

Introduction to Engineering Seismology
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Lecture – 40
Earthquake Prediction (Some Precautions)

So vanakkam so we will start our engineering seismology lectures I will continue. So, we have been discussing about the prediction of the earthquake. So, we are discussing the about the saying that it is not possible predict very accurately earthquake. But still we have been discussed nine way of predicting that you have earthquake and also, we see it depends upon the time how we predict okay it is like the short-term long term and then medium time prediction.

So generally, the short-term prediction is within a day okay within a day if it is predicted 24 hours or 48 hours kind of things in our basis predictions short term prediction. So maybe three a month we can say short term prediction a month to two year is basically medium time prediction so before several years basically a long-term prediction. So even though the scientific basis of earthquake okay so somewhere represented in the earthquake prediction that is a good way of predicting the earthquake.

So, there are a nine scientific relation with that earthquake activity which may not be so much attractive which is that I told that astrology-based prediction okay. So, the planet position-based prediction even though the theory may be strong on that okay mathematics steady may be strong but the relation with the earthquake what happens okay it is not very clearly explained on those methods. But what we discussed based on nine approaches basically all of them a basically the related with the earthquake.

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Earthquakes Predict Methods

9 Methods to Predict Earthquake are

- 1. Unusual Animal Behaviour,
- 2. Hydrochemical Precursors,
- 3. Temperature Change,
- 4. Water Level,
- 5. Radon Gas,
- 6. Oil Wells,
- 7. Theory of Seismic Gap, .
- 8. Foreshocks, 9. Changes in Seismic Wave Velocity !



<https://www.yourarticlelibrary.com/earthquake/earthquakes-prediction-9-methods-to-predict-earthquake/13915>

So, we started with the unusual animal behaviour okay that one. So, as we have seen that so the animal has a extra sensing capacity than a human so which is capable of predicting that the nature okay so behaviour of the earth so which usually moves away from the epicentre. So, most of the animals who lives on the places where there is going to be a epicentre that is going to be a dangerous going to come due to the tsunami or something like that okay.

So, these animals' sense that and the moves around that particular area to the safer area okay so that is how the animal behaviour has been used our unusual animal behaviour has been used to predict earthquake. We have seen that so 1975, 7.3 magnitude successfully predicted in the china which was a first and scientific evidence where the earthquake has been predicted even there are lot of people reported that unusual animal behaviour in the earthquake.

But scientifically proved and predicted is that but then we also notice that it is not only the animal behaviour it is also the hydraulic chemical hydro chemical precursors and water level raise. So, these are all the parameters also basically helped to predict the earthquake okay. So that was maybe the success case so then we have seen raise in the temperature, water level, radon gas, oil well.

So, all those parameters if you look at all of them basically so all these things basically related with the; what happens with the crust, crust of the rock when moves. So, when the both the rock okay it is going to break okay so then so whatever happening here within the

farmer borewell and then the temperature. So, all those phenomena is somewhere related to that the mechanics and physics and the earthquake.

So that is maybe the reason that when you have 2, 3 sequential event at the same place there is a success rate of earthquake being so increases but the problem is that so these are all the technique like oil wells radon gas, water level temperature hydro chemical changes it is not going to give you the size of the earthquake. So that is one of the issues maybe the place of the earthquake we can know and maybe you can predict in the short-term range all of them because it is like a week or two days or a few hours can help but the size of that earthquake is not possible.

But at least animal behaviour they are told that the animals are going to begin a unusual very unusual way close to the earthquake at period okay. So that was observation it is made so linking up this at least some extent we can predict a earthquake that is what we discussed. So even though it is not well-practiced and no earthquake has been successfully predicted so after the china earthquake very few attacks had been predicted. So, but these theories somebody adopted very well okay it can be predicted.

