



MIS-ETC Code 166

„Joint Risk Monitoring during Emergencies in the Danube Area Border“

Workshop: „Air Quality in the Danube Border Area“
17/05/2012

AIR QUALITY EFFECTS ON HUMAN HEALTH AND ECOSYSTEMS

Cătălin-Ionuț PÎRLOG

Company/organisation name: ICMET Craiova
Adress:Bdl. Decebal, nr. 18A, Craiova, România
E-mail: catalinionut@icmet.ro

Ancuța-Mihaela ACIU

Company/organisation name: ICMET Craiova
Adress:Bdl. Decebal, nr. 18A, Craiova, România
E-mail: ancutu@yahoo.com

Florica NOURĂȘ

Company/organisation name: ICMET Craiova
Adress: Bdl. Decebal, nr. 18A, Craiova, România
E-mail: flourica@yahoo.com

Abstract:

Short and medium term effects of air pollution harms human health and harm ecosystems and economy. Long-term pollution affects the environment through: the effect of greenhouse gases, ozone depletion, acid rain, the presence of the micropollutants and of the particulate matter.

Adverse effects of various pollutants on human health have been well documented in Europe and elsewhere. Concerns about these health effects have led to implementation of regulations to reduce emissions of harmful air pollutants and their precursors, the international, national, regional and local level.

Effects on ecosystems extend from the destruction of forests and lakes by acidification, habitat damage due to nutrient enrichment. Most European data on the effects of pollutants on biodiversity and ecosystems concern acidification and eutrophication.

Environmental and health progress aimed at achieving a better understanding of environmental threats, strengthening EU policy in this area and to identify and prevent new threats to health and ecosystem.

The paper shows the main effects which air quality has on human health and ecosystems.

Key words: pollutants, health, ecosystems, acidification, eutrophication

www.cbcrromaniabulgaria.eu

Investing in your future!

1. INTRODUCTION

Environment plays a crucial role in people physique, mental and welfare. Complex relationships between environmental factors and human health factors, taking into account the multiple interaction paths, are analyzed in a larger social-economic and cultural context.

Environment degradation by air pollution, noise, chemicals, decrease of air quality and loss of natural zones, combined with changes of the life style may contribute to substantial increases of obesity rates, diabetes, diseases of cardiovascular and nervous systems and cancer - all being major problem of public health for Europe population.

Human health protection is closely related to the biodiversity preservation, which is fundamental for human welfare, and to sustainable supply of natural resources.

“Biodiversity” includes all the living organisms found in atmosphere, land or water. All species have a role and provide the “living mechanism” we are depending on: from the smallest bacteria in soil to the biggest mammal in ocean. The four basic pillars of building the biodiversity are genes, species, habitats and ecosystems.

2. ATMOSPHERIC POLLUTION

Atmospheric pollution is one of the most serious problems of the present society, both temporally - it has effects both on short and average term and on long term, and spatially - mobility and affected surfaces are high. Atmospheric pollution affects directly human health, agriculture and forestry fund, depending on the pollutant type and concentration, exposure duration and frequency.

Urban pollution of air is known as „smog”. In general, smog is a mixture on **carbon monoxide** and organic compounds from the incomplete combustion of fossil fuels, like coals, and **sulfur dioxide** from the impurities from fuels. While smog reacts with **oxygen**, organic and sulfuric acids condense as drops, intensifying the fog. Until the twentieth century, smog already had become a major danger for health.



Figure 1- Examples of smog presence

Another type of smog, the photochemical one, started to reduce the air quality above big cities since 1930s. This smog is caused by the fuel combustion in the motors of vehicles and planes, which generates nitrogen oxides and releases hydrocarbons from “unburned” fuels. Sunlight determines the combination of the nitrogen oxides with hydrocarbons and changes oxygen into **ozone**, a chemical agent which attacks rubber, harms plants and irritates lungs. **Ozone** is generated by the photochemical reaction of nitrogen oxides (NO_x) and volatile organic compounds (VOC), under sunlight. These pollutants are released by automobiles and industry. The tropospheric ozone (that one located in the atmosphere layer between 0 and 10 km) is formed as a result of the combined action of nitrogen oxides and aromatic cyclical hydrocarbons. The *tropospheric ozone* (unlike the stratospheric one, located at a height of 40 km, which is indispensable to life on Earth, retaining the harmful ultraviolet radiations) is a *very harmful compound*, due to its high reactivity (very pronounced oxidant potential).

