Remote Sensing and GIS for Rural Development
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Week - 01
Lecture No. 01
Introduction to course - Rural development (RD)

Hello, everyone. Welcome to the new NPTEL course on Remote Sensing and GIS for Rural Development. This is professor Pennan Chinnasamy and I am an assistant professor with Indian Institute of Technology, Bombay. I am with the department call Center for Technology alternatives for rural areas CTARA.

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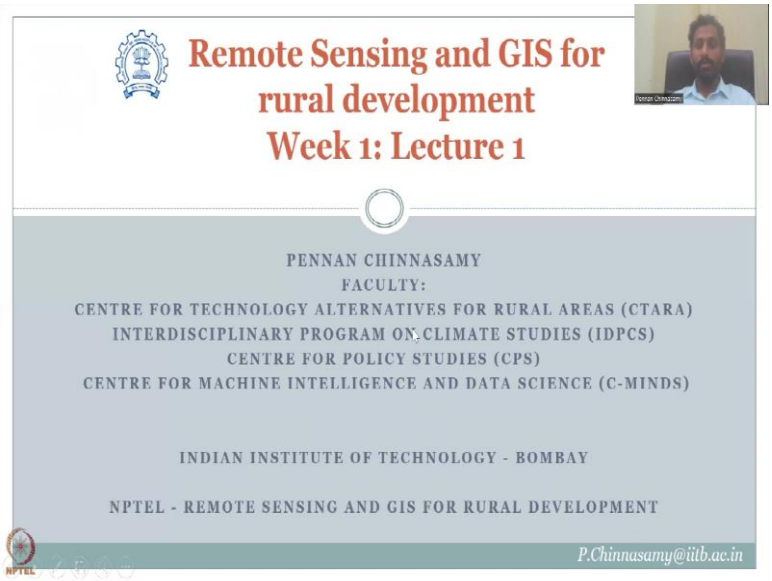

In today's lecture, we will be going to week 1, lecture 1 and also a faculty with the Interdisciplinary Program on Climate Studies IDPCS and an associate faculty with Center for Policy Studies, and Center for Machine Intelligence and Data Science called C - MINDS. With this note, I welcome you all, to the first week, first lecture on new NPTEL course, remote sensing and GIS for rural development.

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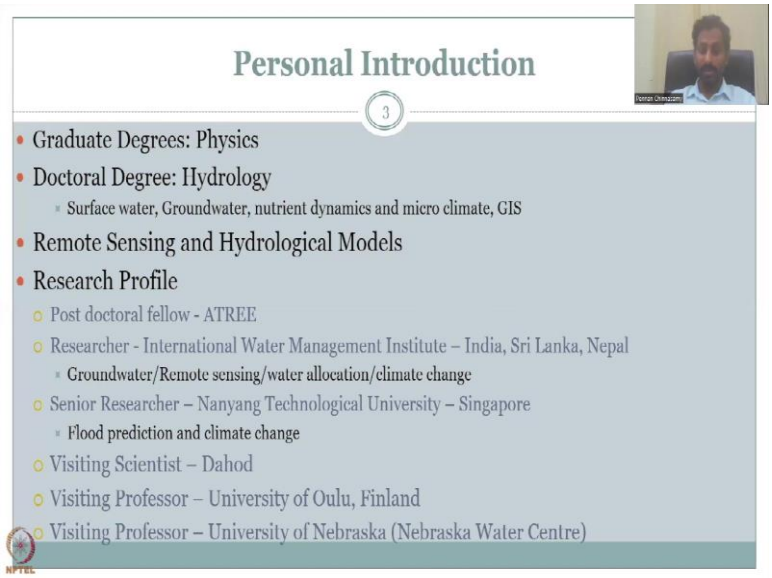

