



Circular Economy Lab & Observatory

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# SOIL CONTAMINATION

Methods of soil remediation from industrial contaminants  
and possible use of phytoremediation  
or other bioremediation technology in those processes

**Italy-4.2**



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## INTRODUCTION:

Soil is the upper layer of the earth's crust, formed by organic and mineral components in liquid, gaseous or solid form.



Waste on the soil -by Benedetta Trocino

According to the most recent studies, we lose about 24 billion tons of fertile soil per year. <sup>13</sup>

Pollution and the accumulation of contaminants in the soils are some of the consequences of the use of chemistry since the 1900s.

The lack of alternatives and the need to give immediate answers have led to contaminations that are difficult to remove. <sup>14</sup>

A site is “contaminated” when “the values of CTC (contamination threshold concentration) are exceeded. In the case of contaminants which occur naturally in soil, even when their levels are not high enough to pose a risk, soil pollution is still said to occur if the levels of the contaminants in soil exceed the levels that should naturally be present.

Law 152/2006 imposes remediation activities only on the following environmental matrices: soil, landfill materials, subsoil, groundwater., Surface water and air are therefore excluded. First of all, what do we mean with soil remediation? Basically, it is the process of contaminants removing from the soil –In addition to household waste, there are special ones deriving from industrial activities, for instance heavy metals, hydrocarbons, and other chemicals.

Removing or degrading these substances is crucial to maintain in good conditions soil, water and air. To grow, plants need nutrients and intensive agriculture can lead to the depletion of nutrients present in the soil faster than nature replenishes them. Fertilizers must compensate for this deficit by introducing additional nutrients. Unfortunately, plants often do not absorb the entire quantity and the surplus, which is initially found in the soil, sooner or later pours into lakes and rivers.



Once in the water, the nitrogen surplus often leads to an overgrowth of plants and algae, whose decomposition can significantly reduce the oxygen levels in the water, damaging the animal and plant species of that ecosystem. <sup>12</sup>

Polluted soils can lead to problems in the structure of the land itself, with a greater risk of phenomena such as landslides. <sup>14</sup> The polluting molecules in the soil are transformed into potentially even more polluting substances and the agricultural sector contributes in part., we see for example that contaminants are transferred within the food chains.



The most famous case is probably that of dioxin chicken in which chicken meat was found containing biphenyl polychloride, a precursor of dioxin which is carcinogenic and can accumulate consistently in adipose tissues. <sup>14</sup>

#### Problem's description:

Soil pollution is a less known and even less studied phenomenon than water and air pollution for several reasons:

it has less immediate effects on humans than air and water pollution;

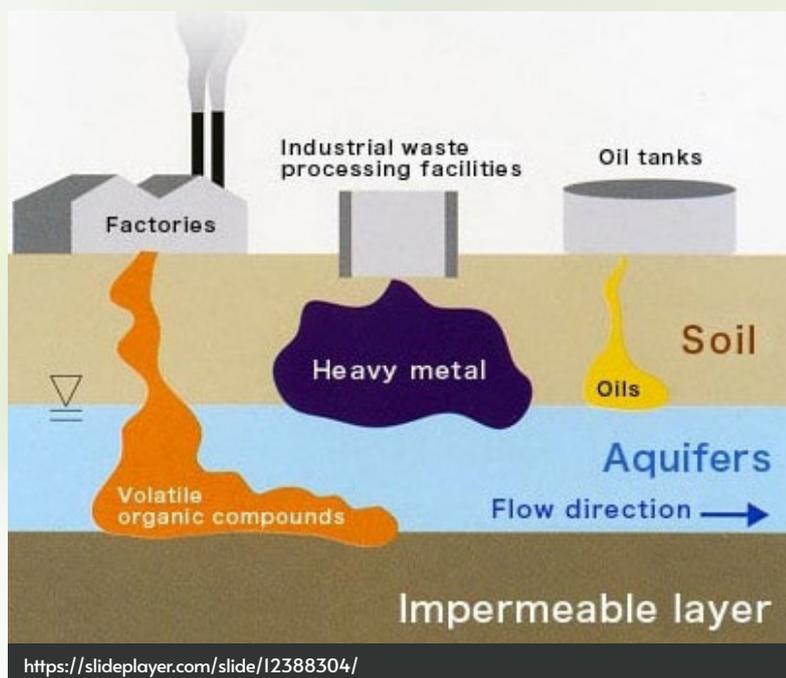
it is less evident than the pollution of a watercourse due to industrial sewage discharges;

It is a less known and studied ecosystem than aquatic ecosystems.