So the another one where you have the recorded data okay the recorded data means the wave form okay the history of the earthquake okay so how many years what big earthquake happened in that? So those kinds of data's will help the theory of seismic gap foreshock and changes in the seismic wave velocity okay so like VP and VS ratio pattern changes. So, these things are possible by using the instrumental record.

So, overall, all these methods basically scientifically proved okay these are all successful method if you combine them very effectively and this one. So as an India as per my knowledge many people report these are all the signature or whatever unusual way whatever observation they made after the earthquake. As on now there is no earthquake in India has been predicted using this technology.

So those who are auditing the scores are taking the course willing to work on this area provided if you have the access to the data and some way where you can have the control over the local places so I can help basically to get this done success okay for part of your

study or part of your research project so any way I can help are extending that for example if you want to predict the earthquake at Uttarakhand okay.

So you want you are living at the place so you should have first the recording data access to you, you should have that recorded acceleration time history continuously whenever we want to we should have the access that if you have and the second you have the control over local area control over means for example you should have the if I tell you that go and say install a digital well monitoring sensors so you should be able to install and get a data yourself without any interpretation.

So you should have some kind of administration control as well as the people support and monitoring animal behaviour so these are all things if you do in the active regions like the place there may be a success rate that we can predict relatively at least for a few hours before the earthquake it will reduce human casualties okay. That is a very important so reduction of the human causality is the prime importance for any of the planning and modelling and then controlled way of approaching of this one.

So that is what you are seeing even the COVID-19 okay so as on today there was a lot of precautionary steps has been taken by the government basically to monitor who has that virus make them isolated from the mass so that it does not spread well and then give them enough medicine okay and then the treatment so that the overcome. So, these are all the way one can control the at least casualties okay so that is a very prime important.

So that way by doing this kind of studies one can help to minimize the human loss due to that any future earthquake particularly active regions like a plate boundary where there is a suspicious about the seismic gap and a very big due earthquake in those regions like who said that western seismic gaps, central seismic gap, eastern seismic gap those region at least those who are interested to involve on that I will be happy to support and extend all my knowledge as well as the team and the equipment's what that I have.

As I told you I have a dedicated seismometer which can record the earthquake okay so we have the technology to measure the dynamic properties of the medium okay so where the downhole survey , up hole survey and the image seismic survey GPR to monitor that there is any variation in there where the surface material moment okay like the fractures are

happening basically you get changed in that dielectric property of the material which I can monitor using the ground penetrating radar then electrical resistivity tomography.

So, these are all the surveys we do frequently at one location you can able to sense what happens in the dielectric properties of the medium electromagnetic wave changes. So, all of those things can be put together in some way that we can get a better prediction which will also help you to develop a future kind of technology or streamlined metrology where it will be monitored okay so that way it will help.

So I will be happy to extend my support whoever if you are interested with the financial support and necessary our administrative support but I can only provide the facilities okay and then guidance not the finance support and then local administrative I do not have any power on those kinds of things but these things at least will help to our comeback. So even if we predict earthquake as I told you that knowing earthquake location okay so the size okay and then the; may not be sufficient to prevent a damage because for that you should know how much okay so damage is expected.

So that is also very another level of importance. But we are done extensive research on that so if somebody able to predict a valid prediction.

What constitutes a valid prediction?

- Date and time ✓
- Place of occurrence ✓
- Magnitude ✓
- Recorded in written form
- Confidence estimate (probability)
- Enough of the scientific basis for the prediction that its validity can be evaluated

Handwritten annotations include a bracket grouping the first three items, a red scribble, and the text "IPE" and "GPE" written in red.

Ref : <https://www.slideshare.net/abhijeetshetkar/earthquake-prediction-26866262>

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Okay the date and time of earthquake okay the place of occurrence magnitude okay so then using this data okay based on our experience and research what I do actually I can get a acceleration time history of the data okay synthetically as I told you that we do so any earthquake I can get anywhere in India we have been equipped for doing that kind of thing.

So, once I get this okay then I will be able to say that we said the area will affect more which are the area will affect less.

