Natural Hazards
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Lecture – 03
Introduction to Natural Hazards (Earth as a system)

Welcome back. So, in previous lectures we were talking about the Earth system, now we will talk more detail about whether we look at the closed system or the based on the processes which are occurring on the surface which are occurring below the surface. So, these are the processes which we are talking about the plate one plate going below the another one, triggering volcanism deforming the earth crust and then because of this we are having earthquakes and all that.

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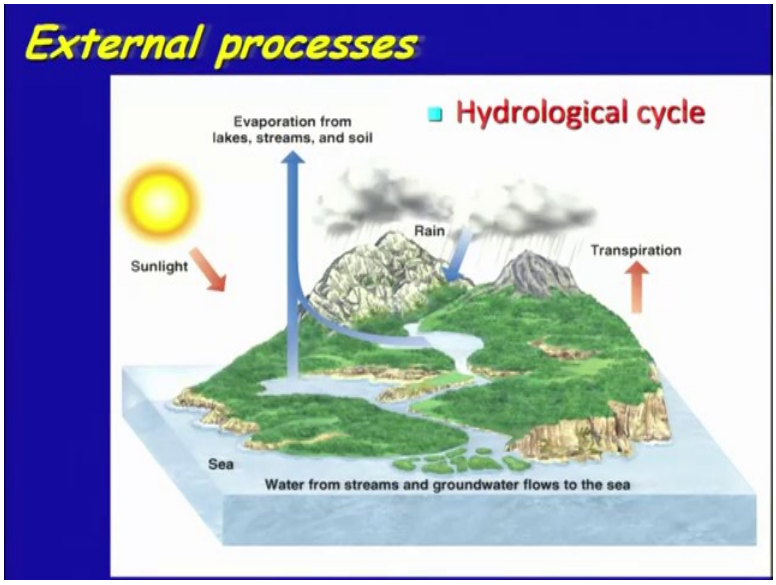

So, we have another process which are occurring external processes which we talk. So, the best example is the hydrological cycle. We will come back to this again at the end when we are talking about the systems. Now, let us see at the at what is the concept behind the system.

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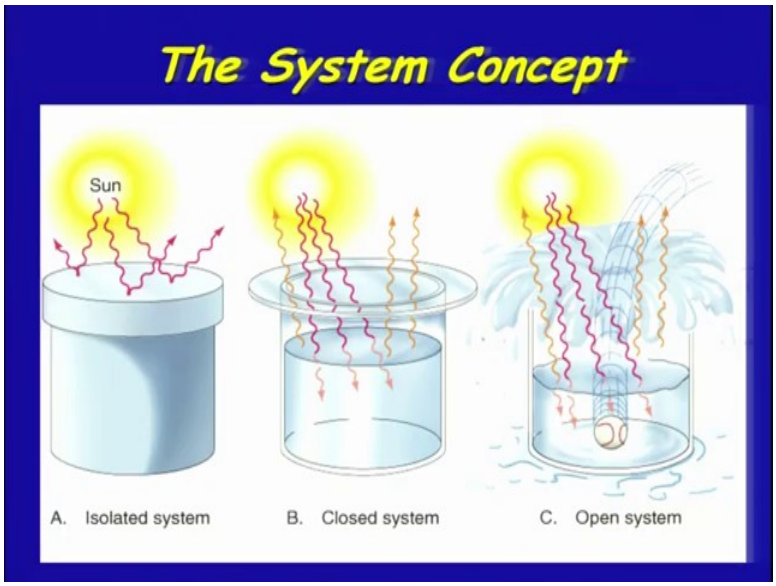

So, we have like either we classify this as in completely an isolated system or we can say that it is in closed system or an open system. So, earth is a on system let us see that what type of system is the earth's system whether it is isolated, closed or open up.

