Remote Sensing Essentials
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Lecture - 52
Integrated Applications of RS and GIS in Groundwater Studies – 02

Hello, everyone and welcome back to the part 2 and here we will be seeing a few more examples, more a quantitative analysis and we will also see that how much time it would take to get effects of these recharge. So, in order to bring quantities in our approach and the discussion which I had about the you know reservoir area and benefit area, here we are defining that the reservoir area the inundated part or water body we consider as a submerged area as shown here.

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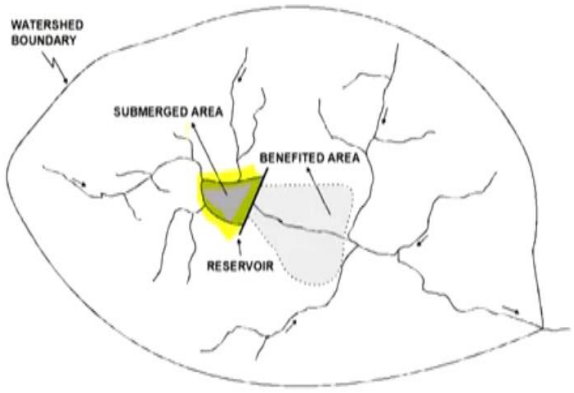

Schematic representation of the concept of benefited /submerged areas ratio
(after Saraf et. al., 2001)

And in the downstream area, which we can identify on satellite images through and delineating the growth of vegetation that we can call as benefit area as you are seeing here. So, this is the basically reservoir is there this is of course a schematic and in a in a in a water set or in a basin, this is what is the scenario which you will see further.

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So, keeping this benefit versus submerge ratio and analyzing existing reservoirs in that bundelkhand region in hard rock terrain and bundelkhand nice complex region, hydoctor in we could identify that there are reservoirs, like the first one which is Chanderi reservoir falls in Madhya Pradesh of bundelkhand region it is having this benefit versus submerged ratio is 28.18 and whereas reserve is like Jamalpur in the bottom.

Which is having the benefit versus submerged ratio is 0.66 so, this B obligue S ratio BS ratio is very little that means, say, if I go for if I construct a reservoir near or in the area which Chanderi reservoir is currently located, then I am going to have about 28 times of benefit 28 times benefit in terms of the area that means, if I submerge one square kilometer of the area to construct a reservoir or dam, then in the downstream I might be getting.

Benefit area of 28 square kilometer this is what this ratio means. Whereas, I am getting a this like example of Jamalpur reservoir if I invest one square kilometer area for construction of a reservoir, then in the downstream only 0.66 square kilometer of area is getting benefited. So, that means that this area is not good for further development but what if we say we fix a threshold say around the 10 if I invest one and say one square kilometer of land.

I should get benefit at least 10 times or 10 square kilometer of downstream areas would get benefit of groundwater recharge. So, if I fix this threshold large number of area, bundelkhand region or large area of bundelkhand region through these reservoirs we can know and beforehand that how much return I am going to have in terms of benefit area. So, analyzing

satellite images anyone can develop such a benefit versus submerged ratio for a particular area.

Say for a Gujarat part or Maras part, we are lot of water problems are they are all in South India and looking at the satellite images, identifying water body reservoir and the downstream area which is getting benefit and creating such ratio now you know in the vicinity of suppose a reservoir is located here and which I am seeing then and there are possibilities of getting construction of reservoir elsewhere then I know that what kind of return I am going to have.

So, 28 times is a very good return in terms of benefit area in that particular area. So, even a 10 times is no way is bad. So, such kind of benefit versus submerged analysis before any such a structures are constructed can be done.