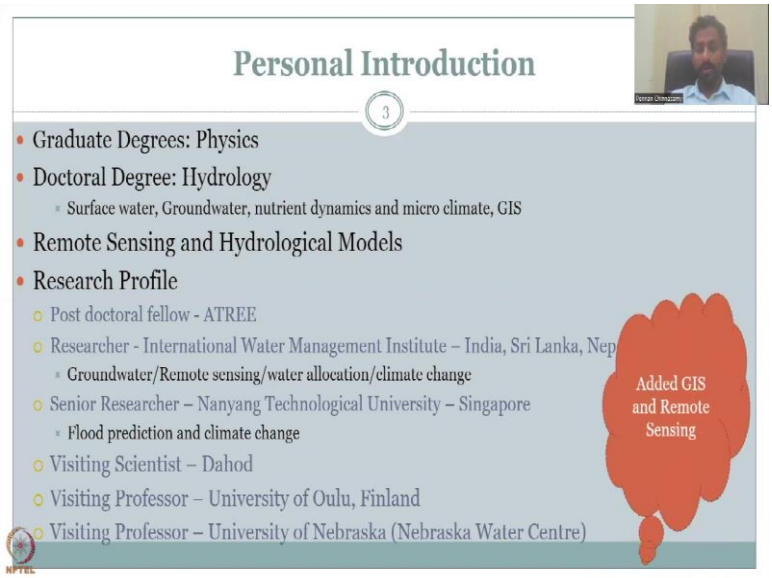

First, let me walk you through a personal introduction, so, that we understand the basics behind this course, and why this course has been arranged. First, I would like to thank everyone for joining this course, it is a very different non-traditional course and for being interested in rural development.

I am from the rural background. So, with my personal introduction, I will go through what I have been doing in the last 10-15 years providing studies and stuff, so I have an graduate degrees in physics. And then after my master's in physics, I joined the PhD program hydrology, where I focused on surface water, groundwater movement, hydrology. And I also looked at nutrient dynamics and microclimate using GIS and remote sensing.

Once where there was less data for observation, and also less scenario based models, I started learning remote sensing techniques and hydrological models. Once I am done with my studies and PhD experience, I move as a research scholar with ATREE Bangalore, followed by stints in Nepal with International Water Management Institute as a researcher in groundwater remote sensing.

Then I moved to Singapore as a senior researcher with Nanyang Technological University where I did flood prediction and climate change models, and a visiting scientist country with Dahod foundation, and also a visiting professor with University of Oulu, Finland, and University of Nebraska, Nebraska Water Center. You could note that I have been in a very fundamental science program, which is physics. And then I also did a lot of ground hydrology and observation data in my PhD.

But suddenly, I have had more interest and applications using GIS and remote sensing. This is because when I came back to India, the data was not as freely flowing. So, GIS and remote sensing games methods protector and that was used in these kind of settings.

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So, moving on, we will be looking at the team. The team consists of myself as the lead instructor followed by two TAs. The first TAs is Mr. Pranad M. He is my PhD student with CTARA. And he is also a gold medalist during his master's program from TISS which is Tata Institute of Social Sciences. Another TA is Mr. Pravin Kolhe. He is also my PhD student with CTARA and has an MTech from IIT, Kanpur on water resources. Currently, he is also the supervising engineer at Water Resources Department, Maharashtra, which is a government position.

So, there will be a lot of insights from both social angle and water observation data angle from the government using your TAs and then we will be contributing their time and expertise throughout this course. So, with this I once again welcome you all to this wonderful non-traditional course, but very very important course on rural development.

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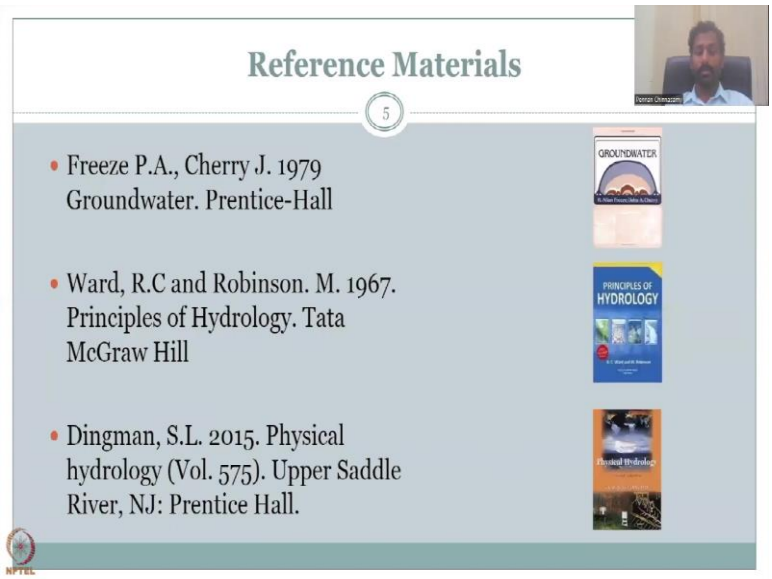

