Natural Hazards
Prof. Javed N Malik
Department of Earth Sciences
Indian Institute of Technology, Kanpur

Lecture - 24
Motoring Seismic Activity Part II

Welcome back. So, in previous lecture we talked about the fracturing of the crust and the emission of the ridden casts, reduction in the velocity of P - wave and then after the filling up of the crack the velocity was recay into normal as well as subsidence and uplifts and we discussed one case of Niigata where the uplift was observed for more than 60 years. Now, there is another evidence which was been observed in 1802 Earthquake of Japan.

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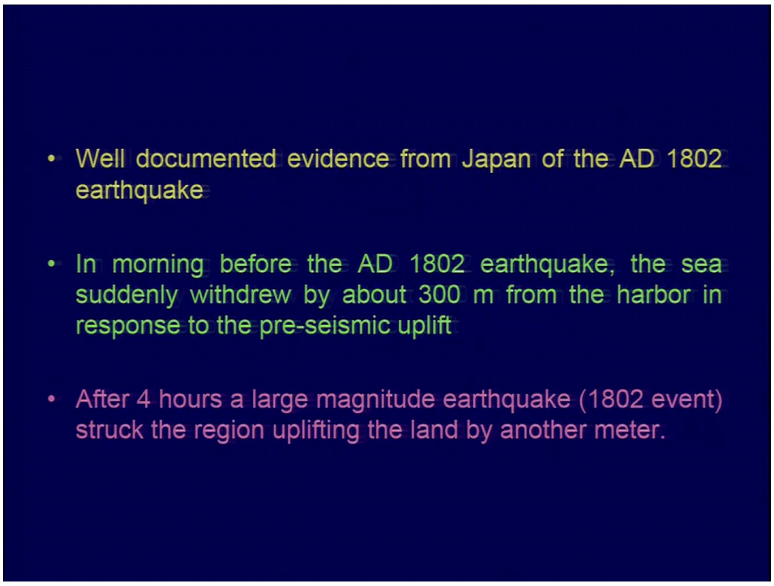

So, in the morning before AD 1802 earthquake the sea suddenly withdrew by about 300 meters and this was because of the pre seismic that is earthquake uplift, so, pre earthquake uplift was resulted that resulted into the withdrawal of sea. Now in 2004 Sumatra Andaman earthquake this phenomena was observed and experienced by few people.

But we were not aware that such phenomena is related to an occurrence of an big earthquake. So, that killed a lot many people and now after 4 hours this is for the 1802 earthquake a large magnitude earthquake struck the region uplifting the land by another meter or so. Now this 1 meter uplift is too large actually and this was also observed and not 1 meter more than 1 meter in northern part of Andaman island whereas, in few locations the area subsided. Probably we will talk this when I am give I am I am going to give a lecture on tsunamis.

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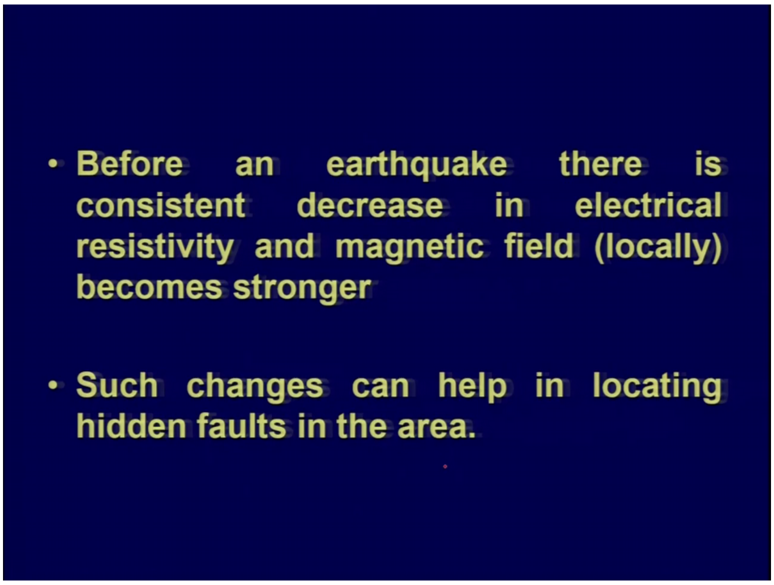

Before an earthquake there is consistent decrease in the electrical resistivity this is another important parameter which people have tried to understand or tried to record and also the magnetic field locally become very strong. Such changes can help in locating the hidden faults in the area also.

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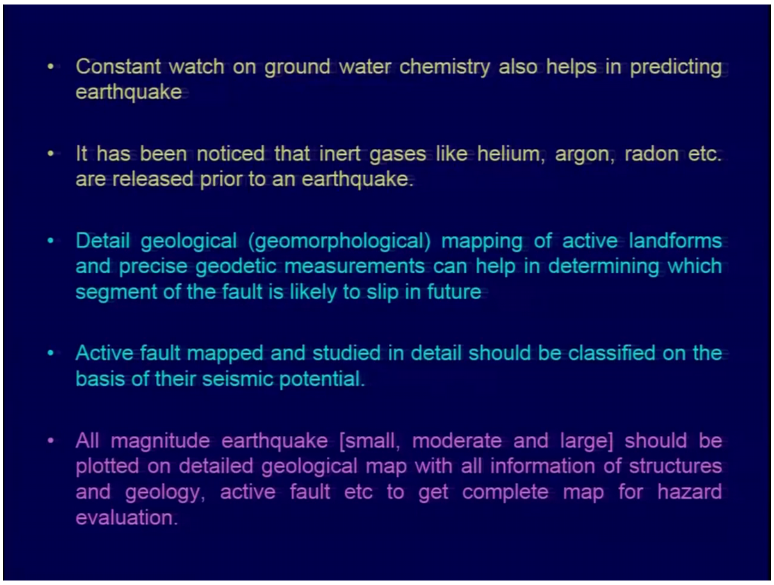

Constant watch on groundwater chemistry is another parameter which helps in predicting the earthquake. It has been noticed that inert gases like helium, argon, radon, are released prior to an earthquake. Detailed geological or geomorphological mapping of active landforms and precise geodetic measurements can help in determining which segment of the fault will rupture or slip in future.

So, this can be done if you are doing a very detailed geomorphological investigations and where we can identify the active landforms. So, we know that which area is prone to earthquake and various the likelihood of this slip to occur in near future that will be your earthquake.

