Remote Sensing and GIS for Rural Development
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Week – 4
Lecture – 1
Introduction to GIS and QGIS

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Hello everyone. Welcome to Remote Sensing and GIS for Rural Development NPTEL course. This is week 4 lecture 1. Let us quickly look at what we have been looking at in the past weeks and how it connects to this week, because we are starting a new lecture.

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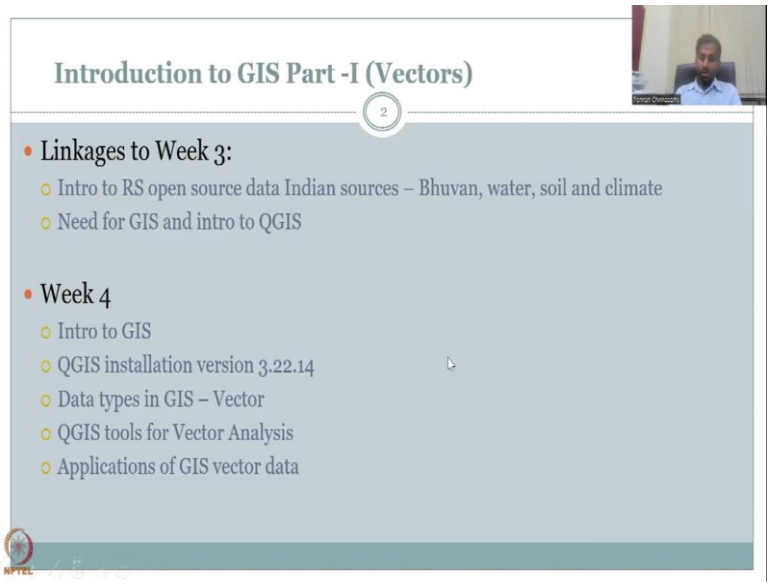

Upto week 3, we were looking at various remote sensing open source data, some Indian sources example Bhuvan and some foreign sources example NASA were discussed and we looked at specifically data for water, soil and climate. These would be incorporated into rural development schemes. And once you know to retrieve these important data, water, soil and climate, you could also retrieve the other less complex data such as images land use, land cover, etcetera.

Then we also stopped on the need for GIS and is very short intro for QGIS was given. The need for GIS comes again from understanding that we have plethora of data, satellites, remote sensing, near sensing, crowdsourcing data. We need to convert that into a usable format and the platform that helps us to achieve this is GIS. There are multiple GIS platforms but we want to promote through this lecture series an open source software and the one we have identified is QGIS. It is one of the largest open source mapping software used in the world and even governments are using as I mentioned.

So, we will, in this week, we will give a more in-depth introduction to GIS while installing the QGIS software. The installation takes approximately 45 minutes, if we have good internet. So, we would not do the entire process because the lecture is 30 minutes. We will show snapshots of how to download, how to install and then put it on your system. Then we will discuss the different data types in QGIS and GIS, especially, vectors and rasters. In this week, we will look at vectors as an analysis tool and some applications using vector data.

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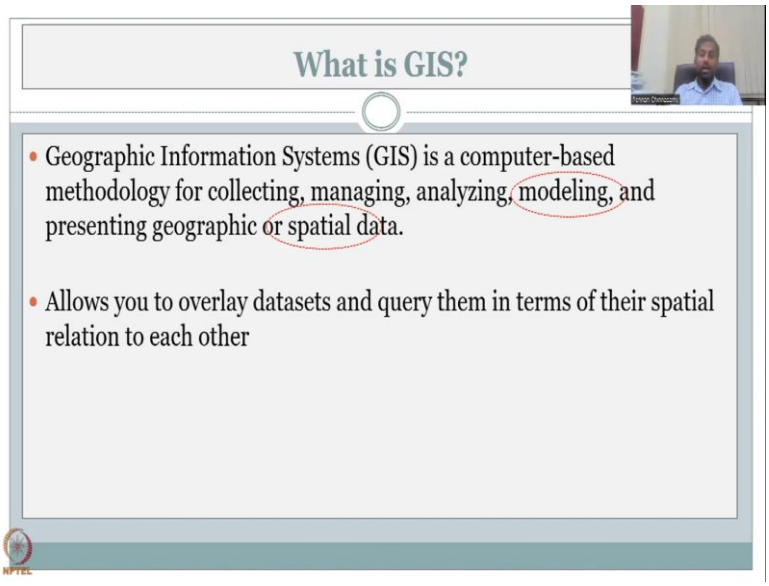

So, let us get into this week's core content, what is GIS? If you expand it, it is Geographic Information Systems and is a computer-based tool for analyzing, collecting, formatting,

modeling of geographic or spatial data. It is not normal data. These are specific data with a spatial allocation to it.

And this software allows you to overlay different data sets and query them in terms of their spatial duration between each other. For example, if I have a layer of land use, land cover and I say this is Mumbai and I have urban settlements I can also put road network on it, I can put schools, I can put colleges. So, you can stack it up like a cake.

Now, we can assess how far the distances from the school to the nearest main road or the school to the nearest highway. So, these kind of analysis is possible once you layer the data on top of each other and query. For layering, the key ingredient which holds the layers together is the spatial location.

So, if you know that when I say Mumbai, so, I am going to have a map of Mumbai, all the layers are of Mumbai. I cannot put Chennai on top of Mumbai because there is no spatial relationship. So, that is spatial relation we are trying to establish here and that tool is what differentiates it from a normal table data or a normal data that you write in books. So, these are different because this has spatial location on it. So, the most important, I would say from this is spatial data and modeling analyzing managing etcetera.

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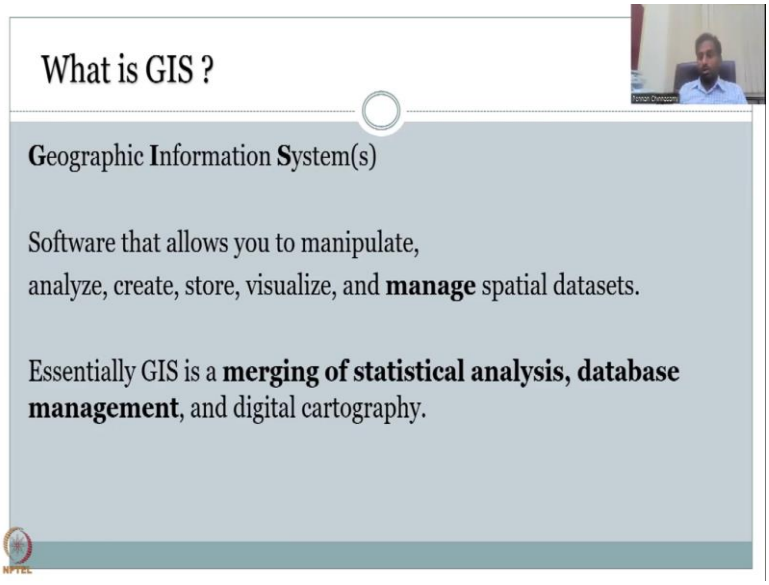

One more definition of what is GIS. It is an information system which has geospatial information. And if you look at it as a software, what is GIS software? It is a software that lets you to manipulate, convert, reformat data and manage spatial data. This word manage is

very important because scare data can be scattered in different locations, and to truncate it to one district, one zone, you need to manage it and that management can happen in GIS.

The beauty is, once you do it with GIS and save it as a map, then all the layers, all the layers that you stacked will be saved with a path file. So, you do not have to go each time and collect data and put it in. Once you open the map, all the data will come together. Essentially, it is merging of statistical analysis, database management and digital cartography. There is a lot of analysis that you can do with GIS, especially, statistical analysis.

And then there is database management. As I said data can be in different different locations and formats, but when you convert it to one layer and top and top of layer then it is easy to manage and that is what we use for digital cartography.

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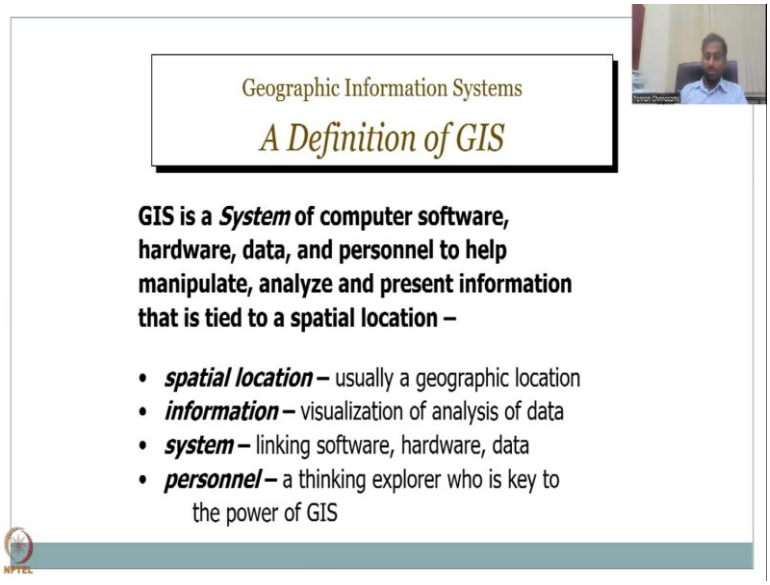

If I will, one we could say is, it is a software, it is a combination of software-hardware. That is why it is called a system. If we just say GIS is a system, it includes a computer software which is QGIS, for example. And then it includes your hardware which is your computer, your scanner, etcetera. Data, so, with the software and the hardware, there is a data that comes in.

And the person the GIS user, all these have to come for a GIS system. Because, the user controls what data comes and the user controls the software and what tools to use in the software. Then you manipulate, analyze and present the information as a spatial location. So, here the different terms, here are spatial location is a geographic location as I said Chennai is a city, it is a location. It has longitude, latitude.

And if I print data to Chennai, it is anchored in Chennai. Information is visualization of analysis of data. You are visualizing data in GIS. It is put as maps. Numbers are there. It is not put as tables that we have different software. Here, we put as maps. And the system is what links everything together like software and hardware and the person as I said is us who are learning GIS and using GIS.

He, she is the key to the power of GIS. Because it is a very creative tool. Suppose, you have a paintbrush and I give you a canvas. The canvas is your GIS software and hardware, monitor but it is you who wants to drive, you who want to paint and draw what you want. And that is the importance of the creativity, the personal is the importance of GIS applications.

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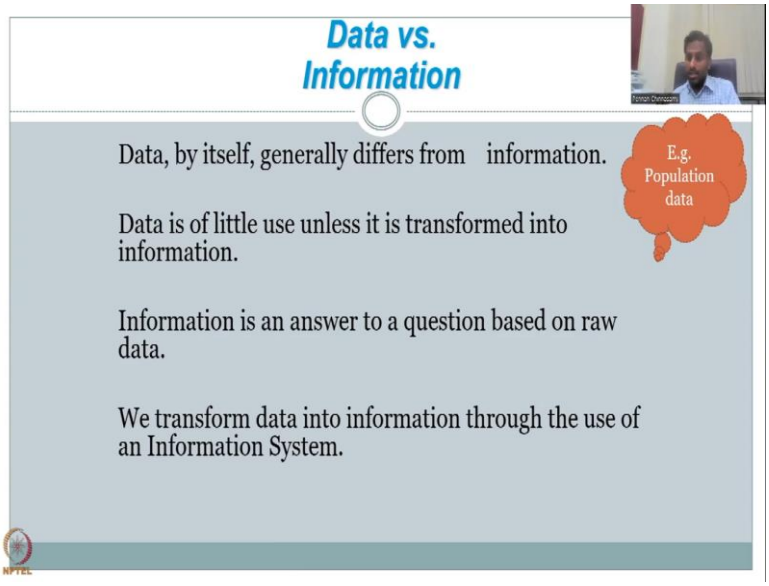

Let us ask this question which I ask a lot in IIT. What is the difference between data and information? And many struggle to answer this. Because they think that it is the same. Numbers are data and you call numbers as information. No, it is not. Data by itself differs a lot from information.

Data is of little use unless it is transformed into something that can be comprehended as an info or an information. Information can be an answer which you query or you raise a question and you use raw data to answer the question, then an information comes. We transform data into information through a software and here it is GIS or an information system.

Let us take an example of operational data. Everyone knows population data comes in a lot of tables, once in every 10 years, census data. If you just look at it as numbers, it has no meaning. There is no information coming out. But when you query it, when you map it, then

you have information coming out. For example, if a table is there of just a number of cities, population, male, female. You just look at the data, there is nothing that comes out. If you do analysis, etcetera then you convert it into an information.

If I say what is the, if I ask a question to the data, what is the percentage of male and female. That is information. If it says 60 percentage of population is males, 40 percent is females that is information. It is based on the data but data itself is not throwing any information. So, it is always based on query and data by itself as a number does not make any change. Data also has a lot of time stamps. When was it taken, is it relevant, what is the methodology that the data used, etcetera.

