

TRANSBOUNDARY AIR POLLUTION IN THE REGION OF SKOPJE

A. EFREMOV*, E. CEKOVA

ATREZ – Agency for Technological Development and Environmental Protection, 113 “Jane Sandanski” Blvd., 1000 Skopje, FYROM

Abstract. This paper presents results of the investigations concerning the issue of transboundary pollution by airborne acidic contaminants in the region of Skopje. In the city, especially in the municipality that bounds with Kosovo – FR Yugoslavia, has been carrying out large control of the air quality through monitoring the contaminant concentrations. The investigations show that the values of air contaminants at all measurement spots in the town are often higher than the permitted ones in accordance with the actual state environmental legislation. The results of investigations also show that the local weather system travels from Kosovo, the unfavourable orthographic, climatic and meteorological conditions, as well as the increased traffic by the military vehicles passing through the city to the border-cross Blatze, strengthen the impact of the transboundary air pollution. The ecological problems in the Skopje region are also strengthened by the sulphur dioxide and smoke pollution which originates from the intense local traffic, the strong demographical load, the bad natural ventilation in the central city area, as well as by the unfavourable location of industrial and central heating plants that are located in the city itself. It is assessed that the overcoming of the ecological problems is not possible without establishing international co-operation. For this purpose a regional framework for controlling and reducing the damage to human health and environment by transboundary air pollution is needed.

Keywords: airborne acidic contaminants, transboundary pollution, Skopje.

AIMS AND BACKGROUND

One of the most formidable challenges in the several past years in the world concerns the atmospheric changes, which are result of deranging the natural equilibrium of gases and chemical reactions in the atmosphere.

In the last quarter of the century a rapid development of large lignite-fired power plants and metallurgical complexes of non-ferrous metals in Republic of Macedonia and in south province of Federal Republic of Yugoslavia, Kosovo, has been accomplished. These development patterns have a very negative impact on the vicinity ecosystems. This is the reason why the authors of this paper through the most famous environmental NGO in Republic of Macedonia “Opstanok” (“Survival”), have been trying for three years to make topical the issue of transboundary pollution.

* For correspondence.

Following the world experience, it is shown that the thermo-power plants and non-ferrous smelting capacities are the biggest polluters of the air by emission of sulphur dioxide, nitrogen oxides and particulate matter bearing heavy metals. It is also known that the airborne acidic pollutants are transported by large-scale weather systems thousands of kilometers from their point of origin before being deposited.

The origin of the transboundary degradation of ecosystem is manifested by acid rains. They are formed by chemical changes of the emitted sulphur dioxide, nitrogen oxides, and carbon monoxide in the atmosphere. These air contaminants, especially the sulphur dioxide, are by-products of coal-burning power plants, as well as from smelters of non-ferrous metals.

Rainfalls, snow, fog, or dew then carry the polluted water droplets to the earth. The acid fallout appears to play a crucial role in land degradation problems, problems related in decreasing of agricultural and forestry sector of economy, conservation of biodiversity, as well as in improvement of the quality of life.

Breathing sulphur and nitrogen oxides is approved to be a link between these emissions and appearance of acute and chronic respiratory damages. In such a way acid rains may present human health hazard.

The land mainly is highly sensitive to acid rain. Acid deposition, i.e. acidification, as a further cause for concern, has influence on increasing the acidity of water streams and lakes. These aqua systems suffer from chronic acidity because they have a limited capacity to neutralize acidic compounds (called "buffering capacity"). Acid rains leach the metals from soil and may allow metals such as lead, mercury, and aluminum to reach drinking water supplies.

It is found that acid rain should be also a large transboundary problem as a result of harmful impact to the growth and diversity of the wildlife and fish population as well as to the forest conservation.

RESULTS AND DISCUSSION

The past investigations and the performed analyses show that the city of Skopje is facing pretty serious ecological problems connected with air quality.

The most frequent contaminants are sulphur dioxide, suspended particulate matter, volatile organic compounds, carbon monoxide, nitrogen oxides and lead. In the city of Skopje, especially on the territory that bounds with Kosovo, i.e. municipality Karposh, air quality control has been carrying out through monitoring the concentrations of sulphur dioxide, nitrogen oxides, carbon monoxide, lead, total oxidants and ground-level ozone, volatile carbohydrates, as well as smoke, dust suspended in the air and aero sediments¹.

