INDIAN INSTITUTE OF TECHNOLOGY ROORKEE

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NPTEL ONLINE CERTIFICATION COURSE

Digital Image Processing of Remote Sensing Data

Lecture – 19
Applications of Image Analysis

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Hello everyone and welcome to the second last topic of this digital image processing of remote sensing data. And we have seen various digital image processing techniques including in the previous one data merging, mosaicing, image fuse and techniques also. And we have also discussed the image interpretations, but now in this one not only we will be seeing the examples of image analysis, interpretations, but the most important one after interpretation which comes the inferences.

That has to be also incorporated and this is what that mean aim of ultimate aim of remote sensing, image is to exploit to the maximum, so that we can get the information about that.

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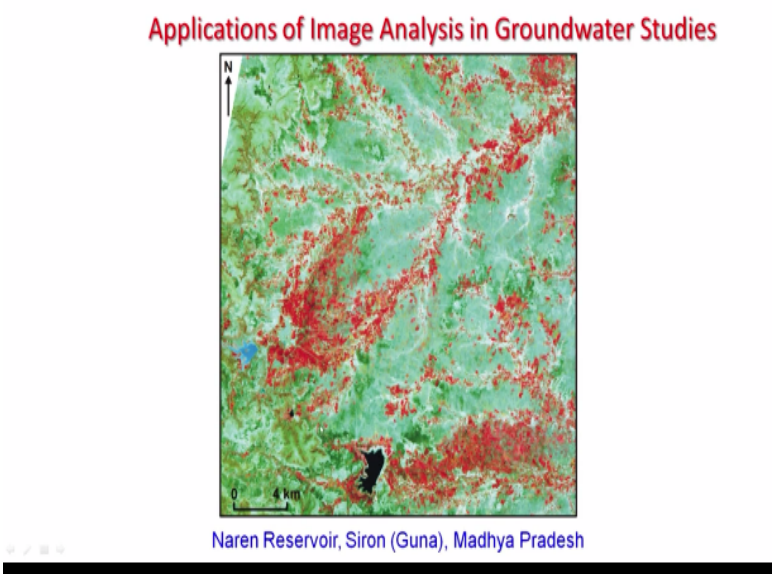

This image in the previous lecture, in other lectures I have already shown to you, and this is a IRS list three image which you are seeing here, and this is false color composite, and here you are seeing the three reservoirs, one reservoir here, another one is here, and third one is here. Now I am going to use the interpretation keys, as well as how inferences can be discussed here or can be made out of this image.

And then along with some other data's here how we can exploit, and came view in site of this area, but the start point is simple if false color composite. So three reservoirs are located here, and downstream were these reservoirs, there is a growth of vegetation. Now this growth may be natural one or human made. But if you look the area carefully you would find that area wise, the area is same, but in this part where reservoir is there in the downstream you are having more vegetation, but in other parts we do not see much vegetation.

Because there is no water body and here also we are having reservoir and in downstream you are having growth of vegetation. Even a tiny small reservoir is also having a benefit area in the downstream. Whereas, these there are no reservoirs here, and therefore, the growth of vegetation is very scandal, but is it, and I am assuming and this area tarrying wise geologically same, then void is happening.

So that these reservoirs are recharging he ground water receive and this is the inference which is coming out of this image interpretations. In image interpretations we are using keys like color, pattern, associations, everything is being used. And based on that I have said that there is a

reservoir, there is another. Then you do not have the growth of vegetation as here. So we can assume that probably these reservoirs are charging the ground water regime.

Another important point which also you will notice while doing image interpretation is that if we compare this two reservoirs one is appearing as blue in vascular composite and second one is appearing dark. So this blue one probably having the shallow and depth or water column thickness is quite less as compared to this one. One can argue that there might be pollutant in it, but from ground information we know that both had the same water quality except that in this one the thickness of the water column was less and therefore there is a reflection from the bottom of the reservoir.

And in the vascular composite it is appearing as blue, whereas here the water column depth if quite thick and therefore a water body in infrared general will appear completely dark. Now there is another very important thing which one can, if incorporate some other data sets can identify about these.

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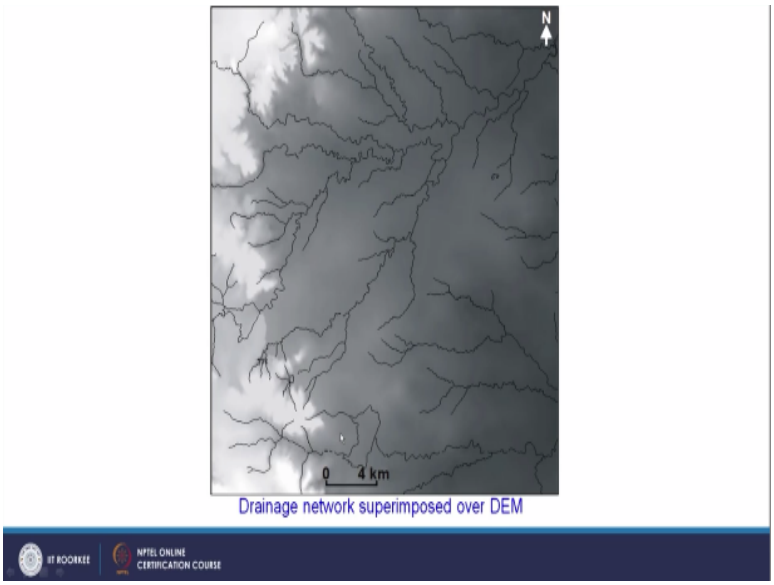

So this I will go to this one first that you are having a digital elevation model and if you overlay on a GI spirit form the positions of reservoir the drainage system, what you would find that reservoir, the smaller one is located on higher grounds compared to the larger one which is located relatively on lower ground.

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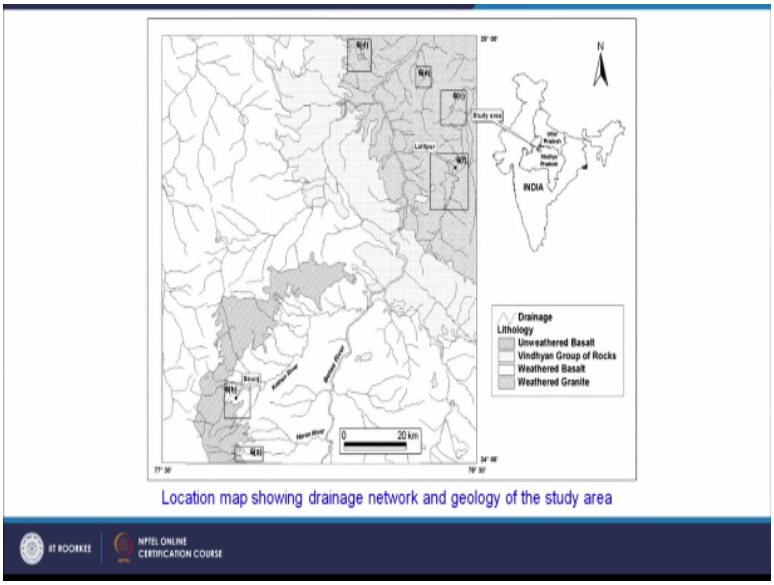

