Remote Sensing Essentials
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Lecture-11
Prominent Characteristics of IRS, Cartosat, ResourceSat Sensors

Hello everyone, and in the previous discussion we have these 3 satellites comparison Landsat, SPOT and Sentinel and there we also discuss their prominent characteristics. And now in this current discussion we will be focusing on our own Indian satellites and their prominent characteristics and we will be comparing them especially about IRS Cartosat and Resourcesat sensors.

So not only their satellites emission and the sensor especially our aim is to focus on sensors here and which are on board of different satellites of Indian origin.

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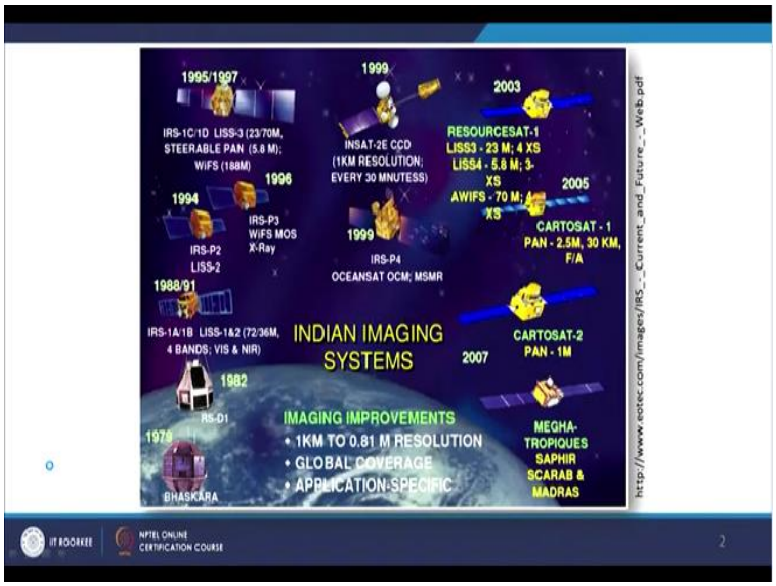

And that we are having a series of satellites as discuss also earlier but I would like to focus on this IRS-1A/1B and then IRS-1C/1D as you can see that and things have improved. They had 2 scanners LISS 1 and LISS 2 and a 72 meter and 36 meters space resolution in LISS three that things have improved 23 meter and 70 meter resolution and at the same time we also have a steerable pan at 5.8 meter resolution.

And one more sensor in is IRS-1C and 1D was added but this at 188 meter resolution in between IRS-P2 and IRS-P3 were also launched and then in 2003, a new series started coming which is Resourcesat, which has again this 3 scanner as same as IRS-1C 1D and then this 4 scanner at 5.8 meter resolution, this was also there, then a Cartosat series and the main purpose of this series was to have a complete coverage of the globe using a 2.5 meters resolution steropairs and then Cartosat 2 also came and that about 1 meter spatial resolution.

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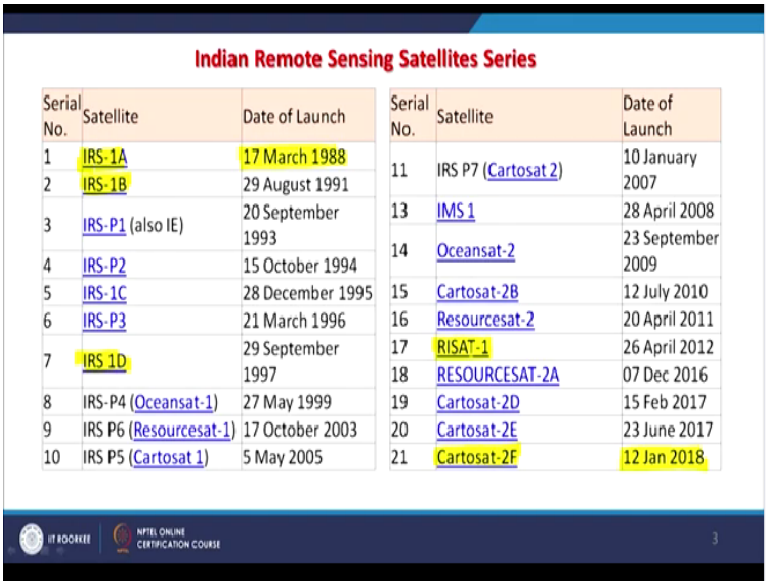

