Geographic Information Systems
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Module No # 01
Lecture No # 03
Introduction (Continued)

Hello Namaste so let us come back with the module 1 lecture 3 which is on how GIS evolved over a period of time it is very essential in a subject for us to understand how the subject was born and how the subject as progressed over a period of time? So in today's lecture we will understand how the subject was born what was the idea behind bringing GIS then once GIS was born how it developed over a period of time and what is the status today.

We will also look at what are different software's that are there? What are open source software you can access in wherever you are and extremely efficient software's that are there in today's context.

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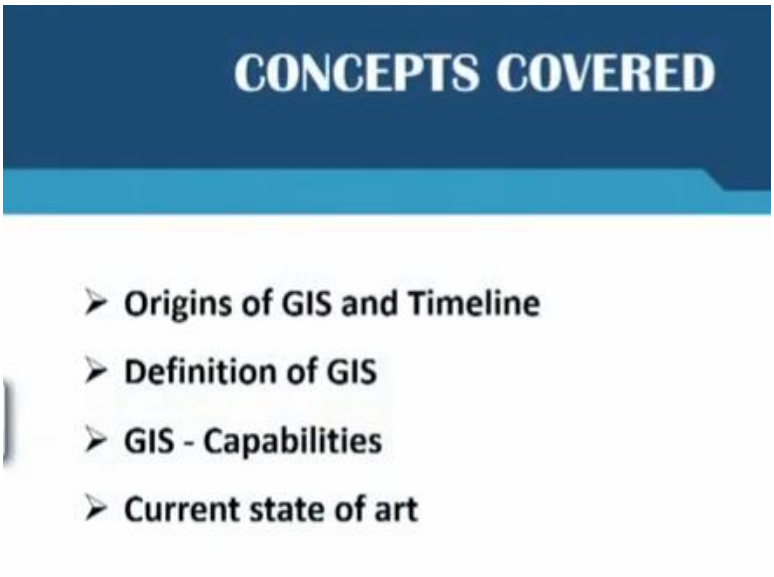

When we look at the entire concepts that will be covered today the first one is origins of GIS and it is timeline how it is started what is today? Then I would look at definitions of GIS so when every researcher looked at GIS in a different lens they could see different ways of applying GIS they have different structured methods of applying GIS. So that is where the definition of GIS comes from.

Then is the capability of GIS so what GIS can do so I would list out of few of them but it is not everything but few of the capabilities that may be useful to many of us in daily life if you are trying to apply GIS. I would give you a list of capabilities and some of those can be applied maybe during our practical class you would even cover some of those applications. And the last part is current state of part so what do we mean by current state of part?

Did we start with something that is the stop capability and what is till today and how we are progressing and what are the essentials that if you need to be a state of art technologist. So what is the thing that you need to understand is what we will see in this set of slides.

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So when we think about the origins of GIS it was with the advances in the computing, cartography and photogrammetry which started with automated GIS in 1960's. So cartography was that its initial stages it was picking up pace whereas computing was really a very advanced stage at that point of time and photogrammetry was a point where a people where understanding how it can be applied in that case the concept of automated GIS abort.

But it was Ian McHarg published designed with nature in 1969 where he proposed a concept of land suitability and capability analysis. So when land suitability that suitability of land that is because of geographic feature it is started with the evolution of in geographic information system. That was the first point when the GIS started evolving but it was afterwards in Harvard

laboratory for computer graphics which developed and made available a series of automated mapping and analysis programs.

So during that time it was only for mapping so they did the automated mapping systems having solutions, software's etc., for mapping an analysis program. So this was the first baby step in where the GIS was really progressing well. Then the when we if we have to really say the entire package of GIS was to be built the first GIS was born with the Canada geographic information system which is also called as CGIS.

So Roger Tomlinson in 1960's a rehabilitation and development of Canada's agricultural lands was his work wherein he introduced a concepts of what do you understand by geographic information system where the geographic information was on the agriculture land and the information was developed based on how to rehabilitated and how to develop these agricultural lands for Canadian system. So this is where the first ideas of being a system evolved before this it was just a software but now it evolved as a system.

Now once the system evolved it was in 1970 where the very well-known major players of industry started the commercial development in 1970's that is ESRI and Arc GIS. So ESRI started producing its own cartographic part products along with Arc-GIS. Arc-GIS was is one of the excellent software's today which as every module of how you look at GIS. You can even write certain programming using modules of GIS modules of other GIS tools to produce a new GIS tools that is how it become a software end user into the system.

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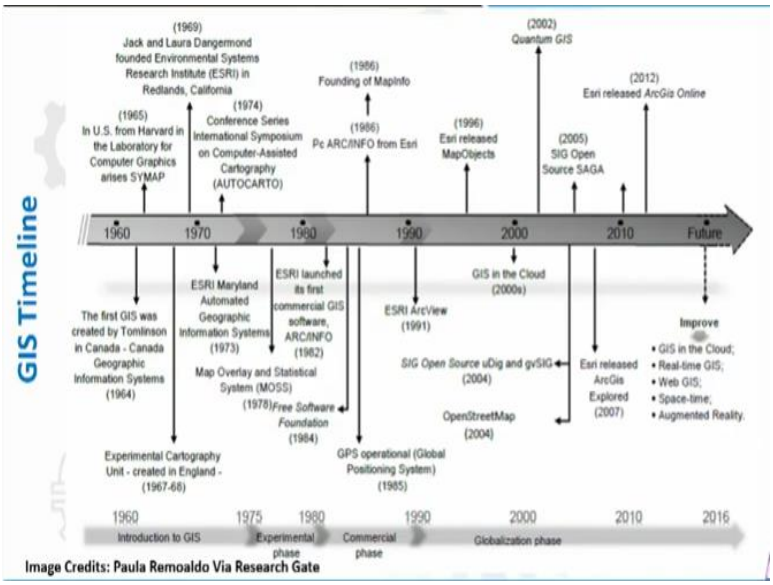