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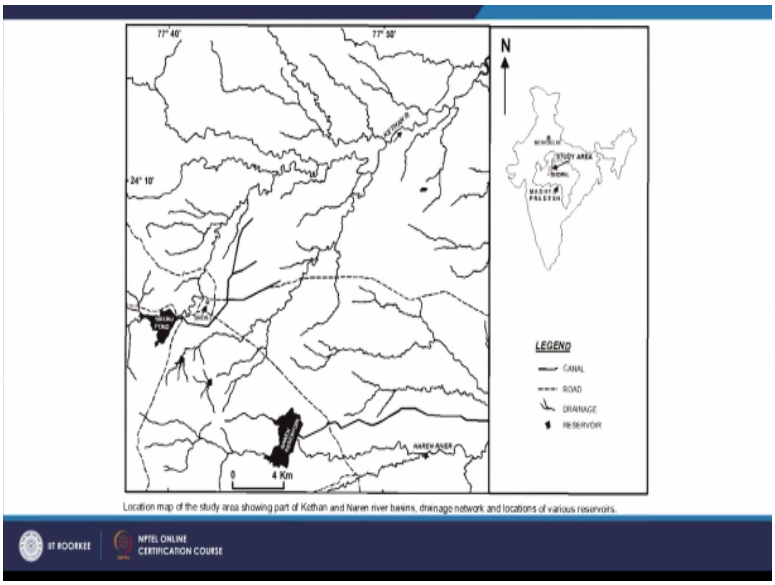

Location map of the study area showing part of Kethan and Naren river basins, drainage network and locations of various reservoirs.

And therefore , it is recharging if you see the influence of this small reservoir or the benefit area of this reservoir which is relatively larger though the size of reservoir is small, but this reservoir relatively is larger, but the benefit area is smaller as compared to against this small reservoir. Now we have to also interpret or investigate why this so, if we look again the digital elevation model locations of these reservoirs and then the drainage system what we find that since this reservoir is located on higher ground and therefore, it is recharging ground water in a much better way.

As compared to reservoir which is located on the lower ground though larger in size. Now further inferences we can make out of this comparison between image and digital elevation model that if we want to make the other areas having also the same kind of vegetation, same kind of agricultural practice, same kind of vegetation growth, then we need to have reservoirs or ground water recharge structures like this, the blue one in the different areas here.

And if it is done probably in one or two years time the benefits can be seen through growth of vegetation. And I have used this word one or two years time, I will be showing some examples how quickly in a hard rock tarin the ground water receive improves once you are having ground water recharge structures like in this case. So only in the downstream of reservoir you are having growth of vegetation, wherever you do not have any reservoir structures you do not have much growth of vegetation.

So these are the inferences which are coming out of image interpretation one, if you imply or if you use the G aspect from incorporate some other datasets like digital elevation model maybe geological map, maybe a swilled map and further interpretations in satellite image like lenium and land use, you can create new products which will tell lot many things than a simple image. So image, image interpretation and then inferences and integration with other datasets can build up a entire knowledge about that area specific to some problem in this case the ground water.

This is the lithology of that area, this larger area is shown and there is a relevance which, but the reservoir which I was talking are located here. So you are having this unweathered result here, it is unweathered result here in the basement you are having granitic rocks.

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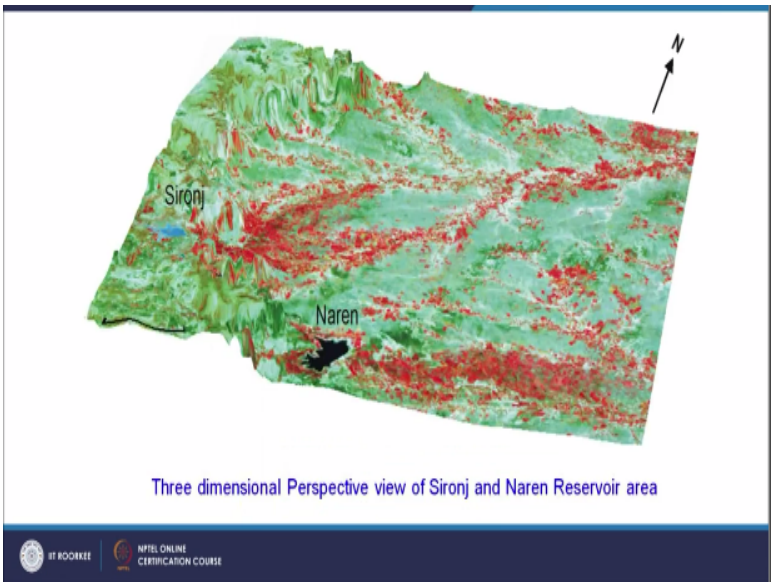

And now the point which I was saying that the blue reservoir is on higher grounds can also be relies in this 3D perspective view. This is on the lower ground; this is on the higher ground. Since it is on higher grounds it is causing a better hydraulic gradient and therefore, better recharges as compared to reservoir here. And this is how the image analysis should proceed. Image interpretation is after enhancement and improvement in the quality of image, the next step comes the image interpretation.

And during image interpretations the inferences should start building up, and if it is possible to integrate with other datasets, then the entire new world can be open through the originally started with the satellite images.

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Flow chart showing the methodology adopted in the present study

And this flow charts sounds very complicated, but I am not going very detail or each box through this one but I will show you that bend the geological which shown of that area we can integrate in G I So assigning the certain weights and for the different geological feature. So through the four maps are here one is the geology map.

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Table 2. Weightage of different parameters for groundwater prospects

Sl. no.	Criteria	Classes	Weight
1	Geology	Weathered basalt	1
		Unweathered basalt	2
2	Geomorphology	Valley fills	1
		Alluvial plain	2
		Pediment	3
		Residual hills	4
3	Lineament	Present	1
		Absent	2
4	Slope (%)	0–0·9	1
		1–2	2
		2·1–5	3
		>5	4

Source: Saraf, A. K. and P. R. Choudhury, (1998), Integrated Remote Sensing and GIS for Groundwater Exploration and Identification of Artificial Recharge Sites, International Journal of Remote Sensing, Vol. 19, No. 10, pp.1825-1841. (Google Scholar Citation 345 on 1st March 2017)

And only two very simple areas have been identified weather w solved weather we solved and from the ground water point of the view the different weights have been in assigned is to unearthed ascend is most suitable as compared to the salt. Therefore, the more weight as been assigned so similar for the morphologies similar for the linear site and then similar for the slope ands all these four map nib the bund is coming from elevation model.