So, this is an important studies which we have been doing. So, active fault map and studied in detail should be classified on the basis of their seismic potential. All magnitude earthquakes small, moderate and large should be plotted on detailed geological map with all information of structure and geology, as well as active fault etcetera to get complete map for hazard evaluation. So, this involves lot of layers of your map or thematic maps you can say all right from the historical seismicity you can talk you can discuss with the modern seismicity inclusion including your micro or moderate and large magnitude earthquakes.

If at all they are experienced because large magnitude earthquakes will be very few, but moderate and small magnitude you can come across. As well as the geological structures which have been marked or identified mapped and geomorphological signatures of past earthquakes should be mapped and that will give you an complete understanding that this area is prone plus you one can do the (Refer time: 05:17) investigations to understand that whether this fault is capable of triggering large magnitude earthquake in near future or not.

Along with that the if you incorporate or complement the GPS studies, then you will be doing the best job in terms of hazard evaluation and also you can also predict the then the near future earthquake in that particular region.

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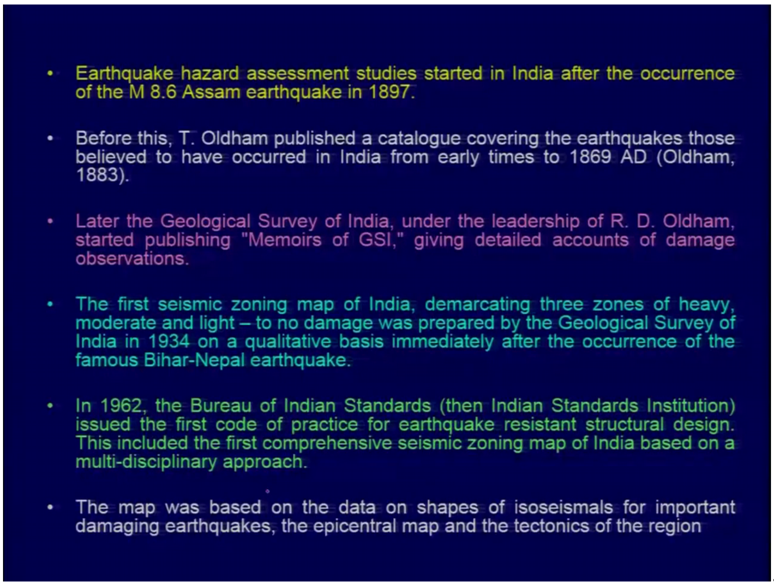

Now history of earthquake hazard assessment in India if you take quickly the earthquake hazard assessment study started in India after the occurrence of 8.6 Assam earthquake in 1897. Now, this earthquake is also been termed as Shillong plateau earthquake before this Oldham published a catalogue covering the earthquakes those believed to have occurred in India from early times to 1869 AD. Later geological survey of India under the leadership of again R D Oldham started publishing memoirs of GSI giving detailed account of damage observations.

So, be because earlier being because of the lack of instrumentation mainly the records of past earthquakes were been studied using the damage pattern and based on this you can generate the isoseismic map we still do that, but most now we have in most of the areas we have well place seismographs so, we can we can use that data.

So, the first seismic zoning map of India and demarcating 3 zone heavy, moderate and light was prepared by the geological survey of India in 1934 and this was on the basis of the occurrence of Bihar- Nepal earthquake this was in 1934. There was a large earthquake in close to the India Nepal border that was termed as Bihar- Nepal earthquake in 1934.

In 1962 the Bureau of Indian Standard BIS then Indian standard institution issued the first code that is on building code of practice for earthquake resistant structure design. This included the first comprehensive seismic zoning map of India and that was based on multidisciplinary approach.

Now, usually when such maps are prepared the path seismicity, that is historical seismicity, the ongoing seismicity, the damage pattern and the geological structures are taken into consideration and even the active faults are taken into consideration to come up with the seismic zonation map and the most important is the ground acceleration. So, if the ground acceleration data is available you will understand that which area will have the maximum intensity of ground shaking as compared to the another one because that helps in protecting these several structures, because earthquake will not kill the people, but the structure will kill the people.

So, this saving the structure is very important protecting the structure and building the several structures with proper codes proper building code is extremely important because then those structures will be able to sustain themselves at the time of peak ground acceleration of the ground shaking.

So, the map was based on the data on shapes of isoseismic. This isoseismic have been prepared considering the damage pattern. So, isoseismic for important damaging earthquakes, the epicentral map and the tectonic of that is the structures tectonic structures of the region. So, this was been taken into consideration for preparing the seismic zonation map.

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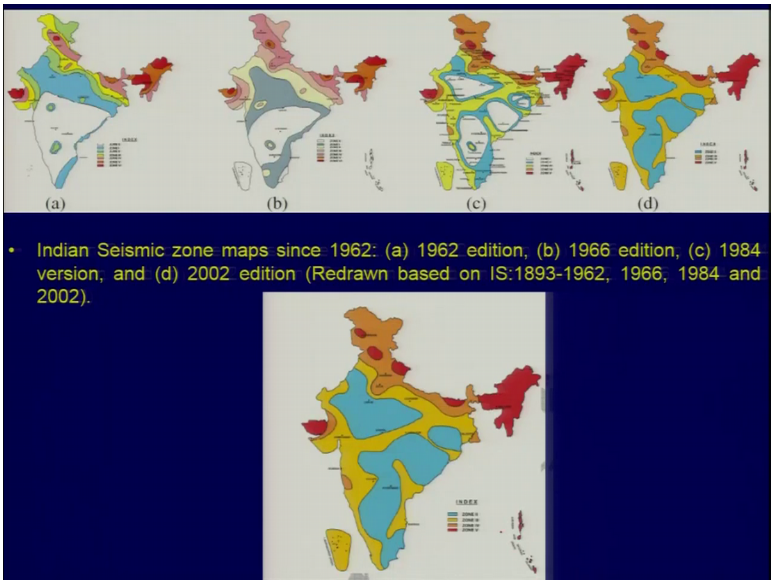

So, if you look at the variations or the transformation of different maps which are been listed here a b c d and this where over the time where been changed or modified or we can say updated based on the information which we kept on getting. So, earlier they were more than 5 zones, then they reduced to 5 and lastly what we see now is your only 4 zones. Because the effect of the seismic shaking was observed a different as compared to what it was been observed in the past.

