Geographic Information Systems

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Lecture - 01

What is Geographic Information Systems?

Hello everyone and welcome to this course which is geographic information systems. This is the first discussion which we are going to have related with this course. And first question is basically what is GIS? So, in short geographic information systems, we call as GIS. As you know that this is not today which has been developed, it has taken many-2 years or decades to develop.

And first I would like to dedicate this thing to the person who developed GIS, who gave the concept of GIS. Not only concept but also developed and he is known as the father of GIS. His name is Roger Tomlinson. And I will also narrate little history related with his development. He is computer scientist and when he was working for Ottawa Municipal Corporation.

Ottawa is capital of Canada. And there a task was given to him to develop a system so that different networks can be maintained. The problem was there because many underground networks which are located at different depths and sometime located also differently. And when one water supply party goes for some repair or laying new line, they used to cut the telephone line or power supply or other things.

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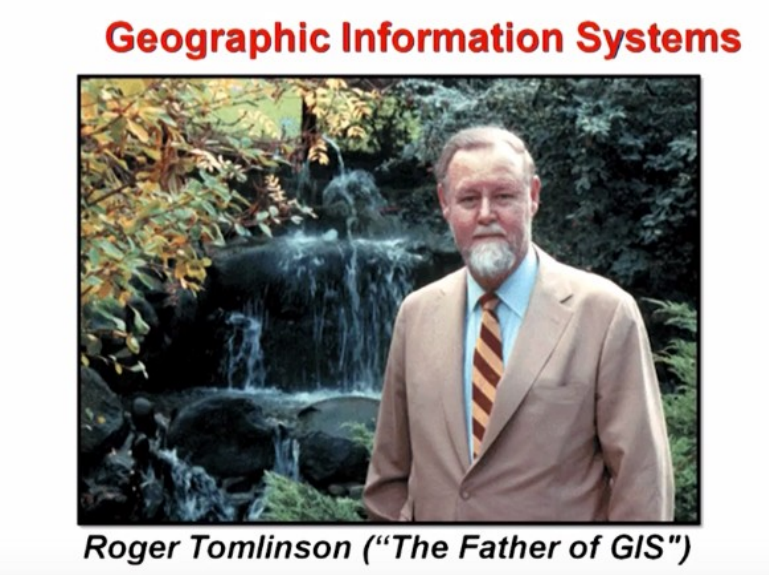

Roger Tomlinson ("The Father of GIS")

So, the task was given to Roger Tomlinson to develop a system so that before a party for repair or maintenance is dispatched; the party should know exactly at what depth, they will find which network. And for that purpose, he started developing this on the Dec 20 machines. And compare to what today we are having the powerful machines. At that time as comparison to today, it was not that powerful machine.

But he developed first this system and he gave this name: geographic information systems. There were one prefix also that was the Canadian GIS: CGIS. And of course later on, some company ventured in this one and that is ESRI and in short, we say Esri (Environmental Science Research Institute). It is a private enterprise; private company owned by husband and wife that is Jack Dangermond and Laura Dangermond of USA.

And they started developing a more user friendly commercial GIS; that was first GIS was developed ArcInfo on again machines. They were running either on UNIX or Some Solaris operating systems. And cost was very heavy. Nowadays the development has come to the level where we can have even script version of GIS or a custom design GIS, even on our smart mobiles.

So, the technology has moved from there to what we see today. And as we know that technology related with computers, technology related with communication improves. And also the location technology: that is navigation technology through GNSS (Global Navigation Satellite Systems) that improves. So, the GIS applications will improve. GIS system will going to be also improved.

So, this is a very brief history about what is basically GIS, who developed the GIS. Exact definition of GIS, we will discuss in a few minutes time. I would like to explain; this basically say one single watershed shown as a and b. And as you can see here that if I discuss the figure a; you would see that there is an area in the south west quadrant which is marked dash with these lines.

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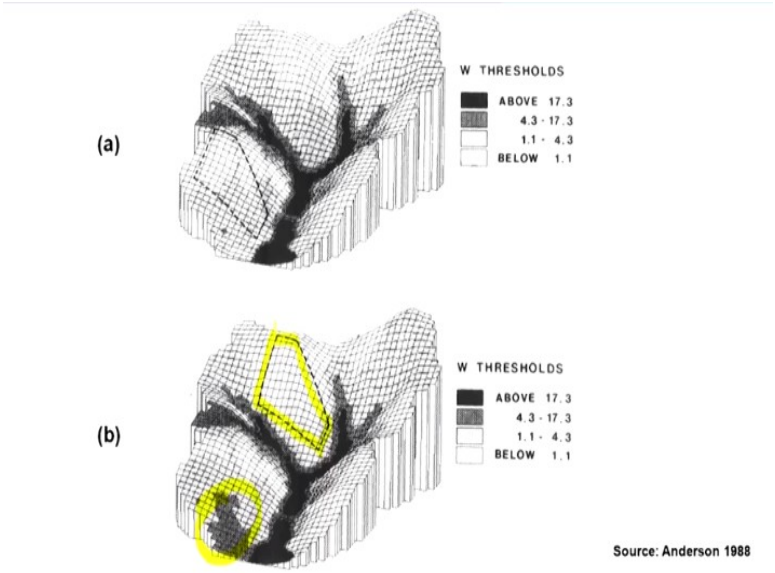

This is the area which is shown that plant deforestation will be done. And if it is done, then what is going to be the soil moisture conditions in that particular watershed. Those who are not familiar with the word watershed; basically it is a hydrological unit and you are seeing in a 3D perspective. So what would happen if that area of forest, at that particular location is removed from that watershed?