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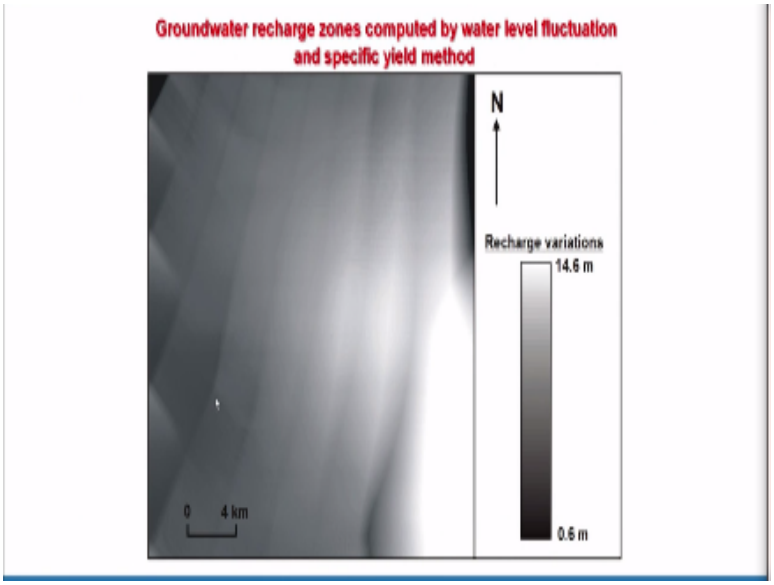

Another one is coming from light image interpolation this is also coming from the satellite images interpolation geology map might be coming from the zoological survey of India some other sources and when we integrate alone with the ground water recharge information is coming from monsoons post monsoon water level measurements in the observation wells. Then we can

this is the linear men map and then we can create new product to the integration of these map on the goes plat form then meaning could remember.

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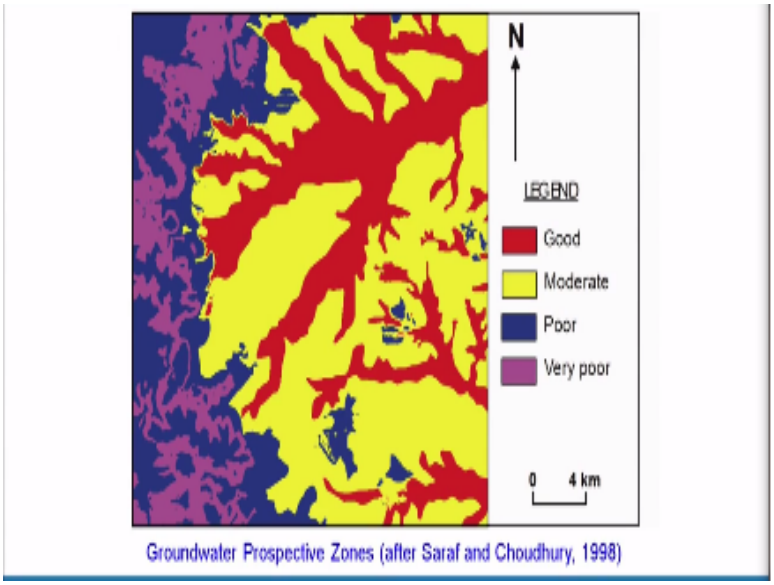

Is the satellite image in the image announcement image analysis meant image interpolation inferences integration with the other dataset now you are sewing the product which is telling for the same are abut this is the, if you are looking for the ground water level in this area then these radar area just for the representation the red color has been choose. So these radar as sewing for better proper ground water where as if you go for areas which are in this color.

This magenta color these are the areas where it has highly likely wood of getting in the water .so you know why this is because these areas a fuel fly. There are lineaments and this is the unearthed based lower grounds and there for there are very high chances of getting water on the ground water here. So this is the ground water prospect and the zone map can be created for any

areas pacely this technique can be applied in the hard doctrine in the ITC blind and the remote sensing images there announcements analysis interpretation inferences integration with the remote sensing and the G I C data and some other data cells.

A new product can be create and the another product can also be created where exactly there is the charge structure come which are the areas as the suitable for the ground water structure because we made inferences it developed the knowledge that the reservoir and higher grounded relatively on the higher ground then it would provide the better ground water. So there this if we apply this area over the entire region or they are of the interest.

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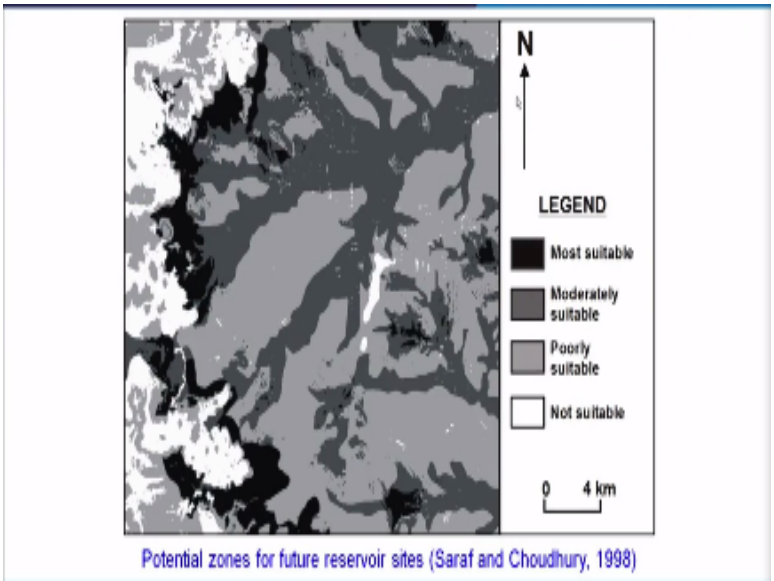

Potential zones for future reservoir sites (Saraf and Choudhury, 1998)

Find this black are the most suitable they are not at the same level were to the area which we want to provide the benefit. So there are it has the higher ground but not in higher and the lower order of the streams. So they are at not worried high grounds in the middle grounds but having some having the bill and the gradient significantly, so these are the area's most should will where are the areas which are moderately suitable then poorly suitable to areas the if you go and create and the charge structure you do not have an extreme you do not have the.