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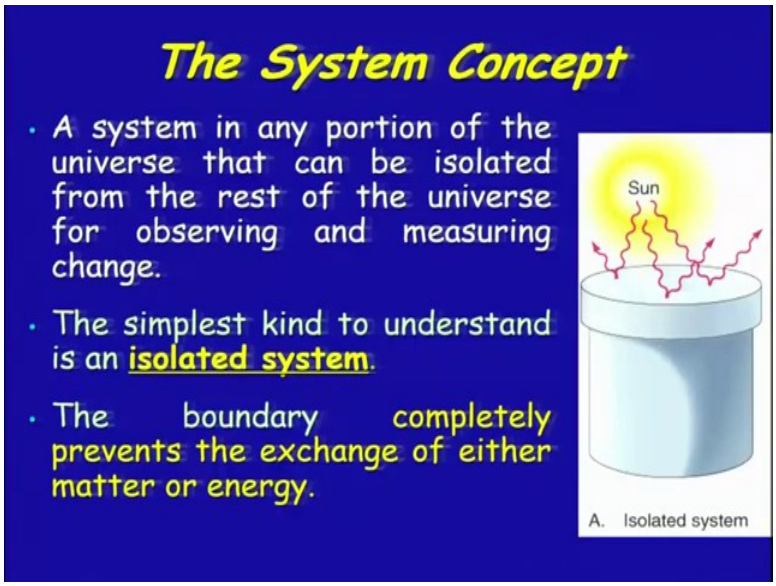

So, first the isolated system if we take, then we define that the system in any portion of the universe that can be isolated from the rest of the universe from observing and measuring changes. So, you cannot do anything, it is completely isolated. The simplest

kind to understand an isolated system is that the boundary completely prevents the exchange of either matter or energy. So, nothing can be exchanged.

So, this type of system we term as an isolated system. For example, the radiation coming in, but nothing is happening nothing is absorbed by this container. Consider this container is an earth and the radiation is coming and going back into the atmosphere, but nothing has been absorbed by the earth. So, this is one kind of an isolated system where there is no exchange of matter or energy.

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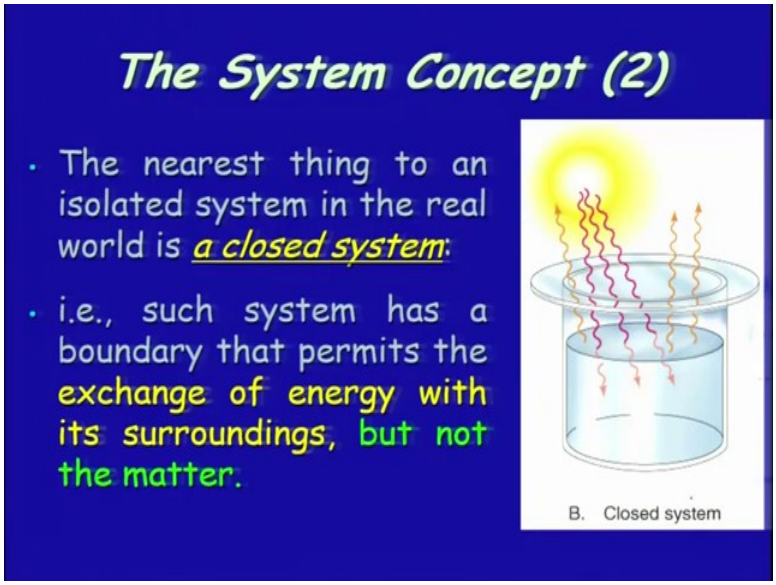

Then second is the closed system. So, again the closed system the nearest thing to an isolated system in the real world is the closed system that is such system has a boundary that permits the exchange of energy with its surrounding, but not matter. So, this we can say that this is an exchange of heat also or exchange of radiation which is coming in absorbed. Because, there is some sort of a layer which allows this radiation to penetrate through either you say this an atmosphere is true of course, it gets into the system, it is absorbed, but at the same time it is also reflected back to the atmosphere. So, there is an exchange of energy with its surrounding, but not the matter. So, no material exchange has been taking place. So, we say that is a closed system so, only energy exchanges there.

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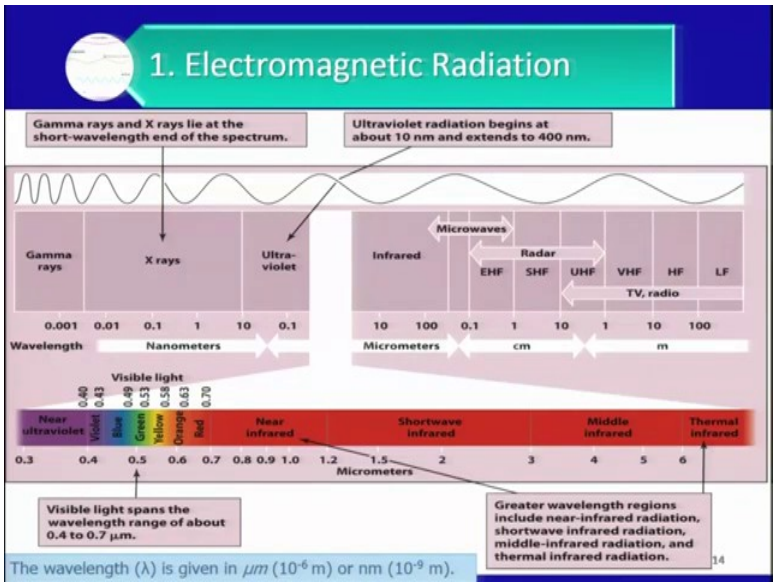

