Acid Rain

What is Acid Rain?

- It is a form of precipitation that is acidic in nature.
- When atmospheric pollutants like oxides of nitrogen and sulphur react with rainwater and come down with the rain, then this results in Acid Rain.
- Distilled water, once carbon dioxide is removed, has a neutral pH of 7. Liquids with a pH less than 7 are acidic, and those with a pH greater than 7 are alkaline.

- "Clean" or unpolluted rain has an acidic pH, but usually no lower than 5.7, because carbon dioxide and water in the air react together to form carbonic acid, a weak acid according to the following reaction:

$$H_2O\ (l) + CO_2\ (g) \rightleftharpoons H_2CO_3\ (aq)$$

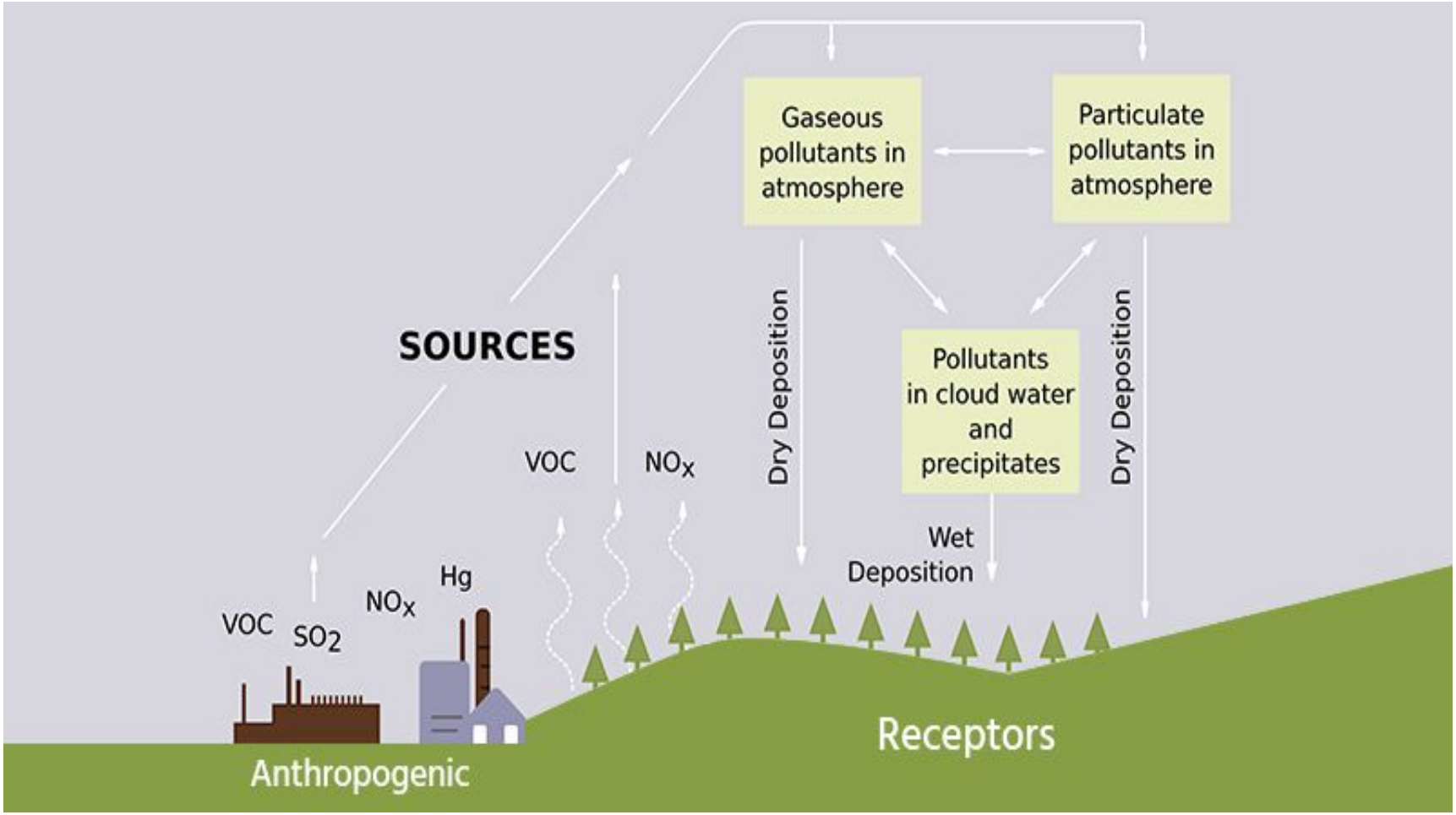
- Carbonic acid then can ionize in water forming low concentration of carbonate and hydronium ions