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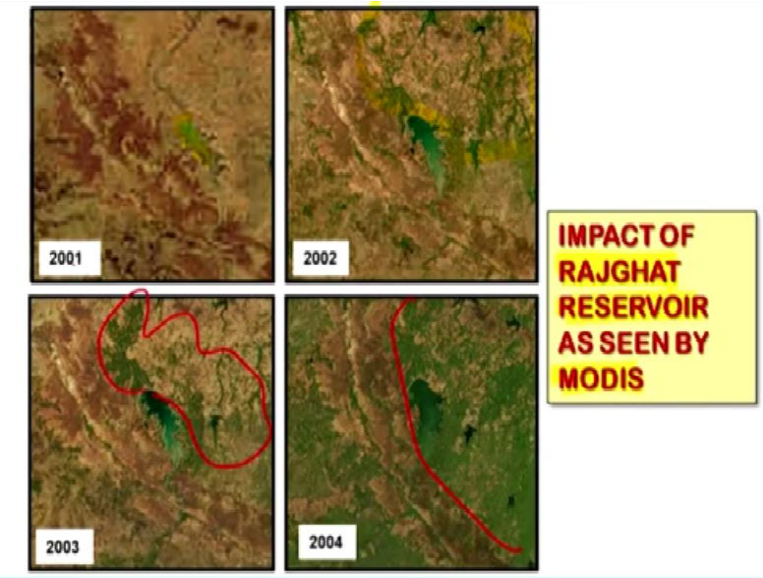

Now, I also mentioned that it will take 2, 3 years time in hard rock terrain and to get the benefit because the hydraulic conductivity that means the water from in subsurface condition in groundwater condition will flow from one end to another in a very slow pace They say this is what we say hydraulic conductivity and it takes you know years to reach to few kilometers or to go through few kilometer in.

Because it depends on the fractures in the rocks or weathering zones in the rocks because this is a the example which I am taking is a really hard rock terrain. So, the only the top part is you are having which is weathered and fractured and it is having unconfined aquifer

condition. So whatever the water which you can store is only in the top few meters say a maximum 10, 15 meters below that you are having very solid granitic rock.

Therefore there is no chance of storing water there. So, it is better to store water as far as possible in the top layer of this hard rock terrain, see the one reserved which was under construction, which is called Rajghat reservoir or also called as Rani Lakshmi reservoir and you see in 2001, these are the MODIS images and which are available on daily basis, the resolution is 250 meter does not matter for such kind of his study.

And what you see here a reservoir was just started filling in 2001 and seeing that this is a true color image, therefore, vegetation will appear in green color, and you do not see any growth of vegetation. But you come next year 2002 and use in the downstream of this reservoir, you start seeing the growth of vegetation. When you go in the next year, that is in 2003 and this is what you are now I started seeing that see there in the downstream area.

Large part is getting benefited and in just 3 years time, the entire area is now green this is water said or the rich so therefore you do not have much effect of groundwater recharge induced by this reservoir, but in remaining areas you are having. So, this large part is now has just compared this one with 2001 hardly there were any growth of vegetation. So, and at that point I can and this is the point which I am trying to justify that it takes about 2 3 years time in a typically hard rock terrain like in Bundelkhand region to get the benefit.

So, hydraulic conductivity is not very high, it is slow, but none the less, you can get benefits. So, if it some majors are taking today, then in 2 3 years time, we will get start getting benefits and if someone can argue on this image that probably it is because of this, the 2001 might be pre monsoon, and 2002 might be the post monsoon or 2004 made which is shown here might be post months and therefore, a lot of differences are seen it is not true.

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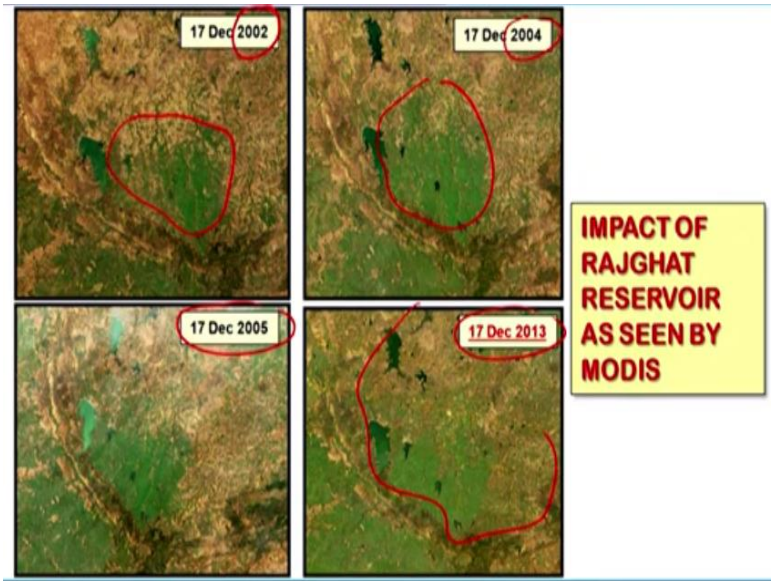