When man-made chemicals reach the soil, the result is contaminated soil. Whatever the cause of contamination is - industry, agriculture or bad waste management, it leads to soil degradation and can heavily damage whole ecosystem.

The main soil pollutants are petroleum hydrocarbons, heavy metals, pesticides and solvents. When we talk about soil pollution, we refer to both the surface of the ground and the subsoil.

The greatest effects on health are linked to the direct contact of people with contaminated land areas, the intake of contaminated water, the entry of toxic substances into the food chain (for example through animals that have grazed on polluted land) can cause adverse health effects, acute and chronic.

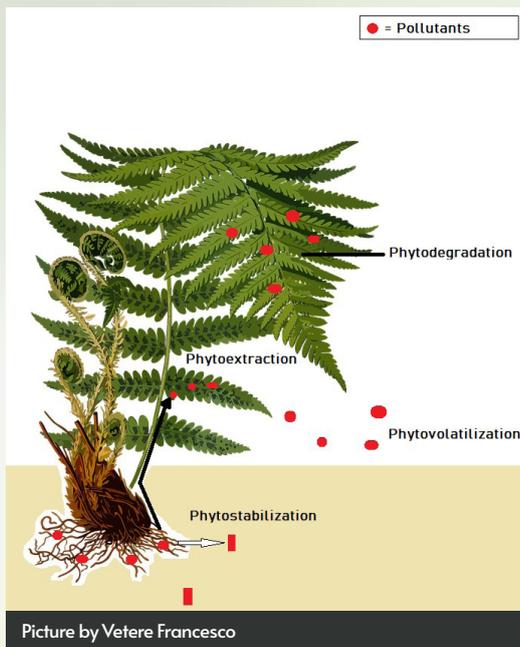


In Europe, one third of soils are moderately or highly degraded due to causes other than pollution, like erosion, compaction, loss of soil organic matter and carbon content, salinization. It takes about 1 000 years to form 1 cm of topsoil, meaning that we won't be able to produce more soil within our lifetime.

What we see is all there is. Yet, soils are facing even more pressure from soil pollution. The current rate of soil degradation threatens the capacity of future generations to meet their most basic needs. <sup>15</sup>

Contamination of the soil with the radioactive pollutants is an important source of hazard for the environment and health safety, as well as for the economy.

Soil pollution, as it profoundly upsets the chemical-physical and biological balance of the ecosystem, impoverishes organic matter.



A polluted soil therefore becomes less productive and compromises the quality of the products so much that it may be unsuitable for any use. Exploitation of nuclear energy is a key source of pollution.

Radiation can enter and affect the environment at any of the stages of the nuclear fuel cycle, starting with the excavation and processing of uranium ore, over production and recycling of the nuclear fuels, to the processing and disposal of radioactive wastes. Chromium and various plant protection products are carcinogenic. Lead is particularly dangerous for young children, in whom there is a high risk of developing brain and nervous system damage, while more generally the risk is related to kidney damage.<sup>10</sup>

### Possible solutions:

#### Bioremediation:

Is one of the most common types of soil remediation. Specialized bacteria are utilized in this technique to absorb and degrade soil contaminants. The bacteria naturally expire once they have devoured every last particle of pollution.

