols. Remotely sensed image represent a reduced scale certain properties of the landscape system, similarly that toposheet also.

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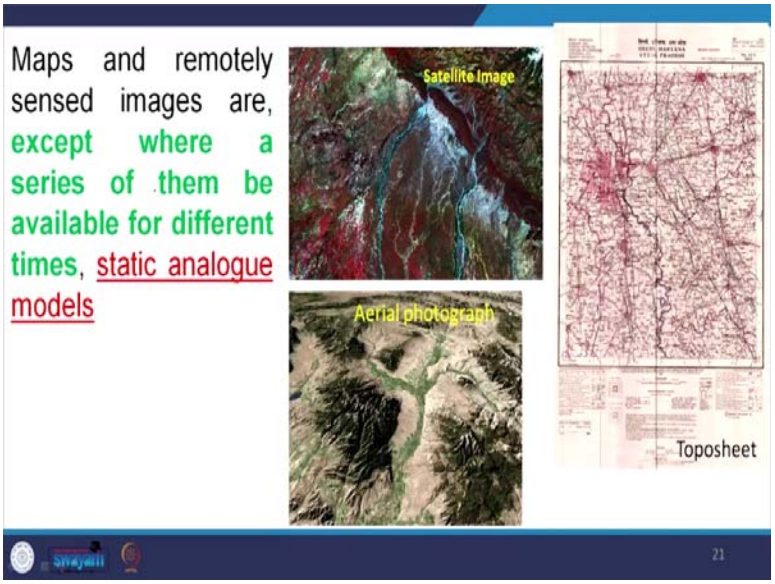

And you see here. We have satellite image, we have toposheet, we have aerial photographs. So there called the Static analogue model that we have discussed that means only maps or toposheet or satellite image or aerial photographs if only consider only one time of those that is called static system or static model. But if series of maps are available for the same area and the series of map we are extracting information and change we are detecting change then we can predict these are the change and this is the rate of change.

So those models are called the dynamic models. Now dynamic analogue model can also be built by hardware which is system size is changed and in which material is used are analogue but not the same. For example if you see here in the first image we have a river system is modeled. In the systems second the river what is the Alluvial fan system is model. So, here we have dynamic, these are the dynamic model because suppose we are creating some natural material or creating some artificial material of identical characteristics and water where; putting water here.

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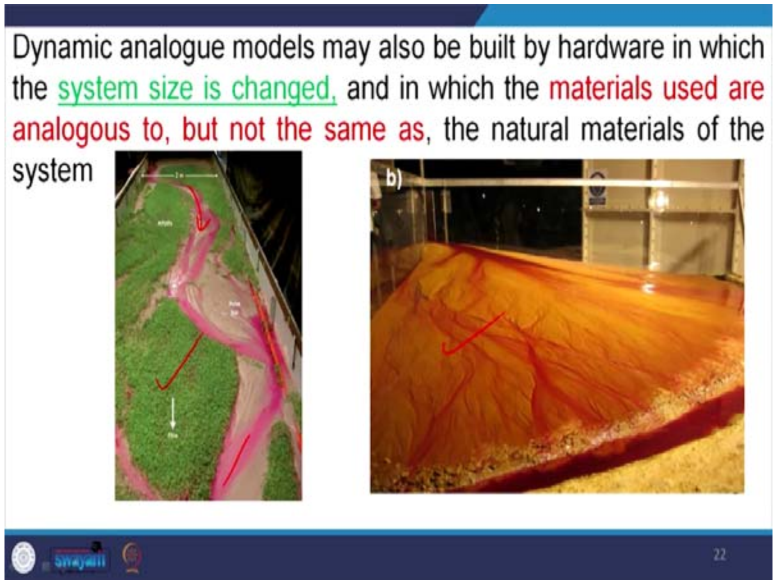

So, once you are putting water here, we are creating a river system. River system somewhere there will be side bars. There will some ripples there will be some dune. Whatever this features available in fluvial system this features will form. We increase water, we increase the velocity we increase the slope so that means we can detect the changes how the fluvial system is changing. Suppose for example if we increase the slope instead of this River system looking like this braded system meandering system that will create braded system.