So, the Indian seismic zone zonation maps since 1962, the first edition was in 1962, then 1966, 1984 and then 2002. Now, this was after the 2001 Bhuj earthquake. So, now, we no more have the zone 1, which was been seen here this white part is all like the this zone 1. So, this zone 1 is not available this remains the same which are the red part is zone 5 and this is of course, this is quite surprising that a small patch here which is sitting away from the this active seismic zone has under zone 5, because this is of like (Refer Time: 11:39) this region has experience or the region has been struck by major earthquakes like 1819 (Refer Time: 11:48) and the 2001 Bhuj earthquake. Whereas, this of course is remains in zone 5 because it is along the subduction zone here.

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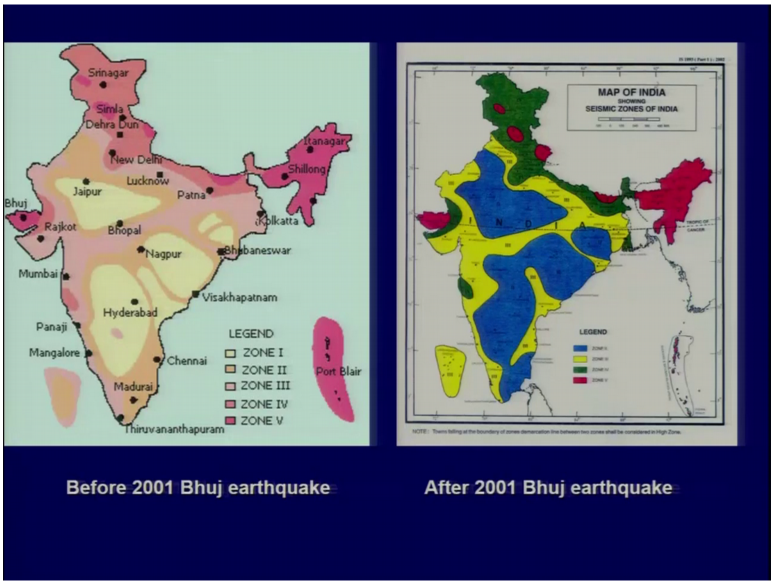

So, now from before 2001 we have been having zone 1, zone 2, 3, 4 and 5, but now we are having only zone 4 starting from zone 2 to zone 5, zone 1 has been removed. So, this was after 2001 Bhuj earthquake.

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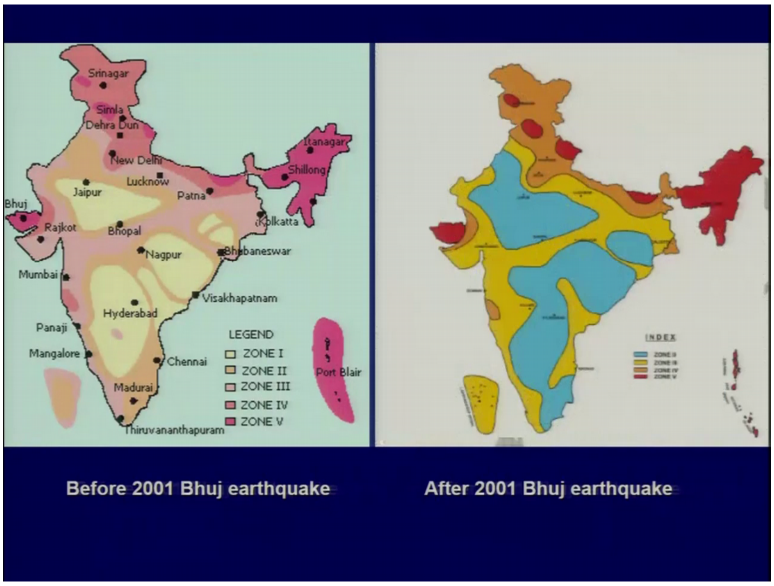

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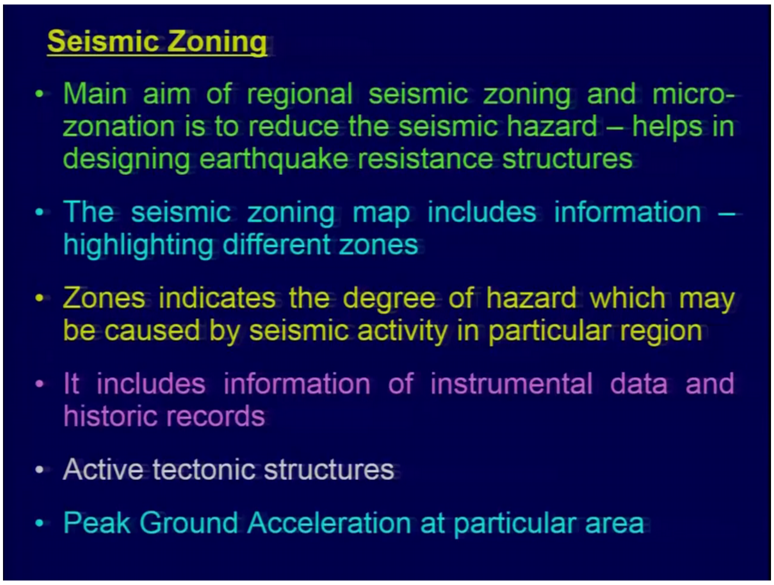

Now, seismic zoning main aim of regional seismic zoning and micro zonation is to reduce the seismic hazard, which helps designing earthquake resistance structures. The seismic zoning map includes information like zones indicate the degree of hazard which may be caused by seismic activity in particular region and in micro zonation we also consider the particular site of interest ok. It includes information of instrumental data and historical records, active tectonic structure, peak ground acceleration at particular point of interest have a particular area.

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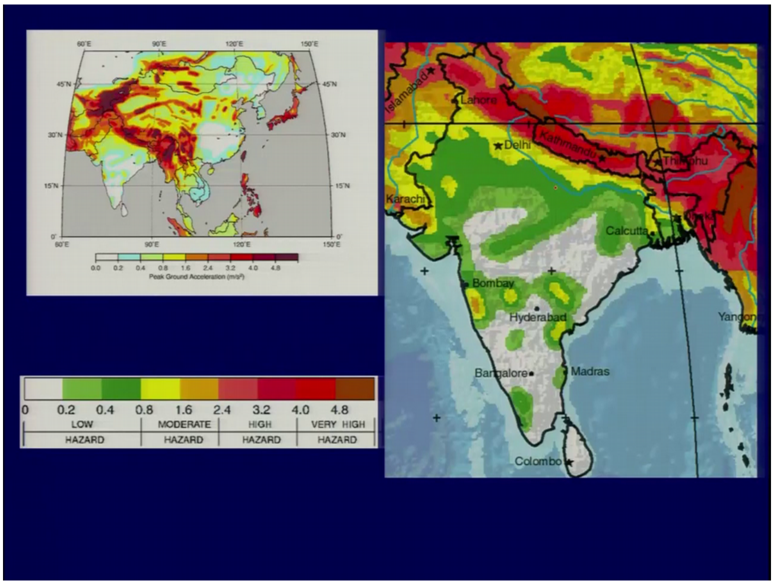

So, these are the seismic zonation peeve showing the seismic zonation map showing the intensity the different areas will experience.

