Groundwater Hydrology and Management
Professor. Pennan Chinnasamy
Center for Technology Alternatives for Rural Areas
Indian Institute of Technology, Bombay
Lecture 57
Case studies of Groundwater in India
Part - 2

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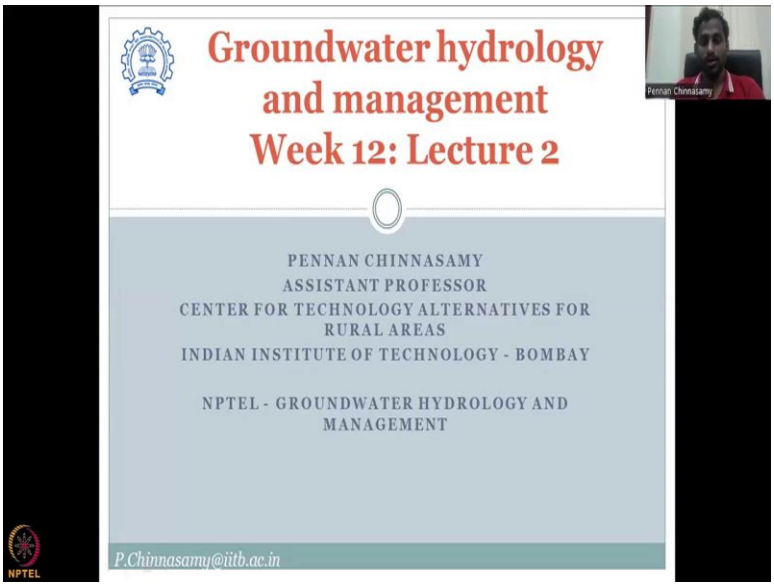

Hello everyone, welcome to Groundwater Hydrology and Management course, this is week 12 lecture 2. In this week, we are completing the data requirements and access from the WRIS website. Most importantly, we are looking at hydro metrological data that we have for the water balance equation to understand ground water hydrology.

We would like to also look at why each parameter is important, just a refresh I will do why this parameter is important in the hydrological water balance. So, in the last lecture, we looked at the soil moisture, so how rainfall was in and part of the water is kept in the soil moisture the remaining goes down to groundwater.

So, now, we know like in the storage ground water storage, not all rainfall goes in after it infiltrates there is some soil moisture that has to be removed and this will be also used for the remote sensing data that we will be using later especially the grace data.

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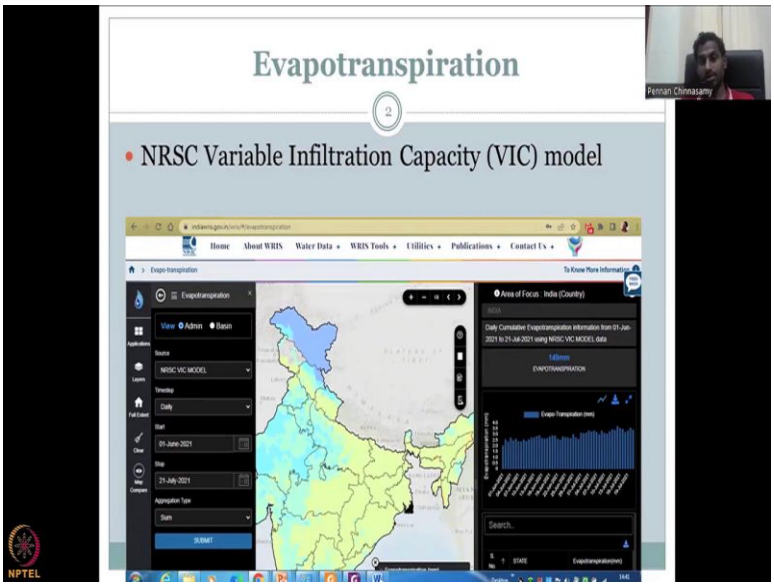

So, the evapotranspiration which is two words evaporation and transpiration, evaporation is from the land surface or water body surface open surface where water is being evaporated. And the transpiration is the process where the roots take water and goes through the plants and then comes out during the photosynthesis activity. So, both evaporation and transpiration start with liquid water, but then it vaporize converts it into vapor and then goes up.