So, what I did I got the same dates data of different years completely cloud free data almost completely cloud free data. So, this is 2002 which you are seeing, then this is 2004 17 December same 17 December 2013 and you can see that in only in 2001 or 2 this reservoir started getting filling and water and the benefit area started developing and in 2013, the entire region has got green tea there.

So, this say green leaves and is really coming because of groundwater recharge through a large reservoir though this reservoir is multi purpose reservoir, and there is lot of when a you know other purposes are there like for example, a it is also having you know the hydro power it is also having lift irrigation, canal irrigation all those things are there another important point which I want to bring is that if you see this channel here.

If I marked this channel, this is Betwa river so, there is already one reservoir here which is called Mata Tila this is the reservoir which is called the Rajghat. So, what we what we need to do now, that wherever possible construct reservoir and in cascading fashion that means, the one tale of one reservoir ends another reservoir after just one or 2 kilometers can be constructed like here and it will have soon tail like this and then you are having another reservoir and likewise.

So, whatever the rainfall which is quite good in this area the average rainfall is around 950 millimeter per year. So, whatever the rainfall, which we are having and whatever the surface runoff, we can store through these cascading one reservoir after another in the same on the

same river system and we can store a lot of water we can delay the groundwater and surface we can delay the surface runoff.

Therefore, we will allow a force and groundwater recharge and in just 2 3 years time, the entire area can have benefits of that the water will be available in form of groundwater, and then farmers can fetch that water very easily. So this is what is needed to be done. And that wherever possible construct may not be large reservoir I am not saying anything about the large reservoir maybe smaller a small reservoir does not require much time.

To construct maybe in 6 months or 2 3 years to 3 months time that the local material with local people and constructs as reservoir on the smallest streams and that too in cascading, the tale of one reservoir ends, another starts and so on so forth and when the monsoon will come, all these will be successive reservoirs will be filled and then they will recharge groundwater disease and the benefit is start will start coming in one or 2 3 years time very quickly so, this is the what advantage of water in a dry land.

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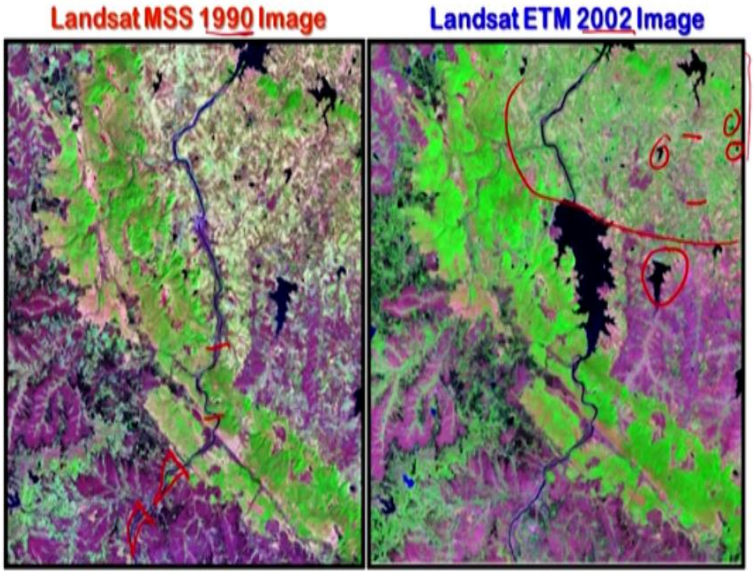

If I bring the same example of Rajghat, this is landsat MSS image in you know landsat image here and what vegetation is appearing here green and there is no water so far it is it was not really and you are under construction because it took 30 years for construction is a larger reservoir. So, there is not much growth of vegetation and in 2002 that that was the only first year of filling of the reservoir and you can see in the downstream area the benefit and started coming so, large area gets the benefit.

