Environmental Impact Assessment
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Lecture 42
EIA Methods – Coastal Ecology and Geomorphology Part I

Welcome to the course, Environmental Impact Assessments. In today's lecture, we are going to look at the EIA methods, particularly with the coastal zones, how you deal with the coastal areas, and what kind of tools and techniques you use.

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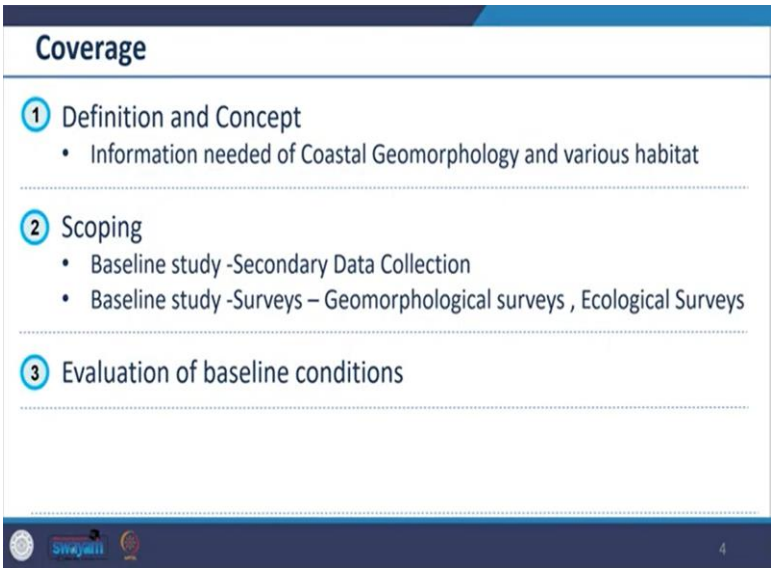

So accordingly, our coverage would include that. We will first look into definitions and concepts, and then we will look at what kind of information is needed for coastal geomorphology and how you look at various habitats. And then how you work on the scoping part. And then what kind of data has to be collected for baseline study, the secondary data is required, as well as what kind of surveys have to be undertaken related to geomorphological survey ecological survey.

And then how do you undertake an evaluation of the baseline conditions, what you have studied? So that is what we are going to cover.

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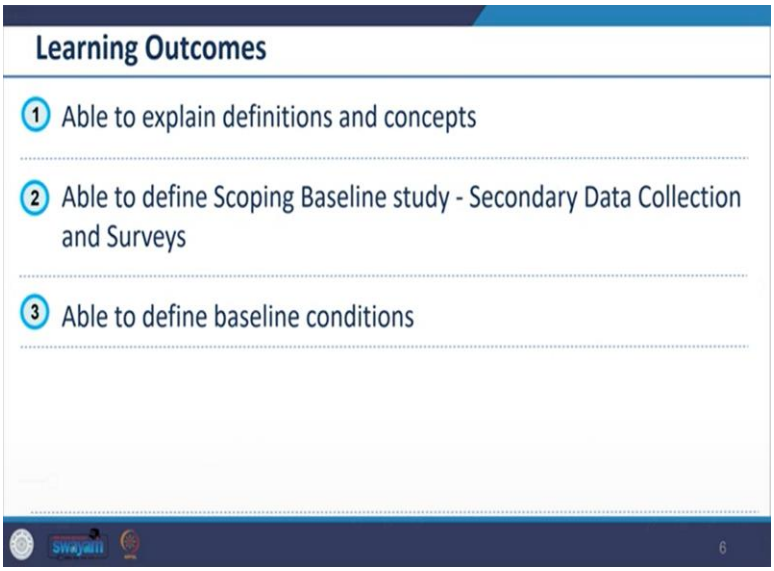

The learning outcome expected from you after completion of this session is that you should be able to define certain key concepts and items in this. Then you should be able to list various information that are needed to undertake coastal geomorphology and various habitat studies. Then you should be able to review the purpose of scoping when you are dealing with coastal areas. Then you should be able to identify various secondary data sources that will be required for you to undertake a baseline study.

As well as you should also be able to identify and select among the surveys that are available for geomorphological survey and ecological service. And then you would know the basic concepts and the process of how you evaluate the baseline condition. So that is the expected learning outcome. So moving on, to the definitions and concepts. So one, keeping in mind the key idea that coasts are among the most dynamic parts of the Earth's surface.

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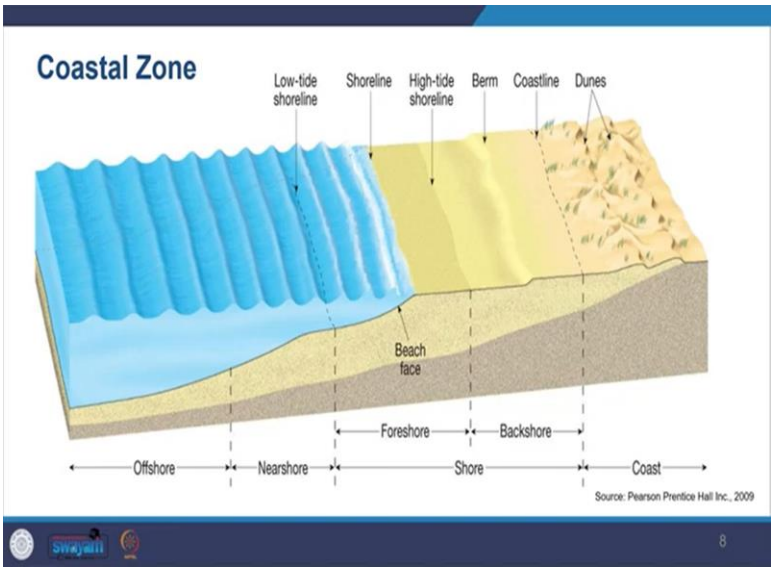

So you see that their boundaries keep changing, they keep changing, they are going on transforming all the time. And then they change as the shoreline changes and the shoreline changes almost every day with the tide. And you also see seasonal variations, and you also see variations in the geomorphology itself.

You see that the coastal landforms are shaped and reshaped even by the winds, waves currents and which in turn also vary through time the geomorphology varies and all these keep on constantly changing. So, here you see the entire coastal area and all the terminologies.

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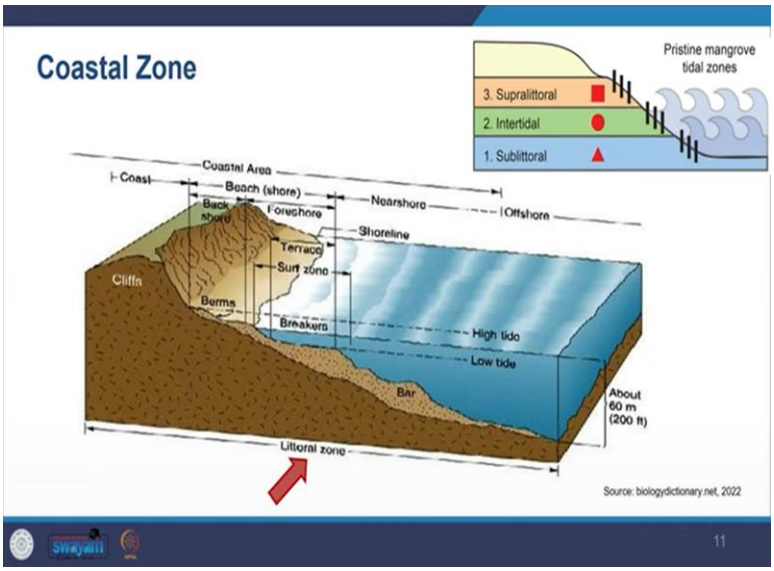

So looking at the Supralittoral term, so Supralittoral is above the high tide mark and is usually not underwater. So you can see in the image that the area shown in the arrow is the area we are talking about. And then you have the littoral zone, which is the part of the course that is exposed, wherever the water level is low, and it is submerged when your water level is high. So it is the Intertidal zone. So which is the littoral zone, you see here?

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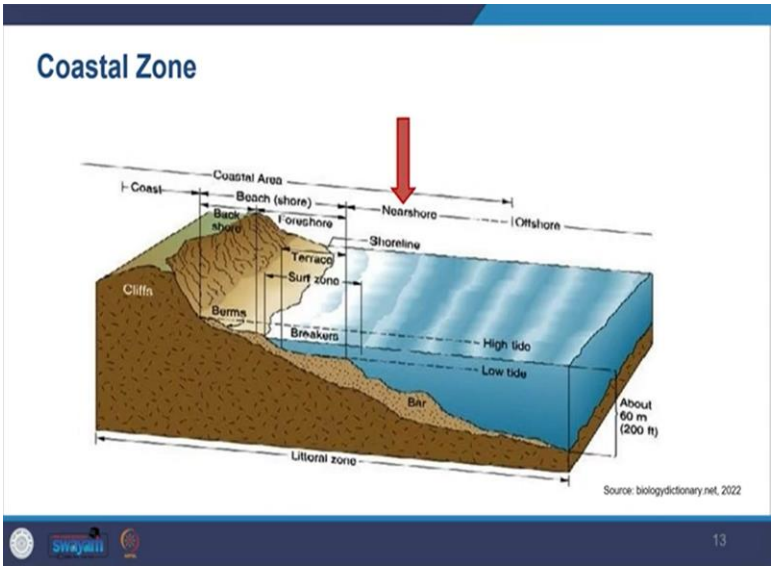

The near shore. The sublittoral zone is the coast seaward of the littoral zone. So it is on the seaward side to the water depth where sediment is not disturbed during fair weather conditions. So there is no disturbance in the sediments there. So you see that in the image. The habitat and communities within all these three zones, we are looking at, are influenced by the geological and geomorphological process in the area.