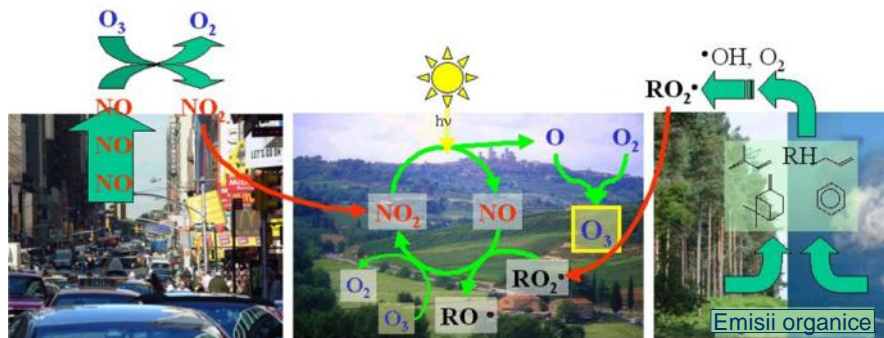


Figure 2 - Photochemical reactions in atmosphere which lead to ozone forming

The hydrocarbons are oxidized in substances which condense and form a visible and penetrating fog.

Most pollutants are possibly “washed” by rain, snow or fog, but only after traveling long distances, sometimes even continents. While pollutants gather in atmosphere, sulfur and nitrogen oxides are changed into acids which combine with rain. This acid rain falls on lakes and forests, where could lead to the death of fishes or plants and could affect entire ecosystems. Finally, contaminated lakes and forests may become lifeless. Acid rains are determined by the presence of sulfur and nitrogen oxides (SO_2 and NO_2) in atmosphere; in the presence of water vapors and under the influence of ultraviolet radiations, they change into very toxic acids (sulfuric acid and nitric acid).

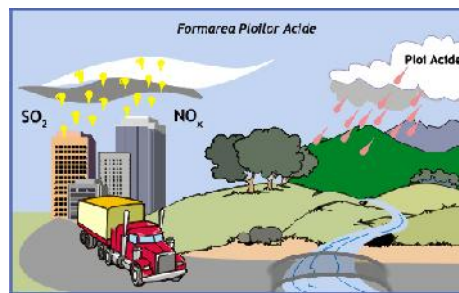


Figure 3 - Forming of acid rains

One of the biggest problems caused by air pollution is the **global warming**, an increase of Earth temperature generated by the accumulation of some atmospheric gases like carbon dioxide. With the intensive use of fossil fuels in the twentieth century, the concentration of carbon dioxide from atmosphere increased dramatically. Carbon dioxide and other gases, known as greenhouse gases, reduce the heat dissipated by Earth but do not block the Sun radiations.

Atmospheric pollution, long distance cross-border atmospheric pollution inclusively, is unanimously recognized as a serious threat to the environment quality.

Pollutant influence in atmosphere is measured by using a few indicators related to air quality, such as:

- Emissions of Volatile Organic Compounds (VOC);
- Emissions of nitrogen oxides (NO_x);
- Emissions of sulfur dioxide (SO_2);
- Emissions of carbon monoxide (CO) and methane (CH_4);
- Emissions of ammonia (NH_3);
- Emissions of sulfur dioxide (SO_2);
- Emissions of acidifying substances;
- Emissions of nitrogen precursors;
- Emissions of particulates (PM10 and PM2.5);
- Emissions of heavy metals;
- Daily exceeding of air quality limit values for ozone in urban areas
- Daily exceeding of air quality limit values for particulates;
- Ecosystem exposure to acidifying, eutrophication and ozone;

2.1. Affected zones and zones with atmospheric pollution risk

The affected zone or the hot zone is that zone on whose territory there are recorded systematic exceedings of the environment quality indicators against the standardized norms, serious deteriorations of environment state being produced, with a lot of consequences on human health, economy and ecosystems.

2.2. Background pollution

Background pollution represents the pollution existing in the zones where the influence of pollution sources does not manifest directly itself. The concentrations of the pollutants from air and precipitations, measured in these zones, are precious indicators for assessing the pollution at regional and global level.

