Remote Sensing Essentials
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Lecture-51
Integrated Applications of RS and GIS in Groundwater Studies - 01

Hello everyone and welcome to discussion on new topic and today we are going to discuss how remote sensing and to some extent GIS can be used in groundwater related studies which is very important and this discussion is in 2 parts, so first we will have part 1 and then later on part 2. Because I have to show a lot of examples about how Remote Sensing can be applied in groundwater related study.

So mainly two types of studies one is exploration that means where to find good groundwater and secondly how to find out the suitable sites for ground water recharge.

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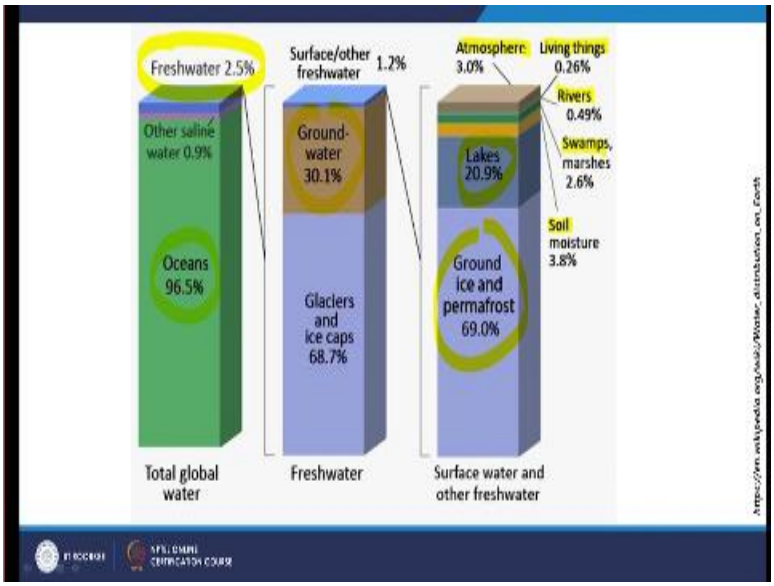

But before that if we start thinking about the water ground water then from whatever the total amount of water which is available on surface of the earth is the ground water component is really very little. And that is very much required for the sustainability of human life on the earth. So if you see the first bar or tower then 96.5 % water is the ocean water. And the freshwater which includes snow and ice caps and underground water as well that is only 2.5 % is a very tiny amount of that water.

And out of that 2.5 % only roughly 30 % is the ground water. So you can have an idea that only roughly less than even 1 % of the total water which is available on the surface is the ground water. And the problems are large with ground water especially finding suitable and ground water sides and also how to recharge that water. The other surface waters are also given here which are in the say in the lakes or in the form of ice or snow. And river waters swamp waters very little percentage of those waters are there if we consider the total amount of water which is available on the surface of the earth.

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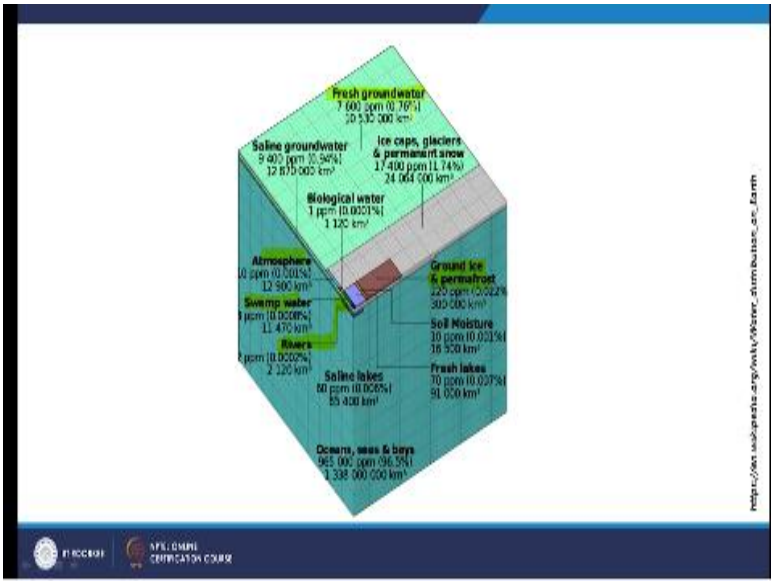

It is a very tiny amount very tiny amount as you can also see here that this ground ice and permafrost is this much part then the river water is again a very blue small dot on the edge of this cube which is the rivers water than swamp water. And this fresh groundwater is only roughly point 76 % which is very tiny amount related to what the water which we are having on the surface of the earth.