So whatever happens, how is the geology, how is the process, all that habitat and communities vary with that and it has a great influence, all these geology geomorphological processes has influenced on that.

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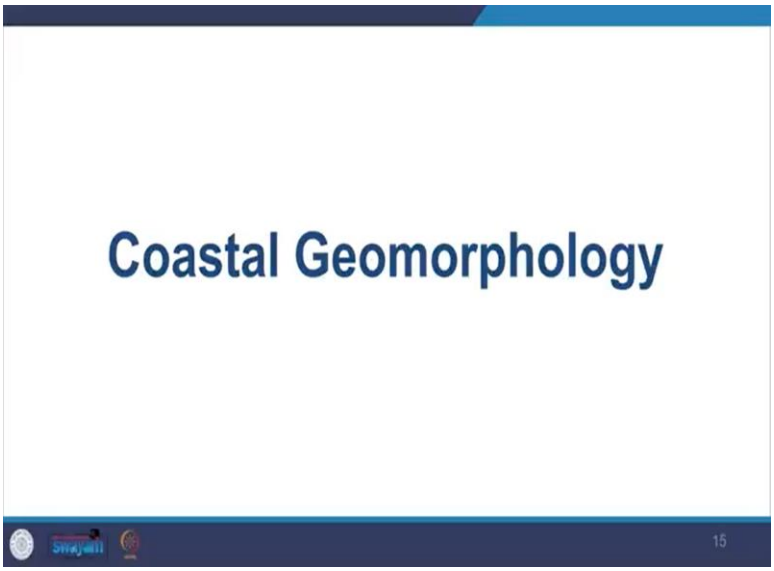

So, looking at the coastal geomorphology. So, this coastal geomorphology is very important in EIA for two main reasons.

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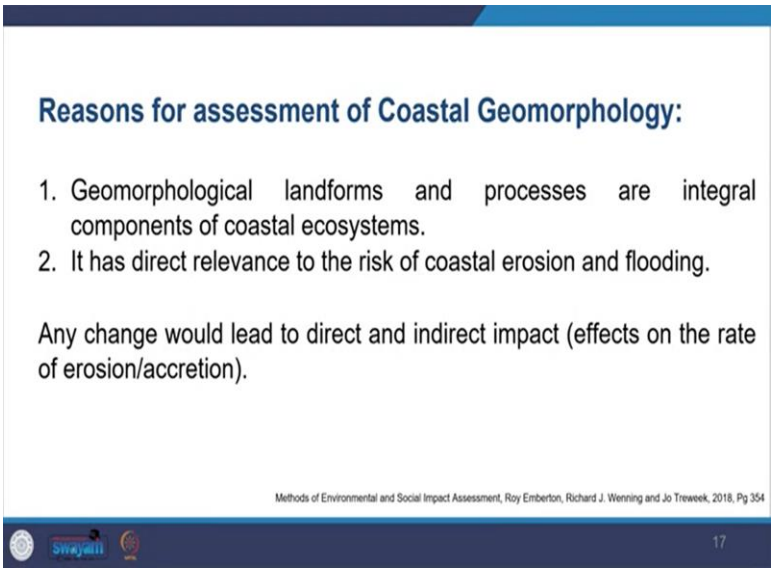

So, we see that geomorphological landforms and processes are very like they are part and parcel of the coastal ecosystem. And they have direct relevance to the risk of coastal erosion. So, whatever, the processes are, and the forms are, so, they eventually influence coastal erosion and flooding. So, it has a very direct implication in EIA.

So, any kind of change in this would lead to direct and indirect impacts since it has a relationship with the risk of the, or in the coastal area. So, you would have erosions and all flooding, all this can happen here.

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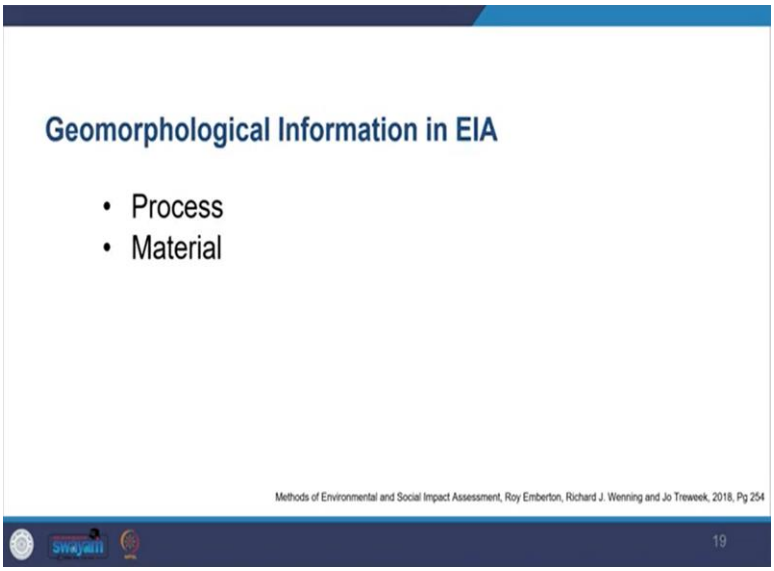

So, for EIA, if you look you need two geomorphological information, that is, one is the process and the other is the materials.

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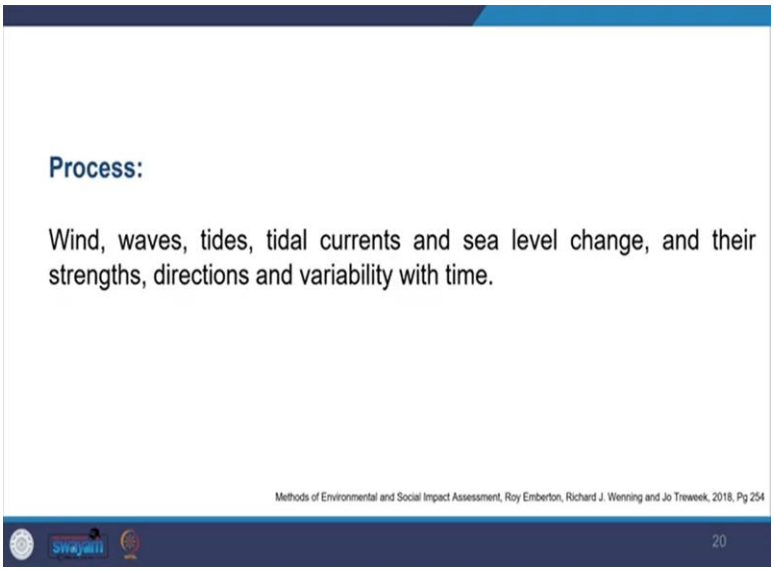

So, for the process information, that includes, like you look at Marine forcing factors which are present in the process, like what is the, you look at the wind, waves, tides, tidal currents and sea level change. And you also look at, like their strengths, in which direction they are going, and then how do they vary with time, how the variation is. So, you look at all these trusses. So, it is important when you're undertaking EIA. So you look at these aspects of the process while looking at EIA.

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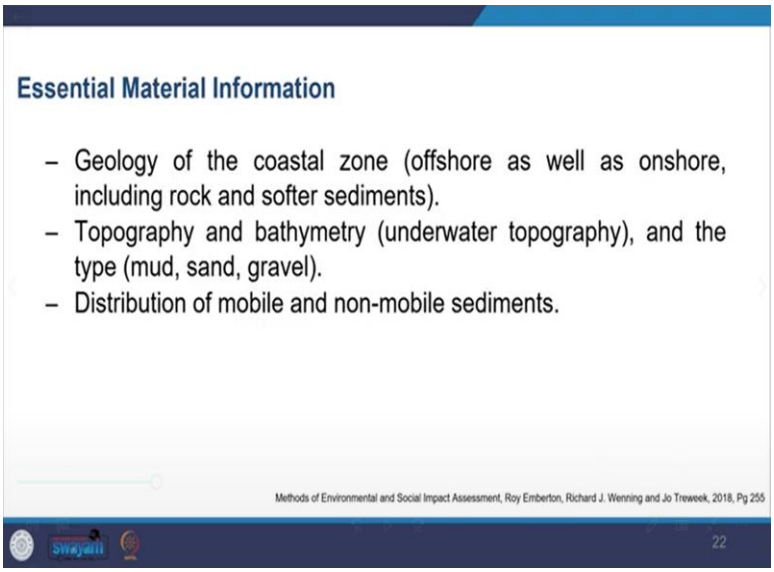

So, the other, you see is, I said, the material information. The important material information, which you require for EIA purposes is the geology of the coastal zones. Such as, if you look at the, how is the geology offshore, what is the geology onshore? How is the rock, how are the sediments of the sediments, and so on?

