Natural Hazards
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Lecture – 04
Introduction to Natural Hazards (Cyclones & Earthquakes Part I)

Welcome back. So in previous lecture we were talking about the internal and external processes and some information about the cyclone.

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Now, coming to the atmospheric disturbance and related hazard, this is an important portion where we have been experiencing the cyclones every year and during the month of like did not this from monsoon season we experienced the most.

So, last couple of years back, there was a severe cyclone vardah which originated again in then the other the eastern part of the Indian ocean and then moved towards the Indian mainland and the landfall was an along the southern eastern coast of South India.

Similarly, we had very recently another Cyclone Gaja and this picture which you see as the cloud cover and the eye which has been developed here at the center is of Cyclone Gaja. Which was again a devastating event but, water was more intense as compared to this.

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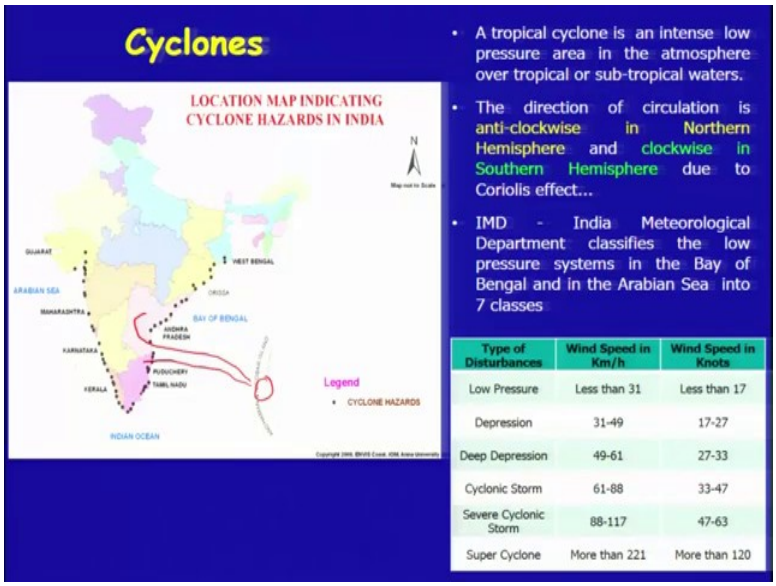

So, usually the tropical cyclones are very intense and it is because of the intense low-pressure areas in the atmosphere, over tropical and sub-tropical waters. Now one of the most important point which you should remember is the direction of circulation that how the circulation will take place when the cyclones have been formed or developed. One is the circulation is anti-clockwise there is what you can remember so, anti-clockwise in the Northern Hemisphere.

So, if you divide the globe in Southern and Northern Hemisphere, then the anti-clockwise you will observe the circulation and the Northern Hemisphere in the clockwise in the Southern Hemisphere and this is due to the Coriolis Effect. There is one of the important point which you should remember. Now in India the Indian meteorological department is one of the agencies which usually issue the warning for two different states which are going to be affected at the area which are going to be affected at during the cyclone and mainly at the time of the landfall.

Nevertheless, they also inform keep informing that what will be the speed of winds and which are the areas are going to be affected over the time, from the time when the there is the low pressure start developing. And they have different categories which are been shown that is in terms of the classes and if you look at the type of disturbance what they will they will give as an information is the low pressure.

And then what will be their wind speed kilometer per hour and in knots also. And then what is what will be the type of disturbance that will be 20 into patient deep depression, cyclonic storm, severe cyclonic storm or super cyclonic storm. This is helpful in gauging that what will be the amount of damage or other risk we are going to have from a particular cyclone.

So, mostly what happens is that we have learn until now that most of the cyclones will develop in this portion here and then they will move on toward, towards west. So, development of the cyclone over here and then slowly it will move or that. So, if you see the previous data's you will find this different track which will be shown and then, and then that will be also marked by the landfalls. It is not only in this area, but also over here you will find the development of the cyclones which are moving towards Gujarat or towards Maharashtra and all that and in the Karnataka and Kerala side.