And b figure is basically the same watershed but the location of the deforestation area has been changed. And as you can see very carefully that there are many areas especially in this part; that is southwest part, the conditions are going to be completely changed if the b proposal is accepted. Like, if forest is or deforestation is done in the northwest part of this watershed.

So, nothing has happened in the ground but through GIS modelling that is very ultimate aim of using GIS, generally is to model and models are for prediction. So how to predict this particular scenario or few scenarios based on the actions which are being planned. That is the

main purpose; ultimate purpose of GIS is like that. Nothing has happened on the ground. Things are being planned.

And a GIS expert can provide different scenarios to higher officer or decision makers. And then, they can take the best decision. GIS expert can also suggest that as per his analysis; this is the best decision. But before that nothing happens on the ground; whether you say soil moisture condition analysis or say route alignment for civil engineering or for any such purposes, this thing can be employed.

Even electrical engineers nowadays have started using GIS to plan their lines: power supply or towers. Huge towers install for power supply. So, there it can also be used and optimum path for that layout can be thought before anything really happens on the ground. So, it not only saves the resources but also saves time and the best decisions can be taken by the decision makers. That is the biggest advantage of GIS.

So, what basically GIS which includes 3 words or I would call them 3 terms; basically Geographic Information System. So, geographic information system; the first word is geographic. Some people may get confused that it is probably related with geography, not at all. The word geographic means it relates to the places on the earth surface where something is.

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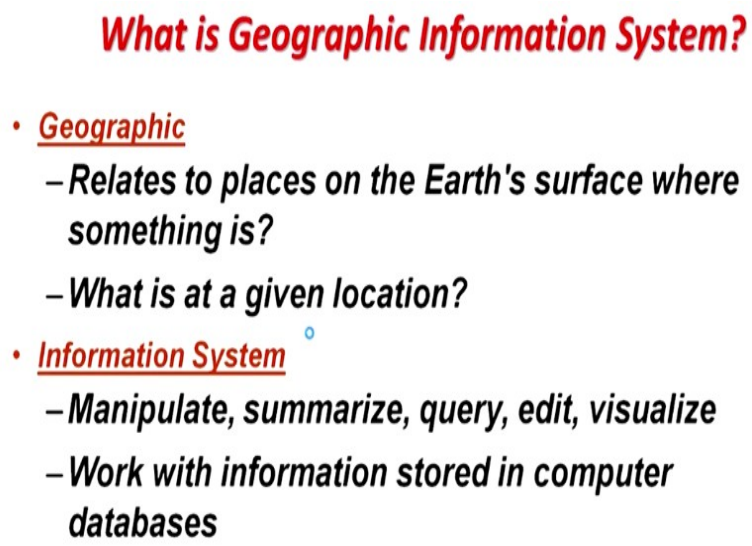


Basically any object which is present on the surface of the earth and nowadays even also on moon or mars where our satellites have reached there. Then that individual objects can be

addressed using geographic location. How we address geographic location? Like latitude, longitude or in some other map projection we use like in UTM, we use easting northing but those are also geographic locations.

So, it is basically nothing to do with the geography. But it is basically location specific data or location objects which are having their own location. If I give an example like over the globe, India is having its own location over the surface of the globe and then within India, like I am speaking from Uttarakhand, Roorkee. So, within India, Uttarakhand is located. Then within Uttarakhand, Haridwar district is located.

Within Haridwar district, Roorkee is located. And within Roorkee, IIT is located. And within IIT, Roorkee and this e-learning center is located. And within e-learning center, I am in a specific room. So, that means every object can have its own unique geographic location. We can give in terms of latitude, longitude. You are already familiar with the coordinate geometry.

In coordinate geometry, we use geometric coordinate system whereas in GIS, we use geographic coordinate system. But the concepts and whatever the understanding which we developed while studying or going through this coordinate geometry in during our 10 or 10+2 classes, all these concepts and understanding which we developed is going to be used in GIS as well.

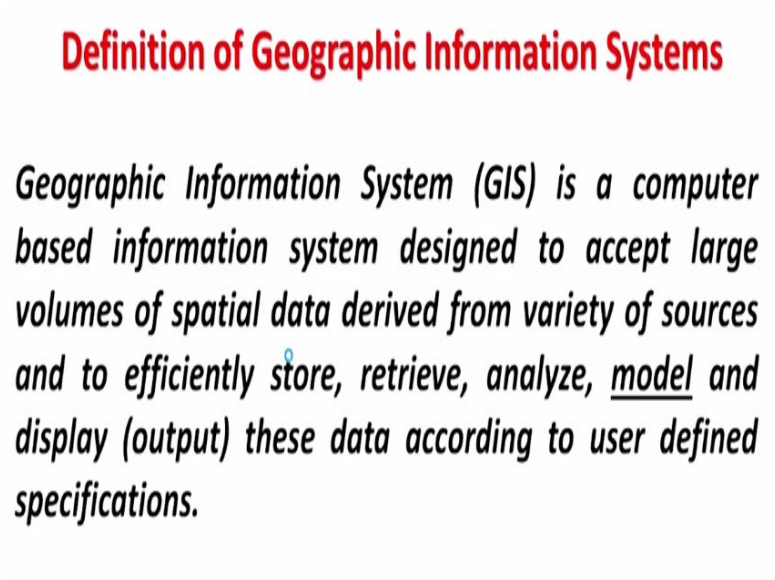
So, geographic basically has to do with the location specific data or location that is present on the surface of the earth. Now 2 more terms together; information systems because nowadays as we will see that the definition of GIS contains: it is a computer based information system. So, computers have to be used. And for that we use the systems. And this whole thing falls in the category of information system.

