STUDIES 41–55

Air Pollution in Slovenia in Socialist Yugoslavia

JANJA SEDLAČEK – MARTA RENDLA

Sedlaček, Janja – Rendla, Marta: Air Pollution in Slovenia in Socialist Yugoslavia

After World War II Slovenia was characterized by severe air pollution. Although it experienced rapid industrial-, and economic growth until the mid-1970s, with a focus on heavy industry especially in the first decade of the postwar era, air pollution was distributed unevenly, and pollution levels varied greatly from place to place. This paper argues that Slovenia's geographical characteristics and location played an important role in the large difference of air pollution levels. Other important factors that influenced air pollution were a growing societal awareness of environmental issues and government response to tackle emerging environmental problems. The main purpose of the paper is therefore to analyze influencing factors of air pollution and its harmful impact on humans and the environment in Slovenia and also within a broader Yugoslav-, and international context.

Key Words *Air Pollution; Slovenia; SO_2 Emissions; Environmental Degradation; Environmentalism*

doi.org/10.15452/Historica.2022.14.0004

Contact *Institute of Contemporary History, Ljubljana; sedlacek@inz.si – marta.rendla@inz.si*

Introduction

After World War II, increasing environmental pollution was a problem faced by both the developed West and countries of the Eastern Bloc, who were trying to catch up with the already industrialized Western states via accelerating industrialization and in particular, by developing highly polluting heavy industries. By the 1960s, pollution problems became so urgent that they were tackled on both sides of the Iron Curtain.

Research by environmental historians shows, that the countries of state socialism were generally characterized by a contradiction between, on the one hand, the ideological importance of a clean environment, which was supposed to provide workers with safe-, and clean living conditions and opportunities for leisure and rest, on the other hand, the reality in which, due to the lack of financial resources, efficient environmental protection solutions often remained only at a declaratory level.[1]

The development of the environmental movement in socialist countries of Central-, and Eastern Europe had some similarities in the 1960s and 1970s, and especially in the

[1] MIGNON KIRCHHOF, Astrid – McNEILL, John R. (eds.): *Nature and the Iron Curtain : Environmental Policy and Social Movements in Communist and Capitalist Countries 1945–1990*. Pittsburgh 2019; MAZURSKI, Krzysztof R.: *Communism and the Environment*. Online, cited on 12 December 2022, accessible at http://www.mazurski.tomy.webd.pl/krm/files/Communism_and_the_Environment.pdf; PÁL, Viktor: *Technology and the Environment in State-Socialist Hungary : An Economic History*. London 2017; Idem: Toward Socialist Environmentalism? : Scientists and Environmental Change in Modern Hungary. *Environment and History* 29, 2023, no. 2, pp. 239–259.

1980s. However, it is clear from the research conducted so far that environmentalism was a complex process and that each country has its unique history in that respect.[2]

Yugoslavia, in particular, has taken a unique path. After the break between Tito, Yugoslav leader, and Stalin in 1948, the Yugoslav regime decided to take its own path, and in the early 1950s began developing its own version of socialism, the so-called self-governing socialism.[3] Yugoslavia did not belong either to the Eastern-, nor to the Western bloc as it shared an underlying ideology with the East, but was characterized by greater openness and less ideological rigidity because of its intensive contacts with the West. This was also reflected via the Yugoslav authorities' responses to environmental problems, in the context of environmental awareness and environmental activism in postwar Yugoslavia.[4]

Although environmental problems and environmental protection already existed before World War II, it was under post-war communist modernization, when intense yet dispersed industrialization as well as urbanization and deagrarianization produced alarming signs of an ever-increasing environmental pollution and degradation in the Slovene part of socialist Yugoslavia. In Slovenia, the northernmost of the six former Yugoslav republics and two autonomous provinces, air pollution was the most pressing of the degradation processes. With the emissions of 131 kg of sulfur dioxide per inhabitant, Slovenia ranked at the top of the most polluted European countries in 1988. Compared with domestic SO_2 emissions, the precipitation in Slovenia contained 2.5 times more sulfur.[5]

Thus, Slovenia was among the areas with the highest concentrations of sulfur in the air in Europe; only two other areas, Czech Silesia and the Donetsk Region in Ukraine, both known for their intensive industrial structure, had similar amounts of sulfur in the air as Slovenia. In 1975, 28 Slovene settlements ranked in the class III. and IV. of air pollution on a four-level scale, where IV. class represented the lowest quality. In 1987, there were already 44 settlements in those two categories, where a quarter of the Slovene population lived.[6]

Slovenia is often considered as a country with high ecological stability and regenerative capacity due to diversity of landscape types and biodiversity. Thus, the question emerges, how such high levels of air pollution were possible?