Slopes available and therefore the benefits will not come in at all so the end of the white areas are complete suitable because there are in the higher ground they are in the unearthed based on the rock the extreme order as also very low and their judgment areas is going to be very small. So there is no use of this so employing all these concept and the knowledge one can develop as

the such products for the ground water recharge posses remaining in the same the regional condition we are having the NIC complex hard rockery and again thinking from the ground water point there is the another simple solution which we are seeing weather.
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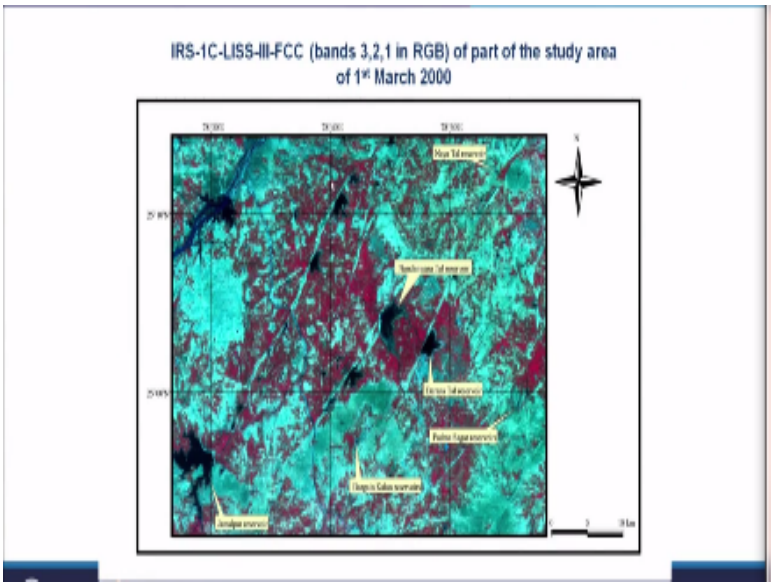

That if you see this image now the image interpolation image now you interpolation seeing done here after the announcement and the things the image is here which is IRC is three false color composite image what we are seeing here that there are white lines are here and if one is having little knowledge about that ground condition what we would know these lines are nothing but the quarry these are reside kinds of things which are present on that, there is the genesis would be the there are not going on the genesis but these are the raised grounds in the linear form.

General trained of and the image is from the south east and the west, so most of these dreams either going in this direction or may be in some other direction, so if this streams are going like this if there is the quarterly in the past people have been blocked this quire wires that means that the image unshaped going to the quarterlies.

This quarries' as been used as the dam axes and that part which was align is extreme go through was blocked and small and small reservoir are the ponds have been created which you can see as in the earlier interpolation we have see that false clear composite it will appear red. So in the visibility or the do misting these reservoir we have seen growth of the vegetation and where ever

the large as the such ponds and the reservoir ponds we are seeing vegetation and where ever where do not have reservoir we do not see any growth of the vegetation.

So that means that where are streams are going in the checked in the quarries those areas can we used to clear it has the small reservoir pond by checking the extreme using the quarter the dam axis in the past has been done there are many extremes and still are going to checked and if it is done then many areas came also become green in the false color composite and of course we will appear red in the one are two years' time.

If we identify this the few second while and sewing one are two years old the affect of the ground water which are subsequent growth of the vegetation is take it in these areas because this is most rocketing the quarter are complete unconfined and we are having this is the ace reservoir full good rain is there you are having ground water for the some mounts of year. So therefore these ground restocked place very important role towards the supply of the ground water.

And nature has created these dam axis running's of hundreds of km running would be from north east to south west direction, most of the streams are going to south east to north west they can be checked and search ponds are reservist can be created. Now what would be the benefit area what would be the effect those things can also be estimated if we do further analysis further interpretation and take out further inferences. Few more examples we will see there is a reservoir in this.

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The stream is cong from North West direction and it is blocked and downstream area you are seeing growth of vegetation as well as in the periphery of this reservoir. But in remaining areas you do not see much growth of cvegetat80on, so what we are learning now this we can call as sum merged area; we call this as a benefit area. Few more example quagery phase like this, it is going through and it is creating its own benefit area, same reservoir downstream having benefit area.

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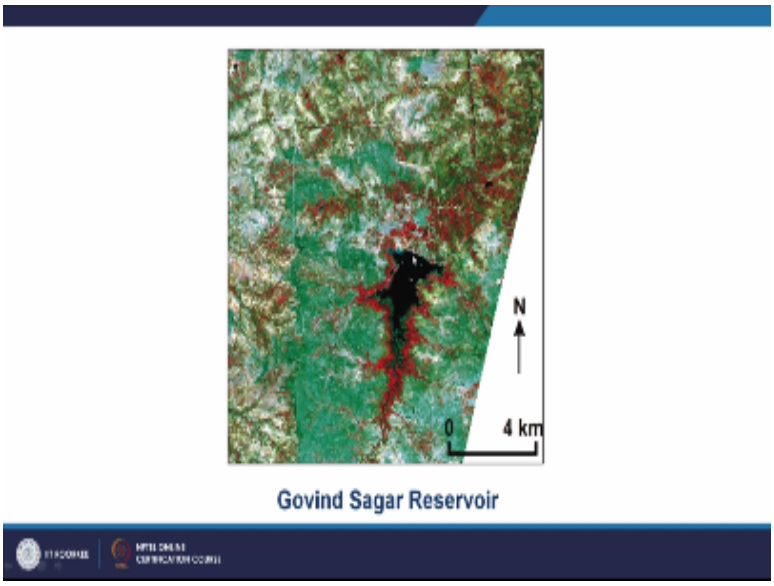

Again this is the benefit area this is the perimeter of the reservoir and this going roughly from south towards the north.

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So what we see where we see such reservoirs we see in downstream the influence there influence in the ground water.

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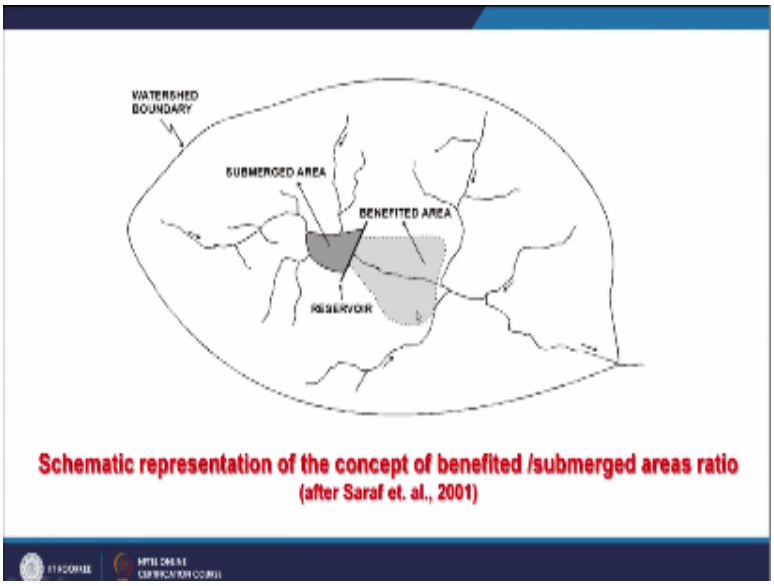

So we now here in this schematic we can bring quantities in it by implying a very simple concept of ratio, that this I consider this is the submerged area this is the benefit area, so I can create a ratio between benefit area and submerged area just by interpreting and satellite image and measuring these two areas and it is very easy to measure on satellite images specially on falls Clare compose it. And this is what exactly done in that when they will come reason of about 21 reservoirs.