So, this Gaja again had originated here in the eastern south-eastern portion of the Indian subcontinent and moved towards the East Coast of the, are the Indian mainland.

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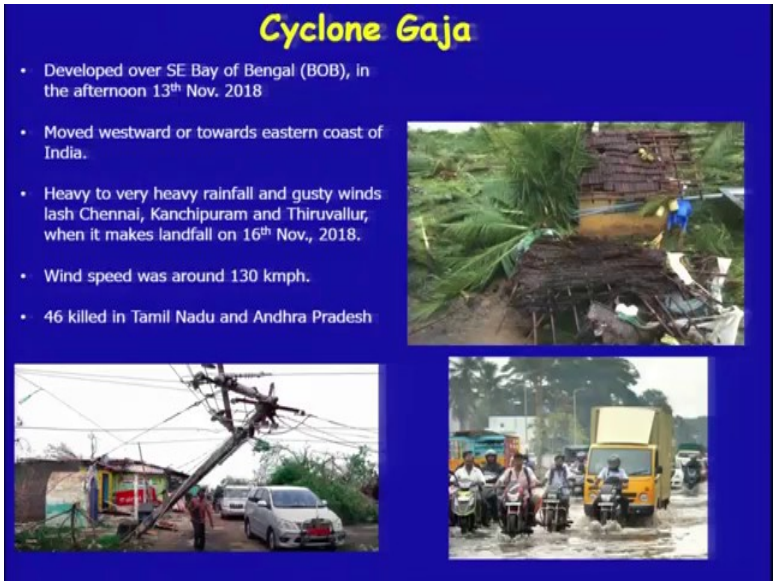

So, Cyclone Gaja developed over South East Bay of Bengal or you can say the part of the Indian Ocean in the afternoon of 13 November, 2018, moved westward or towards east coast of India. Heavy to very heavy rainfall and the wind speed was very high which affected the areas like Chennai, Kanchipuram and Thiruvallur when it makes the landfall on 16th.

So, he started on 13th and the landfall was on 16. So, its journey between 13 to 16th was also been given as a warning, and it was being updated day to day basis. So, wind speed was around 130 kilometers per hour and it killed around 46 people in Tamil Nadu and Andhra Pradesh.

So, this was the conditions where when it made the landfall many trees were been uprooted, electricity lines we have been disturbed and of course. It also resulted into flooding. So, this the cyclonic effects are twofold usually we have a very high wind speed and which will affect the other utilities, but at the same time you have the issues with it with the heavy rainfall in the region.

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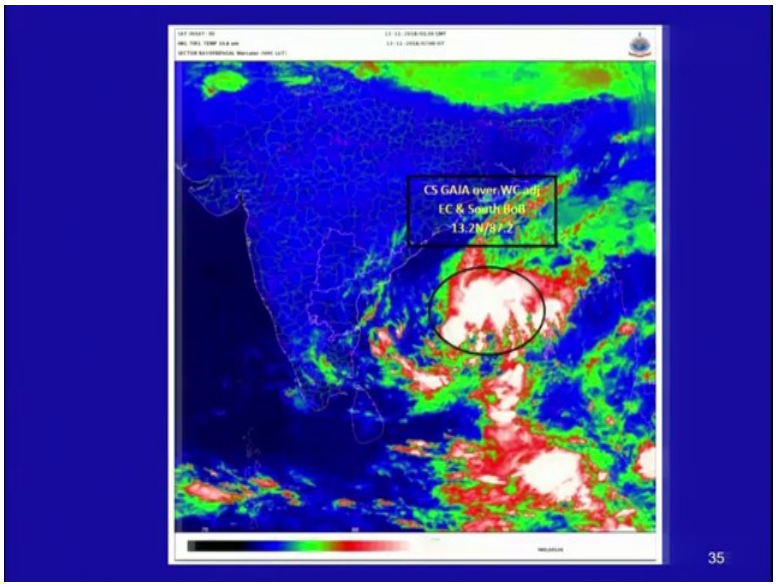

This is another picture of from taken from by based on the satellite data which shows the eye or the development of the Gaja. It not only affected the ideas along the east coast of the mainland, but also some part of the other countries adjoining Indian Ocean in the in the eastern side.