Rather than going for large reservoirs, which takes a lot of time for construction, it is all better to go for a smaller reservoirs like these, there are many such reservoirs and in the cascade infested like the one is here, one can be constructed here, one can be constructed here and likewise and cascading fashion and lot of benefits can be and the advantages can this stream is still having lot of possibilities.

This Betwa river is having a lot of possibilities of having reservoir so, the reason why it can be constructed here then and tail of one reservoir will end another one here like this and series of reservoirs can be constructed and you know what I am trying to say that whatever the water which comes in the form of rain or precipitation, so we stored at first as a surface and storage very quickly it will go in few months time it will go in the groundwater region.

There will be some evaporation losses, let it be otherwise, you are 97% of water and you are anyway loosing as a surface runoff. So, if, if through this reservoir, if I am getting 15%, 20% loss as a evaporation loss does not matter, because ultimately I am going to recharge ground water region and if canal irrigation and other irrigation systems can also be developed that would be wonderful but a small reservoirs and cascading reservoir successive reservoirs on a stream can solve the groundwater problem in the country.

This is just to let you know if we will photograph and we are a few years back before that the construction of Rajghat dam there were no water, no vegetation and such a joy of water was not there.

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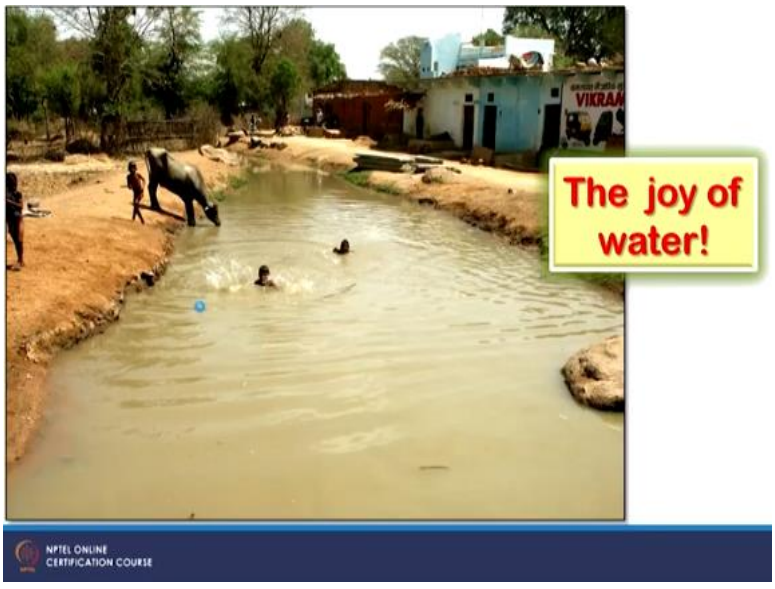

And once that reservoir came a is small canals passing by passing through a village and you can see the joy and not only humans are enjoying and benefits of water, but the animals too are enjoying the benefits of water.

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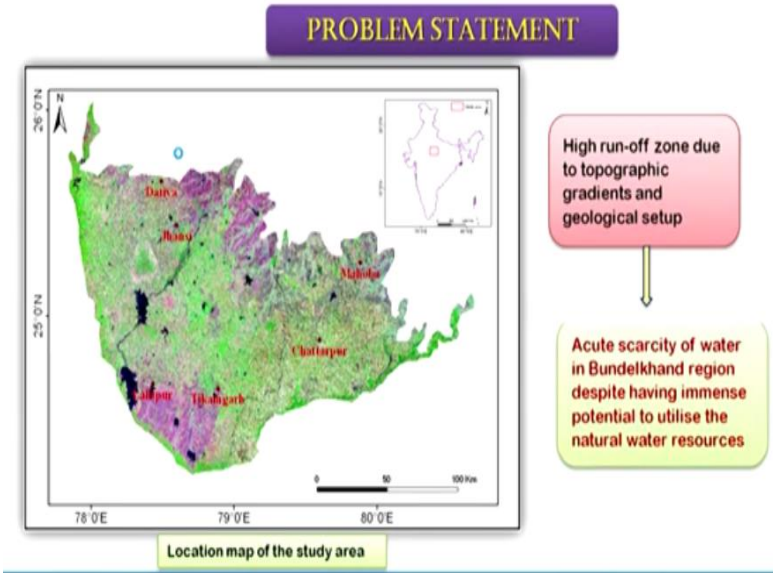

So, water is so important in this part of or in many parts of the country more than 54% of the part of the country is suffering or in the deficit of groundwater. Now, I will take this Bundelkand condition as a whole and how the help of remote sensing and GIS we can do further work on this. So, very quickly I will go through this that what we have done we have analyzed this entire dataset of Bundelkand condition which is a big region.