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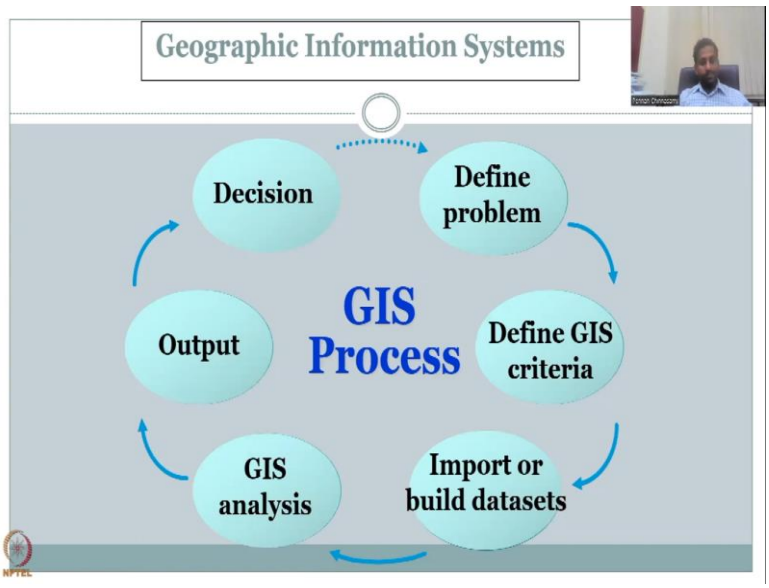

Let us continue the short description of GIS. Let us look at the GIS process. Now, we know what GIS is. It is used to convert special data into spatial information with geospatial locations. So, in the GIS process, the normal process, you define a problem as I said you query, you define a problem, you ask a question and from there you take what kind of criteria you want like define GIS criteria or the tools that you want to use or the the complexity of GIS steps that you want to create.

Then once you know the steps or visualize what you want to do using GIS then you import the data for it. So, import or build data sets. How do you import? You bring from remote sensing, in this case. So, in this case, in our lecture series, in the course content, we define the problem could be map the or identify the schools with proper road connection.

Then the GIS criteria is to map, map the location of the schools, map the roads and then you know how many are connected. So, this is the GIS criteria. Now, I have told, I am going to map the roads, map the schools. Now, we have to import the data set. What data set? We need the road data set, we need a school data set. Then you do the GIS analysis.

There are multiple, multiple tools that help you to identify the distance between the road and the school and form clusters. How many schools, villages, clusters are attached to a particular road connection. Then you get your output. Are you done? In a normal scenario, yes, you stop the process. But the beauty of GIS is you can redefine the problem through discussions.

So, once you have the output, you have a decision taken. You say, okay, x number of schools, like say 40 percent of schools have poor road network connectivity, 60 schools have good road network connectivity. Now, the 40 percent, you are going to discuss or take decisions on how to increase.

But the beauty as I said is you can keep it moving along the same part in GIS and this cyclic process helps you to refine the data, the output that you have here becomes your importing new data set. So, you have new GIS analysis. And you can keep on fine tuning the data and the results, up to the point where you are satisfied. And this process can go on as much as you have a time, data power, etcetera.

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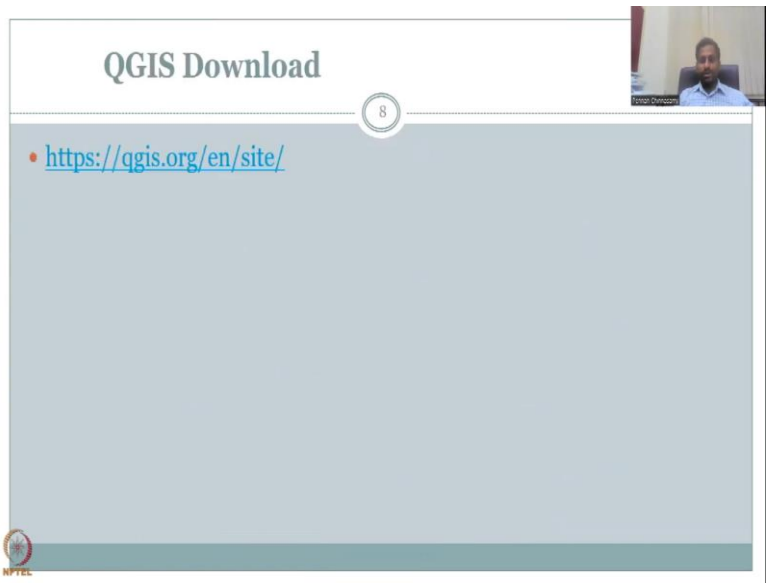

So, with this short introduction, as I promised, let us look into how to download the QGIS. This lecture series is recorded in 2023. For 2023, the stable version we are going to see what is what can be used in QGIS. If this course is re-run in some other year, because we have

around 1800 registrations already, which means the course may likely to be re-run in the following years, in that case, please, go to the same website or the QGIS website and look at this table version. Now, I will take you to this website. So, I am going to click on this. It will open my web page. I love to share the window here.

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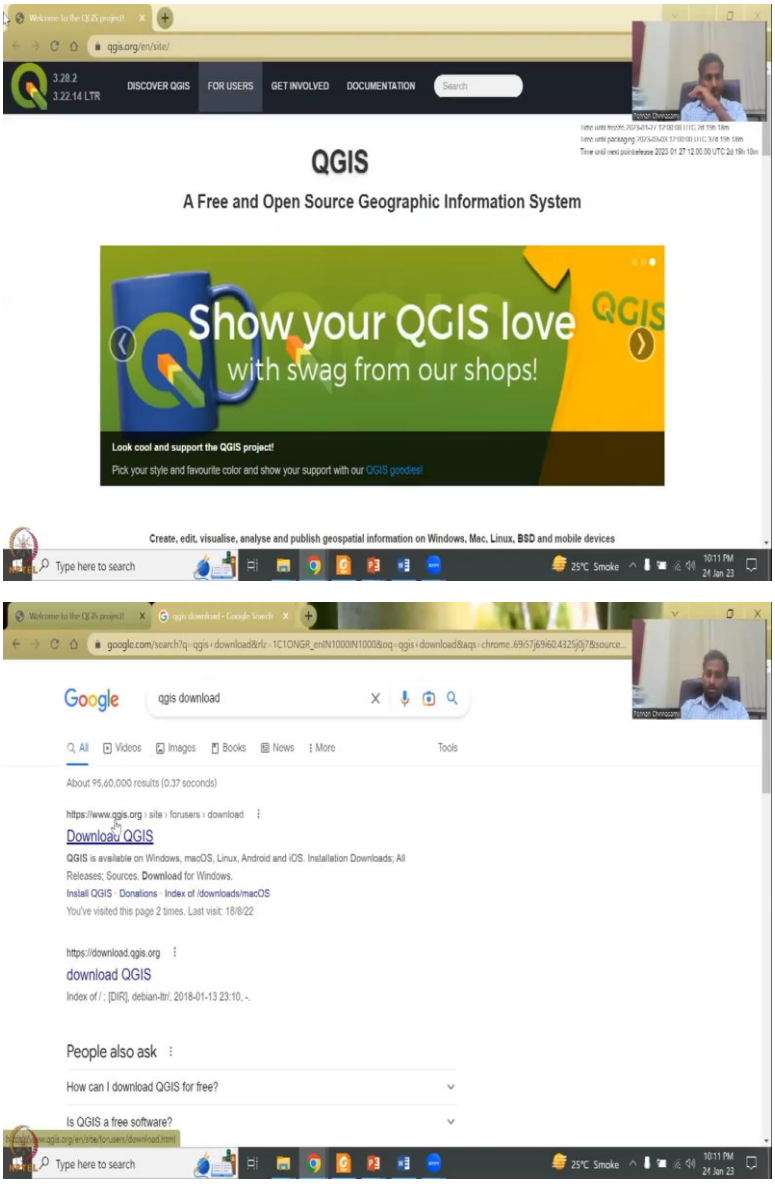

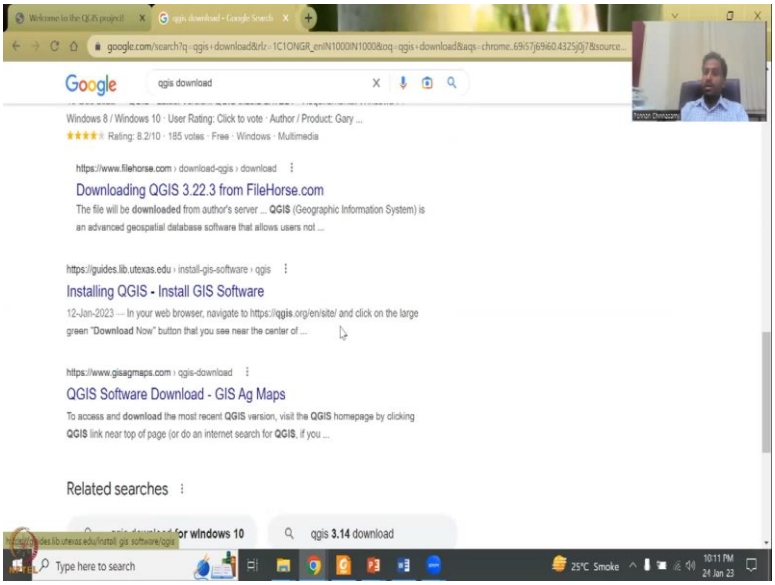

So, when I clicked the link, you bring it here. If those in a different year, the link is not working, because they have updated it. Just type QGIS and download. And then you will have download QGIS. So, do not go into other software packages and download it. Because it is free. It has no payment. So, do not go to other websites where you are asked to pay or maybe some kind of bugs may come. So, the best is to use dot QGIS dot org. And I have given the link, I have tested the link. So, we are going to do it now.

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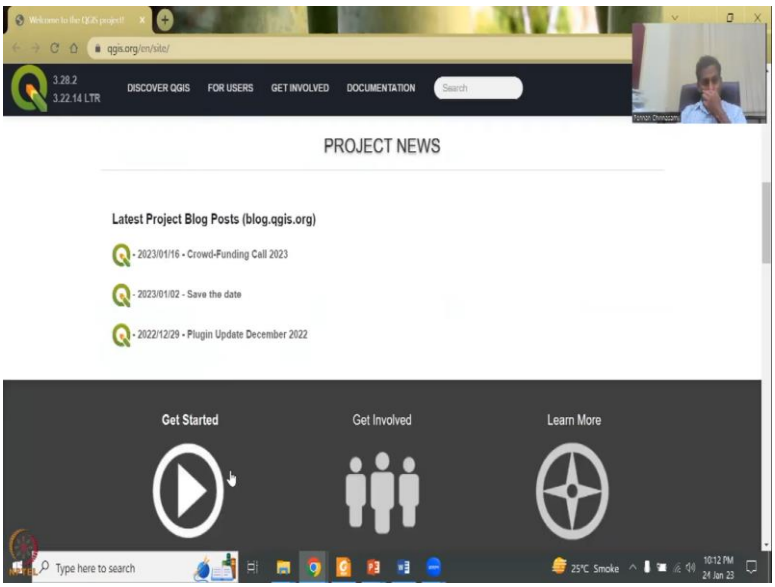

So, suppose, this is link is working, the page like this will come, first page where they say that how do you like fere open source software and especially QGIS, what are the projects going, crowdfunding get involved, volunteering, etcetera.

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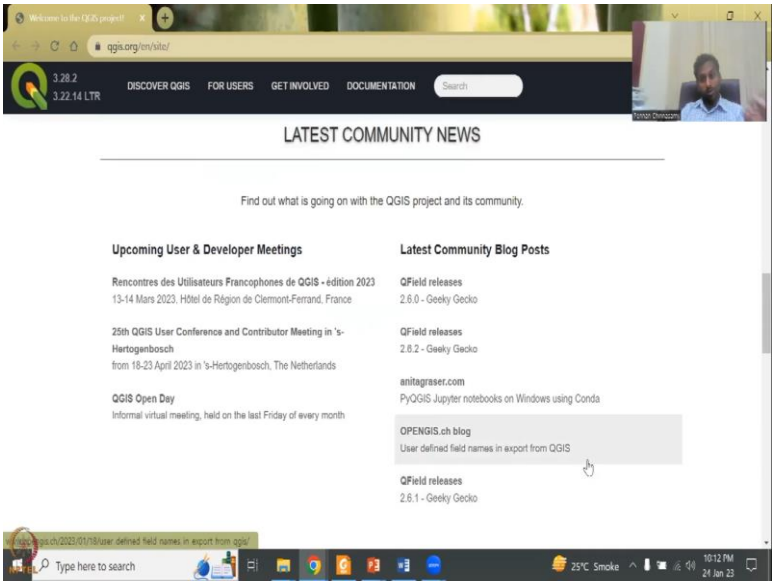

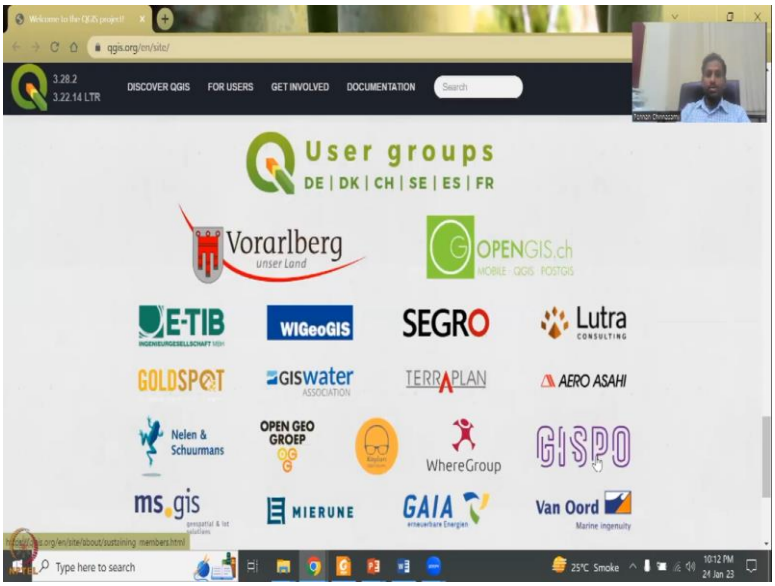

Again, this is the open source software. So, a lot of volunteers take part in building the software, members, who are using it. In my last week's lecture, I picked cases from these users and show like that they are using this software even for launching rockets, sub countries.