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So to give you a brief of how the time it evolved as I said the first GIS was created by Tomlinson in Canada geographic information system later it was in US from the Harvard university where they develop SYMAP. So once this was done there as a short communication wherein Jack and Laura Dangermond founded environmental systems research institute that or its called as ESRI in Redland California.

So this actually paved way for commercializing GIS so once it was done in ESRI Maryland where automated geographic system was born in 1973. So and in 1974 there was the first conference series which was called Autocarto. So this was a targeted conference in order to develop the geographic information and also the spatial data how the spatial data can interact with the geographic information. So it is the geo-spatial information the conference it was the first one so it was more on assisted cartography which is otherwise called as geo-spatial information.

So with that they did that in 1978 it was MOSS that Map overlay and statistical system this was a very effective I would say rather than a software tool in order to understand how the map overlay happens and how we can take it forward. Then is still on 1980's he launched is first commercial ARC-info and 1996 it was map info. So map info is another software which it as extensive I mean whatever you take analysis with geographic information system as good number of tools they have developed over a period of time.

So ARC-GIS and mapped in part two very players in terms of handling geographic information and the spatial data whatever the tool is required for any kind of research can be developed or can be also found in this systems but also it can be developed they have made it itself an evolving software where one can design their own tools own systems their own procedures of handling this geographic data.

In 1990 ESRI ArcView which has a platform to to deliver the data to the users was developed in 1991 and later ESRI again developed mapped objects. So these are small parts of the same software that was actually built for different purposes but the revolution came in 2000 where GIS in the cloud that was the first that was first thinking where GIS can also be put on the cloud and GIS can be understood as may be a system that can be connected elsewhere and you do not need a system to look at a particular process or software.

It can be centralized such thought came into existence in 2002 Quantum GIS was born as I said Quantum GIS is a free and open source software and it is one of the very foremost and I mean very good software's in terms of handling any geographic information and spatial analysis of any data. So then you had SAGA GIS also it is extremely good in terms of handling both any kind of data models that are available in geographic systems.

So then we ESRI released and Arc GIS explored in 2017 so this how is started actually the Arc GIS started then you had Arc info then Arc GIS started evolving I think Arc GIS as recently even released Arc GIS 10.7 it has evolved over so many years and ESRI to get online wherein Arc GIS online was born in 2012 what today's context all the software's in today if you just go into some of the free and open source software list you can find huge number of software's available for anyone to do research without even investing a (()) (10:24) into a software part.

I do not say that the pass of (()) (10:28) are only things that has to be used it can be a commercial software's also a fast of quite capable of handling any type of data given that the user has certain competence in handling the data. So what is the future? Future is GIS is now into the cloud I every computing is going into the cloud so centralize systems of computing as taken over the hardware resources that needs to be there.

So you do not need a hardware resource you need to only have a centralize computing systems so that is one good thing that has a over a period of years has changed and probably the students researches will have more better capabilities handling of this data can be come in future with the GIS on the cloud. Then people are trying to really work on real time GIS so that is where the next research next phase of research really kicks in the web GIS this is the big part of today's research.

So web GIS how do you really have geographical information's in the web context what are the different standards how do you put out the standards is the data interoperable? How do you save your data? How do you actually share your data? So all of these are very important part in today's context when web GIS is the one that is actually taking over the GIS as in a big way and making it possible for every citizen of this country or across the world across the globe to look at the GIS data.

Then looking at augmented reality so this is the next gen thinking that the people has started using into the GIS system when the augment reality AR systems will be used in order to develop GIS data in a much better platforms so that it is much more appealing and also gives understanding of what is the depth information into it. So this is how the GIS has evolved over a period of time.

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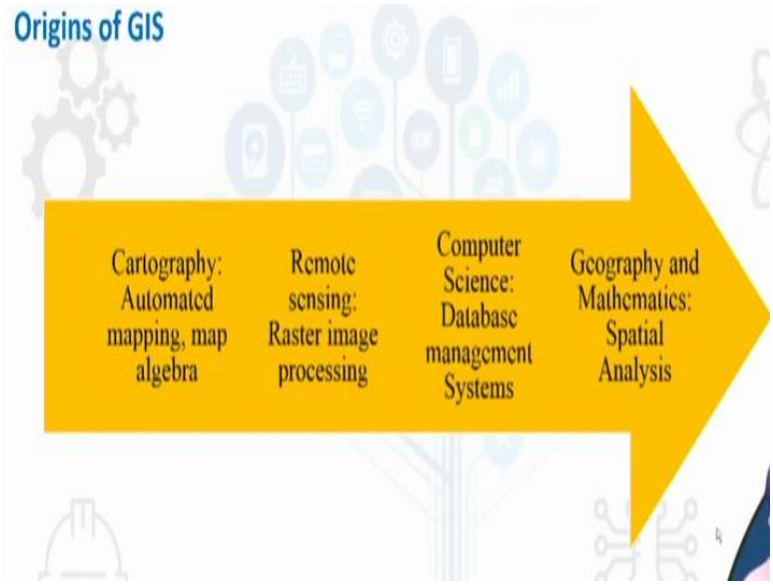

So when we just put it across first thing was cartography automated mapping and map algebra and that was a first step of how GIS evolved. So it was just with cartography and automated mapping everything started then it was with remote sensing which actually pushed GIS into also handling raster process in capabilities. So we had the rater processing capability I will in the further classes may I will inform you what do you mean by raster and what kind of model it is and how the model runs.