Because we have been working on in density predictive equations and models. Ground motion predictive equations and the models which we will be discussing in the detail future classes but just I am telling you. So, it will help you to identify what type of damage level okay 50% 60% whatever damage level you can expect and what is the acceleration you can expect.

So, based on that one can go for the next level of using the prediction effectively to prevent not only prediction will help because even if you say that this is earthquake going to come if there is no proper planning and then estimation is a useless data okay. So, but since I have worked research do research on this area work extensively so I can support those knowledges to get all the information.

Okay so if time permits, I will also discuss one of the recent earthquakes what we are doing with respect to the future earthquake so what do we are taken basically? Himalayan region okay so we have identified about 16 seismic gap okay 16 seismic gap where seismologist and geologists believe that that may be chances of some earthquake in this region in the future so what do we do actually this 16 location okay.

So, these 16 locations so what do we did actually we estimated yeah probable magnitude using the regional rupture character which I developed we will be discussing that the regional rupture character of the this one and the estimated each location what is the M max possible? So using this M max we estimated we simulated girded pattern a acceleration time density at each location at the depth of bedrock Indo-Gangetic basin 270 location.

We created 16 into 270 earthquake has been created at each location then using the dynamic properties what we measured using the MSW and others we estimated what is the expected PJ value at the surface what is the amplification? So that the future design can people can consider this and design so by the time if the I get the acceptance of the manuscript I will give you the some glimpse of about this study which was one of the good study where which will help you basically to future hazard will be considered in the present.

So, like that those kinds of technologies okay developments are available with us. So as I told you that the earthquake prediction how it will help. Okay so sometime the wrong prediction will create a unnecessary disturbance and impact in the society which will be more than the impact caused by the earthquake itself. So, what are those problems? Those problems called as a socioeconomic impact and adjustment on an earthquake prediction.

So, if the earthquake predictions are not done properly and also if done even properly with a different time period what is the socioeconomic impact? So that is the one of the main concern many scientists believe that prediction of earthquake is almost create a lot of other trouble in that case not predicting itself good that is what they believe group of scientists.

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Socio Economic Impacts and Adjustments to an Earthquake prediction

- The social and economic consequences of earthquake forecasts are a subject of some controversy. Yet, as **seismological research continues, numerous earthquake warnings from diverse sources will probably continue to be issued in various countries.** For example, numerous forewarnings have been issued in China.
- In some countries, studies on the unfavorable as well as the propitious consequences of prediction have been made. For example, if the time of a large damaging earthquake in California were accurately predicted a year or so ahead of time, and continuously updated, **casualties and even property damage directly resulting from the earthquake might be much reduced; but the communities in a wider region might suffer social disruption and decline in the local economy.**
- For example, if after the scientific prediction and official warning, massive public demand for earthquake insurance cuts off its availability, then **temporary but drastic effects on property values, real estate sales, construction, investment, and employment might ensue in the region.**

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So the socioeconomic consequences of earthquake are subject of some controversy yet the seismological research continues number of earthquake warning from diverse source will be probably continued to be issued at various countries example for example number of fore warning have been issued in the china after successful prediction of those earthquakes 1975 some countries studies an unfavourable as well as a propitious consequence of the prediction have been made.

For example, if the time of a large demanding earthquake in California were accurately predicted in a year or ahead of the time the continuously updated casualties and even property damage directly resulting from earthquake might be much reduced but at the same time so the community's wider region might suffer social deception and a decline the local economy okay.

So, that what happens that is what we are going to discuss in detail. For example, if after the scientific prediction of the official warning and massive public demand of the earthquake incidents. Okay so earthquake incidents cut its availability and then temporary but drastic effect of property values, real estate sale construction investment and employment and then all these all them will effect.

So basically, somebody predicted one year two years before saying that a big earthquake going to happen in the Bangalore then what happens? The company who is mean working in the Bangalore they tried to move away from Bangalore for example software companies which is one of the main incomes for the government. So, they will be shifting to Mysore or some other place where they are more convenient.