So, these two are kind of losses in the hydrological balance system whereas one loss for example of photosynthesis loss transpiration is needed, but again as a water it is a loss, all the water is not kept in the system, it is taken up and not fully used and then sent into the atmosphere. So, once we know how much is sent back to the atmosphere, we will know how much we need to save water for groundwater recharge and for surface water storages.

Again evapotranspiration is as I mentioned there is land and then there is plant, maybe the land you could put some monitoring devices and then assess based on the radiation incoming radiation how much evaporation can happen and based on the land type and stuff, but for plants is very difficult right because each plant might look different, the biomass is different even within the same species, the leaf area is dependent all these would impact how much water they take and pump.

Think about leaves as factories where it pumps the water out of the system through stomata. So, water comes through the roots goes to the stem and it goes to the leaf and from the leaf it

transpires So, there is a lot of studies that we have done in school where we put the bottle and inside the bottle we put the plant and we see the transpiration happening, etcetera. That depends on the biomass and belief etcetera.

So, if you have one tree, it is easier to estimate the evapotranspiration compared to a forest because forest we have multiple things that can go above. So, we will look at that and that is where similar to the soil moisture, we are going to use a variable infiltration capacity model VIC. And the VIC is again driven by remote sensing data, because as I said, your incoming radiation is important, the leaf area is important, the barren land open surface is important.

So, all these have to be clubbed together in one model and then the result should be how much evaporation plus transpiration happens. And that model which the NRC uses is called the variable infiltration capacity model or VIC. It has been successfully used across India where a lot of advisories have been built for farmers on this.

For example, if they know the evapotranspiration rate ET from the crop, then the farmers are advised to say this is how much volume is lost per day, millimeters per day. You multiply it by the area you get the volume. And so now the farmer knows okay, if so much water is pumped, would I be able to sustain the whole crop or should I be pumping more water or asking the water policymakers and the engineers to release more water in the channels.

So, all these discussions advisories are based on this model outputs which is ET based and also remote sensing driven data, there could be some data that has been used for ground proofing, observation data ground data, but most of the model is driven by your remote sensing data. Like earlier, I will not get into the full details of a model but because here we are just looking at the data and where it comes from, so it comes from a model and the model is driven by remote sensing data. This is how it looks like when I made the slide.

And there are some changes in the WRIS evapotranspiration link, the link is same, but how it opens, how it visualizes is slightly different and that keeps updating. And so, but the overall arrangement is the same wherein you have your right side with the focus area, the time and the data, and the central part is for the map and the left hand side is to tweak the model outputs how you want to see it.

So, now let us go to the WRIS website where we will be looking at the different methods and availabilities of different data. One thing we need to understand that is we do have multiple data, but we need to understand that because it is a government led data, this WRIS data is used widely. So, please just understand that it is not one data we are promoting, because this is from the government, we are going to use this data. So, I am going to share the screen with WRIS website.

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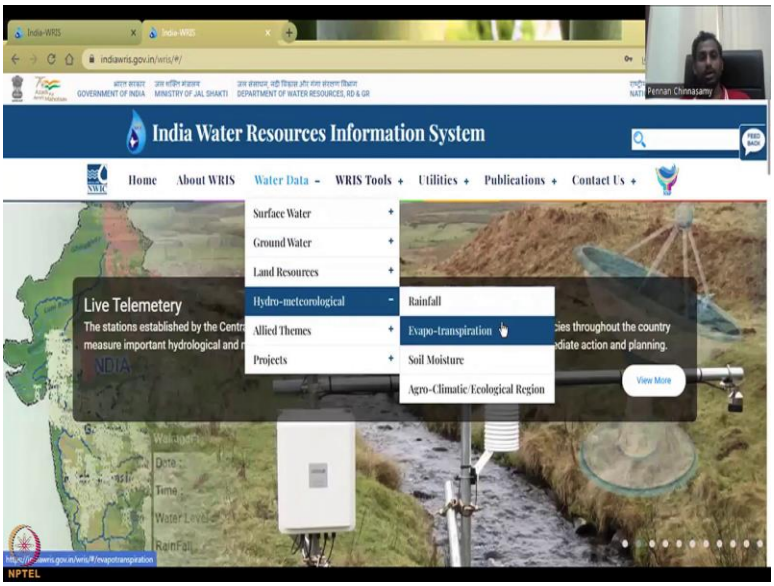