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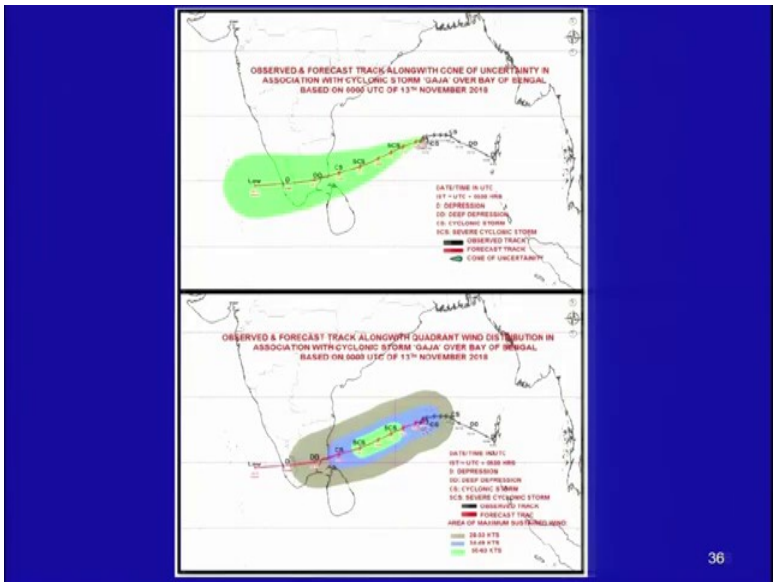

So, as I was talking about in one of the slide but you will find some very typical track along which the cyclone has moved. And the notations which are been given here like T D C S S E S are being given here as D depression, DD is deep depression, then cyclonic storm and then severe cyclonic storm.

So, at places you will find that while it is traveling from its origin the cyclone will get strengthened more and more, and then in between you will have somewhere before the landfall at the or at the time of the landfall you will find that the cyclone has become very severe. So, that part is very much important. So, this data shows that how the cyclone develops and was strengthened up and in which portion of during its journey it became very severe ok. So, severe cyclonic storm which has been shown here.

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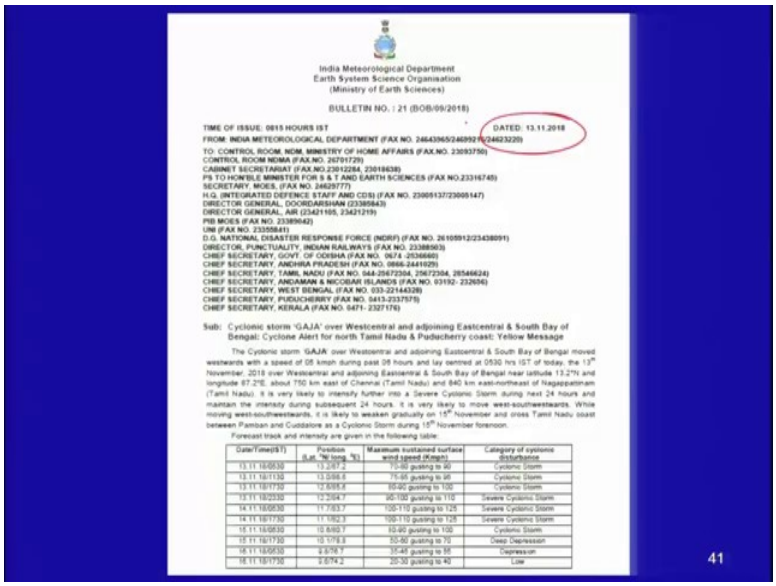

So, this is a warning which was or the bulletin which was been issued by Indian meteorological department or cell system sciences organization ministry of first sciences, which talks about the location and that is your time and date and the location and there is a lot long coordinates are been given. And at that particular coordinate and time what will be the wind speed which is expected in that region and what is the category of cyclonic disturbance either it will be cyclonic storm or a severe cyclonic storm, it will be these warnings or the bulletins they are regularly issued. So, this was of 13th November.