This paper aims to answer this question, and by doing so, it relates the effects of air pollution to the geographical characteristics of Slovenia, places it in the context of Slo-

---

2 BRAIN, Stephen – PÁL, Viktor (eds.): *Environmentalism under Authoritarian Regimes : Myth, Propaganda, Reality*. London 2019; MIGNON KIRCHHOF, A. – McNEILL, J. R. (eds.): Nature; MAZURSKI, K. R.: Communism; PÁL, V.: Technology; Idem: Like Industrious Bees : Paper Waste and Recycling in Communist Hungary, 1950–1990. *Environmental History* 28, 2023, no. 2, pp. 335–360.

3 Self-governing socialism was a mixture of planned and market economy elements, in which workers were to own the results of their labor. Since the early 1950s, workers have had a say in company decisions through workers' councils, including what to do with some of the income the company generated. In the mid-1970s, policymakers sought to replace the market and the economic role of the state with "self-governing agreements" between companies. In this way, workers were to direct economic trends themselves, and the state's role was to consist only in the organized protection of social property. This meant a significant decentralization of decision-making, which was not limited only to the economic sphere, but it referred to other important social-, and local issues as well, including ecological ones. But only within the limits of the plans, which remained the ideological instrument of the communist party until the break-up of Yugoslavia.

4 These topics are covered by Z. Oštrić, H. Petrić, and David E. Kromm in their works and listed in the bibliography section at the end of this paper.

5 PLUT, Dušan: Naravnogeografski vidiki degradacije okolja in razvoja v SR Sloveniji. In: LAH, Avguštin (ed.): *Slovenija 88 : Okolje in razvoj : zbornik*. Ljubljana 1989, p. 61.

6 RAVBAR, Marjan et al.: *Zasnova poselitve v Sloveniji*. Ljubljana 1995, pp. 105−106.

vene economic-, and urban development after World War II, as well as examines the attitude of Slovene authorities in the post-war period towards pollution and environmental protection and the development of environmental awareness and activism within the Slovene society. This essay also puts the Slovene case in the context of other Yugoslav republics and at times some other state-socialist countries as well.

A number of researchers have dealt with the problem of air pollution and environmental policy with regard to postwar Europe, for example Henrik Ehrhardt[7] on West Germany, Michel Dupuy[8] on East Germany, Christine L. Zvosec[9] about the countries of Eastern Europe. Stanley J. Kabala[10] and Aida Ličina Ramić[11] are among the few authors who have dealt with air pollution in Yugoslavia. Environmental history research for the era of modernization is still at an early stage in Slovenia, with very limited scholarship about air pollution after World War II. However, in the 1970s and especially in the 1980s with the gradual development of environmental awareness, numerous professional-, and scientific contributions on the subject of environmental-, and air pollution were written by contemporary geographers, urban planners, health experts, for example D. Plut, A. Lah, D. Radinja, M. Špes, D. E. Kromm.[12] The publications from that time, including the comprehensive survey *The Green Book on the Threat to the Environment in Slovenia*, which in 1972 pioneered the problem of pollution in Slovenia, as well as *Slovenia 88*, served as our main sources. Public statistical data for air pollution is only available from the late 1980s, thus publications by experts, who had access to those statistics, are therefore an excellent source. This paper mostly relies on data about the concentration of SO_2 in the air, because data for other pollutants are scarce. Although SO_2 contributed only around a third of all impurities, it was a good indicator of general air pollution.[13]

The Social and Economic Development of Slovenia in Socialist Yugoslavia

After World War II, the new communist government embarked on a radical social-, and economic transformation. The focus was on accelerated industrialization, especially on basic heavy industries until 1956.[14]

Until the mid-1970s, Slovenia experienced extremely rapid industrial-, and economic growth, which slowed down in the second half of the 1970s and turned from stagnation

---

7 EHRHARDT, Hendrik: Keeping the Air Clean? : Environmental Policy, Utility Companies, and Social Movements in West Germany since the 1970s. In: MIGNON KIRCHHOF, A. – McNEILL, J. R. (eds.): Nature, pp. 73–86.

8 DUPUY, Michel: Retention of Sulfur Dioxide Emission in the GDR : Between Technology, Economics, Diplomacy, and Public Opinion. In: BRAIN, S. – PÁL, V. (eds.): Environmentalism, pp. 162–179.