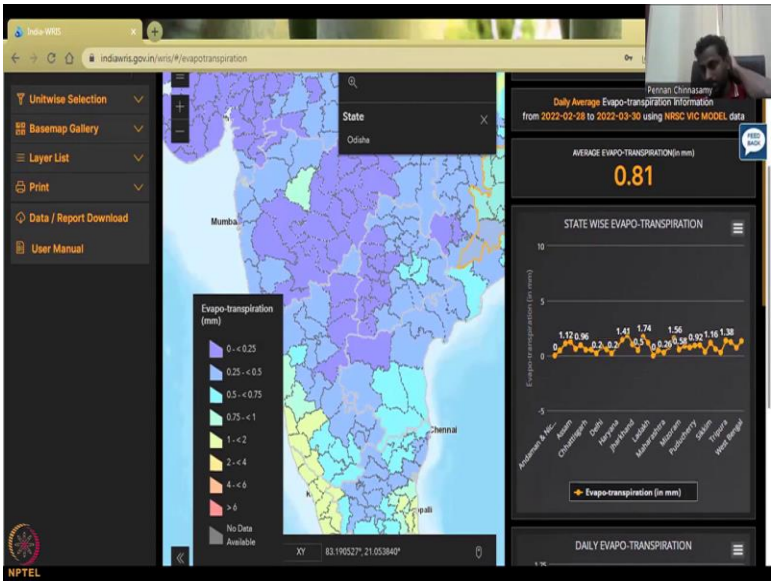

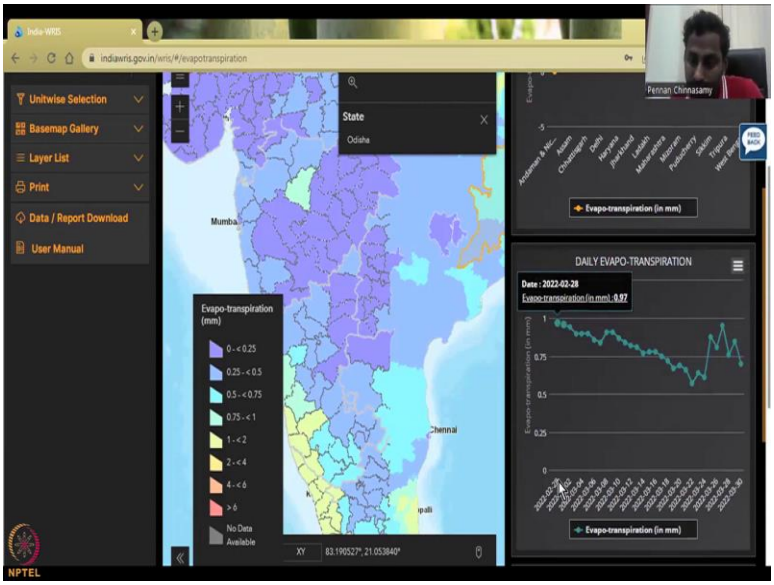

And this is how it looks just to show how you get here I am going to come back. So, it is WRIS the home page can be taken. And from the homepage, we will go back to the hydro metrology and then evapotranspiration. So, to save time I have already downloaded so I go to water data come down to hydro metrology and evapotranspiration, then you click it this page opens and it does take some time you could see and then it populates.

So, India WRIS you have evapotranspiration. The right hand side says it is India scale the whole scale of India is taken and you have daily average between the two dates, which is a 28, actually three dates 28, 29, 30. So, three days is taken and the model uses the VIC model. So, the average transformation across India is 0.81 millimeters per day. Now, here is the question. Is it okay to see the whole India at ET red?

No, because at the end of the day, you are going to manage this water and supply water to farmers and people for water management because this is groundwater, we look at how much goes back to the aquifer. And if you see that the aquifer changes across India. So, there is no point of having one value for India as ET. You can differentiate as regions and those regions are all agro climatic regions, we have agro climatic ecological regions, those are regions with similar land type, geology type and climate.