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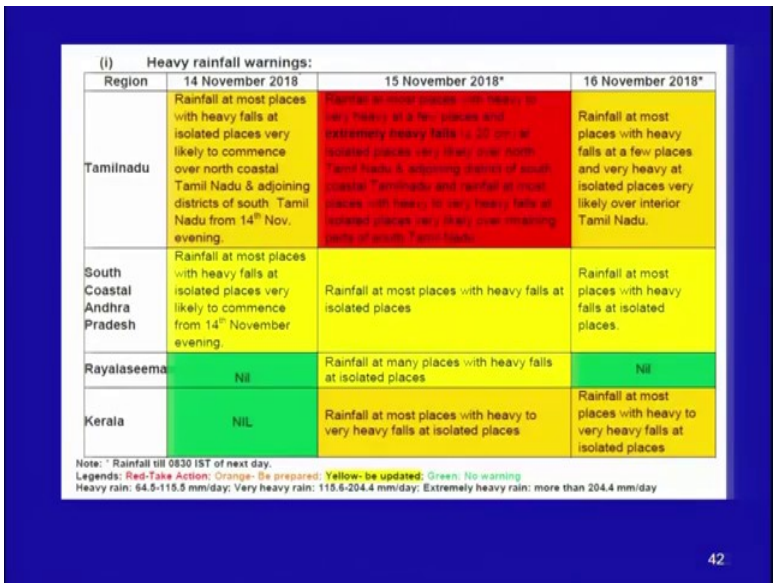

At the same time, along with that the other information which I have been given and this table shows the information of heavy rainfall warnings, which were been issued from 14th to 16th and 15th which has been shown by red box.

It says in Tamil Nadu, rainfall at mode most places with heavy to very heavy; at a few places and extremely heavy fall which will be greater than 20 centimeters. At isolated places, very likely over North Tamil Nadu and adjoining districts of South Coastal Tamil Nadu and rainfall at most places with heavy to very heavy fall at isolated places very likely over remaining parts of the South.

So, this type of information's which have been given are very useful to local people not only over the land staying on the land, but also for the fisherman's who tends to move for their day to day activities. Now, this part of information is extremely important for the strait officers to plan the evacuation. Because, a lot of people who are staying along the closed are mostly the fisherman's and so they need to be evacuated and of course, we if you understand that what will be how far it is going to enter that is the landfall and how much area inland from the coast will be affected depending on that one can go for the evacuation.

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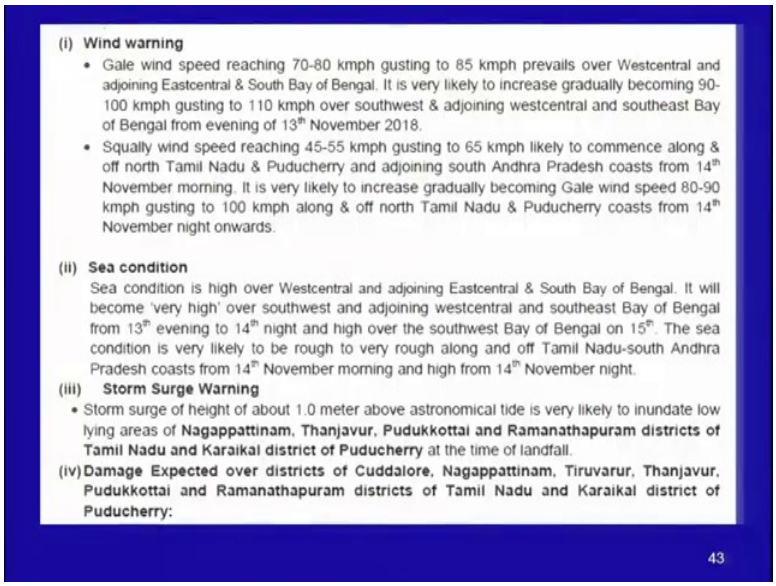

Then there is again a piece of information which has been given that what will be the event conditions and sea condition as well as the storm search along the coastal areas this information is also provided.