So, a lot of development has taken place in Indian remote sensing satellite systems. In summary, all these are listed here, starting from IRS-1A. So, that was 17th March 1988 was a beginning of a new era of Indian remote sensing satellites. And it is continuing, things are still like Cartosat-2F was launched in on January 12 on 2018. So, it is a continuous progress is going on, there is always one satellite or another or sometimes 2 or 3 in space to cover different part of EM spectrum.

And sometimes in tandem or also and like I have been IRS-1A and 1B they were also designed in tandem IRS-1C 1D but D had developed some snags and problems at very early stage. So life was very much shortened. Also RISAT-1 which is radar remote sensing satellite, RISAT- 2 will be launched in the year either end of 2019 or 2020.

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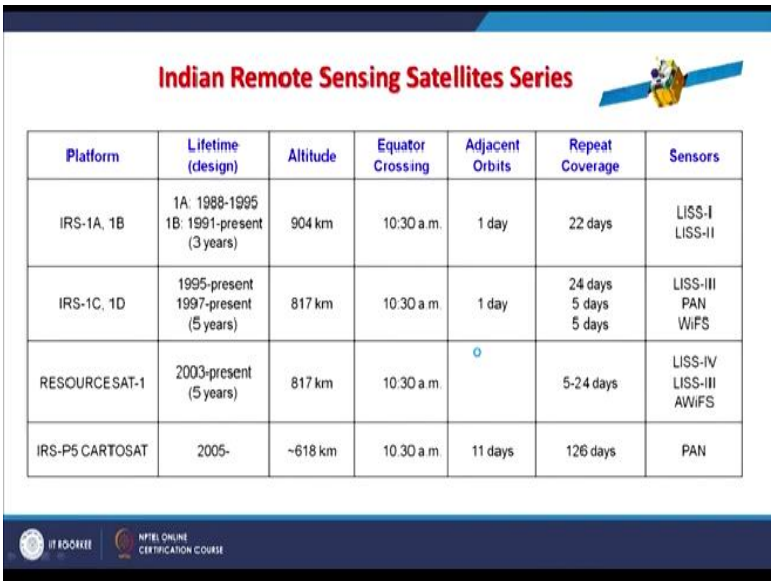

Now, when we compare the bands and other details. So, what we find that IRS-1A 1B, it has 2 sensors LISS 1 and LISS 2 repeat cycle was 22 days and this was the altitude and things changed little bit and these were put in little lower orbit like Resourcesat an IRS-P5 much this just 618 kilometer and it has only the pan because we wanted to have a higher space of resolution. So, this was the design like this.

And repeat cycle also if it is a steering wheel then it is possible to have repeat repeativity or repeat coverage within 5 days also. Otherwise, like in case of IRS-1C 1D the repetivity was on 24 days and in Cartosat because the resolution improved very significantly and therefore, and this repeat coverage also reduces. This point we have also discussed earlier and one is that if spatial resolution is relatively coarser like in case of NOAA AVHRR then repeat coverage maybe 2 times in a day.

But if you go for higher and higher space resolution that repeat coverage and the well though the number increases, but the revisit time and becomes very large like in case of Cartosat-P 5 it is 126 days. So, because the swath becomes very narrow and in order to cover the entire globe and come back again to the say first track or first orbit, it will require 126 days.

