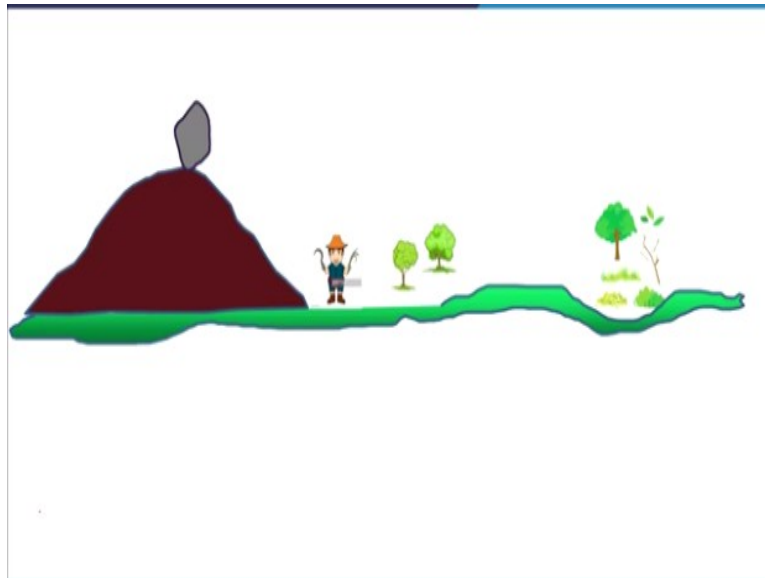


Disaster Recovery and Build Back Better
Prof. Subhajyoti Samaddar
Disaster Prevention Research Institute
Kyoto University, Japan

Lecture – 01
Disaster Risk
Hazards X Exposure X Vulnerability

Hello everyone, we are talking about lecture course on disaster recovery and build back better. I am Subhajyoti Samaddar, from Disaster Prevention Research Institute(DPRI), Kyoto University. In this lecture, we will talk about disaster risk considering 3 components; one is hazard, exposure, and vulnerability. so, we will give some small examples; illustrations with some theoretical ideas to define the very core aspect of disaster risk.

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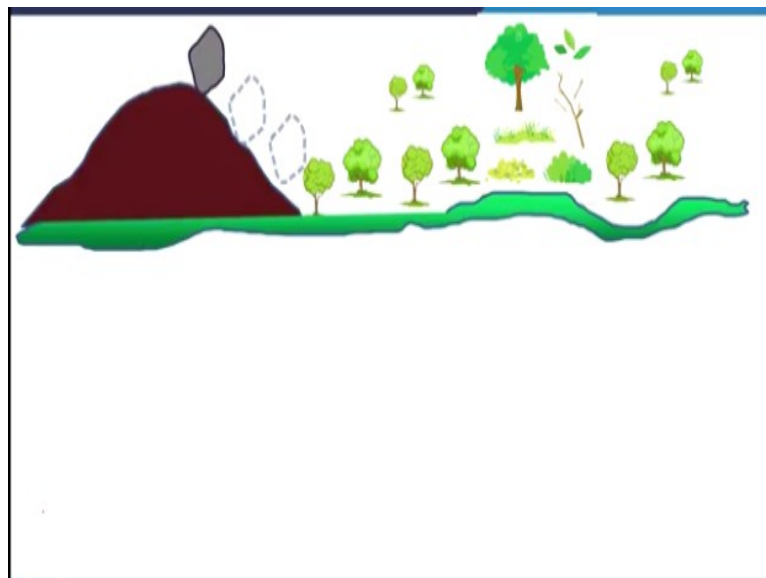
Let us imagine that this is a place near Roorkee in Uttarakhand; it could be a tourist spot, people coming here watching this mystic stone in a mountain well now, considering this slide is it risky? Does it look like that this could be fatal for the people, should you consider this is as disaster or disaster risk? Now, how about that if there is one individual is there; working there on the foothills, should you consider it more risky than the before one?

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Now, look at the next slide, so if there is a rain then, there is a possibility that this stone would hit this person so yes, we consider this is as risky.

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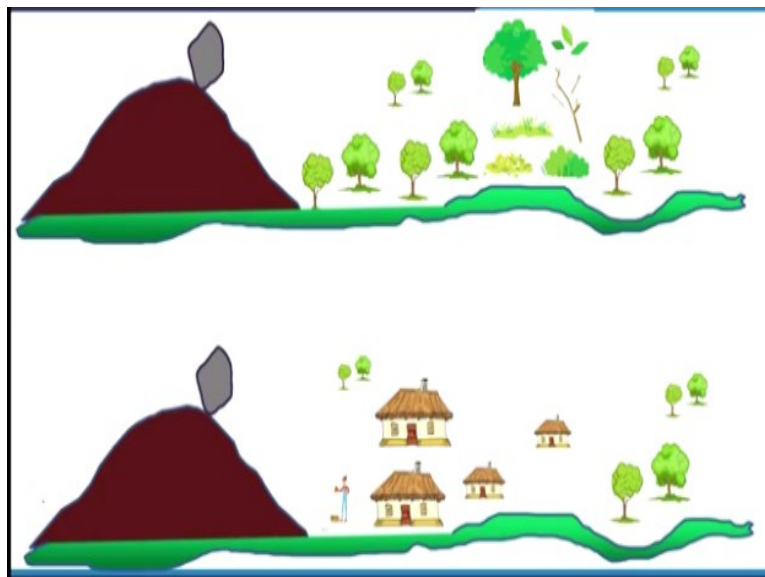


But if it is like that maybe in a mountain when there is no human being and this stone falling down on a forest, do you consider it as risky; a disaster?