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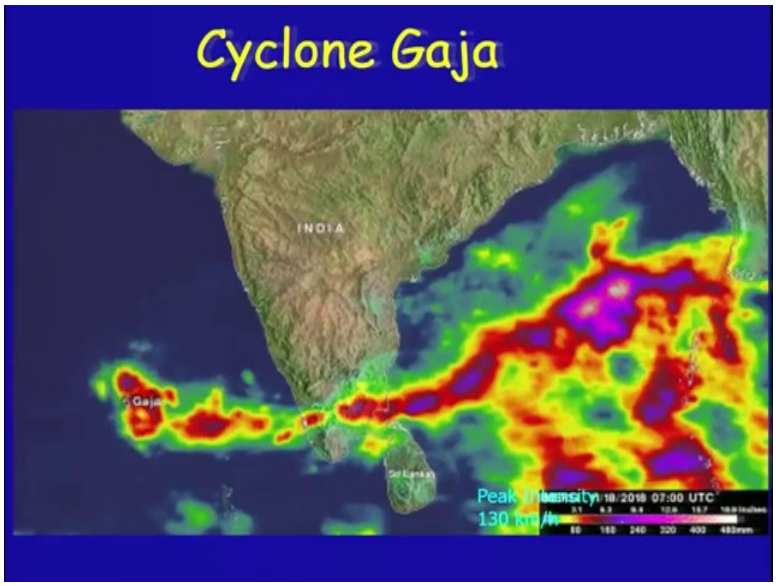

So, this is a jist that how it has been developed over the time. So, it started here somewhere and the southern part of the Andaman and Nicobar Islands, and it moved further affecting some part over here in Myanmar, and then moved and had a down fall over here and it the one important part is that it crossed be hold the southern tip of the mainland India and went towards the other side of the coast talking.

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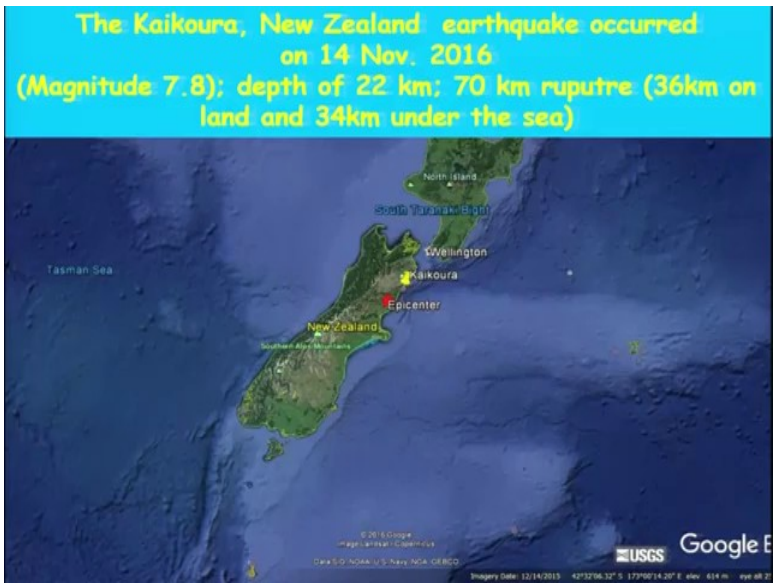

Now, another important topic what we are going to discuss here is in brief of course, we will discuss in detail later on is related to earth quake. Now, this is an example of an Kaikoura earthquake, which occurred in 2016, the magnitude was 7.8.

So, the information which is shown here is extremely important in terms of the hazard assessment. One is the magnitude, second is what depth and the earthquake has occurred and then the rupture length. So, the depth was quite close to the surface only 22 kilometers of course, 22 kilometers for us is a quite large distance, but in terms of the depth 22 kilometers for an earthquake and the energy to reach to the surface is quite lesser. And if a shallow earthquake like this is experienced in India in Himalaya is going to result in to like severe damage to the Indo-Gangetic Plain.

