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Soil Pollution: Causes, Effects and Solution

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Industrialization, wars, mining and intensification in agriculture have left a legacy of contaminated soils around the world (Bundschuh et al., 2012; EEA, 2014). The term "soil contamination" has frequently been used as a synonym for soil pollution. The Intergovernmental Technical Panel on Soils (ITPS) under the Global Soil Partnership (GSP) has formalized definitions of the two terms (FAO and ITPS, 2015). Soil contamination occurs when the concentration of a chemical or substance is higher than would occur naturally but is not necessarily causing harm. Soil pollution, on the other hand, refers to the presence of a chemical or substance out of place and/or present at a higher than normal concentration that has adverse effects on any non-targeted organism. Now a days, soil pollution is an alarming issue. One of the main sources of soil pollution are anthropogenic, resulting in the accumulation of contaminants in soils that may reach levels of concern (Cachada et al., 2018). Fortunately, awareness on the importance of soil pollution is increasing around the world, leading to an increase in research conducted on the assessment and remediation of soil pollution. The Revised World Soil Charter (FAO, 2015) recommends that national governments implement regulations on soil pollution and limit the accumulation of contaminants beyond established levels in order to guarantee human health and well-being. Soil pollution took centre stage at the Fifth Global Soil Partnership (GSP) Plenary Assembly (GSP, 2017). Recently, the United Nations Environmental Assembly (UNEA-3) adopted a resolution calling for accelerated actions and collaboration to address and manage soil pollution in the framework of Sustainable Development. This consensus, achieved by more than 170 countries, is a clear sign of the global relevance of pollution and of the willingness of these countries to develop concrete solutions to address pollution problems (UNEP, 2018). Though coordinated effort on assessment of soil pollution is absent at national level in India, sporadic information has been generated by several researchers on various aspects of pollution affecting soil quality.

Types of Soil Pollution

a. Point-Source Pollution: Soil pollution can be caused by 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 represent the main sources of point-source pollution.
b. Diffuse Pollution: Diffuse pollution is pollution that is 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 (FAO and ITPS, 2015). Diffuse pollution involves the transport of pollutants via air-soil-water systems. Complex

analyses involving these three compartments is therefore needed in order adequately to assess this type of pollution (Geissen et al., 2015). For that reason, diffuse pollution is difficult to analyze, and it can be challenging to track and to delimit its spatial extent. Many of the contaminants that cause local pollution may be involved in diffuse pollution, since their fate in the environment is not well understood (Grathwohl and Halm, 2003).

