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# **ASAC 1101 : FUNDAMENTALS OF SOIL SCIENCE (2+1)**

**Level : B.Sc (Ag), I semester**

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**SOIL SCIENCE AND AGRICULTURAL CHEMISTRY**

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## **Topic**

**Soil pollution -causes, prevention and  
mitigation of soil pollution**

# Soil Pollution



“Any undesirable change in the physical, chemical or biological properties of the soil, which is harmful to environment, living organisms and plants”

- **Two types:**

1. Point-source pollution
2. Diffuse pollution

# Point-source Pollution



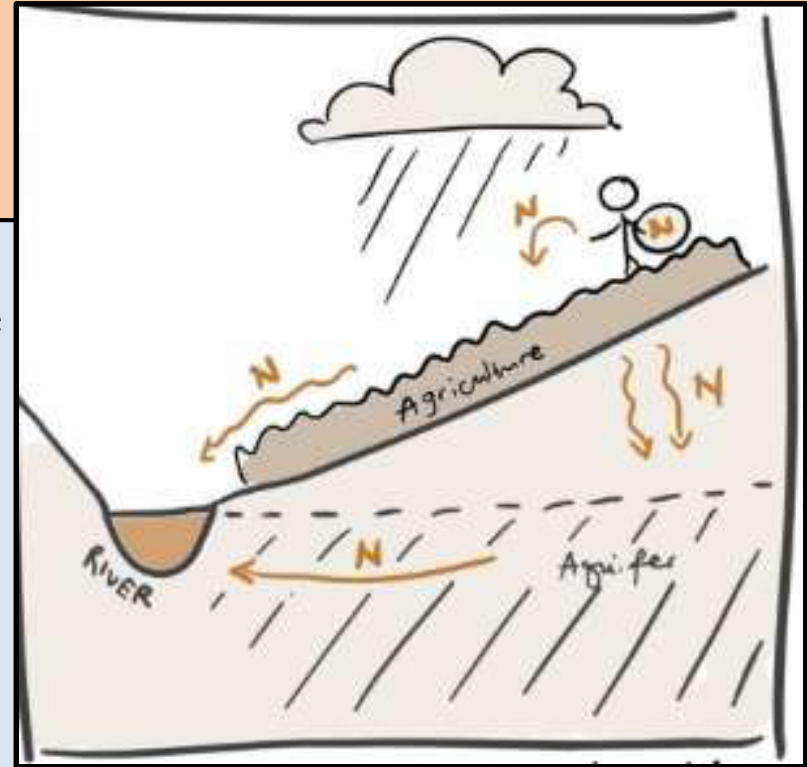
- A specific event or a series of events within a particular area in which contaminants are released to the soil, and the source and identity of the pollution is easily identified. This type of pollution is known as point-source pollution.
- Anthropogenic activities and urban centers are main sources.

# Examples of Point Source Pollution



# Diffuse Pollution

- When pollutants spread over very wide areas, accumulates in soil, and does not have a single or easily identified source.



- Diffuse pollution occurs where emission, transformation and dilution of contaminants in other media have occurred prior to their transfer to soil.

# Examples

- Sources from nuclear power and weapons activities
- Uncontrolled contaminated effluents released in and near catchments
- Land application of sewage sludge
- Drifting of agricultural pesticides

# Causes of Soil Pollution

## 1. Natural and Geogenic

- ❖ Parent materials
- ❖ Volcanic eruption

## 2. Anthropogenic

- ❖ Industrial Activities
- ❖ Mining
- ❖ Urban and Transport Infrastructures
- ❖ Waste and Sewage Generation and Disposal
- ❖ Military Activities and Wars
- ❖ Agricultural and Livestock Activities

# Natural and Geogenic

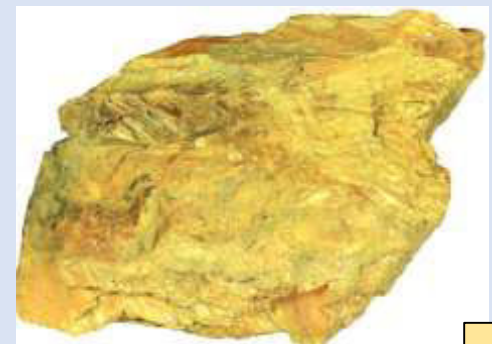
- Several soil parent materials are natural source of certain heavy metals and other elements, such as radionuclides.
- Natural sources of As include volcanic releases and weathering of As-containing minerals and ores.