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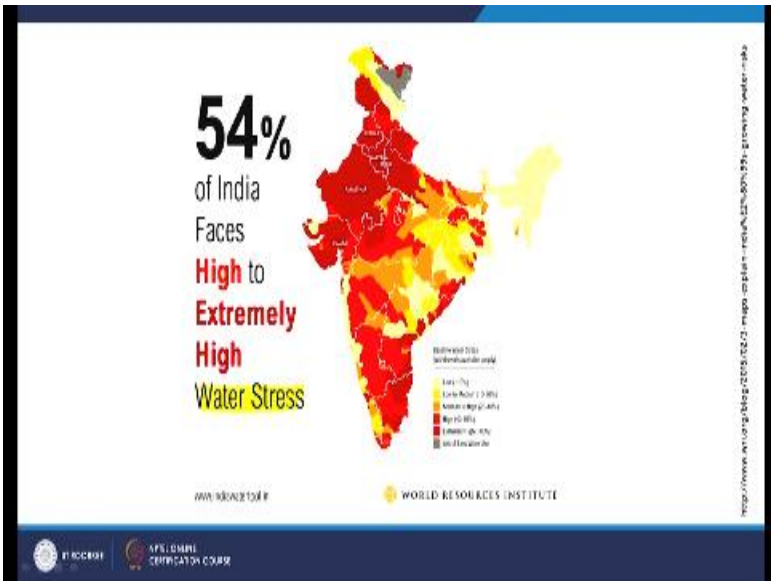

Now when we start thinking about the India then 54 % of India faces high extreme conditions or water stress conditions in India. Say a large part of India is having problem more than half of the country is having problem in especially in the summer months which is matter for real concern.

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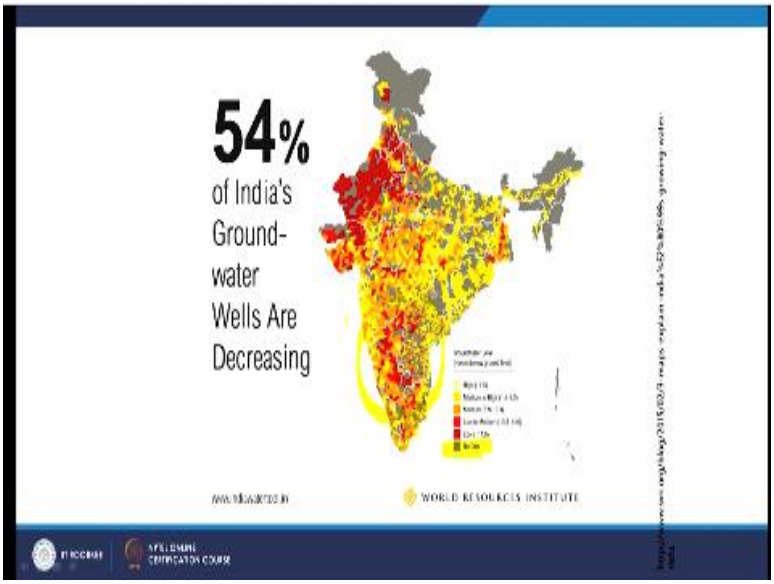

Then also that 54% of India's ground water wells are also decreasing. That means the water level in these reasons which are shown here in red color are going down that means this is in the deficit budget we are not recharging enough either through the rainfall or by some other means and therefore the everything are in real deficit which we are having. And of course grey areas which are also occupy the large part.

For which we do not have the data historical data or long term data that is why those areas have been shown as grey that no data values are there. Nonetheless if we see but a large part of India is having problems especially in the western part of India Rajasthan some part Gujarat, Maharashtra, Central India and then South India is also having such problems.

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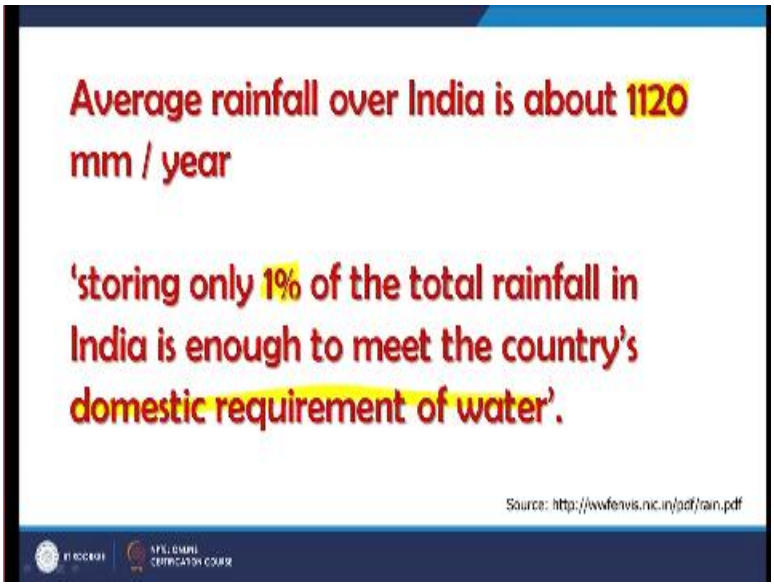

Now if we think about the quantity that average rainfall over India is not by any means small. Average rainfall of India is about 1120 millimeter per year. And only what we are storing in as a ground water or as a water domestic requirement of water is only about 1 % of rainfall. So whatever the rainfall which we are getting is 1120 millimeter per year only 1 % of that is being stored in India currently.