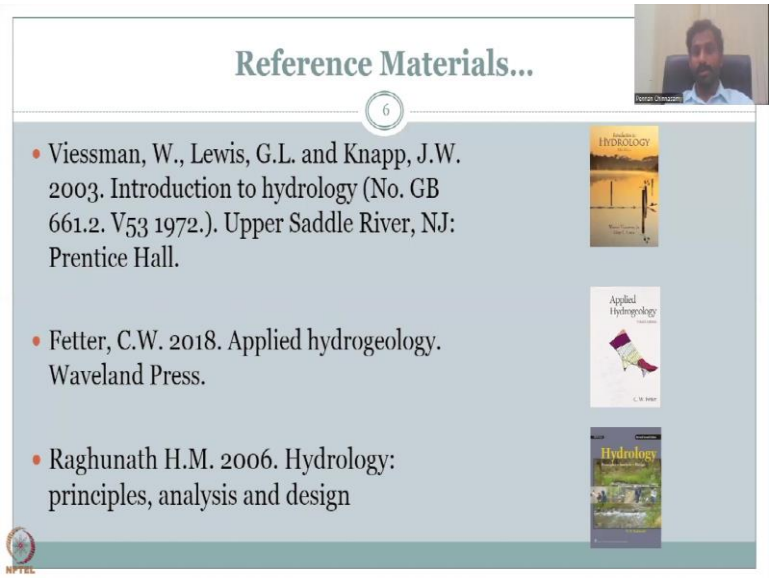

Reference materials will include groundwater by Freeze and Cherry. Groundwater is one of the key resources that has been managed for rural development in India. So, I will touch upon a little bit of groundwater and water resources using principles of hydrology by Ward and Robinson. Physical hydrology book by Dingman and some more hydrology books and applied hydrogeology books or the hydrology book by Viessman Lewis and Knapp on Introduction to hydrology is a very good book followed by applied hydrogeology by Saddle

and the local systems hydrology using hydrology principles analysis and design by professor Raghunath.

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One more important, this course will draw upon data and information from government reports because rural entities may not be that established in books. And the Indian rural systems are very, very different than other rural systems. So, we will be focusing a lot on government reports and the need statements. And how do you do rural development using GIS and remote sensing, it is mostly on understanding the rural development and then pushing the rural development forward using GIS and remote sensing techniques.

So, for GIS, we will be using an open source system, we would like everyone to understand GIS and use it for this course which we will do some basics from QGIS, which is a Quantum GIS, an open source system, very well-known system, which has been also used for launching rockets in European countries and mapping where and how, et cetera. So, it is very, very important tool and the basics will be taught in this course.

But however, we would like you to pick it up from lot of different educational materials, including our own NPTEL courses. I will be giving the links to these courses during the coursework. As I said, there will be lot of many field notes that we will be using for this course. Field notes are notes that you go and when you do field work surveys in the rural environments to take notes in a very systematic way. And those field notes will be used for the class lecture. So, that gives you the real life experience and real life problem solving what is needed those kinds of aspects.

So, AGC reports as I said government reports are there when I say AGC, it could include NGOs, state agencies, central agencies, international bilateral agencies, like the World Bank, Asian Development Bank, the central agencies like MuPAD, NGOs like Dan Foundation, Watson, and more importantly, a local Gram Panchayat requires answer.

So, these we do have a lot of data already collected for this course which will be seeing how and why it can impact a rural development. And we will also take lot of new articles from news agencies, and also chance. So, the NITI Aayog book I have shown is a very important government report on the development scenarios in India especially rural development. So, we will be using lot of these NITI Aayog reports and news articles.

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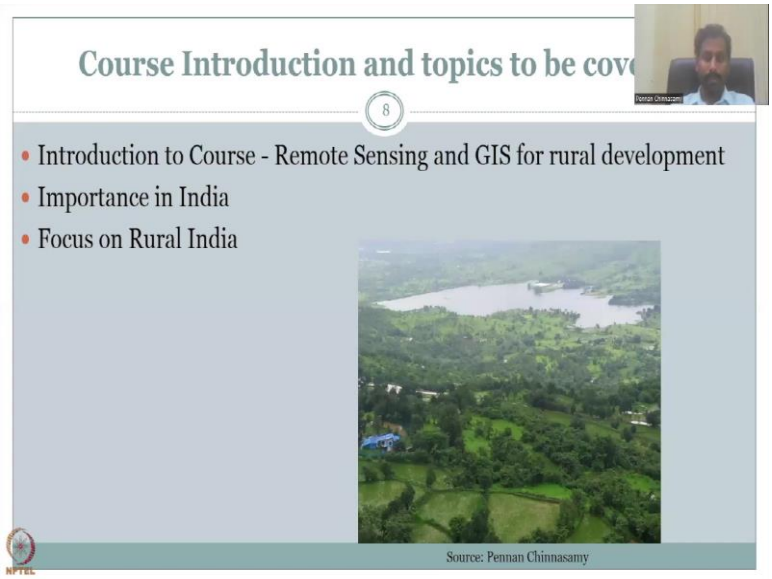