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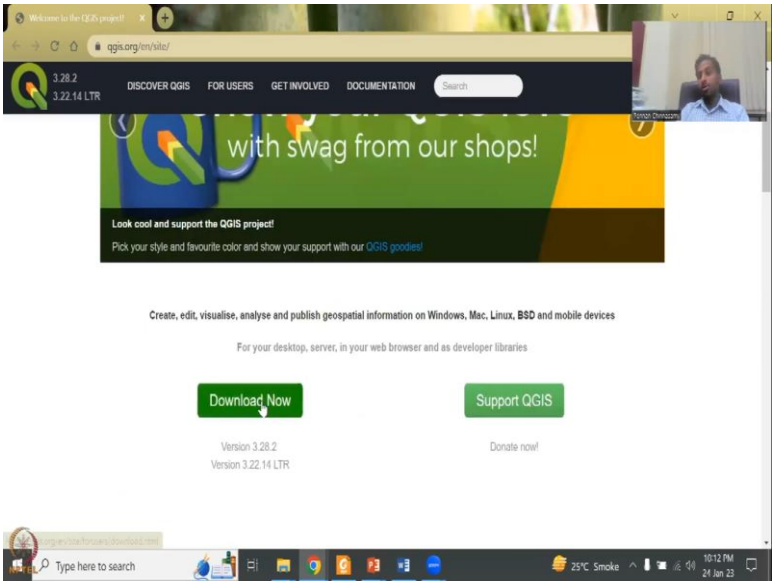

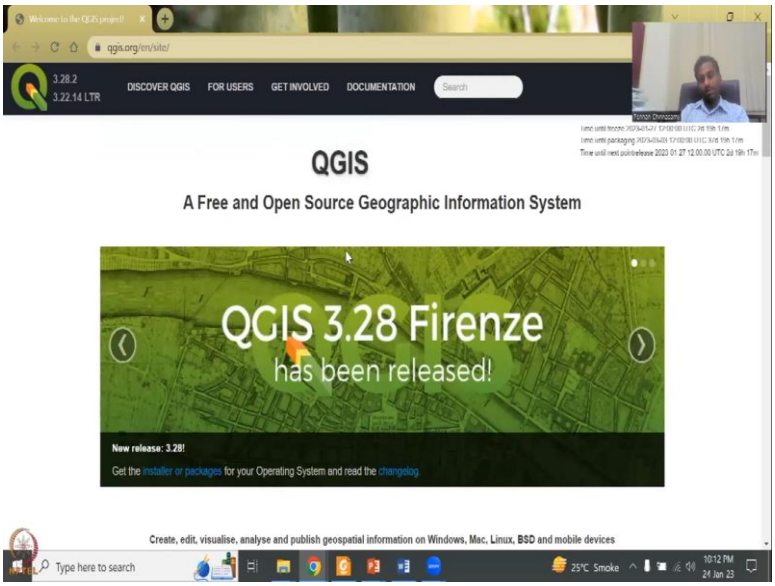

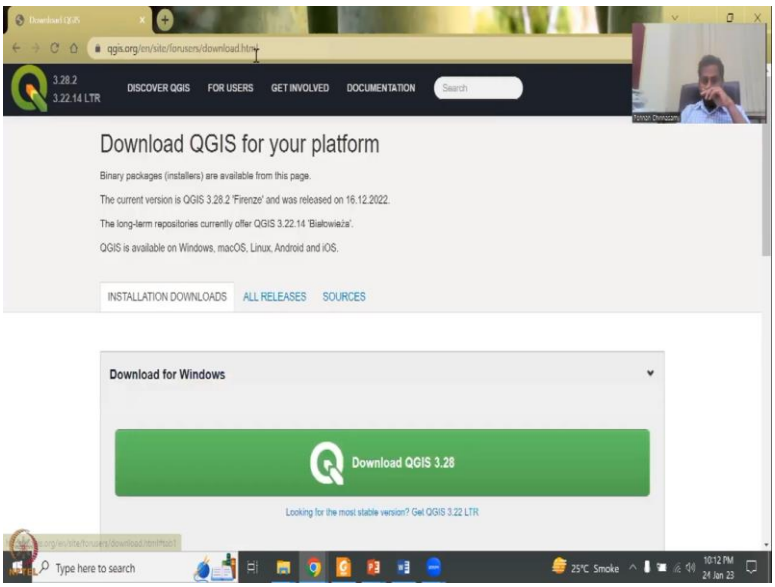

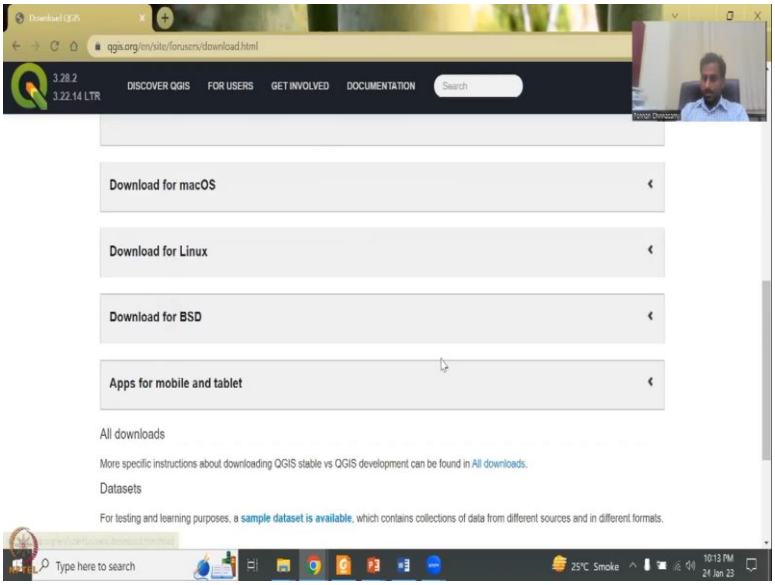

So, coming back, this is the download button that you need to click. And this is the latest version that is available. Please, note that the latest version need not be the most stable version. I will tell you what is the difference when we go to this page. So, here you click download now and when you click download now, there will be multiple users, open source software or a different OS users. So, this is for Windows. So, normally Windows Mac, OS, Apple, Linux, BSD, tablets, etcetera is there. Most people would have the Windows version. So, let me click the Windows version.

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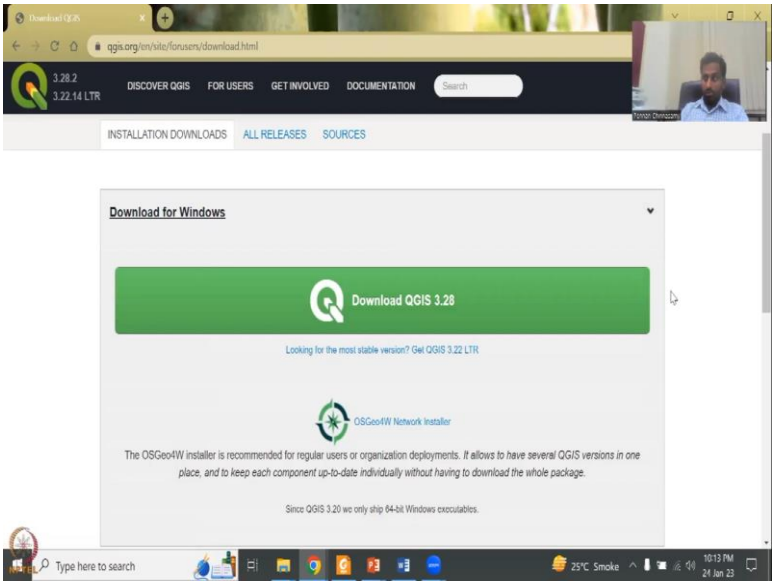

And you have the first green button which says download QGIS version 3.28. So, this is the most richest, newest version, however, like any other software, the model gets updated

regularly, which means there is a community which is updating the software by introducing new tools, better sophistication models, GUI, the Graphic User Interface.

So, what we will have to do is we will have to use the most stable version. You can see here which is 3.22 long term version. So, do not use this the download, the green big button which is 3.28. Because for beginners I am saying, if you are advanced user, yes, you can use it and then play and understand, if it crashes.

Stable version means it has been there for long term, it has been tested and the bugs are less, like any software. Every software will have bugs. So, new softwares will have more bugs. So, do not go for the newest one when you are a beginner, go for the more stable version.

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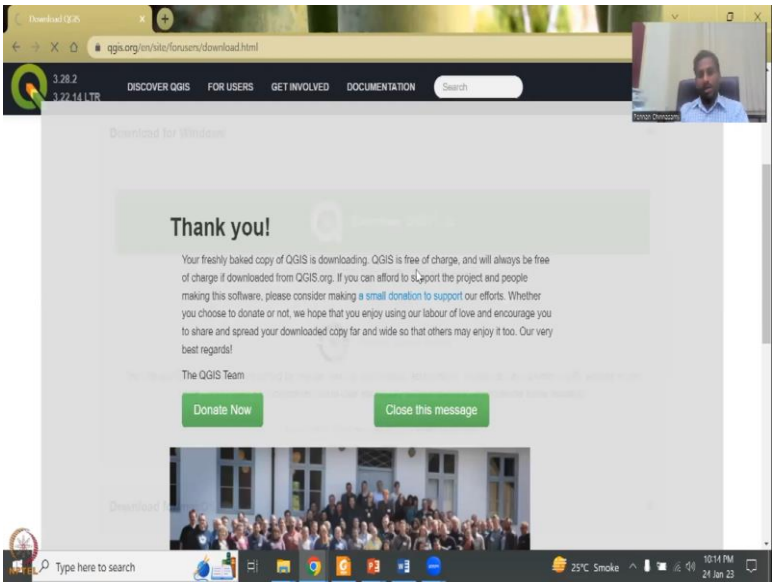

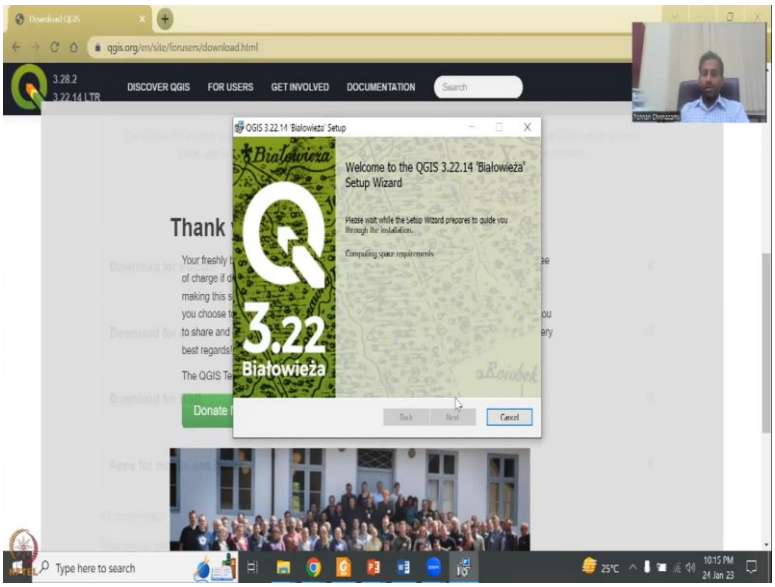

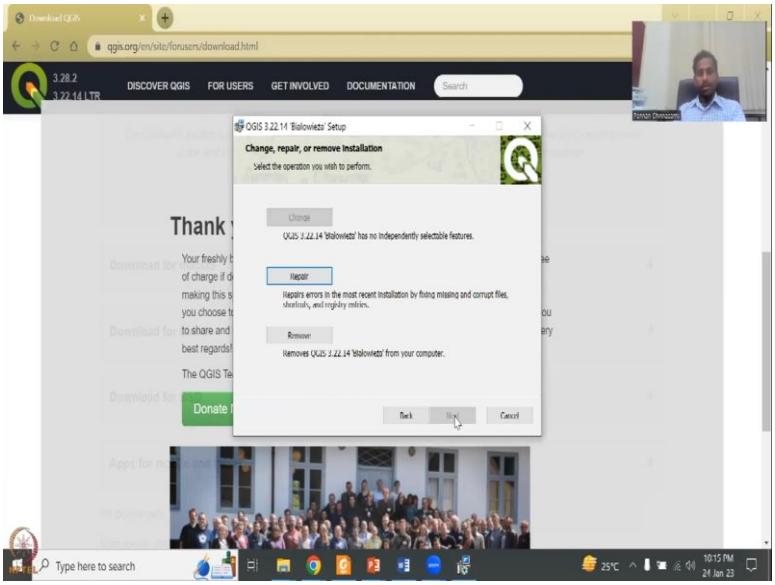

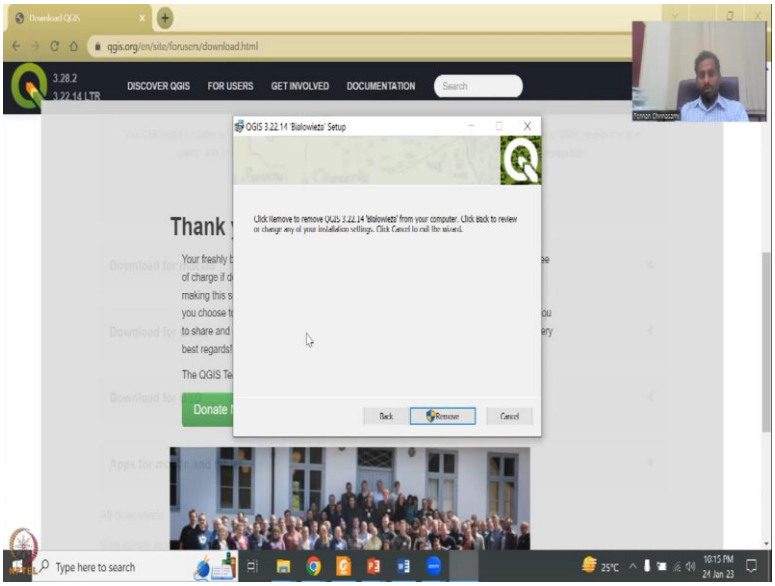

Once you click it, a download page will come and ask where you want to download. I have already downloaded it here because it takes long time, as I said downloading took me like 45 minutes and we cannot wait that long for class. So, I have downloaded it, put it in your download folder. And then there is a message which comes here about supporting QGIS, if you want to.