So if I say that rainfall is not less by any means our storage of this rain water is very less. Extremely less and why simple efforts which we are going to discuss how through Remote Sensing we can do it by simple efforts if by if we increase this 1 % of storing rainwater 2 or 3 % then the entire problem of a domestic requirement of water will be solved at least for few years. So this is very important that sufficient amount of rainfall is there but our storage capacity especially in form of groundwater is really poor.

And lot of efforts are required to solve this problem in this can be done there as I will be showing through several satellite images. Now if we see in terms of volume of total precipitation which is

occurring over India is about 4000 cubic kilometer again it is a good amount of precipitation over India.

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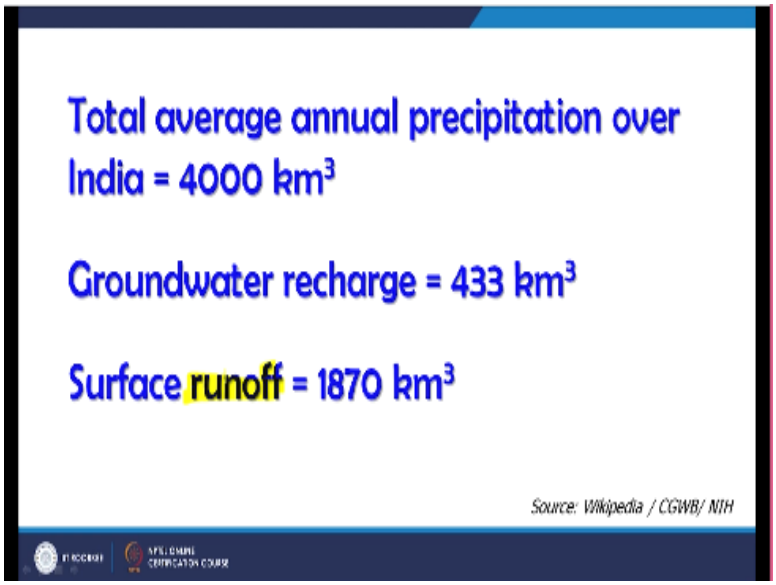

And groundwater recharge is very little only 433 cubic kilometer we can increase this one by some groundwater recharge efforts and so on. And large part of this and total average annual precipitation which is falling over India is going as a surface runoff. So why some means if we can reduce the surface runoff or delay the surface runoff by few hours or few days of weeks or months then we will increase our groundwater recharge we will improve the availability of groundwater for domestic consumption.

So with some efforts and the results can come if we start taking efforts doing things now in 2 years time, 3 years time one would start seeing results and that too in hard rock telling I will be showing examples of that one also. So let us take the real example this I am taking of a part of Central India of this Betwa basin.

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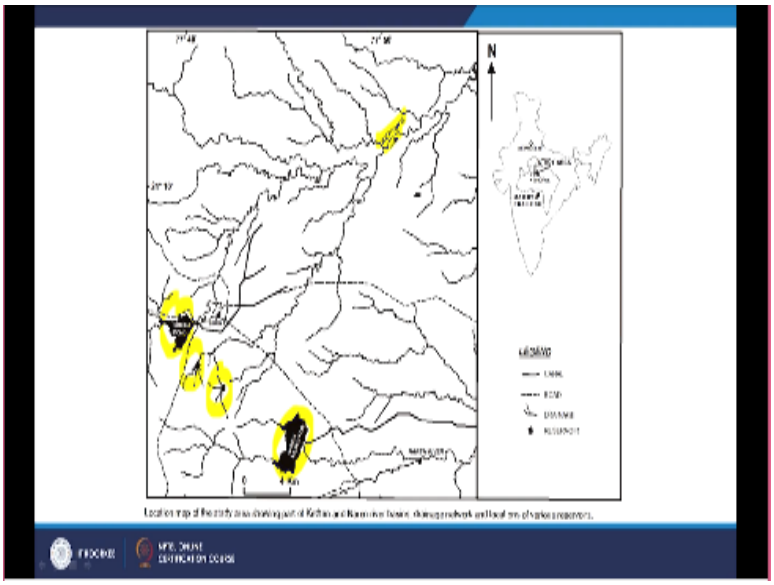

In which is ultimately meets say you know the Chambal, Yamuna and then Ganges. So you can think is a part of Ganga basin and this is part of Madhya Pradesh what you are seeing here that 4 reservoirs and which have been delaminated through Remote Sensing data I will you bring image very quickly. So there is one reservoir relatively of quite good size than you are having another reservoir of Sironj and then you are having because Sironj is the town. So this name and the 2 tiny reservoirs are also seen in this once. So this is basically the Kethan River which is flowing in the north east direction and ultimately it meets the Chambal.

