

**Introduction to Engineering Seismology**  
**Prof. Anbazhagan P**  
**Department of Civil Engineering**  
**Indian Institute of Science-Bangalore**

**Lecture - 01**  
**Introduction**

So (FL). So my name is Anbazhagan. I am going to talk about the engineering seismology, the first class on hazard and preparedness. The hazard, what is mean by hazard? The hazard is actually a danger or risk, okay. So when we call it in the noun.

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## Introduction

### Hazard

- **Noun** :

- 1) a danger or risk.
  - "the hazards of childbirth"
- 2) Literary: chance; probability.
  - "we can form no calculation concerning the laws of hazard"

- **Verb**

- 1) say (something) in a tentative way.
  - "he hazarded a guess"
- 2) put (something) at risk of being lost.
  - "the cargo business is too risky to hazard money on"

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So the same thing if you call it in the verb, it says like say something is tentative way or put something at risk being a lost, okay. So the hazard is basically any event which causes some kind of disturbance or the problems to the living things okay is called as a hazard, okay.

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## Hazard

Man Made Hazard

Natural Hazard

## Disaster

- A sudden accident or a natural catastrophe that causes great damage or loss of life. :  
"159 people died in the disaster"

So this hazard can be categorized as a two major category. One is a man-made hazard, the another one is the natural hazard. So what is meant by man-made hazard? Anything which is made by the human being which causes okay so loss or damage to the living things is called as a man-made hazard. For example, somebody excavate a pipeline or a pit and leave it without closing.

Then somebody going there and unknowingly fall on the pit which causes a hazard or risk to that particular person. So that is called as a man-made hazard. So the man-made hazard is like any hazard which is created by the man is called as a man-made hazard. The other hazard is natural hazard. So this natural hazard is anything which occurs due to the nature system, okay.

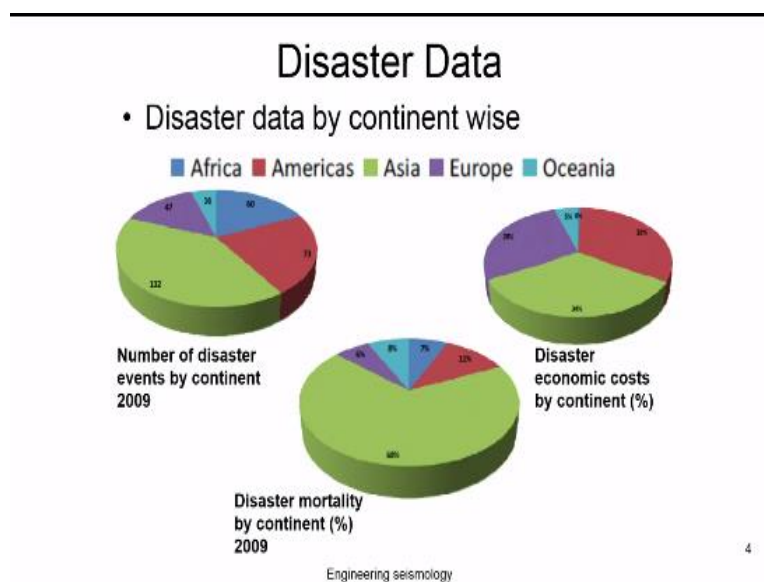
So due to the change in the climate or movement of the earth or rotation of the earth. So or the falling of something which is naturally occurs. So those kind of things is called as a natural hazard. So this hazard basically even though we call it as a risk, but all the hazard may not be disastrous. So then what is meant by disastrous? So the disaster means a sudden accident or natural catastrophe that causes a great damage or loss of life.

So any hazard which causes the more loss and damage is called as a disaster okay. So for example, the flood occurs you will get only small height of the water or 2 inch water is occurring due to the rain. So that is a flood, so that is a natural hazard okay.

So if that flood sometimes flows very higher level and causes damage to the house and human being and animals, so that flood is called as a disastrous.

So that is how the hazards and disastrous we should differentiate. So in this class we try to understand what are the different type of natural hazard okay so present in the world and how this natural hazards are grouped okay. So how you can prepare yourself to overcome this kind of natural hazard okay. So this will be the first part of our engineering seismology course. So where we will be discussing about the hazard and preparedness.

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So if we look at the global level, okay, so if you divide the entire world into five continent, like the Africa, America and Asia and Europe and Oceanic, so with different color, you can see that the green is Asia, purple is Europe and light green is Oceanic. And then the red is America, okay. So if you look at the five division, the number of disaster happened, okay. So up to 2009.