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If we have avalanches, landslides in Himalayas, do we consider these events as disasters?
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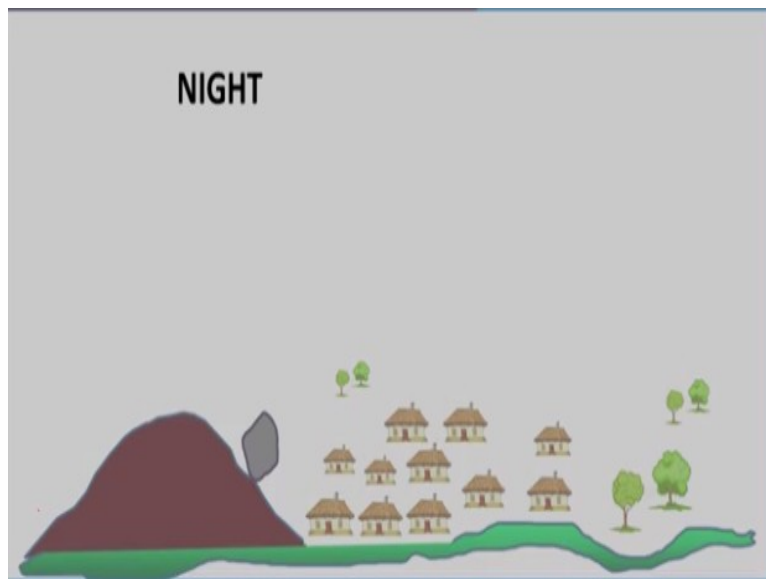
But maybe if it is not in a remote mountain but people are living there, settlements are there compared to that top one, if we consider the bottom one to us, it is more risky than the top one.

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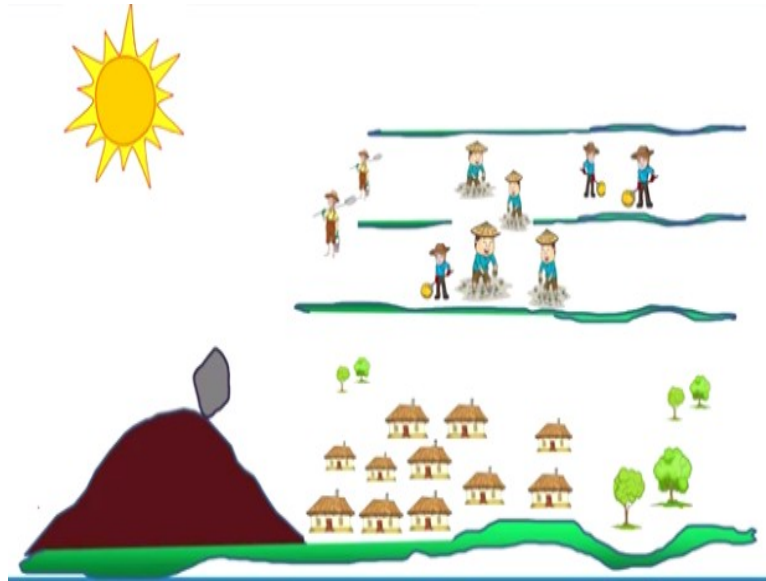
Maybe, we are more concerned, when there are more settlements are there.

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If this is happening; this landslide at night time.

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And if this landslide is happening at day time, we have different concerns and different way of measuring risk. So, we considered that night time may be more risky because people are sleeping there. But day time maybe people are not sleeping at their home but they are working outside so, they are not exposed to that kind of risk.

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But if this same thing is happening in an urban place in a city area what happens?

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Should we consider this is as risky? more risky so, these illustrations I am giving you just to explain that what is the meaning of hazard exposure and vulnerability and how these 3 components define risk in our case, it is kind of disaster risk.

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So, here are 3 scenarios; 3 pictures you can see in the left hand side; a landslide happened somewhere where no people are there, no settlements are there so, this is considered to be less risky in another place there are people but not that densely populated settlement, we consider to be more risky or more disastrous than the previous one. In the extreme right, we have another one which is an urban area and disaster landslide took place and more casualty and losses are reported.

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Hazard

A potentially damaging physical event, phenomenon or human activity

may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation.

latent conditions that may represent future threats and can have different origins:



Now, this one is considered to be risky and with this stone can fall, if we have rainfall; heavy rainfall or if we have earthquake, then it will come and hit this place so, it has some kind of conditions; some latent conditions that may trigger some threat in future and can have different origin, it could be earthquake, it could be a landslides, it could be heavy rainfall.

So, hazard is defined as a potentially damaging physical event phenomena or it could be human activity that has some latent conditions that may represent future threats and can have different origin but also it may cause the loss of life of injury, property damage, social and economic disruption and environmental degradation. So, hazard which is a potential damaging physical event and phenomena or human activity which can cause in future may cause some loss of life, injury and property damage and social and economic disruptions.

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Natural Hazards

- ☐ Natural processes or phenomena occurring in the biosphere that may constitute a damaging event.
- ☐ Natural hazards can be classified according to their geological, hydrometeorological or biological origins.




And it has different origins like, we have natural hazards which are triggered from natural process or phenomena occurring in the biosphere that may constitute damaging event. Natural hazards can be classified according to their geological, hydro-meteorological and biological origin.

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Origin	Phenomena/ Examples
Hydrometeorological hazards Natural processes or phenomena of atmospheric, hydrological or oceanographic nature.	- Floods, debris and mudflows - Tropical cyclones, storm surges, wind, rain and other severe storms, blizzards, lightning. - Drought, desertification, wildland fires, temperature extremes, sand or dust storms - Permafrost, snow avalanches
Geological hazards Natural earth processes or phenomena that include processes of endogenous origin or tectonic or exogenous origin, such as mass movements.	- Earthquakes, tsunamis - Volcanic activity and emissions - Mass movements, landslides, rockslides, liquefaction, submarine slides - Surface collapse, geological fault activity
Biological hazards Processes of organic origin or those conveyed by biological vectors, including exposure to pathogenic	Biological hazards Outbreaks of epidemic diseases, plant or animal contagion and extensive infestations

Let us look here, we are talking in the origin and the phenomena; one origin is hydro-meteorological hazards and the phenomena's are flood, debris and mudflows, tropical cyclones, storm surge, wind, rain and other severe storms, lightning. Also, we have drought, desertification, wildland fires, temperature extremes, sandstorms or we have more snow avalanches so, these are all considered as hydro-meteorological hazards.

We have also geological hazards, these are considered to be natural earth process or phenomena that include processes of endogenous origin or tectonic or exogenous origin such as mass movement, let us look at the phenomena of geological hazards. They are like earthquake, tsunami, volcanic activity, emissions, surface collapse, geological fault activity, mass movement, landslide, rock slides, liquefactions, all are considered to be geological hazards.