You look at the topography, you look at the profile of the land, like what all is there, and what is the shape profile of that land, and then you look at the underwater topography, which is also called bathymetry. So you also look at that. And then you look at the types, like what type you have, you have mud, sand, gravel, and all.

And then the distribution of mobile and non-mobile sediments, the sediments that are moving or they are stationary. So, you need to have this kind of information.

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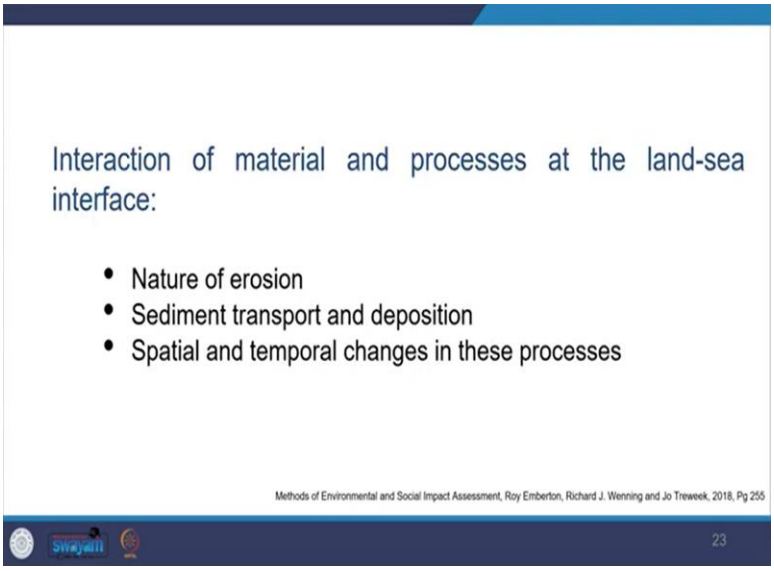

You must look at the interaction between the material and the processes at the interface, land, and sea interface. So, this would mean that you have to look at what kind of erosions are happening, what kind of sediment transports are happening, and what kind of deposition is happening. And how it is happening across the area

spatially, and how it is happening across, at different periods, what kind of changes are happening, temporal changes are happening in these processes. So, you need to look at this information.

So, while looking at coastal geomorphology, the interaction between the physical process of the wind, waves, tides, and tidal currents, becomes very important. And they erode, they transport and deposit sediments to create landforms. So understanding that is very important.

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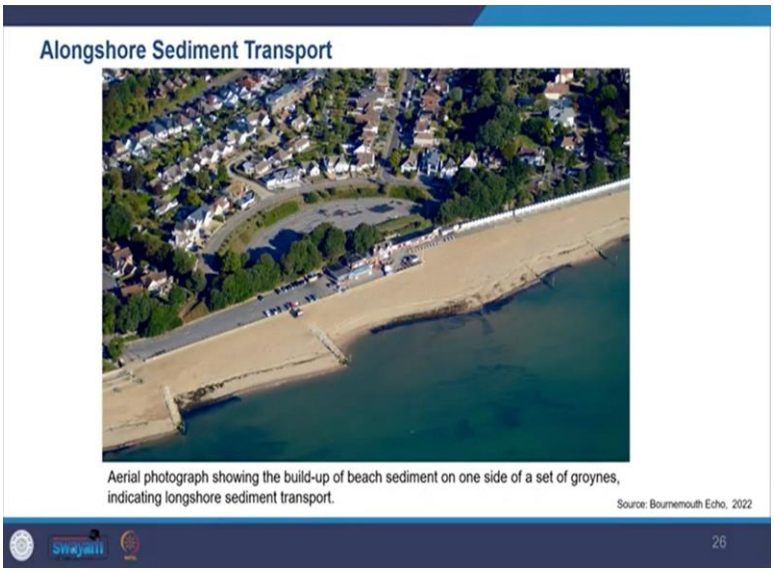

You need to review that alongshore sediment transport in the EIA process, so, how is the sediment transport happening along the shore, and then what kind of net transport direction can be established, what is happening and that you can do through field survey, field criteria, you need to consider several parameters.

And for that, you can have a buildup of, you can take observations of the buildup of sediments, which you can see the cross-shore structure and alongshore growth of spits. We are going to see what spits means. So, by the observation of the shoreline, you can also understand how the transportation, in which direction the transportation is happening. So that allows you to understand what's the real characteristic of this place.

Further, you can also undertake modeling, numerical modeling can also be done to understand how the sediment transportation is happening. And you have a wide range of models available for the purpose. And process of sediment deposition leads to a variety of coastal landforms. And then the most of which is, so looking at some of the landforms because of the sediment deposition.

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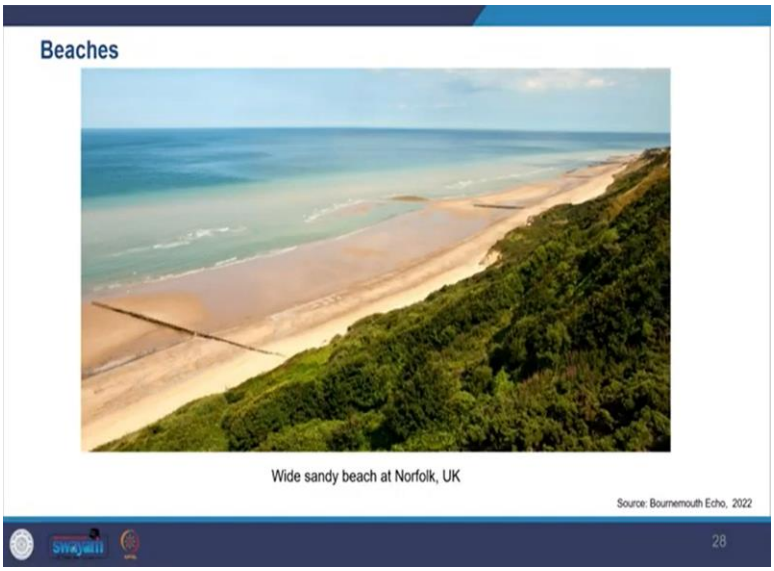

You can look at the beaches, you are familiar with beaches. So that is one of the landforms. So, you will see that it is the accumulation of loose sand or shingles that change shape in response to changes in wave energy. So that is the beaches. A beach can maintain itself in a state of dynamic equilibrium with its environment due to the mobility of its sediment, so sediment is constantly moving. So that is why it can maintain the dynamic equilibrium.

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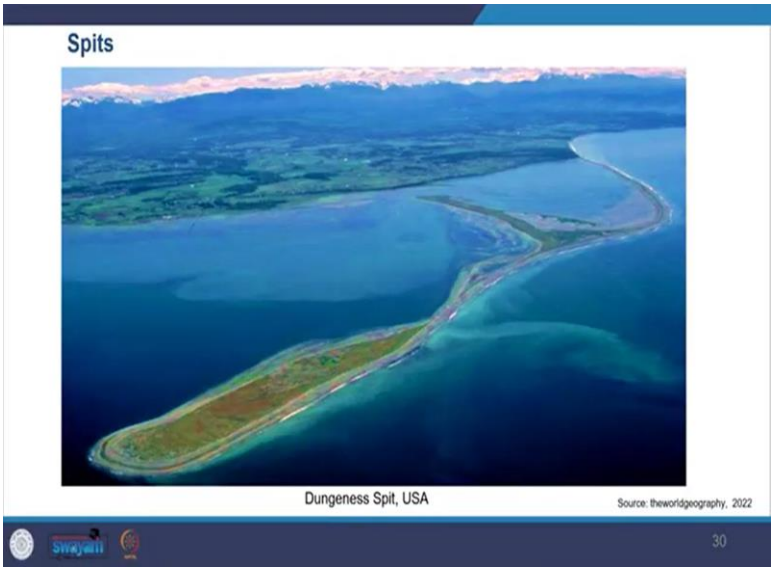

Now looking at spits. So, spits are something when a coastline turns abruptly landwards. So, the coastline is not looking towards the sea, but it is looking towards the land. So, that is what it spits. And you can have various forms, as you can see in the picture. Generally, spits are connected to the end of the attached beach by a narrow neck and are fed, and then they are, they regularly get sediments eroded from other areas and get the transport, like as per the transportation system there.