2.3. Impact pollution

Impact pollution is the pollution produced in the zones located under the direct impact of the pollution sources. In the network for surveying the impact pollution, measurements on sulfur dioxide, nitrogen dioxide, ammonia, suspended particulate matter, sediments are performed.

2.4. Indoor environment and human health

Most of healthcare policies related to pollution are directed depending on the outdoor environment. A somehow neglected zone in this regard is the indoor environment, taking into account that European citizens spend inside up to 90% of their time.

The indoor environment quality is affected by the ambient air quality, building materials and ventilation, consumer goods, furniture and appliances inclusively, cleaning and household products, inhabitant behavior, smoking inclusively, and building maintenance (e.g. measures for energy saving). Exposure to suspended particulate matter and chemicals, combustion products, also to moisture, moldiness and other biological agents was connected to asthma and allergic symptoms, lung cancer and other respiratory and cardiovascular diseases.

Recent evaluations of the exposure sources and policies related to indoor air pollution have analyzed the benefits of different measures. The highest benefits for health are connected to smoking restrictions. The building and ventilation policies which control the indoor exposure to suspended particulate matter, allergens, ozone, radon and outdoor noise offer high benefits on long term.

3. Air pollutant effects on human health

They are an important issue, because during many serious events, air pollution may have a significant effect on human health, especially on children, elderly or sick people.

Sulfur dioxide is a colorless, bitter, non-inflammable, sharp odor gas, which irritates eyes and respiratory tracts. Depending on concentration and exposure period, sulfur dioxide may have different effects on human health. Exposure to a high concentration of sulfur dioxide, for a short time, may cause severe shortness of breath. Exposure to a reduced concentration of sulfur dioxide, on long term, may lead to infections of the respiratory tract.

Nitrogen oxides are a group of very reactive gases, which contain nitrogen and oxygen in variable amounts. Most nitrogen oxides are colorless and odorless gases. Population exposed to this kind of pollutants may have shortness of breath, irritations of respiratory tract, dysfunction of lungs. Long term exposure to a reduced concentration may destroy lung tissue, leading to emphysema. The persons most affected by the exposure to this pollutant are the children.

At ambient temperature, **carbon monoxide** is a colorless, odorless, tasteless gas, of both natural and anthropogenic origin. It is a toxic gas, being a lethal one in high concentrations (at concentrations of about 100 mg/m³), by reducing the transport capacity of oxygen in blood, with

consequences on the respiratory and cardiovascular system. At relatively low concentrations, it affects the central nervous system, weakens the heart rate, decreasing so the blood volume distributed in organism, reduces the visual acuity and physical capacity;; short time exposure may cause acute fatigue, shortness of breath and chest pain to the persons with cardiovascular diseases, determines irritability, migraines, lack of coordination, nausea, dizziness, confusion, reduces the ability to concentrate.

Benzene is a very light, volatile and soluble in water, aromatic compound. 90% of benzene quantity from ambient air comes from road traffic. It is a substance belonging to class A1 of toxicity, known as carcinogenic for human being. It produces harmful effects on central nervous system.

Suspended particulate matter is a complex mixture of very small particles and liquid drops. An important problem is represented by the particles with aerodynamic diameter shorter than 10 micrometer, which pass through nose and throat and penetrate in the pulmonary alveoli, producing inflammations and intoxications. The persons with cardiovascular and respiratory diseases, children, elderly and asthmatics are especially affected.

Toxic metals come from the combustion of coal, fuel, household waste etc and from certain industrial processes. Metals accumulate in organism and generate short or/and long term toxic effects. In case of exposure to high concentrations, they may affect the nervous system, the renal, hepatic, respiratory functions.

Polynuclear aromatic hydrocarbons PAH are compounds formed of 4 up to 7 benzene nuclei. These compounds result from the combustion of fossil materials (diesel motors) under gaseous form or as particles. The most studied is benzopyrene. Polynuclear aromatic hydrocarbons are known as carcinogenic for human being.

A high level of **ozone** reduces the functional capacity of lung and causes certain inflammations or swellings of respiratory tracts. If the ozone level is extremely high, symptoms as coughing or irritations at throat level appear, and the chest could hurt when breathing. For those who suffer of asthma, ozone effect on the organism could be a stronger one.