So, to move on with the course introduction and what will be covered, we will be covering a lot of material that is linked to remote sensing and rural development. When I say what is rural development, we will have a understanding about the need for rural development. So, in the introduction, let me introduce what is rural development.

Rural development includes the development of rural entities and natural resources, economic, social, health, and all verticals. It is not only economic development should happen. Multiple development scenarios should happen side by side. And for that, there is a very very important need to identify sectors where rural development can occur and based on that, we will conduct analysis of particular schemes.

So, in this course, we will only not look at water even though water is I will say the most important factor for rural development because agriculture is dependent on water, livestock

rearing cows, sheep, cattle, chicken all the livestock and there are fish aquaculture all require water. So, water is the key resource for rural development. But there are also other aspects, good road connectivity for example, health structures in schools, local entities for managing transportation, communication towers, so, all these will be covered slowly one by one and those who are interested in water can work on water, those are interested in health or rural infrastructures can work on road infrastructures.

The importance in India is very very high because India is still an agrarian nation; agrarian as in agriculture or agricultural related livelihoods is still the key in rural India. And rural India becomes the backbone as many have said for India's development. More importantly, we are poised as a very high populous country and population is very high and still on track to rise as soon as we will hit the peak, but still we are on the rising curve and for that population is tremendous need of food and water security.

Food security comes from rural entities and the rural entities need development that is what we will focus on in principle. So, it is very very important for India and India's development as a whole. You cannot neglect the contribution for rural India in the entire nation's growth. Yes, we are progressing in science technology, information technology and other aspects. But as a backbone as a support as a pillar, dual entities always will remain and we are still a good food producing nation, we do a lot of exports and we support the growing population.

So, that is why we will be focusing on rural India especially for this course. There has been a lot of remote sensing and GIS analysis urban systems like mapping floods, new infrastructures to be developed bridges, dams, very good roads, train connectivity etcetera. However, rural entities have not been that much study as of course, it has not predicted.

So, this is one post that can aid in understanding the rural scenario and then what is needed for rural development followed by how can GIS and remote sensing help for rural development.

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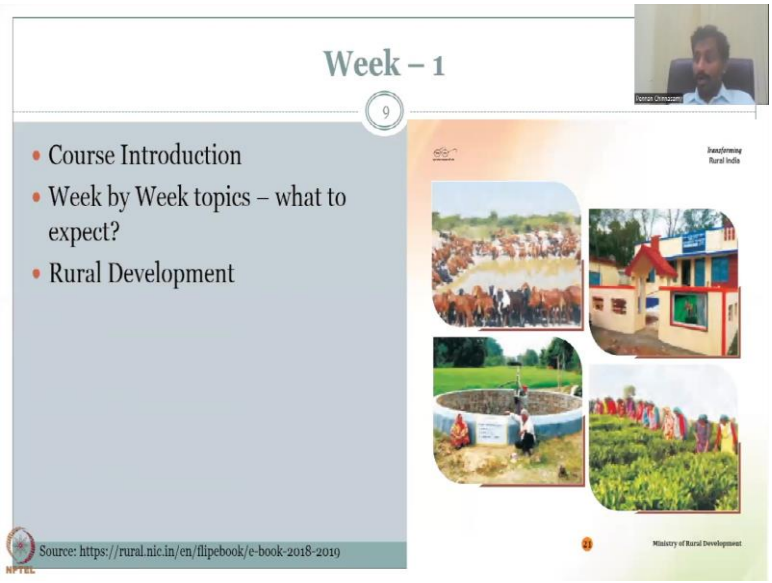

So, let us see what is the in state for week 1. In week 1, we will be looking at the introduction of the course. And this is one of the books that has been released by Ministry of Rural Development transforming. I have taken a lot of insights from these books and government reports. You could see almost whatever we discussed in the previous slide being covered here, starting from wells and water for agriculture, you see a farmer and his poor farmer sitting near water resource looking at how you replenish water and the farming increases because of farming there is good livelihood development. And because of that, that is rural development, so that is all tied to this one image.