You can see that so in Asia, you can see that 132 natural disasters are reported in Asia and 79 natural disaster events are reported in America and then about 60 okay, so natural disaster event reported in Africa and 16 reported in the Oceanic and 47 reported in the Europe, okay. So the number of event occurred if you compare a five continent, this continent more or less with size okay.

You can compare the size the number of natural disaster occurring in the Asia is comparatively large when compared to any other continent. So when you compare the number of events, we will talk about how these events causing the economic and as well as the number of people die, that is a mortality, okay.

So if you divide the five continent with number of people die, due to this natural hazards, you can see that a 68% of the people die due to the natural hazard in Asia. And then about 11% of the people die in America, 7% of the people die in Africa and 8% of the people die in Oceanic and then 6% of the people die in Europe.

So you can see that the number of percentage of the people die okay due to this kind of natural hazard basically less in Europe, okay then followed by the Oceanic and then the followed by the Africa and then America and very large number you can find in the Asia. So there may be reason for this.

Actually, you may be knowing that the most of the Asian countries are basically located on the plate boundaries and most of the climate okay, so where you can see that a very drought as well as a large amount of the wind and then the people living close to the sea is very large in Asia, okay. It is not only that, there is another reason, which we will be discussing in the little later.

So why the Asia is getting a more number of people die when compared to other developed countries. So if you look at a economic loss, okay, so the same number of event which causes more death in Asia, but if you look at a economic loss, you can see that the Asian continent has only a 34% of the economic loss. So when you look at economic loss in America, which is basically 33%.

If you look at a US, which is basically 23%. So rest of them are like 5% and a smaller amount. You can see that the Europe and America okay, so even though the number of events are less like 50% closer is less than the Asia and then the number of people die actually is very large extent less than the Asia but the economical loss basically more or less similar.

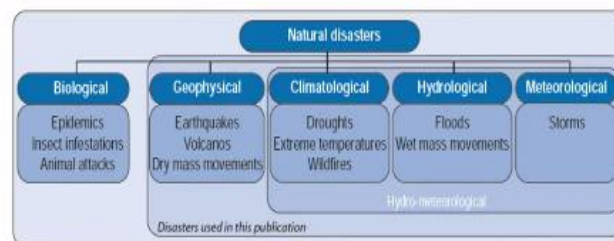
The reason behind it that actually, one is that our currency variation, second the cost of living, okay or per capita income per the people. So since Asia, most of the Asian countries are developing countries or under developing countries, so our economical per capita income is low. Because of that our economical loss due to natural disaster is less okay when compared to developed regions like America and Europe.

So this gives you a glimpse of idea, okay. So even though we face more number of natural disaster, but our economical loss is very close to the developed countries, but the mortality rates are five times six times larger than the developed countries.

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"Disaster Category Classification for Operational Databases". Technical meetings were held in Munich in 2007, which brought together CRED, MunichRe, SwissRe, ADRC and UNDP.



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So this natural hazard okay can be broadly categorized as five type. So what are those five type basically? So this five types basically a biological hazard, geophysical hazard, climatological hazard, hydrological hazard and metrological hazard. So what is meant by biological hazard? Biological hazard is the hazard which is basically happens due to the biological changes in the world, okay.

For epidemic okay, insect infection and animal attack. So you may be aware that there was a animals which destroying the farmer land as well as the cultivated, so those kind of hazard is called as a biological hazard. So the remaining hazard okay so called as a hydrometrology hazard, which is like climatological like drought, extreme temperature, wildfire, hydrological flood and wet moss movement and then metrological storm.

So these are all related to water and climate. So that is why it is called as a hydrological hazard. The other hazard is called as a geophysical hazard, which is like happens due to geophysical activity of the earth and around the earth, which is called as a earthquake, volcano and dry mass movement.

So in our class, we are going to discuss more of geophysical hazard in particularly we will be going to discuss in geophysical hazard how among these three which is dominating and which one is causing more damage.