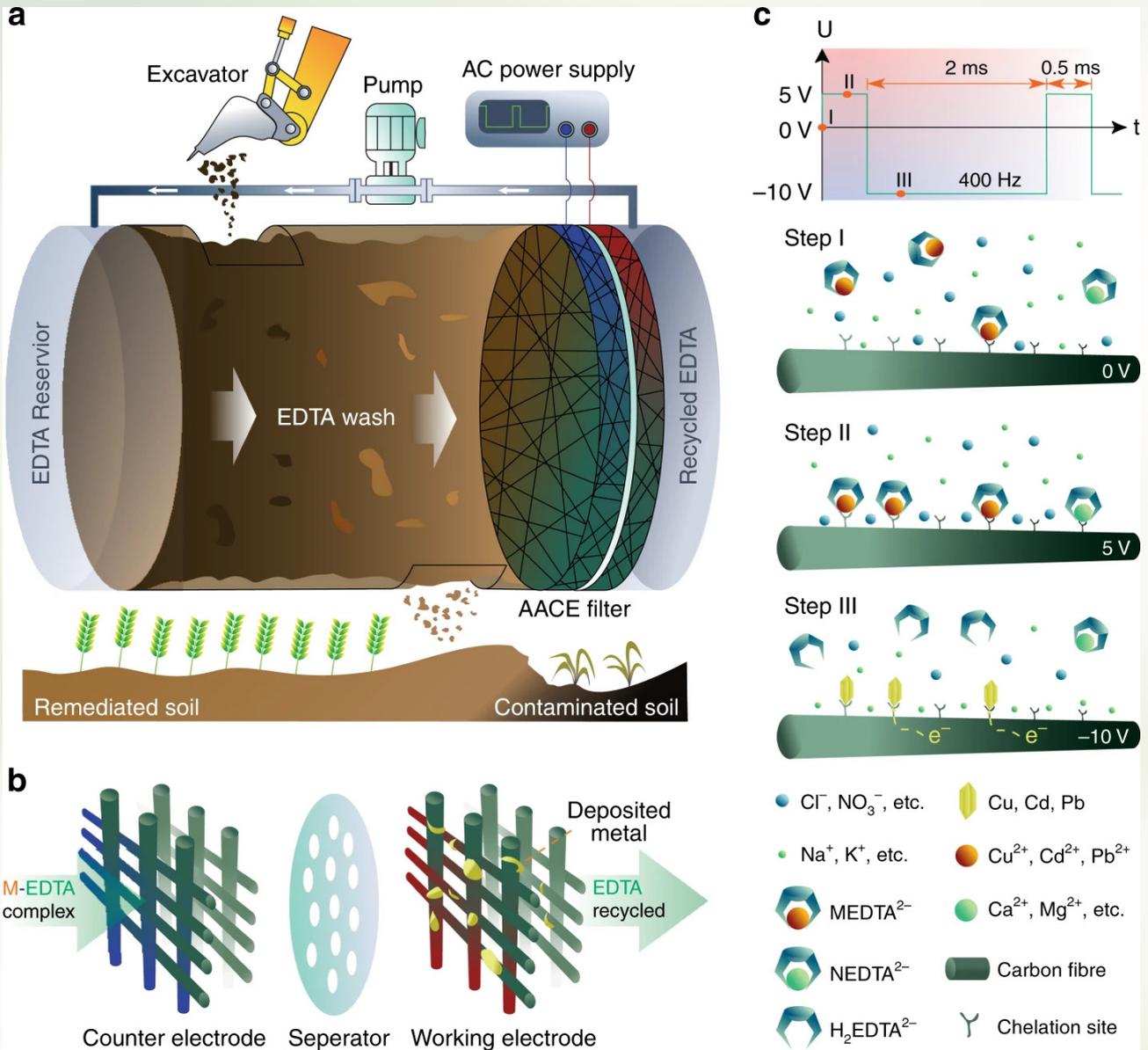
#### Soil encapsulation:

While with remediation the contaminants are either removed or degraded into less harmful substances, with the encapsulation the contaminants are just isolated and kept in a confined environment, so that they cannot spread elsewhere. It is not the best solution if we want to use the soil for other purposes, for instance, for farming. If the soil is encapsulated, no edible plants can be cultivated there.

Removing arsenic with ferns is just one example of phytoremediation, using plants to purify land or water. By putting plants to work, remediation practitioners can save money on excavation costs and preserve soil structure.