Then you had computer science the database management systems then finally the geography and mathematical aspects in terms of spatial analysis. So clubbing all these things will make a GIS. So geographic information system is about cartography is about remote sensing data it is about database management and it is about spatial analysis clubbing all these would give you single system that is nothing but geographic information system.

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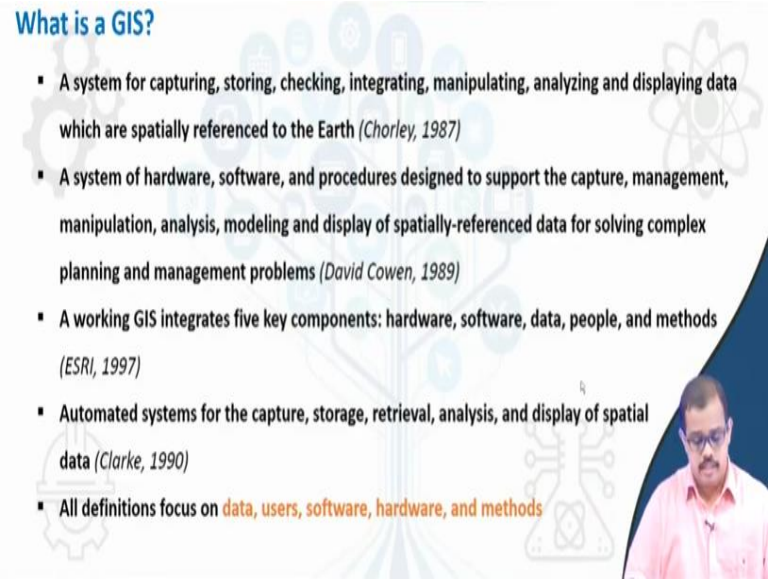

So if someone asks you what is GIS you have several definitions over a period of time that has been defined. The first definitions is that I can think of is it is a system in capturing, storing, checking, integrating, manipulating, analyzing and displaying data which are spatially reference to the earth. So now when we look at this it is says spatially referenced earth that is why it is called as geographic data.

So when there is system which can handle this data in order to capture. Capture may be through your scanner so digitizers etc., or even camera's it captures, it stores it may be using the database

then integrating it for various issues manipulating the data in order to extract information analyzing the information and displaying the information in such a way that it is understood by various users.

So this so it means to say that it has information it has a system to handle it and it is a geographic in nature that is what it means. So other author David Cowen who defined it has a system of hardware, software and procedure designed to support, capture, management, manipulation analysis, modeling and display of spatially reference data. So he has put in more efforts in defining from the scratch to the end which means to say that it has an hardware,

Basically as I said in the previous class it has an hardware it can be defined as a software so along with the hardware and a software it is a science. It is a science helps us to capture manage manipulate modeled and display the data. So and for solving complex planning and management problems that is what Cowen said I mean had visually given the entire process of how the data analysis can be done spatial analysis can be done.

And ESRI in 1997 defined the 5 integrative components the key components of GIS it said the key components of GIS are hardware, software a data, people and methods. So this was first where it started with people until then it was with data and information but ESRI did define it has data with people and methods. So that is where integrating of science tools and information's started and delivering it to the end users started to be looked at.

Then there is automated systems Clarke in 1990 it as before (()) (16:44) actually putting a subjective Clarke in 1990's said automated system in order to captures, storage, retrieval, analysis and display. So this also define the same thing but it is on display of only the spatial data so when we look all of these definitions whatever the definitions that have defined here there are many more definitions to be looked at but these are some of the very well-known definitions.

So when we look at all these definitions it is based very specifically data, users, software, hardware and methods. So collect a data and users are the last part so data to users you have a software you have hardware and a method. So that is how GIS is all about so that is entire process of how GIS is made is can be defined as.

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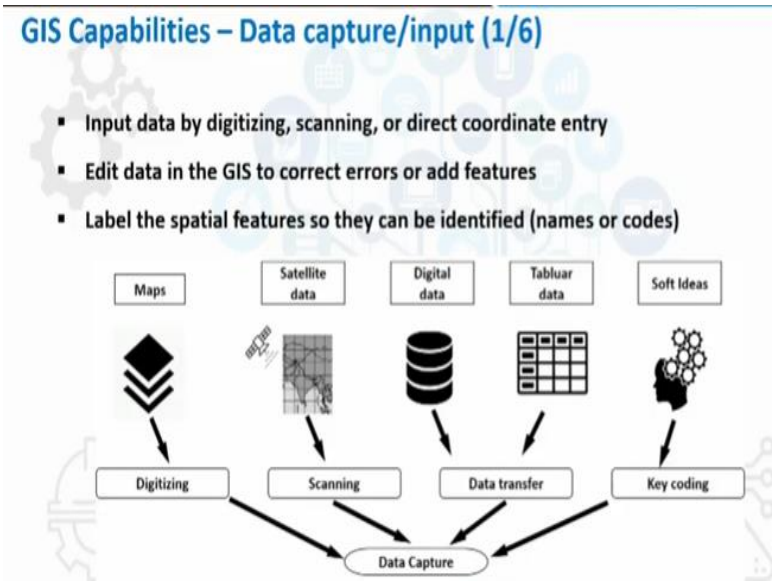