We have also biological hazards like, outbreaks of epidemics or some kind of animal contaminations or extensive infestations, these are considered to be biological hazards.

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TECHNOLOGICAL HAZARDS

Danger associated with technological or industrial accidents, infrastructure failures or certain human activities which may cause the loss of life or injury, property damage, social and economic disruption or environmental degradation, sometimes referred to as anthropogenic hazards. Examples include industrial pollution, nuclear release and radioactivity, toxic waste, dam failure, transport, industrial or technological accidents (explosions, fires, spills).

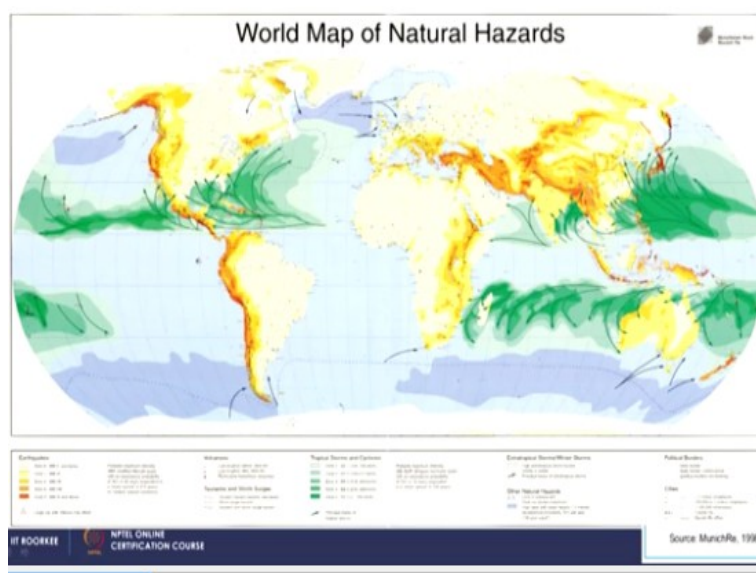
ENVIRONMENTAL DEGRADATION

Processes induced by human behaviour and activities (sometimes combined with natural hazards) that damage the natural resource base or adversely alter natural processes or ecosystems. Potential effects are varied and may contribute to an increase in vulnerability and the frequency and intensity of natural hazards. Examples include land degradation, deforestation, desertification, wildland fires, loss of biodiversity, land, water and air pollution, climate change, sea level rise and ozone depletion.

We are also not very related to here, but we can also consider some technological hazards can happen through disasters and also some environmental degradations which can also cause disasters. In case of technological hazards like, if there is an earthquake or heating an oil refinery, it can also cause technological hazards or even if we are exposed to heavy metals, hazardous materials, this should be considered as technological hazards.

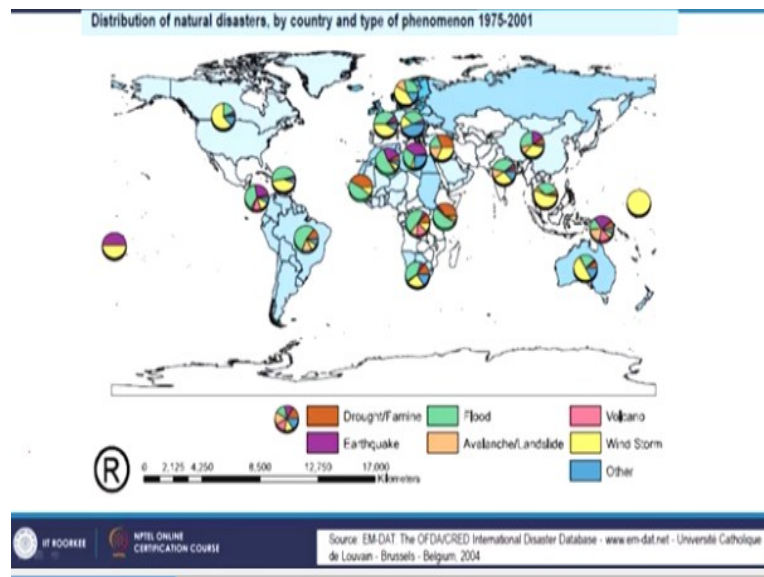
Similarly, we have environmental degradations; we are not going to discuss in detail of these. But just to give you a brief idea about the types of hazards in natural disasters.

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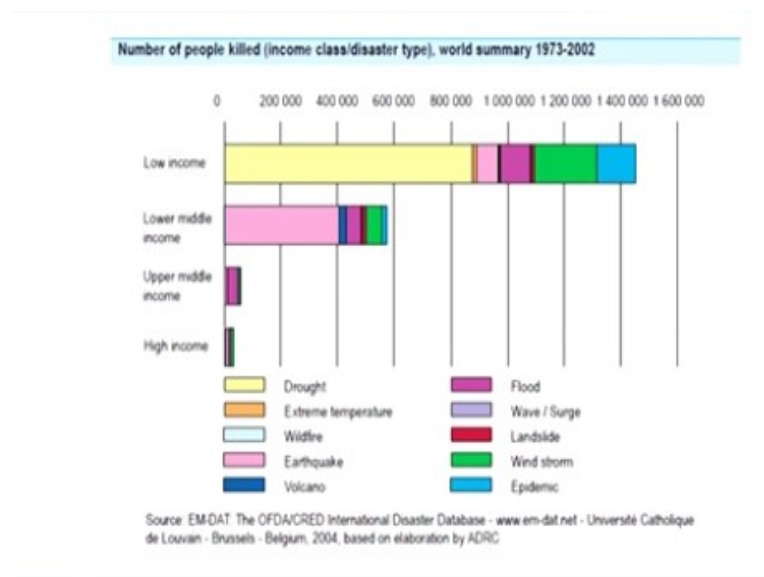
Here, the map that showing the distribution of natural hazards let us look more maps on these.

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This one is the distribution of natural disasters by country and type of phenomena from 1975 to 2001. If you look into this distribution, you can see that the flood; this is one of the most reported disasters from 1975 to 2001.