So, you will have a better way of putting this in as an average value for agro climatic zones. But for India level it is kind of stretching far because we will not be using this value per se for water management or groundwater recharge activities. However, this is the default scale, the India

scale comes up and a particular date comes up in the VIC model. You can come down the base layer has been black, which is okay I can change the base layer, like this map did not say that I will put streets so that it might be faster.

So, yeah, it is faster, you can put imagery layer list you want district boundary, it is only three layers list. So, the print and data download is there we will come back to that later, what I would suggest is we will stick to the Maharashtra one because of the evapotranspiration that occurs. So, let us do this. The right side as I said has your average evapotranspiration in millimeters for that particular time period three days.

And per day is there, the unit is per day. So, please do not say that the per day is not put into it, it is a kind of known value, because when you say evapotranspiration for what, for a day or for a month, you have to specify that. And when you specify for a day, then the day is one in the unit is just millimeters. So, make sure that you know that it is per day and I will show you the time series of graph also.

As initially done we do have some states not all states would be able to be fit on the graph. So, you will see down there are different states, you have states here and those states can be put up in this graph, when you download it as an Excel sheet. And then there is a daily evapotranspiration rate from 28 to 30. So, automatically there is a daily ET rate given for India for a period of months and you can see that it comes down goes up, comes down and slightly goes up in the March period.

So, the coming down is also because of less availability of water. I am reminding you ET is the process of evaporating the water, but for that you need to have water. So, would there be high ET during the rainy season after the rainy season? Yes. Because you will have water to evaporate, you will have water for the soil for the plants to take up.

There will not be much ET losses in the summer, because already the water is gone, it quickly evaporates and after evaporation there is nothing more to evaporate in the land. So, understand that part and it is very carefully to be understood and taken, why it is high in rainy season and why this low in non rainy season.

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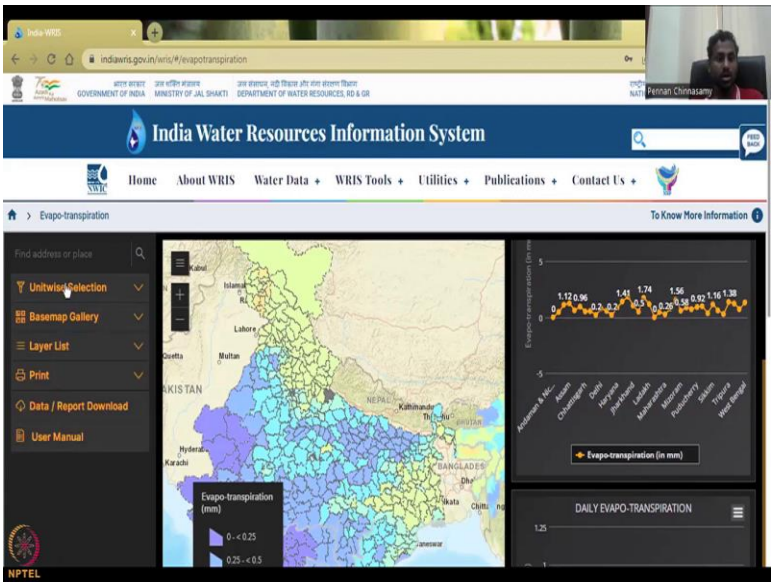

So, coming down, you also have the other states, and again, it is my duty to explain that it is not that Andaman has no ET it does have a lot of forests. So, Andaman will have ET however, because of the size of Andaman, which is smaller, you can see here it is smaller to the size of the satellite or remote sensing data, you will not have data. So, no data should have been there rather than 0, 0 is kind of misleading.

I am going to click India again and show another island state which is your Lakshadweep Island. I click India, so I think it is taking some time to go back to the initial stage. And looks like the base layer, the black layer is taking a lot of time. So, what I am going to do is I am going to teach you how to change the base layers. It is not even populating but when you change the base layer, base map gallery, go to streams, and then quickly it will come, comparatively.