What these systems allow us, to manipulate. Manipulate does not mean that we are distorting the data, not at all. Manipulate means changing from one format to another. Maybe from analog to digital, maybe from digital format to another digital format or organizing differently rows as columns and column as rows and so on, so forth. So that is, what is manipulating. Then summarize, query because GIS is having own database system.

We can also connect to the external database systems also, so that it allows us to make ad-hoc queries or you know regular queries very easily. Or sometime, very complicated queries, if our system is well developed, it is full of data, rich in data then we can make very good

query. We can also edit our data sets if we have collected. And of course, finally is to visualize either on the screen or we can take the print outs of our analysis output.

As I have shown earlier like here that the analysis is done, it is shown on the screen. And basically, all information which is first organized on a GIS platform and then stored in the computer database, so this is how the 3 terms meaning here. Now I will go little slowly on this definition; that is a definition of GIS or geographic information systems. Basically it is a computer based information system designed to accept large volumes of spatial data.



Spatial data when we mention that means data which is having its geographic location. So, spatial data always will have its own location of the data. I gave the example like this room in e-learning center can be assigned a very specific location. So, that too can become spatial data. Even within this room, there are different benches and objects are there, including me can also be given a unique id as well as coordinate. So, that I become also a spatial object.

So, GIS is a computer based information system designed to accept large volumes of spatial data so that variety of data can also come in large volume. So, the next part is that data is coming from variety of sources. Variety of sources means that data might be remote sensing data so that is coming from satellites. Data can be a field data that might be coming after field service; field investigations.

Data might be available with some organization like meteorology data, like groundwater data or some other data sets like population data, pollution data. All these data may be in different formats. But what we will do or if whatever the target is accordingly, we collect the data from

variety of sources and organize data; organize means we not only change the format but we assign the geographic location, if that data set which we have brought in our system does not have that.

So we have to make that data as a spatial data. And then efficiently store; efficiently stored here means that we would like to store in a manner so that it can be retrieved very easily. If you go to the older file systems; a room or big godown may be full of files but if I cannot retrieve a particular file then it is useless information.

So, in a computer database our aim is always to store in a manner so that the data can be retrieved very easily. So, that is why these 3 terms are there: efficiently store, retrieve and analyse. If I can retrieve the data then next step comes; the analysis part. And also the next word is model which I have underlined is, that is the ultimate aim of GIS is to model things too and use for prediction.

And then display that 1 watershed with 2 scenarios. We have already seen that example that is nothing but the modelling. Sometimes in modelling, we may require an external expertise. A GIS expert is good of handling data within the GIS platform. But he may not have the knowledge about the models which predicts the soil moisture conditions.

He may not have a model which predicts the water flow in the underground conditions or groundwater. So, we may be requiring some experts. So, 2 experts: one GIS expert, another expert coming from different field, when these sit together then a new product; new scenario can be developed. And of course then we create an output and these data analyse, display everything; these data according to user defined specifications.

A user has to be there who defined the specification that this is what I want the output from GIS. This is how the analysis and modelling should be done by the GIS. I will give you a very simple example. Many of us have started using these apps through our smart mobile about calling a taxi or taking taxi services. So, whenever you use these Ola or Uber or any other taxi services, what you do? You are as a user, you provide the destination.

And where you are standing, that information is already known to that app because that information is coming from your GNSS receiver which is already inside of your mobile. So, from where you want to go that information you need not to provide. Exact information is already fed to the system once you open this app. And then destination you have to provide. So, you are a user; you are defining now specifications.

Next specification you are defining is which type of car do you want; a big one or a smaller one or in between. So, whether you want micro or mini or large and or maybe a motorcycle or something depends on the city where these facilities are there. And then this information is fed to the system. And then that system predicts that where other vehicles are there, the type of vehicle as per your definition.

You have provided those types of vehicles, where they are and how much time they will take to reach to your destination, where you are standing and once you take this, it will also let you know that how much time it will take to reach to the ultimate destination which you have provided. And this is all based on the prediction current data depending on the traffic conditions.

So, in peak hours the time which is shown by the system is maybe very longer whereas in you know midnight or 3 AM or 2 AM that may be half or even one fourth times. So, this all data is coming from variety of sources and that software or that app is a custom design GIS product. It is not only using GIS but as I have said; GNSS technology and computer communication technology or communication technology through your smart mobile.

And then you get the convenience, you get the vehicle as per your specifications and you reach to a destination. So, this is very simple example, we have started using GIS. If I gives another example that is Google Earth or Google Map, Again if I talk about say Google Map then you are having detailed road or street map in the Google Map.

And again you provide there your location. Sometimes say if your computer is already known your location, no issue it automatically is fed to the system your current location and your destination, then it predicts 2, 3 routes and fastest routes or you know routes which does not have much toll plaza and other things, you choose whichever the route. If I give example like if I feed that I am from Roorkee to Dehradun, I would like to go.

