Pollutants and their effects

Atmospheric dust

Atmospheric dust consists of a mixture of solid and liquid particles suspened in the atmosphere varying in composition, source and size. Atmospheric dust particles can be removed out of the atmosphere by dry and wet deposition and fall back on soil, vegetation or watercourses. Atmospheric dust particles can be classified according to their diameter (measured in micrometers or µm. 1000 micrometers equivalent to 1 millimeter) ranging from 0,005 to 100 µm. Within this interval atmospheric particles are classified as:

- **primary** particles – diameter ranging from 2,5 to 30 µm;
- **secondary** particles – diameter lower than 2,5 µm.

Primary particles form from combustion, soil erosion and disintegration. Pollen and spores figure in this category. Secondary particles are generated by vehicular traffic, industrial activities and thermoelectrical implants. Atmospheric dust particles with a diameter of less than 10 µm and 2,5 µm draw special attention and are defined PM10 and PM2,5 (PM= Particular Matter), respectively. PM2,5 particles are a subset of PM10 and count for 60% of its weight. PM10 is an inhalable particle as it can travel deep into the breathing apparatus to the larynx; and it's also breathable as it can settle in the pulmonary alveoli. These dust particles raise serious health concerns as they have been linked to a number of breathing and cardiovascular diseases. Sources of dust particles can be natural (volcanic eruption, sea aerosols, spores, pollen, soil erosion,...) or man-made (vehicular traffic, industrial emissions and combustion processes).

Benzene

Benzene is a molecule composed of 6 carbon atoms joined in a ring and 6 hydrogen atoms. Benzene is classified as a polycyclic aromatic hydrocarbon (PAH). It's a liquid substance, but at high temperatures it has a rapid volatilization process passing from a liquid phase into a gas phase. Benzene is either natural and can, for example, be generated by volcanic eruptions or is man-made.
In urban centres benzene is almost exclusively generated by human activities as vehicular traffic, oil-refining and fuel distribution. Its major sources are, in particular, exhaust emissions and to a lesser extent evaporation losses during the handling, distribution and storage of petrol. Tobacco smoke is an important source of benzene in indoor air, and median benzene levels have been found to be 35% higher in the homes of smokers than in non-smoking households. Benzene absorption occurs by inhalation, dermal route and ingestion and can cause chronic and/or acute effects. The most reported effect of chronic benzene exposure is potential carcinogenicity.

Acid deposits

The atmosphere contains acid-reaction substances that deposit on the Earth's surface and contaminate it: they are the so-called "acid deposits". The substances that make these deposits acid are generally nitric acid and sulphuric acid, that form by the reaction of water and nitrogen oxides and sulphur oxides (SOx) contained in polluted air. Nitrogen oxides are produced by the combustion of fossil energy sources rich in sulphur – especially coal and lignite – and by volcanic eruptions. Instead sulphur oxides can have a natural origin (lightning, fires, bacterial decomposition of organic materials, biological processes of the oceans), or an anthropogenic origin, deriving from the combustion of fossil energy sources. Acid deposits alter the acidity of lake and river waters (making it impossible for fish and other water organisms to live there) and that of soils (by altering the availability of nutritional elements, resulting in the reduction of fertility and productivity). Acid deposits can also directly damage the vegetation (for instance by melting the wax that protects the leaves and making them more vulnerable to parasitic attacks), buildings, monuments and, if particularly intense, man and animals as well.

Ozone

The Ozone Hole

Ozone (O_3) is a gas found in in high levels in the stratosphere, in a region also known as the ozone layer, between 15,000 and 40,000 metres above the surface where it plays an important role screening the sun's ultraviolet radiations which are harmful for living organisms. In the past years stratospheric ozone levels have declined due to the effect of anthropogenic substances, as chlorofluorocarbons (CFCs), methyl bromide, halon gases and methyl chloroform. Once these gases reach the stratosphere they emit chlorine and bromine, which affect ozone formation.
Since the 1980s slow and gradual depletion of the stratospheric ozone has occurred, especially over Antarctica. Size and rapidity of the ozone hole formation alarmed the scientific community: in 1987 was issued the Montreal Protocol, the first international treaty ratifying the reduction of CFCs use. So far the Montreal Protocol has been adopted by over 190 states (link to sustainability for more information on this subject): nowadays global use of CFCs is lower but many years need to pass before existing CFCs can be eliminated from the atmosphere.
The major direct consequence of the hole in the ozone layer is an increased amount of ultraviolet radiations (UV – frequency from 100 to 400 nm) reaching the Earth's surface.
These radiations cause:

- increased risk for skin tumours and eye diseases;
- decreased immune system functions in men and animals;
- photosynthesis reduction and DNA damage in plants with a significant negative impact on agriculture;
- lower levels of marine phytoplankton production causing serious damage to the marine chain in aquatic ecosystems.

Ozone in the Lower Atmosphere

Ozone pollution refers to higher ozone concentration in the troposphere, the only atmospheric layer which can support life, and which shouldn't be mistaken for the ozone hole.
Tropospheric ozone is formed by the interaction of sun radiations and primary pollutants, especially nitrogen dioxide. Ozone is harmful for men and the environment as it's a powerful oxidant which can cause negative effects when reaching high concentration in the air, after long-term exposure and high concentration in ambient air breathed by humans.

Radioactive pollution

The sudden explosion that occurred in April 1986 in the Chernobyl plant, in the former Soviet Union, brought the whole world face to face with the tragic consequences of the nuclear pollution of the air, related in particular to the international dimension of this risk of pollution. The radioactive cloud that followed the explosion had released into the atmosphere several radio-nuclides (Barium 140, Iodine 131, etc.) that were carried far away by the winds before falling back to the ground through meteoric precipitations. It was observed, therefore, that the damage caused by nuclear pollution is not limited to a specific area, but it can affect large regions, even very far from its source. When aground, the radio-nuclides, that contaminate the vegetal species and get into the food chain, are taken in by man and concentrate in some specific organs. In man, exposure to rays emitted by radio-nuclides increases the number of cases of tumours and leukaemia.

Photochemical pollution

The "photochemical smog" is a typical form of pollution of all the main urban and industrial areas of the world. It occurs in or near areas with a high traffic density, in the presence of specific climatic conditions (no wind or weak winds, high temperatures, etc.), that cause the concentration of polluting gases to increase and prevent them from dispersing. In these areas, the concentrations of some gases (tropospheric ozone, carbon monoxide, particulate, VOC, nitrogen oxides, etc.) very often exceed the threshold values, above which there are risks for human health, farming and natural vegetation.