9 ZVOSEC, Christine L.: Environmental Deterioration in Eastern Europe. *World Affairs* 147, 1984, no. 2, pp. 97–126.

10 KABALA, Stanley J.: Economic Growth and the Environment in Yugoslavia : An Overview. *Ambio* 17, 1988, no. 5, pp. 323–329.

11 LIČINA RAMIĆ, Aida: Od ekološke katastrofe do olimpijskog grada : Sarajevo 1971–1984. In: DURANOVIĆ, Amir (ed.): *Poplava, zemljotres, smog : Prilozi ekohistoriji Bosne i Hercegovine u 20. stoljeću*. Sarajevo 2017, pp. 115–147.

12 Their works are listed in the bibliography section at the end of this paper.

13 Sulfur dioxide is the chemical compound with the formula SO_2. It is a toxic gas produced as a by-product of copper extraction and the burning of sulfur-bearing fossil fuels.

14 PRINČIČ, Jože: *Kapitalna, ključna kapitalna in temeljna investicijska izgradnja v Sloveniji 1945–1956*. Novo mesto 1992.

to a slight decline in the second half of the 1980s. Industrial production increased tenfold in the period 1939–1972, and Slovenia's economic growth rate in 1953–1972 was among the highest in the world. By far the fastest growing industry during this period was the electricity industry, which increased at an average annual rate of 21 %, producing 45 times more in 1972 than it had twenty years earlier.[15]

In the early postwar years, Yugoslavia followed a Soviet-style central planning system. With the abandonment of the Soviet development model and the transition to its own version of socialism in the early 1950s, Yugoslavia gradually shifted to more balanced investments, among which light industry gained a prominent role.[16] Despite the disproportion to the generated social product, capital-intensive economic sectors, such as the industries related to energy raw materials, again took a central place in investments in the 1970s. This meant that heavy industry, with its harmful effects on the environment and human health, maintained a central role until the break-up of Yugoslavia. For economic planners, growth was necessary without regard to costs, because new factories were a sign of progress, an opportunity for employment and a higher standard of living.[17]

At first, industrialization was located especially in the so-called industrial crescent, where pre-war industrial centers were already located along the main railway lines. Later industrial projects spread spatially.[18] Slovenia followed a polycentric urbanistic model since the 1960s and as a result many relatively small industrial-, and urban centers were spread across Slovenia. Urbanization was especially intensive in the 1960s and 1970s.[19] Spatially dispersed centers of industrialization and urbanization had both negative and positive environmental effects: pollution reached all parts of Slovenia, but at the same time its effects were spread out and not concentrated in certain industrial centers.

Many urbanized and industrialized cities and industrial centers have emerged in alpine and pre-alpine basins and valleys with multifunctional natural potential. The Slovene valleys and basins in the lee of the Alps, where the majority of the population lived and a large part of the industry was concentrated, represent a particularly sensitive mountain ecosystem from an ecological point of view.[20]

The Geography of Slovenia and its Impact on Pollution

The environment in Slovenia as a whole and especially in some areas was characterized by being more degraded than expected given the emission of pollutants, the standard of living, as well as the industrial-, and urban development achieved. On the other hand, the acidification of the environment was in some areas unreasonably low, when compared with the high amounts of sulfur in precipitation.[21]

---

15 BERIČ, Karel: Dvajsetletni razvoj industrijske proizvodnje SR Slovenije. *Prikazi in študije* 7–8, 1965, pp. 1–29; BRGLEZ, Franček (ed.): *Družbeni razvoj Slovenije 1947–1972*. Ljubljana 1974, pp. 38–74.

16 RENDLA, Marta: *"Kam ploveš standard?": Življenjska raven in socializem*. Ljubljana 2018.

17 OSET, Željko: Environmental Activism during Communist Era in Slovenia. *Review of Croatian History = Revue für kroatische Geschichte = Revue d'histoire croate* 15, 2019, no. 1, p. 66.

18 VRIŠER, Igor: Razvoj industrije v Sloveniji. *Geografski vestnik* 48, 1976, pp. 29–45; Idem: *Industrializacija Slovenije*. Ljubljana 1977.