Sources of Soil Pollutants

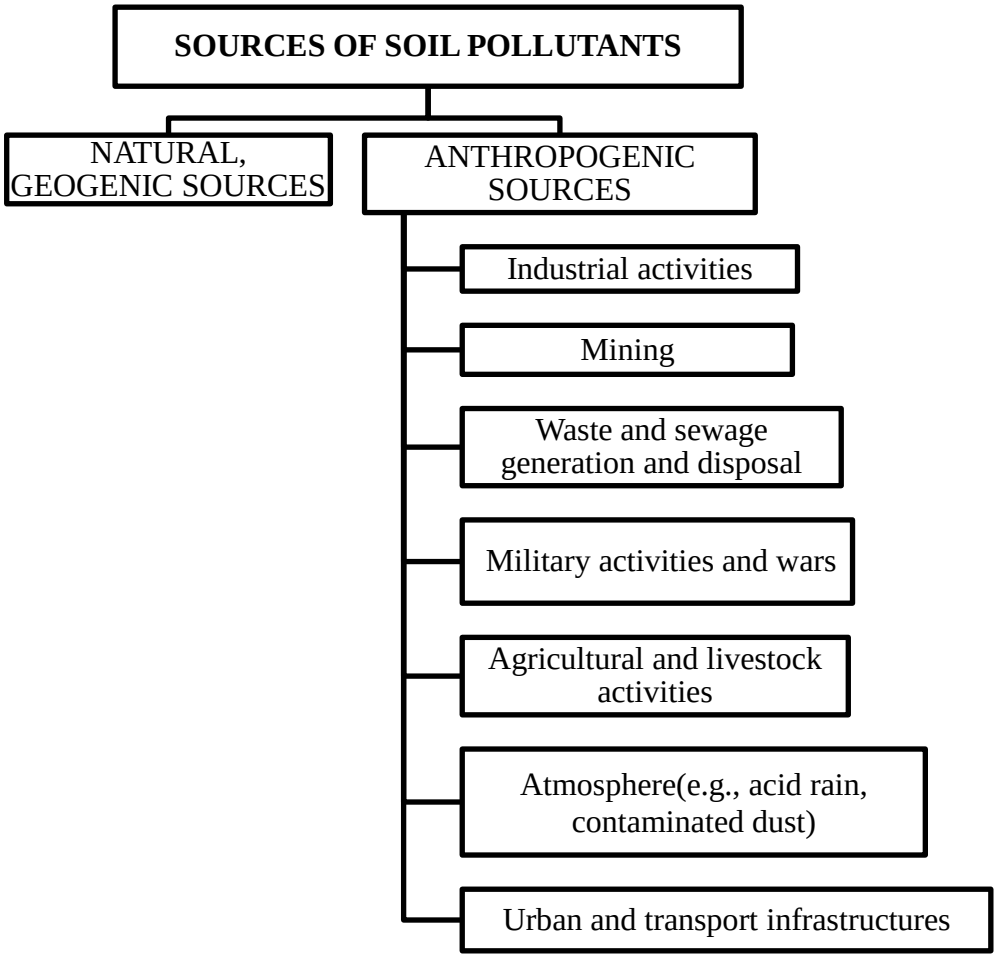

Fig. 1 Sources of soil pollutants

Main Pollutants in Soil

There are different agricultural sources of soil pollutants those are mainly responsible for decline in soil quality. These are a) over fertilization b) irrigation with poor quality water c) livestock wastes d) amendments with solid waste, e) use of pesticides, f) irrigation with untreated wastewater. Swartjes proposed a systematic categorization of pollutants (Figure 2) that may be useful in better understanding them (Swartjes, 2011).

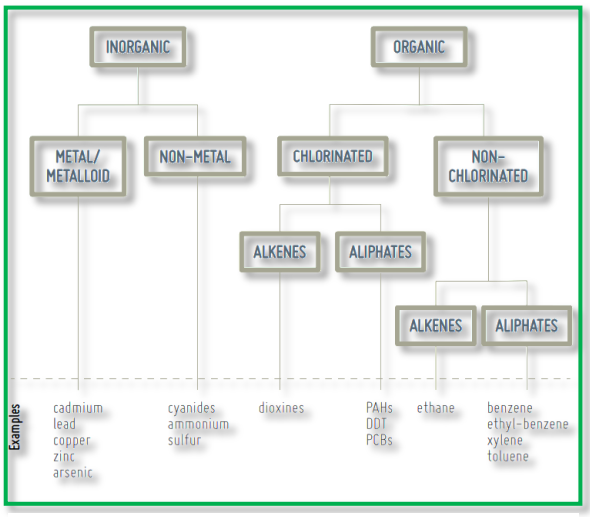

Fig. 2 Systematic categorization of the main pollutants in soils. Source: Swartjes, 2011

Entry of pollutants directly (release of effluents on land) or indirectly (use of polluted water as irrigation to crops) has been reported to contaminate vast areas of soil resources and groundwater bodies, affecting crop production as well as human and animal health through food contamination (Saha et al., 2017). Agricultural inputs such as fertilizers, pesticides, antibiotics contained in animal manure or the ones used for illness prevention and infection treatment in plants are major potential pollutants in agricultural lands and pose special challenges due to the fast-changing chemical formulas employed (GSP, 2017). Intensification of agriculture to produce enough food, fibre and biofuel has led to a heritage of polluted soils.

Effects of Soil Pollution

Indian agricultural system is badly affected by soil pollution leading to reduced soil fertility, reduced nitrogen fixation, increased erodibility, larger loss of soil and nutrients, deposition of silt in tanks and reservoirs, reduced crop yield, imbalance in soil fauna and flora which ultimately moving forward to soil degradation and decline in soil quality vis a vis unsustainability. The cost of polluted soil is considerably higher when it comes to the ecosystem. Contaminated soil should no longer be used to grow food, as the chemicals can leach into the food and damage those who consume it. When polluted soil is utilised to grow food, the yields are generally lower than if the soil was not contaminated. This, in turn, can exacerbate the problem since a lack of plants on the soil causes additional erosion, transferring toxins to territory that was previously uncontaminated.