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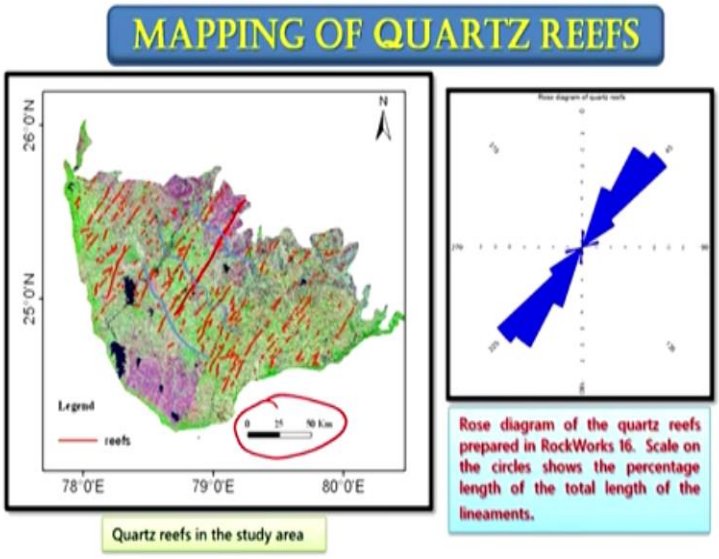

And then we have identified those quarts reefs which are running northeast Southwest direction, and there are many, many quarts reefs and some of them are running for 100s of

kilometers as you can see that this is 50 kilometer escaped. So, they see these quarts reefs are running for very long distances, part of them is exposed on the surface which can be mapped easily through satellite imagery part of them is not exposed does not matter.

But we can know that there are the quarts reefs and there might be some extremes, which might be flowing in this one, which is the streams are flowing like this and completely unchecked, as I have marked in the blue color and if by some means a we can check, where these dam access have been provided for more quarts reefs, then we can construct a reservoir very quickly this is what our ancestors have done and that will provide and as delay in the surface runoff, and of course, indirectly that will provide the groundwater recharge.

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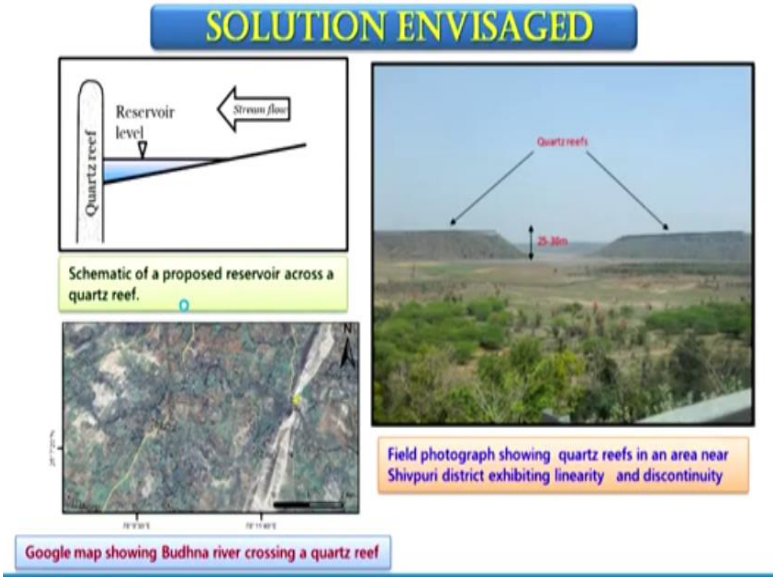

If I see a ground field photograph of an area this is the satellite image so from satellite image in high resolution even using Google earth images and we can see that a stream is going through like this and the quarts reef is running again in northeast southwest direction this is the field photograph and the height here is 25 to 30 meter. So, this is a natural you can say natural dam and if by some means if we can block this part.

