ACID RAIN - GS I AND III MAINS

Q. What is acid rain? Also explain its various adverse impacts on India. (10 marks, 150 words)

News: *Acid rain: Real danger or overhyped doomsaying?*

What's in the news?

- Acid rain comes in many forms: rain, snow, sleet, hail, and fog (wet deposition), and as acid particles, aerosols, and gases (dry deposition).
- Acid deposition forms when sulfur dioxide (SO2) and nitrogen oxides (NOx) combine with moisture in the atmosphere to produce sulfuric acid and nitric acid.

Acid Rain:

- Acid rain is rain with high levels of acidic substances like sulfuric acid or nitric acid.
- It forms when emissions of sulfur dioxide (SO2) and nitrogen oxides (NOx) released from burning fossil fuels, industries and human activities mix with water vapor and chemicals in the air.
- These acidic pollutants combine with water droplets in the atmosphere and then fall to the ground as rain, snow, fog, or dry particles.
- The pH of acid rain is usually between 4.2 and 4.4.

Types of Acid Rain:

Acid rain is scientifically called acid deposition, which may be a wet or dry deposition.

1. Wet Deposition:

- If the acid chemicals in the air are mixed with wet weather in the atmosphere, the acids can fall onto the ground in the form of acidic rain or other wet depositions of snow, fog, or mist.

2. Dry Deposition:

- If the acidic chemicals in the air are mixed with wet weather in the atmosphere, the acid mixes with dust or smoke and falls onto the ground as dry deposition, sticking to the ground, buildings, vegetation, cars, etc.

Causes of Acid Rain:

1. Fossil Fuel Combustion:

- Burning Fossil Fuels, particularly those containing sulfur, release sulfur dioxide (SO2) and at higher temperatures, nitrogen oxides (NOx).
- Fossil fuel combustion is prevalent in vehicles such as automobiles, and is a primary source of environmental pollutants.
- The combustion of coal in power plants and industrial processes also releases these substances.

2. Natural Sources:

- Volcanic Eruptions and Lightning also contribute to the presence of sulfur dioxide and nitrogen oxides in the atmosphere.

3. Air Pollution:

- In the atmosphere, the pollutants SO2 and NOx undergo chemical reactions, forming sulfuric and nitric acids.
- When combined with water vapor, they create acid rain during precipitation.

Impact of Acid Rains on the Environment

1. On Water bodies:

- Ocean Acidification - Acid rains or deposition lead to the acidification of oceans. It leads to a decline in the health of aquatic organisms such as fisheries and other marine organisms.
    - Acid rain lowers the pH of water bodies. It harms aquatic life by damaging gills, reducing reproduction, and altering food availability.
- In wetlands and marshy ecosystems, the high acidity, especially from sulfur deposition, can fast-track the conversion of elemental mercury to methyl mercury, the deadliest neurological toxin. And it bio-accumulates in the fish tissue.
- Acid rains react with harmful pollutants (like cadmium and lead) and contaminate water resources thereby causing harmful health risks.

2. On Vegetation:

Acid rains adversely affect trees and undergrowth vegetation in the forest in numerous ways, causing reduced growth or abnormal growth. The symptoms of vegetation due to acid rains include:

- Early ageing of older needles and loss of feeder-root biomass in conifers.
- Death of affected trees especially in poorly buffered soils.
- Unusual Proliferation of lichens on affected trees.
- Discolouration and loss of foliar biomass.
- Increased susceptibility of damage to the secondary root and foliar pathogens.
- Death of herbaceous vegetation beneath affected trees.

In a way, it leaches nutrients, weakens plants, reduces water absorption, and stunts growth. It led to reduced crop yields and plant fatalities.

3. On Soil:

- The poorly buffered soils are susceptible to acidification because they lack significant amounts of base cations (positively charged ions), which neutralize acidity.
    - Buffered soils can withstand or neutralize acidity.
- The exchange between hydrogen ions and the nutrient cations like calcium, potassium and magnesium in the soil cause leaching of the nutrients, making the soil infertile.
    - The impact of acid rain on Indian soil is less because Indian soils are typically alkaline with good buffering ability.
- It can also release toxic metals such as aluminium from the soil, further damaging plants and aquatic life.

4. On Man-made Structures:

- Corrosion of statues.
- Acid rain can dissolve marble and limestone through direct contact.
- Discolorations of Monuments made of marble and limestone. For example, Acid rains caused discoloration of the Taj Mahal, which is made of white marble to pale yellow.

5. On Materials:

- Cracking of rubber
- Fading and discoloration of textiles
- Embrittlement of paper
- Surface erosion of glassware
- Corrosion of metals, etc.

Government Measures:

- To regulate polluting industries, the Ministry of Environment, Forest and Climate Change (MoEF&CC) has developed the criteria for the categorization of industrial sectors based on the **Pollution Index.**
    - The pollution index is a function of the emissions (air pollutants), effluents (water pollutants), hazardous wastes generated, and consumption of resources. Industries are categorized based on pollution index scores as red (60 and above), orange (41-60), green (21-40), and white (<20).
- To improve the **Ambient Air Quality (AAQ),** the Union Ministry of Environment, Forests, and Climate Change released a notification in 2015, according to which thermal power plants across India, from 2017, will have to cut particulate matter emissions including P.M10, SOx, and NOx by as much as 40 percent and reduce their water consumption.
    - This will reduce mercury pollution by 70% and reduce the energy requirement for the drawl of water.
- In 2015, the Ministry of Environment, Forest and Climate Change (MoEF&CC) introduced SO2 and NOx emission limits for coal power stations by adopting **flue-gas desulfurization (FGD) technology** by June 30, 2020.
- The Government of India actively promotes **renewable sources of energy -** solar and wind, etc.
- Governments across the globe are also working together to reduce acid rain. For example, in Asia, **the Acid Deposition Monitoring Network in East Asia (EANET)** operates to address this issue.

Challenges:

- Most of the coal plants in India have not installed the flue-gas desulfurization (FGD) technology, which is necessary to scrub emissions clean of sulfur.
- According to recent data compiled by Central Electricity Authority (CEA) for all power plants, Central, State, and Independent Power Producers (IPPs) show that most of the power plants would not be able to meet the deadline in spite of advanced efforts due to several constraints.

WAY FORWARD:

- The government of India shall constitute a committee comprising the Ministry of Power and the Ministry of Environment (MOEFCC) to review the timelines for FGD implementation, by conducting an assessment of the requirements and prevailing bottlenecks.
- A time extension may be granted for the installation and commissioning of FGDs by captive power plants (CPP).
- Creating an enabling environment for Indian manufacturers to ramp up capacity.
- Improving the buffering capacity of the soil to resist change in pH.