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### Natural disaster occurrence and impacts: regional figures

No. of Natural Disasters	Africa	Americas	Asia	Europe	Oceania	Global
<b>Climatological 2008</b>	10	4	9	9	0	32
<i>Avg. 2000-07</i>	9	14	13	19	2	57
<b>Geophysical 2008</b>	3	8	18	2	1	32
<i>Avg. 2000-07</i>	3	7	22	3	2	37
<b>Hydrological 2008</b>	48	39	73	9	9	178
<i>Avg. 2000-07</i>	42	39	82	28	5	196
<b>Meteorological 2008</b>	10	44	43	13	2	112
<i>Avg. 2000-07</i>	9	34	42	15	7	107
<b>Total 2008</b>	71	95	145	33	12	354
<i>Avg. 2000-07</i>	63	94	160	65	16	397

So what we should do to minimize that is our engineering seismology scope. So if you look at a number of natural disaster happened from 2000 to 2017, and then with continent wise, and then global wise, so this is what the picture you have seen in the previous bar chart okay, the cumulative one you can see.

So if you look at the number of event with respect to each category of the hazard and you can see that the Asia basically if you look at Asia, so you can see that in the Asia the number okay is considerably high when compared to any other continent, okay. The number of natural hazard occurs in Asia is much larger than the any other continent.

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Map 1 – Percent share by disaster sub-group  
by continent in 2008



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So this is a naturally occurring okay, we do not have any control to prevent this natural hazard. Only thing we can minimize disaster due to these kind of natural events, okay. So if you see the percentage of the share by the disaster subgroup by continent in 2008, this graph has prepared you can see that all this four category of hazard is listed and then each continent wise you can see.

For example, the geophysical hazard, which I told that we will be going to discuss in detail. So the number of geophysical hazard, like for example earthquake, volcano, and then the dry landmass moving that is landslide so occurring in Asia is basically 58%. So if you look at other continent, for example Africa is very small. And then the America it is like, so the moderate. So then Europe also it is small.

And then Oceanic is also small. So the number of geophysical hazard occurring in Asia is much more than the any other continent. So if we look at other hazard which is like for example, the metrological and hydrological so you can see that the highest number is reported in the metrological hazard in America. As you know that there is always a cyclone okay, which causes a huge loss and then disaster in the America.

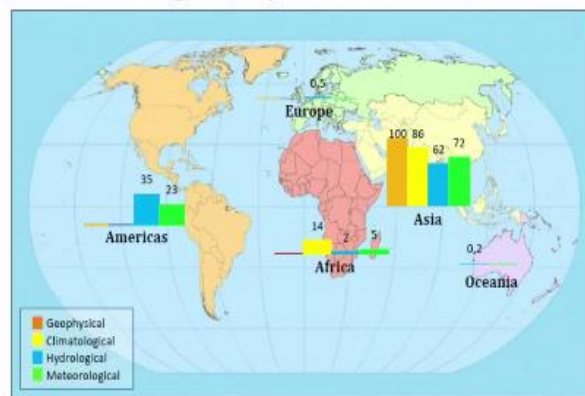
That is why there is a number of this one. So similarly if you look at the other continent we are not very less but we are slightly less than the America. You can see that the Asia is actually having the meteorological hazard of around 38% okay, which is slightly less than the US but comparatively more than the other continent. So like that then the climatology.

So climatology our Asia we have actually 28%. So where you can see that Africa you have the large amount because there is a huge amount of the climate difference within the Africa continent, you can see that 31%. So where we are in 28 and then America is very less and then Europe, actually it is a 28. So equal to Asia. The Oceanic region, so this hazard basically the climate and other things also very less.

So as this continent is basically located on the eastern part of the globe, okay, so which is causes basically less hydrological meteorological and the climatological hazard. But among this category basically the geophysical hazard in oceanic regions are larger when compared to any other hazard okay?

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Map 2 – Percent share of victims by disaster sub-group by continent in 2008



So for this hazard okay this hazard how much the disaster subgroup okay percentage of the share the victim of the people. So let see that we have seen that we have the very large geophysical hazard, but relatively lower the meteorological hazard. But the number of people die due to these hazard. If you take a geophysical hazard, Asia 100% of the people die. For example, in the one year, there is 100 people died in the globe.

That 100 people died because of the geophysical hazard, mostly from the Asia. So if you look at same way the meteorological hazard the 100 people die in the globe, the Asia is going to only 72% people die in the Asia. Remaining people are distributed to



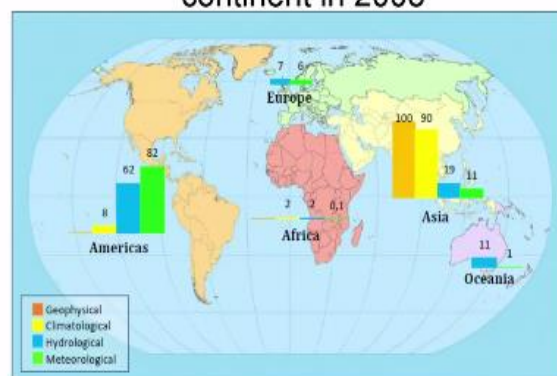
basically US, then little bit in the Africa. So similarly, the hydrological hazard we have less number of people and climatological hazard also we have very high.