$$H_2O\ (l) + H_2CO_3\ (aq) \rightleftharpoons HCO_3^-\ (aq) + H_3O^+\ (aq)$$

- Unpolluted rain can also contain other chemicals which affect its pH.
- A common example is nitric acid produced by electric discharge in the atmosphere such as lightning.

Causes of Acid Rain

- The causes of acid rain are *Sulfur and Nitrogen particles which get mixed with the wet components of rain*.
- Sulfur and Nitrogen particles which get mixed with water are found in two ways either man-made i.e as the emissions are given out from industries or by natural causes like how a lightning strike in the atmosphere releases nitrogen ions and sulphur is released from volcanic eruptions.



Formation of Acid Rain

- Sulphur dioxide and nitrogen dioxide undergo oxidation and then they react with water resulting in the formation of sulphuric acid and nitric acid respectively.

$2SO_2\,(g) + O_2\,(g) + 2H_2O\,(l) \rightarrow 2H_2SO_4\,(aq)$

$4NO_2\,(g) + O_2\,(g) + 2H_2O\,(l) \rightarrow 4HNO_3\,(aq)$

Effects of Acid Rain

- Acid rain is very harmful to agriculture, plants, and animals. It washes away all nutrients which are required for the growth and survival of plants. Acid rain alters the composition of the soil in agricultural field. (Soil acidification)
- It causes respiratory issues in animals and humans.

- When acid rain falls down and flows into the rivers and ponds it affects the aquatic ecosystem. As it alters the chemical composition of the water, to a form which is actually harmful to the aquatic ecosystem to survive and causes water pollution.

- Acid rain also causes the corrosion of water pipes. Which further results in leaching of heavy metals such as iron, lead and copper into drinking water.
- It damages the buildings and monuments made up of stones and metals.

Real-Life Examples

Taj Mahal, one of the 7 wonders of the world, is largely affected by acid rain. The city of Agra has many industries which emit the oxides of sulphur and nitrogen in the atmosphere. People continue to use low-quality coal and firewood as a domestic fuel, adding to this problem. Acid rain has the following reaction with the marble (calcium carbonate):

$$CaCO_3 + H_2SO_4 \rightarrow CaSO_4 + H_2O + CO_2$$

- The formation of calcium sulphate results in the corrosion of this beautiful monument.

Statue of Liberty which is made of copper has also been damaged by the cumulative action of acid rain & oxidation for over 30 years and is, therefore, becoming green in colour.

Prevention of Acid Rain

- The only precaution that we can take against acid rain is having a check at the emission of oxides of nitrogen and sulphur.
- Many coal-firing power stations use flue-gas desulfurization (FGD) to remove sulfur-containing gases from their stack gases.
- Fluidized bed combustion also reduces the amount of sulfur emitted by power production.
- Vehicle emissions control reduces emissions of nitrogen oxides from motor vehicles.
- Being responsible citizens, one should be aware of the harmful effects they cause and of the industries which give out nitrogen and sulphur compound wastes unethically.

International treaties

1985 Helsinki Protocol on the Reduction of Sulphur Emissions under the Convention on Long-Range Transboundary Air Pollution.

Thank you!