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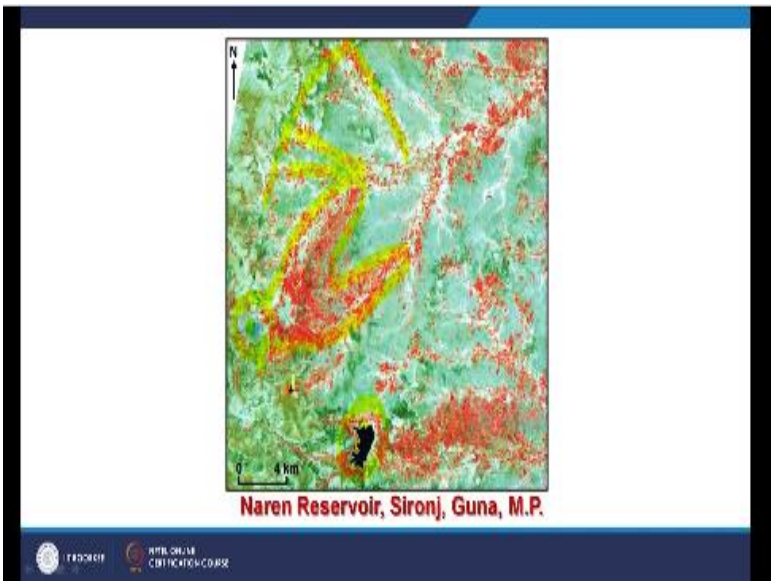

Betwa and then Chambal. So what we see when we see the satellite image this satellite image have introduced here also but today we are going to interpret from completely different

perspective especially for groundwater related thing. Earlier we have seen as a false color composite. So this is definitely IRS list 3 false color composite image and what we are seen here that these reservoirs wherever these water bodies are there 1, 2 and this small one tiny one which we are having here. And these reservoirs are having in the downstream they are having the benefit area and that benefit area.

We can delineate and can see through the growth of vegetation in the downstream. Since it is a false color composite therefore vegetation will appear in red color. And if you see very carefully you would find that there were no water bodies are located like in this path then in the downstream areas we do not have much growth of vegetation. This growth of vegetation is generally agriculture practice because of this reservoir in the downstream area the ground water region is getting recharged.

And the water is available through wells to the farmers and their fetching the water and putting in the agriculture field and that is what you are saying this is a image of February month. So what you see also that the reservoir here is this one is reservoir this is relatively larger than what you see on this Sironj reservoir. But the downstream area of you see the benefit area then this small reservoir that is we name is Sironj is having the large benefit area compared to what you see for this Kathen reservoir.

And even small reservoirs to they are having their own benefit area. So why a small reservoir is having large benefit area and why large reservoir is relatively having smaller benefit area that we will analysis and this knowledge which we will get through the analysis and interpretation of satellite images we can implement latter on for groundwater exploration and recharge groundwater recharge point of you.

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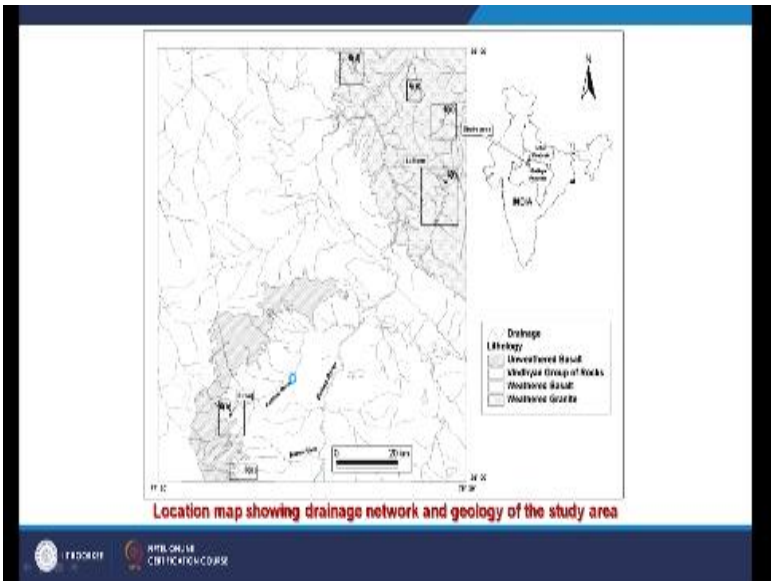