Now, for example, if you take the radiation, the electromagnetic radiation which is coming in a different wavelength and you have spectrum which is very important for us that is your visible light. So, this spectrum or the electromagnetic radiation with the different wavelengths which are we have classified as a gamma ray, X-ray, ultraviolet. And then we have visible light and we get into the microwaves and radar waves. And the waves which we use for the receiving the signals of TV or television and radio; now how far this radiation or is absorbed by the earth.

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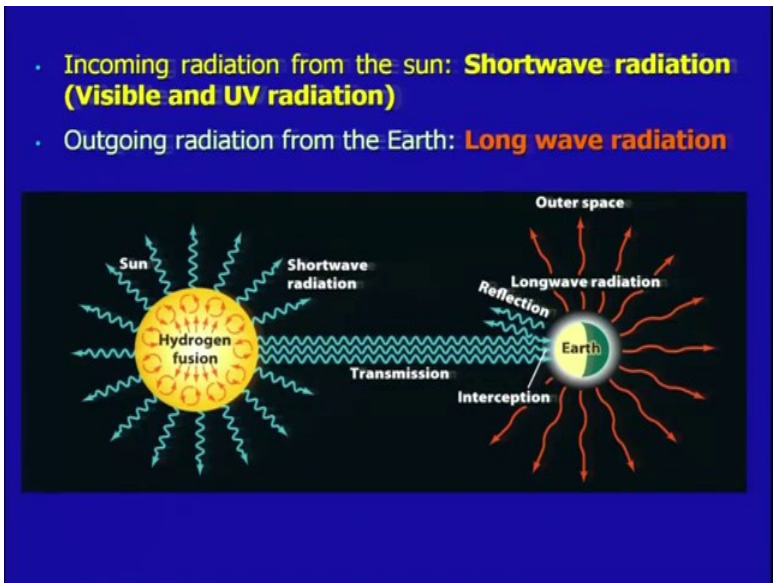

So, if you take this example where we are having the of course, this is the source of radiation which generates shortwave radiations. It traveled through and crosses the atmosphere, this is the inception. Some is reflected back, some is absorbed and after this the long waves are been radiated back to the outer space. So, incoming radiation from sun shortwave radiation, visible and ultraviolet radiation what we classify and then outgoing radiation from the earth is in form of the long wave radiation.

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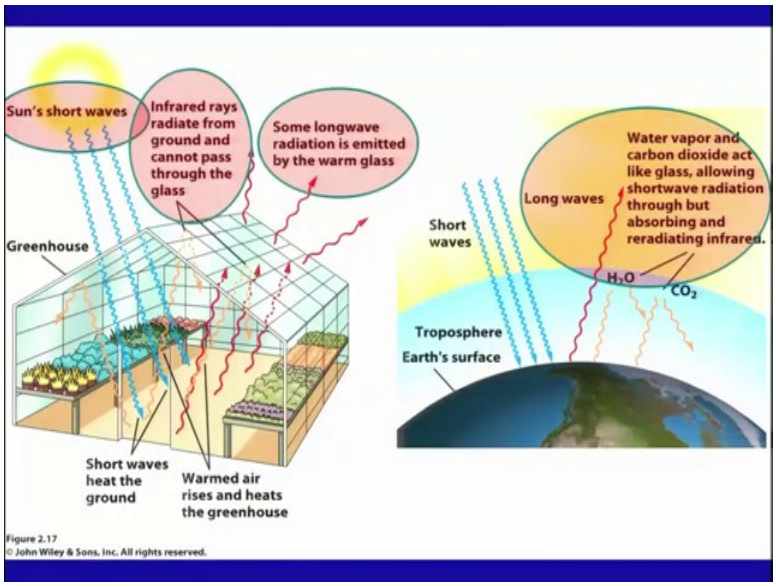

So, further if we take this as a very sermon in a form of a very simple example. So, we again have the source here. So, this explains somewhat the model of what we talking about the greenhouse effect. So, what happens exactly? So, short waves from the sun is coming to the atmosphere and it penetrates through the atmosphere on the earth's surface. So, what it does is that the short waves heat the ground, warm air rises and heat the greenhouse. Because, if you carefully see this blue is your shortwave which is coming here. And then you have this orange color which are the infrared rays radiated from ground, but it cannot pass through the class and the class is very much similar to your atmosphere.