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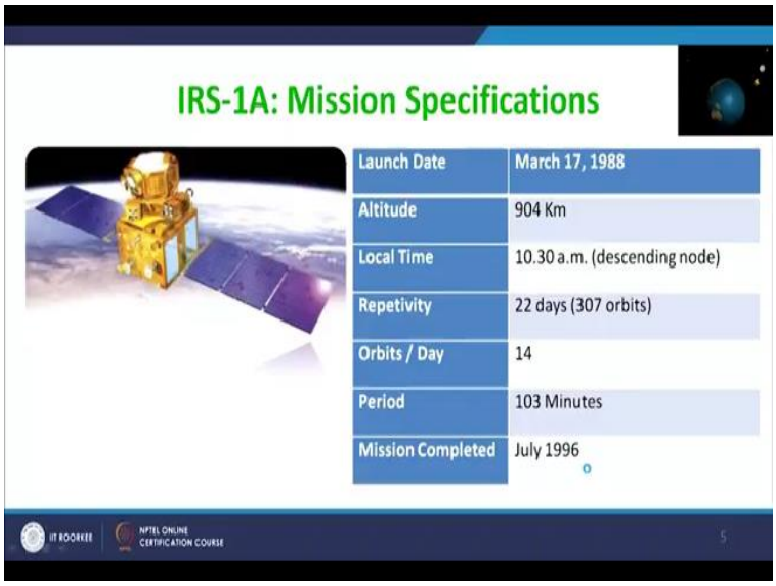

So, IRS-1A mission we have already discussed in previous discussions so I am not going to focus.

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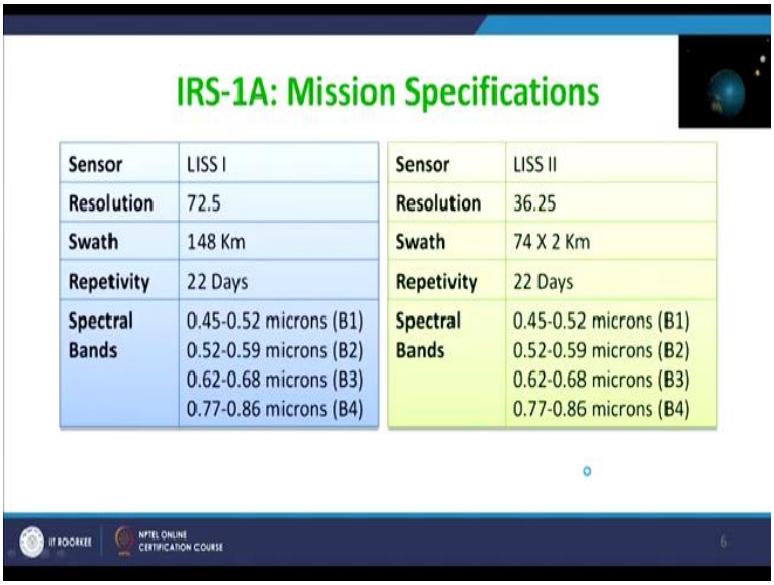

What I would like to focus on sensors itself LISS 1, LISS 3 and as you can see also the spatial resolution varies 72.5 to 36.25 and then swath as specialization improves the swath reduces the repeat cycle remain same repetivity and bands are also same in list 1 list 2.

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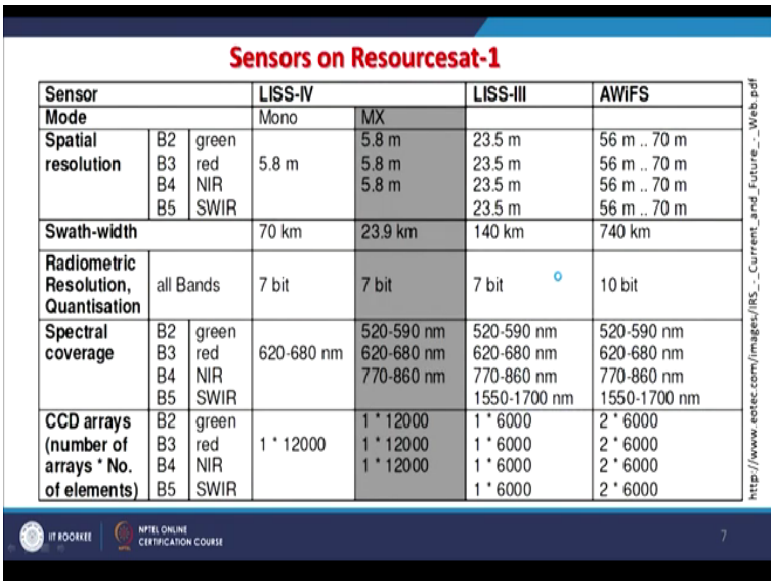