So, it was make 22 kilometers depth 70 kilometer of rupture, out of which 36 kilometer was on land. That is what they show here somewhere and then about 34 kilometer was under the sea because the fault line or the feature along which this earthquake took place extended on land as well as in ocean submarine. And similar, event was experienced recently in Paulo that is Indonesia, which also resulted into like strong ground shaking as well as tsunami.

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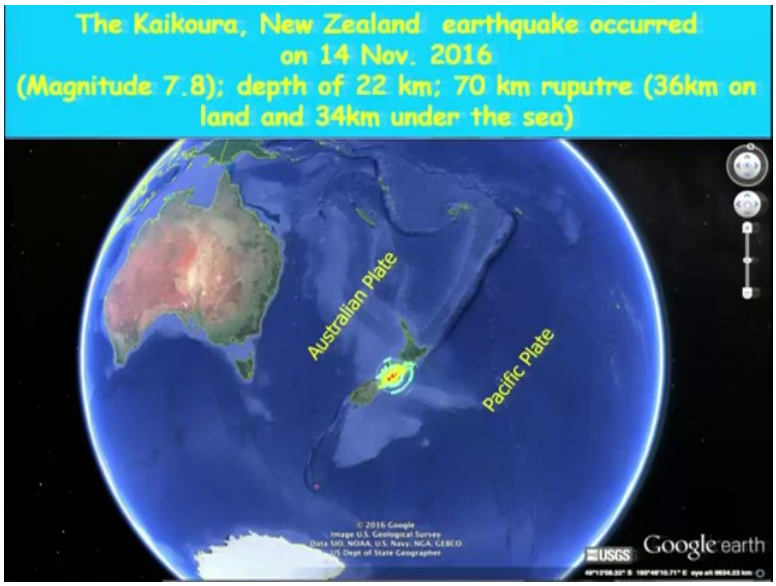

So, the epicenter was near Kaikoura, and this was because of this tectonic sitting. I am not getting into the detail right now of this that is subduction zone, but we will talk when we are discussing about a plate tectonics part, you will understand more in detail. But

this feature on the earth globe, clearly shows that there are some unusual things which are happening here where one plate from this side is sub ducting below the another one here. And the strain which was developed because of this subduction where one plate is pushing itself down below the another one, the strain which develop was released that is sudden release of the strain resulted in to earthquake and strong ground shaking was experienced.

So, this is a pacific plate and this is Australian one. So, the pacific plate is sub ducting below on the Australian plate or you can say the Australian plate is riding over the pacific plate. So, this are the plates which are sub ducting or overriding. So, between this two plate usually they do not pass through very smoothly, they have a lot of friction which is which develops between both of them which result in to the development of strain and sudden release of the energy stored along this plate boundaries results into earthquake.

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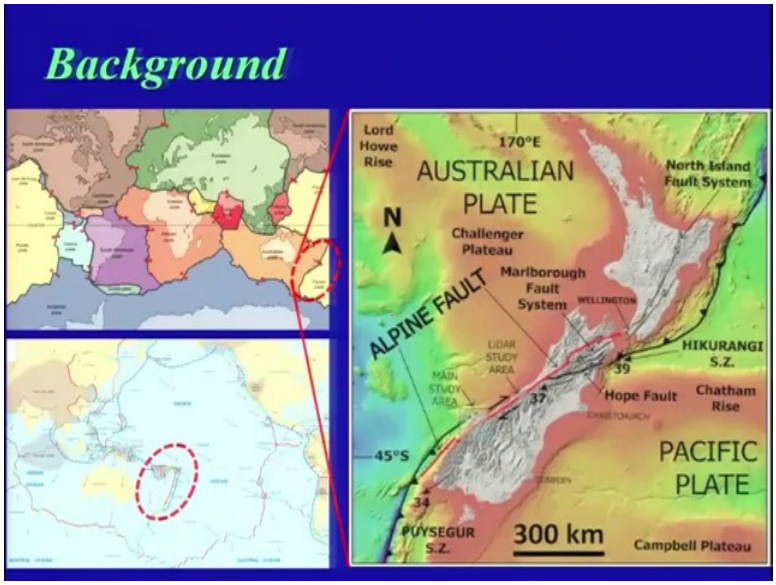