Okay so in that case so once the software company most people will lose their job who was locally engaging in the job that is the one thing second government loses his income stacks and grant due to that so the software people most then the associated problems okay. So, the person who is selling to them vegetable and all the groceries all those people get chain of people will get effect okay.

So not only that now okay so then the next is this people mostly buy apartments and stay and then. So, what they will do so basically these people look like there are about lakh and two lakh and three lakh people are moving together so then they will sell their houses the real estate value will reduce okay demand for insurance will increase people all of them want to insure their house because something happened they will get some compensation.

So, they demand for the insurance get the real estate business will then since there is no real estate buyer and all construction will affect okay. So, then the employment okay unemployment all those things will be created because there is a mass moving of this company, I am giving you a bit of a scenario. So, this even you can experience people because of this lock down you might have seen that many cities okay so many cities many people are jobless because the company has to pay without job that is what government says during the lockdown.

So how will the company will pay when the company is running with some income from the outsourced work. So if the nobody is giving them job how they pay to the employee then the employee losing their job. So when the employee is not getting the job so how he will spend money? If you do not; you spend your money our economical will grow so basically the people who are small scale business there are affected very widely that is why government after some time even there is a increase in the rates of COVID-19 cases in order to stabilize economy.

They try to open up and to say that people be safe and to try to yourself self-isolate and make things happen so no spreading is happening so that is the way this one. So, this is at least where it is only disease okay? It does not create any this one but this kind of earthquake kind of things it affects entire a big area when compared to other areas for example of the Bangalore is predicted people easily move to Chennai.

Now it is not possible because everywhere the same scenario. So, in the earthquake it is possible they moved to Mysore, they moved to Chennai, they moved to Hyderabad so where the one place the demand will increase another place the supply will suffer. So, all those things are the sequential event which is a socioeconomic impact of the prediction of the long-term earthquake okay. Sometime this impact okay the loss due to this okay will be much more than that the actual earthquake which is even occurred in the same place. So that was the scientific argument that some of the scientists believe the this.

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- But what would be the economic and social impact of the prediction **over the coming year**? It is likely that a large number of people would move away, businesses would shut down, and the economy would probably go into freefall. The economic and social cost for Newtown would be huge – and indeed might be greater than the cost of the earthquake itself.
- This is made far worse when **one considers that the prediction cannot be 100% reliable** – indeed as I'll show below it is likely to be a long way from this — which means that it could well be a false alarm, or the magnitude might be overestimated, or the location would be wrong. In this case of course **the unnecessary damage to the economy and social functioning of Newtown would be very large indeed.**

So, but it would be economic and social impact of the prediction over a coming year. So, if it is likely that large number of people would move away from business would shut down the economic would probably go free fall the economic and social cost of the Newtown would. So basically, people and moved to other place again that there the land cost will increase okay living costs of the people will increase.

So such kind of things will again affect the that region also okay so that people may be getting some vegetables at X rupees because of this new people move there so then X become a 2X, 3X okay so that is what you see and even COVID time in the lockdown was announced without a proper intimation so many of the groceries and vegetable shop raised so same thing will happen when people migrate from one place to other place all those things problems will come.

So, this is also made as well then one considers that the prediction cannot be 100% when the prediction is not 100% reliable okay this kind of scenarios are make more worse. In case after happening all this thing the earthquake does not happen then it is a very problematic because the people moved, they cannot resettle all those things. So, these kind of problems are scientists thinking that okay so should not end up by prediction wrong things.

So, unless otherwise there is sure and reliable then only the earthquake prediction should be informed okay. So, the unnecessary economic and social functioning okay of the world and Newtown will be reduced considerably these kind of steps are taken.