So in overall all these four type of natural hazard okay, which causes a disaster the Asia is experiencing a largest people die or largest people affected by this kind of hazard, okay.

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Map 3 – Percent share of economic damages by disaster sub-group by continent in 2008



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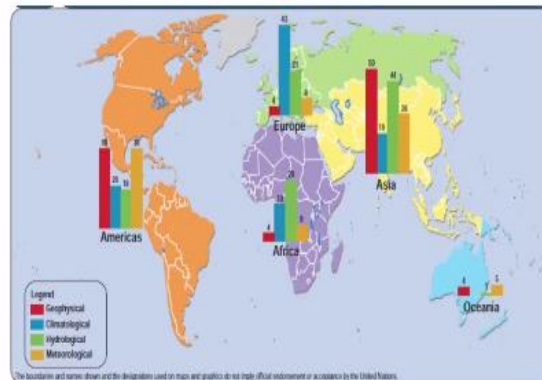
So the similar way we see the economic loss, okay. So if you look at a economic loss, so we have seen that all these four hazard basically occurs okay and then only this is large amount of the victims are from the Asia. So if we look at the economically we have only the geophysical and climatical hazard causes more economic loss then a your hydrology and meteorological hazard.

So the meteorological and hydrological causes a more loss in the US, economic loss when compared to other part of the world okay. But we are more affected by the geophysical and climatic loss with respect to human loss as well as the economical loss.

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2007 Natural disasters: Global proportion of occurrence by major disaster groups by region (in %)



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So if you look at 2007 natural disaster global preparation occurrence by the major disaster group, okay, you can see that how people going to expose okay, so this kind of hazard in the region, percentage wise. You can see that we have been about 50% okay the natural disaster is we are exposed to that. So if you look at the American, geophysical is 38% and then the climatology is 38%.

And then rest of the place like Europe, you can see the climate and hydrology plays a major role. Africa again the climate and hydrology. The oceanic, those are all the percentage share with respect to global is very less, okay.

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### Natural hazard mapping across the world

<https://cybergeo.revues.org/25297>

- The assessment of hazard was performed using the Centre for Research on the Epidemiology of Disasters (CRED) AMDAT database, which has catalogued 13000 natural disasters worldwide since the year 1900.
- Focus solely on the last 30 years, since we considered that the information available is more reliable and more exhaustive.
- From this data on natural disasters we grouped events according to four main classes: earthquakes, floods, droughts, and wind phenomena (cyclones and storms).

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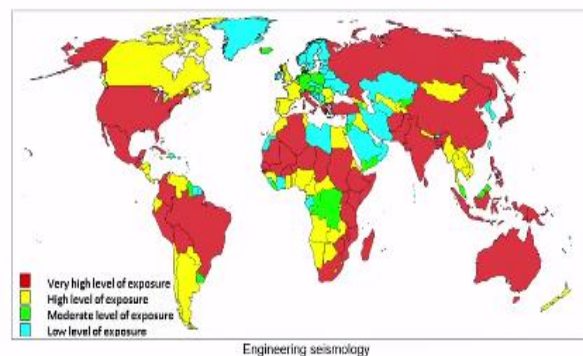
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So the people try to map this hazard and try to understand how the preparedness is happening with respect to this kind of natural hazard. So the assessment hazard was

performed using the Centre for Research on Epidemiology and Disaster AMDAT database, which has catalog 13,000 natural disasters worldwide since year 1900. They tried to study this data and try to analyze and try to come up with that how these different countries are really affected by this hazard and also how they are prepared, how the future risk is associated with that they made an attempt.

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- Exposure of the different countries to natural hazards leading to natural disasters
  - Developed from the sum of probabilities for occurrence of each type of hazard, and weighted according to the dangerousness of the phenomenon.



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So they found that okay how the exposure of the different countries to the natural hazard leading to a natural disaster. As we have seen that natural hazard is any hazard which is caused due to the nature, the natural hazard. This hazard events becoming a disastrous when many more people die. So those kind of natural hazard leading to natural disaster a continent country wise they use to map and study and the given a result.