And when we look at capabilities so first capability of GIS is data capture and input. Input data can be anywhere it may be by digitizing the scanning or direct coordinate entry you can type in yourself or you can scan your map sheets, you can scan your photographs, you can digitize your photographs. So it means you manually on a digitizing board you create those photograph by yourself. So edit data in the GIS to correct errors are to add features.

So sometimes when you are collecting certain data you may have certain errors that you may be because of there may be certain shortcomings in the field or it may be because of some issues that data would be wrong or it may not be as accurate as it have to be. So this can be easily corrected these errors can be easily corrected and you can add features certain features you may have noted it down.

So that can be easily added into this data without much of a headache so labeling the spatial feature so that they can be identified for example name or code. So when we look so let us say I have 4 different map sets so if I just put all the 4 different map sets into my geographic system I would not be able to understand which map set belongs to which region so I have to then look at every map set look at its coordinates so where it belongs to then again may be located on the ground or on the map or on Google earth where this actually this map belongs to.

Instead if you label it as for example this map to Kolkata, this map belongs to Delhi, this map belongs to Mumbai. So such labeling can also be done in GIS that is what I mean by data labeling.

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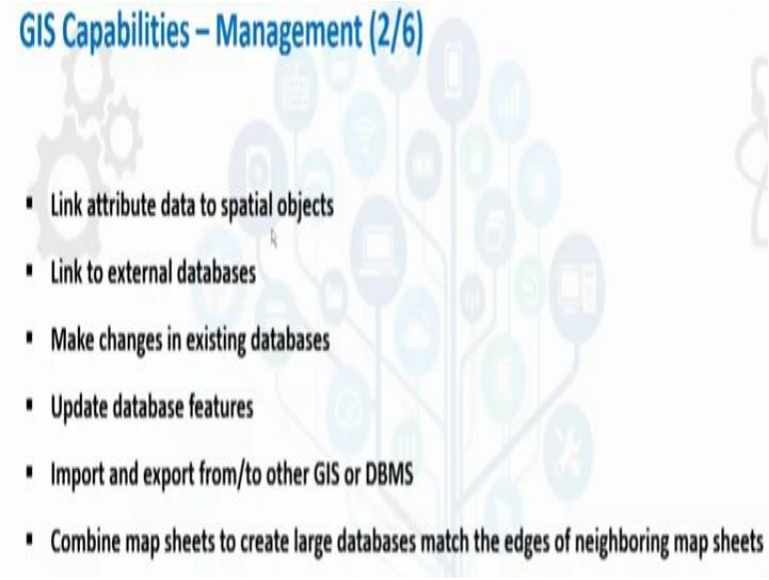

The GIS then next capability of GIS is to manage this is the most important and most powerful part of how GIS works it can I spoke about the attribute data so both spatial data and non-spatial data can be added as attribute data so the querying the linking of attribute data is extremely good in GIS. So you can have huge sets of data for example if you have 100 students in a class so every student information can be stored in the database and whatever the query whichever teacher wants may be subjective query or it may be the query about the information about a student of the particular student can be easily done with just with small query small probably English prompt.

Then link to the external databases so you may have certain databases that the governmental agency actually putting it forward. So you can easily link that database and match the database retrieve information from those databases and use it for meaningful output that is also extremely possible. Then make changes in the existing database so this is very important in GIS no other map system or no other system as any capability of making any changes if there are certain errors.

So such a system can be done using geographic information system so you can update database features so which means it temporarily it can be changed it can be updated may be the feature in 1997 would have changed in 2003 to have in changed from much better to 2010 it could have been completely different. So every updation can be done much easier way. Import and export from to other GIS or database management as I said can be done combined map sheets to create larger databases.

So as you understand you have different scales in a map sheets you have different map sheets based on scale if you take 1 is to 50000 if I am looking at one particular city may be I need 4 or 5 or 6 maps for looking at the entire city so if that is the case instead of doing analysis that is only on one map and extracting information then again doing a analysis in second map this can be combined and create a large database as large single database where in it can be used for multiplicity of purposes.

So these are done based on the edges of the neighboring maps we also look at how we will reference in map how will we see how the edge of a map is there how do you we actually geographically reference without any errors. So all this things will also look it in the software part of this subject.