Similarly we increase the sediment bars will be formed. If we decrease the sediments for water will erode its valley. So that means through this we can predict the change also and these are called the dynamic analogue models. Here material is used and the system dynamics the geomorphic dynamics can be studied.

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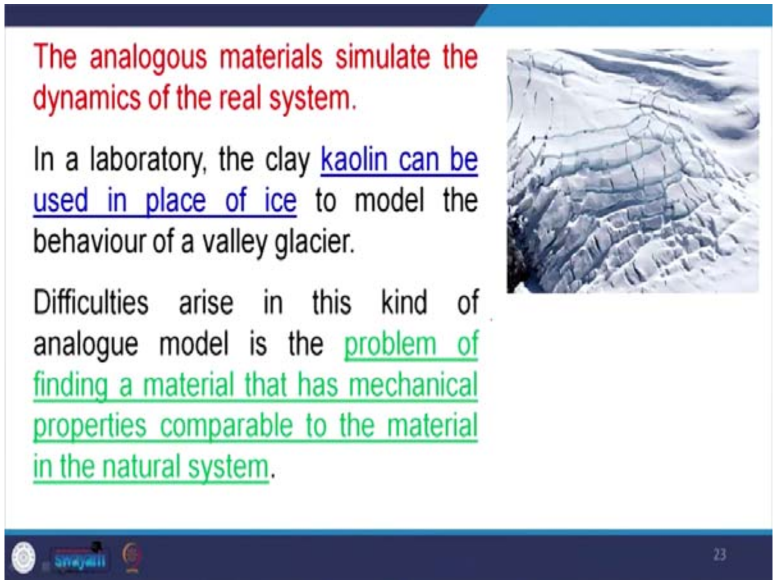

The analogue materials simulate dynamics of the real system that we already discussed. We are prepairing; we are using the analogue material, this system dynamics can be reflected can be studied through it. In laboratory the clay and Kaolin can be used in place of ice to model the behaviour of the valley glaciers. Similarly difficulties arise this kind of analogue model when problem finding material identical to the natural material is there.

It is very difficult to find out the materials which are identical to the natural material. This is a challenge to the geomorphologist. But above all we prepare geomorphic models, through the geomorphic models, we study the system study the dynamics of this geomorphic system and we predict for the future. This is applied sense of geomorphology applied aspects of geomorphology.

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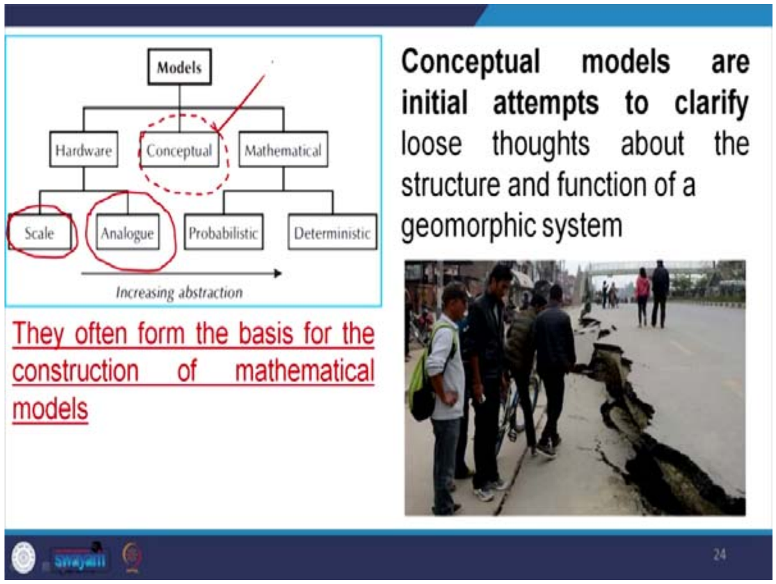

Another model is conceptual model that we have discussed already. Conceptual model that means by looking problem different concepts different possibilities comes in our mind. That means we create some conceptual model by looking at problem and that conceptual model has to be verified and should be supported through quantification by the mathematics that means it is mathematical model. So, conceptual model until and unless it is reflected through mathematics and related to the real world it remains a conceptual model. It is of no use.