So, let it populate, while it populates I am going to come down all this data is already there, you can see Lakshadweep, so Lakshadweep is 0. This is what I am trying to say there is no 0 ET, cannot be 0 ET there should have been some ET but it is not there, because it is not measured. So, it should have been no data rather than no 0 ET, because 0 is a value.

And I hope 0 was not taken in for the averaging because it pulls down the average value also. So, 0.81, so that could be an exercise you can download this data and then for all the states and then estimate the average now you could remove Andaman and remove Lakshadweep zeros and then do the average, if the average is same, then it is correct.

If the average is different than it is wrong, because the Lakshadweep and Andaman should not have 0 ET. By physics by the land use lamp tower that we know there should be some evaporation and transportation, always there is some evaporation transportation, it is not a 0. So, now you see that district boundaries, because we have here as admin, boundaries we want to see. And here we will go back to the full view of India. So, then what we do is we want to see if selection, So, then we would going to see for India how it looks like in a particular state.

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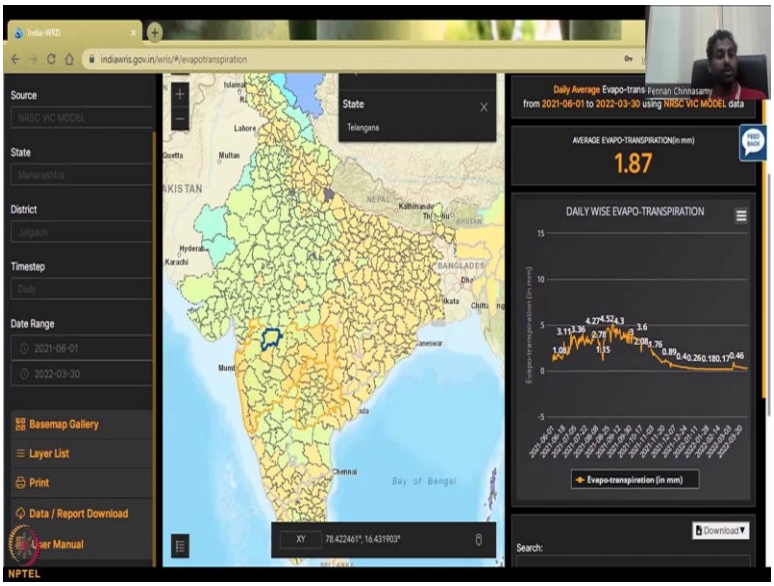

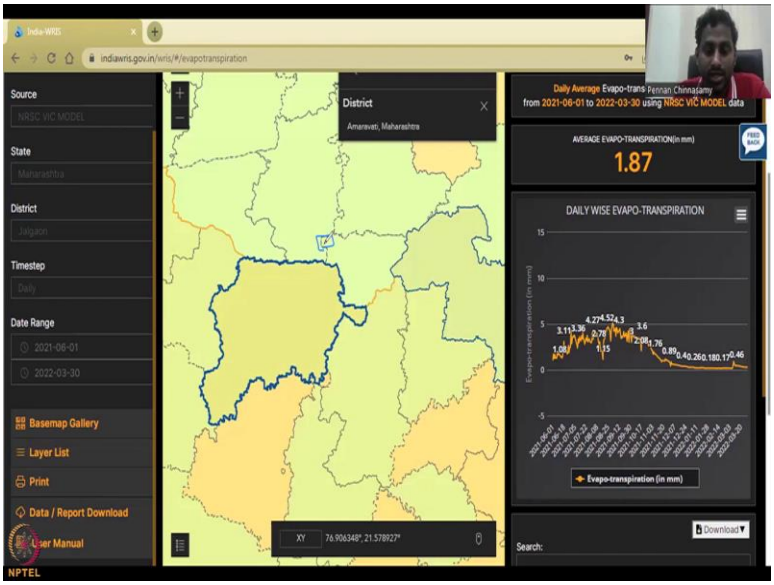

So, let us go to state thing and then as I said your ET can be a sum of ET for a month, or average, average is good because then later you can sum, so let us do an average. And then there is only

one more in our NRSC VIC model. We are going to do Maharashtra again. Let us pick Jalgaon again, because Jalgaon we use for the soil moisture, you can see it is very low, but we will increase the date to have more spread of the data, so Jalgaon is slightly increase and then the time stamp is daily is fine.