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- So if the economic and social impacts of a very long-term prediction are problematic, what about short-term predictions? Say a prediction could be made that the same earthquake will strike Newtown 24 hours from now. This would avoid the long-term economic and social impacts, but would permit a high level of preparedness to be achieved. Again, buildings could be evacuated, hospitals made ready, schools closed, etc.
- In essence this is appealing, but the practical problem lies again with uncertainty in the prediction. Let's say the prediction was perfectly correct in terms of the time and the magnitude, but was 200 kilometres out for the location. This could have disastrous consequences if the population has been moved from the area of the prediction into the area that is now affected. This could (and probably would) make the impact of the earthquake far more serious than if no prediction had been made.

So, if the economic and social impact of very long okay so long-term prediction are problematic so what about the short-term prediction. So, say a prediction is made same earthquake strike Newtown 24 hrs from now. For example, Bangalore I predict that before tomorrow evening there is a big earthquake is going to happen. So, then what it will do then basically.

So, then the people okay so if they do not have the proper preparedness okay they try to move okay they try to escape as a mass so that will create your traffic congestion and then stampedes and then a lot of other issues okay and then since people know that if something happens I will be losing this that everything they also do involve in their criminal activities may be. Now you might be seeing that there are a lot of the WhatsApp and YouTube videos that because of this COVID lock down okay so people even rich people trying to steal break a shop and try to get whatever they want.

So, these are all there this kind of pandemic and epidemic activities will. So similarly, this kind of short-term prediction will lead okay today a different problem. So, the practical problem lies again uncertainty period let us the prediction was perfectly correct in terms of time and magnitude but it was some distance away okay. So, if the 100% predictions are not achieved okay there is a problem the short-term prediction also putting pressure on that for example hospitals may not be made ready because 24 hours nothing you can do as you know that the system of working and all those things.

So then even if you prepared you cannot provide that damage only you can do small things okay like you can close the schools okay so but it still people in the house also say for not we do not know okay the mass gathering can be prevented. So those are all the some of the steps which help under the short-term prediction to overcome all those things but the error in the prediction with respect to location. Because as we know that the earthquakes are going to affect starting from the epicentre area about a few kilometres to the 750 kilometres.

So, somebody predict the error of 100 and 200 kilometre with the geological scales is nothing because if you put India in the whole world map so if you mark some dot so that will represent several tens of kilometres. So, if the error in such kind of kilometre so okay so then it will be for example you say that this location earthquake going to come it is happening at 200 kilometres away from that area. So, these people may be prepared but those people may

be relaxed they will die more okay those kinds of consequences also dangerous when you do not have that 100% prediction possibilities okay.

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- Or let's say that the earthquake location and magnitude was exactly right, but that **it happened three days later than the prediction.** There is a large chance that the population would start to move back into the affected area, and could be more vulnerable than if no prediction had been made.
- In reality, **the mechanics of earthquakes makes predicting them even more problematic.**
- First, while it is common to imagine that an earthquake is similar to a bomb being detonated at a point underground, with the energy waves travelling away from that point, the actual mechanisms are rather different. In fact, an earthquake occurs as a result of two blocks moving past each other on a fault — an underground surface — with energy waves being radiated from every point on that surface. The earthquake typically starts with a rupture event that starts a slippage, which then spreads along the fault over a period typically of a few minutes.

So these are all the aspects we are talking about the socioeconomic issues with respect to prediction of the earthquake particularly when there is not possible to predict 100% okay. Let us say that the earthquake location magnitude was exactly right but it happened three days after the prediction what happens if the time prediction is wrong? One we are seeing that the distance prediction next is that time prediction.

So, you say that tomorrow I said that next to 24 hours before but unfortunately it happened that because of the geological age and calculation problem. But then the people it does not go going to happen why we should worry too much then after two days the same earthquake happened many people today than the expected because these people will be now be relaxed they do not even believe second time tsunami warning system has been issued or kind of things.