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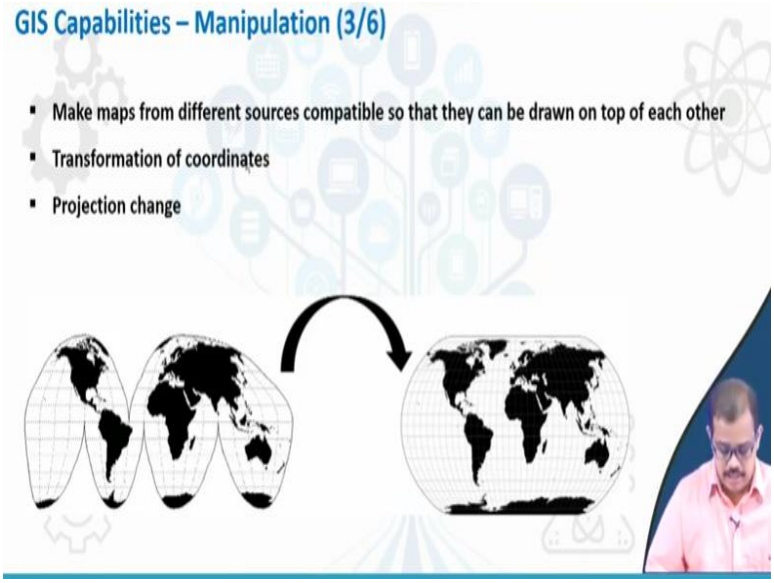

And when we look at the third capability manipulation so manipulation in terms of different source that are compatible so they can draw on top of each other which means you can have

different sources but this sources should have a common system. So common coordinate system, common projections so that they sit on each other and all the information can be easily drain out from that system. So this can be again presented for various purposes.

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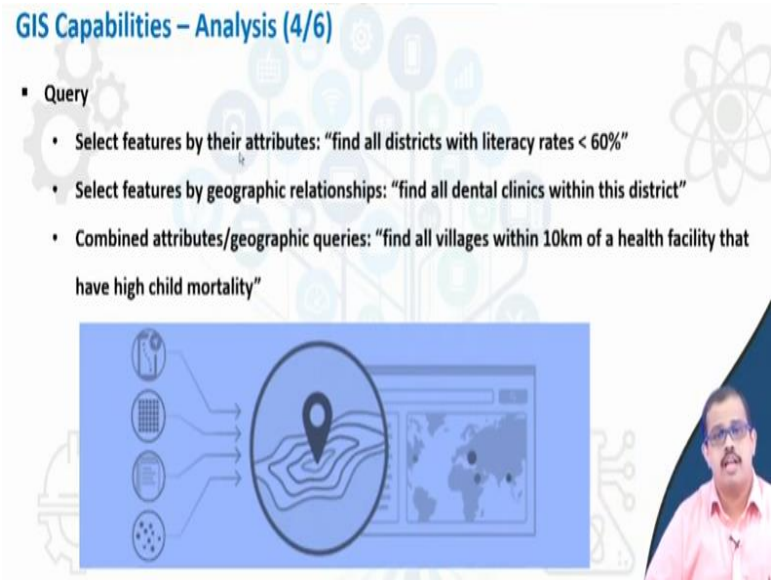

And when we look at the forth component it is about the GIS capability that is analysis this is the most important tool that any software can provide that is it you can select features by their attributes for example I have a map of entire west Bengal let us say so if I have to find out all the districts which have a literacy greater than 60 it means to say that I will just give a command prompt or a query wherein I will say list out that particular row which has greater than 60%.

So literacy rate anything greater than 60% if I give a small query the entire list is with me because the entire database would have been populated. So I can select that feature then create a map out of it and display it to the audience when and wherever it is required. Then select features by geographic relationships for example if I am in Midnapore in west Bengal. So if I have to find out all the dental clinics within the district I will just give a query with.

For example if we have dental clinic's there I just give a query saying that the find out all the dental clinics that particular label name in this Midanpore district so the entire list would have been dropped down to my reference and I can create the thematic map out of it and a map or just a map out of it. Then combined attributes or geographic queries so when I say the first two

aspects select features attributes as select by geographic relationship you can even combine both of these.

For example find all the villages within 10 kilometers of health facility that have high child mortality okay. So such examples are can be easily done so if you have variables that you are trying to understand or trying to put into a model so it is just a query of all those variables can be taken then this model can be easily built that is where analysis comes into effect.

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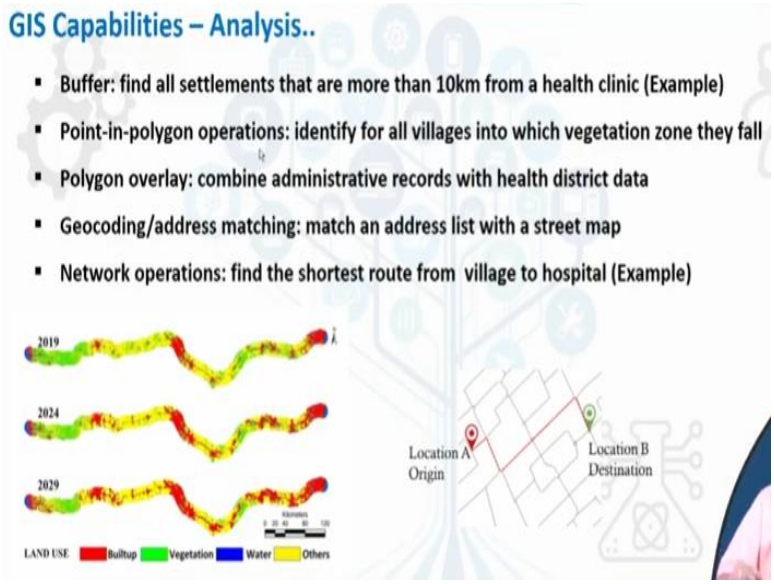

As we see we have already seen how we can do buffer analysis that is one of the very important aspect of how GIS can give us lot of information on development or issues that have that are concerned or how the societal aspect as to be handled. Similarly point-in polygon operation these are certain operations that I am trying to put out so that you understand how a different tools are there in chase where you can utilize it.