And then you also see what a resource be managed well, so that livestock can take water, fish can take water and also domestic water supply can be attained using these resources. We also see the need for education, infrastructure and rural entities. The literacy rate is very less compared to urban centers. So, the government has built missions to put everyone on the same baseline.

We need to pull them up to the same levels make the field a leveling playing field by giving quality education for which we do need infrastructures to be identified for that GIS and remote sensing can aid. We also looked at livelihood options that can cater to local demand like it could be like labor, that force that needs work and also women livelihood options are to be catered to.

Based on this you also have cottage industries, small scale industries like tea, you can see here, women plucking tea and then the post processing can happen at a small village scale rather than industrial scale and those can help in the local rural economy. Still, if you go to

some rural villages, you can find these small cottage industries that sell produce or sell small, sustainable farmed products in packaged format. Tea is one herbs or another things local medicine, these you can buy from rural entities, and how there is no maps or GIS and remote sensing tools that can help them develop more. So, these aspects we will cover this course.

In week 1, we also will look at week by week topics especially for today's lecture, we will go through the week by week distribution of the course, this I feel is important, because we need to understand what is in store for the next 12 weeks. So, that students can take it or they can prefer another course. So, I prefer to walk you through what you can expect for the next 12 weeks in week 1 lecture. In all the sources for the materials that I use will be put on the bottom as source and the links will be given. Feel free to go to these links and access these information.

So, I have already developed rural development and how it is tied up. So, we do have rural development as a scenario which is needed for India's growth. There are lot of missions that has been proposed by the Prime Minister of India and the different sectors for attaining high rural development, economic health, every aspect of rural development will be pressed upon.

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So, rural development, as I said, is very important for the nation's growth. And let us see how we divide this course in today's lecture. So, the first week, we will be covering an introduction to rural development which has been started already in today's lecture. We will focus on water security, both surface and groundwater and issues in rural India. So, how I have mission this course is to first give you an introduction about the issues so that you can take a call on the severity and need for data based rural development scenarios.

So, I will first walk you through in week 1, week 2 on what are the issues in India, both starting from water security, including surface and groundwater resources issues in India. We will also look at food security and rural issues. So, food security can happen in urban and rural settings also. We will focus on the food production and food security in rural areas and how that is tied up to the entire market.

We will also look at agriculture and rural infrastructure issues. Agriculture could be like dams and canals that bring water from dams to the farm plots. Whereas, rural infrastructure can also include water and agriculture infrastructure plus infrastructure for education like small schools, libraries, internet connection for communication, course materials, power supply, health, good access to health facilities, roads to take the produce and livelihood options development and also roads for connecting the rural India to the center hubs, so that better quality education or health if needed can be accessed. So, accessibility is key. And that is what will be included in the rural infrastructure issues.

And we have already discussed about what is rural development and why do we need rural development for a sustainable growth pattern in India. In week 2, we will do an introduction to geospatial technologies, remote sensing and GIS. So, remote sensing is included in geospatial technology. But then when you process the data, you do need a platform and that platform we have chosen as GIS. A multiple platforms that you can use. But throughout the world GIS has been used widely.

There is a big community that uses it. So, you can always learn from others on how to use GIS. So, that is where we have take remote sensing and GIS in the topic itself. And how geospatial technologies that is the one sensing and GIS is important for all that. We will cover that aspect in week 2. We will start with the data issues, observation data, what are the issues in the current setting? How can this be managed well, or in scenarios how can you augment data?

Rural data issue is a key chapter because there are lot of aspects that go into rural data. The key is cost, timing, labor to collect the data et cetera. So, how do you overcome these, you cannot put lot of instrumentations into rural areas. It is very expensive and time consuming. So, how do you surpass this is the question.

So, that is where in the data issues, we will discuss about different techniques of remote sensing and GIS. And that is why we will have introduced what is remote sensing and how it is used for rural water and crops as an example. I will also talk about remote sensing for rural

infrastructures, and how you can use it so week 2 is also like an introduction on the course material and why you need and how you need remote sensing and GIS.

The aim is also to make you think on different aspects about remote sensing and GIS that can be used for rural development. So, let me give you an example. We hope that it kindles some interest in you to look at different aspects in rural areas. The beauty about NPTEL course is it is open to throughout India. So, there will be some students taking it from a rural environment or like me, they would have come from a rural environment.