But now as I would like to mention that the ministry of our science and in particularly national center for seismology has taken up a job and that big project which will have the with an aim to go for micro zonation of 30 cities in India and mostly most of the cities will be close to Himalaya and then this region as well as in this region, but many cities will be here because they are sitting in and very loose sediments.

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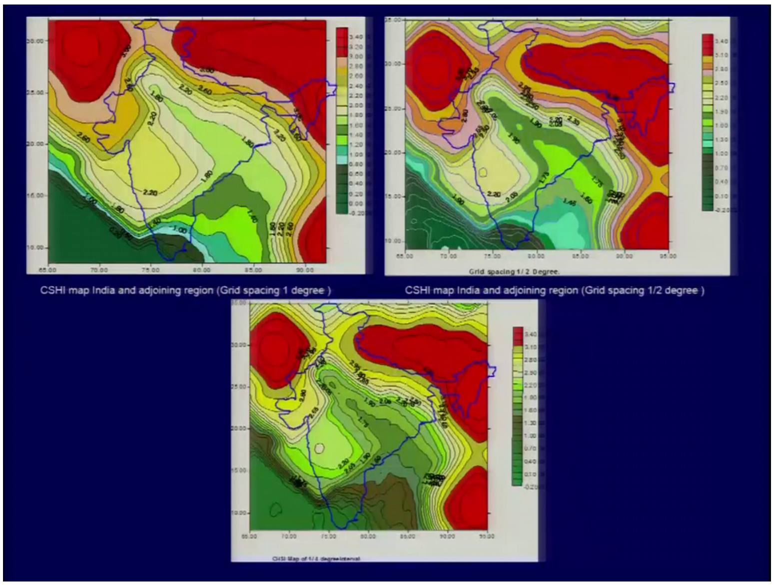

This was one of the exercise which we did, but I would not say that this is in particularly complete one because whatever the data was available we did this exercise to understand that which areas will have more of ground acceleration.

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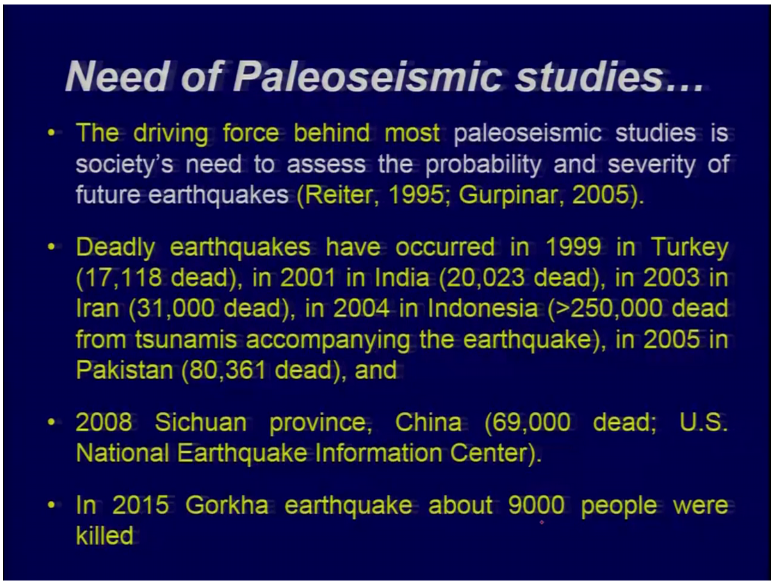

Now, need of paleoseismic studies as I have been mentioning in many of my lectures, the driving force behind most paleoseismic for the ancient earthquake studies is societies need to assess the probability and severity of future earthquakes. Deadly earthquakes have occurred in 1999 in Turkey killing almost 17000 people, in 2001 in India killing about 20000 people, in 2003 in Iran 31000, 2004 in Indonesia and this was the this Sumatra Andaman earthquake which took lives of more than 2.5 lakh people from tsunami as well as the earthquake in 2005 Pakistan earthquake killed or you say the Kashmir earthquake almost 80000 people. And in 2008 Sichuan earthquake killed 69000 people 2015 almost 9000 people.

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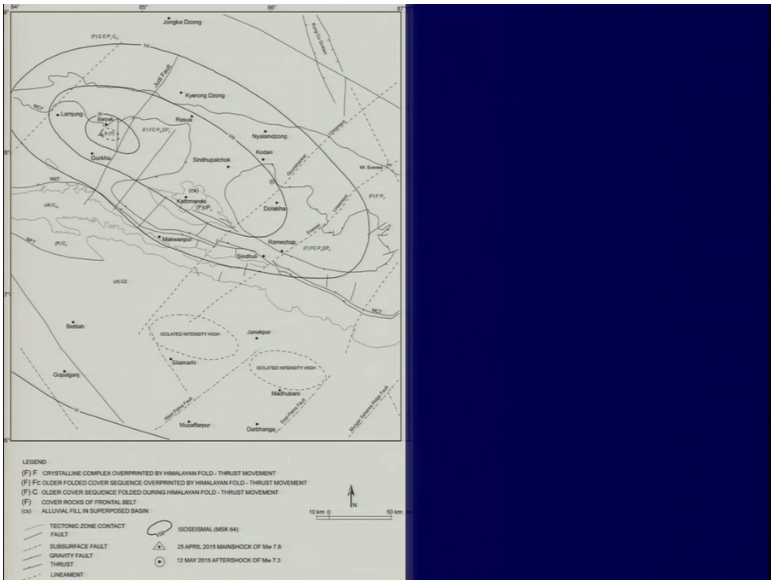

And this was one of the reason that we have discussed in the past in one of the lecture when I was talking about the Gorkha earthquake. So, this was this is the isoseismic map of Gorkha earthquake 2015.