When we compare LISS 3, LISS 4 and AWIFS then of course on this for we had a monochromatic or photo panchromatic camera or panchromatic capabilities, a resolution was much more better 5.8 meter in case of list A it was 23.5 meter, and therefore, the swath width also reduces in case of list 4 just became half as compared to list 3 and AWIFS of course is a much more course of resolution satellite 70 meter spatial resolution 56 to 70 meter.

So, the swath is worth much more and obviously, that repeat cycle will increase they will improve and the data generally 7 bit that means the pixel values within an image can have maximum variation between 0 to 127 or total number of variations of 128 and generally in like in landsat series the 8 bits is more common and for the radiometric resolution, whereas in case of AWIFS it is a 10 meter resolution.

If I compare with the NOAA AVHRR then the NOAA AVHRR provides at 11 bits. So, it depends on the resolution, as well as the requirements and of course, the sensitivity of those sensors which are on board of and different satellites, spectral coverage this 0.62 to 0.68 micrometer and in different sensors, we had a different coverages and if we see the type of scanner, then these are long trackers scanner CCD arrays

And a number of elements by 12,000 elements were there. So, in one line will have 12,000 pixels in case of list 3 we had 6000 again in case of AWIFS 6000. So, the point which came in earlier

discussion is that more number of arrays are there more challenging to calibrate them and make them functioning in identical manner. But these are the things which are obviously done before the launcher these all satellites are especially about the sensors.

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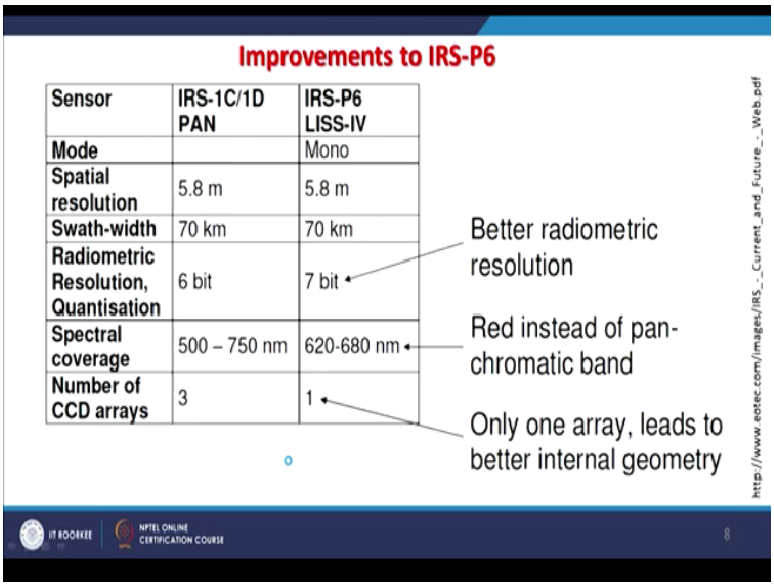

And when we compare IRS-1C PAN in LISS 4 that is a panchromatic or mono resolution wise the same, the swath width was same, that improvement the list 4 was the 7 bits. So 6 bits means 0 to 63 total number of variations an image can have of 64. But when we go for 7 bits it becomes just double though it sounds just 1 bit extra, but 1 bits extra becomes double that instead of 64 values total values we can have now 128 values.