So they found that the natural hazard okay different country exposed so the dark red is used basically to show that very high level of exposure. Exposure means you get a chance of very high level. So the light blue one basically low level of exposure. So if you look at the continent wise and the country wise you can see the red mark okay almost like more than 50% of the world is actually having the very high level of exposure to natural hazard, which lead to the natural disaster okay.

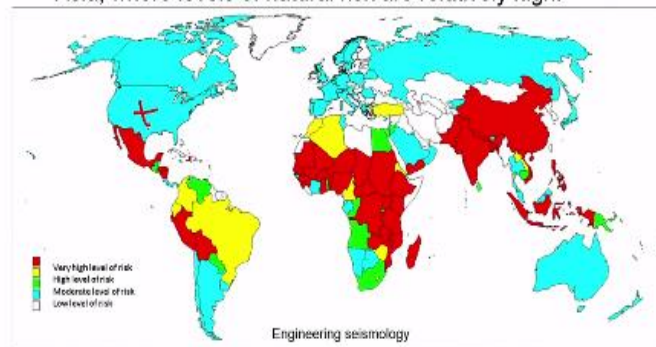
Then the second category is actually yellow one and then the another one is a moderate and low. So this is like the number of events going to occur or number of people going to suffer due to or the expected natural events in the entire globe. So if

you look at that, okay, the red we have seen at several places. So you remember this color and continent. For example, you keep on the central US part and this is very dark with respect to the this one.

And if you take similarly the India, so there also you have basically your so similar kind of exposure.

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- Map of estimated levels of risk for the different countries according to a social approach to vulnerability
- The level of natural risk is fairly low in "Wealthy" countries in the northern hemisphere, Oceania and South America. The developing countries in Central America, Africa and Asia, where levels of natural risk are relatively high.



So but when you look at the level of risk of the different countries according to the social approach to the vulnerability. If these events are happening, how people are exposed to a risk, how people are going to be affected? So that is again used as a like red, yellow and green and blue and then the white. So white means basically very low risk and red means very high risk.

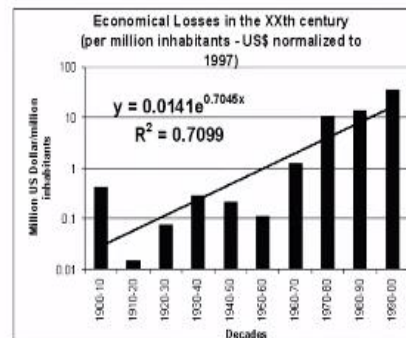
So if we compare again the global map with different countries for example, you take US and India you can see that, US even though these people has very level of exposure to natural disaster events, but they are actually very moderate to low risk region. That means the earthquake or natural disaster comes the people are not going to affected much okay.

At the same time if you see the Asia there also the number of events occurrence also is very large, exposure also very high, the people at risk also is very high. So mostly you can say that most of the developed countries even though the exposure level is

close to India, but their risk okay are dangerous due to this events are less which is falls on the category of moderate and low.

So basically the developing countries okay like Brazil and other places like India and other all other regions you can see that they are all in the very high risk due to this natural disaster.

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- Figures clearly indicates a steady increase of economic losses, especially in the last decade, in contrast with a slight decrease in human casualties

So the global data has been collected for the several decade and then it has been analyzed and plotted out this hazards economic loss, okay changes with every decade, okay. So this is from 1900 to 2000 they plotted. They found that the economical loss okay, so keep on increasing to the year to every decade it keep increasing in trend. So in general so it start at some x level and when the decade are coming this keep on increasing.

So this is not only because of the exposure of the people or the number of events occurring, this is because also the people economical status development okay. So the economical loss due to the natural hazard keep increasing with decade every year it is occurring.

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- In relation to earthquake risk, it is interesting to analyze the tendency to divide the political world into two large geographic areas: the world of poor countries and the world of rich countries.
  - For the former ones, human casualties are increasing throughout the century and are one order of magnitude above the rich countries, whereas, for these ones, the opposite tendency is observed when dealing with economic losses.
  - Even though great advances in seismology and earthquake engineering have been acquired in the last 20 years, a great deal of implementation is still missing. Many international organizations have spoken out for this problem, but results from these campaigns are still difficult to judge. It is worth noting that the same pattern of damage (human and economical) has been observed in the first years of the XXI<sup>th</sup> century.