Then automatically I get a dam very quickly reservoir, very quickly and can upstream part of this can we start getting inundated in next monsoon season.

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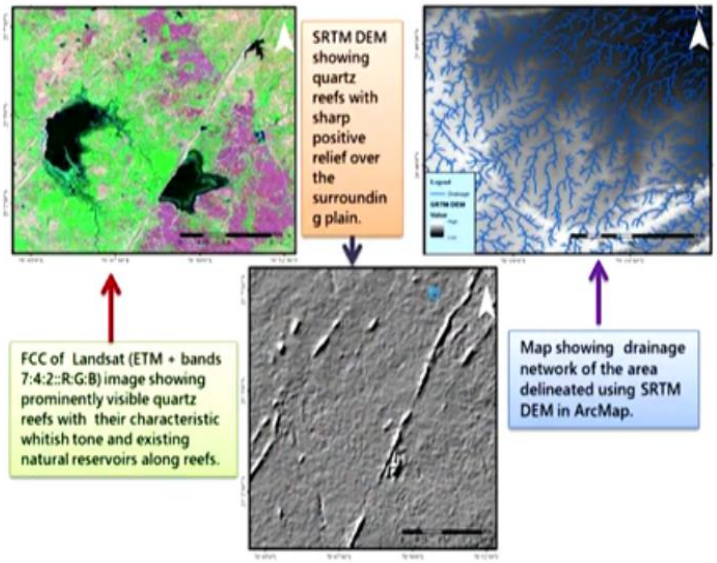

And benefits really start coming in to 3 years time like ancestors have done the quality of his running like this reservoir was constructed and the benefit you are seeing in the downstream. Similarly here, quarts reef is there it was blocked his stream and then you are having reservoir and surroundings is getting green so likewise, 100s of the sites can be located using remote sensing data only.

Or along with maybe like a shared relief model derived from digital elevation model and an almost all the data these datasets are available free of cost, the one need not to buy anything, just go on internet download the data, analyze the images, the way I have just demonstrated to you and you start and then of course the construction is required. So it is a lot of sites which are marked here with the red color have been identified.

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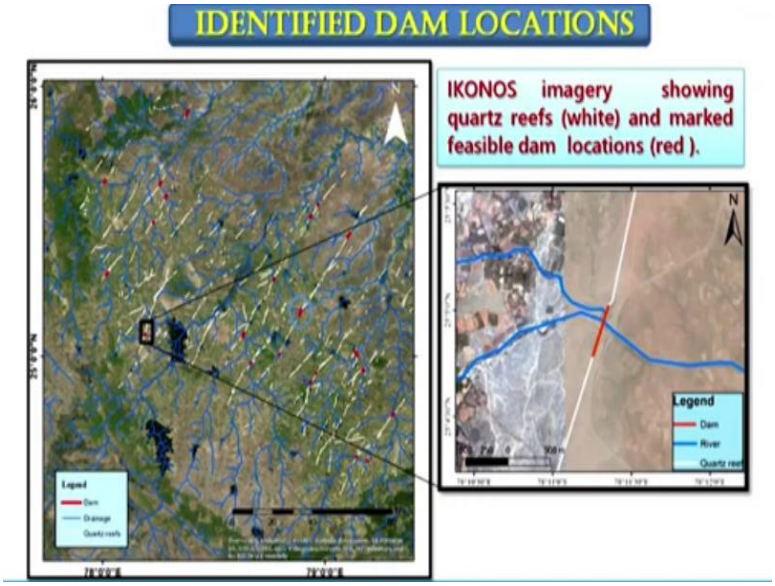

Here and this which, you are seeing they have been identified like this, and the red color which you are seeing here and one site is the zoomed part of that site is there that this is the proposed dam access and the remaining is the quartz reef stream is you know flowing like this and then if it is checked, then the dam will come.