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What you see that this benefit versus submerged ratio in some cases is 28 and that what it is indicating that if you invest 1^2 km of the land towards the construction of a ground water recharge structure a pond or reservoir in the downstream 28^2 km of area will have growth of vegetation or ground water recharge. So is a west man in terms of land investment in terms of and this is 28 times but there may be some reservoirs like Jabalpur this example is given there the benefit is not one it is less than one this the ratio is less than one that means you are investing 1^2 km of a land but benefit area is just 0.6^2km.

So if I am having more places where this Chennai and this jacora reservoir are there or more possibilities in the seventy or surrounding of these existing deserviors if it is there then I know that if a reservoir is constructed in this particular area where these reservoirs are look at it immediately one or two years time I am going to have benefit of 28% 28 times which is a great benefit f5rom ground water point of view and that two in a area which is starving for water at least for three four months of summer time.

So this is how we started with simple image interpretation and there this is what we are reached is still we can imply some more interpretations inference and some other data sets and can do further analysis over this which I will show you like this one. I made this is the statement in two three years time you can start seeing the benefit one of the example though we say larger reservoir which was created.

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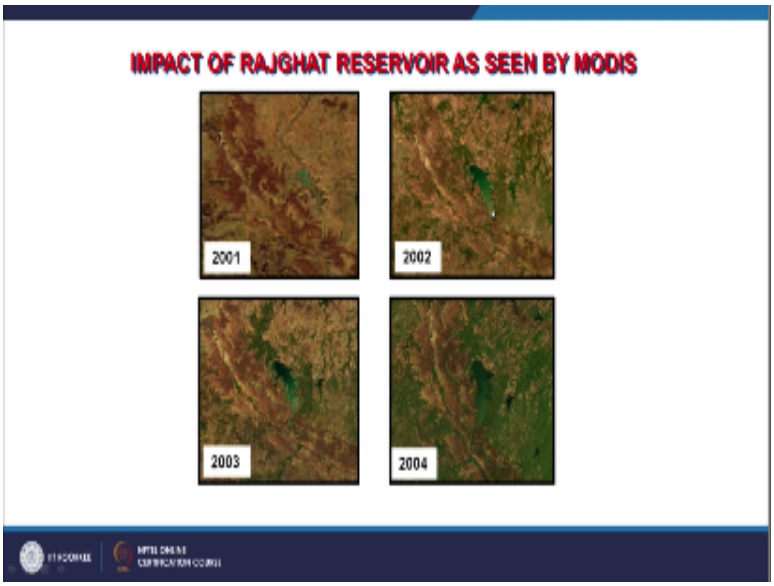

Which is called Rajghat reservoir in the same tern conditions the reservoir is started fling in 2001 and this image is modes image is say true color image because there are many 36 bands are there and therefore it is possible to create in near true color image and this is was it was created, so what you are seeing the reservoir is started filling and see in just one year time when the reservoir got filling the growth of vegetation in the downstream area.

This is the multipurpose reservoir, so it has got the vegetation lift rogation hydro power and of course indirectly it is doing the job of ground water recharge which is reflected here and in three years time the whole area is getting green. This is see how quickly a reservoir is causing ground water recharge and that is why I said in if a reservoir is constructed in such areas toddy in two years time you will start seeing benefits of ground water recharge.

And that can be assist through remote sensing data in terms of growth of vegetation that you can see just compare this image with this image just two years time difference see the downstream area, no vegetation was use to grow there now you are having and most of these are agriculture land, agriculture fields are year corps are growing. So that is the advantage of doing such a work in a trainee which is having water problem and it is started it can be done just first interpreting the satellite images and can reach these stages these are the time sequence if one see this four images one can argue that one have might have been taken a pre months one and then post months and that is the time different known.

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So what I have tried I have taken images of the same date of different years. So one year after the reservoir was filled and this one I am talking and the second year in 2004, 2005 and 2013 that is the situation. So your reservoir because a multipurpose it has good irrigation can a irrigation system left irrigation, so what are available in all sides crossing you in water side limits sand therefore growth of vegetation.

So the water was available only it was flowing as a surface run off through this width forever and it was no time chart that there in downstream there is a reservoir but which cannot hold so much of water. So at this is holding further larger amount of water and creating ground water recharge structure.

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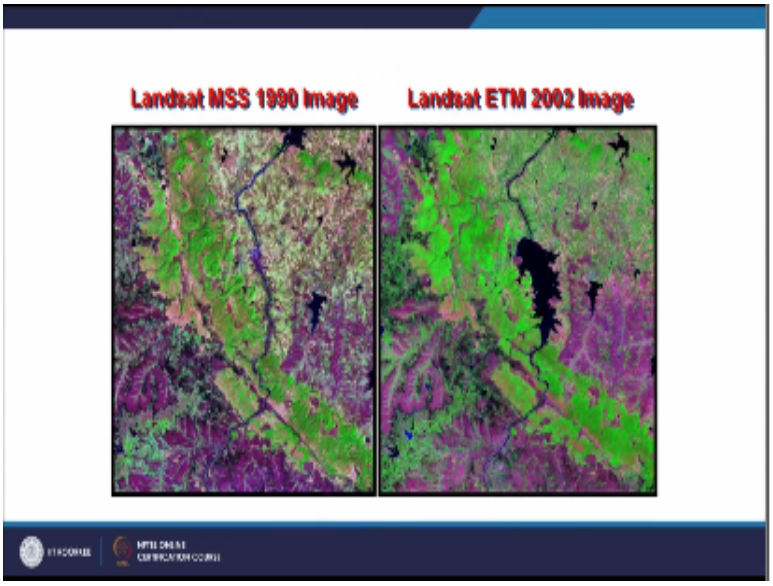

Another proof of this one this was the 1990 image from land side images and this is ETM image of 2002, and this is what you see here, see the reservoir was not there at all and see the vegetation condition this is again true color image here what you see the condition of vegetations. And other there were no new reservoirs I have come except this large cart one, so we can conclude their easily at tribute to this reservoir that because of the filling of the water in this large cart dam this is what the growth of vegetation which we are see in the surrounding specially in the downstream of the areas of the benefit area of this reservoir is very use.

Now this interpretation of quartzreef is inferences integration with some other data sets implying some other tools can build up a further story and this is what I am going to discuss in this party of this discussion.