So obviously lists 4 had the better radiometric resolution and spectral recoveries was a little different for both number of arrays. In case of pan there were 3, in case of at LISS 4 there were 4, so, only one array leads to better internal geometry. So, in that way it was quite improved system is compared to IRS-1C 1D panchromatic and here the red or visible part of EM spectrum the red instead of panchromatic band was used in case of list 4.

And these were these bands will be located what should be the resolution depends on 2, 3 factors one is for what purpose these satellites are being launched or designed and experiences of past experiences and whether the data was used for what kind of purposes what is the demand by the users and accordingly these things are done. So that exercise is always on that if we need a

particular band in future sensors, then we should justify and get that demand. And these organizations like ISRO and NASA, they tried to incorporate in their future sensors.

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Just to give you a comparison of 5.8 meter resolution 7 bit and 70 kilometer swath and that is the red band of EM spectrum in a mono mode means in black and white of list 4 and this is a IRSA again list 4 5.8 7 bit and this is 70 kilometer, but this is color composite and whereas it is of course, the location is different this is Milan and this is Palm Island images at a 5.8 meter resolution when they are fused with the multispectral data of course, a resolution this kind of merged product or fused products can be created like this for very famous Palm Island of Dubai.

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Few more examples of IRSA AWIFS which is relatively very close resolution, very famous lake Manasarovar lake is there. Of course this is colored image and part of Myanmar coastal area and the sensor IRS-P6 and sensor is LISS 3. Of course this is multispectral scanner. So you get a very good discrimination for vegetation and other things here hardly you find any vegetation so therefore you do not see though this is also a color composite.

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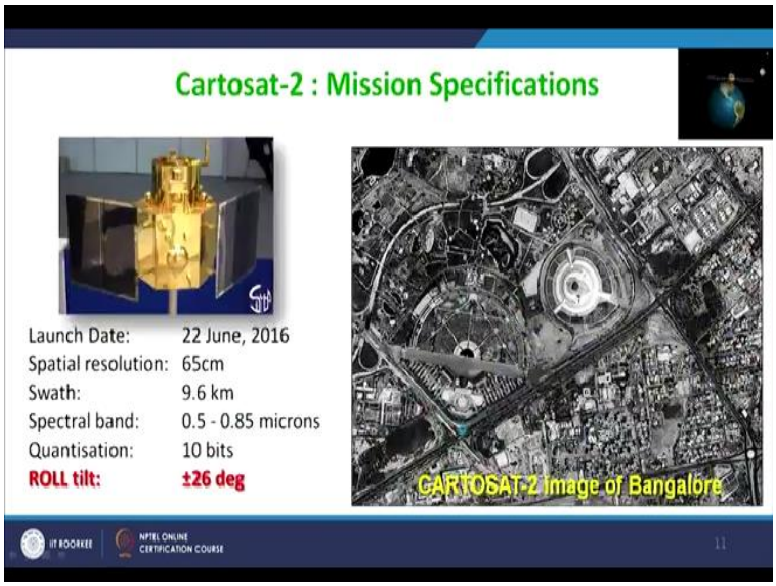

And in Cartosat, Cartosat became very popular because it has the capabilities this radiometric resolution was also very good and it has capabilities of acquiring data in a stereo pair and very much innovation was done and see the space of resolution. Now we are talking about 65 centimeter in Cartosat-2. So the best part here that for stereo images in a SPOT.

And these sensors used to look the sideways and in order to have a one stereo pair for common area and suppose the satellite is over passing on day 1, and after 28 days when it overpasses on the covering the same area, by the time there might be clouds and therefore the stereo pair becomes almost useless. So one image is having no clouds and another image is having clouds.

And the time difference is also 28 days or 22 days depending on how orbits have been designed. So in order to overcome this problem, instead of looking side forward and backward cameras we have took. So, at the same time within few seconds 2 pair or 2 images for 1 stereo pair were

acquired by Cartosat satellite. So, that was the very good innovation, which was done with our satellites.