So, what will happen? They are reflected back to the ground and some long wave radiation are emitted by through the warm glass which will get into the atmosphere. So, we have short waves here, we have atmosphere. It penetrates through absorbed by the earth's surface, some goes back that is what we are talking about the infrared rays, but it

is their reflected back here and some goes into the atmosphere. So, the water vapor and the carbon dioxide act like glass allowing short wave radiation true, but absorbing and radiating reradiating the infrared back to the earth's surface. Now, this will increase the warming up of the earth's atmosphere and the earth's surface and this in particular what we are talking about the greenhouse effect.

So now, this example you just keep in mind and try to correlate with what we were talking about the isolated system or a closed system; isolated no matter no energy is exchanged, closed system energy is extend, but no matter. So, you can guess what is what in that sense we should categorize the earth; either it is isolated or closed system. Let us go ahead and then see that what is the open system now.

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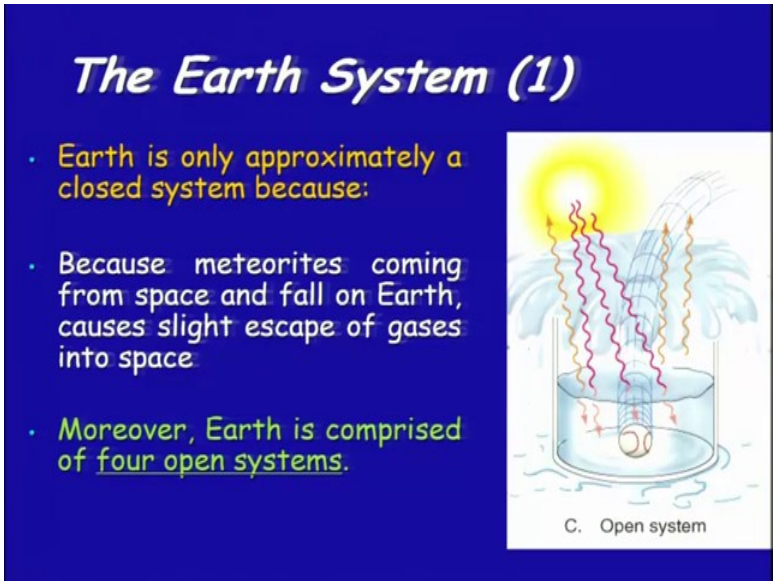

So, the open system is earth is only approximately a closed system. So, closed system we are talking about only energy can be change, but no matter. But, here we say it is approximately close system. Now why? Because, the meteorites of course, this activity or the phenomena is happening in very like few numbers, but in some places yes, it is more, but in past it had. We have examples of the white craters which have been formed because of the material impacts and all that and we have evidences of the meteoritic impact on the earth's surface.

And you might have watched some movies where they say that a big chunk of rock mass is moving towards the earth and all that fine. So, this is it exactly that part. So, what it

happens is that because, the meteorites coming from the space and fall on earth causes slide escape of the gases in space. So, whatever the gases which are available within the atmosphere or we can say the glass which is not allowing to exchange the matter, it will get exchanged at that point of time. Because, it is puncturing the meteorite which is coming in, it is puncturing the atmosphere and it allows some gases to escape into the space. Moreover, earth comprise of four open system. Now, this example what we are talking which is because, these is an energy exchange of the energy as well as the matter then this become an open system.

But, as in the first bullet what we talk about the closed system by approximately closed system is because of this because most of the time earth remains as a closed system, but when there is a meteoritic impact it is disturbed it and there is an puncturing or the or the there is a slight escape of the gases. So, that is it exchange matter also, there it is partially closed system. But, within earth has a hole, it comprises for open system bit or because at a keep exchanging matter as well as energy. Let us see what are those fine.