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Then another term you can look at is dunes. So, from where the supply of dry sand and wind move, it exists together. So, you have dry sand and then the wind, they come together. So, dune systems are usually fronted by sand beaches, and sand bars exposed at the low tide. So, that is the dunes, and their development and maintenance depend to a large extent on the vegetation which allows stabilization of the sand. So they are also important.

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Then you also have muddy shorelines. And you will see the additional lines are common along the upper level of the intertidal zone of estuaries and shelter tidal zones. So, you see that in the figure. They form where tidal currents velocities are too weak to re-suspend completely the mud that settles out at a higher water slack. So, that is the muddy shorelines, you see that. And you see that in all of these tides, the central feature on which the habitats function.

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So, further, you also see that you have salt marshes and mud flats, which are also important for flood defense and all. They are important because they dissipate wave and tidal energy. So, they reduce those things, they reduce the wave and then they reduce the tidal energy. And when they reduce it, they also reduce the chances of erosion. So, that is why they are important.

Salt marshes and mud flats are set to have very high natural value and they also support a large population of invertebrates and birds. So it has a lot of significance. So all of these systems depend on the continuous supply of sediments. So how those sediments are coming and coming from the river which is, which discharge or the coastal erosions and so on.

So, which can be interrupted by activities such as coastal protection works and dredging. So, any kind of changes in the sediment supply can also cause downdrift effects. So drowndrift effect is the impact on the lease side of the coastal activities and it also causes downdrift erosion.

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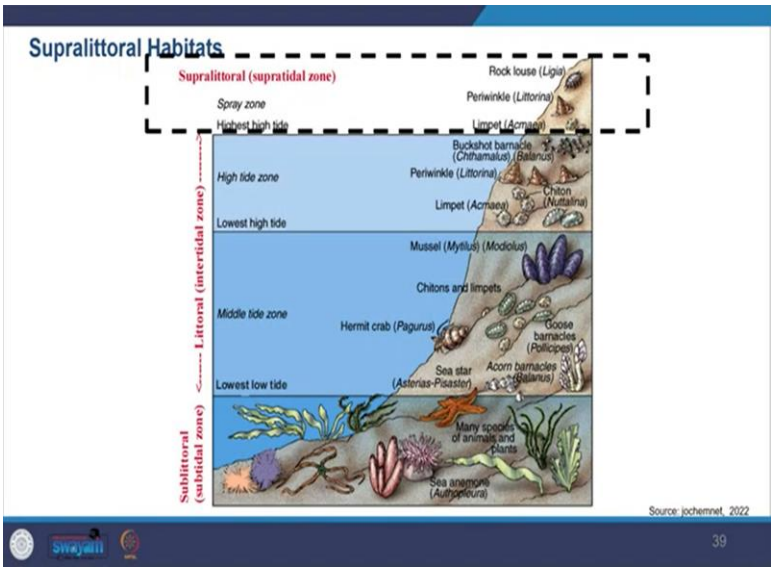

So, now looking at what kind of habitat exists in all these three layers we talked about.So Supralittoral habitat, so that is the image that we saw. So it is the level about the limit of the extreme high water spring tides. And this Supralittoral zone supports a lot of terrestrial vegetation. It is mostly near littoral locations which are affected by wave splash and spray.

So, you would see the salt-tolerant plant species, and they would often dominate the vegetation community. So, because the waves are coming, and then it is spraying that area, you would find that there are salt-tolerant plants near those areas. So, this Supralittoral zone includes several important habitats including coastal cliffs and vegetated shingles, so you see them.

And then the coastal cliffs and slopes, they also vary a lot in character. They show the local geology, landform, and many processes ranging from vertical to gently sloping. So you would see all these in the coastal cliff. These features support, like a lot of habitats, and you would find like a rock, perverse and ledges, see pages, coastal grasslands, heat lands, and scrub and all. So this range of variety which you see in the coastal cliff.

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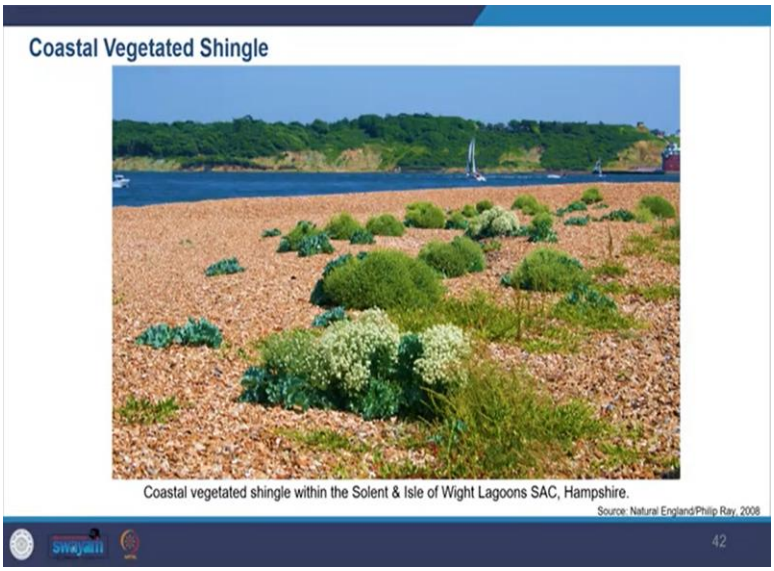

Then you have vegetated shingles. So, you see these scrubby vegetation or grass sward. And in the exposed areas, you have open vegetation and scattered vascular plants and lesions which you can see here. And if you note that this habitat is particularly sensitive to human disturbances, and if they are damaged, it is said that recovery is very slow.

So, one has to avoid those damages there. Then you also find dunes, which typically consist of several dunes aligned approximately parallel to the coastline. They are said to be a very complex system that includes a range of habitats that are sensitive to disturbance.

So, supralittoral habitats are usually like after that you have agricultural land or then developing land, you would find that. And like, you would have various land use, industrial, residential, and so on. If such kind of land use is not coming where human interference is there, then these habitats would create inland into fully terrestrial habitats such as woodland.

So if human interference is not there, then there are likely chances that you might have woodlands in this zone. So it might be like, it is said that it might be a little difficult to clearly define this area. So that is about the habitat in the supralittoral area zone.

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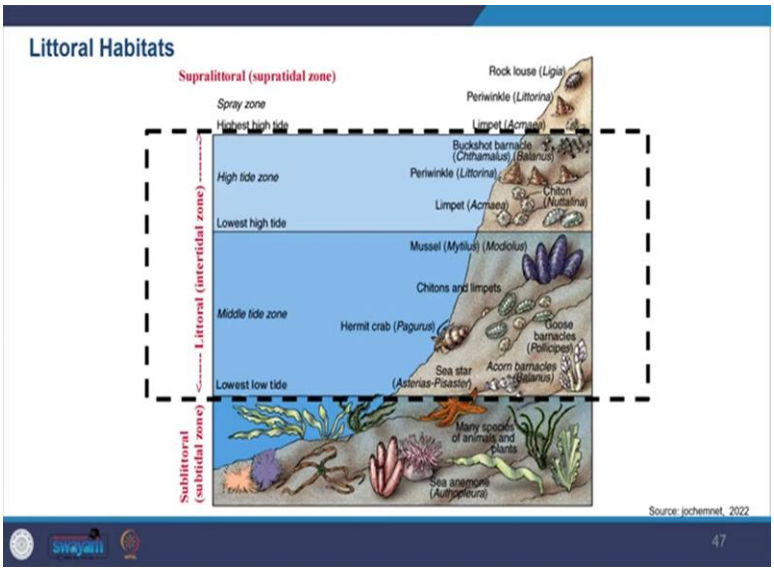

And now you look at the littoral habitat. So littoral zone, as we had seen, it is the, it is a very narrow zone. So you it is between the high tide and the low tide area. And you would see that you have steep shingle beaches or you can also have mud flats. You will see that in most littoral habitats, whatever species are there, which sustained in this particular zone, are mostly marine. They are much more adapted to the cyclic system, which is there in the marine cyclic system which is there. So they are very sensitive to that and adjusted to that.

So, the communities usually, which exist here, they show like, it is really how the entire area is working. So, it aligns itself with that. So, it is controlled by the kind of elevation it has, and how high it is from the water level, compared to how far it is from the water level. So, the depth makes a lot of difference to the littoral habitation. So, you would be looking at various substrate characteristics, and different pockets in these littoral habitats, and that will again depend on the geology landform type and what kind of exposure they have.

And you would also see that usually the mud accumulates in many of the locations and you would, wherever the exposure is happening, you might find different kinds of sediment deposition.