Generally, it shows the 2 routes. One is by Haridwar, another one via place which is called Chutmalpur. Now these 2 routes will have different distances and also have different travel times. Now the choice is with me as per my specifications so I can take the decision now as a

decision maker for a small decision that which route I should follow. And that way I travel to Dehradun. So, this is how the prediction is done into the GIS.

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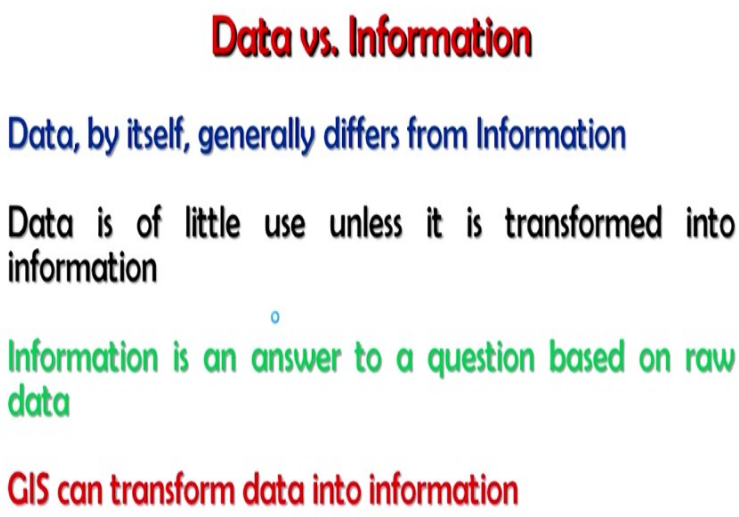

Now, we will continue on this discussion about data information and knowledge. So, first we discuss: data versus information. Basically if you recall the definition of GIS which we have just discussed; the data is coming from variety of sources. Now, what is basically data? Data is a basically a plural word and it is a raw facts.

So, raw facts are there. And data by itself generally differs from information because data only after analysis becomes information. So, data has to be processed. Otherwise simply if I am having a data say on, a print form or data I am having in pen drive or hard disk does not mean anything. But if I perform an analysis on the data; even if it is textual data or data related with the sensors or any other thing.

It is just raw facts. It has to be analysed then only it becomes information. So, data and information are 2 different things. Data in the hierarchy is at the lowest level which is nothing but a raw fact. So, data has to be transformed through analysis into information. And information is an answer to a question based on raw data. To some extent, some questions can be answered after the processing.

And when data becomes information; questions can be answered so that is another advantage of that. Now, GIS is capable of transforming your data into information. Because it is a computer based information system and therefore it can do lot of analysis on spatial data. There might be database management system and someone can say it might be like you know, these CAD CAM like software like AutoCAD others.

No, they do not have the database. They cannot handle the spatial data.GIS is the only unique platform which handles spatial data; data which is having a geographic location. So, that data can be used analysed and that data, we can transform into the information. So, I show in few steps this what we have discussed and to reach to up to knowledge; that raw facts or data using computers, we can make as information or it can be transformed to information.

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But when we use the GIS on data or information, GIS analysis and model then we can convert that data; basically originally data coming into your system and ultimately you are getting the knowledge. Knowledge means it can not only answer one question, it can answer many questions and many complicated queries can also be raised. So, if I give the example of like JEE examination which is conducted every year.

So in JEE examination, whoever applies to appear in the main examination, their data; that candidates details are stored in a computer system. To some extent that is analysed and centre wise that lists are prepared. So that data after certain analysis becomes information. Now, if we bring the location data of each candidate and plot on a map of India, then we might be able to see the pattern or distribution pattern of the candidates appearing say in JEE advanced or in JEE main examination.

So, if I take the example of JEE advanced examination then we might find that there are clusters in India where we see that lot of candidates are appearing for JEE advanced examination. Now the question, because the very good part of GIS is it answers certain questions. Decision makers can further raise few questions and then those can also be answered later on.

So, once I plot the location of all main qualified candidates for JEE advanced; their location once is plotted, I might be able to see some clusters. So, the next question will come; why there are clusters? Is it because of socioeconomic conditions? Is it because of good power supply? Or, is it because of coaching? So, we may find that around Kota, maybe around Jaipur, maybe around Delhi, maybe around Kanpur, Hyderabad, we may observe several such clusters.

So, if we want to further analyse those who have selected; what were the background, socioeconomic background, whether they have studied in government colleges or private colleges. All that can be done on the geographic platform; that is on GIS. And lot many questions can be answered further, which currently that kind of analysis using GIS is not done on JEE candidates but this is how it can be done.

And new knowledge about the candidates and their success rate and their location can be developed. So that can be very useful information for decision makers to think about how JEE should be conducted in future. Let me also mention the 3 terms; 3 technologies. First is GIS; we have just started discussing on this; the entire course on this, 60 lectures on GIS.

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GIS, GPS & Remote Sensing are

generic, spatial and digital technologies

But very briefly I will touch, also earlier we used to call as GPS so deliberately I have written GPS here. But now we can use a different term which also encompasses GPS technology which is called the GNSS: Global Navigation Satellite Systems. So, GNSS includes GPS. GNSS includes the GLONASS which is Russian navigation system. GNSS includes the BeiDou which is a Chinese navigation system.

GNSS also includes Galileo which is a European system. And GNSS also includes Indian system; earlier it used to be called IRNSS. Now a new term has been given which is NavIC. So, GNSS includes every such navigation system. So, there are many systems that is why global navigation satellite systems, so plural is there and remote sensing. Remote sensing which is based on the satellite data acquisition system.