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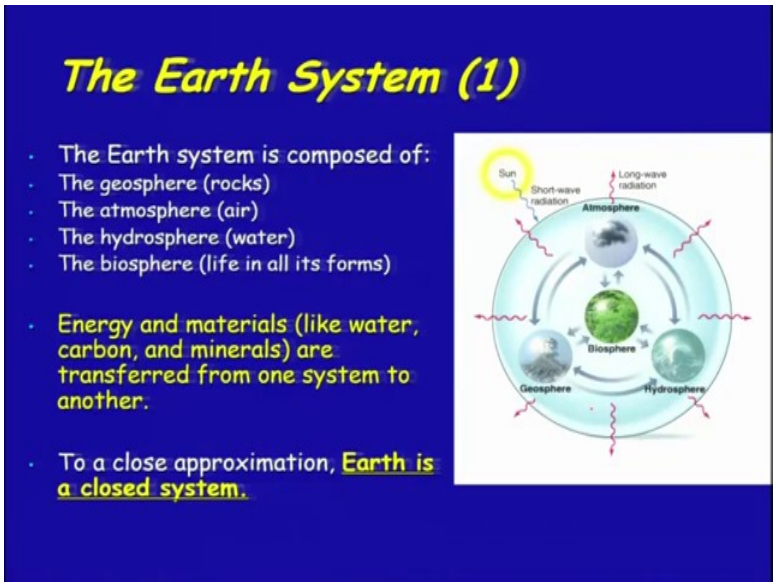

So, earth system as a system if you take what we have is that we have atmosphere, we have geosphere, we have biosphere, we have hydrosphere. Now, these are all systems within the earth system. So, earth is comprised of atmosphere, geosphere, biosphere, hydrosphere.

So, geosphere mostly we talk about the rocks, volcanic eruptions and all that. Atmosphere we talk about air, hydrosphere we talk about water, biosphere life in all its forms. So, energy and material like water, carbon and minerals there are sediments and the two sediments are minerals small minerals of the right from rocks are transferred from one system to another one. Hence, it is considered as an open system. So, to a close approximation earth is a closest. So, if you ask that what is the earth what so, as in system it is in closed system, but approximate core system not in complete closed system. But, within earth system what we have atmosphere and as I told other biosphere, geosphere, hydrosphere they are open system.

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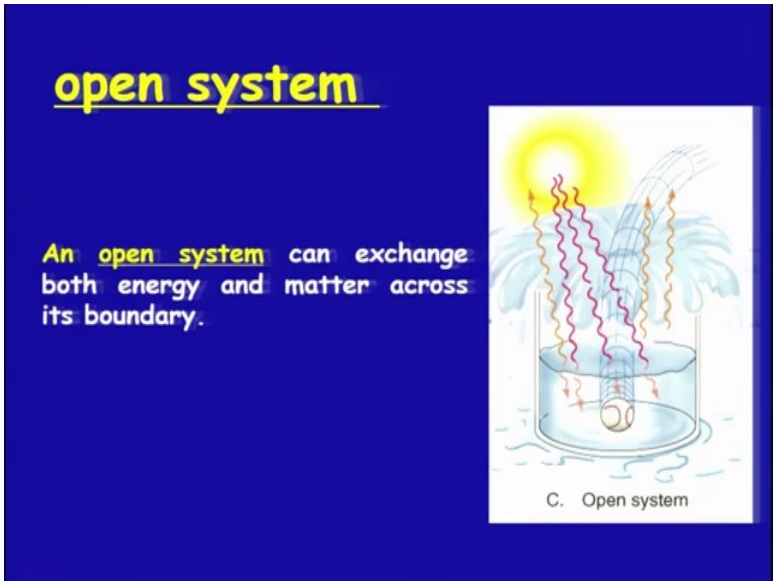

So, open system can exchange both energy and matter across its boundary. So, at the time of the meteoritic impact it is becoming partially open system.