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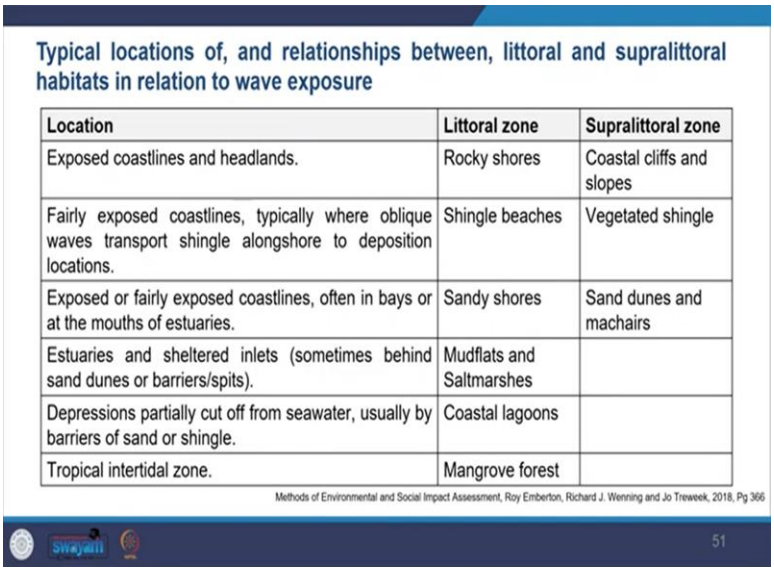

You would also see rocky shores, which are also important and they provide a very impenetrable kind of zone, so you cannot penetrate that zone. You see that very few organisms would be living there, but you would find that they support seaweeds, animals that are like really like to live on the rock surface. So this will also vary with the wave exposure and what kind of rock type is there. So, with that also there will be variations. So, you might be required to also look at different locations and then see if the area is coming in the supralittoral zone or littoral zone.

So, you would be looking at the exposed coastline and headlines and then you would find that there are rocky shores or in the supralittoral zone, you would have coastal cliffs and slopes, and then fairly exposed coastlines. So you would see that you have shingle beaches, and then in the supralittoral zone, you have vegetated shingles. Then, when you look at the exposed or fairly exposed coastlines in the base or the mouth of the estuaries, you would find sandy shores and then you would also see dunes and machairs in the supralittoral zone.

Then you will also see estuaries and shelters, sheltered inlets which in the littoral zone would have mud flats and salt marshes. And then in the depression, partially cut off from seawater, you would have coastal lagoons, tropical, intertidal zone you will find in the littoral zone, you will find mangrove forest.

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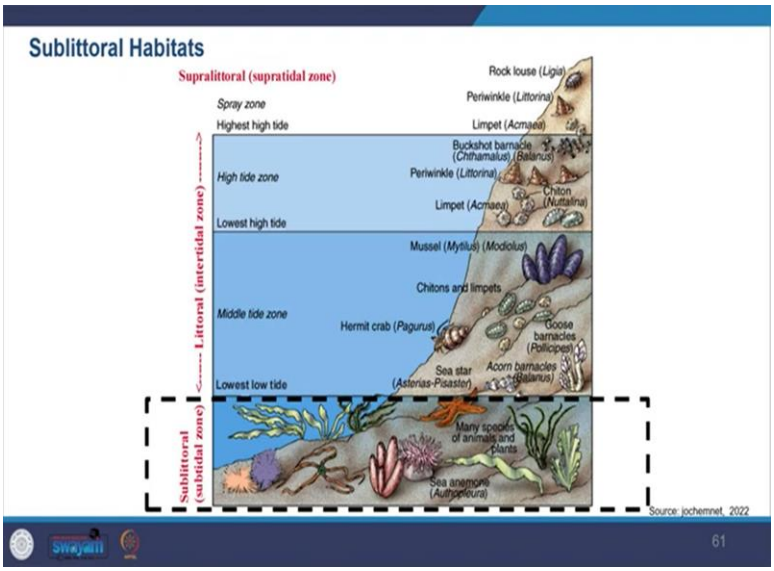

So now moving on to another sublittoral habitat. So this is the upper limit of the littoral zone where you have an extremely low water spring tide level, and the seaward limit is less clear. So where it ends, it is not very clear. So you can see that, you can include the shallow sea to the depth where sediment is not disturbed at all. So you can see where there is shallow sea to the deep sea, you can take that area as the sublittoral habitat. And you will see that the environmental fluctuation is very low in this littoral zone. And the seabed is very soft in this area.

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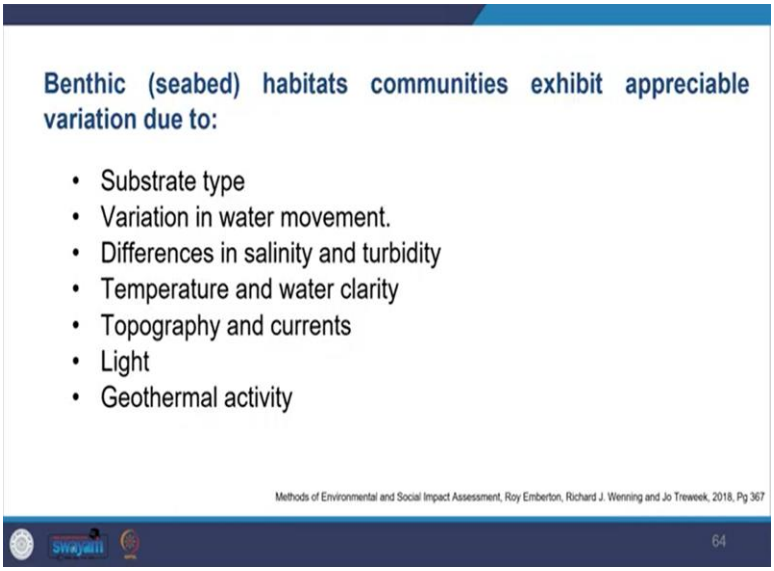

Looking at the substrate type of this habitat, sublittoral habitat. So this largely controls the range and types of organisms that are present in the area. And there are a lot of differences in the salinity and turbidity in this particular area. And then there is also variation in the temperature and water clarity. You would also see differences in topography and currents, light, and geothermal activity in this particular zone.

So if you see that the ecosystem of this sublittoral, an open seeker will depend on the flow of energy, how the energy and nutrients are flowing, what is happening in the food chain, based on all the kinds of activities and

the processes which are going on there. So we will not get into the details of that. So one needs to understand that these kinds of variations are there and how they vary across and how the habitat would vary, how the processes would vary. So that understanding is needed.

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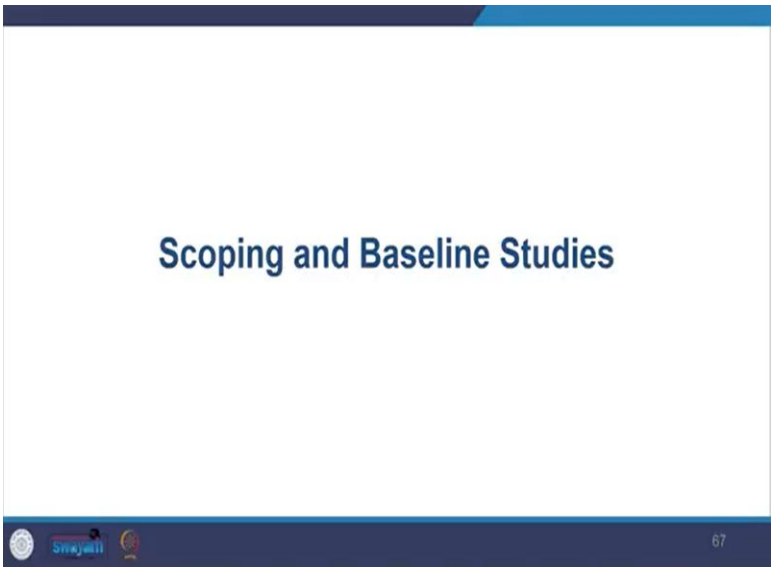

So moving on to the scoping and baseline studies.

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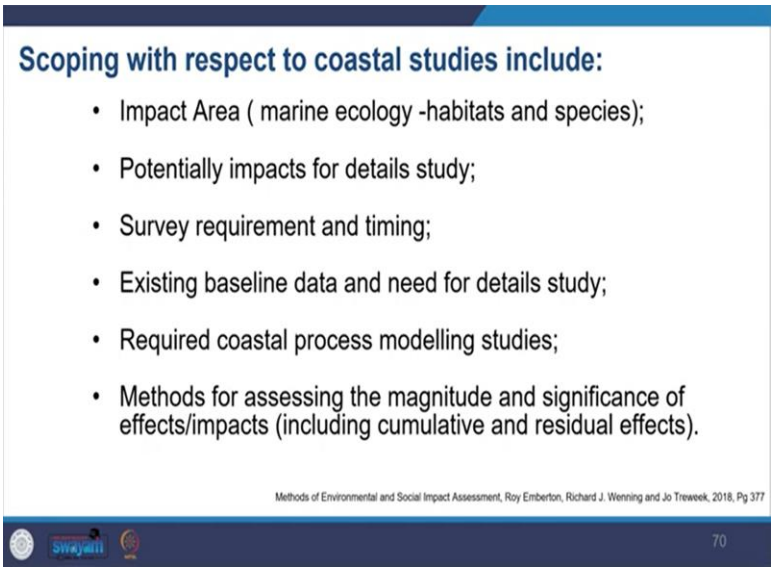

So while you are doing scoping, here you need to see that there are certain key issues that you need to consider in the scoping stage when you are dealing with the coastal area. So first, you would identify the impact area. So you would look at to what extent the impact of any development what you are doing will happen. And impact in terms of the marine ecology, you are going to look at. What kind of habitat, and what kind of species are there?