So, now let me open the folder where I store it and double click. When I double click the version, so, you see that it comes up as do you want to download. And you will see, yes, next, next. So, it says you already have a version. So, let me just remove the one, I have already removed it, but sometimes there will be some traces of the software. It is a very quick software to install, if you have downloaded the software. So, while it is downloading, let me go back to the slide. Yes, where.

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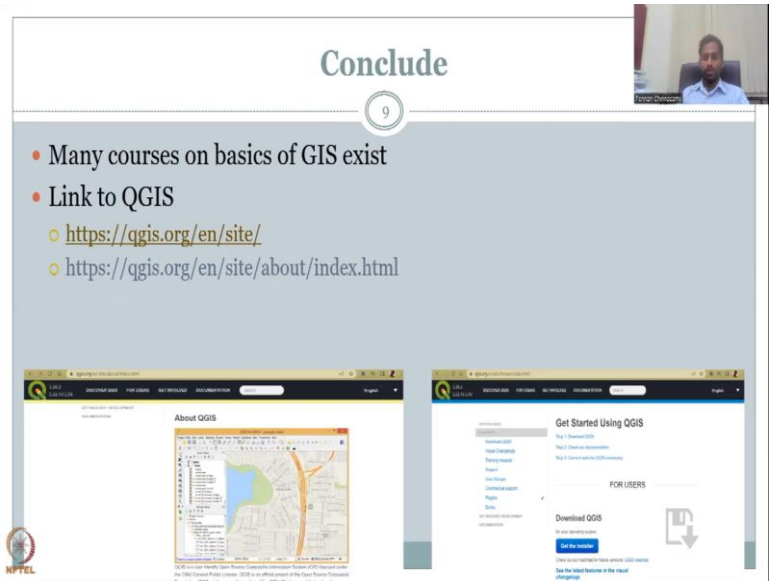

I also wanted to show you the other users or knowledge products in QGIS web page that you can collect. So, now you could see that it is just setting up the space and then removing the traces of the software. So, it will reinstall my software from the package I have. In the meantime, we will be discussing these other things from QGIS website. The link is given here. Let me click it. It will go to a new page and I will share it.

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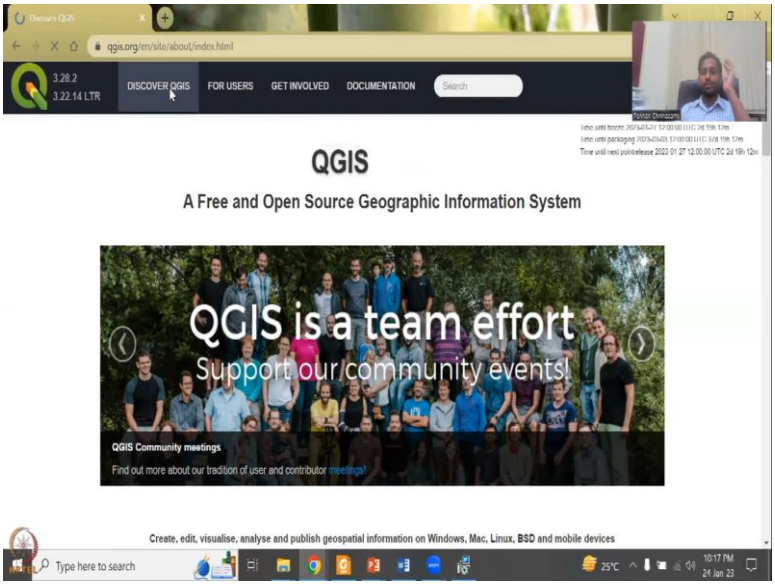

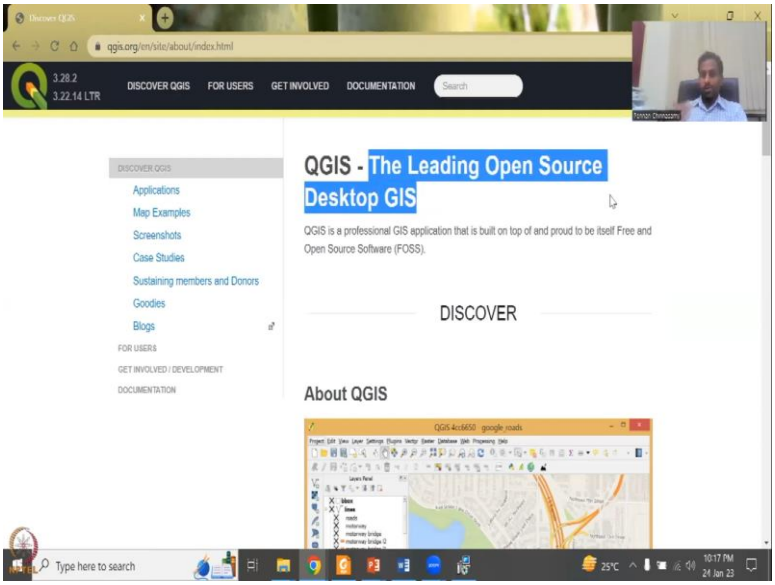
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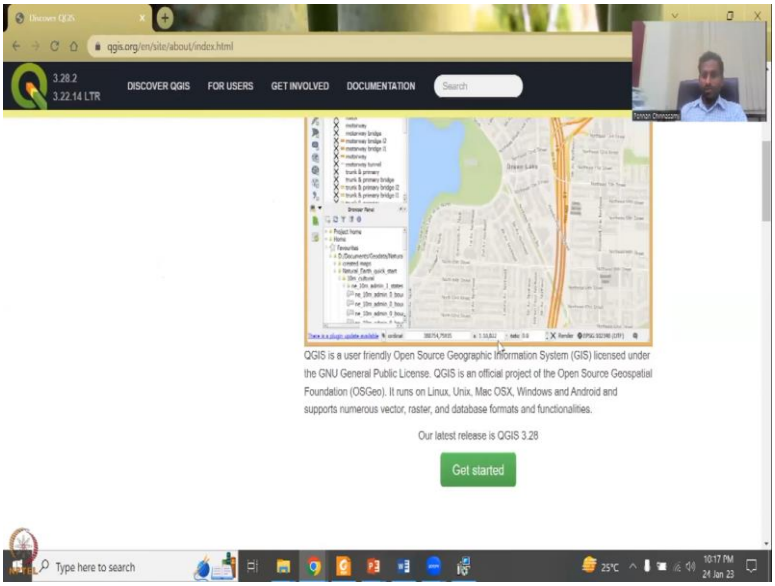
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QGIS is a user friendly Open Source Geographic Information System (GIS) licensed under the GNU General Public License. QGIS is an official project of the Open Source Geospatial Foundation (OSGeo). It runs on Linux, Unix, Mac OSX, Windows and Android and supports numerous vector, raster, and database formats and functionalities.
Our latest release is QGIS 3.28
Get started
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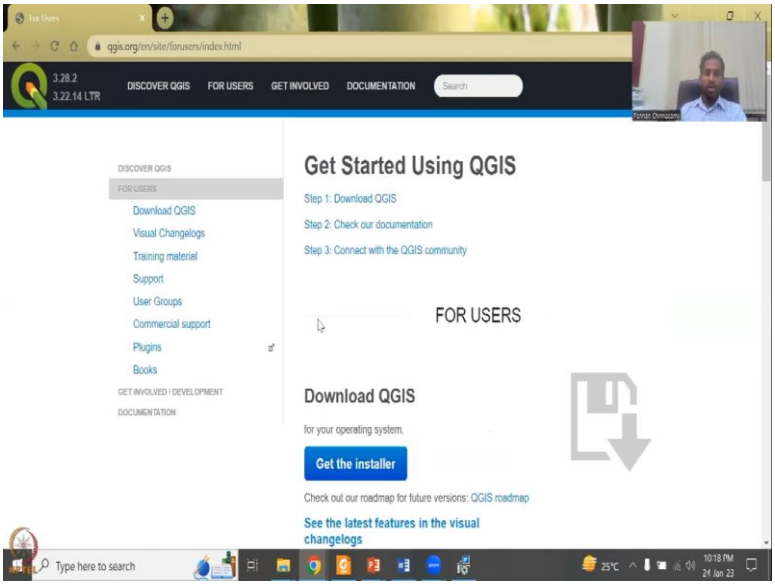
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Step 2: Check our documentation
Step 3: Connect with the QGIS community
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Get the installer
Check out our roadmap for future versions: QGIS roadmap
See the latest features in the visual changelogs
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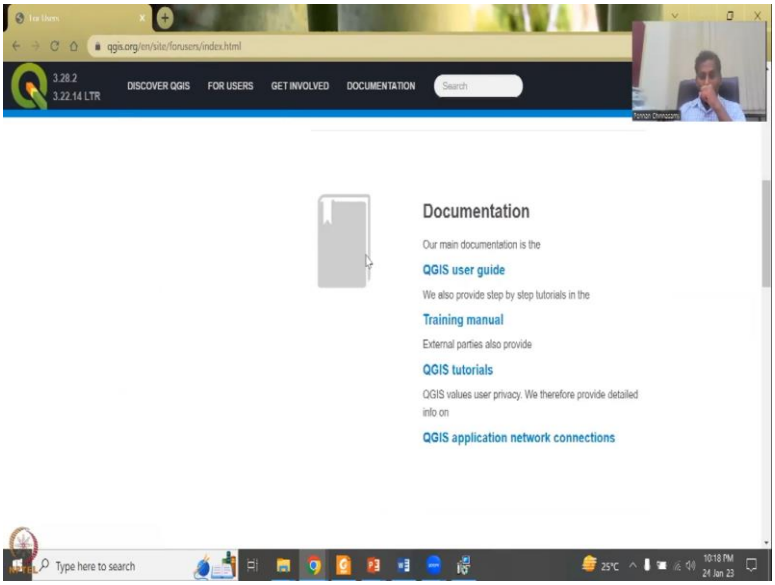

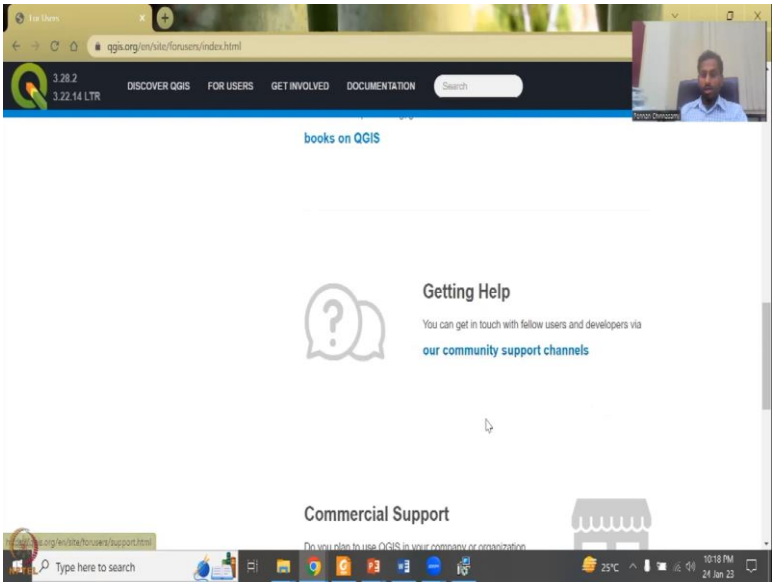

Yes, in this, you have discover QGIS. In the discover part, you have, it claiming that it is the leading open source desktop GIS in the world. So, it is very professional, it is used by many many people and you have the applications and stuff. So, this when you click get started, it goes to the download page which you already have downloaded.