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Go to next slide; if you look into the disaster distributions, different kind of disasters or hazards in different countries, the most affected people and killed are in low-income countries and the least the high-income countries. So, poorer the countries, poorer the communities, poorer the societies, they are more affected by disasters than the prosperous developed nations and societies and communities.

So, low-income countries you can see that most they are affected by drought and also their flood, in case of lower-middle-income group countries, you can see that these they are

affected mostly by the flood, and the other bigger contribution of human losses came from flood and also from epidemic.

Now, hazards; when we are talking about hazards, we have to consider few characteristics of the hazards or features when we are talking about disaster recovery or disaster risk management.

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Hazards ?

1. Frequency
 - how often is the event likely to happen
2. Duration
 - the length of time the event lasts
3. Extent
 - Size of area or region affected

One is the frequency of the hazards; how often is the event likely to happen, and then is the duration of the hazard; the length of time that when it happened how long it continued, an extent; the size of the area where it took place, it is in a village or in a town, what extent, what geographical area it is covering so, these are important components of hazards will dealing with disaster risk management.

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4. Speed of onset

- Sudden, without warning, over quickly?
- build slowly before a peak period

5. Spatial dispersion

- Area likely to be affected by a particular event

6. Temporal spacing

- How hazards occur in time; are they random or do they occur within a cycle

Now, coming another important feature is the speed of onset like, if we consider a flood, it is a flash flood, it is very sudden without warning, very quick or is it a kind of slow process like in case of cyclone, we have much time to predict so, we have; we can prepare our self, we have better early warning system and we can take time but in case of earthquake, we do not have any time, it is very sudden or in case of flash flood, we have less time also consider to other kind of a flood.

Or so, speed of onset is very important and when you are considering the hazards in disaster risk management and the spatial dispersion; area likely to be affected by particular event. And temporal spacing also very important; what time, when and it is happening, are they random, are they occurring in a cyclic process in a recurring process or they are one-time events, so these are important features when we are dealing with hazards.

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Earthquakes

- Earthquakes occur along the boundaries of the tectonic plates of the earth's crust.
- When these plates come in contact with each other, the pressure builds up and an earthquake occurs.



In case of just for an example, maybe we can see that in case of earthquake; earthquake occurs along the boundaries of the tectonic plates of the earth crust. this is one hazard and when this is the source of the hazards and when this happen and this happens, we can see that these plates come in contact with each other and the pressure builds up an earthquake occurs.

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Tectonic Plates



Now, this is just simply a physical event, this is you can see some of the distribution of the tectonic plates in some places and this hazard; this earthquake hazard, we have 3 processes; physical process that can trigger this hazard.

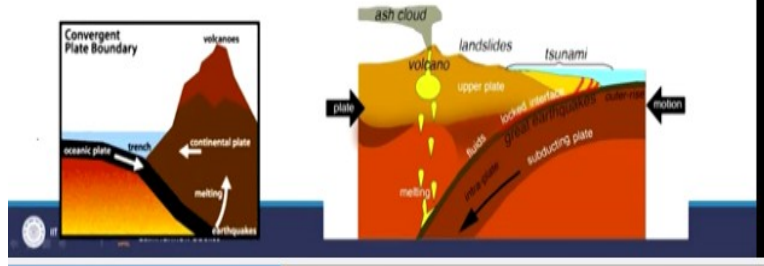
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Types of Earthquakes

Convergent Boundaries - When two plates collide together. This created the Himalayan mountains.

Subduction occurs when one oceanic plate goes under a land plate. Created the Andes Mountains.

Divergent - When two plates are moving apart.



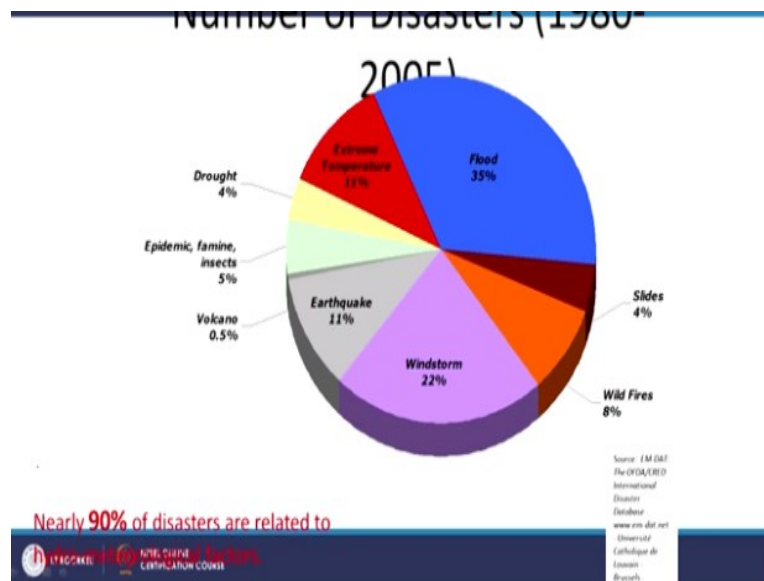
One is that convergent boundaries; when two plates collide together this created the Himalayan mountain so, one way of the event of earthquake that can happen when two plates are colliding each other. Another was is the subductions; there is when one oceanic plate goes under the land plate and created the this kind of earthquake. And another one is the divergent one, when two plates are moving apart, this can also cause earthquake. And this is we call divergent region.