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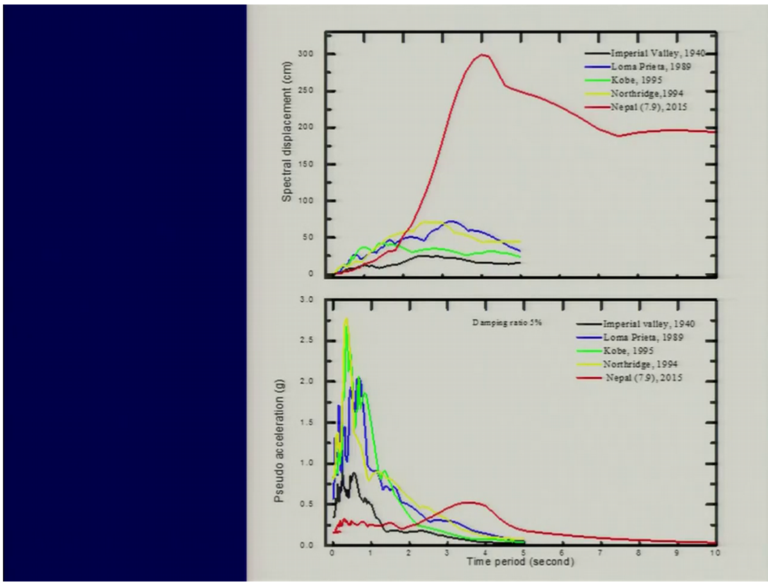

And the reason was the energy or the acceleration which was observed was not similar to what it was observed in most of the earthquake of similar magnitude. So, the time period as well as the acceleration was not similar to what it was been observed in like

Northridge, Kobe, Loma Prieta, Imperial valley earthquake this was like an swing which came and moved the surface.

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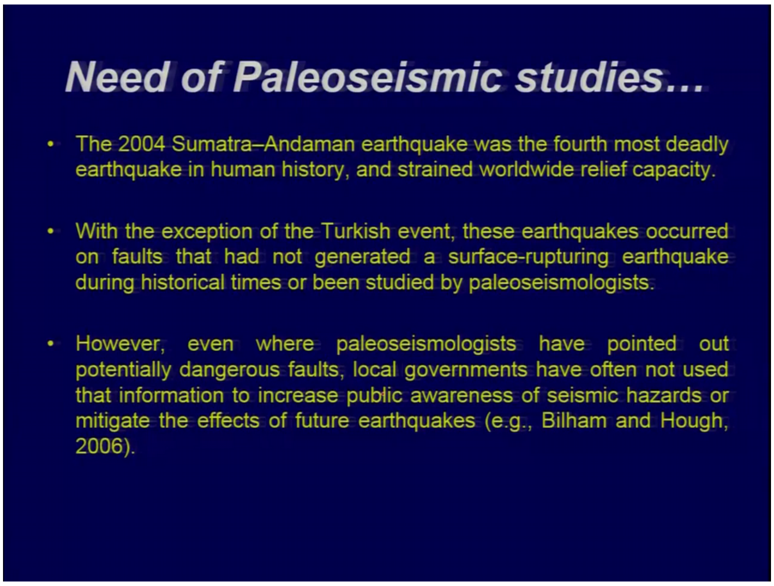

So, further in 2000 like 2004 Sumatra - Andaman earthquake was the fourth most deadly earthquake in human history and the strained worldwide relief capacity it was really and many really damaging earthquake. Of course, after this earthquake the Japanese people were quite alert to understand that similar magnitude earthquake can occur in that area and in the region and that happened in 2011 Tohoku earthquake.

Now with the exception of Turkish event, this earthquakes occurred on fault that have that had not generated the surface rupturing earthquake during historical times or being studied by paleoseismological.

However, even where paleoseismologists have pointed out potential dangerous fault, local government have often not used that information to increase public awareness of seismic hazard or mitigate the effect of future earthquake. This of course, has been very important that whatever the information has been generate form paleoseismologic investigation the local government should inform the people in that area or you can increase the people awareness because they should not construct the houses on that particular fault line.

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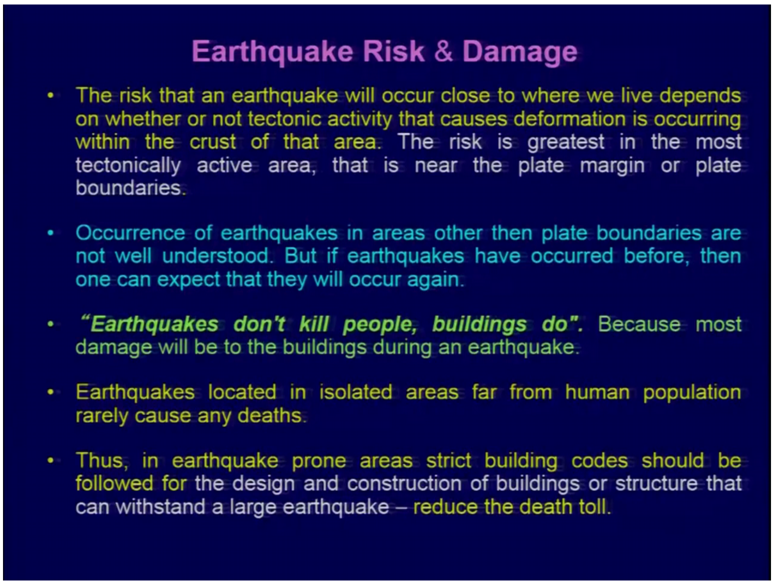

Earthquake risk can damage the earthquake risk from and the particular earthquake will occur close to where we live depending on whether or not tectonic activity that causes deformation is occurring within the crust of that area. The risk is greatest in most tectonically areas that is near to plate margin and plate boundaries. So, this is very clear that we know that were in India and we are going to expect a large magnitude earthquake that is of course, this is the Himalayan front.

Occurrence of earthquakes in area other than the plate boundary that is away from the plate boundaries are not well understood and this is what has happened when we had an earthquake of 2001 Bhuj because it is the area is sitting away from the plate boundary and we considered that ideas and stable continentally region and even the Latur earthquake which was sitting in the cratonic area. But if the earthquake have occurred before in that region based on the historical data or the paleoseismic study if you know then one can expect, but they will occur again in that particular region.

So, "earthquakes do not kill people, buildings do". Because most damage we will be to the buildings during an earthquake. Earthquakes located in isolated areas far from human population are not going to affect us and they are not posing any short of and hazard or risk to us if it is going to occur in a remote area and that what happened in 1819 earthquake (Refer Time: 20:10) in Kutch because it took place in an remote area where not much people were affected.