And then we are going to go to month of January. So, while it is doing this, you can also see India how ET happens. And ET is high in Rajasthan and Gujarat. But the rainfall value and groundwater value is low. So, now here is the deal. If it is low in let us do that quickly before we look at the Maharashtra data. So, if this you could see, if I could pull down my point, yeah. So, what do you see here is the dark blues are in the Rajasthan part, Punjab and Gujarat region, which also has less rainfall, and less groundwater.

So, what are they doing is they are pumping more water into the system by using extra groundwater and letting it evaporate and transpire. This is done for crop growth, they are just not simply pumping and putting it on the ground and evaporating. They want to do more and more agriculture. So, for that agriculture, there is a lot of groundwater use.

And that relates beautifully to the evapotranspiration pattern, you will see less evapotranspiration on the water bodies because moving water evaporates slowly compared to a standstill water. For example, you have a dam, the dam water would evaporate faster than moving water because while moving it does cool down. So, you have these kinds of effects. And also you have a detailed view of all of India well ET is high and ET is low for that particular day.

So, we have picked Jalgaon and that one month data is taken. So, you could see that it is going down and then slight blip and then goes down again. So, but if you take like your soil moisture from your June month, which is your monsoon month there is no submit button. So, when you do the trick is when you do the final date, button it automatically happens. And beautifully you can see it go up and come down.

So, here is where the Rabi crop picks up and the Kharif is here, which means during the rainfall season the ET is slowly building up because people would put crops and then wait for it to grow. And while it is growing, you have the crop water requirements and those water requirements are converted to evapotranspiration. So, then what happens is you have also the data on crop type, crop area and acreage.

So, all these are put together in one model and then the evapotranspiration is taken out, rainfall, radiation, crop area all these things. So, you can see that is slowly picks up and then the growing period is attained, water is there grows and then it starts to stagnate. It comes down and then one low value is attained. This could be different for different districts, you can zoom into the district if you want.

So, I am double clicking and zooming in and you can see how the boundary is put for Jalgaon and you are getting these data out. You could see it is like a box-box type. Why is like a box-box on the edges? This is because it is a Pixel, a Pixel is a box. All these are remote sensing driven data, so the boundaries are not set like original boundaries, it is set as pixel.

So, if you have one pixel let me draw it, so you have a pixel which is coming in like this, so, you can have part of this data is going to the other district, but part of it is most of it is in within your district. So, you will keep that major part of the data. So, there is some averaging that is done at a district level, which is beyond the scope of this class. So, I will not be teaching it but please understand that the boundaries are kept for the pixel data also.

So, now you have this data and you can download it as a CSV file or you can take the image as a PNG trap. So, you can just quickly put this anyone. Reports and other work just take this as an image, but you can also download it as Excel file CSV file, and then you can work on it as a table and do more calculations.

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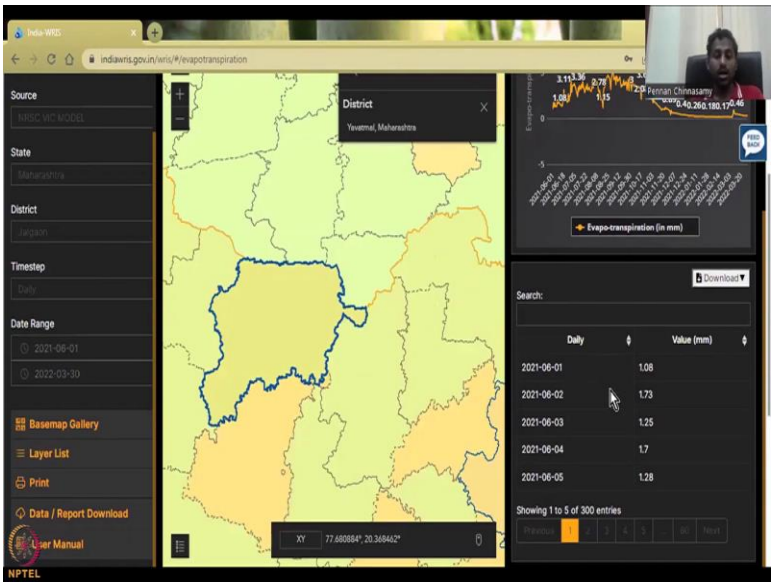

Then when you come down you have the average value per day and you have different dates here where you can put different values and then you have the data downloaded options are available. So, this is how you could see the data for evapotranspiration, it is hard to now break the evaporation and transpiration all you could do is you could say that this is kept within, one second I just closed this district because it is actually causing some confusion.