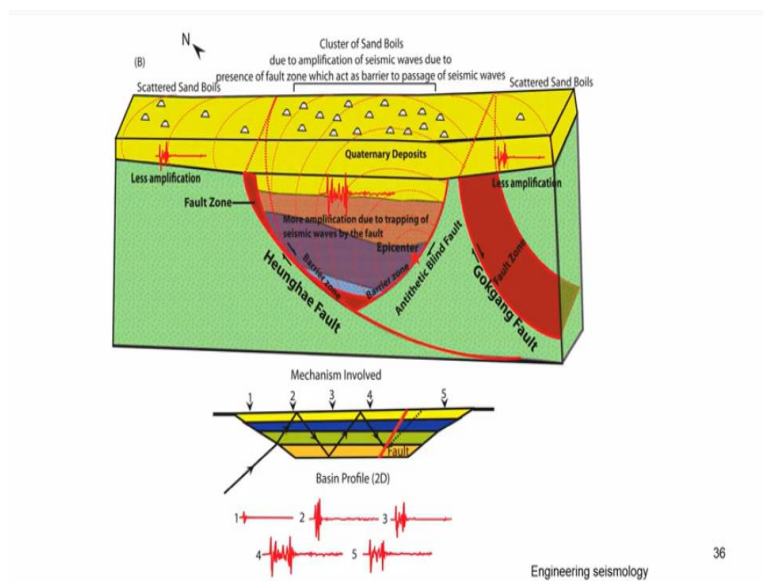
Okay this is in fact true so soon after Sumatra tsunami must set up your warning system and then they also tried to announce okay so what happened? But as the tsunami is only happened going to happen when the vertical displacement there are earthquake in the sea but it does not have the vertical displacement it is only horizontal. So, but the government since the earthquake is there soon after that they start issuing the tsunami warning there are many false tsunami warning systems has been issued by the government okay?

So, these are all the things which is problematic people even if you issue sometime the right information because of several false this they do not follow right one. Because these are other some of their social behaviour impact on this outcome wrong prediction. Okay so the mechanics of the earthquake makes prediction more even problematic. First if the common imagine that the earthquake is similar to the bomb being detonated at the point undergone with the energy waves traveling away from the point actual mechanism are rather different.

So, in fact the earthquake occurs as a result of two blocks moving past each other on a fault an underground surface with energy waves being radiated from the earth point is the surface. The earthquake typically starts with the rupture event that starts slippage it is even spread along the fault over a period typically few minutes. So, the phenomenon okay the mechanism happens in the earthquake sometime what happen if you predict earthquake that is a point and say that around this 100 kilometre will affect.

But sometime it effects on only one direction of the earthquake for example depends upon the fault orientation. Other direction even though it may be closer to the epicentre it may not experience any problem. So, when you have urban settlement okay Delhi kind of regions okay the earthquakes are occurring at one place but it is going to damage severely one place another place not damaging then this can create up a problem with the people. Okay so a lot of the management issues and handling up so all of those things are there common these are the people who have not faced with this kind of hazard will be this one.

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So, it is necessary okay to predict well the earthquake when is that? Even if not only prediction that prediction how is going to cost a damage okay how are you going to that area going to behave how the wave propagation that area going to happen because of that that earthquake. So, if you want to model these aspects well before and then predict the earthquake and the link both of them and adopt yeah, the warning system precautionary measures that will be more efficient way okay. So, as we have seen that earthquakes occur anywhere on the fault okay so then okay. So, this earthquake so; anywhere in the fault it occurs okay then the waves get radiant.

So, depends upon the location okay as you we are seen in the wave propagation theory you get at one place okay so less amplification okay so we say this one so you had a more amplification so like that depends upon the place to place this wave are keep changing. So, you should know you should understand this well in advance then only your prediction data you can use effectively to prevent a loss to the human loss also this one.