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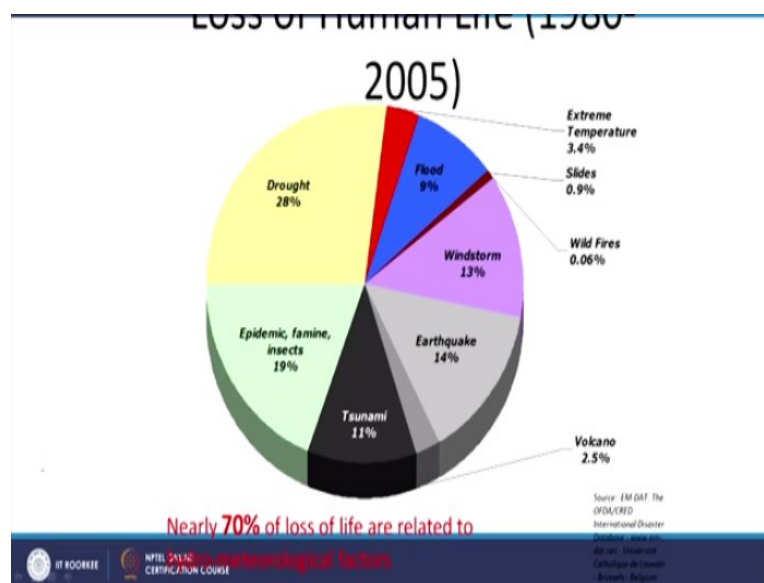
Now when we are talking about hazards, can we avoid hazard? No, historically hazards were there, it is there and it will remain. So, we cannot avoid hazard basically.

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Now, looking into the disaster; number of disasters from 1980's to 2005, you can look as I told also before, it is the flood that is the most reported disastrous event. 35% of the all disasters are from 1980 to 2005 are flood disasters. Another one is also big share is the wind storm, earthquake is only 11%, an extreme temperature is 11%, so overall 90% of disasters are related to hydro-meteorological disasters, that is very important finding.

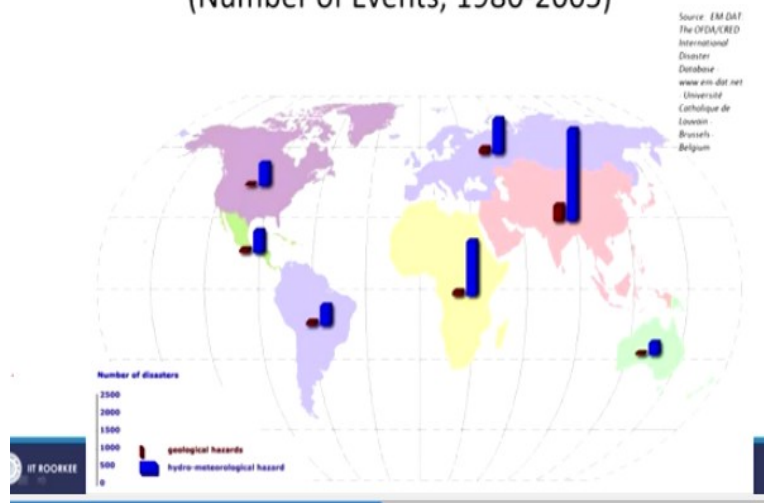
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Also, when we are looking into the loss of human life from 1980 to 2005, we can see that nearly 70% of loss of life are related to hydro-meteorological factors. So, hydro-meteorological disasters are very critical, particularly when we are looking into developing countries or underdeveloped countries. Here you can see that 28%, drought is the reason of human loss in 28%.

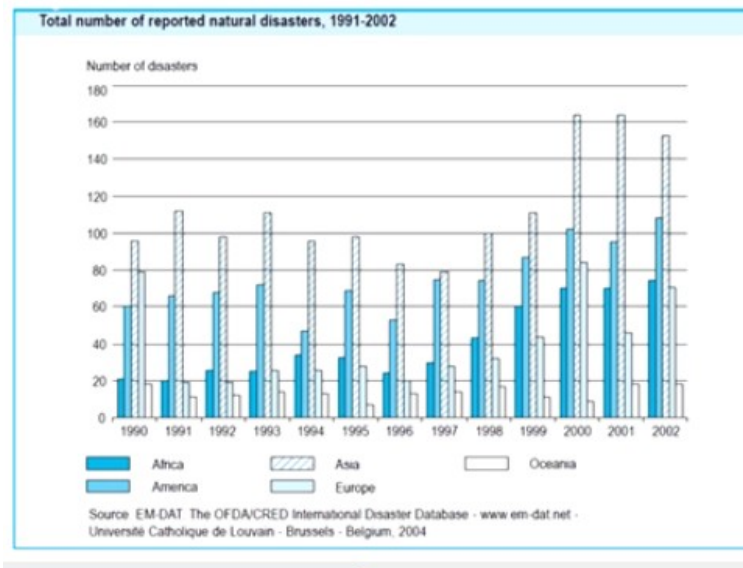
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Regional Distribution of Natural Disasters (Number of Events, 1980-2005)



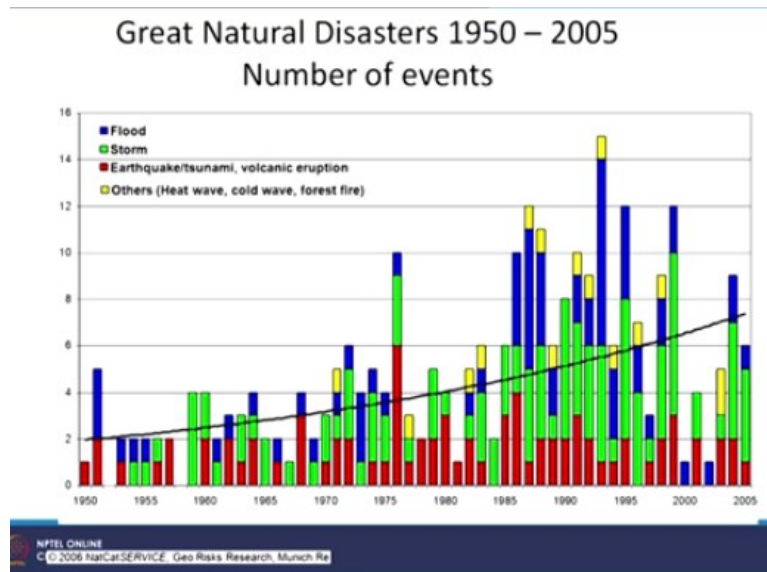
Similarly, flood 9%, earthquake is only 14%, here is the regional distribution of natural disasters from 1980 to 2005. You can see that Asia is one of the biggest source of disaster, it is one of the hotspot compared to any other region, when we are talking about disasters. And it is the hydro-meteorological particularly, the flood and drought which play a big share of the all disasters and disaster impacts.