Until unless our concept has to be mathematically proved and actually real world it is related, it can to predict the future. Yes whatever we are predicting whatever the concept in your mind the same thing happening in the nature. Same reason until unless it is proved. The conceptual model becomes a conceptual model it is of no use. So, conceptual model are initial attempt to clarify loose thoughts, loose thoughts about the structure and function of a geomorphic system.

So, once the thought comes in your mind to prove this thought to be right or wrong we have to refine it, we have to relate it to this geomorphic system or geomorphic process going on. If our thought are proved to be right and the rate again, the mathematical relationship is build up. Then the conceptual model is converted to a mathematical model. For a example if you see here Nepal earthquake in 2015. It creates some fractures in the Ganga plain surfacial faults.

Very wide fractures are developed. In the geological past also we have some wide fracture faults in the Ganga plain and through these faults we created some terminal fan some small, small fans. If based on this fans by their age of formation these conceptual model could have been developed if, this is a; suppose for example. If we take a graph here decide we take the age and decide we take this fan. So it could have been plotted a graph with age how the fans are formed.

And finally we are coming towards mathematical solution, we are coming to a mathematical formula of the straight line and we could have been predicted this 2015 earthquake. So that means I want to say until unless this concept is mathematically proved and it is related to this ongoing geomorphic process which in going on in front of us, this conceptual model has no meaning. It becomes a concept forever.

So that is why to convert the conceptual model to mathematical model. We should do some experiments, mathematical experiment mathematical modelling. Like that we are discussing here.

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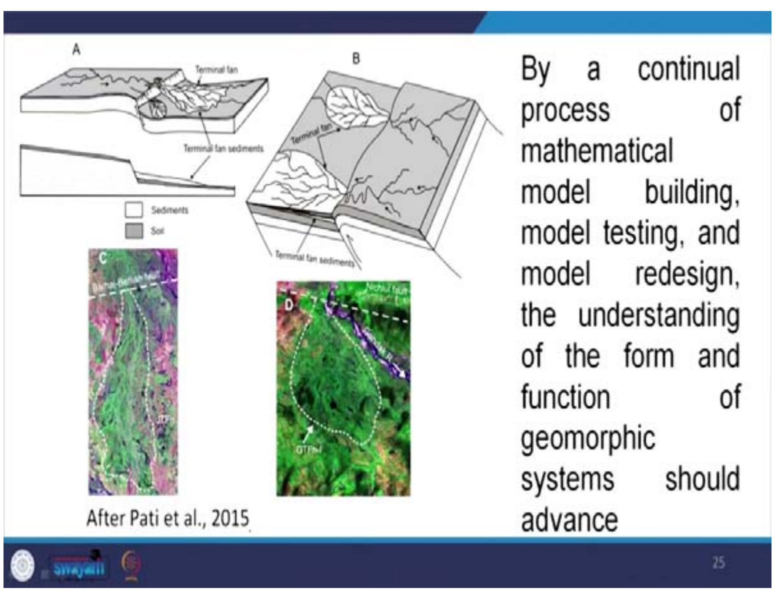

Now you see these are the surface faults these are the surface fractures through which sediments is eroded here and deposited here creating terminal fans if I can date it this sediments this bottom sediment we can say when this faulting was occurred, so we have faulting occurred here in this time. The next fault occur in this time next fault occured in this time next occurd. So that means we are putting in a straight line we are fitting a straight line and in the straight line y = mx + c, so it is the mathematical formula through this mathematical formula we can put it.

So, through which we can predict when the next event of earthquake on next event of surface ruptures is the result. So that means, by this way, we can predict for the future. so conceptual model through mathematical relationship it is converted to mathematical model through this mathematical model. We predict what will be the future scenario? This is all about this Geomorphological modelling. So, we have discussed this mathematical modelling.