Arsenopyrite



Realgar



Orpiment



- High natural radioactivity is common in acidic igneous rocks, mainly in feldspar-rich rocks and illite-rich rocks. (Blume et al. 2016)

<b>MINERALS</b>	<b>SOIL CONTAMINANTS</b>
Thorite, Monazite	<b>THORIUM</b>
Uraninite, Andersonite	<b>URANIUM</b>
Torbernite	<b>RADON</b>
Greenockite	<b>CADMIUM</b>
Galena, Wulfenite	<b>LEAD</b>

# Anthropogenic Causes

- Industrial Activities
- Mining
- Urban and Transport Infrastructures
- Waste and Sewage Generation and Disposal
- Military Activities and Wars
- Agricultural Activities

# Agricultural Activities



- Excessive fertilizer usage can lead to soil salinity, heavy metal accumulation, water eutrophication and accumulation of nitrate, which can be a source of environmental pollution but also a threat to human health.
- Trace metals from pesticides and fertilizers, such as, Cd, Pb and Hg are considered soil pollutants as they can impair plant metabolism and decrease crop productivity

# Persistence of herbicide in soil

<b>Herbicide</b>	<b>Half lives (days)</b>	<b>Herbicide</b>	<b>Half lives (days)</b>
Atrazine (Aatrex)	13-58	Metribuzine	23-49
<b>Butachlor</b>	<b>5-24</b>	Metolachlor (Dual)	8-24
Fluazifop-p-etyl	8-24	Oxyfluorfen	12-29
Fluchloralin (Basalin)	12-46	<b>Pendimethalin (Stomp)</b>	<b>15-77</b>
<b>Imazethapyr (Counter)</b>	<b>57-71</b>	Sulfosulfuron (Leader)	3-27
Isoproturon (Ronak)	13-21	2,4-D (Gaurd)	7-22

Sondhia (2007)

# Persistence of fungicide and Insecticide

<b>Fungicide</b>	<b>Half life (days)</b>
Azoxystrobin	65
<b>Captan (Orthocide)</b>	<b>1-10</b>
<b>Mancozeb</b>	<b>70</b>
<b>Metalaxyl (Apron)</b>	<b>70</b>
Propamocarb	30

**Gadwa (2002)**

<b>Insecticide</b>	<b>Half life</b>
<b>DDT</b>	<b>10-15 years</b>
Aldrin	5 years
Heptachlor	Up to 2 years
Carbaryl (sevin)	10 days
<b>Dimethoate (Cygon)</b>	<b>7 days</b>

**Chaudhary et al. (2002)**

<b>Soil Contaminants</b>	<b>Potential Sources</b>	<b>Health Hazards</b>
<b>Mercury (Hg)</b>	<ul style="list-style-type: none"> <li>• Incineration of coal</li> <li>• Alkali processing</li> <li>• Medical waste</li> <li>• Geologic deposits</li> <li>• Accumulation in plants</li> </ul>	<ul style="list-style-type: none"> <li>• Loss of hairs &amp; teeth</li> <li>• Photophobia</li> <li>• Kidney dysfunction</li> <li>• Memory impairment</li> <li>• Insomnia in children</li> </ul>
<b>Lead (Pb)</b>	<ul style="list-style-type: none"> <li>• Lead paint</li> <li>• Vehicle exhaust</li> <li>• Construction activities</li> </ul>	<ul style="list-style-type: none"> <li>• Weight loss</li> <li>• Irritability</li> <li>• Neurological problem</li> <li>• Headache</li> <li>• Autism</li> </ul>