And then you would look at not only the area, but you will also look at the impacts. What kind of impacts are happening, what potentially significant impacts would happen, and because of that, what indications you are getting in the scoping stage so that you might have to take a later detailed study concerning that?

And then at the scoping stage, you would also decide the time of the survey, like when you are going to undertake this survey, depending on what kind of impact would be there, and what kind of area you have to cover. So, you also need to decide the time of the survey in which season you would do and in what frequency you would do it. Further, you would also see whether whatever the existing data, which is available the secondary data is available, is sufficient or not, and whether you will be able to determine any kind or draw any kind of conclusion from there.

And that would also help you to understand what kind of detailed study has to be taken. And in this stage itself, you need to also decide what kind of modeling study you would do if it is required. So, the modeling study for the coastal area can be very complex, very expensive, and it can be time-consuming as well. And then you also need to see what kind of methods you will be using for looking at the magnitude and significance of the impacts which will happen.

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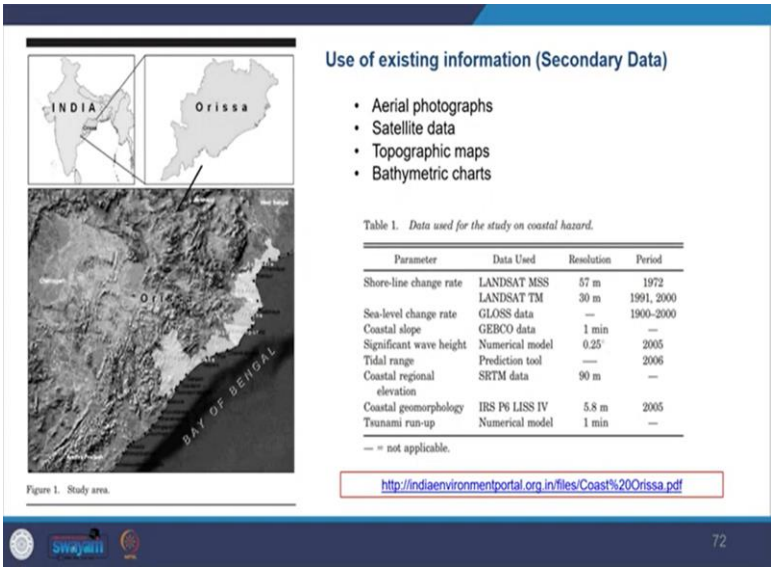

When you look at the secondary data, so, what kind of secondary data you would require? So, most of the existing information, you would see that now, aerial photography is most used, satellite data is more used, because you see that the coastal areas are wide and complex, and it is not easy to have any point data in most of the places. So, we are seeing that more and more use of aerial photographs in satellite data is increasing.

And you also need to have topographic maps, and also bathymetric charts have to be prepared. So all of these provide key information on the current and the historic morphology of the coast and then they allow you to identify what is happening. So, you can see what kind of trend is happening and what you can project and predict. So, here in this snip what I have taken from a study you can see what kind of data they have used.

So, you can see the shoreline change rate they have used data used as LANDSAT and sea level change rate, coastal slope and significant wave high tidal range coastal regional elevation and all that you can see SRTM data IRS P6 LISS IV data and then you have tsunami run-up, which is a numerical model which they have used

and then the resolution and the period for which that have done. So, I'll have given you the link from where you can download this study which is there.

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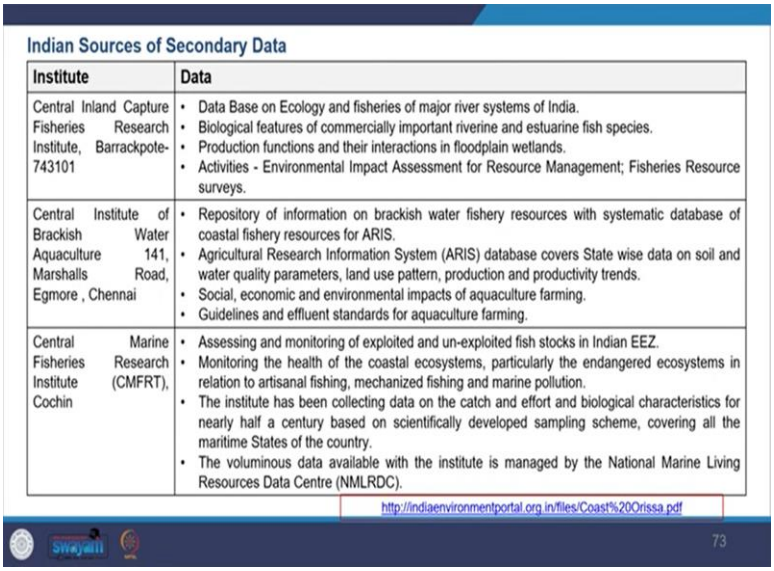

Further, through the manual of the shipbreaking yard, I have taken what could be the possible source of data. So, I have not taken all of that, but you can see some of these here. So, you have like Central Institute of Brackish Water Aquaculture. So they have like they keep a repository of information on brackish water fishery, Agriculture Research Information System they have, social, economic, environmental impact and guidelines, all these you can get. Then you have Central Marine Fisheries Research Institution, which again, keeps data.

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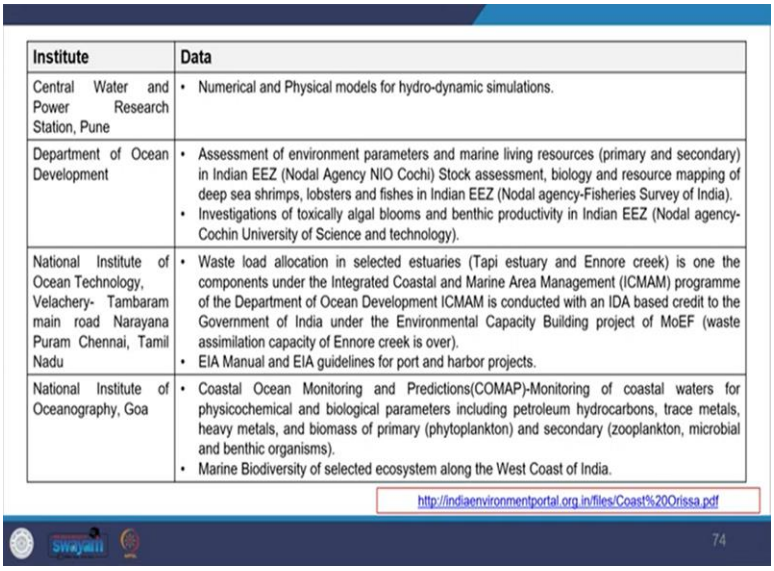

Then you have the Central Water and Power Research Station. They also maintain data. Then you have the Department of Ocean Development. So, you can see a range of data that they keep. You have environmental parameters, living resources, stock assessment, investigations of toxic algal blooms, and a coastal ocean

monitoring and prediction system. All these, you can use a lot of secondary data which has been constantly monitored.

You also have the National Institute of Ocean Technology, and you have the National Institute of Oceanography. So, all these are available in the Indian scenario where you can collect data for your further analysis and baseline study. Further, you would be required if only it is required. So, you can undertake the geomorphological survey. But these should be very expensive and tedious, time-consuming.

So, one should go for secondary data and undertake a primary survey only if it is required, and if your project is low large enough to allow you that kind of time and investment. So, looking at what kind of geomorphological surveys are undertaken. So, you can review all the geomorphological parameters in different kinds of methods and some of the methods are like you can have, in the site itself you can have certain recording instruments or you can also have remote sensing techniques. So those can be used here.

So you undertake geomorphological monitoring only if required. So when you take it, what things do you record? So you take a tidal current meter and a wave station is used when you monitor that. You have sediment samplings, what can you, you can undertake, and you, with that also that bathymetric and topographic surveys can be done. And then you also have laser-induced directions and arranged LIDAR measurement of distance using laser and then you also have aerial photography which can be used.