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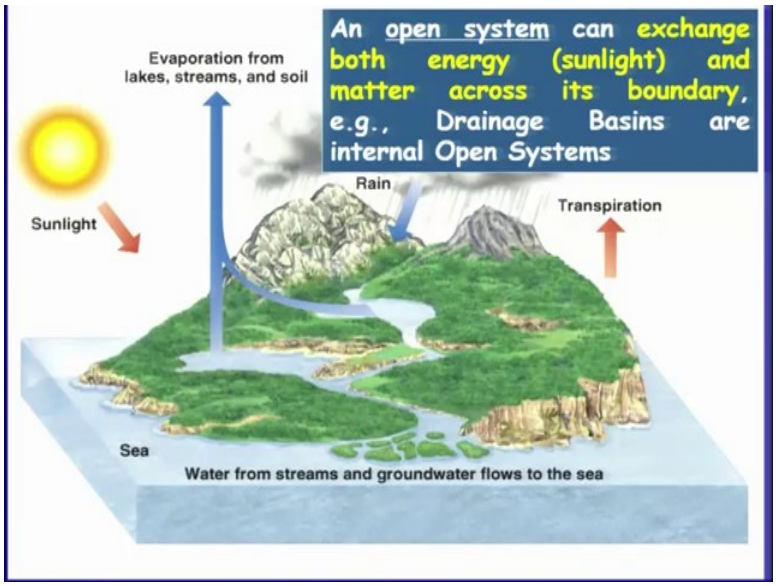

Now, one of the system if we talk about. So, what is happening here this hydrosphere or hydrological cycle if we say then we have of course, the energy coming from sun. Then we have if we have water body on the surface or water body either isolated either ocean or in the river there will be an evaporation from lakes, streams and soil and then there will be in transpiration also through the vegetation and all that. So, what ultimately, we get back is the rain. So, when there is rain there will mean erosion on the surface.

So, it is eroding the material and it is transporting the material from one system to another system. So, this way what we talk about is it is an open system here also there is an exchange. So, an open system can exchange both energy that is sunlight and matter cross its boundary. For example, drainage basin is internally open system because they exchange the energy as well as they exchange the material.

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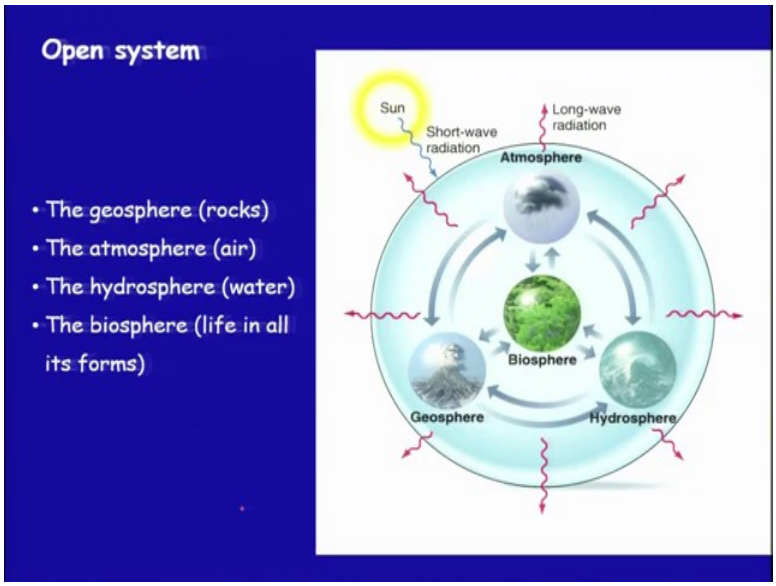

So, the open system now, it is clear that we have four open system within the earth system.

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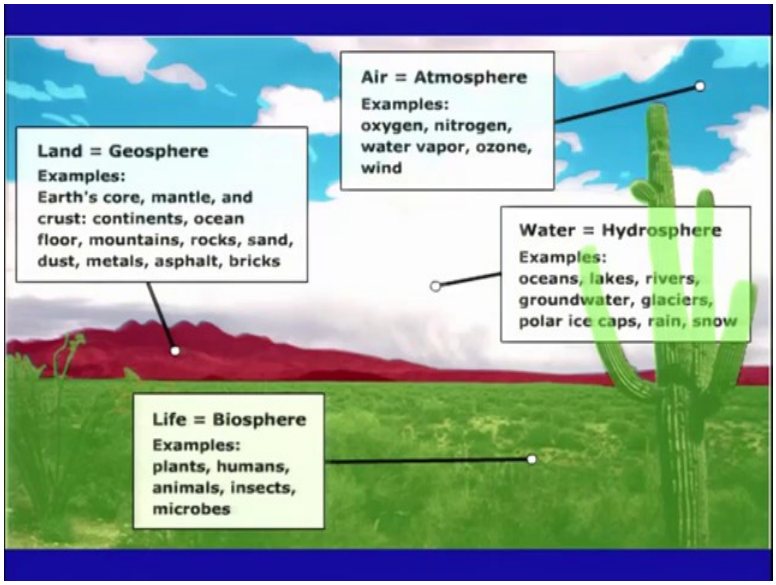