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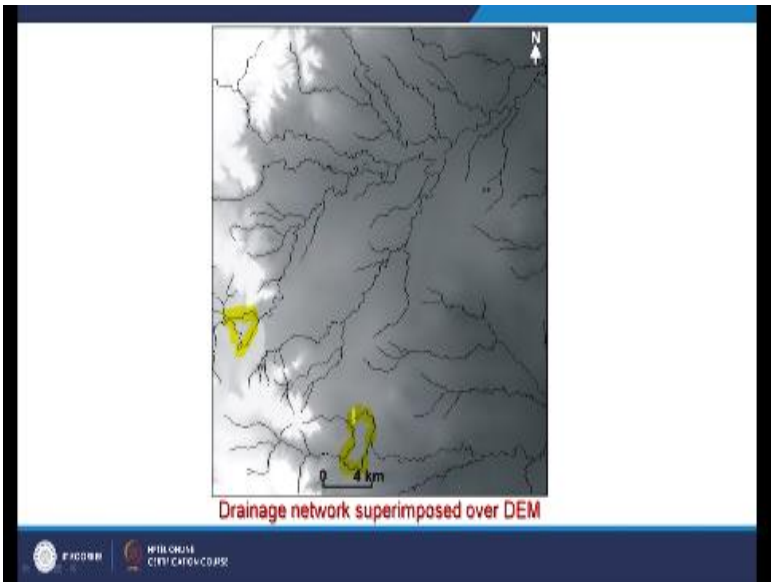

So if I go and start looking the Lithology or Geology part of this area then what we see that the small relatively small reservoir that is the Sironj Reservoir is located on the higher ground as compared to the Kathen Reservoir which is located in the lower ground relatively. This is digital elevation model in the background and if this is the situation then there is Sironj reservoir is having better hydraulic gradient and therefore it is recharging a large groundwater and large area downstream area as benefit area.

Where is this reservoir is almost on the same level only till higher ground relative will it has got less hydraulic gradient and therefore it is having relatively less benefit area. We will also start analyzing the quantities from quantitative analysis point of view little later.

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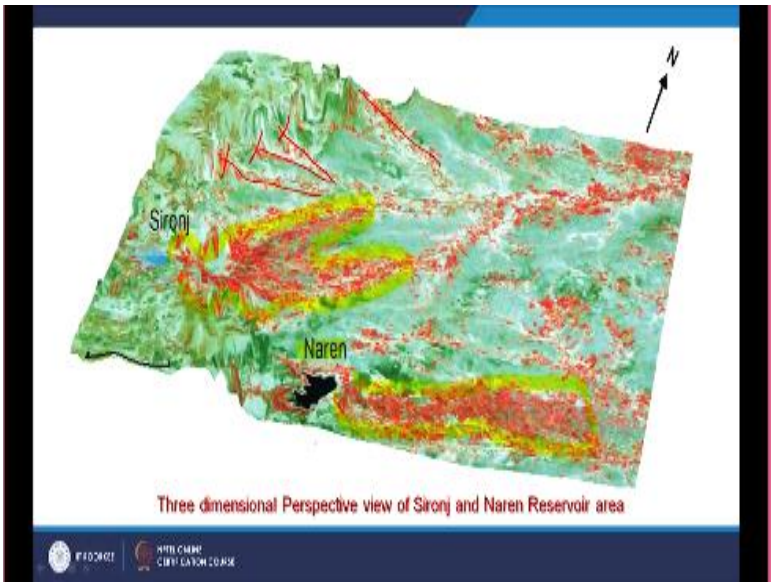

So just to prove that point that this Sironj Reservoir is located on the higher ground is a this is 3D perspective view which you are seen and this is Naren Reservoir at this Naren Reservoir is located on the relatively on the lower ground. And therefore it is having less benefit area as compared to the Sironj Reservoir which is having very large benefit area because of better hydraulic gradient.

So this is giving information on knowledge about particularly about this area that is in future if these well is have to be these areas if we want that these 2 also becomes green and few years time then Reservoir is a little higher ground should be constructed like this. And then we will get the better benefits rather than Reservoir is constructed at lower grounds. Because this Reservoir at little higher grounds will provide better hydraulic gradient and therefore better groundwater recharge.

Another evidence of that there is no difference in the turbidity of suspended particles in these are pollution but the Naren Reservoir is showing completely block color where is this one is showing in on the blue color that means the depth is here is quite Shallow. So even having less

volume of water but it is recharging better groundwater basin then a water and then in the other Reservoir Naren Reservoir which is having a large water body but benefit area in the downstream is not that.

So by analyzing images like this are interpreting images along with some other datasets as I have used main lead 2 datasets one is Lithology and another one is digital elevation model and based on that some conclusions can be made or some knowledge can we gain about particularly about this area. So using these datasets along with some other datasets like groundwater fluctuation and specific yield and liniment information drive from again satellite images and using this weighted average method we applied in one GS platform and we could develop a map which is a for groundwater prospective.