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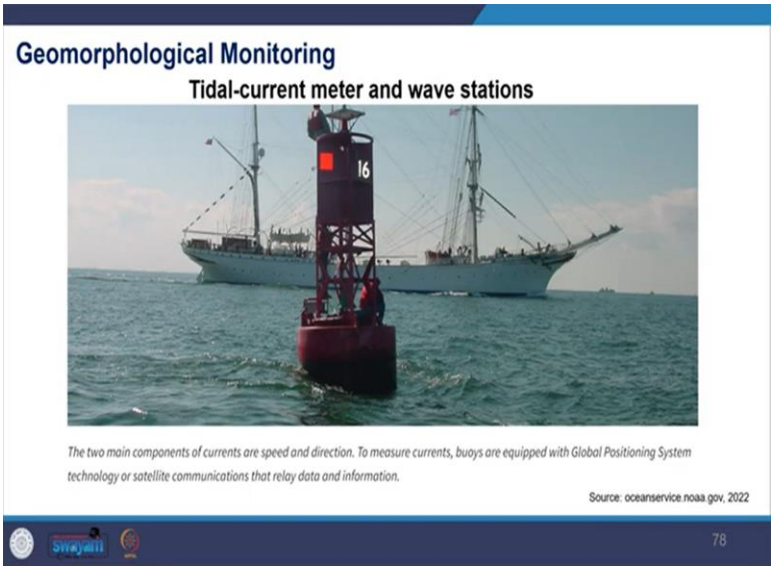

So in this image, you can see the tidal current meter and wave station. I have also given you the link.

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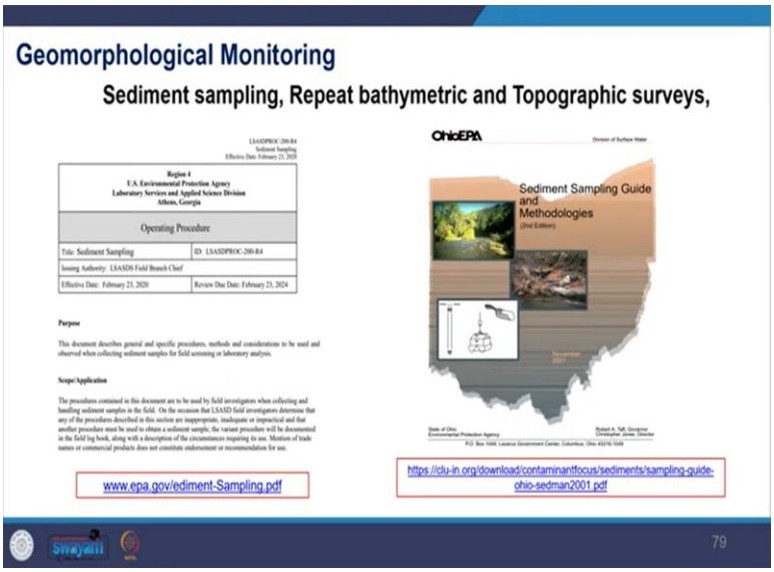

Then you can also see how sediment sampling can be done. So these are the manuals and guidelines that are available. I am not going to get into the details of it. So these guidelines are the links I have provided to you.

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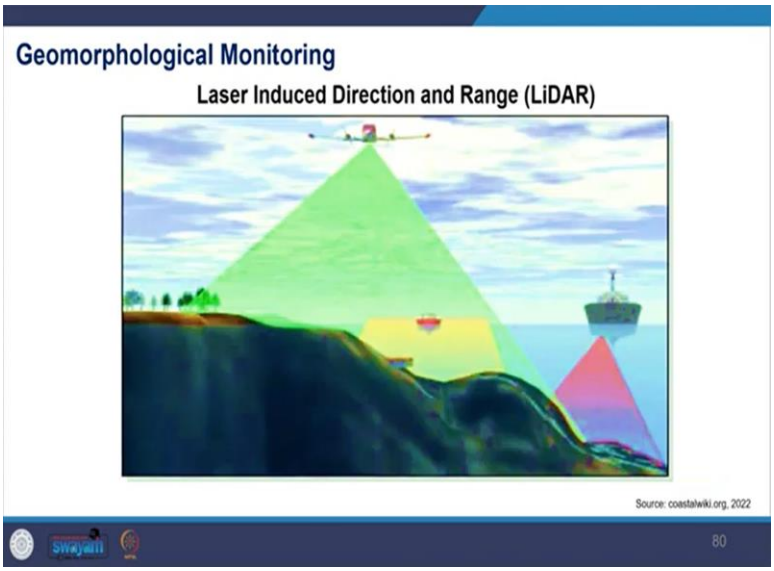

Then this is the snip I am showing about the Laser Induced Direction Range, LIDAR, and how it measures the distances.

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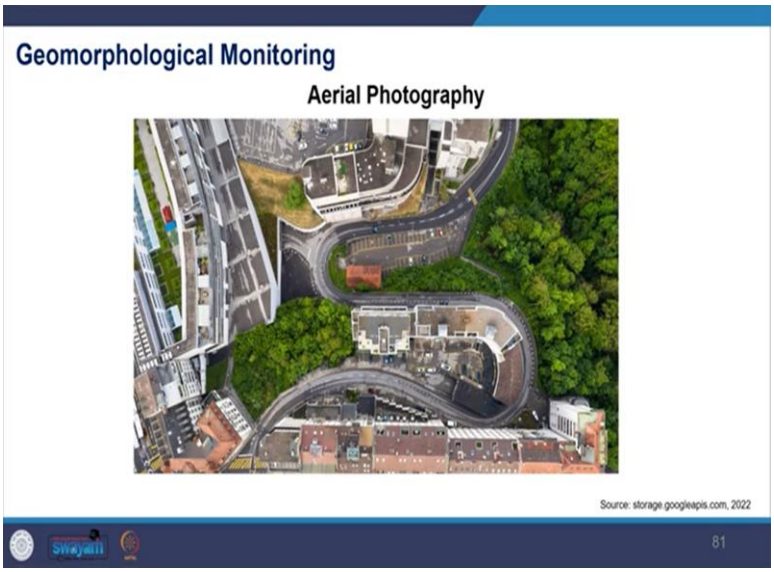

Then, how you can use aerial photography. So the data from waves, tides, and currents are usually taken from direct measurement. Like, you can use wave recorders, and you can have a tight gauge and current meters also. And, however, you can get all these data but the main problem is that when you use the specific site, specific data is the problem of how much you can generalize these things for the larger area. So that challenge remains.

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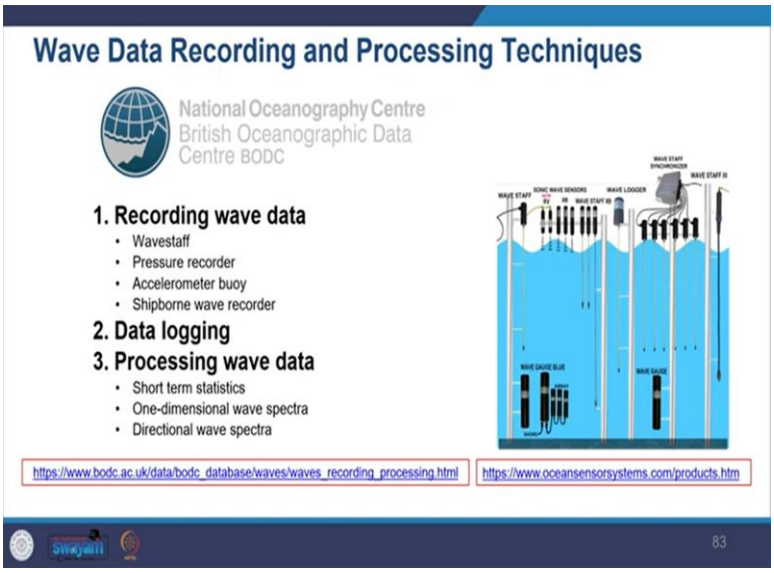

Looking at the wave data recording and processing techniques. So there are certain methods for which you have certain instruments which can be used like you have wavestaff, pressure recorder, accelerometer buoy, and shipborne wave recorder. So looking at the ecological survey, the coastal zone has this particular problem of ecological sampling. And this problem is much more pertinent in the sublittoral zone.

And, but it is, the main idea is that you should maximize use the of secondary data and only go for primary data unless it is required. You can also use different scales of surveys and then you can also have different kinds of classification systems which can be used for this. For this, you should also refer to the ecological, where we studied the methods for the ecology part. So you may revisit that also.

And one needs to be very clear on the timing of the field survey. You might also need to have repeat sampling because many ecosystems have a high degree of seasonality. So you need to have repeat sampling.