Soil Contaminants	Potential Sources	Health Hazards
<b>Arsenic (As)</b>	<ul style="list-style-type: none"> <li>• Coal-fired power plants</li> <li>• Lumber facilities</li> <li>• Electronics industry</li> <li>• Agriculture</li> <li>• Natural accumulation</li> </ul>	<ul style="list-style-type: none"> <li>• Pregnancy complications</li> <li>• Infant mortality</li> <li>• <b>Bladder or lung cancer</b> in cases of long-term exposure</li> </ul>
<b>Cadmium (Cd)</b>	<ul style="list-style-type: none"> <li>• Fossil fuel combustion</li> <li>• Phosphate fertilizers</li> <li>• Natural sources</li> <li>• Steel production</li> <li>• Cement production</li> </ul>	<ul style="list-style-type: none"> <li>• Headache</li> <li>• Weakness</li> <li>• Fever</li> <li>• <b>Pancreatic cancer</b></li> <li>• Chest Pain</li> </ul>

<b>Soil Contaminants</b>	<b>Potential Sources</b>	<b>Health Hazards</b>
<b>Polyaromatic Hydrocarbons</b>	<ul style="list-style-type: none"> <li>• Coal burning</li> <li>• Vehicle emissions</li> <li>• Cigarette smoke</li> <li>• Wildfires</li> </ul>	<ul style="list-style-type: none"> <li>• Immunosuppression</li> <li>• Cancer</li> <li>• Liver damage</li> <li>• Respiratory tract diseases</li> </ul>
<b>Pesticide</b>	<ul style="list-style-type: none"> <li>• Agricultural activities</li> <li>• Gardening</li> </ul>	<ul style="list-style-type: none"> <li>• Birth defects</li> <li>• Reproductive problems</li> <li>• Leukaemia</li> <li>• Blood disorders</li> </ul>



## Heavy metal concentration in soil around hazardous waste disposal sites

	As	Cr	Cu	Ni	Pb	Zn
Minimum	6.1	12.2	11.0	12.5	42.9	26.9
Maximum	411.4	480.5	186.6	131.9	1833.5	882.1
Average	51.7	127.9	35.2	48.0	206.4	122.3
Threshold Value*	12.0	64.0	63.0	50.0	70.0	200.0

Location : Hyderabad

Vandana et al. (2011)

## Impacts of Soil Pollution on Environment

- Decomposition of sewage may also release various toxic heavy metals that cause characteristic heavy metal toxicity symptoms in plants.
- Soil pollution allows great quantities of nitrogen to escape through ammonia volatilization and denitrification, and the decomposition of organic materials in soil can release sulfur dioxide and other sulfur compounds, causing acid rain.

- Soil pollution increase the salinity of the soil making it unfit for vegetation, thus making it useless and barren.
- The oxides of sulphur and nitrogen, chlorides, fluorides, ammonium etc. emitted into the atmosphere in combustion from various industries come down as dry or wet deposition (acid rain) onto the soil and lower the soil pH.

- Acidic deposition into the soil can hamper its ability to buffer changes in the soil pH, causing plants to die off due to inhospitable conditions.
- Small life forms may consume harmful chemicals in the soil which may then be passed up the food chain to larger animals, which may lead to increased mortality rates and even animal extinction.

# Management and Remediation of Polluted Soils



- Oil and related materials should be handled with care during storage and transportation. Addition of certain species of microorganisms i.e. *Pseudomonas fluorescens*, *P. aeruginosa*, *Bacillus subtilis*, *Flavobacterium* sp., *Micrococcus roseus* in polluted soils can decompose oil and related materials.
- Promotion of organic amendments and bio-pesticides in place of inorganic agrochemicals.



- Landfill locations for waste disposal should not be near to residential areas or ground water level.
- Thermal remediation can be used to volatize chemical contaminants out of the soil by vapour extraction mechanism.
- Consideration of reusable or recyclable containers, irrespective of plastic.
- Industrial toxic waste should be treated to reduce its toxicity before it is disposed off.



- Soil polluted with heavy metals, organic and inorganic toxic substances can be ameliorated through phyto-remediation and bioremediation.
- Bioremediation include landfarming, biostimulation and bioaugmenting soil biota with commercially available microflora.
- Examples of hyperaccumulator are sunflower, mustard, oats, barley etc.