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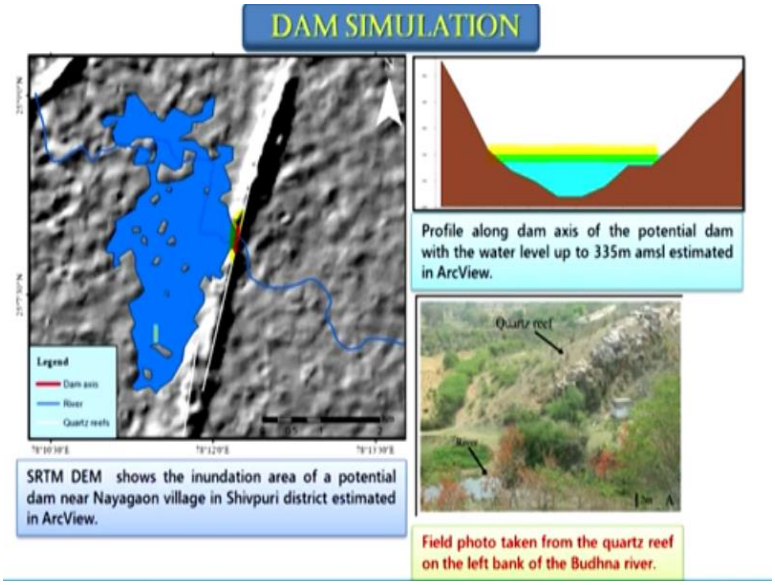

In few Years time now implying GIS and implying digital high spatial resolution digital elevation model of this area we can even simulate a reservoir before its construction and this is what exactly it has done that once we have decided that the reservoir which is marked here is red and will come, then this is how the profile will look and if we decide the height of the reserve is as soon here with the blue color.

Then what would be the inundated area and a stream that can also be modeled and this is what it has been done through this damn simulation on a GIS platform and things can also be checked in the field that weather and whatever it is being done on the computer it is possible on the ground or not as and done in this case.

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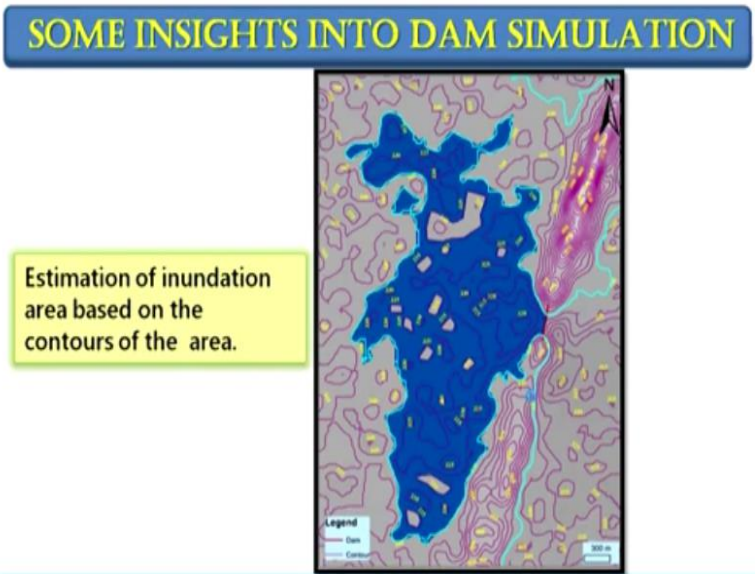

And also you can not only calculate the total volume of water which will be available, but many other parameters, which are required for civil engineers, and like wetted perimeter and many such parameters.