So, this is your geosphere. So, land mainly which includes for example, earth core, mantle and crust, continents, ocean floor, mountains, rocks, sand, dust, metals, asphalt, bricks etcetera. Then we have hydrosphere, the examples are oceans, lakes, rivers, groundwater, glaciers, polar ice caps, rain and snow. Then we have atmosphere, but even we talk mostly about the gases oxygen, nitrogen, water vapor, ozones and of course, the

air or the wind. So, this is the part of the atmosphere. Then we have geosphere the example again is the plant, humans, animal, insects and microbes. So, other than these three system we have another important one is the biosphere which includes plants, humans, animals, insects and microbes.

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Now, when earth's environments systems if you take the earth's environment has a complex network of systems interlinked with one another. Now, why this statement is come here because, if you disturb one another will get affected. So, that is one of the reason why we have been emphasizing that, there is a human interference which are resulting into the extreme events, which are resulting into the warming up of the earth; this is what is there. So, if they are interlinked with one another.

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So, human influence if you take basically we are influencing earth's external geological processes. So, we are not we cannot come on cannot interfere or influence the internal processes, but we are influencing the external processes mainly. More than 7 billion people we see that or we know that they are on earth. So, what basically we are doing ok. We are being loading the system. So, if you overload the system this will happen. So, this is one of the example just to have a fun, but of course, this is what is happening on the earth, population is growing exponentially and that is going to affect the overall external processes.

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World Population (2017 and historical)

View the population data for all years

Year	Population	Yearly % Change	Yearly Change	Median Age	Fertility Rate	Density (P/Km²)	Urban Pop %	Urban Population
2017	**7,515,284,153**	1.11 %	82,620,878	29.9	2.5	58	54.7 %	4,110,778,369
2016	**7,432,663,275**	1.13 %	83,191,176	29.9	2.5	57	54.3 %	4,034,193,153
2015	**7,349,472,099**	1.18 %	83,949,411	30	2.51	57	53.8 %	3,957,285,013
2010	**6,929,725,043**	1.23 %	82,017,839	29	2.56	53	51.5 %	3,571,272,167
2005	**6,519,635,850**	1.25 %	78,602,746	27	2.62	50	49.1 %	3,199,013,076
2000	**6,126,622,121**	1.33 %	78,299,807	26	2.74	47	46.6 %	2,856,131,072
1995	**5,735,123,084**	1.55 %	85,091,077	25	3.04	44	44.8 %	2,568,062,984
1990	**5,309,667,699**	1.82 %	91,425,426	24	3.45	41	43 %	2,285,030,904
1985	**4,852,540,569**	1.79 %	82,581,621	23	3.59	37	41.3 %	2,003,049,795
1980	**4,439,632,465**	1.8 %	75,646,647	23	3.87	34	39.4 %	1,749,539,272
1975	**4,061,399,228**	1.98 %	75,782,307	22	4.48	31	37.8 %	1,534,721,238
1970	**3,682,487,691**	2.08 %	71,998,514	22	4.92	28	36.7 %	1,350,280,789
1965	**3,322,495,121**	1.94 %	60,830,259	23	4.96	21	N.A.	N.A.
1960	**3,018,343,828**	1.82 %	52,005,861	23	4.9	23	33.8 %	1,019,494,911
1955	**2,758,314,525**	1.78 %	46,633,043	23	4.96	21	N.A.	N.A.

Source: **Worldometers** (www.Worldometers.info)

Elaboration of data by United Nations, Department of Economic and Social Affairs, Population Division. World Population Prospects: The 2019 Revision. (Medium-fertility variant).

So, this is the world population based on the data from the historical as well as from the present until 2017. So, this is one of the example, if you see we have crossed almost like 7 billion years.

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Human influence our daily activities are having measurable effect on one rainfall, a climate, air, water quality, erosion. So, if you take this of course, to some extent if you keep warming the earth we will have the effect on the climate, we keep polluting the air . And we have been watching on the television that how polluted are our cities. Order quality we keep on pouring the garbage or the effluents, the toxic effluent in the river or the oceans. We are polluting the water quality and this is happening slowly of course, the effect you will see as a long-term effect because, immediately it will not get affected.