So, if you look at the background here as I explained that we have like pacific plate which is subducting below the Australian plate here, this is what is the whole mass is the Australian plate and this one is the pacific plate. And the rupture which was experience or the energy which was released along the fault line is you are having one of the active fault line is the alpine fault line.

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So, the damage which was experienced was extensive, you can see not only the structures or the civil structures or houses or the buildings collapsed. But along with that there was huge deformation which was experienced or was seen on the surface that is what we call crown deformation.

So, this is one of the example which has been shown here the land has moved apart and also one portion of this one portion one side of the land has moved down. So, this was the pattern of damage and another feature which you see in this photograph particularly what we call the land subsidence resulted because of liquefaction. So, this all like things we will discuss in detail particularly about the land subsidence like faction and they rupture areas and all that.

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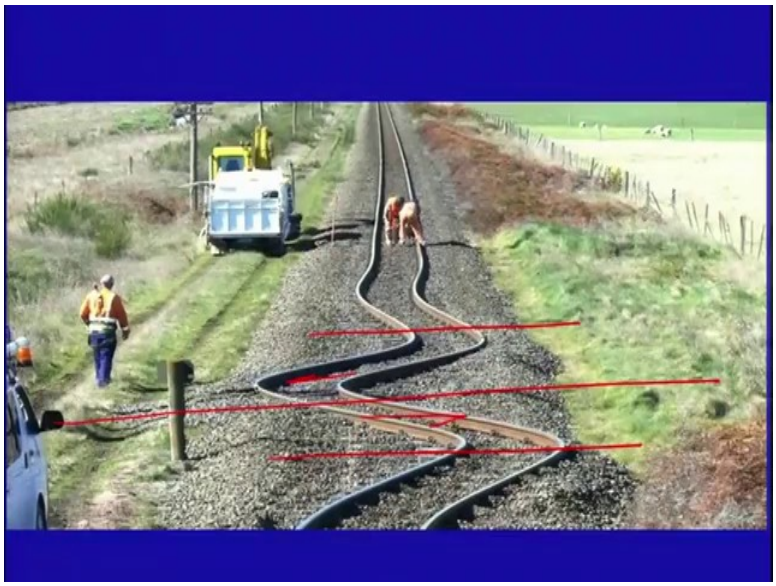

So, this was a deformation pattern which was been experienced or recorded at the time of the earthquake where you can see the real track has been zigzagged or deformed because of surface rupture, the surface rupture runs here another part of that runs here. So, if you need to make out the sense of moment, then what you can see is this part has moved like that and this one is like that and this again.

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That was not enough like this is another example which shows and how the earthquakes can modify the complete landscape at the earth's surface. This is the wall which you see here never existed before this came up at the time of earthquake.

So, this is what we call surface rupture western neuron (Refer Time: 18:36) faults (Refer Time: 18:37) on (Refer Time: 18:40) looking here the (Refer Time: 18:42) action the first clime of (Refer Time: 18:44) along the (Refer Time: 18:45) way this site here when (Refer Time: 18:49) and (Refer Time: 18:50) an half and the consider the (Refer Time: 18:52) grand (Refer Time: 18:53) side to (Refer Time: 18:54) to most very interested (Refer Time: 18:57) ah which will little bit (Refer Time: 19:02).

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Little bit insertion (Refer Time: 19:04) and; that means, we can say a person (Refer Time: 19:06) lot of (Refer Time: 19:08) where in fact (Refer Time: 19:11) something like this so this saw here resonant flow by many (Refer Time: 19:17). This was (Refer Time: 19:19) from (Refer Time: 19:20) requires physics probably this was gap rupturing (Refer Time: 19:26) with the economy (Refer Time: 19:28) taken. So, this is a with this a very large area (Refer Time: 19:33) here and saying (Refer Time: 19:37) here

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(Refer Time: 19:38) This (Refer Time: 19:39) noise (Refer Time: 19:40) most running up the top of this (Refer Time: 19:42) and seeing that the noise was just (Refer Time: 19:46).