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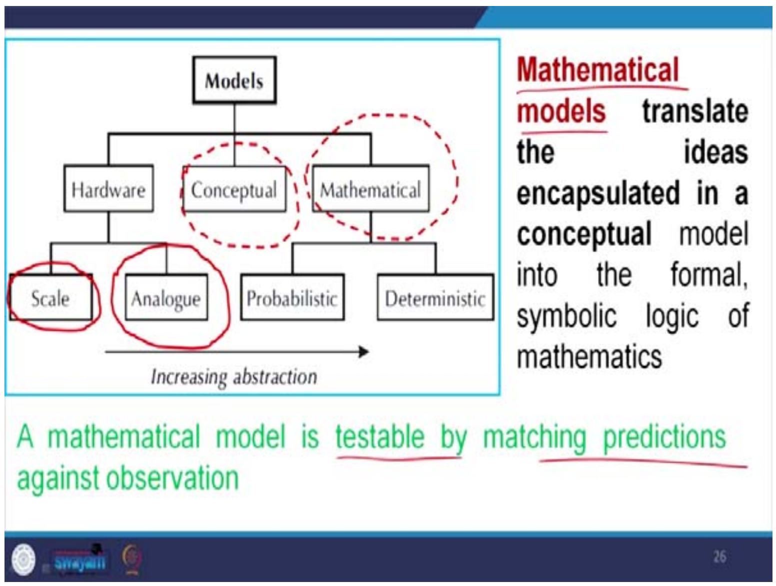

A mathematical model is testable by matching predictions against observation this is very important. Only creating a mathematical formula and relating this concept to a model is not enough. Mathematical model then it will be proved to be accurate or it is workable if it can relate the present day observation. What is going on in a geomorphic system in front of you, if that can be predicted through the mathematical formula and it is proved, yes, whatever the mathematically we have predicted, we have proved this same process is going on here.

Then this mathematical model will be truth model otherwise only become same mathematical formula it has no meaning. Mathematical model is testable by matching the predictions against observation. We have observed something our observation is mathematically modelled mathematically related it is formulated through this formula we are coming to a result and coming this result is predicting this will happen after this year or some. And if it happens so then our mathematical model is right. Otherwise there is nothing like a model.

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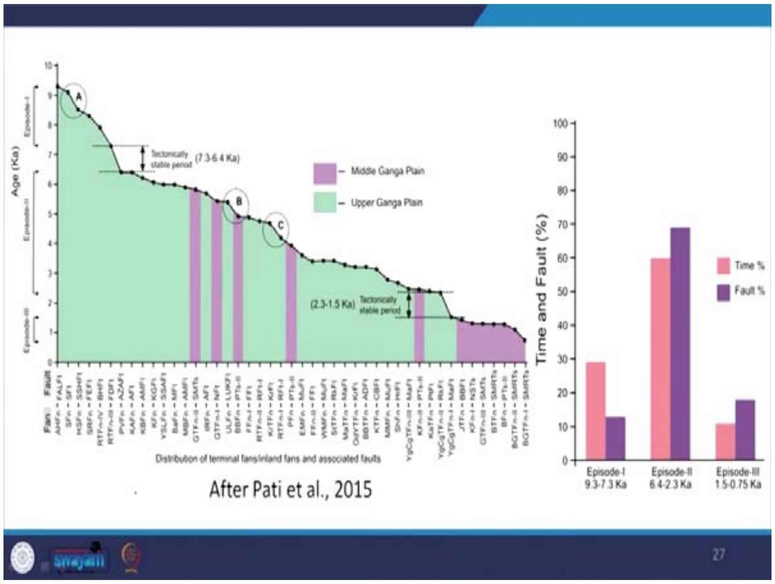

So, the same thing is can be shown here in the figure. We have this terminal fans different terminal fans associated with different faults. So now these are this episode, these are the tectonic episode first episode 2nd episode 3rd episode in between we have tectonically stable period here. We have a tectonically stable period here and in between we have small tectonically stable period here. So here if we arrange those in graphical format, we can say in episode 1 here in episode 1 we have time percentage is more fault percentage is less.

So, that means in more time there was less faults. So that means the rate of tectonic activity was less but here less time more faults that means here the rate of tectonic activity the rate of surface rupturing process it increased. Similarly in 3rd episode here this time percentage is here and fault percentage is here. That means more faulting episode more surface rupturing episode is associated. So, that means if we predict from 10000 years 9300 years up to present day up to 0.

Then we can say in ganga plane the rate of surface rupture process has increased from early Holocene to present day. So, this is the prediction, so this is the prediction. through this prediction we can say when the next surface rupturing event is waiting.