The steps are you have download, check your documentation, connect with QGIS community. The community is where you discuss the problems, the statements between the users. So, here is where getting help the community. I will come to that part later.

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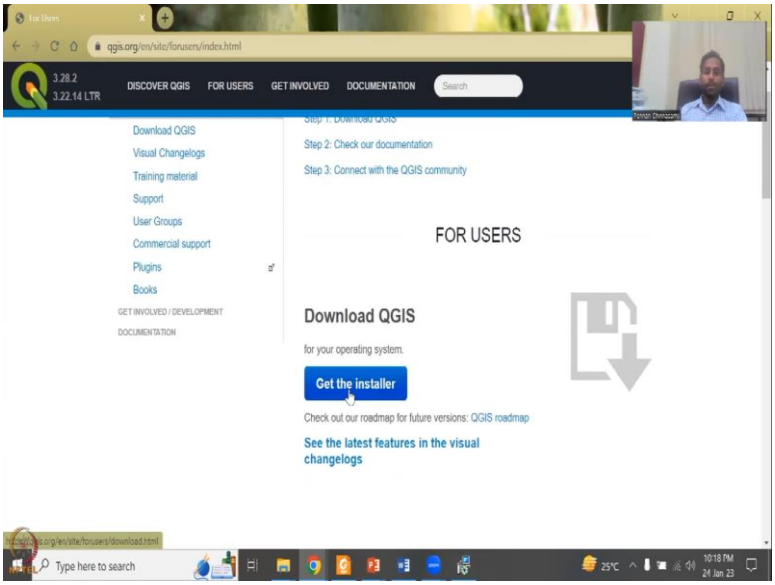

But for now, let us go here. For the users, we can download get the installer. We have already downloaded it. It is it is going on. I will just check the status.

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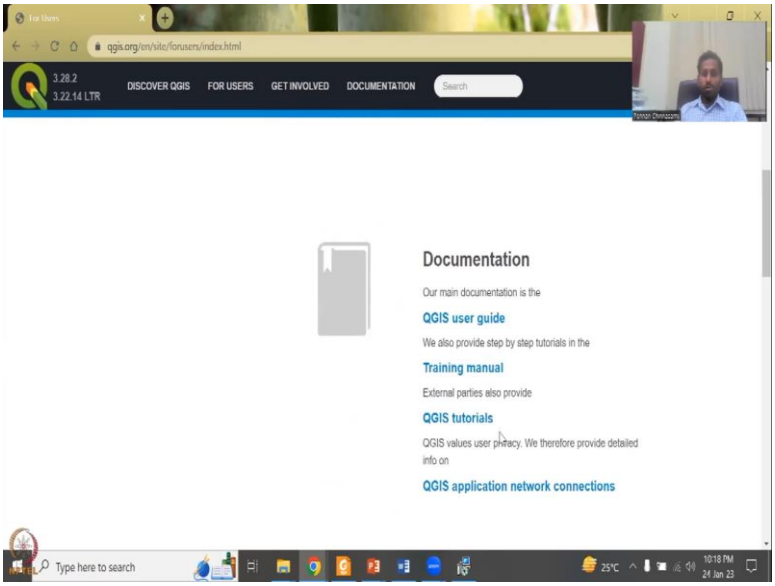

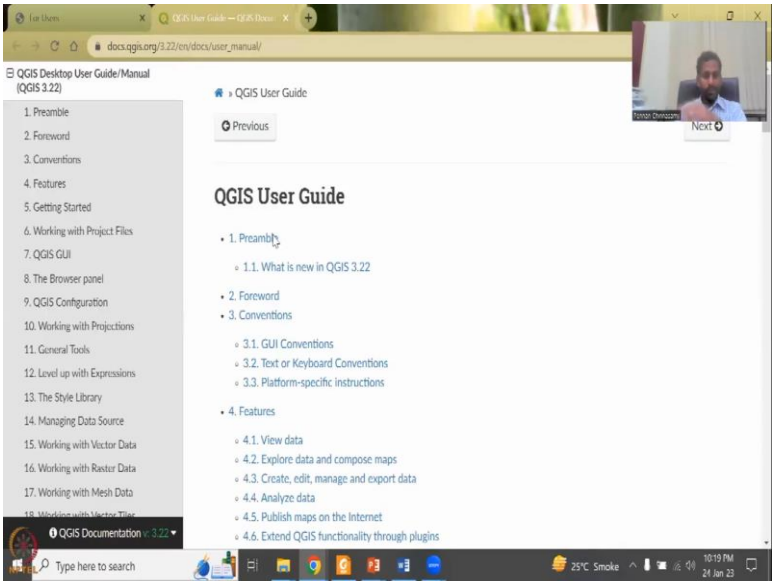
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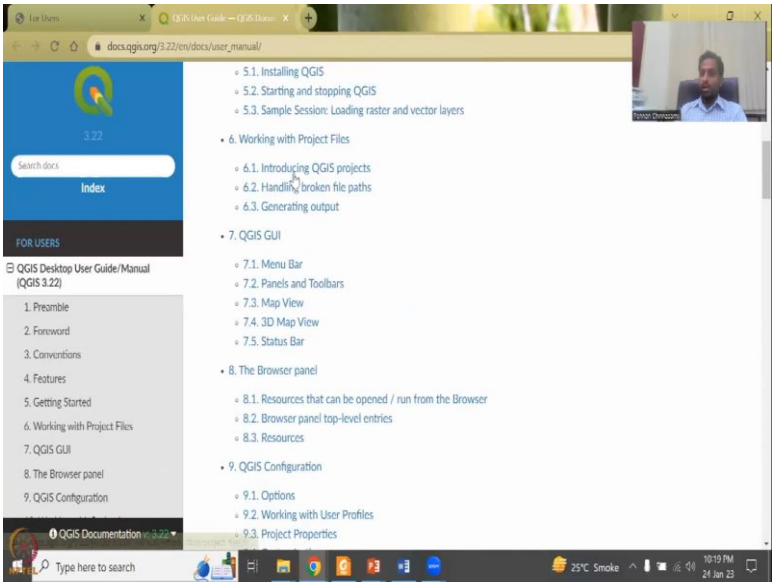
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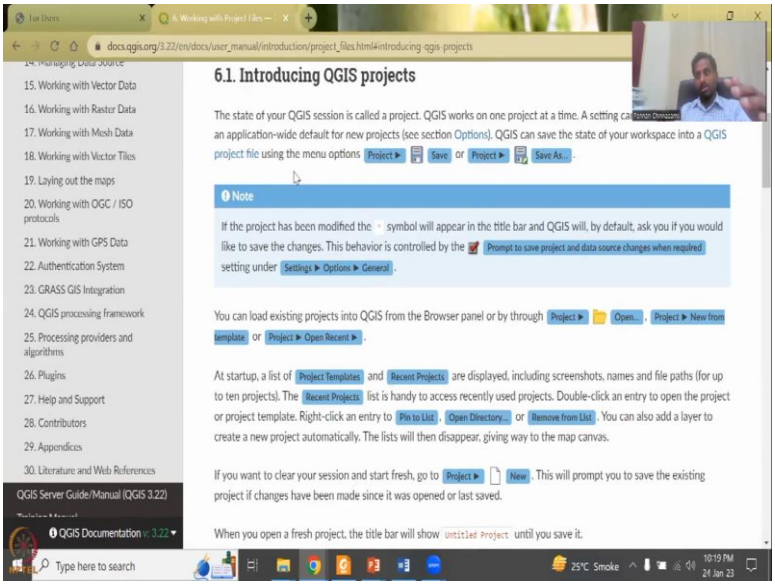
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6.1. Introducing QGIS projects
The state of your QGIS session is called a project. QGIS works on one project at a time. A setting ca
an application-wide default for new projects (see section Options). QGIS can save the state of your workspace into a QGIS project file using the menu options Project ▶ Save or Project ▶ Save As...
Note
If the project has been modified the * symbol will appear in the title bar and QGIS will, by default, ask you if you would like to save the changes. This behavior is controlled by the Prompt to save project and data source changes when required setting under Settings ▶ Options ▶ General.
You can load existing projects into QGIS from the Browser panel or by through Project ▶ Open... , Project ▶ New from template or Project ▶ Open Recent ▶.
At startup, a list of Project Templates and Recent Projects are displayed, including screenshots, names and file paths (for up to ten projects). The Recent Projects list is handy to access recently used projects. Double-click an entry to open the project or project template. Right-click an entry to Pin to List , Open Directory... or Remove from List . You can also add a layer to create a new project automatically. The lists will then disappear, giving way to the map canvas.
If you want to clear your session and start fresh, go to Project ▶ New. This will prompt you to save the existing project if changes have been made since it was opened or last saved.
When you open a fresh project, the title bar will show untitled Project until you save it.
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Then what you do is you have the documentation where you have the user guide, training manual, tutorials, etcetera. So, let us look at the user guide. In the user guide, we have what is new, how does it work, 3.22 etcetera, etcetera. Yes. So, you can quickly download and look into these different different materials. It is like a book but with chapters. So, it is like a web page book.

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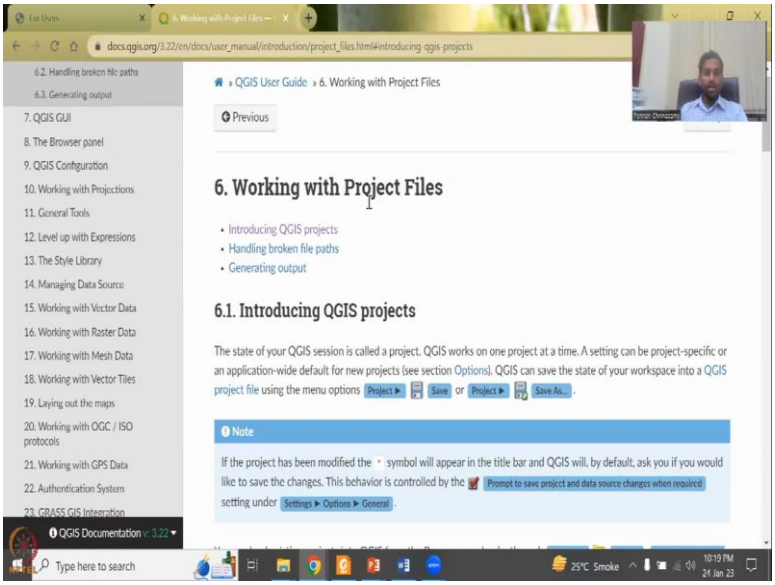