#### Sunflowers:

Aiming to recover the soil for farming, scientists and farmers have tried to find the way to remove the radiation from the soil. Among various expensive methods, they found the solution for solving the radioactivity problem in the areas with high farming rates. This solution is a sunflower plant, which being an hyper accumulator, has efficient mechanisms for pulling nutrients, water, minerals and certain radioactive isotopes like strontium and cesium from the soil.



Remediation of heavy metal contaminated soil by asymmetrical alternating current electrochemistry, BY Jinwei Xu, Chong Liu, Po-Chun Hsu, Jie Zhao, Tong Wu, Jing Tang, Kai Liu, Yi Cui, [https://www.researchgate.net/publication/333609338\\_Remediation\\_of\\_heavy\\_metal\\_contaminated\\_soil\\_by\\_asymmetrical\\_alternating\\_current\\_electrochemistry](https://www.researchgate.net/publication/333609338_Remediation_of_heavy_metal_contaminated_soil_by_asymmetrical_alternating_current_electrochemistry)

Sunflower is attractive also because it grows well, produces a lot of biomass quickly, it's adaptable to a lot of different climates and it doesn't take a lot of management to grow, compared to some other crops.



Those radioisotopes mimic some of the nutrients that the plant takes up normally. So the plant really doesn't distinguish between those radioactive isotopes and some of the nutrients in the soil like potassium and calcium that it takes up as a matter of course.



Sunflowers – photo by Trocino Benedetta

Planting of sunflowers is, for now, the best solution for removing radioactive isotopes from the soil, but scientists need to find out new farm technologies to achieve better results. In the site of the nuclear disaster at Fukushima, sunflowers can manage to remove only 0.5% radioactive cesium in the soil.

The extent of the sunflower's role as the most effective, non-invasive means to cleanup nuclear radiation remains wholly unknown, but the promise and possibilities inherent to the plant's biology are constantly revealing themselves.<sup>10</sup>

#### Nanotechnology:

Np (nanoparticles) contains enormous surface area and surface vitality and with these unique features. Np is capable of absorbing large quantity of pollutants in a rapid rate and more sustainable way and very close to emission free approach as much as possible.<sup>11</sup>



## Conclusions:

Soil pollution can be considered, however, a direct consequence of air and water pollution.



Pollutants that reach the ground with rain or gravity undergo dissipation or degradation processes that change their characteristics.

Prevention is very important, for which some associations such as The National Asbestos Observatory and the Victims of Duty Department deals with the risk of health protection from asbestos and other carcinogens. In the first place it prevents exposure to substances harmful to health and also eliminates soil pollution.<sup>13</sup>

Reforestation and waste recycling are two more common approaches to mitigate soil pollution. Deforestation frequently causes soil erosion and fertility lost, and subsequent activities in deforested areas can reach to soil contamination. Reforestation is a good way to stop soil degradation.

Another efficient way is to reduce the amount of garbage that ends up in landfills by recycling materials like plastic, paper, and metals.



Meeting outdoors about soil pollution- by Vetere Francesco



Clayey soil - by Garrubba José

The waste is divided into municipal waste with a very heterogeneous composition, special waste, used wood, paper waste and similar waste, sulphite lyes and biogenic waste.

Burning waste releases various air pollutants.

Regulations in Eu countries as well as in the US and other states, prescribe in which plants the waste is to be burned.

Emission limit values must be observed during operation of these plants. The waste incineration plants must be equipped with air filtration systems. In addition, special waste such as cables and hospital waste must be incinerated in special waste incineration plants or in special plants. In addition, the outdoor incineration of waste in landfills has been banned.<sup>16</sup>

To summarize the main points that each of us should undertake to perform are:

Engage with separate waste collection.

Never skimp on recycling materials.

Preferably use biodegradable containers. The accumulation of residues, such as plastic, requires many years or decades of degradation.

Limit the use of chemicals in agriculture and use only organic fertilizers.

Counteracting air and water pollution, following an eco-friendly style.

Encourage the use of individual total oxidation purification plants or other types of similarly effective systems for the disposal of civil wastewater.



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