The air quality is continuously followed at seven measurement spots in the city. In the most critical year up to day – 1993, the average annual concentrations of sulphur dioxide were 12 $\mu\text{g}/\text{m}^3$ in the south-east suburb settlement Drachevo, up to 92 $\mu\text{g}/\text{m}^3$ in the central city area. Sulphur dioxide concentrations above the

maximum permitted limits (MPL) of $150 \mu\text{g}/\text{m}^3$ had been recorded up to 59 days in this year. In the same period the average annual concentrations of smoke were from $18 \mu\text{g}/\text{m}^3$ in Drachevo up to $62 \mu\text{g}/\text{m}^3$ in the central city area.

The average numbers of days with smoke concentration above the MPL of $50 \mu\text{g}/\text{m}^3$ were from 17 for the measurement spot Drachevo, up to 123 days for the measurement spot AMSM in the central city area. The average annual values for the smoke concentrations are close or above MPL at 3 from 7 measurement spots in the city.

At the measurement spot Karposh IV, besides the measurements of 24-hour concentrations of sulphur dioxide and smoke, the 24-hour concentrations of nitrogen oxides are also being measured. According to the average monthly concentrations in 1993, the period when the MPL of $85 \mu\text{g}/\text{m}^3$ was exceeded, is five days. At this measurement spot are also being followed the 24-hour concentrations of total oxidants and ground-level ozone. The prescribed norm for maximal single short-lasting concentration for this parameter of $125 \mu\text{g}/\text{m}^3$ was exceeded five times.

The 24-hour concentrations of lead are being followed at measurement spots in Karposh IV and in the central city area. The maximum recorded concentrations are 3.3, i.e. $1.9 \mu\text{g}/\text{m}^3$, respectively. The permitted level according to the Ambient Lead Standard of $0.7 \mu\text{g}/\text{m}^3$ is not achieved at the measurement spot Karposh IV during 3 to 6 days per month, while in the central city area it is not achieved during 4 to 9 days per month in the months when the investigations have been carried out.

The concentrations of carbon monoxide are being followed at four cross-roads in the central city area by instant measurements. The recorded values point to presence of extremely unfavourable load of carbon monoxide in this part of the city. All the measurements show carbon monoxide concentrations above the permitted concentration of $3 \mu\text{g}/\text{m}^3$.

The content of suspended particulate matter and the presence of heavy metals in the air are being followed by simultaneous measurements at the four most heavily loaded cross-roads. The quantity of particulate matter in accordance with the World Health Organization's Statute, that is $120 \mu\text{g}/\text{m}^3$, was exceeded in each measurement at all the measurements spots.

The quantity of dust deposits is systematically followed at 11 measurement spots in the city. The maximum recorded values are 1.5 to 3 times bigger than MPL of $300 \mu\text{g}/\text{m}^2$ per day, at ten of eleven measurement spots².

Generally, it could be concluded that at all measurement spots occasionally, and regarding some pollutants permanently, are being notified values that are higher than the permitted ones in accordance with the actual legislation in the Republic of Macedonia.

It is also assessed that the air pollution originates from the intense traffic, the unfavourable location of industrial complexes and central heating plants, strong demographical load, as well as from the transboundary air pollution caused by the

industrial and power plant capacities from Kosovo. The traffic infrastructure in the city from the aspect of air pollution is very unfavourable. There are no ring roads for heavy load vehicles that would connect the city with the most loaded north-west magistral road. For this purpose the basic city traffic roads are being used. This problem increases the actually large air pollution by lead, sulphur dioxide, volatile organic compounds and nitrogen oxides that are emitted by loading and military vehicles passing through the city to the border-cross Blatze. This traffic road today is for sure the most heavily loaded traffic road in this part of Europe.

In region of Skopje the weather system generally travels from north-west to south-east, i.e. it comes from Kosovo. The average altitude of the Skopje Valley is 260 m a.s.l. and is about 200-300 m lower than the appropriate one in Kosovo.

The air pollution is also influenced a lot by the unfavourable terrain topography, as well as by the local climate and meteorological conditions, which strengthen the impact of the transboundary pollution. The air pollution is often critical for the population's health in the winter period, when temperature inversions and anti-cyclone conditions cause the toxins in the air above the ground to be retained for weeks. The temperature inversions appear when the temperature of air in the lower parts of the valley is smaller than the temperature at the surrounded mountain massifs. The difference between these temperatures could reach up to 10°C. In the winter period there is an enlarged frequency of foggy days up to height of 750 m a.s.l. In this case the smoke in the air, as particularly characteristic pollutant in the region, endangers at great level the health status of the population, ecosystem and the natural and created worthiness in the region. Due to the semi-arid character of the region, the problems are more complex due to frequent absence of rains (there are mainly rainfalls, while the snow cover lasts on average 25 days per year).