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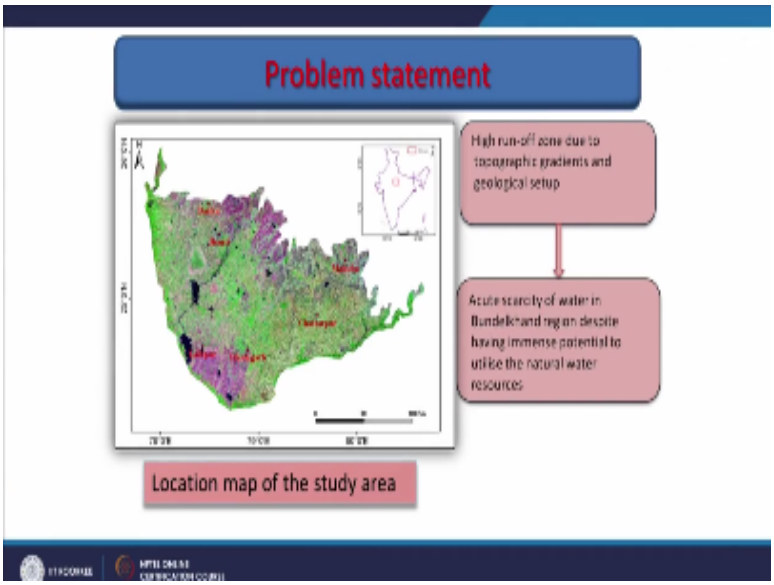

That this entire indigene when they will come reason was taken in this one in this example.

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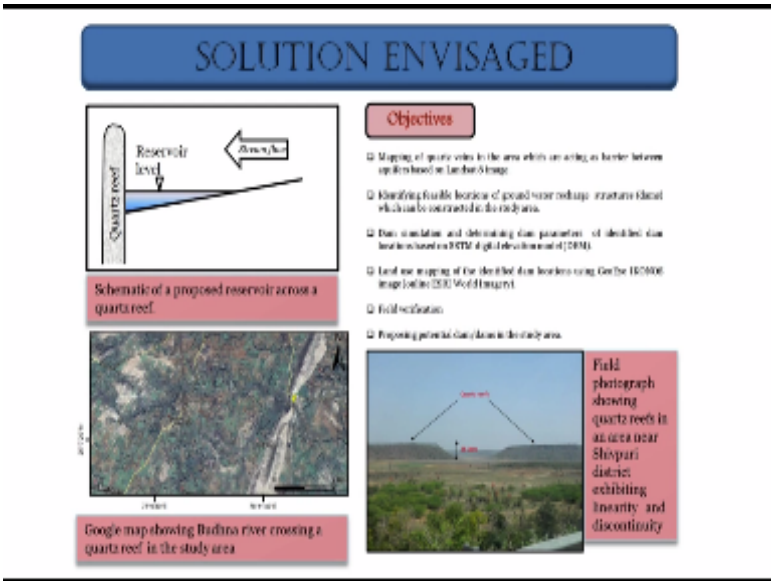

And this quartzreef we are also identified using image interpretations you can use the Google earth images or you can sue the land set images are thus and as you can see that in high resolution satellite images these quartzreef can be identified very easily. This is the ground photograph filled photograph were you are seen the quartzreef are having a height of about 30m or 25 to 30m, and therefore these quartzreef can serve as a dam axes these are nothing but the ground water various does not matter we want to stop the water the flow across this.

So that water can be we can reduce the surface run of can hold water for some time delay the flow and therefore ultimately will recharge the ground water stream, it may recharge ion the downstream area it may recharge in the vicinity or of stream of the area some examples are also there but ultimately.

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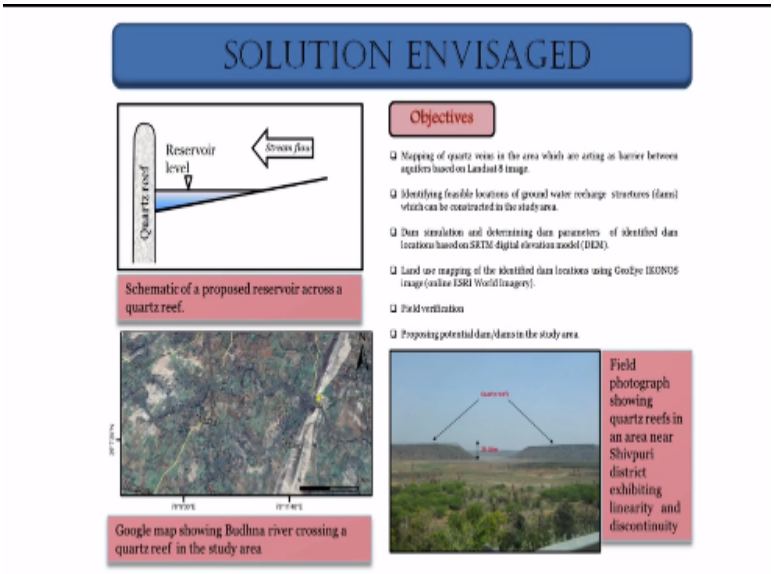

Level for ground water consecutive the growth of vegetation which can be judged which can be measured through the satellite images of later years.

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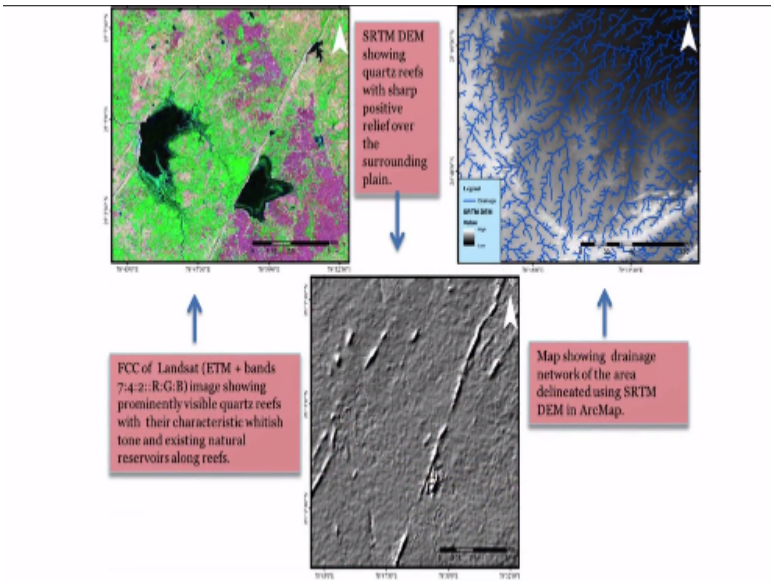

So here what are you seeing is again twp color images, the quartz reef are there but still there are places where the streams are going unchecked, so by implying digital elevation model or quartz reef maps through satellite image, schedule model we can identify those areas where dam can be constructed. Now this is orientation general trend of quartz reef.