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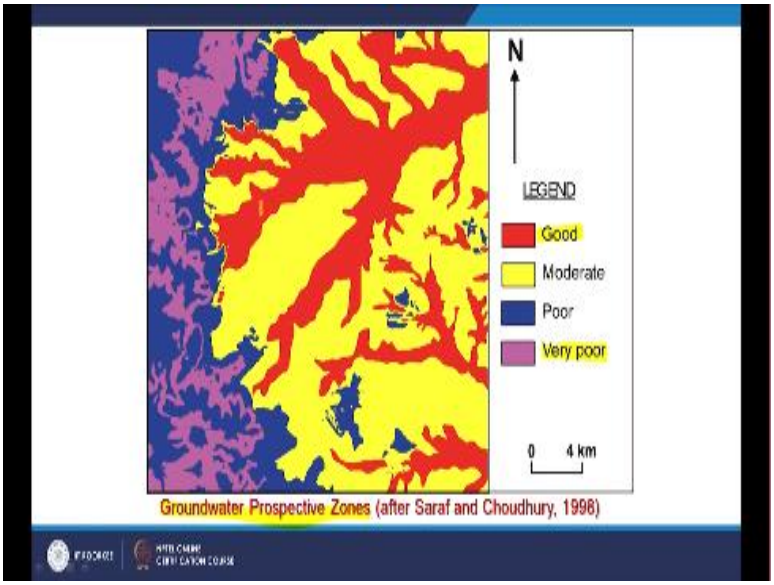

This is groundwater prospective zones map that means that I can get water where this is showing high possibilities like these areas which are defected here in the red colour are having the better prospects of finding groundwater then the areas which are shown here as cyan color dark cyan colour are having less possibilities of finding water. The reason is because the recharge area for these areas smaller. And where is the recharge area as we go just at the foothills in the downstream it is larger and therefore all this Alluvial fill regions and are having better prospect to finding and the groundwater.

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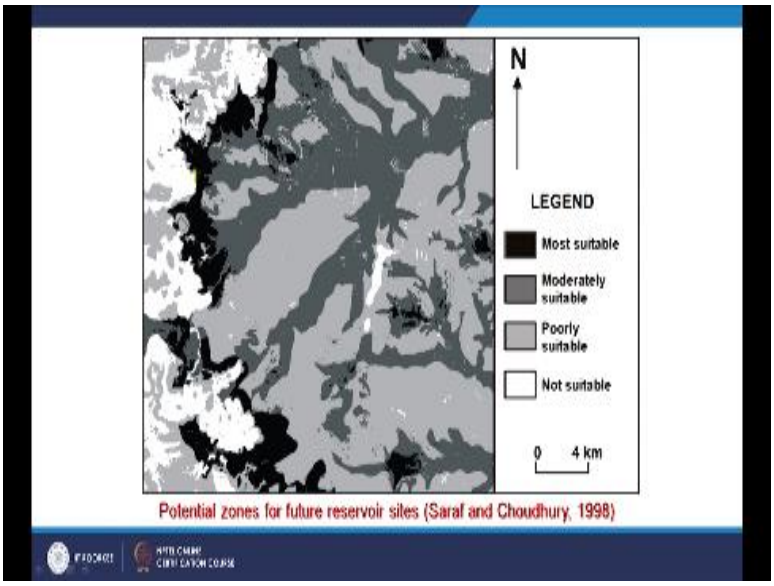

An another product can also be created which is more important from the groundwater recharge point to be that which are the suitable sides most suitable sides to develop groundwater recharge structures. So just foothills of that Deccan trap basaltic rock on the large part we are having rooted basalt on the basement you are seeing that granitic terrain and on the; towards this western side what we are seen is it Deccan trap and basaltic rock on hire grounds also.

So if we just in the foothills of this hill if we go and develop groundwater recharge structures as we have seen for that Sironj Reservoir then we can make this whole area green in just 2 3 years time. I will justify this statement also of 2, 3 years time by going through the time series data are successive Remote Sensing data of this area or adjacent areas in will so that once a structure comes how much time it takes to get effect and their because that also depends on hydraulic conductivity how water can flow from one end to another how quickly and how far that we will be also saying.

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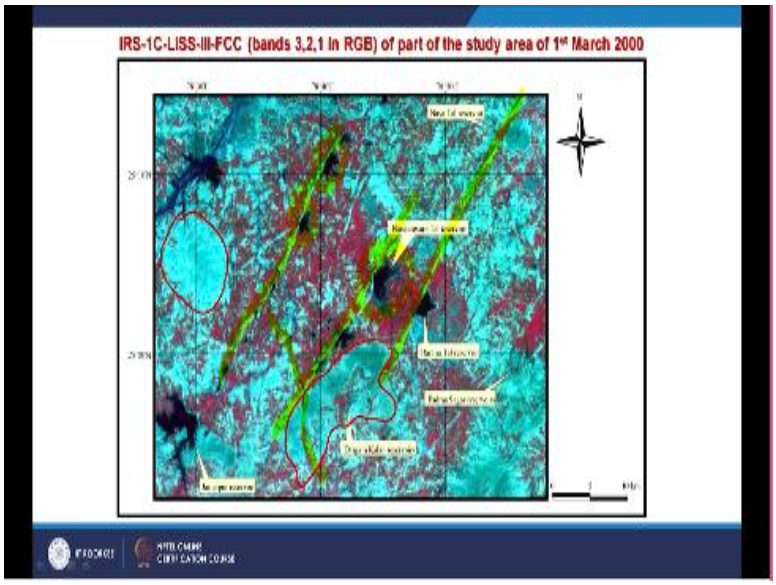

