Environment and territory

Soil degradation

The soil is a dynamic system that has reached a balance with the other surrounding elements. Man can compromise it with his activities and behaviour. The urban development of cities, industrial expansion, the creation of infrastructure like railways, roads, bridges, agriculture, modified the use of soil and sometimes determined its degradation. Soil degradation becomes apparent through some phenomena: desertification, erosion of the superficial layer, an unusual increase of salt content (salinization), acidification and the presence of pollutants. Soil pollution is a particularly serious phenomenon since it has repercussions not only on soil productivity, but also on the composition of the water it gets in contact with (especially drinking water and aquifer water) and on the atmosphere. This is why men have to carry out their activities in such a way as to ensure a high environmental quality of the soil, by eliminating the pollution that has been created in the past (recovery activities) and, above all, avoiding to overexploit the soil. The direct pollution of the soil by inorganic and/or organic pollutants can occur: - in agricultural lands, when the natural balance is threatened by polluted irrigations, by phytosanitary products, herbicides, fertilizers, etc.; - in urban, industrial, abandoned areas, also close to mines, as a consequence of the wrong disposal of waste water (water that is used for productive processes or sewage water), and as a consequence of waste containing chemical pollutants.

Erosion

The word erosion indicates the slow disintegration of the soil due to the action of agents such as the rain, run-off water (rain water that runs on the land surface), and the wind. Erosion is a natural process that depends on several factors like the topographic configuration of the interested area, the soil composition and structure (in particular, its granulometry), the climate (in particular as far as precipitations are concerned), and the state of its vegetation cover. Some human activities, such as intensive agriculture, deforestation, intensive animal farming, and the use of inefficient or inadequate irrigation systems, accelerate or intensify the erosive process.

Salinization

Saline soils form when the water leaves the ground mainly due to evaporation, transpiration, or percolation. This mainly occurs in dry areas, where precipitations are not sufficient to eliminate the salt from the ground. However, salinization is also frequent on irrigated grounds. If irrigation (which is fundamentally important in dry regions) is not done in a functional way, or with appropriate water, it can provoke an accumulation of salt (in particular chloride and sodium sulphate) that reduces the ability of plants to absorb nutritional elements from the roots, therefore making the soil sterile. The reclamation of saline soil is apparently a very simple process, as the salts can be removed with water. But before irrigating, it is necessary to increase the soil permeability, by increasing its porosity (pore number and dimension), in order to favour the passage of water and eliminate excessive salts. In nature some vegetal species tolerate salinity, as they are able to survive or produce (if they are very tolerant) even if there is an excessive quantity of salt in the soil.

Desertification

Desertification is a complex phenomenon that occurs in all those areas where temperature and humidity do not make it possible for vegetation to growth. Like for many other natural processes, men can have an influence on desertification, sometimes in very negative ways. Fires and the destruction of the savannah near tropical forests in order to create land for cereals and forage cultivation, are some of the worst examples of irreversible destruction of a delicate ecosystem that favours the desert moving forward. Millions of hectares of land are involved each year in new desertification processes. Degraded lands can be hundreds of kilometres from the nearest desert, but they can expand and get closer one to another, by creating desert-like conditions.

What areas are at risk?

Most of the regions that risk to become dry areas are near the world five deserts:

• Sonora desert between Mexico and the United States

• Atacama desert in South America

• una a wide desert area that stretches from the Atlantic Ocean to the east, including the Sahara desert, Iran and former Soviet Union deserts, the big Indian desert of Rajasthan and last Taklamakan and Gobi deserts, that are located in China and Mongolia

• Kalahari desert in South Africa

• most of Australia.

This does not mean that desertification does not threat milder areas (even though they are quite dry), like the south of Italy, or some wet areas like the Amazon Forest.

What are the causes?

Mainly, the human causes for desertification are three:

• the over-exploitation of pasture areas and agricultural nearby areas, which provoke the disappearance of grass cover and reduce soil fertility;

• excessive presence of water, that in wet areas provokes a rise in aquifer levels, damaging crops from the root, while in dry areas it provokes salinization of the soil due to strong evaporation;

• deforestation, a phenomenon that, especially in wet regions, leaves the soil without vegetation, reduces water retention in the ground, and allows violent tropical rains to exercise a strong erosive action.

Soil pollution

Among the various air pollutants that act negatively on soil balance there are gaseous compounds of photochemical origin, like ozone and free radicals, sulphur and nitrogen compounds that are responsible for the increase in rain acidity. In particular, acid rains determine a soil pH reduction (acidification), which, for agricultural soil, can be useful as it satisfies the nutritional needs of many crops that tolerate soil acidity. Instead, on forest soil that is already slightly acid, it provokes a slow but progressive damage to the vegetation and sometimes it even provokes the death of vegetation. Another source of soil pollution is the water for field irrigation, which can contain natural organic substances, or artificial water, mineral substances, inorganic substances or micro-organisms that come from industrial waste or not correctly treated sewage water. This phenomenon can cause damaging pollutants to enter the food chain, as well provoking a reduction in agricultural production.

Pollution of agricultural land

Modern agricultural farms today use large quantities of industrial-origin chemical products (fertilizers and phytosanitary products). If these products are used in the wrong way and in excessive quantities, they can cause water, air and soil pollution, as well as being toxic for men and animals. The economic advantages of these substances made people underestimate their negative effects. Negative effects can be direct (when consuming them or getting in contact with them), and indirect, as they change the original balance of the ecosystem. In particular, the more and more frequent use of phytosanitary products and their ever-increasing number highlighted the problems related to their use and the effects they might have on the environment.