19 RAVBAR, M. et al.: Zasnova, p. 26.

20 PLUT, Dušan: Industrija in degradacija okolja v Sloveniji. *Geographica Slovenica* 18, 1978, pp. 88–89.

21 RADINJA, Darko: Pokrajinske značilnosti industrializacijske onesnaženosti v Sloveniji. In: *Geografski prob-*

In the case of Slovenia, the influence of non-anthropogenic factors seems to be the key to explain the discrepancy mentioned above. In an area of only 20,000 km^2, the four basic European landscape-, and ecosystems types meet: the Alps, the Pannonian Plain, the Dinarides and the Mediterranean.[22]

On the one hand, the diversity of landscape elements and landscape types conditions the ecological stability of Slovene landscapes; on the other hand, this characteristic leads to very different self-regeneration capacities and the ability of nature to resist degradation. From the point of view of air pollution and consequent environmental degradation, the relief dissection should be emphasized. The dissection and diversity of the Slovene relief, especially in deep and narrow valleys and basins, affects the extreme spatial variability of the self-regeneration potential. While the settlements of sub-Mediterranean Slovenia have the highest regeneration potential, the alpine and pre-alpine basins and valleys, as well as the karst fields, have relatively poor air self-regeneration capacity in the winter months. Strong negative landscape pollution effects in alpine and pre-alpine basins and valleys as well as karst fields are due to air-locked systems, especially in winter, when there is temperature inversion, caused by even relatively small amounts of harmful emissions. The absence of strong winds and frequent temperature inversions contributes to the formation of fog in narrow valleys and basins. Even at the beginning of the 1990s, the fog lingered for 100 to 150 days a year, most often during the winter heating period.[23]

Slovenia is also characterized by its unfavorable position in terms of transboundary transmission of air pollution. From Central-, Western- and even Mediterranean Europe – especially from the nearby, heavily industrialized northern Italy – polluted air masses spread unhindered to Slovenia, where they are stopped by the orographic barriers at the Alpine-Dinaric transition zone. There, orographically enhanced precipitation (among the most productive in Europe) leaches sulfur from the atmosphere. The effects of acid rain – the acidification of the environment, especially of soil and water – are relatively successfully counteracted, directly or indirectly, by the predominant carbonate rocks and some other landscape features.[24] The openness and transitivity of the Slovene territory thus leads to the fact that Slovenia absorbs, transforms and releases detrimental material and energy inflows and outflows such as polluted air masses and polluted water.[25]

Air Pollution: The Yugoslav Framework

In Yugoslavia, the first non-systematic measurements of outdoor air pollution were carried out in 1950–1951. These measurements related to the air in the vicinity of industrial plants and mines. Among the first such tests were the air measurements in the vicinity of the steelworks in Zenica (Bosnia), the ironworks in Jesenice (Slovenia), the copper

lemi življenjskega okolja = Geographical Problems of Human Environment. Ljubljana 1979, pp. 75–84.

22 PLUT, Dušan: Onesnaženje in prostorski razvoj Slovenije. In: Idem: *Geografija in aktualna vprašanja prostorskega razvoja : 70 let geografije na ljubljanski univerzi = Geography and Current Questions of Spatial Development : 70th Anniversary Year of Geography at the University of Ljubljana*. Ljubljana 1989, p. 175.

23 Ibidem, pp. 105–106.

24 Ibidem; ŠPES, Metka: Vpliv lokalnih virov emisij in čezmejnega zraka na kakovost okolja v Alpskem ekosistemu Slovenije. In: GOSAR, Anton (ed.): *Sonaravni razvoj v slovenskih Alpah in sosedstvu = Sustainable Development in the Slovene Alps and its Neighbouring Regions*. Ljubljana 1999, p. 142.

25 PLUT, D.: Naravnogeografski vidiki, p. 63.

mine in Bor (Serbia), the lead mine in Trebča (Kosovo), as well as some other industrial sites in Slovenia. In the 1950s, sporadic measurements continued to be carried out, and systematic measurements began in 1960 in Belgrade and a year later in Zagreb. These tests showed that Zagreb was more polluted in 1962–1963 than Milan in 1956–1957.[26] Since 1965–1966 regular measurements of air pollution in Sarajevo were carried out as well, and also showed serious air pollution.[27]

In 1963, a report prepared by the members of the Yugoslav Academy of Sciences and Arts, pointed out that the chemical analysis of air pollution indicated that in Yugoslav cities industrial air pollution was the most critical one. There were major differences between air pollution in industrial-, and non-industrial areas of the towns and rather small seasonal variations within industrial areas.[28] This however was not true for Sarajevo and Ljubljana, the two republic capitals, which despite the polycentric development of industry in Bosnia and Herzegovina and Slovenia were facing severe air pollution. Both cities lie in basins, thus the air circulates poorly, especially in winter, when there is a temperature inversion. The main source of air pollution in both cities was therefore heating, although other pollutants also played an important role.