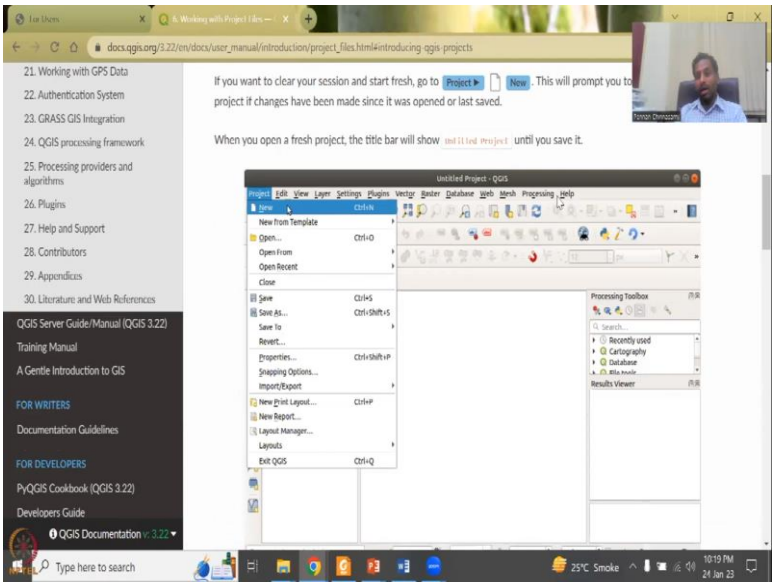

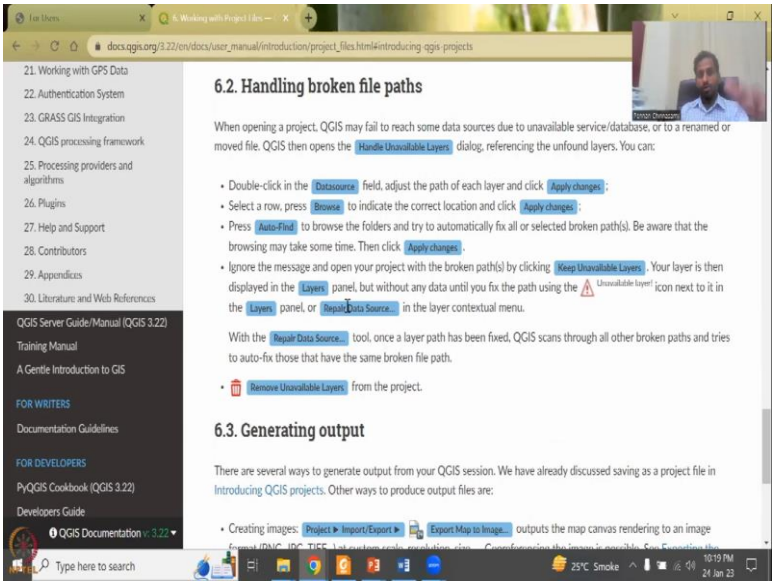
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6.2. Handling broken file paths
When opening a project, QGIS may fail to reach some data sources due to unavailable service/database, or to a renamed or moved file. QGIS then opens the Handle Unavailable Layers dialog, referencing the unfound layers. You can:
Double-click in the Datasource field, adjust the path of each layer and click Apply changes;
Select a row, press Browse to indicate the correct location and click Apply changes;
Press Auto-Find to browse the folders and try to automatically fix all or selected broken path(s). Be aware that the browsing may take some time. Then click Apply changes.
Ignore the message and open your project with the broken path(s) by clicking Keep Unavailable Layers. Your layer is then displayed in the Layers panel, but without any data until you fix the path using the Unavailable layer! icon next to it in the Layers panel, or Repair Data Source... in the layer contextual menu.
With the Repair Data Source... tool, once a layer path has been fixed, QGIS scans through all other broken paths and tries to auto-fix those that have the same broken file path.
Remove Unavailable Layers from the project.
6.3. Generating output
There are several ways to generate output from your QGIS session. We have already discussed saving as a project file in Introducing QGIS projects. Other ways to produce output files are:
Creating images: Project ▶ Import/Export ▶ Export Map to Image... outputs the map canvas rendering to an image
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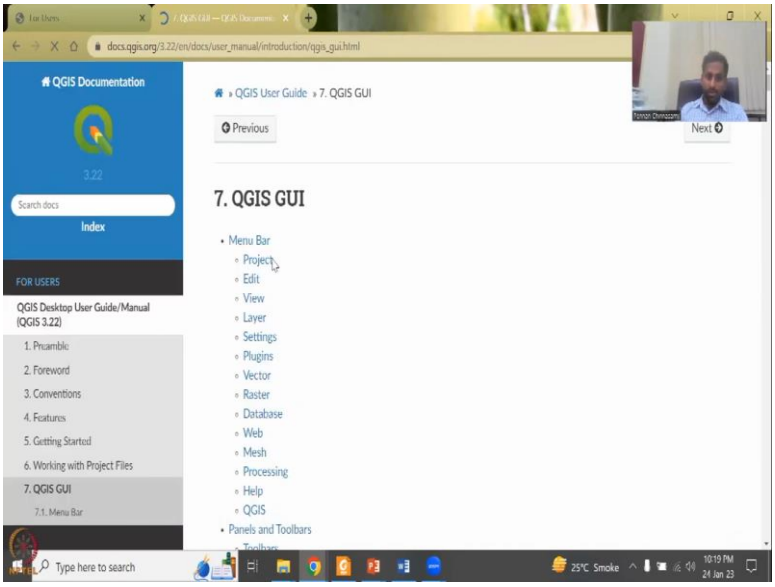
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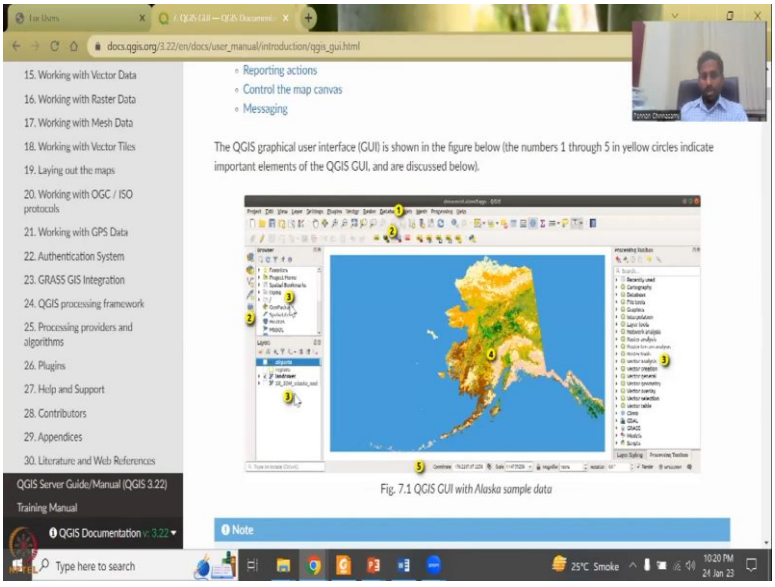
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Control the map canvas
Messaging
The QGIS graphical user interface (GUI) is shown in the figure below (the numbers 1 through 5 in yellow circles indicate important elements of the QGIS GUI, and are discussed below).
Fig. 7.1 QGIS GUI with Alaska sample data
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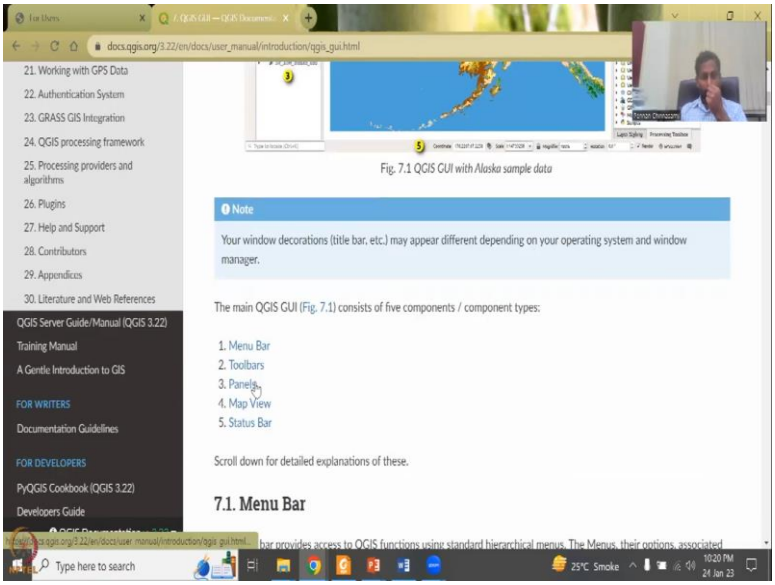

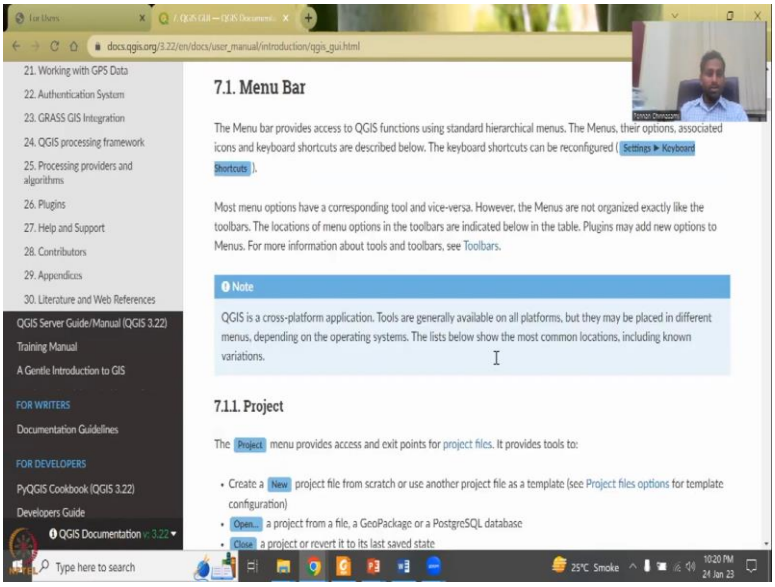

You can see here that how do you work with project files, what does each tab mean. I will go through this in the this week class. So, do not worry about learning all these by yourself. But it is just a basics, I will give. So, if you need more in depth, you can go here or there are links to a lot of tutorials, video tutorials.

How do you handle broken paths file site. So, I told you there is a lot of path files that you can do, the interface, GUI's, the menu bar, what is the menu bar, what is the panel bar, all these things. So, they are very very important panels that you need to have, the browser, the processing toolbox, the major toolbox and then these are your vector and cluster tools, the layers where you put the data etcetera, etcetera.

So, menu bars, toolbars, panels, map view and status bar. So, this is your map view and the status, how and when it is running. So, all these things you can learn as a book. This is a tutorial book that for QGIS because beginners who you want can learn.

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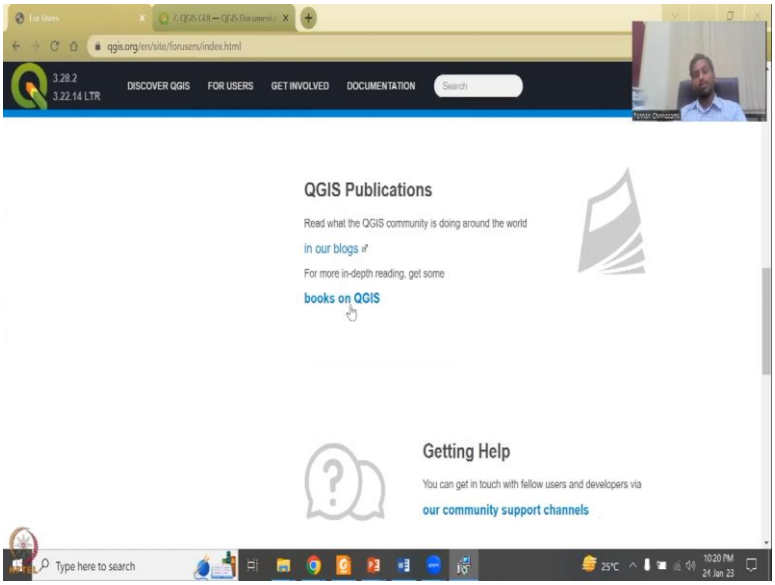

Moving on, there are publications. So, people use GIS and publish a lot of work. So, we you will be able to see these publications in this space.

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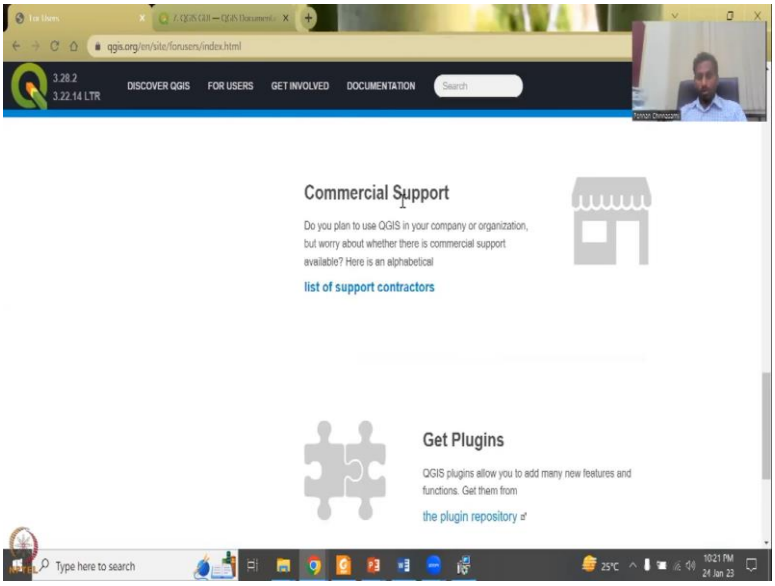

Then you have support, commercial support. So, even though QGIS is free, there are places where some companies and entities would require a higher level of association with QGIS. So, there is a commercial support also, wherein they have to pay. So, but most time, you can do what you want with free open source software alone.