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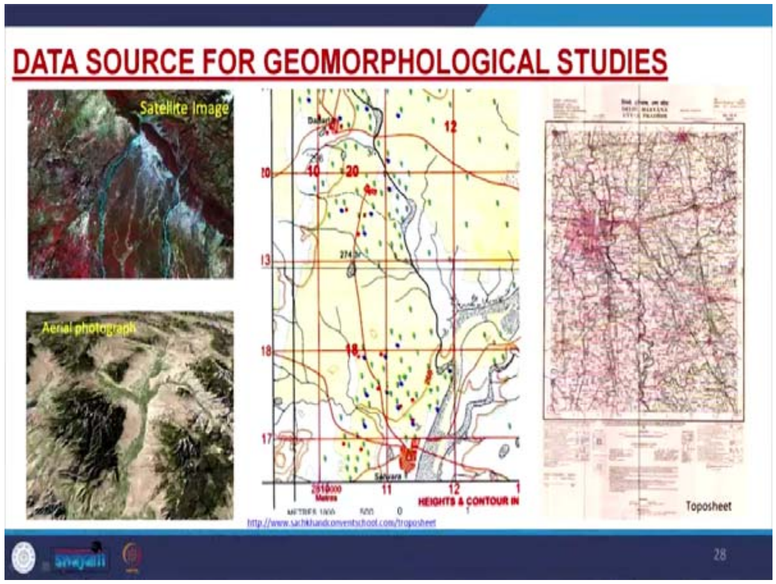

Now data source for geomorphological studies we have modeled the geomorphology. Now, we need where from place. What is the different source we can extract data to prepare this models. Data should be available there, the first and foremost is satellite image of different series of time series so that different at different times the information can be extracted then aerial photograph then toposheet isn't it?

So these are this different source from which data can be extracted. Apart from that there are some organizations like CWC like irrigation department, like geological survey of India so from there the data can be also extracted. So, which whatever the aspects on what aspect you are working based on that aspect you have to explore where from I can get those data. If you are getting those data using that data the past data using those past data you come to amathematical relationship.

And through this mathematical relations through this mathematical formula you predict for the future then complete set of geomorphological model you can prepare. Then from this data source elaborating more these are the different data.

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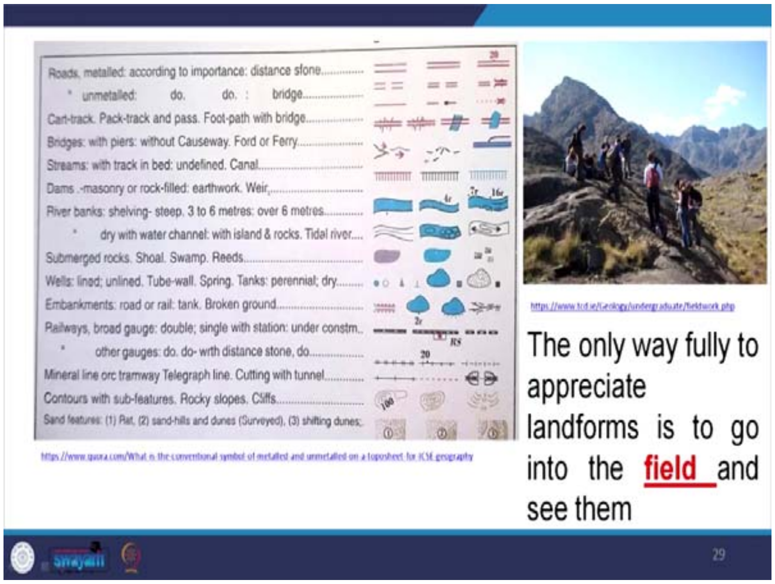

Different symbols map symbols if you have suppose you are given a toposheet. but you do not know which symbol is represented what it is of useless. So, that is why understanding or recognizing the field symbols recognizing the map symbol that is also important. So if you see here this closed contour for example, this is closed contour. This is dotted contour see here. So these are canals the roads the rivers the rocky portions, the meanders isn't it ?, the swamps so there are different symbols that has to be understood and these symbols has to be properly understood when you interpret a geological map or a topographic map.