So, if you keep adding the pollutants or toxin into the water system, then it will overall also pollute the groundwater table and it will affect us only. Of course, deforestation and all that we have been talking about which will result into more of erosion, more of erosion and more of bed load has been added to the streams or the rivers. And that will eventually to some extent reduces the channel area through which the water will flow in a particular river channel.

And if you increase the sedimentation or the deposition of the because, of the heavy erosion you are reducing the cross-sectional areas. So, you are leaving a very small area for the water to flow through. So, what will happen is that you are having the excess rain,

then the channels will spill over and it will be in the flooding states. So, that will return result into the flooding in the nearby regions. So, this is what we are influencing as a human.

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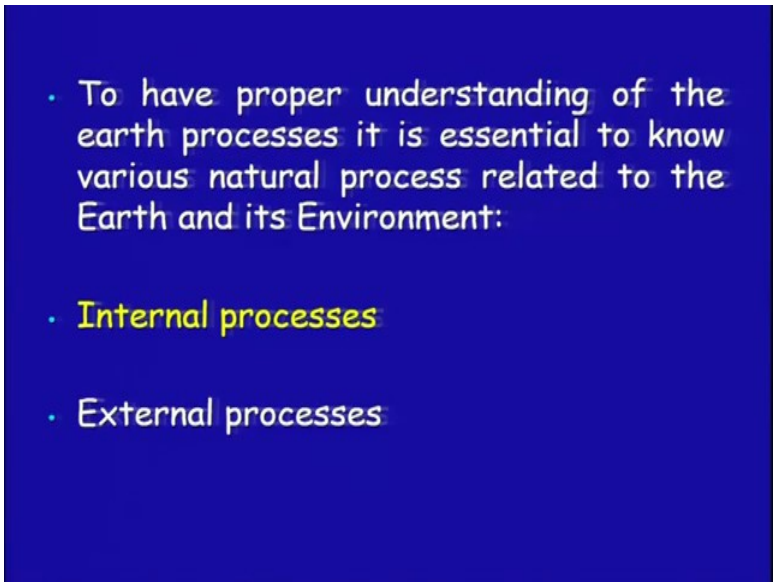

So, to have proper understanding of the earth processes it is essential to know various national processes related to earth and its environment. So, we collectively take as a system and its environment, we talked about the different systems within the earth system that is atmosphere, hydrosphere, the geosphere and biosphere. So, we have internal processes, we have external processes. So, we will get into detail of this and topic wise we will talk about the internal and external processes.

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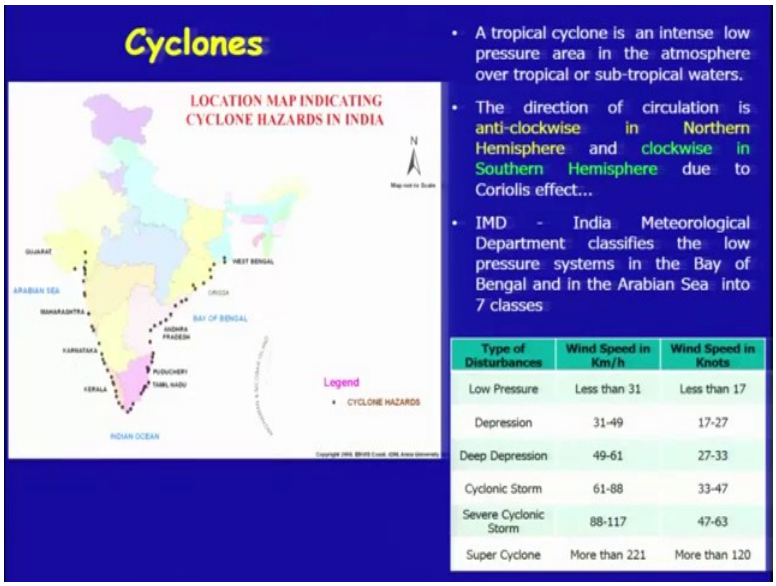

Type of Disturbances	Wind Speed in Km/h	Wind Speed in Knots
Low Pressure	Less than 31	Less than 17
Depression	31-49	17-27
Deep Depression	49-61	27-33
Cyclonic Storm	61-88	33-47
Severe Cyclonic Storm	88-117	47-63
Super Cyclone	More than 221	More than 120

So, I will stop here and we will continue in the next lecture.

Thank you so much.