So, for example so the rock region the damage will be completely different a basin region the damage will be completely. So this is the 2D modelling of a particular basin which is almost a similar to our Indo-Gangetic indirect entity kind of things where a thick deposit in that the earthquake happen you can see their different point how the wave form okay you can see that 1, 2, 3, 4, 5.

So, each location you will have the different wave form so depends upon as you know that the wave amplitude and duration, we are going to get a damage. So, modelling of this wave okay is very important understanding of this wave how it modifies in the regions also very important if you have this knowledge then you predict the earthquake then you interlink both of them then it is possible to get more reliable loss assessment from the earthquake okay.

So, the mechanics-based earthquake predictions are very well but if it is not very sure you should not create a panic among the people because it will go into creating a socio-economic impact okay sometime these impacts are very large okay. So, I can give you the example okay so this covid-19 lock down so because the migration of the people who are in the different places of India not considered when you are issuing the lockdown.

So many people are suffered without a job without food then they started moving themselves by walking okay so now what happened? All this generation will have the mindset at any cost I should not go move from my land to other places because I may end up in similar kind of situation in the future. So this kind of the psychological problem will come okay people will be hereafter will be afraid after covid-19 lockdown at the different countries people will be afraid to go to other countries operate to go to travel afraid to go to work for other places so obviously this all will impact on the economics okay?

So, the people may you may not get your proper people to do your job okay you may not get here proper support for anything as you have seen that the air industry as though one of the worst affected because the tourism industry is another one was affected. Here after people will be afraid to go and necessarily travel okay nobody will be willing to go here and there as I told you the social the interaction will reduce considerably travel will reduce it will also affect the subsequent industry which is supporting.

Okay here after the malls movie theatres and then mass gathering people will be problem even the marriage halls okay so there is a time when January or other places married hall used to charge you know for one day they used to charge you know 10 lakh, 15 lakh rupees to conduct a marriage. So now that all that there is no more marriage with the mass gathering so all those businesses got gone okay.

So, such kind of social behaviour and the economical impact will create the wrong kind of things prediction particularly earthquake if we predict wrongly all this synchronize will affect. So, in order to take care of that if you are only 100% sure the prediction is going to right then issue a warning okay otherwise say that this prediction this time if you stay away okay at least you can save your life.

Okay such kind of things will happen but more or less anything which related with the plate tectonics and the wave propagation based prediction will be more reliable and more authenticated that is what I think actually according to the subject also if you understand the physics behind the earthquake that is the only way it will help. So hopefully India right now we do not have any system of wave prediction of Earthquake.

But in future I hope some scientists will work towards that where people have access to the data control over local monitoring system then we will be success in predicting a bigger earthquake that will reduce a lot of people life okay. So, the fatality will be reduced economic and loss will be corrected if we predict well. So, we should work towards that at least to a future we can do this.

So, with this we will be closing our earthquake prediction subject which we have discussed in the last four classes. So it is the one of the very interesting and the fascinated subject many people try to work even starting with a school student because their prediction earthquake I was telling know if somebody is 100% success in prediction earthquake subsequently they predict okay so they even get a noble prize okay there is no well-established way of predicting that only this happening sometime.

Sometime it is not happening because of the several associated geological scale behaviours of the crust okay. So hopefully this will science will grow future. Even if you predicted earthquake it does not mean that you will escape from the earthquake okay the damage and losses so how do you reduce those kinds of things? So, the prediction is one thing okay but right now prediction is not possible okay that 100% we are sure that cannot be predicted well.

So, another way is then how do you minimize loss due to the earthquake damage due to the earthquake, if the earthquake come so that is prediction of earthquake hazard parameters or prediction of earthquake hazard not prediction of earthquake it is the perdition of earthquake hazard okay. So, the prediction of earthquake hazard okay the prediction of earthquake hazard parameters the ground motion parameter time domain parameters those kinds of activities are the next very important activity to reduce the impact due to the earthquake. Okay so that is what we are going to discuss from the next class onwards. Thank you very much for watching this video so we will see in the next class. Thank you.