So, we acquired the data. So, remote sensing provides the data, GNSS provides the location whereas GIS is a platform where all analysis can be done. Data from GNSS, data from remote sensing and data from other sources; recall the definition, spatial data coming from variety of sources. So, not only the data from GNSS, remote sensing but from other sources can also come.

Now, these 3 technologies which I have just mentioned GIS, GNSS and remote sensing are generic, spatial and digital technologies. Generic, I have just explained but I will again further elaborate on this. Generic, nowadays we hear a lot about generic medicines. So, they do not have a particular brand but the salt in it is what is like there is any medicine you take like Paracetamol or other things.

So, a company might be making using the same salt as a different brand name. So, nowadays government is promoting that people should use the generic medicine. No brand name or doctor should prescribe the generic medicine. Here, generic means basically that these technologies can be applied for variety of applications.

I as a geologist, I use these technologies for my own applications: maybe for ground water exploration, maybe for groundwater recharge studies, maybe for earthquake related studies, maybe for landslides or other natural hazards. A civil engineer may use all 3 technologies in integrated fashion or in separately for root alignment, for pollution studies, for topographic surveying and for transport planning; for many application they can use.

And the same technology can also be used by electrical engineers. Same technology can be used by hydrologists or earthquake engineer. So, that is why it is called generic. So, all these 3 technologies are generic. Spatial, I have already explained that these technologies are having location specific. GNSS itself is providing location. And remote sensing data is also a location specific data.

And GIS is a platform to handle spatial location data or spatial data. So, these technologies are generic, spatial and of course, digital. GIS is a computer based platform. GPS or GNSS data is coming on our receivers or mobile in a digital format. And remote sensing data is also recorded in digital format. And therefore because of these 3 common things with these 3 technologies; their integration becomes much-2 easier.

I give example of these Ola, Uber apps or Google Map, now I will give example of Google Earth. Google Earth is having satellite images of different spatial resolutions in its database. And the database is very efficiently retrieved as we keep zooming to our area of interest. So that efficient storage and retrieval is very much essential component of Google Earth.

Now another very important thing which is stored in the background, which generally we do not see in front, is the digital elevation model which is that topographic surface of the earth which is also stored on or which is also accessible through Google Earth. So, you get not only the latitude, longitude but you also get the elevation; topographic height wherever you are located on Google Earth.

And all this is coming through a computer technology. So, the integration of remote sensing and the digital elevation model is part of GIS. Satellite images are part of your remote sensing and location is also coming from GPS. So, Google Earth is one of the best examples

of integration of these 3 technologies and a very user friendly, very convenient product where you access a huge data set that is not residing on your computer but remotely and getting very good advantages of seeing things in 3D and so on so forth.

Because the digital elevation model allows through Google Earth to see things in 3d; you can develop your fly through, you can see things in 3D and so on so forth. I said that somewhere in 1964, this Canadian GIS was developed by Roger Tomlinson. But the concept of GIS without computers was already there.

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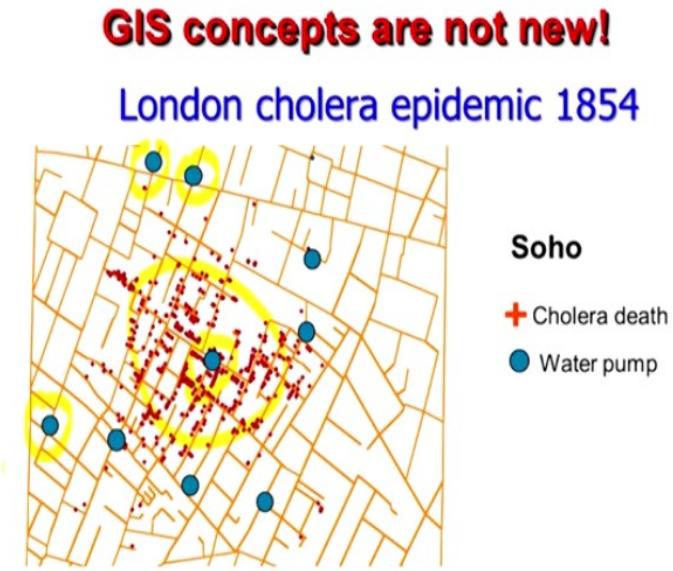

So, I can call as an analog GIS. And this is the oldest example which we get in our literature about the concept of GIS, is in 1854, they were Cholera epidemic. We are going through the Corona pandemic which is more extensive or worldwide phenomena or worldwide pandemic rather than Cholera epidemic in 1854 in London.

And in order to assess because a water borne disease so, it is very much search that which water pump or tube well is providing that contaminated water to the resident which is causing the Cholera. So, 3 layers are together here; one is the street map in the background then Cholera affected people are also shown through their spatial locations and water pumps or tube wells locations are also shown.

So when you see in the center here what do you find that around this centre, lot of Cholera affected people are there! But if I see this well or these wells; though people are living in those parts, they are using the water from those pumps but not getting any Cholera. Then it

became very easy and then people were stopped not to use the water from those particular tube wells or water pumps which are providing you know bad quality water to the resident.

And then this Cholera epidemic could be controlled; that too in 1854 and without using computer based information system. So, simple map overlay analysis was done using 3 layers and still solutions were found. But nowadays all this analysis can be done very quickly. Even for Corona, we have been doing this kind of seeing the plots which are available on different source through servers or different portals.