And they can actually relate to a particular problem that may not be covered in this course. However, the technique of using remote sensing and GIS is the same. So, we hope that this expands the thinking capacity, expands the interest, so that you become the identifier of the problem. And you become a solution provider using remote sensing and GIS.

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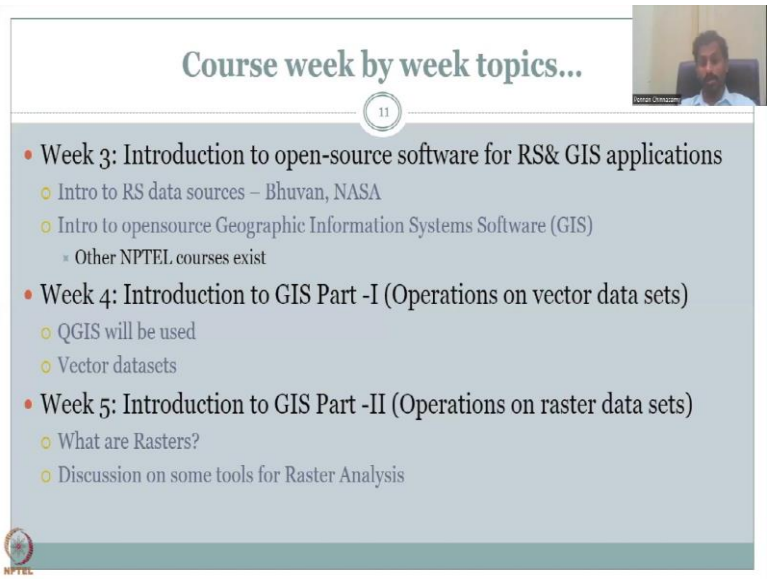

Continuing on the week by week on week 3, we will introduce the open source software for remote sensing and GIS, especially QGIS. We will also introduce some ready-made data and analytical platforms such as Bhuvan and NASA. Bhuvan is our own Indian government funded program ISRO, whereas NASA is from the US side. There is lot of open source data for the entire world that we can use. And we will also introduce the open source Geographic Information System, GIS software, which is Quantum GIS.

As I mentioned, there is other NPTEL courses focusing just on GIS, just on remote sensing. So, it will be reinventing the wheel if I re-teach everything in this course. So, and it is not allowed because there is already a course. So, please go to those courses and take some

information if needed. Learning remote sensing and GIS by yourself is needed in this aspect. Those who know GIS can definitely go through this with ease. But those who are new to GIS can get an introduction from here and go to the other materials that I give for accessing the different aspects about remote sensing and GIS.

On week 4, we will be jumping into the different data types of GIS, especially vectors, and rasters. And what kind of vector data can be used for what different rural issues and rural development. This will be divided into two weeks, week 4 and week 5. So, GIS data can be divided as vector and raster. And in one week, we will look at the vectors and vector tools. Just one or two, as I said, will give you an introduction, more aspects in the covering specific GIS and video course.

So, if you look at this, just to teach you, what is the data type? How do you analyze this data and an example takes one week. And we have tens and fifteen very specific tools for vector analysis. So, that could definitely cover the entire cost. So, that is not the mandate. Here we need to teach you on the using these tools for rural development. So, the rural development is still the key remote sensing and GIS, please brush it up using different courses that are available. Week 5, we will jump into the raster aspects of the data, the raster type of data and some operations on raster datasets using QGIS.

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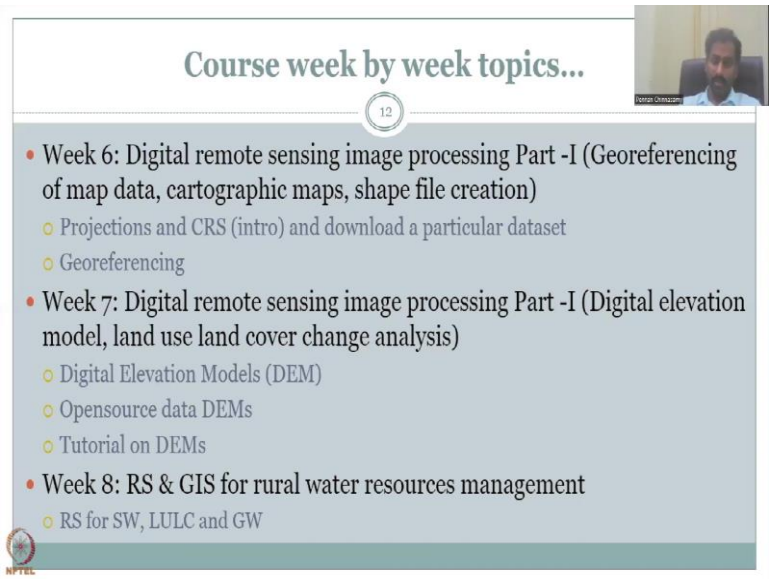