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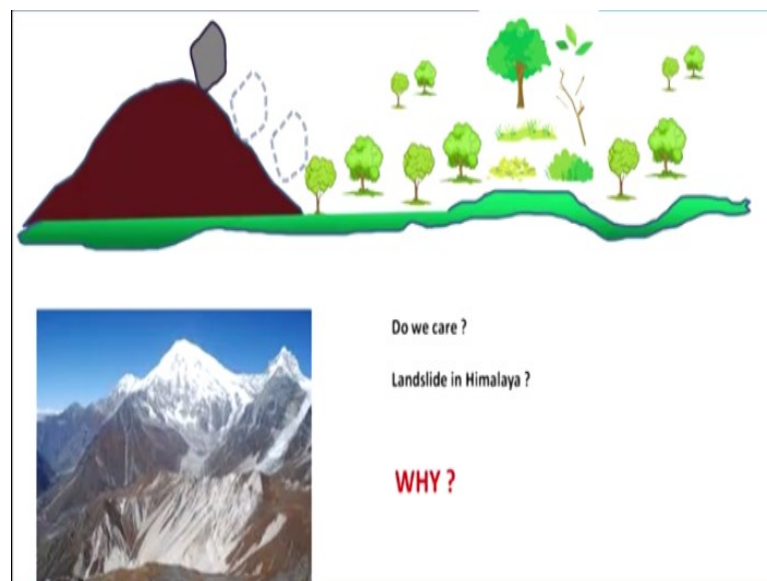
Here is also you can see from 1991 to 2002, the growth of disasters. So, actually it is increasing in all continents particularly in Asia, so in 1990's and 2002, you can see in Asia's, these disasters are actually more and more reported and more and more human losses and property damage are reported.

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So, also here is another chart you can see from 1950 to 2005, the number of events that flood is increasing, storm also are increasing, earthquake is almost the same as from 1950's to 2005, you cannot see much huge differences but other disasters you can see they are increasing very prominently.

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So, we are talking about hazards that this landslide or this stone when it is exposed to heavy rainfall or earthquake, it can have some potentiality to cause human injury or loss or property damage. It may cause, not necessarily that it will cause. Now, as I said that we have avalanches and we have landslides in Himalayas, we do not care why we do not care, if there is an avalanche, if there landslides in Himalaya.

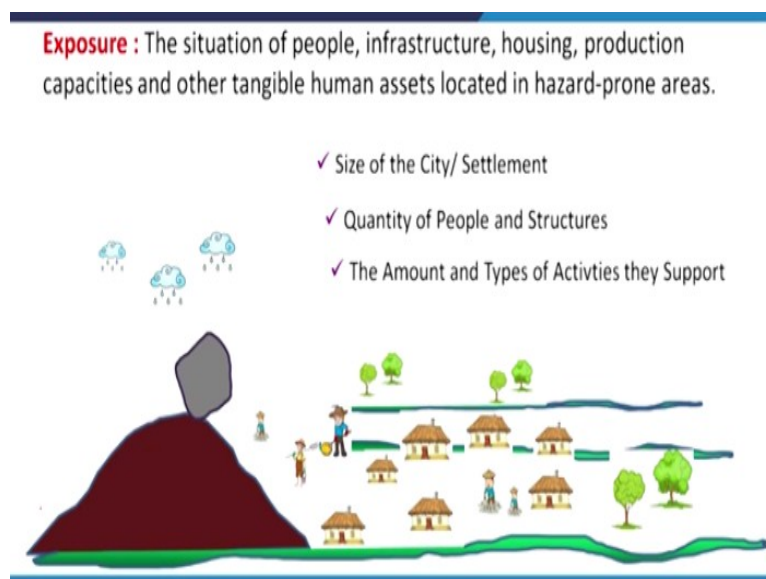
Why, so that is important when we are talking about disaster risk management. When there is an landslide in Mumbai, landslide in Delhi we are concerned about but when there is an landslide in Himalaya, we are not concerned about this, when there is an earthquake in deep sea, we are not very much concerned unless and until the tsunami is coming on the mainland.

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So, now if it is not a barren land or a forest, but some people are working there, then do we care now? Like, it can cause that this rainfall because of the rainfall, this landslide will take place and it may hit this person and he will be injured and property loss will be reported. Yes, we concern because this person is there and earlier he was not there.

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So, the presence of this person is very important. So, it is not only this person but if we have more settlements, more houses, more people we care more right, maybe here you look, we

care more and more because the simple reason is that more and more people and settlements, houses, buildings are there. So, this one we are calling as exposure; the situation of people, infrastructure, housing, production capacities and other tangible human assets located in hazard-prone areas.

So, if these people, these houses are not there, we do not care about the hazard disasters, we do not consider them as risky, we consider this landslide as risky because people, properties, buildings, infrastructures they are exposed to that potential hazard. So, how many people are exposed, who are exposed, these are important in disaster risk management. So, when we are talking about the exposure, the size of the city or the settlements and where this hazard will take place is one important component of exposure.

Another one is the quantity; how many people or structure or buildings are exposed to the hazard, another one is the amount and type of activities they support. Like, if they are engaged in agricultural sectors, if they are engaged in business sector or industrial sectors, they have different exposure, if they are engaged in an industrial sector, small properties are exposed to hazards, then compared to in agricultural sectors.

And also in a city areas where diverse occupations are there, people are also densely populated so, their property is also concentrated compared to in the villages areas. So what kind of activities, amount and type of activities are going so, these also defined that how many and what extent people are exposed to a particular hazard. It also matter that if this hazard would take place at day time, when people are not working, people are working outside, people are not at their home. Or maybe night time when people are sleeping so, at day time of course, we have less people are exposed to hazards compared to night time, at night time people are sleeping and which are very close to hazardous areas, so they are more exposed to these hazards. Compared to village areas, if it is in urban sectors like, in case of big cities; in metropolitan cities compared to a small village; yes, more and more people and properties are exposed.