And you would notice that wherever the density of population is very much then you find that Corona affected people are more. So it is related because the good social distancing is required. Social distancing is not being maintained in highly densely populated areas. If you see the center India like part of southern UP or northern MP or some part of Rajasthan, you see that there are not as many as people as you see around Mumbai or Delhi or Hyderabad or Chennai.

Because population density is relatively less and automatically because of less population density, social distancing is being maintained and we are seeing less Corona affected people in there. So, these things can be analyzed and lot of answers just using 2 layers; one is the population density, another is Corona affected people location, we can analyse such thing. I did not name so far the application of GIS in agriculture.

Remote sensing is being extensively applied. You are being used in agriculture field along with the GIS also. So for irrigation purposes, for water supply or for ground water estimation which is used for the agricultural practices or crop estimation; which implies not only your remote sensing data but other data also.

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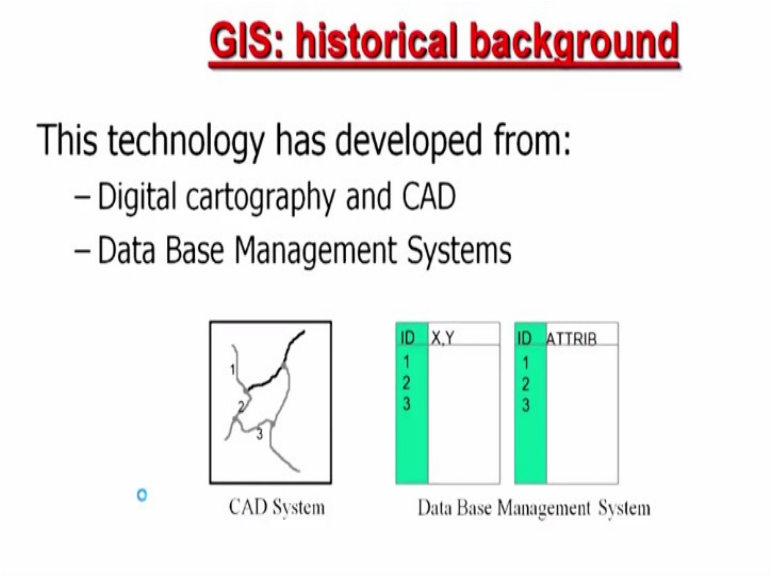

GIS historical background, I had already discussed. But very briefly, I will discuss this point from other systems point of view. Because GIS has incorporated already developed technologies into it and the best example is like digital cartography and CAD: Computer Aided Design systems. So the concepts; technologies tools which were there, have also been incorporated into the GIS.

And Data Base Management System or DBMS that is also a very integral part of GIS. So, those concept except that here we handle the spatial data or data which is having geographic location, so database management tools are also into the GIS. So, from that historical point of view, whatever the best which is available through other already established technologies is being incorporated into GIS.

And more GIS are developed, more users are there, more new questions are asked and people expect more solutions through GIS. And that compels the better development of GIS or more development of GIS. So, it is a continuous ongoing activity. You show certain analysis to your higher ups using GIS. They will appreciate but they will ask can you do further like this? Can you do like this? And you start again.

Go back to your machine and you start doing that kind of analysis which your higher ups have asked. And then you develop something new, again you show and they again ask. So, it is a continuous ongoing activity. Thus, all the time solutions may not be exactly available with you. When I was showing this Cholera epidemic scenario, there are 3 layers were there.

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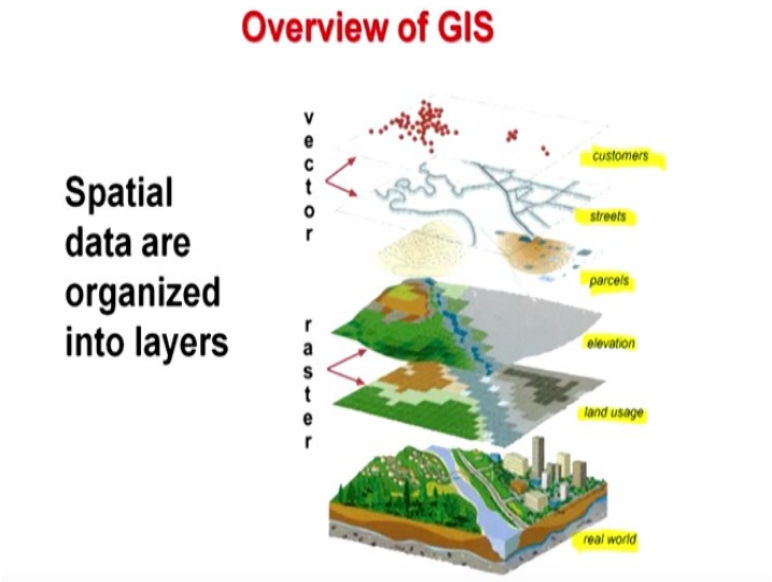

Now in GIS, information store in different layers or thematic layers. So, if I see from the real world; start from real world scenario then real world is having all kinds of data. But we can segment the data in order to organize and efficiently store and analyze data on a GIS platform. So, the real world can be segmented into different layers or different types of spatial data.

Like for example a land use data; so that data nowadays we get from satellite (remote sensing data). Elevation data; digital elevation models, these are also being prepared using satellite data. But they fall in part of GIS and in the last few lectures; we will be discussing lot about digital elevation models and derivatives. How best we can exploit this data set which is digital elevation model.