Now remaining in the same Bundelkhand region which is hard rock terrain and in the basement you are having granite which is very hard and very old granite and what you are seeing here that there are a lot of quadriceps which are running East, West and South, North East and South West direction is I am moving my cursor here. And these quadriceps and they are serving as a damn axis and our ancestors whenever they found some streams which were going like this and breaching this quadriceps they blocked it.

And created reservoirs like you are seeing here then Nandanwara Tal, Barana Tal, Padma Sagar Tal and all this Reservoirs small Reservoirs or dams where created and wherever you see this water bodies there you see the vegetation in the vicinity are in the proximity of this Reservoir weather in the downstream upstream are in the surrounding. And wherever we do not have any water body or this Reservoir like here we do not have growth of vegetation again this is false color composition. Similarly here we do not have any big water body.

And therefore we do not have any green layer here. So wherever the water bodies are there in the green is there in that clearly tell as green in this part of the country that means that you are having some agricultural practices in that area. Because availability of water once the water becomes available in this area can become very fertile and it has been proved many times. So if we see further some individual examples

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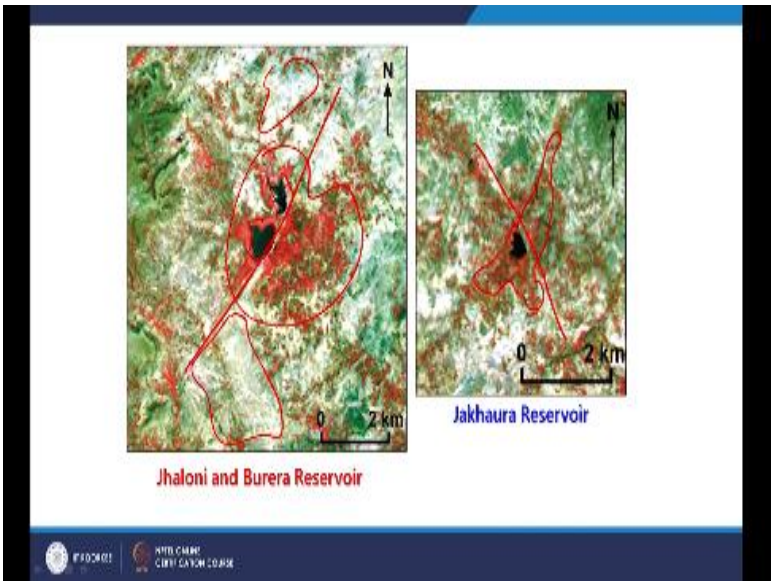

Like here the quargery we say going like this and these are the 2 small dams. So you can call them as check dams and in the surrounding you are seeing the growth of vegetation and where you do not have this reservoir any such structures you do not see any growth of vegetation. So just because of the availability of water agriculture practices is are going on. Similarly here there is another Reservoir and quargery. And if something like this it has been blocked and in the surrounding you are having growth of vegetation and another areas you do not have.

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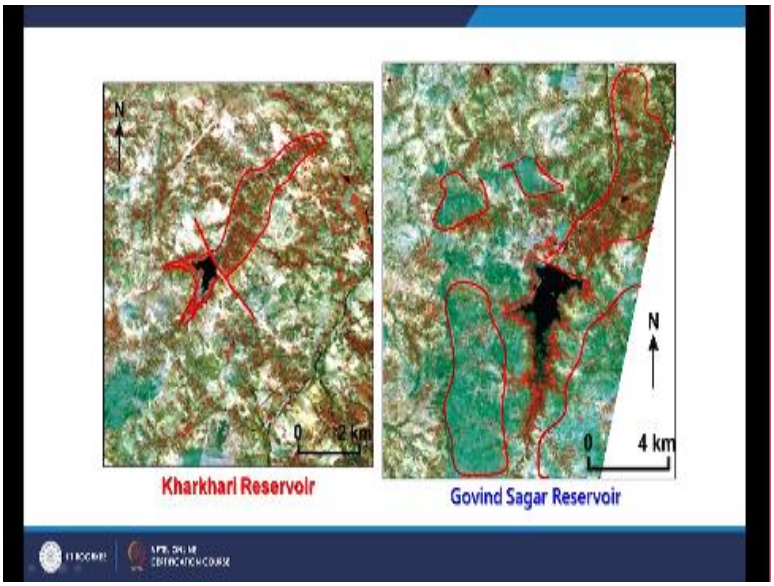