European Union set that population should be warned if the ozone concentration exceeds $180 \mu\text{g} / \text{m}^3$, and this should be done during weather reports

4. Air pollutant effects on ecosystems by acidifying, eutrophication and ozone

Ecosystem definition: *Any dynamic complex of the communities of plants, animals and microorganisms and their environment, being in a permanent functional interaction.*

Depending on the place where they are, the ecosystems are generally classified in:

- Aquatic ecosystems;
- Terrestrial ecosystems.

The effects on ecosystems range from the destruction of forests and lakes by acidifying to the deterioration of habitats because of nutrient enrichment, algae proliferation caused by nutrient enrichment, also because of neural and endocrine dysfunction at the species level, caused by pesticides, steroid estrogens and industrial chemicals, like PCBs. Most of European data regarding the pollutant effects on biodiversity and ecosystems are related to acidifying and eutrophication.

Acidifying is specific manner of diffuse pollution generated by releasing in atmosphere some pollutants, like sulfur dioxide (SO_2), nitrogen oxide (NO_x) and ammonia (NH_x). The resulted precipitate may fall thousands km away from the pollution source, having acid nature, and may engage a considerable reduction of the pH of the waters from rivers, natural and artificial lakes. This phenomenon highly aggresses the natural ecosystems and, in extreme cases, may entail the death of those lakes. Acidifying may entail also an infiltration of underground waters. Water acidifying requires adoption of some clear measures against atmospheric pollution.

Eutrophication represents the progressive increase of the concentration of phosphor, nitrogen and other nutritive substances necessary for plants in an aquatic ecosystem of lake type. The productivity or fertility of such ecosystem increases with the augmentation of the amount of organic matter which changes into nutritive substances. The matter enters the

ecosystem circuit by the currents which carry alluvia. Water bloom (excessive developments of algae) occurs often at water surface, preventing the pelagic (submerged) species to capture the light and to assimilate the oxygen necessary to aquatic life.

4.1. Acid rains and soil degradation

Acid rains exert their harmful action on the soil in different ways (which are illustrated in Figure 4):

- direct actions on leaves (burns, cuticle reduction and increase of water loss) which lead to the decrease of photosynthesis and slowing down of the growth;
- washing of soil nutrients as a result of acidifying;
- blockage of ion exchange as a result of pH decrease;
- reduction of the bioavailability of the water connected to clays;
- solubilization of the toxic elements from soil (Al, Hg);
- reduction of the activity of useful bacteria from soil
- stimulation of the activity of phytopathogenic fungi.

Disequilibria induced by acid rains in ecosystems (especially in forest ecosystems) lead to tree destruction on large surfaces. The phenomenon of acid rains was signaled for the first time in Germany, in the early '70s of the previous century. Forests are the most affected by the phenomena of soil degradation under the action of acid rains because: they are formed of perennials, which integrate in their lifetime the impact of toxics; the soils formed of forests are generally characterized by acidity, and acid rains push the soil pH beyond the value which still allows the optimal development of the biological processes in soil. The phenomenon of soil degradation under the action of acid rains is present also in the case of crops, but in these situations the soil amendments/improvers improve the situation in terms of the pH.