And then parcels also; parcels means here is the land records. So, land records are nowadays like in India, they are with the revenue department. And now many states have organized the data on a GIS platform. And a lot of disputes will also be resolved which are related with revenue or khasra depending on the language which is used in different states.

So, once the data becomes on GIS platform and it is integrated data with other data sets, lot of problems can be solved or lot of answers can be given. Then street data which is a line data, so through this example what we are seeing and of course locations; may be households or

locations of customers, locations of earthquakes, locations of water wells, anything can be stored in the point form also.

So, the real world can be segmented into different layers and then it is stored. In a particular analysis, I can use all layers together or I can use 2 layers, 3 layers, 5 layers or I can bring few more layers from other sources which are not shown in this particular example and then can analyze the data. So, this this basically gives you the idea that how the data is stored or managed on a GIS platform.

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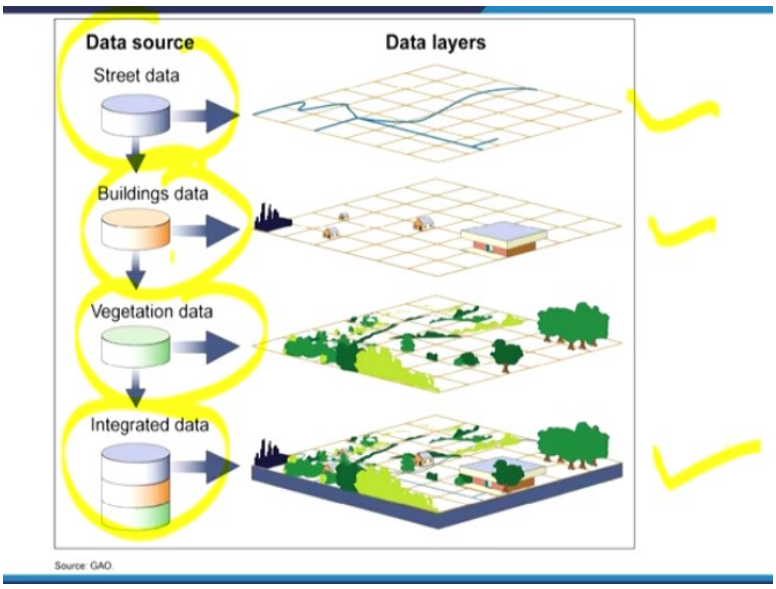

Again the real world is shown in the bottom. Then we start segmenting the data. So this is entirely integrated data like a data source, a street data, a building data, vegetation data is there and everything is stored in the layer. So, when we see building data; only buildings are shown here. When we see the street data; only streets are shown. And as soon as we start putting all together then we reach to the real world.

But remember one thing, very important point which I am going to discuss: a real world cannot be stored on a computer platform whether it's a GIS or database or any other thing. Real world means one to one scale. And all these are the models. They are the abstract reality; the stripped version of reality, not exactly the real world. So, real world is available to us, at one to one scale.

So, if you want to see, we see every day. We can go outside and see the real world also. And even in this room, I am seeing the real world. But if I start putting these details of this room on a computer then I am taking abstract information. I am reducing the information. I am reducing the details of the information and then putting into a computer. So, computer cannot store. There is no computer; in future also I am sure, there cannot be any system or computer which can really store a real world. Whatever is stored is the modelled thing; the stripped version or abstract reality. So this modelling part, we will be also discussing. And models are also assumed lot of things. So, only the key parameters are taken in a model and other less influencing parameters are ignored or assumed that this is like that. But in real world; everything is in one to one scale and real.

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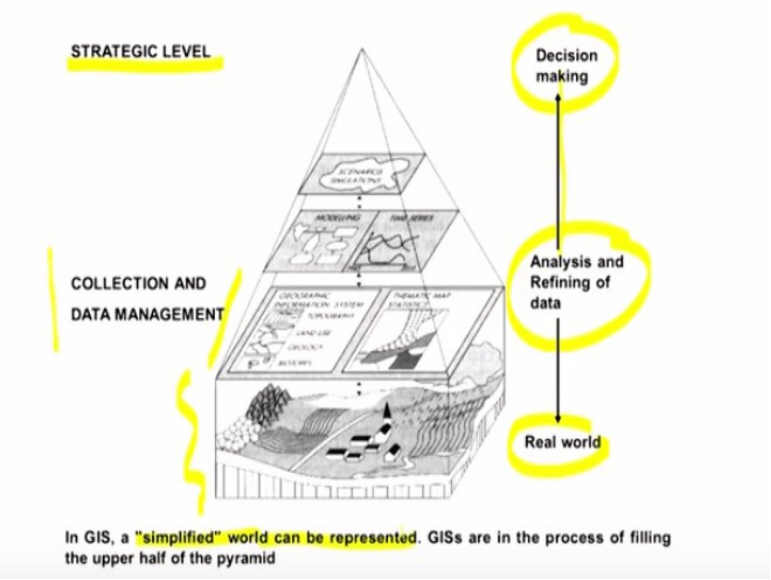

Almost same discussion but as said you know in real world but important point here; see the direction of arrows. Analysis and refining of data and then it goes to the decision makers. Decision makers accept certain things but they ask to do further analysis. We can come back to the real world, can again enrich our analysis part here and can go back again to decision makers.

So, the real world is again segmented here into different layers. So, the people sitting at the top, they are at basically strategic level. Then some people are at collection and data management; these are the real GIS experts. And of course real world is there.So the caption

says simplified world can be represented. It is not real world but a simplified world can be represented.