So, this is another important point even with the moderate magnitude if you are having the population is high you will end up having more damage and more people getting affected because of that. Thus in earthquake prone areas strict building codes should be followed for the design and construction of buildings and structures that can withstand the large earthquake and reduces the death toll. Damage from earthquakes can be classified as follows.

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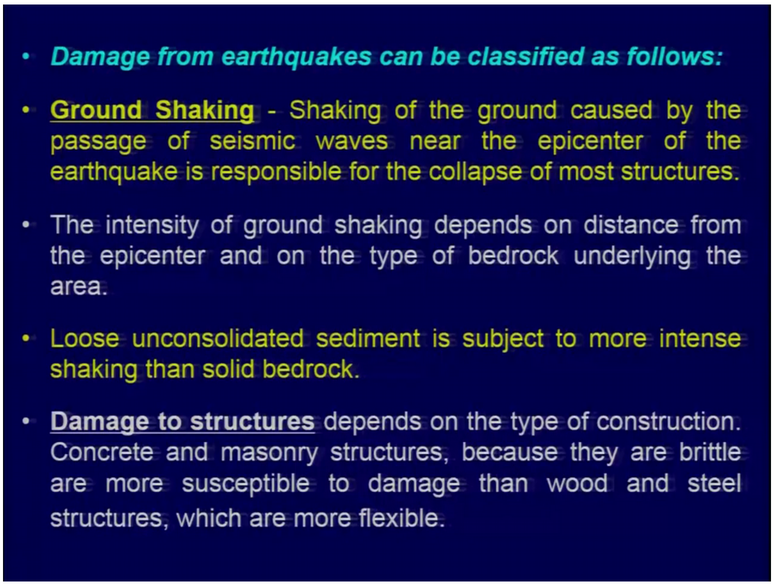

Ground shaking ok; that is shaking of ground caused by this is what we were talking about the liquefaction. The intensity of ground shaking depends on the distance from the epicenter and on the type of bedrock or the material on which you have constructed your structures. Loose unconsolidated sediments will be subjected to more intense ground shaking than the solid bedrock.

Damage to the structure depends on the type of construction ok. So, if you are having machinery structures you have or safe, but of course, you need to follow the building course ok.

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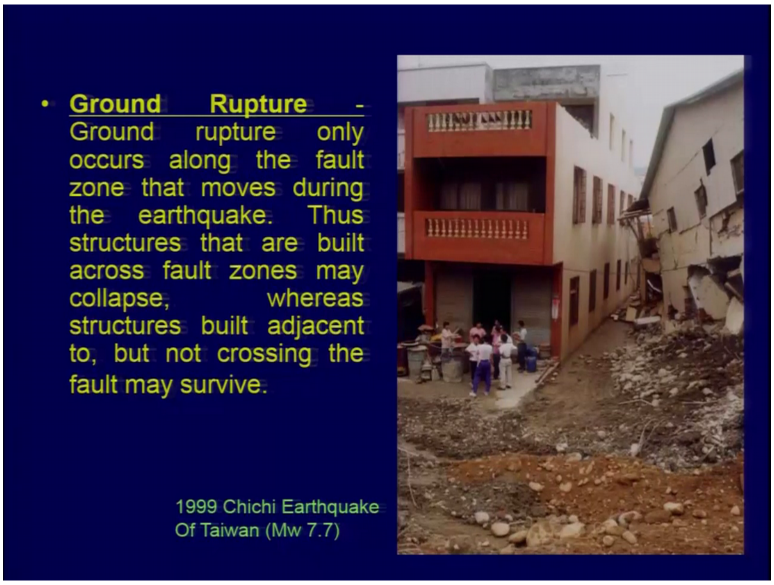

And this is an example of from Taiwan, the rupture pass through this area and this the adjacent house was as it is, but this got damaged because this was been constructed on the default line. So, this is from Taiwan 1999 Chichi earthquake example.

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The landslides from 2000 2005 Muzaffarabad earthquake.

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There is an faults curb from the epicentral area where the rupture took place 2005 Muzaffarabad earthquake. The white part which you see here are all the roof of the houses and this house which is sitting on the hanging of foot wall survived whereas, all the houses which was sitting on the faults curb this is what we call active tectonic landforms. So, this is the faults curb scarp which is of course, quite a bit high that; that means, not this was this fault has triggered earthquake in the past also.

So, this was not in the one go the height which you see here, but it was during the multiple earthquakes. So, this is another and example or the lesson which has been taught by this earthquake of 2005 that initiated in void constructing the houses on the faults curbs or close to the faults curbs or on the fault line. So, the geological hazard related to earthquakes in total if we take we can have a number of ways.

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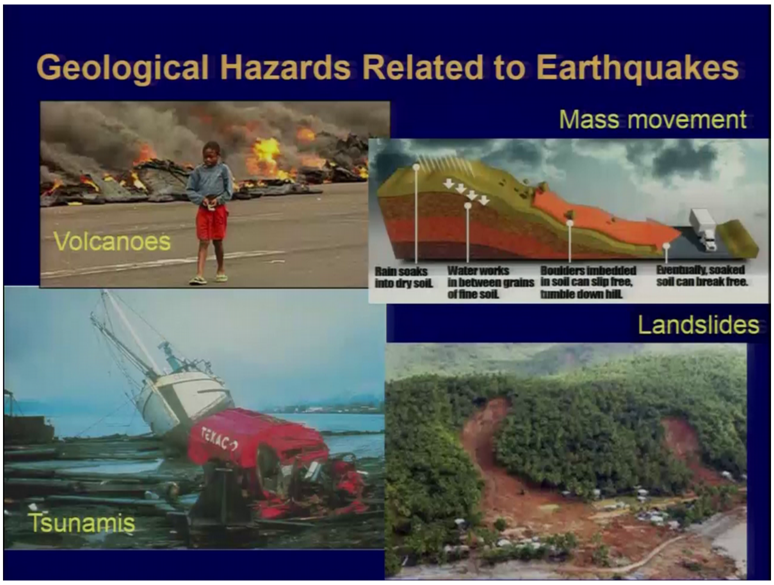

Even if you are sitting close to the fault line close to the plate boundary or you are sitting away from the plate boundary for example, volcanoes, tsunamis, landslides, big fraction. These are all the secondary affects which can which can it should be taken care of and should understand that this areas would be prone to such type of hazards because of strong ground shaking or because of the subtraction which is going on volcanic eruptions can also be triggered because of the great earthquake. So, these are the examples of landslides.