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- **Building Use** – Residential, Commercial, Industrial
- **Type of Buildings**
 - Type of Construction – Steel, Concrete, Masonry
 - Category/Building class
 - Building Height, No. of floors
 - Building age
 - Built up floor area of the buildings
- **Occupancy Details** – Population density

Exposure - calculates how much of the population and buildings are 'exposed' to the natural hazard

So, when we are talking about exposure, maybe these are indicators, we can define how many, what extent, who are exposed. Let us say, building use; residential, commercial, industrial, they define that how many people, what extent, what type of people are exposed to disasters. Also, the types of buildings; the type of constructions or building height, if they are all taller building more people are exposed to hazards or in a building edge or built-up floor areas of the buildings.

So and also it depends on the occupancy details, we have to take like the population density, who are the owner of these houses and buildings.

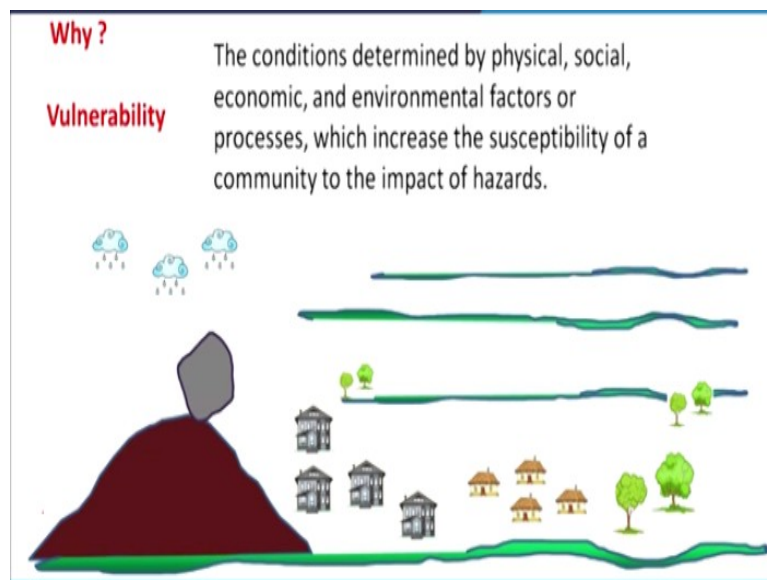
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So, exposed to hazards; it depends on how many people and the buildings are exposed to a hazard. Now, when we are talking about hazard and exposure so, if we say that okay, this

much of people are exposed to this disaster, is it enough to define a disaster? I mean when we say that okay this much of people are exposed to a landslide, a particular hazard, can we say that hazard and exposure, they will decide the degree and the type of disasters, is it enough definition to quote that hazard multiplied by exposure will decide the magnitude of the disaster or the degree of disaster?

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Like, it is not only that how many people, how many buildings are exposed, but what are their characteristics, what are their features also define that what extent they are potentially at risk. If in a place that is prone to landslides or potentially to have a landslide, like this one you can see and maybe in this village, the all people living there are old people; senior citizens above 65 years old.

So, if there are only senior citizens or maybe only children are there, only kids so, of course they are more vulnerable, more exposed and more at risk, this place we consider to be more risky. And so, young people is less so, if a community is comprised by only old people, no young people, then we consider that this community is at risk than a community which has more younger population.

Or if the people who are exposed they are only poor, they are more at risk, they are more vulnerable and if a rich people who have better economic capacity, we consider to be that they are less risk. This also depends on what kind of houses or buildings are there like, if we have Kutchha houses and mud houses and you have concrete houses, it also wood houses, these also define that one extent, people will be impacted with these hazards.

So, hazard that may cause some kind of impact on human life and property does not only define the disaster, it also matter that how many people when they are exposed to that hazard. But that is not only enough, it also depends on what and what types of people, what are their characteristics, what are their features, who are exposed to that disaster, so to define disaster so, the question is why is so?

We consider this is a vulnerability, that vulnerability is one of the critical conditions to define that the degree of disasters. Now, we define vulnerability as the condition, that determined by physical, social, economic and environmental factors or process which increase the susceptibility of a community to the impact of hazard.

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Vulnerability

- ☐ Which places are more vulnerable to a hazard?
 - ☐ Which geographical region, socio-economic class etc.
- ☐ Who are the vulnerable people?
 - ☐ Relative vulnerability among households and individuals
- ☐ What should be done?
 - ☐ Link to intervention/ adaptation

So, which places are more vulnerable to a hazard; which geographical region, socio-economic class etc., who are the vulnerable people like which kind of households or individuals are and what should be done like, what kind of capacity or adaptation, capacity building or adaptation measures, preventive measures we can take.

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Social Vulnerability

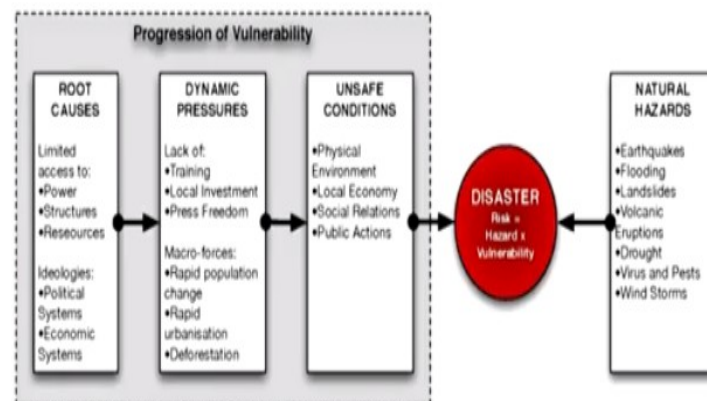
- Coping Ability
 - Resistance
 - Resilience
- Social Environment
 - Age
 - Gender
 - Ethnicity
 - Household type
- Economic Environment
 - Income and Assets
 - Insurance
 - Debts

So, these also define that what extent people are at risk, so as I said that, there are different conditions that define the vulnerability. We have the social vulnerability like, coping ability, resistance or resilience or we could have some social empowerment like, age, gender, ethnicity, household type as I said that younger people are when a society is comprising only by elder people, the society is considered to be more vulnerable than when there are younger people also.