Sustainable agriculture

As we have seen, the soil is essentially important for human survival. Men have developed agricultural techniques that allow to obtain good productions at limited costs. Sustainable agriculture derives from the integration of traditional agricultural techniques, that use chemical products like fertilizers and phytosanitary products, with low-environmental impact biological techniques that require a deep knowledge of complex interactions between the soil, water, vegetation and animals. Each year 30-80 billion tons of soil are lost due to erosion: it is as if a train full of earth was unloaded 12 times a year in the space. One of the most efficient techniques uses some plants, especially herbaceous plants that,

keeping earth particles in their roots, reduce the erosive effect of wind and water. Often herbaceous varieties are seeded after covering the soil with a thick biodegradable net, of vegetal origin (raffia or hemp), which supports the seeds during their germination. Farmers adopt some measures to reduce or block the wind or water erosion. For example, they plant trees along the borders of the fields, they plant herbaceous crops (like cereals) in order to cover the soil during those months that are most at risk of erosion (autumn and spring), they work less on the soil, etc.

Heavy metals

Heavy metals (cadmium, cobalt, chromium, copper, mercury, manganese, nickel, lead, zinc, molybdenum, tin) are among the main soil pollutants. In fact they are widely spread, highly toxic and persistent, as they stay in the environment for a long time (through the food chain, for example). If these pollutants exceed determined quantities, they provoke damages to those organisms that absorb them.

Why can heavy metals in the soil be harmful to living organisms? Usually the metal in the soil is absorbed by the plants and transported through their leaves and fruits. The leaves and fruits that contain the pollutants are eaten directly by the primary consumer (man or animal) that assimilates them in his organism. Pollutants can be absorbed also by eating the meat of an animal that was fed with heavy-metal polluted vegetables. Once they have been accumulated in the organism (man, animal or vegetable) in quantities that are higher than the normal quantity, they can produce serious damages and sometimes provoke the death of the organism. What has just been described is the method through which pollutants are transmitted inside the food chain: for this reason it is very important to have a high soil quality, in order not to have damaging substances in the food.

Why can heavy metals be present in the soil? In nature, heavy metals are present in underground deposits (see the pages dedicated to this resource) and, without men's action, they would very hardly manage to spread in the surrounding environment and particularly in the soil. At the moment, the main cause for their spreading is human activity. Heavy metals can be left in the environment or directly discharged by the industry only during some productive processes (for example they can be discharged by mining industries that extract them from the subsoil or by other industries that discharge fumes or polluted waste water), or by the consumer who uses products that contain them (for example paints, tyres, fuels, and others). These products, when they are used or if they are not correctly disposed of, discharge some heavy metals. Heavy metals, like other toxic elements, derive not just from industrial activities, but also from civil activities (they are contained, for example, in sewage waters).

Is it possible to eliminate this type of pollution? The governments of many countries have been paying special attention to this type of pollution and, in the last few years, they have forced their factories to respect strict limits in the emission of heavy metals. They have also forced the factories to produce goods that do not contain heavy metals or contain very small quantities of them. The aim is to keep their presence in the environment below certain threshold levels, that are safe for men, animals and the vegetation.

The problem of acid soil

Usually soil acidity is due to the presence of high quantities of hydrogen and aluminium. Although some acid soil derives directly from acid rocks, most of them are formed in areas with lots of rainfalls or farmed areas. In fact, acidification speed depends on the speed by which the majority of nutritional elements leave the soil (because of rain, or after being assimilated by crops, during harvest), leaving room to those elements that provide acidity. On acid soil it is very difficult for plants to grow, although the different species have a different sensitivity: some species are tolerant while others require a high soil acidity in order to grow and produce.

Is it possible to eliminate this type of pollution? Reclamation of acid soil occurs by applying calcium and magnesium compounds, like lime (calcium carbonate).

Treatment of polluted soil

Thanks to its absorbing power, its buffer capacity, and its intense biotic activity, the soil is prone to self-treatment, or at least, is able to reduce the negative effects deriving from the presence of pollutants. Of course the soil self-treatment

capacity has some limits. If pollution goes over this limit, the soil can lose its “filter” function in an irreversible way, provoking many damages. Differently from the atmosphere and water, which decontaminate quite rapidly, the soil, although it has a high self-treatment capacity thanks to chemical, physical, and biological mechanisms, keeps contaminated for a long period. It was noticed that, in order to significantly reduce the content of heavy metals in a polluted soil, the quantity of water corresponding to tens of years of rain is not sufficient. The presence of polluting compounds in the soil, especially highly toxic ones, can represent a risk for human health and for the environment, and requires reclamation activities. The reclamation of a land can be based on the inactivation or degrade of pollutants (they are transformed into less dangerous or not dangerous substances) or their removal by using chemical, physical or biological treatments. Reclamations is normally done on agricultural land and areas close to industrial zones or abandoned dumps.

Sustainable use of the soil

The objective of sustainable management programmes is to keep and improve soil quality and make human activities compatible with this resource and nature. The soil quality concept, however, is often difficult to define and the criteria also depend on the final use of the soil. For example, the quality of agricultural soil is assessed according to its productivity (yield and quality of products) and to the presence of pollutants that are dangerous for consumers. The quality of forest soil is assessed according to its integrity and stability, while the quality of building soil is judged according to the presence of pollutants that are dangerous for its inhabitants. It is also very important to safeguard the integrity of ecosystems that are particularly precious, like wet areas, tropical forests and the savannah.