Management and Remediation of Polluted Soils

The management of polluted soils includes assessment and remediation. The first step is the identification of the problem; in this case, the pollutions in the soil. Assessing risks means that, based on scientific evidence, one can estimate the likelihood of a certain outcome and the gravity of that outcome, and use this knowledge to help in decision making. Risk assessment decisions for soils or sediments focus on identifying relevant pathways of exposure that pose a risk to human health or the environment and developing appropriate remedial measures. Risk assessment approaches (RAA) are similar worldwide and consist of a series of steps to be taken to identify and evaluate whether exogenous or indigenous substances have caused or are causing soil pollution, and to what extent that pollution is posing a risk to the environment and to human health. After this, remediation process plays vital role in management of polluted soil. There are several techniques for remediating polluted sites. Those are as follows (Fig. 3).

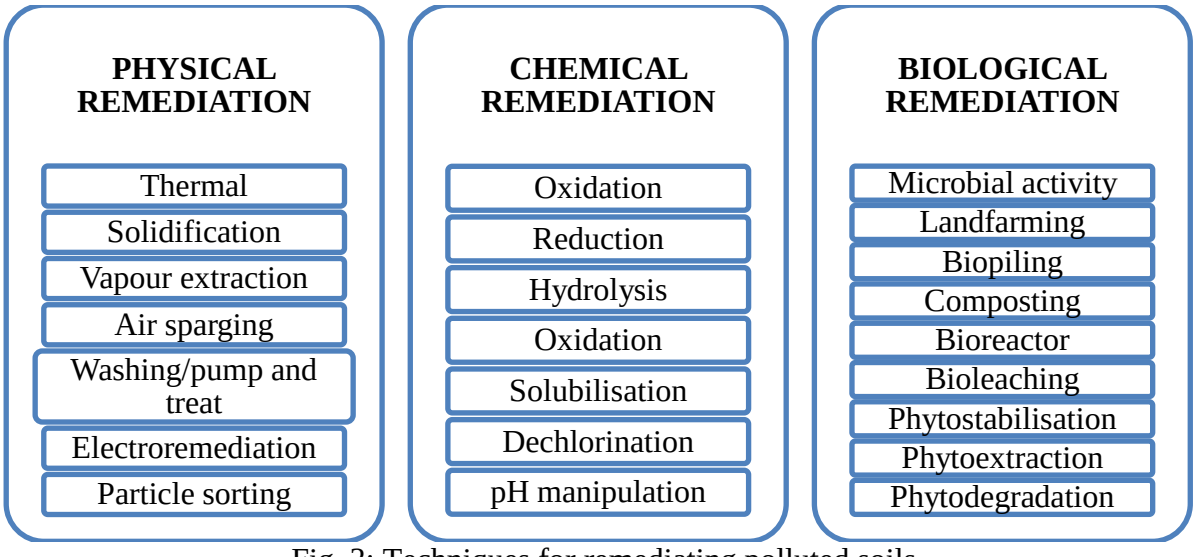

Fig. 3: Techniques for remediating polluted soils

There are also several ways to control the soil pollution like reusing of materials (glass containers, plastic bags, paper, fabric, and other materials can be reused at home rather than disposed of, minimising solid waste pollution); recycling and recovery of materials (paper, various types of plastics, and glass can all be recycled ultimately reducing the amount of waste generated and aids in the conservation of natural resources. One tonne of recovered paper, for example, may save 17 trees); reforesting (soil erosion can be slowed by restoring forest and grass cover, which helps to prevent wastelands, soil erosion, and floods. Crop rotation or mixed cropping can help to increase soil fertility); Solid waste treatment (Physically, chemically, and biologically, industrial pollutants can be handled until they are no longer harmful. Acidic and alkaline wastes should be neutralised first, and insoluble materials should be allowed to breakdown under controlled circumstances before disposal).

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