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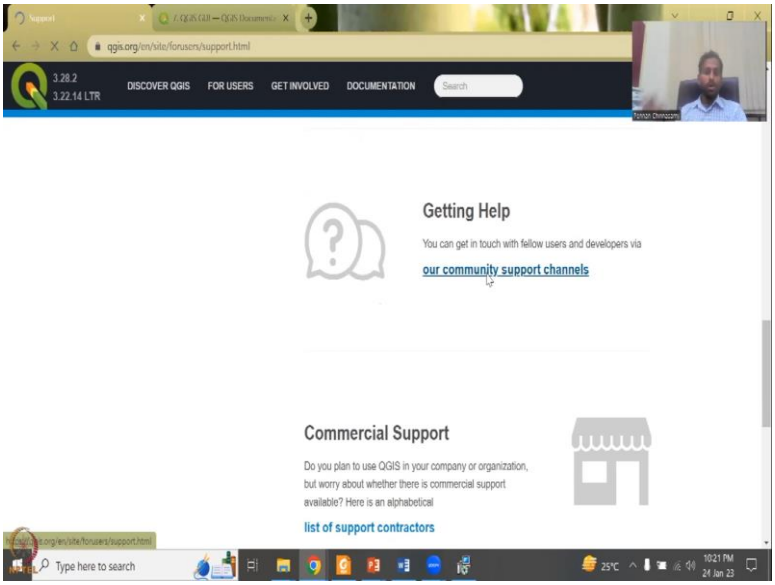

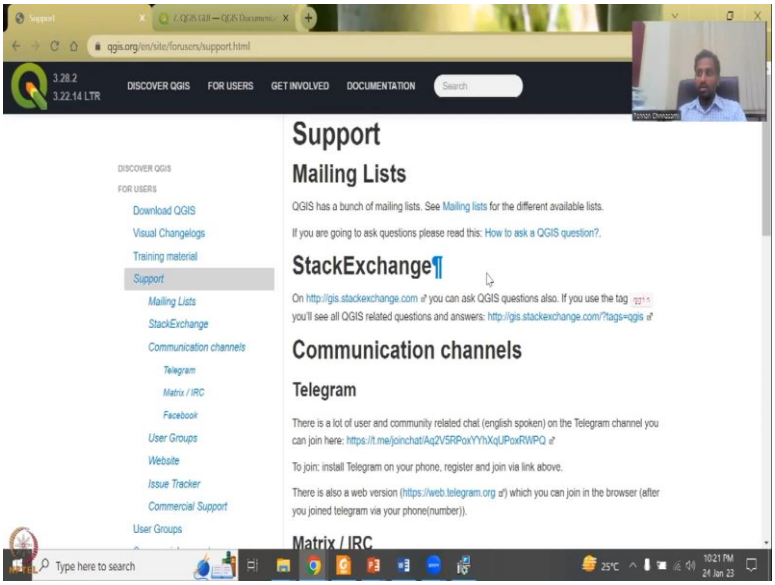

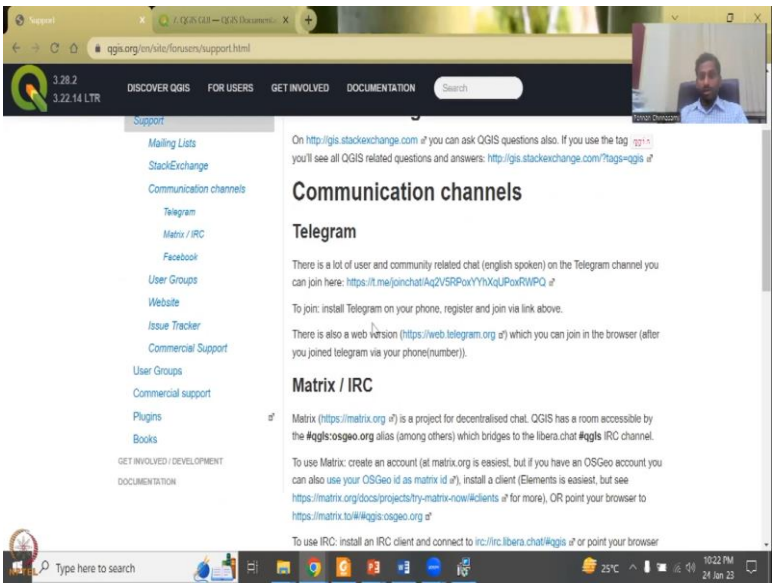

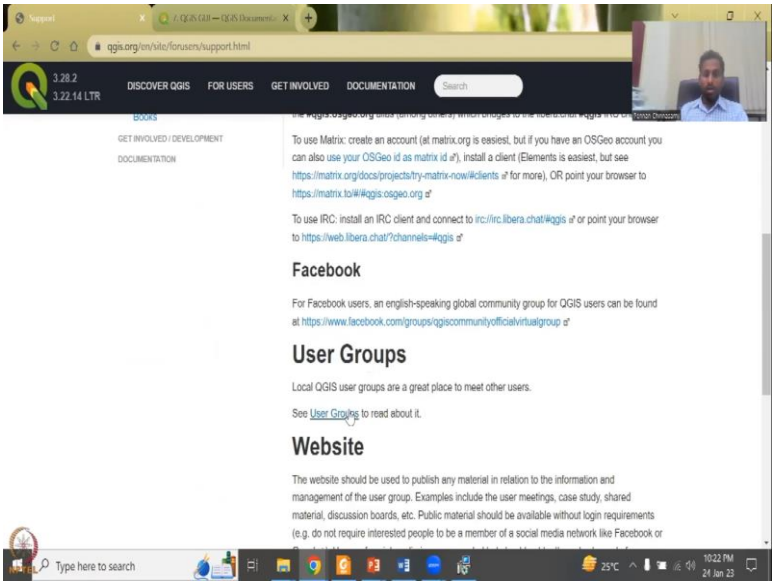

Now, you go to our community and support channels. So, in this part, what you could see is you have mailing list. You can ask a question on how it works. You can join, your put your mail, email into this and join the mailing list. So, that if there are new comments and suggestions, you will get to know about it. So, this part is also there.

And then you have different channels. So, you have telegram like an app where you can exchange ideas, a lot of communities, English, mostly in English. So, you can use it Facebook, Matrix IRC, websites, etcetera, etcetera. So, I do not have any preference but one preference I do have is how to ask a question.

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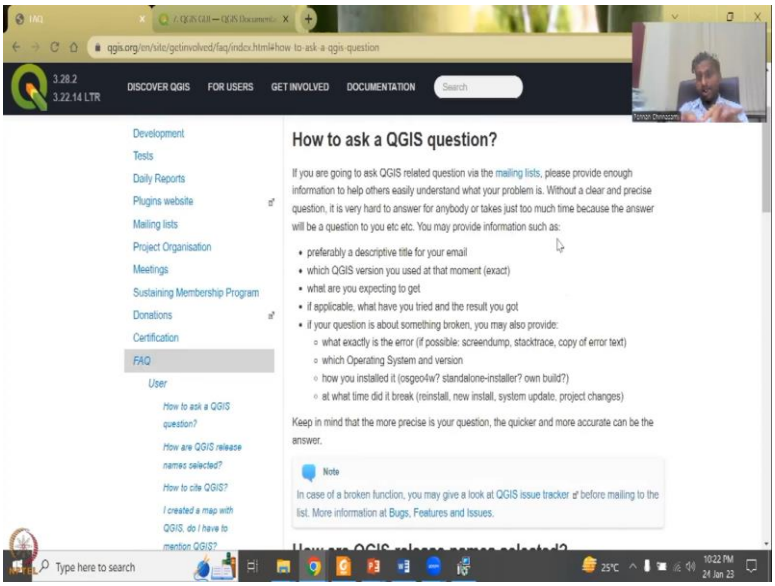

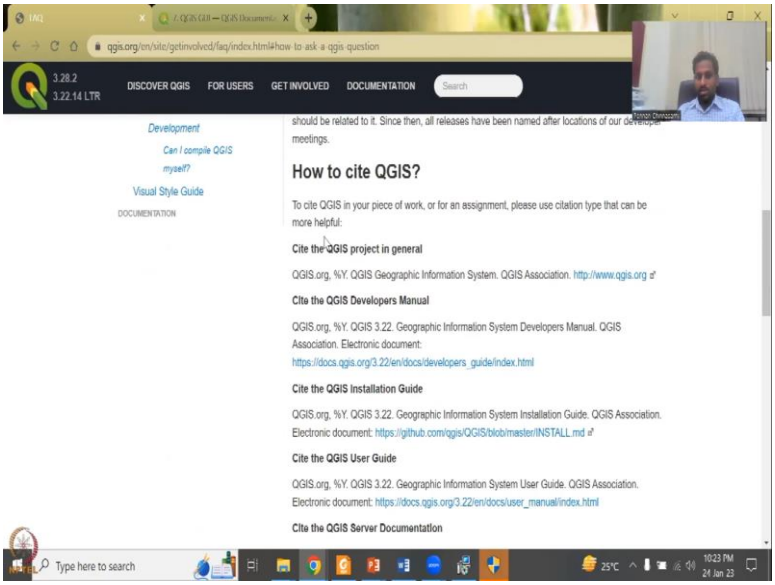

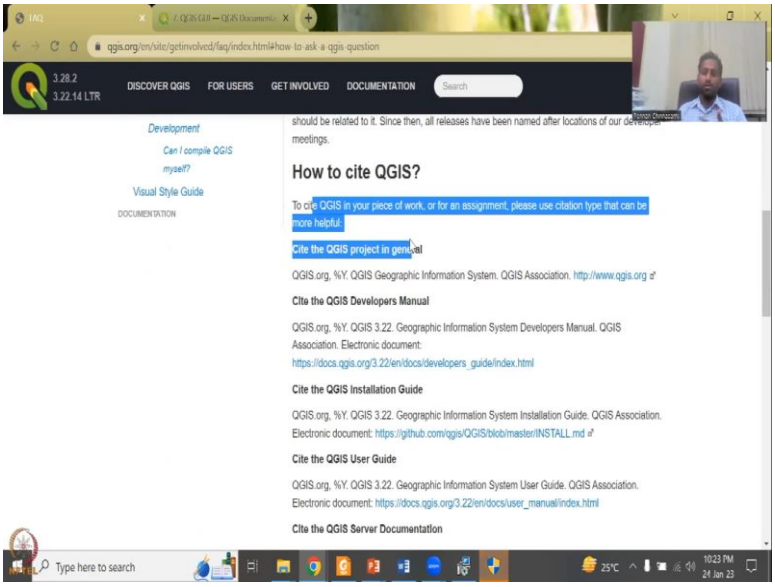

You could just normally go there and type your question and within a day or two, someone like a volunteer, would reply to the question. So, for rural development, for example, what questions can you ask? One question would be I do not find the data set or I do not know which tool to use for this specific application, let us say groundwater mapping in rural villages, I do not know the tool, you can say, for which their community can give you some good examples and those examples you could definitely use for your project.

So, these are how you could use it and citations is needed, like for example if you have a good work a project, you can always cite them because it helps them to get more funds, saying that, yes, I have used QGIS, it is a good software, all these things.

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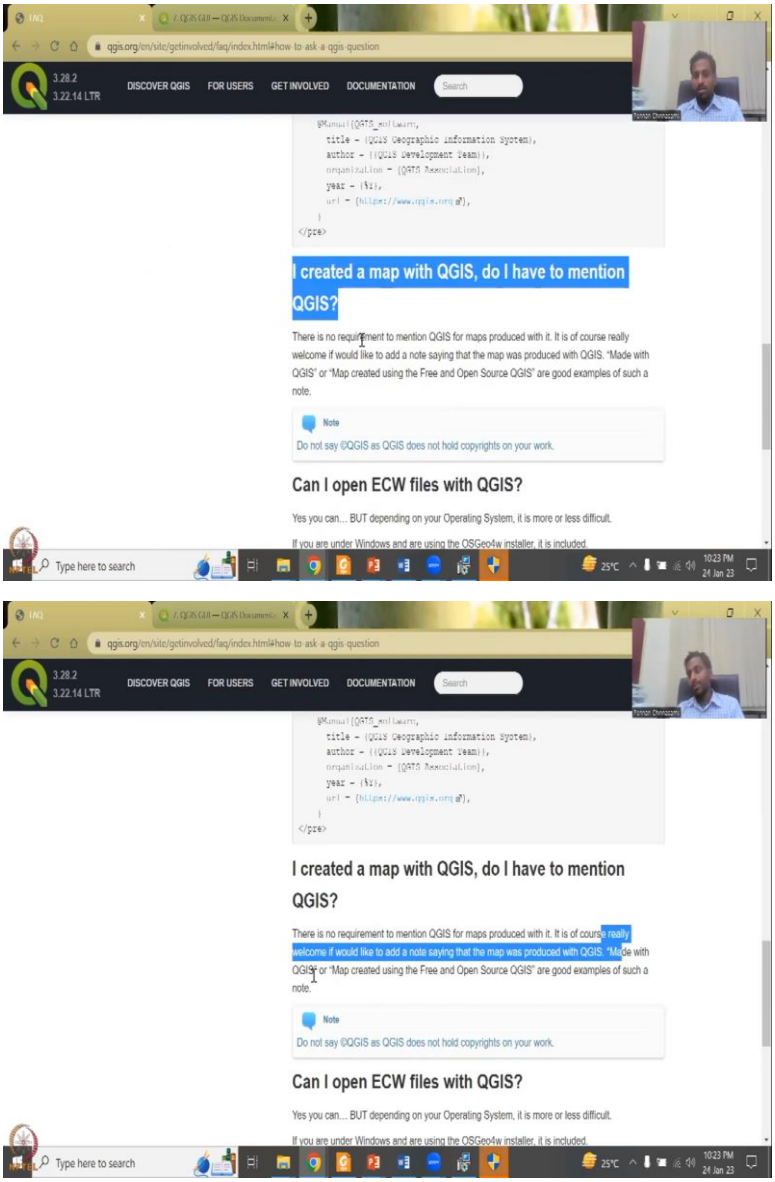

You have to mention QGIS, there is no requirement because that is the principle of open source. But it is good, it is welcome if you could add a note saying that made with QGIS. So, in my projects, in my reports, I will just add a line saying that QGIS is used. Why? Because people should not think that, it is a very complex map, you need a proprietary software to make these maps.

I want everyone to use it, everyone can reproduce the results. So, for which you create this kind of a software where everyone has access to it. It is very simple to use and it does not take as much as memory and computing power as proprietory softwares. Normally, proprietory softwares will have lot of buttons on the site, lot of talking back and forth to the internet because they want to make sure your license is correct.

So, it always communicates back and call whereas an open source does not care about licensing and all. So, that is the part where you will have to understand that you are working with this software and it does not require major changes to your computer. So, these two links I have already shared in the PowerPoint where you could go and learn by yourself and also discover QGIS, look into the communities, you can join the WhatsApp kind of group, telegrams kind of like a WhatsApp and also stack exchange.