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So this happens because the reason is actually our infrastructures development okay on the different continent wise are different. Second, the economical and social status of the people. So for example, the earthquake risk it is interesting to analyze the tendency to divide the political world into two large geographical area. One is that people with in the poor countries okay, the people in the rich countries.

So if we divide the entire world as a poor countries and rich countries the former ones the human casualties are increasing throughout the centuries, but one order of the magnitude of above the rich countries. So whereas, this ones the opposite tendency observed dealing with the economical loss.

So what it means basically, for example, if the natural event of  $x$  occurred, okay, so in Asia and America, okay the number of people die, okay in developing countries or Asia is actually larger than the event of the  $x$  occurred at America, or rich countries because of the our preparedness and our also the education lack in the among the people. So for example, the  $x$  quantity of the hazard caused 100 people die in US.

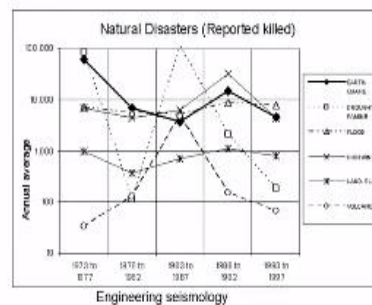
So the same  $x - 1$  event will cause 100 people die in the Asia, okay. So which very clearly indicates that okay, the similar amount of the natural hazard occurred in rich countries causes a less people to die, okay, when compared to poor countries. And if you look at a economical loss, okay, so basically the poor countries, okay, will have half of the economical loss okay when compared to the rich countries because of the currency variation as well as the per capita income, okay.

So the number of people die due to natural hazard is very large in the poor countries or a developing countries, but the economical loss is less compared to the rich and developed countries. So which is due to the economical difference and the exposure of the this one okay.

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## Comparison among different types of natural catastrophes

- In the topic of natural catastrophes, earthquakes play a very important role, world-wide. As a matter of fact, statistics taken from the period 1973-1997 (<http://www.cred.be>), organized by 5-year bins, show that earthquakes are among the disasters with larger death impact even though the total number of flood events is twice per year.



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So the people carried out a research and collected a different type of natural hazard and tried to plot a decade wise from 1973 to 1997 decade wise. You can see that the earthquake hazard okay so almost causing a similar number of loss, okay as well as the damage to the entire region when compared to any other hazard.

So that may be the reason that the other hazard basically with the growth in the scientific knowledge and development, so the most of the other hazard we tried to predict in advance, for example cyclone. So we try to predict an hazard we try to minimize that by making a precautionary steps okay.

We will evacuate people or places where the flooding going to occur and therein we know that there is a damage going to happen and the trees falling our building, we try to move the people because of that. So the loss okay and as well as the human loss, number of people die due to other hazards are considerably less.

But earthquake it is not possible to predict as of now. The number of people die, that remains almost similar since its beginning. So in fact, it increases with time, okay.

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- This analysis on the effects of earthquakes on the built environment can be traced for the entire XX<sup>th</sup> century. This calls the attention to the communities that seismic risk has been increasing along the times in spite of all the great advancements achieved in scientific and technical grounds. **Problems of bad use of "good engineering knowledge" and lack of quality control are behind these poor results.**
- Knowledge can be enhanced by
  - Predication of Earthquake
  - Preventive Planning
    - Estimation of Earthquake and its consequences
- It is not possible to predict earthquakes, it is necessary to minimize the risk, preparing a **Preventive Planning** and to minimize the effects of the event, developing an **Operational Planning**.

So even though there was a very good amount of scientific development and knowledge development occurs okay so throughout the world and we have in the era where all the advancement of scientific things are happening. But still, this loss due to natural hazard, particularly geophysical hazard is not preventable or minimizable. Particularly in Asia it is very predominant, where the number of people death is very large and economical damages also considerable.

So this is because of the problem of bad use of good engineering knowledge and lack of quality control are behind this results okay. So how to improve this basically? How to improve this and how to get minimize the number of people die due to this kind of natural hazard okay. So how to prevent this what planning we can do. So these are all the things we have to try to understand which is called as a preparedness.

Or what we should do to this one? So our class the next video we are going to talk about a preparedness. So how do you do this basically? The first one is basically we try to predict a any natural event. So that if you know that when it is going to occur accordingly you can take a preventive step to reduce human casualties as well as the economical loss okay. So as of now, I told you that it is not possible to predict a earthquake.

Then the next is the preventive planning. So how we can minimize this? So this we will detail discuss in the next class.