The only way fully to appreciate landforms is by field observation without field there is no geology no geomorphology. As a geomorphologist or a geologist doing remote sensing preparing model, extracting data from map, extracting data from reports, from research papers it is not enough. You must have to visit the field to see the real life, what is going on there. How the geomorphic process is acting there? So until unless you visit the field until unless you see in the field how the geomorphic system is working. You cannot prepare a geomorphic model.

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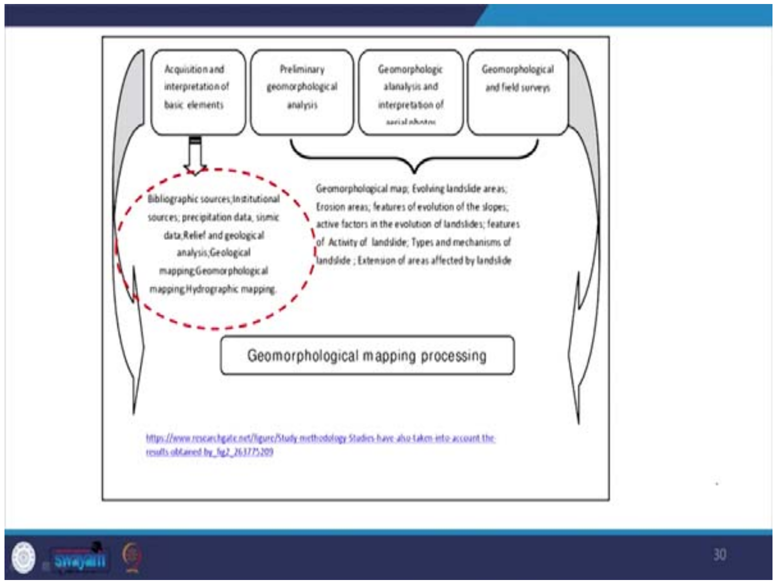

So apart from that we have already discussed bibliographic source material research paper different Institutions are there to provide you the data. Based on those data you come to mathematical model you come your observation and prepare a model and predict for the future. So, landforms; if you see landforms that is vary size from from small to very gigantic size and during preparation of the model you should be cautious that what are the material what are the scales you are choosing that must be suitable for this for predicting the future.

It must be suitable for this model you are representing isn't it. so That is why if I conclude this today's class.

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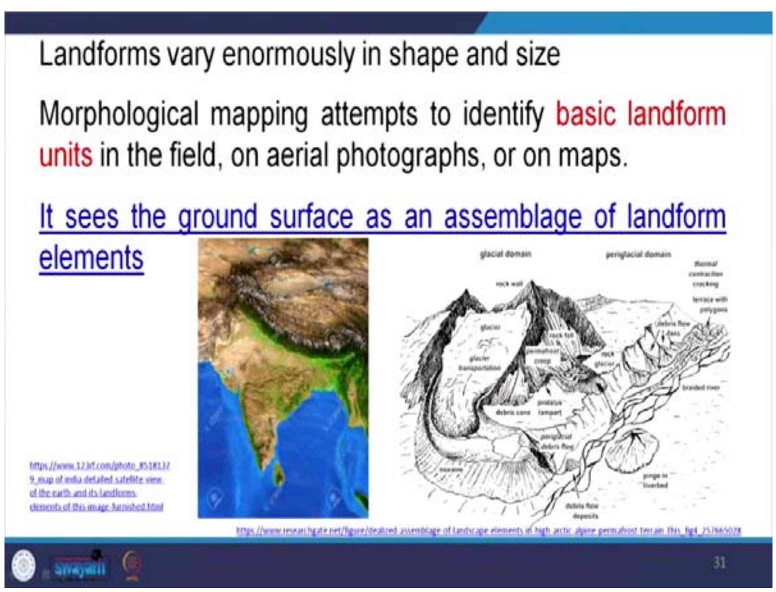

Geomorphological modelling is very much useful for predicting the future. If you are able to understand the problem, you can predict the future in between the geomorphological model that work to understand the behaviour of this problem and before preparing the geomorphological map, you must be sure this geomorphological model you must be sure the material and scale you choosed that must be identical to the nature. Otherwise your model will not work.

And second thing is that you must visit to field before preparing the geomorphological model. You have to see how the system is working until unless you model will not predict that means you cannot understand this system properly. You cannot understand the problem properly. So, this for the today's class, thank you very much. We will meet in the next class.