So, for and after a means looking forward and backward and with the same angle and they along the direction of your orbital flight path, so, when this situation was there, immediately within few seconds, the data was acquired of the same area with 2 different angles. And once this is stereo pair is ready, then one can use to using photochromatic techniques, one can develop a digital elevation model that to add a very high spatial resolution.

It became possible and also, let me add here like I mentioned earlier for Google Earth, which provides the; of landsat another satellites, there is a similar kind of product for in India also and that is called Bhuvan. And in Bhuvan you can have, you know, digital elevation models prepared using Cartosat data at 5 meter or 5.6 meter resolution that to available free of cost. So, many part of India have been covered and that data is available.

So, those who are interested for free digital elevation models of India at a very high resolution, relatively very high resolution then Bhuvan is the portal from where the data can be downloaded also, the data of 3 years old or more can also be downloaded of different sensors IRS and LISS 3 LISS 4 on so on so forth. So, that archive is also available, maybe in future like in case of landsat the data is immediately become available for download.

Maybe in future are very slow may provide that kind of facilities for users to download data once that data has been acquired by the satellite rather than putting data after 3 years of acquisition. So this; another thing is this at 26 degree, and this angle was used for the stereo pair data. But the important point here is that simultaneously the stereo pairs are being created. So, the issue of time difference between 2 images was not there and at very high resolution.

Of course, the swath induced to only 9.6 kilometers, so, very narrow swath does not matter. It is very, very useful.

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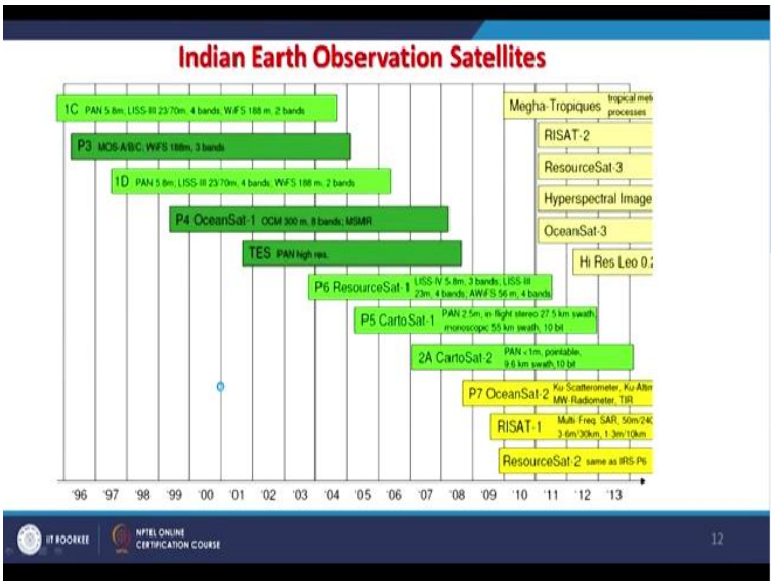

And it also this is a short of in brief, the history of some of our remote sensing satellites here, that is starting from IRS-1C and then 1 D and of course then Oceansat, TES, Resourcesat, Cartosat is there, Carotsat-2 is there then RISAT and that is radar remote sensing and then resourcesat-2 also there. So these are the years and which are given on x-axis and this is how one can.

Now the future satellites which will be coming the RISAT-2 I am already mention Resourcesat-3. And maybe in future we are going to have hyperspectral images from our own Indian remote sensing satellite, high resolution Leo satellites and low Earth orbit satellites might be possible in the near future. And so there were already a series of Indian satellites in future it is going to continue and hopefully we will have very high quality, very high space resolution and a multi spectrum data from various Indian satellites.

So this brings to the end of this discussion about you know, silent characteristics of our own Indian satellites, IRS Cartosat and the Resourcesat satellites, thank you very much.