Week 6, we will do a digital image processing. In part one, we would look at projections and coordinate reference systems CRS intro and download a particular data set. We will show you how to download a data set because that is key I found lot of students know the system, know the tool, but they find it hard to find the data and download it. So, we will show you

how to download this particular data set. Georeferencing is a very important tool that you should be accustomed to. It is a process by converting digital image or a digital paper scan into geospatial form. And once you put it on the geospatial form, lot of analysis can be done. So, that is on week 6.

Week 7, we will be looking at digital elevation models which are needed for laying roads, water infrastructure, agriculture, infrastructure, et cetera. Some open source digital elevation models, DMS will be discussed and a small tutorial hands on session on DNS will be done in week 7.

Week 8, we use a specific role remote sensing and GIS for rural water resource management. So, here we are going to break out into just water issues and specific techniques on how to use remote sensing for SW, surface water, land use land cover and groundwater issues. So, once you address the issue that is development, that is the link for this course as rural development. Right now, the development is limited or challenged because of issues on water and land. So, how do you understand it is by mapping them, providing solutions using maps and then attain development that is discussed in week 8 for water specifically.

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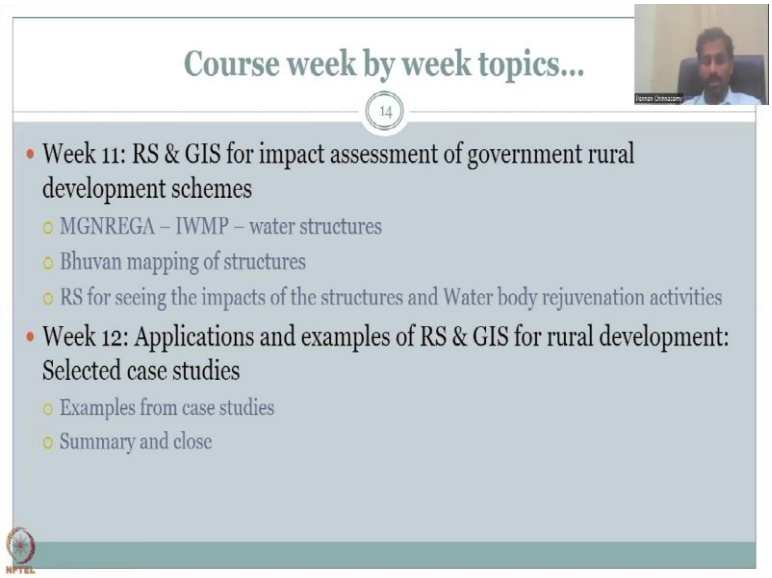

Then we go to week 9 where we use digital remote sensing to look at the last mile connection for farmers where there is no data and how they do storage, those kind of things. And more focusedly you will look at remote sensing for crop and crop management. Water is tied to crop but water can also be tied to domestic use drinking water, sanitation for health, washing dilution and livelihood options such as industries rural industries like food processing, mango pulp manufacturing, mushroom cultivation, aquaculture, cattle all these are linked to water.

In the ninth week, we will look more specifically on crop and crop management. There is a water side but there is also crop management like application of fertilizers, pesticides, crop health, using the color of the leaves that reflection but none of that leaves that satellites can capture. We look into these types of tools. The idea is if we know and capture these information faster, then we will do better development scenarios from where development can occur.

In week 10 which is very very important. We will be looking at elevation models, land-land use, land cover analysis to map health infrastructures, where to put health infrastructures, what is the need and how to use GIS and mapping techniques to identify locations for health centers. So, this aspect we will cover in week 10, first lecture. And then the next lecture we will look at mapping of education centers, how far is it from village centers. For example, a school may be placed in a high altitude or region where the government land is there. But then the students may have to walk 2 hours, 3 hours to come to school.