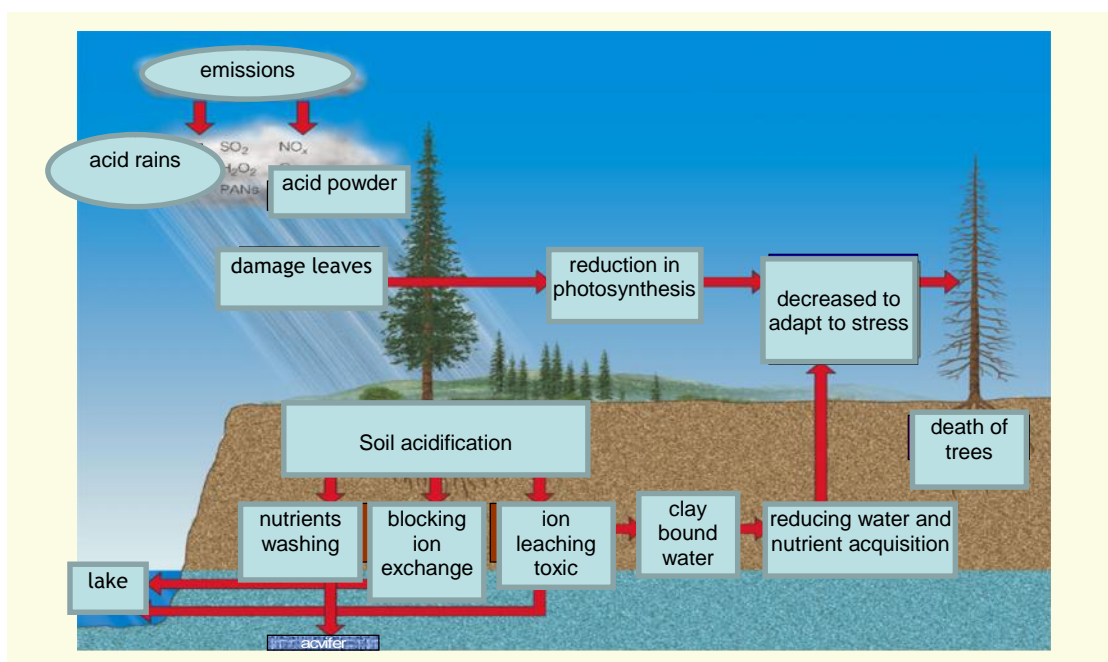


Figure 4 - Affecting of soil and plants as a result of acid precipitations and acid deposits



Figure 5 - Acid rain effects on leaves:
a) healthy leaf
b) leaf destroyed by the acid rain



Figure 6 - Tomato crop from Dumbrava, Prahova county, affected by acid rain



Figure 7 - Acid rain effects on forests

4.2. Tropospheric ozone effects on plants:

For plants, the tropospheric ozone is one of the most dangerous pollutants. Increase of ozone concentrations close to Earth surface has a strong negative impact on vegetation, deteriorating the leaves and inhibiting their photosynthetic potential. Because of the ozone in excess, the forest vegetation dies, ceases to absorb the carbon dioxide and loses biomass.

- leaves may have small light spots of irregular shapes, less than 1 mm in diameter, small dark pigmented zones of about 2-4 mm diameter, sunburn and redness.



Figure 8 - Effects of exposure to ozone on the leaves
a) effects of exposure to moderate ozone concentrations
b) effects of exposure to high ozone concentrations

4.3. Air pollutant effects on living beings

The mechanism through which an animal may be poisoned is in many situations different from that one through which people are affected.

In case of animals, there is a process of accumulation of air pollutants in two stages:

- in the vegetation or fodder which is animal nourishment;
- ingestion effects on animals.

Only a few pollutants with negative effects on animals were noticed. Heavy metals, found in vegetation and water content, are a continuous source of toxicity for animals and fishes.

Arsenic and lead coming from foundries, molybdenum from furnaces, mercury from drilling rigs, are severely toxic pollutants.

5. CONCLUSIONS

The unfavorable action of atmospheric pollutants on human and ecosystem health led to establishing some maximum allowable limits for the concentrations of these pollutants in air and imposed certain emission standards to the anthropogenic pollutants (industrial installations and transportation means).

Practical application of all those measures for mitigating the air pollutant concentration led to the decrease of atmospheric pollution by certain compounds (sulfur dioxide, suspended particulate matter) or to the limitation of the increase trend (nitrogen oxides, VOCx, ozone). Implicitly, lately the atmospheric pollution impact on soil decreased significantly, being emphasized a slight trend of restoring the soils degraded under the impact of acid rains. The tropospheric ozone problem remains of present interest, new efforts being necessary for solving it.

BIBLIOGRAPHY

- [1] Barton, H.; Grant, M., 2006. A health map for the local human habitat. *The Journal of the Royal Society for the Promotion of Health*, 126(6), pp. 252-253. [2]
- [2] Lăzăroiu, Ghe., Series "Ingineria mediului", Course: Soluții moderne de poluare a aerului, AGIR publishing house
- [3] Lăzăroiu, Ghe., "Impactul CTE asupra mediului", Politehnica publishing house, Bucharest
- [4] Brochure: Calitatea aerului în Regiunea Dunării de Jos, realizată în cadrul proiectului numit "Cooperare și dialog în Bazinul Inferior al Dunării
- [5] Council of the European Union, 2007. Council Conclusions on Environment and Health. 2842nd Environment Council meeting Brussels, 20 December 2007.
- [6] *The Clean Air for Europe (CAFE) programme: towards a thematic strategy for air quality*. Brussels, European Commission, 2001 (COM(2001)245).