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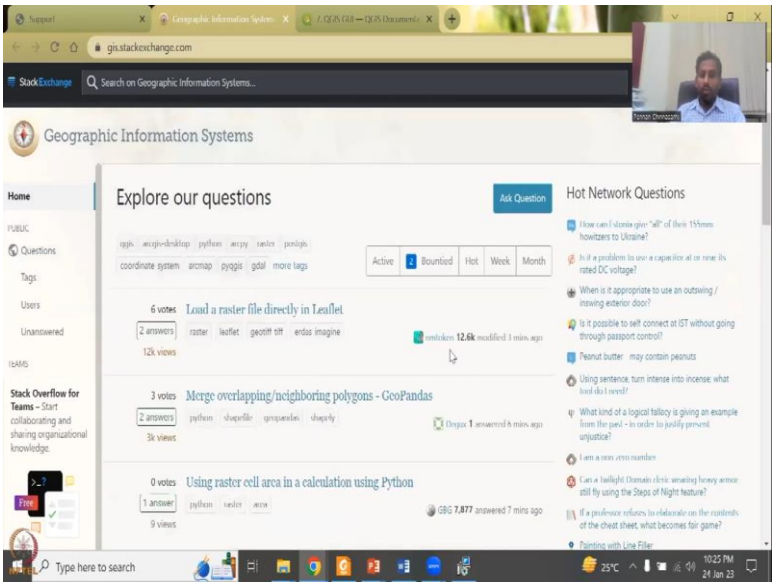

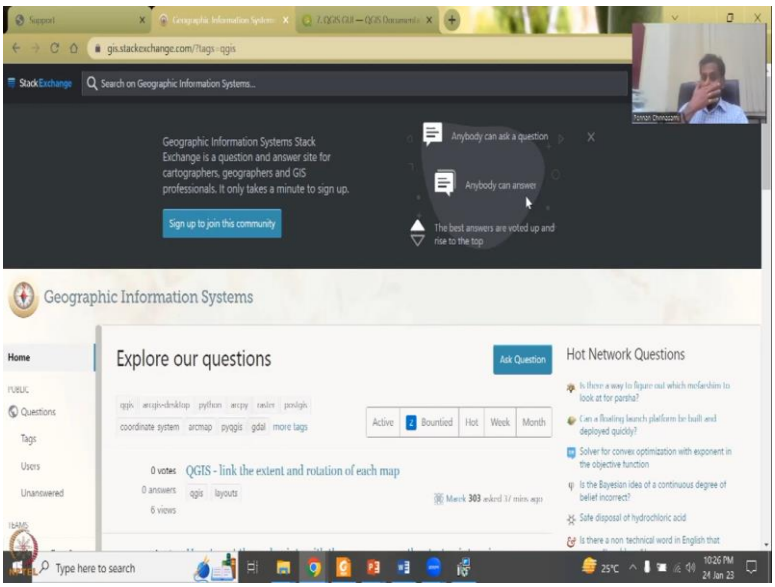

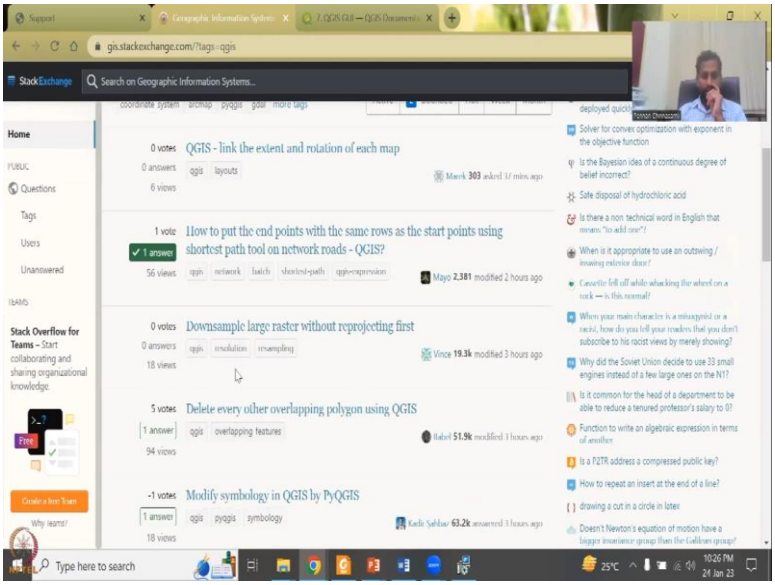

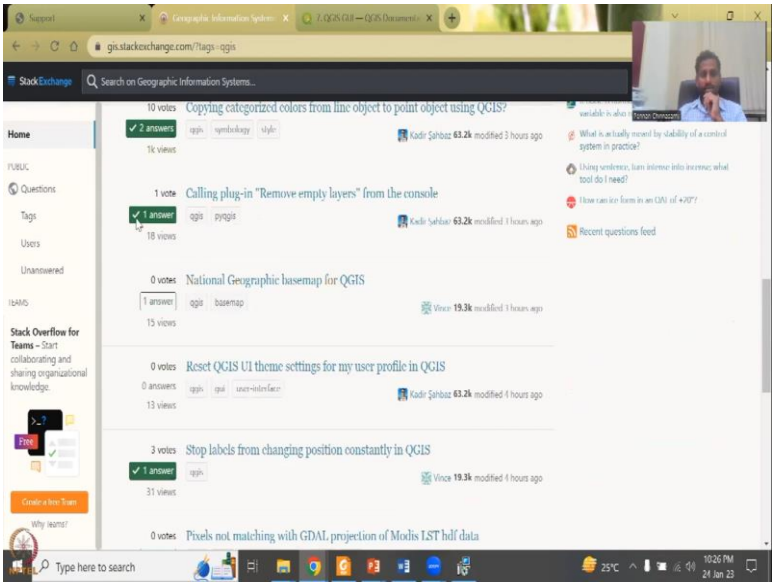

So, the stack exchange is very useful. It is a place where you go and ask questions a lot. So, let us quickly look at how people are asking questions. Some of these questions might be very advance but do not worry about it. Here is a place to learn. So, QGIS is there. Some people can use proprietary and other softwares but QGIS you can click to see only QGIS questions.

You, anybody can ask questions, anybody can answer. So, two things, one is you can be anyone, a student or a owner of a company, you can ask questions and etcetera. Same. Anyone can answer. So, the credibility of the answer relies on your understanding and your use. So, normally how people take a decision is like this. For example, zero answers are there. Let us say, one answer and the user would click the green button to say that yes, I like the answer and it is working well for mine.

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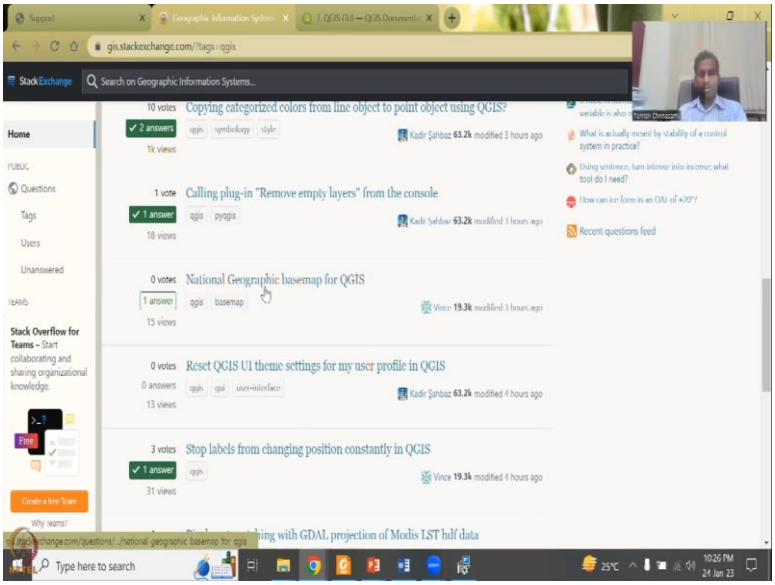

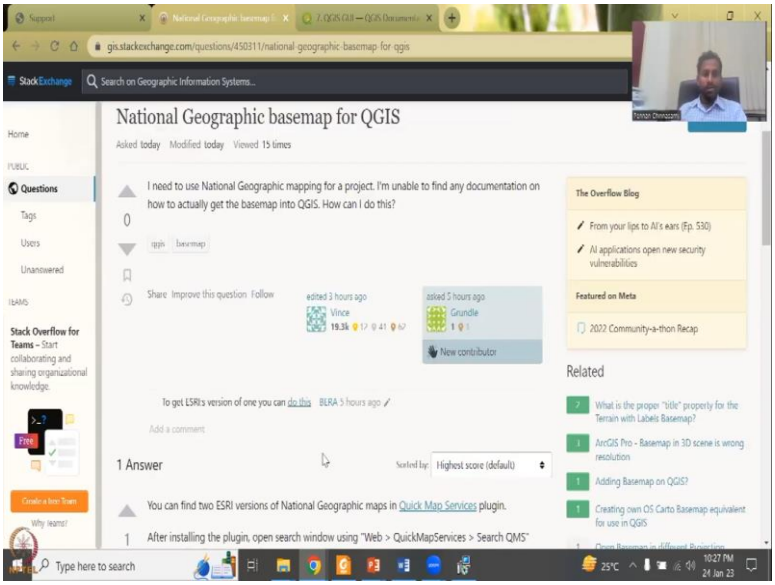

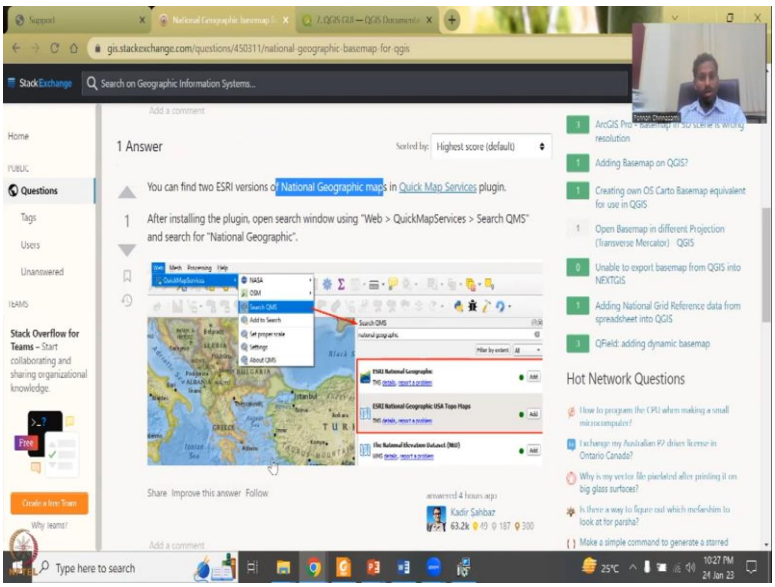

Let us look at National Geographic base map for QGIS. So, what is the question? The question is I need to use National Geographic mapping for a project and I am unable to find any documentation, how do I get this into QGIS, how can I do this? So, then they said there is a user who says there is a different version of National Geographic maps, you can go here and put it and import it into QGIS, therefore it has been answered.

So, sometimes, if there is a good answer, people do not go again and again and answer it. But, if there are answers which require some updation, some others can go and answer. So, for example, you can put here and then answer. So, you can see here how people take time and happiness in spreading the knowledge for free.

It is a very good thing. It is called geographic information XJ stack exchange, you do not have to sign up but it is better to sign because they know who is putting questions and etcetera. There is no payment, there is no, it is a community to learn. So, everyone can learn and stuff. So, with this, I will continue the installation of the GIS software. I will just quickly install it in the next version, lecture and then I will go back to the slides.

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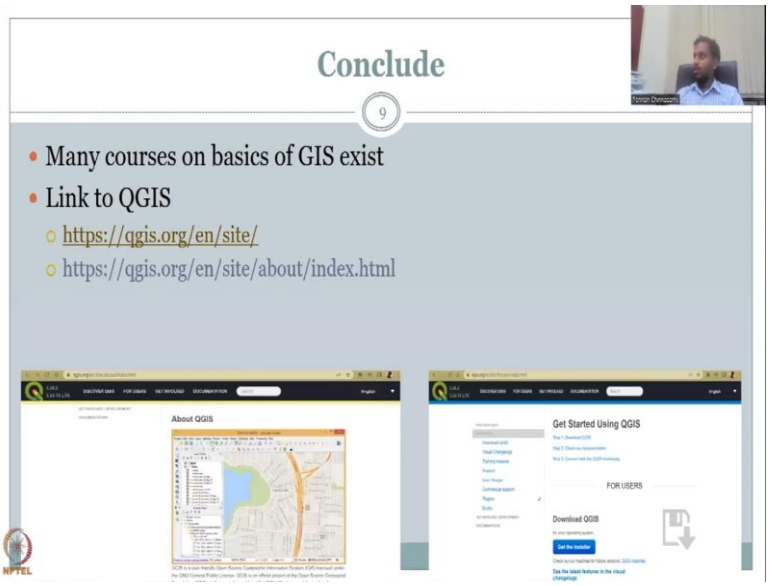

And we will see quickly on the installation of 3.22.14. We will upload it and we will go through some of the bullets before we go into the vector database. With this I will stop today's session. Thank you.