But we will also learn many of these tools when we are looking at the practical aspect of it geo coding and address matching. So match all the address list on with the street map so this also can be done with just a query so you have your network connected so you can always look at this. Look at network operations fine for example if you have a map of your entire region just like a Google map if you create your own map of your district or your region and you have all amenities on it.

So if someone wants to find out the shortest distance of the map it is just a query to say that to this point to that point what is the shortest distance that can be seen.

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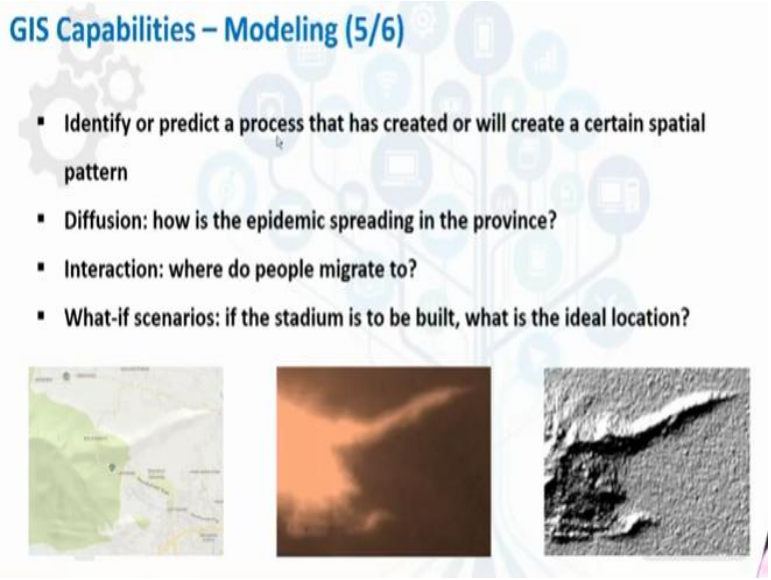

Then the fifth capability of GIS is modeling so for example if someone is looking at what is scenario? Say if the urban growth happens at this rate what may be the change and where the change is in the earth surface on the earth surface where the change may happen why the change is happening what are the drivers that change happens such analysis can be done in the modeling capability. If there is an epidemic that is spreading which province is spreading how it is spreading? What are the geographic locations it has been spreading into and why?

So all such issues can be just analyzed with just collections of geographic data may be in a day or two in a near real-time. So such capabilities also are there are very important for a software of something like GIS.

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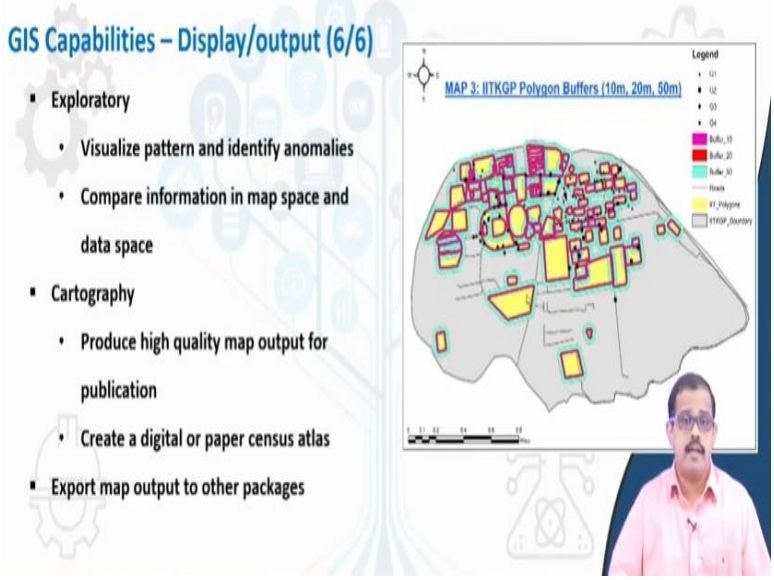

And very interestingly the last part is the display and output this is where we use (()) (27:26) where you have usual patterns and identify anomalies for example I have shown you here is an a partial map of IIT Kharagpur is a certain buildings in IIT Kharagpur the so these are most of them are the academic building. So when we look at this we can do analysis such as if I have a buffer of so many meters so and we have a green lawn so what kind of area that is required around this buildings or what are the facilities that can be put in around the building so that the students have an access to such issues.

If you put it in 5 meter buffers, 10 meter buffers if I put it in 30 meter buffers or if I put it in 500 meter buffers so how many departments are going to be engaged into such issue. So all of these things can be easily analyze just with having certain data that is that can be built in. So any kind of analysis anyone need a specific analysis can be easily done with such data produce very high quality map outputs or publications and also create a digital or paper census atlas.

So this is what actually taking a today's world so digital paper or digital paper census at atlas which extremely good. Export map output to other packages so interoperability of any of those is very say inbuilt package in any GIS software so that can be done.