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A norms (Refer Time: 19:48) on the ground (Refer Time: 19:49) one and half mentions. On the other side this is much (Refer Time: 19:56).

So, this was on very important video where, Kelvin is trying to explain that how the moment took place. One can easily look at that what was the height variation or the difference between this to this place, almost like 2 meters. So, this is what we call is the surface rupture and what he was trying to explain here, was that there was some indication or the striations which developed on the fault plane which was exposed and it shows in particular direction some striations will been observed like that. So, this also talks about or tells us about that what was the direction of movement so this portion it moved up like that.

Now, this type of false curves or the land level changes, occurs mostly at the time of big earthquakes about 7.5. And so, which will definitely result into the landscape change and that what was been explained here where, he was talking about that new reef briefs were developed ok. Like this is one example of that what he was showing.

(Refer Time: 21:40) this is that (Refer Time: 21:44) very large area of new (Refer Time: 21:46).

So, he is talking about that this whole area got uplifted and this will form a new reef, coral reef from this region. Now, we have another similar video, but that is online which we have we will try to show you.

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Western here.

So this, the deformation which moved or we can see on the surface, and that was close to the coast this is on land. So, you can see this rupture and there was an UAV which was been flown over this and they recorded a very good deformational feature, which we would like to show you. I am sorry, there is no sound for this video, but you can easily make out and look at the deformation which was recorded by the 2016, Kaikoura earthquake and the rough rupture length was recorded up to 30 kilometers.

So, usually mapping of such features are extremely important, because this type of features what we call the faults scarps or the signatures of past earthquake preserved on earth surface will be important for future seismic hazard assessment or we can say earthquake hazard assessment. So, that will that is going to tell us have the complete history or we will be able to do the reconstruction of the past earthquakes and such areas.

So, in particularly if I talk about the Himalayan region, we are trying to map similar features where the earthquakes which occurred in the past have left their signatures. And we are trying our best to evaluate and trying to reconstruct the history of the past earthquakes from such features.

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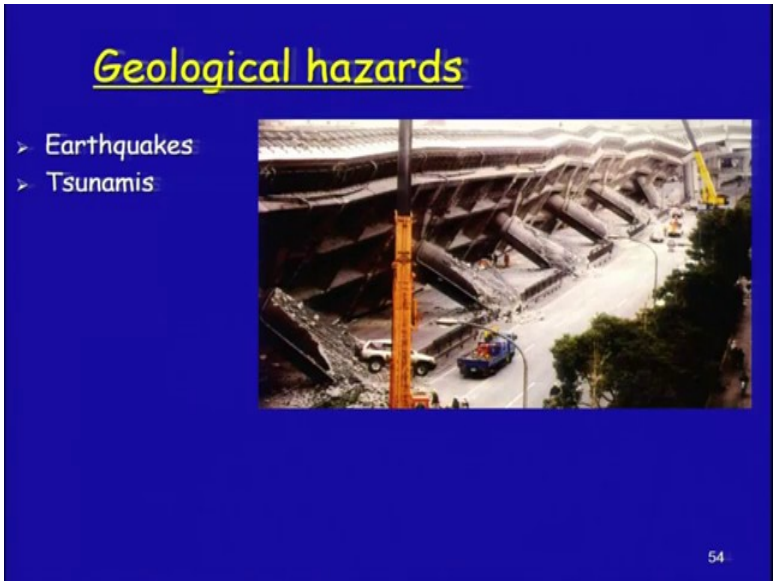

So, geological hazards mainly we have seen some example of earthquakes, and then we have tsunamis. So, if you look at this very devastating earthquake was being experienced in Japan, and this was in 1995. I will stop here, and we will continue in the next lecture.

Thank you so much.