Same thing here again in the; this is the kharkhari which is going on and in little bit upstream because in monsoon season it gets inundated up to that part which I am just smart and in the downstream you can see that large part is getting benefit. In other parts you do not have much

water bodies therefore no growth of vegetation. Similarly one more very good example which I will discuss further on this point. Here this is a also call Govind Sagar dam and this is on the Sajaad river which is ultimately

And you know in again in the Bundelkhand region and what do you find that this Reservoir is there in the dawn of course it is it has not been made quargery but nonetheless in the downstream area you see growth of vegetation. In other parts where you do not have such water bodies you do not have growth of vegetation see like this. And these areas are completely dry and completely divided of vegetation as you can see here also. So where ever in hard rock terrain wherever the water is available you in the downstream in the surrounding you see in the growth of vegetation.

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Now how the ground water crisis has come in the country and this I will take an example see the this is a Reservoir and see the downstream the town which is Lalitput town here. And this Reservoir if you see in the satellite image which is not very old one you will find that the Reservoir body is much larger than the settlement there in the downstream area.

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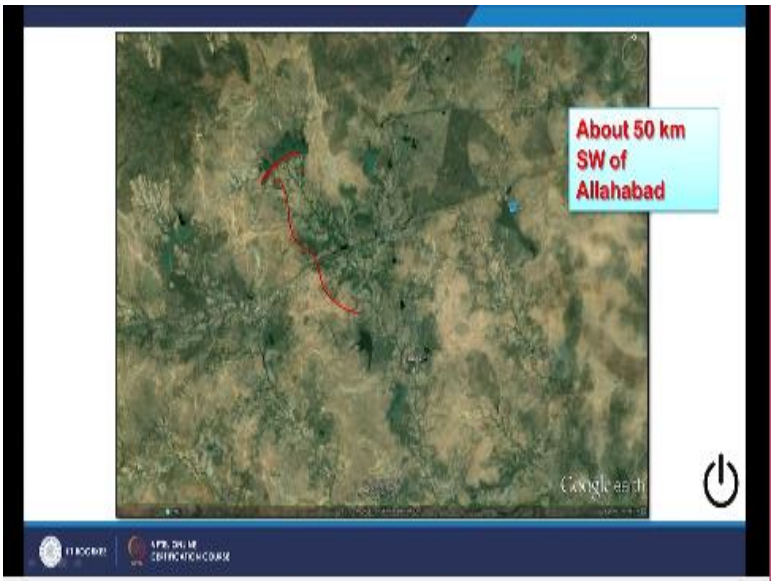

And this is Reservoir was constructed above in 19 this Reservoir was constructed between 91, 1951, 53 and at that time the population of this area was about 30,000. Now it is about 130000 people and the size of reservoir has not increasing rather it has decreased because of siltation encroachment from the surroundings. So 50, 60, 70 years 50 after the construction of the Reservoir or after 2 years say roughly 60 years back the town was getting water 24 hours in there in the tab.

But now the water is available in the tab is only for 20 minutes because the Reservoir that when that time the population was less and Reservoir was really truly very large now the Reservoir has reduced the volume of the capacity of Reservoir has reduced because of sanitation and encroachment. Where is population has grown by 4 times and same time the rainfall has not reduced significant rainfall remain same almost throughout this year's average rainfall for say 2, 3 years is fine.

Then suddenly one year you get route but again if you take an average rainfall and then there is no not significant change or no significant change in the volume of water which is falling over this part of the country. But the; our requirements have increased 4 folds there is our storage capacity as reduced and that is throughout the country this is the problem. And if why some use if we can increase these water bodies which will allow the groundwater recharge quickly in the downstream and therefore we will not have such problems.

Similarly in other parts of the like in Indo Gangetic plane also if you see a Reservoir in the downstream you see the growth of vegetation. So very you find a water body you see growth of vegetation wherever you do not have then that kind of thing is not there. So the major region what we see here is because our requirements having increase many folds see after the Independence.

Whereas the same time we have not augmented groundwater recharge structures we have not improved in the same way in same proportion our storage of rainwater and if you would have done it this problem would not arise and because the and the input which is the rainfall is remain almost same. So only thing is rather than storing only 1 % of the surface are rainfall is groundwater if we increase by 2 or 3 % then for time being are at least for next few years we will not have water problem in the country.

So the solution of this water problem ground water problem or drinking water problem or domestic consumption of water is not very big it can be solved in 2, 3 years time. In I have shown you some examples in the next presentation I am going to show you few more examples that how you can quantify things how you can estimate the time it would take to get the benefits in a particular area. So this brings to end of this part 1 discussion and we will have more discussion in part 2 Thank you very much.