It is Jalgaon, not, it is just an example it says do you want to see Amravati and then when you click Amravati, it goes to Amravati and this changes. So, do not get confused by this name, our district is still Jalgaon. So, whenever you want to assess the data, go back to this name and then you have it as Jalgaon.

So, here is where you could download different data for evapotranspiration. And most importantly, looking at India scale does help for seeing the spread of evapotranspiration. And evapotranspiration is not going to be the same across India because of differences in rainfall, land use land cover type, soil type, and also the plant type, which is part of the land use data.

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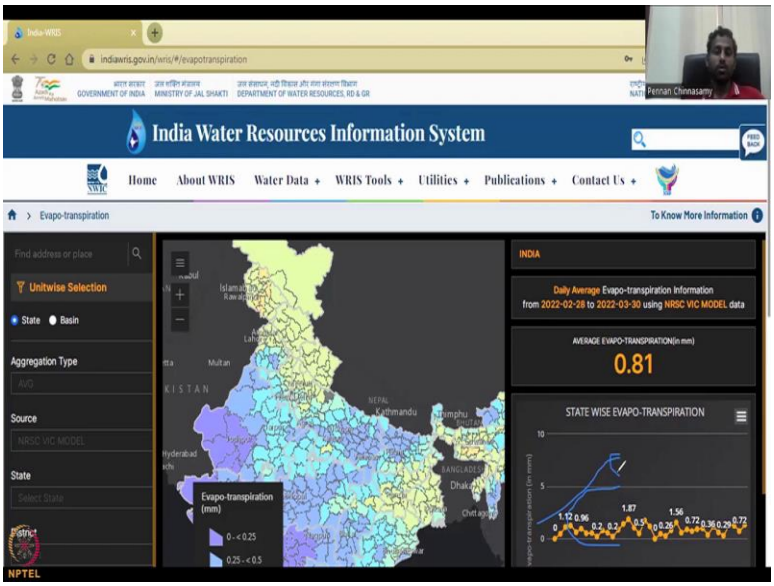

So, we do have, again, the default date is coming. So, now here is the point like, so 30 is there and today is 6. So, within 7 days you get this data and this data can be used to understand how much your land is consuming in a district. So, for example, you take a district where you have majority of the land has one type of crop.

Now, you can tell the farmers saying that per day you losing this volume of water, which is for example, it is 1 millimeter times 100 meters square. So, you get a volume and 100 meter square is too small, but let us keep it for the calculation purpose and 1 millimeter is 0.001 meter. So, you are losing 0.1 cubic meter per meter square area.

So, then what happens is the volume is now calculated and you tell the farmer, this is how much you are losing per meter cube, meter square of water. And then now they will understand that okay, do I have that much water to sustain my crop because now you know that the crop is going to grow for three more months. And do you have water for three more months? For example, this is the average value you get.

Let us assume this is a state and a district. So, there is a growing period. Do you have the sustainable water resources to sustain this growing period? Do you have the groundwater? If not, it is better to stop today rather than putting water and then losing the crop and the water. Remember, the crop has to be fully grown and then you harvest it for the market, you cannot harvest half the crop, half grown crop for the market, it is useless.

And lot of times this happens, they cannot do anything. So, they just let the cattle feed on the crop because the crop is lost, there is no water. So, these types of advisories through the remote sensing platforms help these farmers in assessing the dates for irrigation. And also what type of irrigation and how much acre they can irrigate.

So, these things can be combined together in one platform which can help these farmers tremendously for setting up a good water budget for the groundwater. With this, I will conclude today's lecture, I will see you in the next lecture on more data for groundwater management. Thank you.