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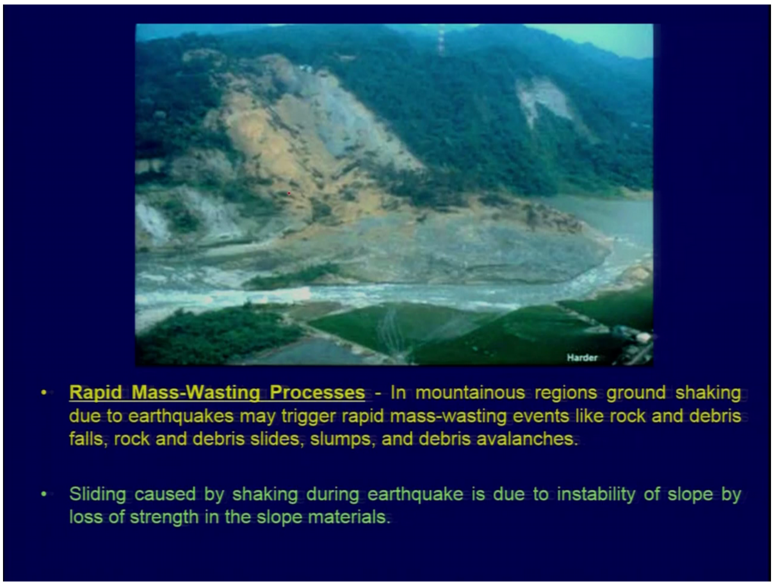

The rapid mass moment processes.

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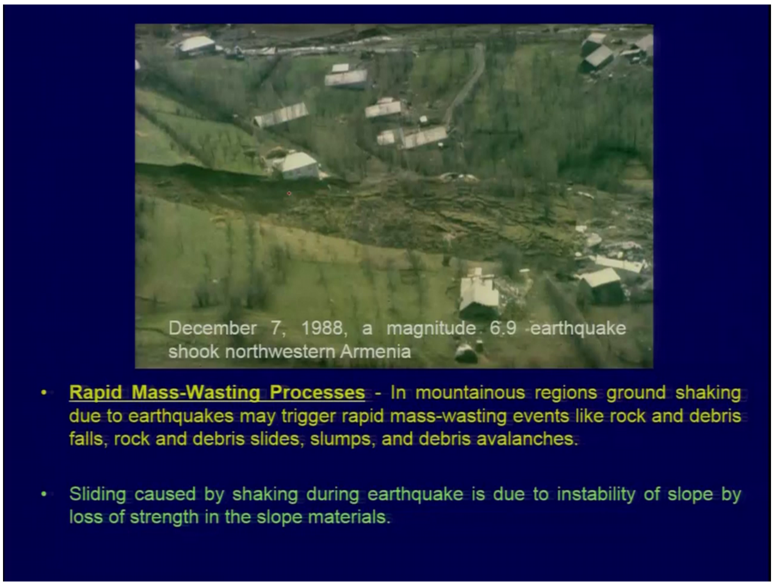

And then lahar flow if you are having in volcanic eruption you can get into the lahar flows in the region.

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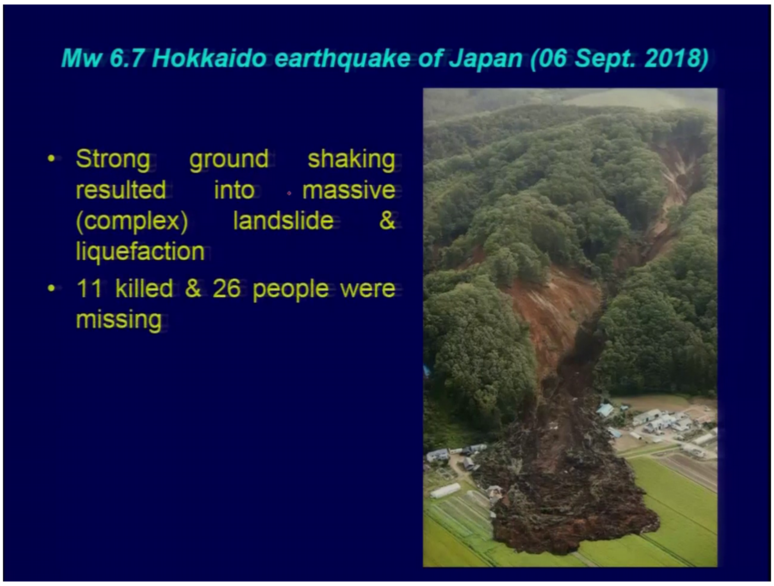

This in recent 2018 landslide which was been caused in Hokkaido region in the magnitude was not much in terms of like 6.7 only.

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But a massive landslide was triggered if you look at the complex features of this, this photograph is before the earthquake.

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And this is after. So, it was in complex landslide which was been triggered the reason was the material and the hills in this area all the hills aware like oversaturated we can say because before an earthquake there was not spill of very heavy rain because caused by the strom in that region which resulted into a massive landslide just within magnitude of 6.7.

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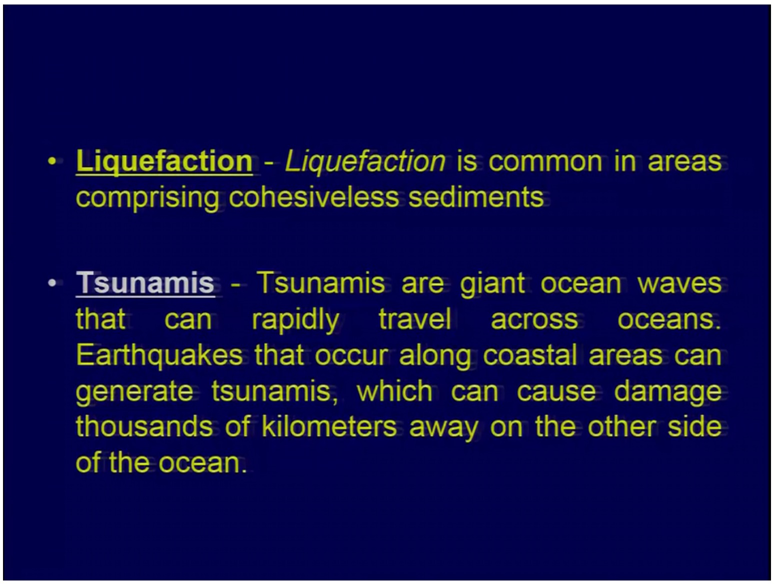

So, liquefaction is the commonly observed phenomena even if you are sitting away from the epicentral area even the tsunami can travel thousands of kilometer it can be transoceanic from one ocean to another ocean it can travel if you are having a mega earthquake along the subduction zone.