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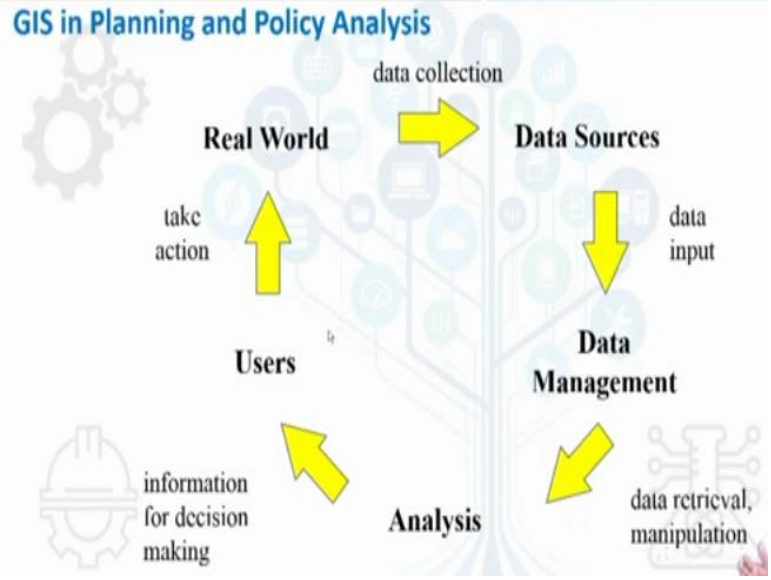

So GIS can be used in policy planning and policy analysis for example when I say I started with the real world how did we collect data? What are the different sources this I will speak in next class. Then we look at data management once we look at the data management how we analyze the data and finally it is users which who get the information for decision making it can be any governmental users, it can be any private users, it can be any normal users who actually look at the data as information. Information any decision making any of the other aspects that is required.

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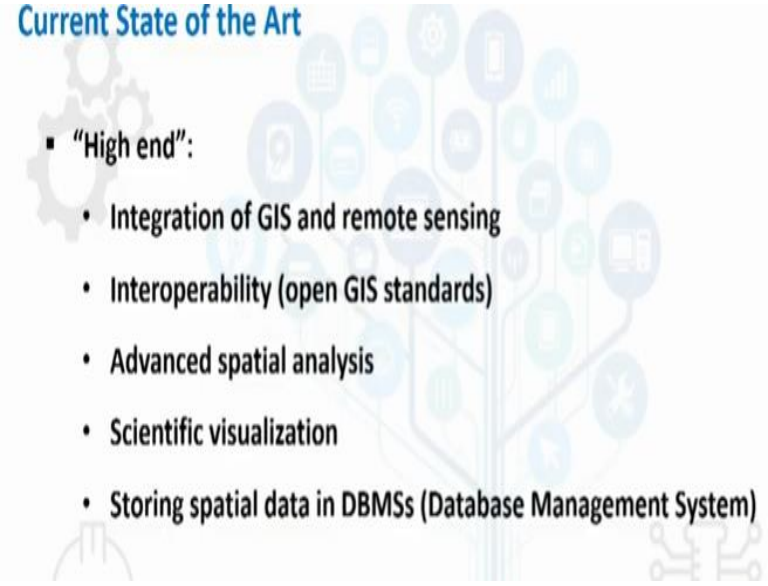

So when I say current state of art there is two things one is if you want to have a very high end state of art. So when I say high end you have integration of GIS you have integration of remote

sensing and added to it you have machine learning you have various other aspects that is built in with which can actually come in handy when you looking at certain modules or modular things that needs to be built in as a models.

So when we are looking interoperability open GIS standards is one that people are looking at and interoperability of any of your layers and interoperability of the capability of software is one that is looked at. Then advanced spatial analysis can it be an GIS system can do an advanced spatial analysis is not just querying but can it do an advanced spatial analysis how also is one of those what we think about. Scientific visualization then storing spatial data in database management system so and also a perfect database management system that is what is called as high end.

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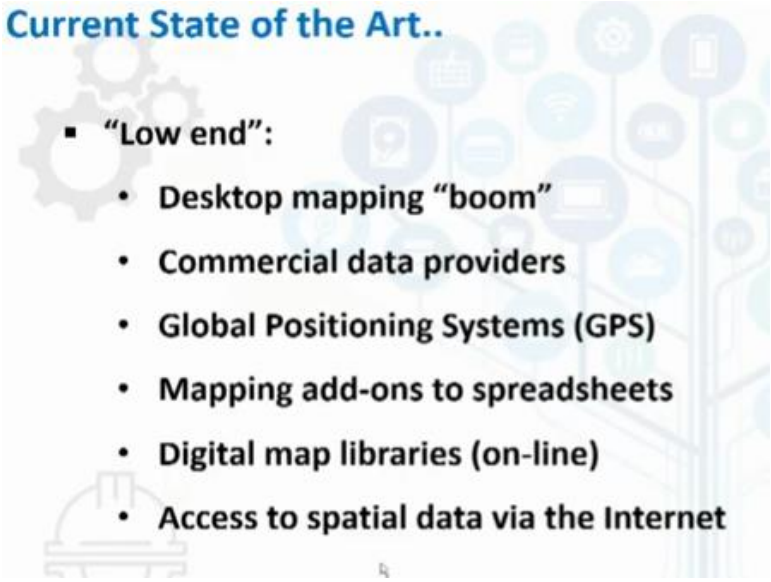

And we look at low end it is desktop mapping any of those commercial data providers where you where many of date many of those data providers do not allow you to actually rephrase or I mean look at your data I mean map your data in a different way it would not be allowed so that is such things I have considered it to be a low end and you have may be mapping add on spreadsheets, Global positioning system, digital map libraries so access to spatial data via internet so these are all considered to be a secondary sources so it is kind of a low end.