I remember my father had said that he used to walk in rural villages couple of kilometers to go to school, no money, no transportation during those days, so they have to walk. And while walking, they also take care of livelihoods by carrying harvest and other produce from the feed to the local markets, drop it in the market, go to school and then come back. So, it is really tough the situation in rural entities right now. It is eased a lot compared to my father's time, but still, there is a lot of room for improvement and development. So, that is what we will be accessing in mapping of rural education centers.

And then connectivity, as I said, how far is the major roads and major roads will have buses, train those connectivities. How far is it, where can you put specific strategic stops so that everyone can get access to your buses, public transportation, and also it includes access to petrol stations, diesel for their pumps, agriculture et cetera.

The last one is very important especially it was shown how important it is during the COVID time communication. So, in urban centers, we are blessed with good internet facilities, good telephone coverages. However, in rural centers, the internet is very unstable. And so you could see kids walking very far carrying a phone to take a class, and sometimes there is no internet. So, they lose the class. There was lot of dropouts in rural centers. So, that is where this specially this lecture will focus on communication, identifying buffers and distance of towers cell network towers, and where do you place them using GIS and remote sensing methods.

On week 11, we will look at remote sensing and GIS for assessing the impact by government schemes, for example, has lot of schemes as I said, the government is very supportive of rural development. There is lot of schemes that have been introduced. However, the assessments are limited to reports and stuff. So, how do you map it is the question and we will look at some mapping exercises.

So, once you map them better, the government can either put more funds into the scheme, because now they know how beneficial the scheme is or they can relocate some money to other schemes, if it is performing less. So, that is where the idea has come and more importantly, you will be seeing a lot of benefits of these schemes and how do you increase funding for these infrastructure.

So, MNREGA is one or MGNREGA is as always called under that there is lot of IWMP water structures, integrated water management plans programs, Bhuvan has already been mapping structures, we will look into these data and downloading the data. And then we will look at how we use remote sensing for seeing the impacts of these schemes, especially water schemes because that is the biggest budget in the rural development schemes.

Last week, we will do examples from case studies, case studies published in government reports in journal Scientific journals, which have been validated, and also selected case studies from my own group that is working on the ground. With this, we will do a summary of all the weeks. You will see how each week course is tied intrinsically, within the week, but also between the weeks the course is tied well, so that estimation analysis we will be doing in the last week.

And we will do a quick summary of the take home points and links to databases, links to remote sensing data, and links to new upcoming remote sensing tools, Google Earth Engine as one and MNREGA, Dhuvan infrastructure, mapping is one so it will give you links to these remote sensing tools and links to new QGIS updates. Because it is a software. It always gets updated.

So, while we are doing this lecture, there will be some updates which may not be covered in this current week. But we will give you the links and how to access these updates. So, once you have the base, which is formed in this lecture series, you will be doing the updates from these kinds of mocks and links. With that, we would close the week 12. There will be homeworks and assessments in between and then you will have a final exam.

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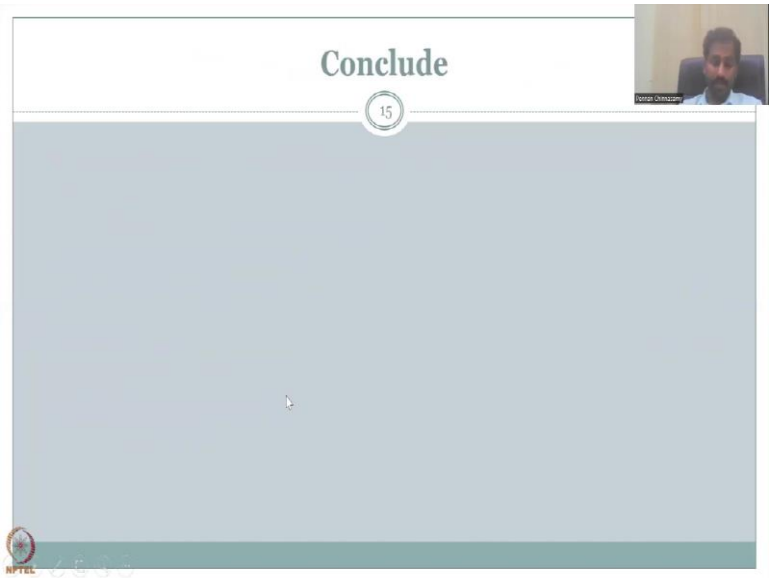

With this I would like to conclude today's lecture. And once again welcome all of you to this very unique, very different NPTEL course on using remote sensing and GIS for rural development. I hope you will enjoy this course as much as I enjoy going through everything. Thank you.