It is fortified that among the seven municipalities of Skopje, the air pollution is the heaviest in the industrial most polluted municipality Gazi Baba regarding all the polluters, except the dust deposit. The pollution by dust is the heaviest in municipality Karposh, which does not possess significant industrial capacities. It is this information that points to the presence of transboundary air pollution, for the Karposh municipality bounds with Kosovo and is greatly exposed to air streams that mostly come from the direction of Kosovo. As possible polluters are the cement plants 15 km away from Skopje, large lignite-fired power complex 70 km away from Skopje and one of the biggest in Europe lead smelter "Trepcha" 110 km away from Skopje.

The presence of acid rains in Macedonia was proved by measurements carried out in the meteorological station located in Lazaropole, which is in the western part of the Republic of Macedonia, 120 km south-west from Skopje. At this measurement spot in the period of 1984-1994, 3 to 25% of the rainfalls had the

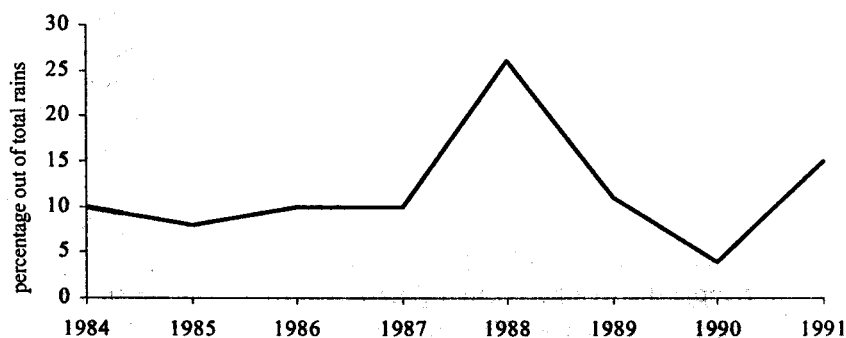


Fig. 1. Acid rains in the region of Lazaropole

character of acid rains ($\text{pH} < 5.6$). The minimum pH extremes at annual level ranged between 3.6 and 5.2 (Fig. 1).

On the base of the previous presented data it should be estimated that transboundary sulphur emissions and suspended particulate matter from suitable power and metallurgical plants from Kosovo take important part in total emissions of these contaminants in the region of Skopje.

The air quality in the region of Skopje could be improved by carrying out measures for optimum limitation of the transboundary pollution as well as by rounding off the erection of the natural gas pipeline, building of ring roads, electrification of the public traffic and realization of other measures. It is thought that the most efficient and economical way of environmental protection could be reached by these preventive actions for reducing or removing the causes for air pollution. It would create favourable conditions for saving the population's health, ecological stability of the region and improvement of the space quality. Unless these measures are realized in time, restoration and remediation measures that must be carried out in the future for elimination of the transboundary degradation of ecosystem, would be too expensive and on long-term realization.

That's why it is assessed that it is necessary to be urgently established Balkan international cooperation in the field of regional environmental protection against transboundary pollution. The cooperation would encourage the resolving of transboundary air pollution problems on a broad regional basis through controlling the levels of contaminants for reducing the damage to human health and environmental degradation. Bilateral and multilateral agreements must be implemented to cover topics of control and preventing of air quality by airborne particulate matter and acid rain, all within the frameworks of the 1979 Convention on Long-range Transboundary Air Pollution, the 1985 Helsinki Protocol and the 1988 Sofia Protocol.

CONCLUSIONS

The world experience confirmed that air pollutants could travel up to several thousand kilometers before deposition and damage occurred. It is estimated that there is a presence of transboundary pollution in the region of Skopje by sulphur emissions and suspended particulate matter, which comes from the industrial and electrical power capacities in Kosovo, FR Yugoslavia. From the middle of last year there is air transboundary pollution, which originates from the heavily intensified load traffic through the city Skopje towards the border-cross Blatze.

Generally, in the region of Skopje at all measurement spots occasionally are being recorded values that are higher than the permitted ones in the air in accordance with the actual environmental legislative in Republic of Macedonia. The pollution is the most critical in the absence of horizontal and vertical air circulation, especially in period of temperature inversions when the prescribed standards for the ambient air quality are not achieved.

The atmospheric pollution is often critical for the population's health in the winter period, when temperature inversions and anti-cyclone conditions cause the contaminants in the air above the ground to be retained for weeks. The hazardous influence of the degraded air quality also impacts the rest of the living world through reducing the biodiversity, deforestation, destroying of green areas and decreasing the soil quality.

This implies that co-operation at international level is necessary to solve problems that come from acid deposits and acidification of soil and aqua systems. It should provide control of the pollution flux mass and levels of contaminants and resolve the transboundary air pollution problems on a broad regional basis. It would contribute toward reducing the damage to human health and environmental degradation.

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