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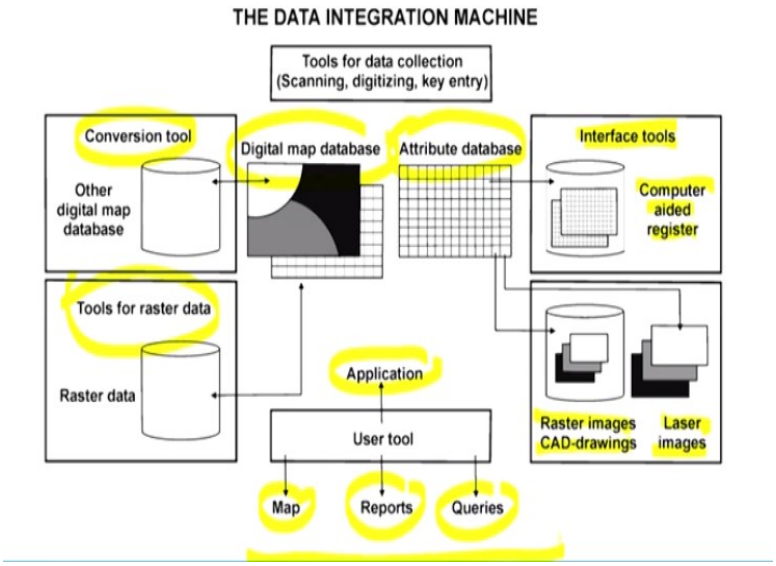

So, if we see in a machine form; how it is stored, the GIS and data and other things then we are having basically GIS. It requires a computer as well as software; different GIS softwares are available. So, that software will support your conversion that is conversion tools are there. Tools for raster data; one type of spatial data like raster data, vector data, these details we will be discussing.

Then attribute data which we know through the database management system. And then you are having digital maps while creating this. And of course, in the last you are having applications: through this, you can create map, you can create reports, and you can create queries. On the right side, you are having interface tools. So, computer aided registers are there, computer aided processes are available.

Raster image, CAD drawings, laser images and other drawings; those outputs can also be created. Finally what we are interested to show our analysis results either in form of map, report or queries or in chart. So one other point before I close this discussion is why GIS is unique? Because people may say that there is already CAD, CAM system available and so on.

GIS as I have been mentioning; it handles the spatial data. Data which is having location or location specific data which can be referenced to its location and that too in geographic form that is in latitude, longitude. And GIS makes connections between activities based on spatial proximities. So, on GIS platform, not only you do the analysis but you also look the neighbourhood, the proximity and then analysis can be performed.

The simplest example like creating a buffer along a highway and finding out what is the pollution level and for protection point of view, in case of forest or in mining; other thing. So, not only the data itself but in the surrounding neighbourhood proximity analysis can also be done. Now, who are the users of GIS? Some we have discussed but in a more systematic manner.

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Different governments; state, central or federal, they are using GIS. Industries are doing using GIS. Of course, academicians are also using GIS. For what purpose they are using GIS? They are using GIS for transportation. I gave the example of these taxi fleets. There are buses, for trains like Indian railways is already completed installation of GNSS receivers and on a GIS platform.

So, they know about each and every engine of goods train; where it is located, how it is moving. So that is completely transportation system, GIS based. Then in hydrology, geology, demographic, crime, health and this is no-exhaustible list. More and more applications, more

and more bridges with different disciplines are being developed related with GIS. If I go for a GIS project, then there are different stages of GIS.

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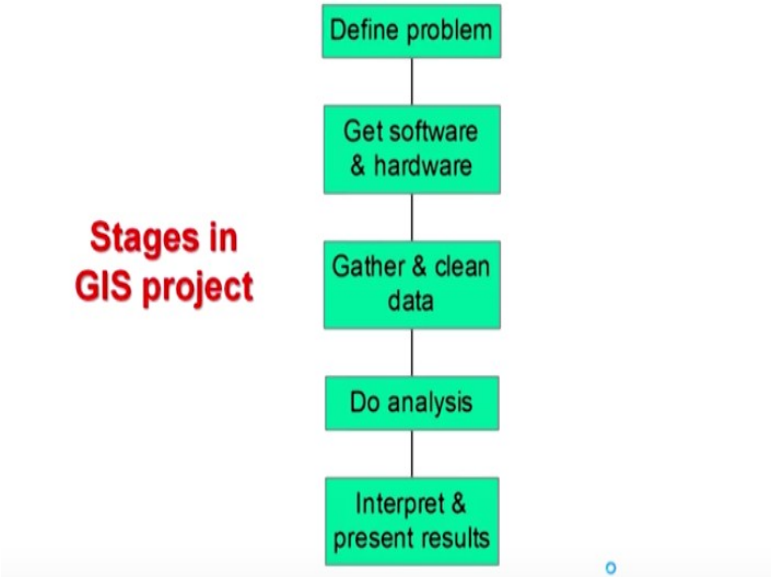

First we have to define the problem; for what purpose? And for what is our aim to use GIS? Then you need of course GIS software and hardware. And then you get the data; always it is to acquire as organized and as clean data as possible. Clean data means data does not have the error. And then analysis which is performed on GIS platform and finally you know through interpretation analysis results are created.

So, this brings to the end of our discussion about what is basically GIS? In very brief, I have explained to you: what is GIS? Thank you very much.