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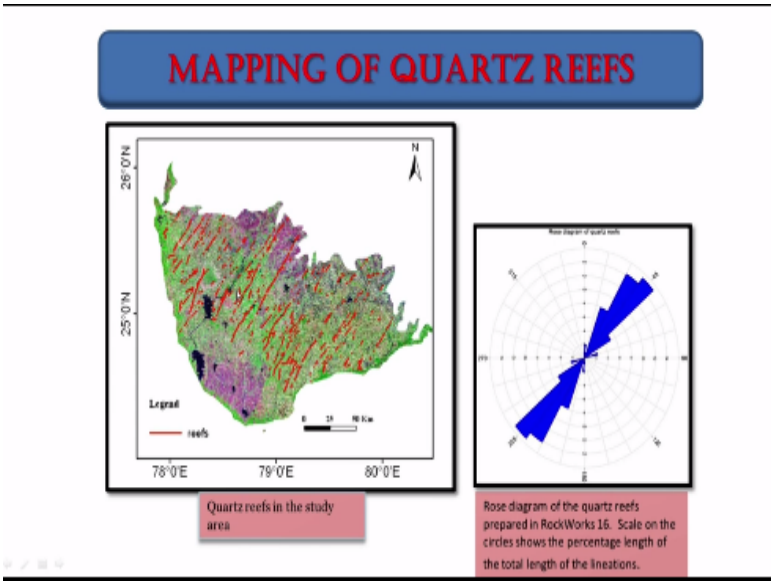

Which is roughly north east direction and the major flow directions and slope are towards the north west and that is the advantage here.

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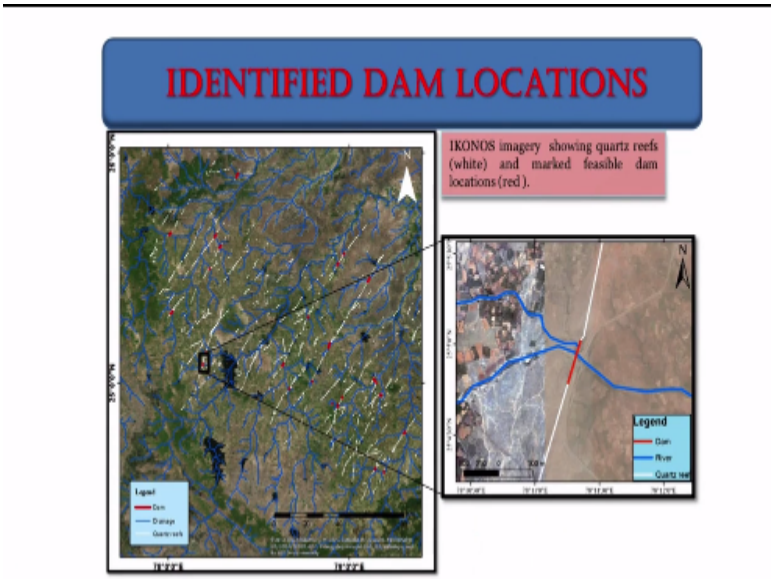

Now there are places, which has been identified where quartz reef there and the streams are going unchecked, as soon as the red part a burn part is zoomed here quartz running like this, this is the proposed dam, not yet constructed but using the a images digital elevation model on GRS platform we can stimulate a dam, not only that one but what we can do we can decide the height of the dam, excess of the dam, length of the excess and then we can calculate what is going to be the summarized area and this is what done here.

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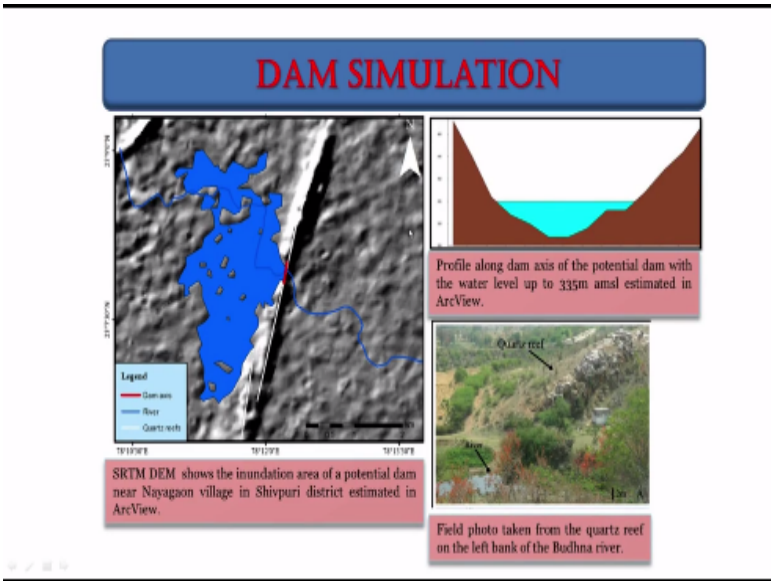

The quartz reef is taken as dam accesses; the bridge part was blocked or assumed that, there is going to be a reserve wire, and when the reserve wire of that particular height is decided, this is what we can stimulate on the GRS platform, that this is the NNDT area is going to be, if this reserve wire comes, nothing is happened on the ground but this is completely modeling, stimulation, that this is what it is going to be.

You can also estimate if you know the benefits of the summarized ratio, you can also estimate that what would happen in the downstream of this area after 2 or 3 years of time because we have leant through the time series images that in 2 or 3 years time the benefits starts coming through the growth of the vegetation. So this is the profile of the dam which you are seeing here, this is the field photograph river is there water body can been seen, so if this reserve wire uses as a dam accesses, then such reserve wire can be constructed.

Since you are having the satellite image you can also do the land used land cover map, so you know exactly which land part or which land usage will be summoned or so on so forth and then exact location, whose land this belongs to? So on so forth, many others thing can be done this is the example here.

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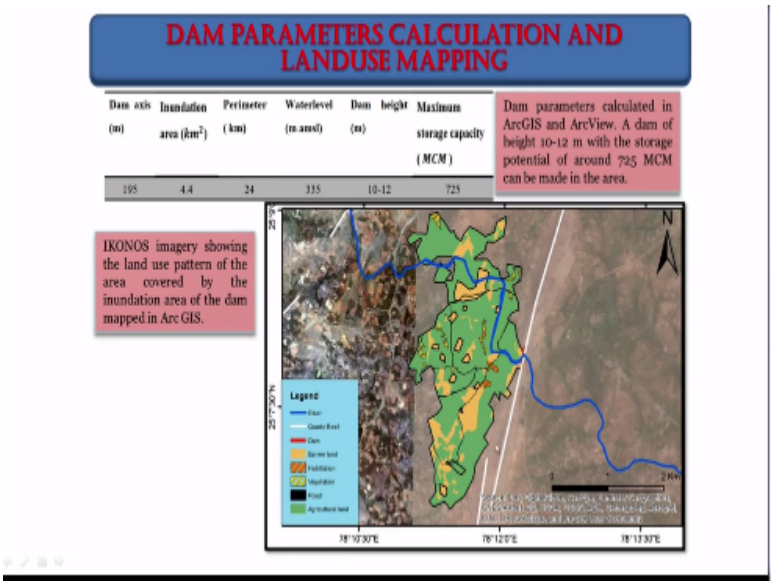

This is the land use land cover map, only for the summarized area was create, so you know that what kind of land will sum merged, if at all a reserve wire comes at the location and nothing is happening on the ground. This is all started with simple image interpretation, so image interpretation inferences and now we have reached to the modeling the prediction part, that is the what going to happen if the reserve wire is going to be constructed here.