And females are compared to be more vulnerable because they have many less socio-economic opportunities, political opportunities, so than the male counterpart, so they are considered to be more vulnerable in a male-dominated society. It is also depends on what kind of ethnicity these are exposed to disasters when a mainstream ethnic community or majority of ethnic community they are exposed; they are less vulnerable than a minority community or minority ethnic races.

So and also it depends on household type, is on joint family or nuclear family, so these all social environments that define the social vulnerability of a disaster, we have to also consider the economic environment or economic factors of vulnerability. One is the income and assets and insurance and debts. How much the person's income has, not only income, but also if they have insurance like if someone has flood insurance so if they are affected, and how they will be impacted by the flood, it depends on insurance. Because if they are impacted, their livelihood would be hampered, and if they have insurance back there that can help them to recover from that process. Also, if they have loan or debts that also define that what extent they can absorb the shock of a particle, a disaster.

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So, we have this model of disaster, defining disaster vulnerability, we will talk this one later on.

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Physical factors

- ☐ Materially oriented
- ☐ Comes from the schools of land-use planning, engineering and architecture.
- ☐ Considerations and susceptibilities of location and the built environment.
- ☐ "placed in harm's way"
- ☐ "being in the wrong place at the wrong time" (**EXPOSURE ?**)
- ☐ Population density levels,
- ☐ Remoteness of a settlement, the site,
- ☐ Design and materials used for critical infrastructure and for housing.

But this is just for as a reference; we can have also physical factors of disaster vulnerability. Like, the land use and this mainly came from land use and engineering architectural perspective to define the physical vulnerability of disaster and also like the which locations the building are there, what are their conditions so, these all defined the buildings of vulnerability.

So, some people are saying that, placed in harm ways, or being in the wrong place at the wrong time, some people may consider this is also as kind of exposure but for some people

this is also considered to be as vulnerability. And so, population density levels, remoteness of the settlements, design and material used for critical infrastructures, what kind of building materials we are using so, these all define the physical factors of social vulnerability.

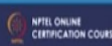
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Social factors

- ☐ Level of wellbeing of individuals, communities and society

- ☐ Education
- ☐ Age
- ☐ Gender
- ☐ Social Status and Class
- ☐ Social equity
- ☐ Culture and traditional values
- ☐ Social Institution
- ☐ Health



And as we discussed also that social factor of vulnerability are the level of well-being the communities of societies like education, age, gender, social status, social equality, culture and traditions, health conditions they all define the vulnerability of the people.

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Economic factors

- ☐ Economic status of individuals, communities and society

- ☐ Income
- ☐ Economic reserves
- ☐ Debts
- ☐ Access to credits, loans and insurances




Also, we have economic factors like economic status of individual, community, and society and income, income reserves, debts, access to credits, loan, insurance they all define the disasters.

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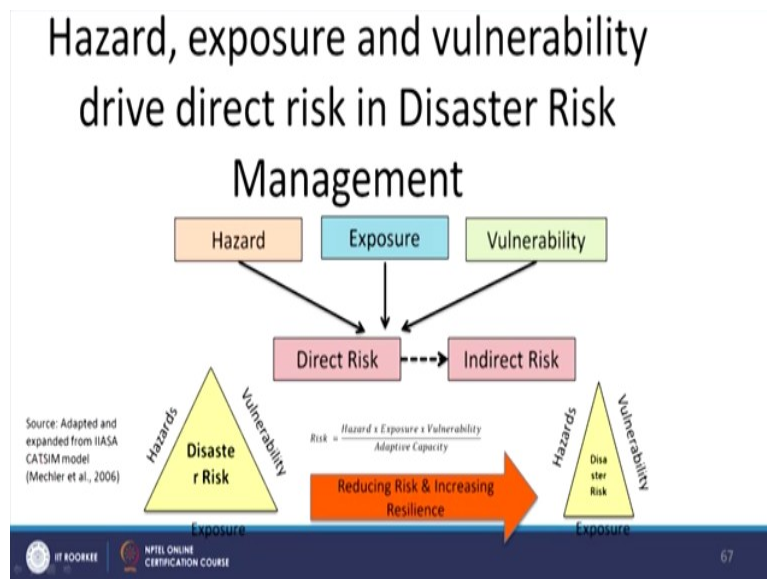
Environmental factors

- ☐ The extent of natural resource depletion
- ☐ The state of resource degradation
- ☐ Exposure to toxic and hazardous pollutants



Also, we have environmental factors like the extent of natural resource depletions, the state of resource degradations, exposure to toxic and hazardous pollutants.

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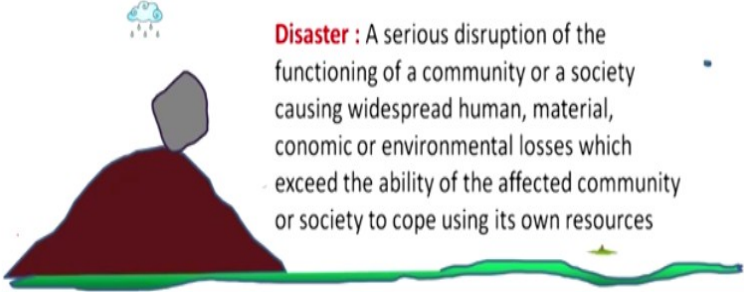


So, hazard, exposure and vulnerability these 3 components are important to understand disaster risk. We will later on also discuss about disaster vulnerability in a more broader perspective.

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So, Hazards X Exposure X Vulnerability = Disaster Risk ?

Disaster : A disaster is a function of the risk process. It results from the combination of **hazards**, conditions of **vulnerability** and insufficient **capacity** or measures to reduce the **potential negative consequences of risk**.



Disaster : A serious disruption of the functioning of a community or a society causing widespread human, material, conomic or environmental losses which exceed the ability of the affected community or society to cope using its own resources

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But, here is the definition of disaster that is hazard, exposure and vulnerability; that is defining the disaster. And it is a formal definition given by United Nations, ISDR as disaster is a function of the risk process, it results from the combination of hazards, condition of vulnerability and insufficient capacity or measures to reduce the potential negative consequence of risk.

So, a disaster is a serious disruption of the functioning of community or a society causing widespread human, material, economic, environmental losses which exceed the ability of the affected communities or society to cope using its own resources.

Thank you very much.