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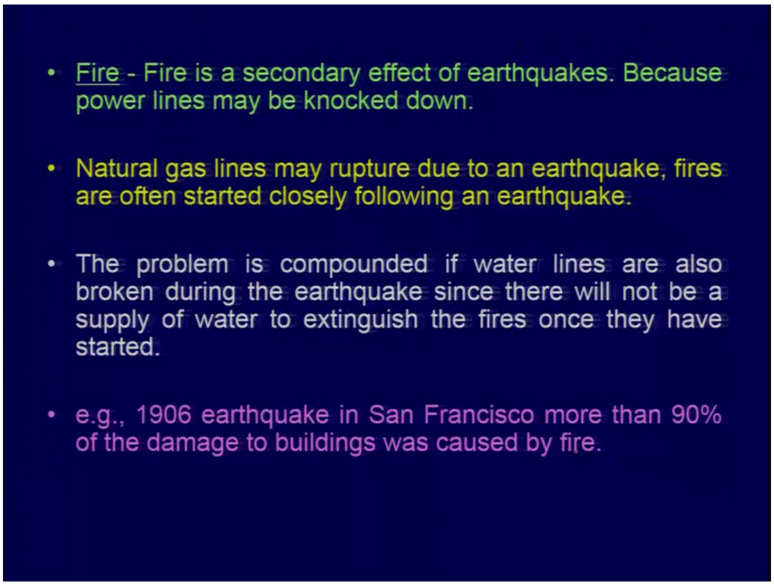

And so, these are the 2 things which can now also be seen in addition to the and then you can have fire which is in secondary effect. So, the earthquakes occurring in evening in a night will have different scenario in terms of the damage and the life loss. Natural gas line ruptures ok, problems in the compounding compounded by water lines you may have if you are having the breaking up of the dams or maybe breaching of the your canals water canals can result into a local flooding and this is an example of 1906 earthquake in San Francisco more than 90 percent of the damage to the building was caused by fire.

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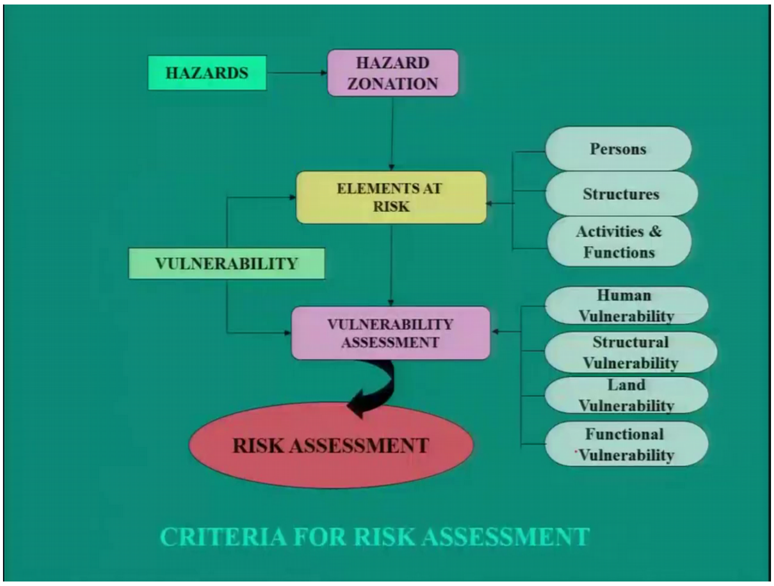

So these are the important parameters which are secondary effect which we feel are very trivial, but we need to take into consideration. So, final what we do the risk assessment includes what type of hazards we are looking at the zonation map and then we take into consideration that how what are the activities and the people will be affected. So, the persons will be affected number of person structures activities and functions and then this information we take has an element at risk ok.

Here then the vulnerability of assessment based on this will give an final input here in with an inclusion of human vulnerability that how many people are going after the structures vulnerability in learn vulnerability in function vulnerability and finally, you can talk about the risk assessment of the area.

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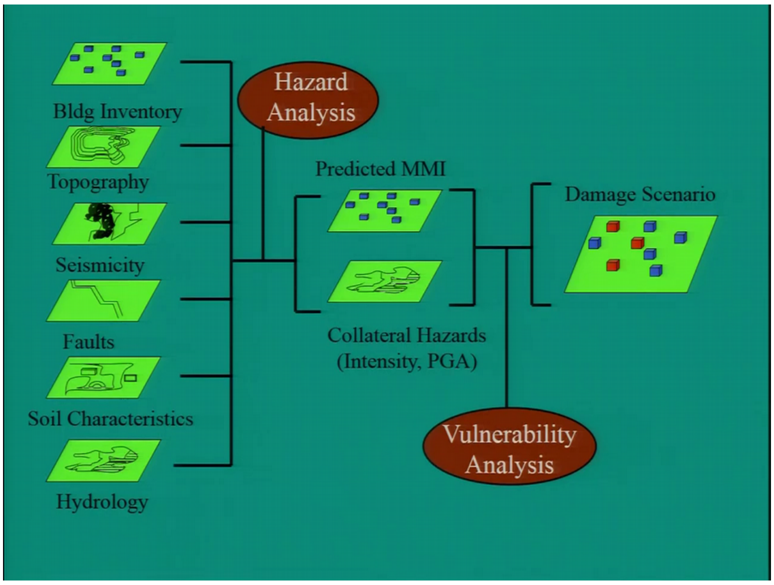

So, you need to have many information and this is the information which usually is required to go for micro zonation. So, you take into consideration the building inventory, topography, seismicity, faults in the area, soil characteristics, hydrology that is a groundwater condition. And then do hazard analysis and prediction in modified mercalli scale that is an intensity and collateral you can put into the intensity in PGA, the damage scenario and then finally, you are talking about which includes the vulnerability analysis.

So, then you can come up with and damage scenario what will be the how much area will be affected and what how many people will be affected because of hazard and. So, I will close this here and we will continue in the next lecture with a new topic.

Thank you so, much.