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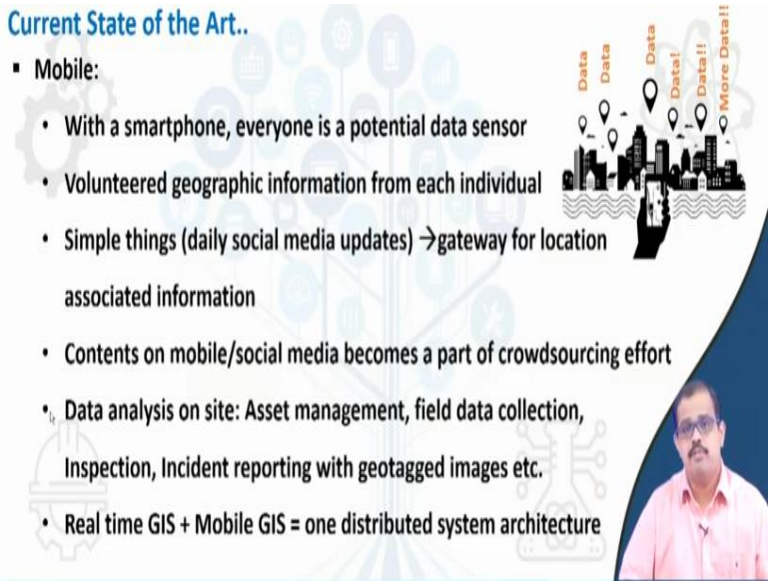

But when you look at today it is all about mobile so with smart phone everyone is a potential data sensor. So this volunteer geographic information can be from any individual collect data collect a crowd source data. Simple things that daily social media updates is the gateway of location associated information geographic information if I am saying that I am holidaying here so someone is travelling from here to there somewhere travelling from here to here these are location based information.

So such information are extremely very important when we are looking at it so then we contents on mobile social media becomes a part of crowd sourcing efforts data analysis onsite for example when you are looking at asset management, field data collection, inspection, instant reporting so all of these are the things that are happening with the mobiles and real time GIS and mobile GIS. So this together will put into one distributed architecture which is very effective.

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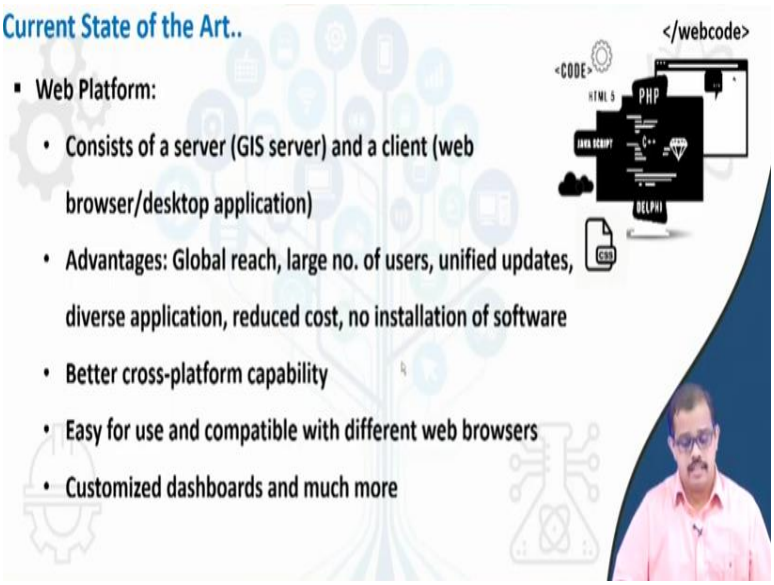

So and finally the last one is the web platform which is taken over the entire GIS system by a revolution so consist of server and a client is normally have a desktop a browser and the GIS server is inbuilt somewhere maybe in remotely. So what is the advantage of this is global reach anyone you develop a dataset so you develop data so anyone who wants access the data may need not go back revisit the same place and access the data whereas this data can be easily access by them for their analysis.

It also helps in diverse application your application can be one but there will be 100, 200, 300 more users who may use the same data in different applications so it may it will reduce cost to a very large extent and you do not need any installation of software. So web GIS is extremely efficient then you have better platform capability that is you can use it on any platform. So like your software whether it as to be installed in Linux or in Windows so it does not have any platform it is just a browser.

So any browser that is capable of handling opening that website and having certain plugins so you can use this web platform easy to use and compatible with different browsers and customize the ports and what else. So such things are the state of art that is there today.

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So to summarize today's class we looked at origins of GIS and timeline GIS is evolving a very strong subjective tool to all fields and GIS is as I said it is a telescope, it is a printer, is a scanner, is a mapper and what else. So GIS capabilities you have data input, management, manipulations, analysis, modeling and display output. So it is from the starting of the data input in order to produce the entire information that is how the capability of GIS is designed and you also looked at current state of art platforms and we looked at how mobile platform and the web platform are taking GIS by revolutions.

So there are extremely good platforms for examples Bhuvan is one such platform if you guys get sometime please look at Bhuvan is extremely good platform in delivering data to users. Thank you very much we will meet in the next class we will look at many more aspects of GIS thank you.