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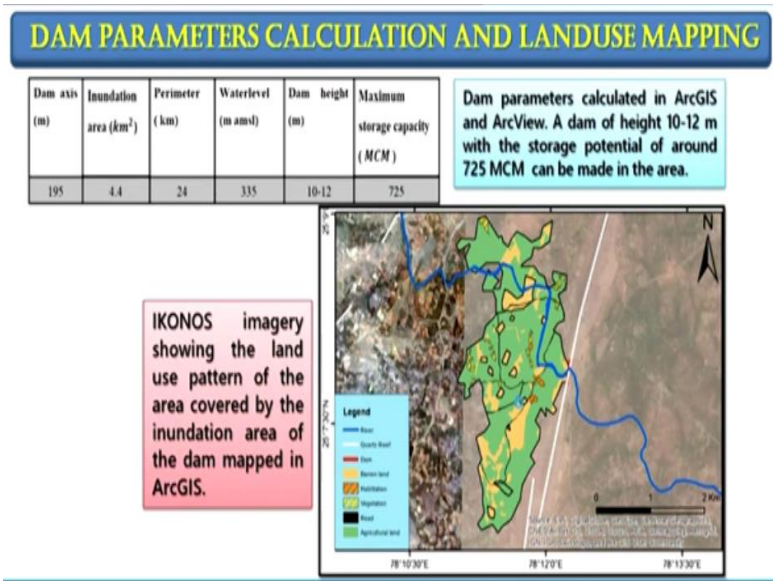

Which I will be showing very quickly like inundated area, perimeter, water level, dam height, maximum is storage capacity all those things can be predicted can be estimated before a reservoir comes and then decision makers can take appropriate decisions. Once that is there also some other things can also be done like using latest satellite images and maybe of relatively high special resolution or moderate resolution.

We can also prepare land use map that if at all a reservoir comes in this part of the country, then what is going to be inundated area, how much area and which area, whether it is

inundation will happen in the agricultural land or in a wasteland or in a built up land in a choice is there and then we can shift this reservoir elsewhere, where we will have less disturbances for human and more benefits.

So doing such simulations on GIS platform and we can decide the best sites and for identification of groundwater recharge also we can also know before and all those parameters which are required to decide about a groundwater recharge structure like a small check dam and also we will know what land use we are going to submerge in the submerged area. So, likewise such analysis beforehand can be done this is this kind of modeling is possible.

One example I am showing here and if this is done, then as I have been saying that in 2 to 3 years time in hard rock terrain in Bundlekhat condition and the problem of water can be solved quite easily and so, what are the possibilities of employing remote sensing and to some extent the GIS so, total geo informatics.

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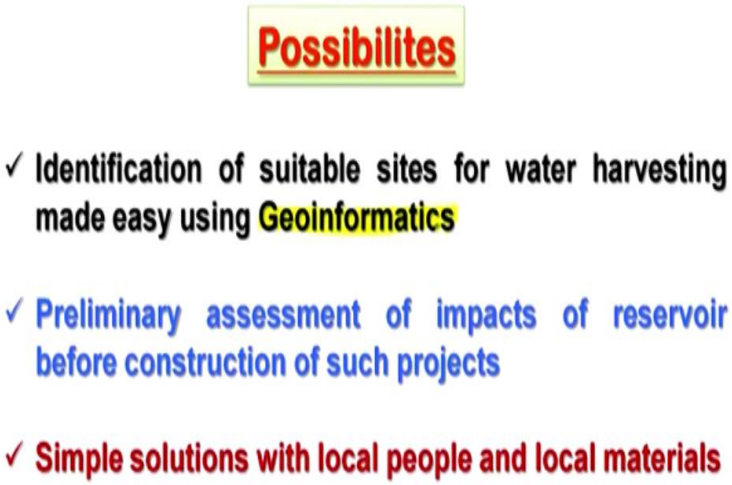

That it is possible to identify suitable sites for water harvesting or groundwater recharge and preliminary assessment of impact or reservoir before construction or such reservoirs is also possible. If they be imply and remote sensing data and gather the knowledge through the analysis of the images of the same area by which we get the local knowledge because the knowledge which I get about Bundelkhant cannot be directly applied in a part of Maharashtra, Gujarat.

So, for developing a local knowledge, I need to study one need to study the satellite images of that area where things should be implemented. Because here the benefit are coming in maybe differently because geological conditions, topographic conditions are completely different. So, therefore, the locally the knowledge should be gathered that through and they should be gained through the satellite analysis of satellite images.

And then such adjustments before construction can be done simple solutions with local people and local material is possible to solve this groundwater problem of the country. So, this brings to the end of this discussion that how remote sensing and GIS or overall geo informatics can play a major role to solve groundwater problem or water problem domestic, water for domestic consumption problem in 2, 3 years time even in hard rock during like Bundelkhant or in many parts of the country. So, this brings to end of this discussion. Thank you very much.