So this level of image analysis can be achieved in much such case where different problems are there, I have taken the problem of ground water problems. One can work on other problem, may be related to landslides, and may be related to road alignments, route alignments, maybe construction or some other things and so on so forth and this is another example of another reserve wire.

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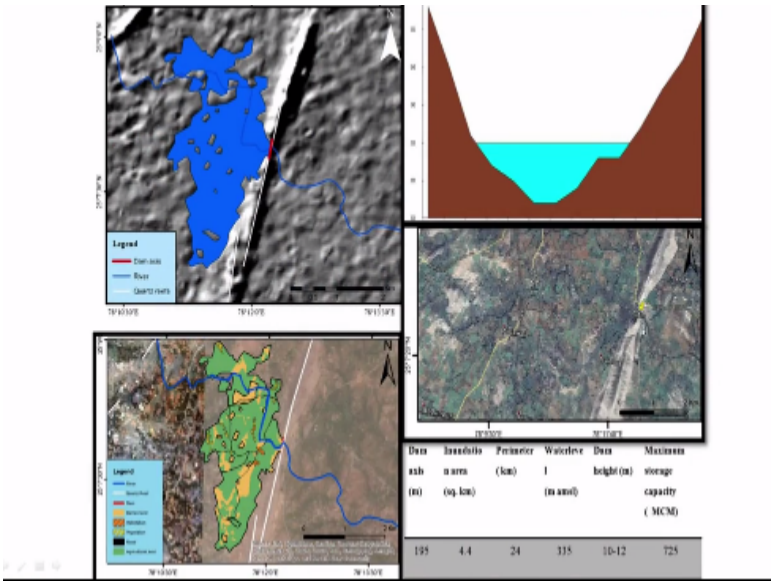

Here that you are having this entire quartz reef sum merged area and other thing.

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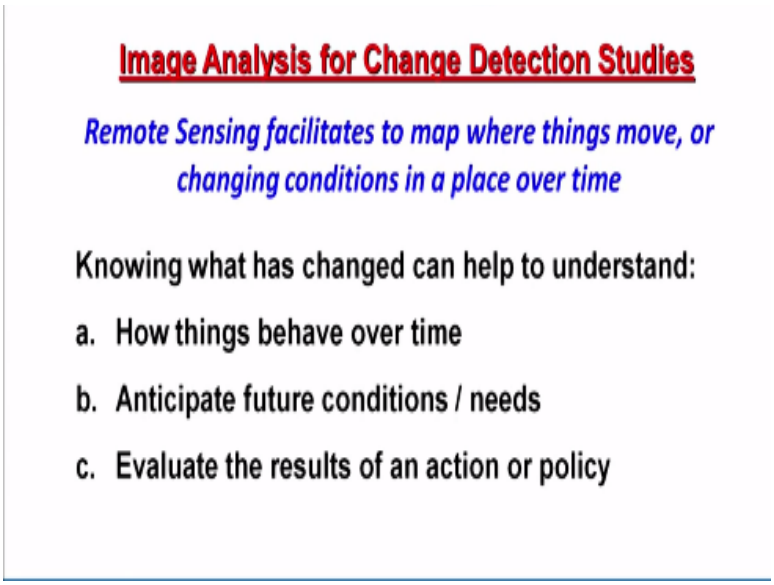

Now image analysis for change detection studies, we have seen change detections in different form while studying image fusion and image merging, so remote sensing facilitates to map where things move changing condition in a place over time, mean what has changed can help us to understand, that how things behave over time, and anticipate future conditions needs and evaluate the results of an action or policy.

You know as I have been discussing, now there is a lot of remote sensing data and that to time series remote sensing data is available, starting from 1972 onwards, there in that time in reference to today special resolution was we have correlation of 80m but those data are very valuable from change detection point of view and these data are available freely on internet, just one has download, register it and organized it on a platform and then change studies, related with environment, related with land use related with any other aspects which linked directly with land can be done.

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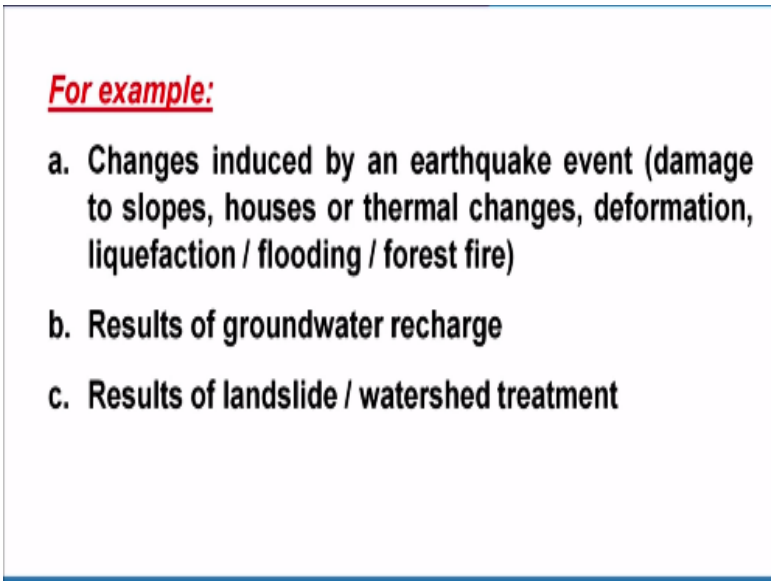

So change deductions I have given the example of earthquake so I am not going to repeat, change detections may be flooding, maybe because of forest fire so on, results of ground water recharge, just take the example of change detection, results of landslide and watershed treatment, some treatment are done you know to maintain the watersheds, so the deturations soil erosions does not happen, so those if you know then you can access it unwisely what changes the measures have brought in a area.

So that also can be employed and also from long term point of view change detection can also be done, ways on the crusted formation but these change detections are may not be purely based on remote sensing data but one as incorporate different gps and other things as well. So this example I have already given, so I am not going to repeat but what I am trying to say that, the image one image in the beginning of this course, it was mentioned that satellite image tells 10000 words.

So a image or a photograph tells 1000 words but a satellite image can tell 10000 words, I have shown some examples that the simple satellite image, we started interpreting that image, we have taken out some references out of that, then in cooperative which knowledge came through in references, in cop rated to other data, created new products and then reached to the modeling, ultimately to the modeling stage and we can say that if the reserve wire comes here, this is the effects going to be.

In terms of ground water recharge, in terms growth of vegetation or in terms of land use or other changes, so similarly in case of some other large products not only the reserve wire projects, may

be a thermal wire project, maybe a nuclear plant project or any such development takes place these things can be assessed based on the current remote sensing data, may be on the past data and if futuristic scenario can also be generated, if we develop better understanding interpretation of satellite images. So this brings to the end of this discussion thank you very much.

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