Welcome to this lecture in Environmental Education. Today we will learn about Acid Rain. I am Dr. Delia Antao from Nirmala Institute of Education. At the end of this lecture you will be able to:

- Explain the meaning of Acid Rain.
- List the causes and effects of Acid Rain and
- Give suggestions to minimize the occurrence of Acid Rains.

So let us begin.

We know that pollutants can play havoc with the environment and acid rain is one of the most dangerous and widespread forms of pollution. Sometimes it is also called '*the unseen plague*'. That is because we can see the rain, but we cannot see to what extent that rain is acidic.

Acid rain has a large amount of acid in it, much more than the normal rain. When I say "much more than the normal rain", it means that rain water is slightly acidic. That is because carbon dioxide dissolves in rainwater to make it acidic, so we have dilute carbonic acid. But acid rains can often go undetected in an area, for years because the effects will be seen much much later.

To understand this, let us see what is the pH of clean rainwater. The pH of clean rainwater is between 5 and 5.5 but the pH of acid rain is between 4.2 and 4.4. To understand this let us compare it with the pH of clean drinking water. Tthe pH of clean drinking water is between 6.5 and 7.5.

Now what is this **pH**? It is a measure of acidity or alkalinity of water soluble substances i.e., pH stands for *'potential of hydrogen'.* It is represented by nothing but a number between 1 to 14. 7 which is a middle number, becomes the middle neutral point. Let us look at these numbers. So you see 7 in the middle. It is a neutral point. And as you go down 6... 5... 4... 3... 2...1, you see that the substance is more acidic.

If you go higher, the numbers tell you how basic the substance is i.e. values below 7 indicate acidity,

which increases as a number decreases, 1 being most acidic. Similarly, values above 7 indicate alkalinity.

Acid rain was first detected in 1927 in England. Now, acid rain is not the primary pollutant. That is because it is the result of sulphur dioxide and oxides of nitrogen being dissolved in rainwater. Acid Rain therefore becomes a secondary pollutant.

Acid Rain is generally referred to as *'atmospheric deposition*', that is, because something from the atmosphere is deposited down on the surface. It could be in the wet state like rain, snow, sleet, fog and dew or it could be in the drystate, like the acidifying particles and gases. Therefore, sometimes Acid Rain is also called *'acid deposition'*.

Now what are the causes of Acid Rain? There could be 2 causes, 2 main causes. That is natural causes and anthropogenic causes. Natural causes such as volcanic eruptions give out a lot of smoke- thick smoke in the atmosphere and these are actually emissions of sulphur dioxide and hydrogen sulphide gases. These dissolve in atmospheric water i.e. water vapour and form sulphuric acid. So around the volcanoes you find a lot of acid rains which destroy a lot of area around the vicinity of the volcanoes.

Wildfires are also causes of pollution. Wildfires or bushfires which are so common in Australia, for example, give out a lot of smoke and these pollutants are a cause of Acid Rains.

There is also bacterial action taking place in the soil when bacteria act upon the dead and decaying matter of plant and animal remains. So 10% of sulphur dioxide is actually released by these bacterial actions. But when nature pollutes, nature also takes care of the pollution. But the problem arises when we have anthropogenic causes which play havoc with the environment. For example, industries and automobiles give out a lot of oxides of sulphur and nitrogen,which dissolve in the atmospheric water vapour and cause Acid Rains.

Burning of fuels for domestic use also are contributing factors to acid rains. So when we work in the kitchen... cooking, heating, etc. we have to pay attention to how much of fuel we use and how much we are contributing to pollution.

Now how is Acid Rain formed? Sulphur dioxide and oxides of nitrogen are released in the atmosphere by various processes. These oxides or these gases, they react with water vapour in the atmosphere and form acids. When it rains, these acids come down and the rain becomes acidic and is called Acid Rain.

Now what are the harmful effects of Acid Rain? There are many. Natural water becomes acidic and therefore it becomes unfit for human and animal use and therefore the water that we get get in our taps, is processed.There is a lot of money involved in the laboratories to purify this water that we consume. Human beings are prone to respiratory diseases such as bronchitis and asthma, which can cause premature deaths. If you go out in the rain,especially in the first rain, you will find that your skin will start itching and it won't stop until you take a bath. So animals too face similar problems because of Acid Rains. E.g. Acid rains can turn water in the water bodies, acidic. Besides that, the runoff from the soil can contaminate fish with highly toxic chemical compounds and cause fish to die.

Now some fish and animals such as frogs - they cannot reproduce in an acidic medium, and so it is important for us to preserve our water bodies. Calcium from the soil can also be leached due to acid rains. Snails depends on soil for their calcium content, but if the calcium is leached then the shells of these snails become weaker and they can easily be crushed or they can die because of drying up. Similarly, the song birds, which depend upon these snails for their calcium content, if the snails become scarce then the songbirds have a problem. Their eggs will have thin shells and they can either break easily or dry out within a few days after they are laid. Most of the chicks that are hatched suffer from bone

malformations. A sure sign of calcium deficiency. In the soil, the nitrogen level when it is increased due to Acid Rains, can have an adverse effect on vegetation. For example, it damages tree foliage directly, but the most serious effect is weakening of trees, so they become more susceptible to other types of damage as well. For example, the green forests, the conifers, such as red spruce at high elevations, which are bathed almost continuously in every acidic fog. Acid rains also damage metals,car finishes and buildings as you see in these pictures. Statues and monuments like theTaj Mahal which are made of marble i.e. calcium carbonate is also affected by acid rains because it forms calcium sulphate. The pollutants come from industries in the vicinity, mainly from the oil refinery at Mathura. Here is a picture of a Buddhist temple. You can see how the Acid Rain has been destroying its walls.

Now how can we reduce the formation of acid rains?

It is highly recommended that we control the pollutants causing acid rain. For example,

- we can make an extra effort to either walk or to use a bicycle whenever it is possible.

-If we have to use vehicles, then it is important that we maintain those vehicles well.

- Ensure that the smokestacks or exhaust pipes are well cleaned.

- Fit devices such as catalytic converters into car exhaust pipes to minimize the effect of sulphur dioxide.

-Turn off lights, computers, and other electrical appliances when you're not using them.

Remember that all our electricity in India comes from... most of it at least comes from burning coal and coal is a pollutant. If you have to burn coal, it should be burned more efficiently. That means it should be cleaned before it is burned so that the dangerous pollutants are washed away. Here are some references for your reading.

Thank you.