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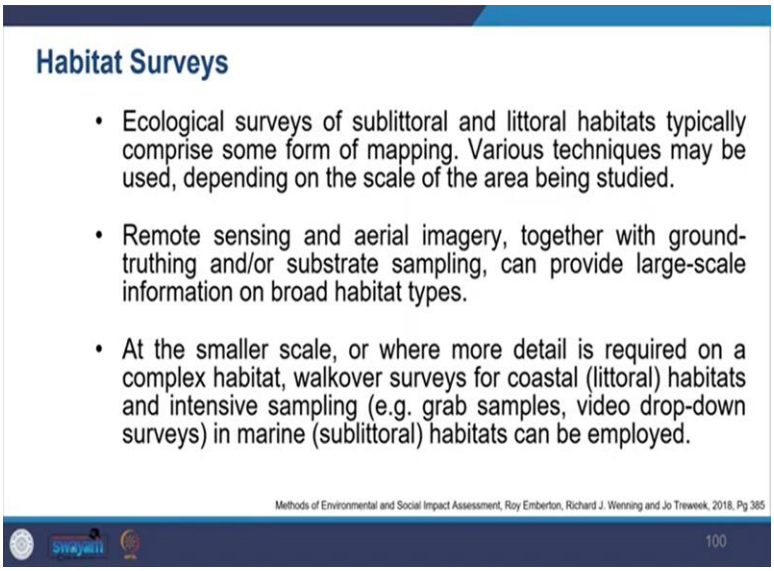

And you also need to have a habitat survey. So you will undertake an ecological survey of sublittoral and littoral habitats. You would undertake mapping of these areas, and you have various techniques that can be used, and it will depend on what kind of scale you are looking at. So most commonly suggested ones are remote sensing and aerial imagery. And that all would require even ground truthing. That means you have to do the field investigation for that.

So when you are dealing with a very small scale, you can, rather than going for a very complex system, you can simply walk, or undertake a walkover survey of the coastal area. You can simply take pictures, and photographs and do the sampling, and you can use similar scale and classification systems. So it can be very simple as well. And for a survey of the maritime and benthic species and communities you may refer to the ecology path which we have already studied.

So coming to the last part here, we see how you evaluate the baseline conditions. So when you are evaluating the baseline conditions, you need to see if are there any sensitive geomorphological systems and whether are there any high-value species habitats or sites in your particular area. So if you remember how we take care of like how do we evaluate the baseline conditions, what are the receptors what are the sensitive receptors, what are the important receptors? So all that has to be taken care of.

And you need to take care of all the protected areas and Ramsar sites which might be there. So you need to also look at the local notifications and national notifications which are there. So you also need to look at the environmental management plan which might be prepared for this area. So even taking care of what kind of mitigation measures would be required here. So that also, you should take in perspective.

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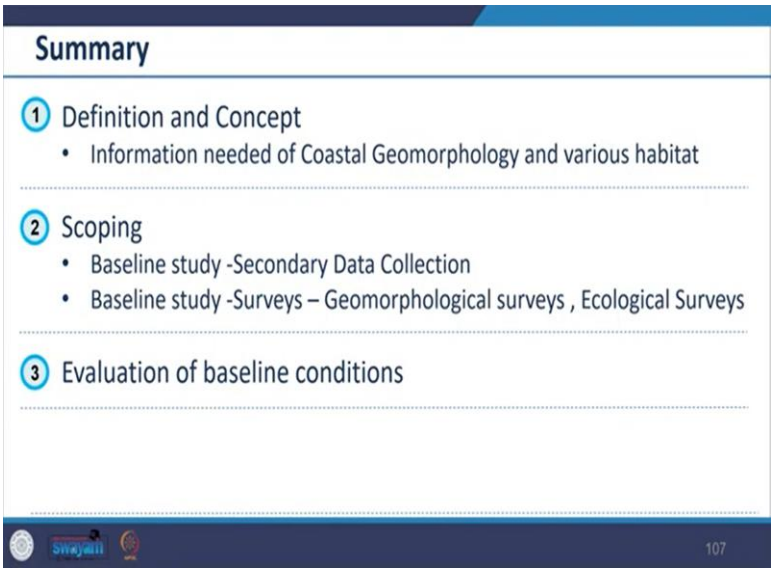

So that is all for this session. To summarize what we covered, we looked into the definitions and concepts, and we looked at the range of definitions. Then we covered what kind of information is needed for the coastal geomorphology, and like what are the various kinds of habitats and then what you undertake in the scoping, what considerations you have to undertake when you are dealing with the coastal area.

And then what kind of information, and secondary data do you need to collect when you are dealing with the baseline study in the coastal area? And then what kind of surveys have to be undertaken in this particular domain? And then how do you evaluate the baseline condition?

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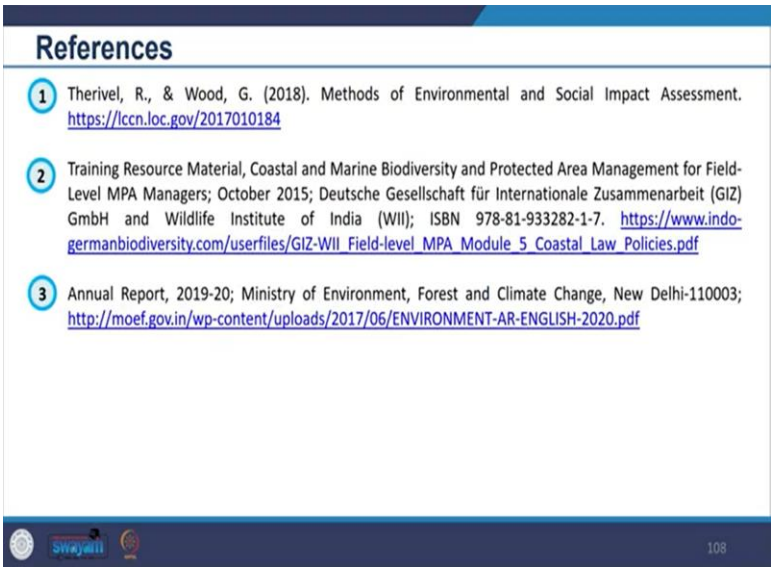

So this was the key reference for our particular session today.

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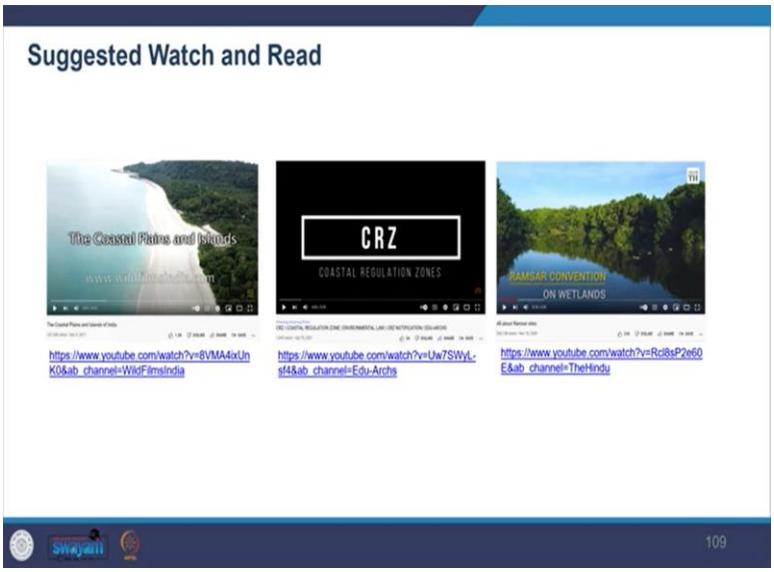

Then there are the suggested reading and watch for other typical terms that you looked at.

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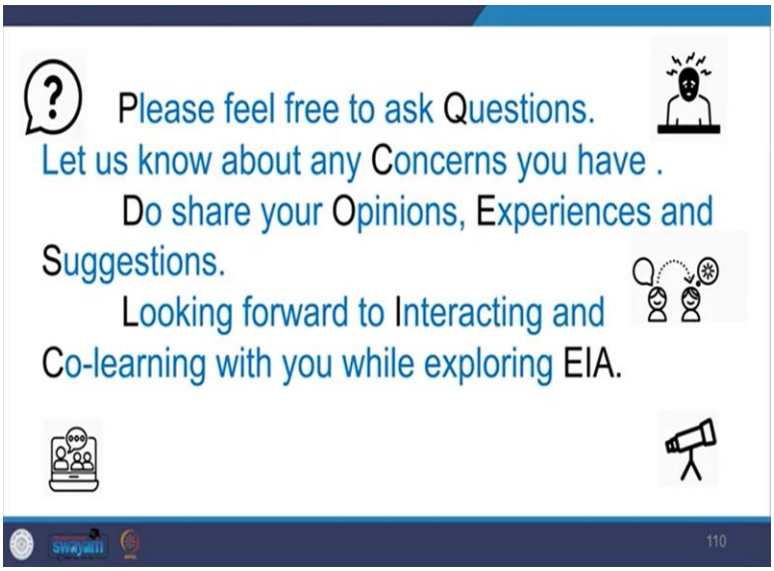

So winding up, please feel free to ask questions. Let us know about any concerns you have. Do share your opinions experiences and suggestions. Looking forward to interacting and co-learning with you while exploring EIA. Thank you.