In 1987, there were fourteen Slovene cities, whose maximum daily measured SO_2 value exceeded 500 µg/m^3, with the highest maximum measured daily value of 910 µg/m^3 in Trbovlje. In other Yugoslav republics, there were only nine cities all together,[29] whose maximum daily measured SO_2 value exceeded 500 µg/m^3, for example Belgrade, with a measuring spot at Vračar (822 µg/m^3), Sarajevo (882 µg/m^3) and Zenica (with 1415 µg/m^3, being highest measured value among them all).[30]

Comparison of daily SO_2 concentrations in the capital cities of republics and autonomous provinces show that the highest mean daily concentration of SO_2 in 1987 and 1988 were observed in Belgrade (146 µg/m^3 in 1987 and 113 µg/m^3 in 1988), Ljubljana (100 µg/m^3 in 1987 and 70 µg/m^3 in 1988) and Sarajevo (94 µg/m^3 in 1987 and 109 µg/m^3 in 1988). Among the Yugoslav capitals, Sarajevo stood out with the highest maximum daily SO_2 value of 1052 µg/m^3 in 1988.[31]

During 1967–1983, air pollution due to the concentration of SO_2 and smoke in the Yugoslav capitals was steadily decreasing. After 1983 SO_2 concentrations stopped decreasing and in 1986 SO_2 and particulate matter was still above the WHO recommendations in some of the capitals' concentration, largely due to Yugoslavia's renewed reliance on domestic lignite reserves in the 1980s.[32]

---

[26] VOUK, Velimir B. – FUGAŠ, Mirka: *A Short Review of Clean Air Problems in Yugoslavia*. Geneva 1963. Online, cited on 23 April 2023, accessible at https://apps.who.int/iris/bitstream/handle/10665/326338/WHO-AP-10-eng.pdf?sequence=1&isAllowed=y, pp. 3–4.

[27] LIČINA RAMIĆ, A.: Od ekološke katastrofe, p. 123.

[28] VOUK, V. B. – FUGAŠ, M.: A Short Review, p. 5.

[29] It has to be stressed out that among 93 Yugoslav cities, for which the Yugoslav statistical yearbooks in the 1980s listed the data about the quality of air, almost half were Slovene cities. It remains unclear whether Slovene cities were more polluted than other Yugoslav cities or whether statistical data was more widely available for the Slovene part of Yugoslavia than in other republics.

[30] *Statistički godišnjak Jugoslavije 1989*. Beograd 1989, pp. 85–86.

[31] Ibidem, pp. 85–86; *Statistički godišnjak Jugoslavije 1990*. Beograd 1990, pp. 83–84.

[32] BUSSIÈRE, Jane (ed.): Environmental Policy in Yugoslavia. *The OECD Observer* 142, 1986, no. 5, p. 31.

Air Pollution in Slovenia

Although Slovenia was among the countries with the highest annual sulfur precipitation per unit area in Europe, the overall environmental degradation and acidification were lower than expected because of the landscape composition, especially due the structure of the carbonate rocks which contributed to the neutralization of the acidification process. Climatic features with distinct seasons and hydrological features with rapid cycling of materials and energy also contributed to lower than expected environmental degradation.[33]

Slovenia remained a source of significant sulfur emissions until the end of the socialist era, producing 98 kg of SO_2 per capita in the early 1990s. During the same period, the United Kingdom, Germany, Austria, and Switzerland produced 84 kg, 52 kg, 47 kg, and 20 kg per capita, respectively. More than half of domestic emissions remained in Slovenia, while the rest was distributed with the air masses over other European countries. An estimated 78 % of domestic emissions came from thermal power plants. From an environmental point of view, the use of lignite (from the mines in Trbovlje, Senovo and Velenje) was the most problematic issue, because lignite is low in calories and contains high levels of sulfur and solids. The largest Slovene thermal power plant in Šoštanj polluted the air more than the thermal power plant in Trbovlje and thermal power plant in Ljubljana, the other two Slovene thermal power plants combined. Slovene SO_2 emissions also came from industry (12 %), transport (1,5 %), and from heating homes and other buildings (8,5 %). By the early 1990s, the major polluters had already taken steps to protect air quality, but overall these actions were not enough, and the concentration of pollutants still exceeded permissible limits in many localities.[34] For example, SO_2 emissions from industry decreased in the period 1978–1988 due to the technological renewal of Slovene ironworks in Jesenice and Ravne na Koroškem, as well as via remediation measures to protect air quality at the Cinkarna metallurgical and chemical industry in Celje and the Mežica lead mine and smelter.[35] Other sources of industrial SO_2 emissions were the aluminum and alumina plant in Kidričevo and the pulp and paper mill in Krško.[36]

At the beginning of 1990s, the most degraded localities or regions, with category "IV." or "critical" concentration of SO_2 in the air included the three largest Slovene cities: Ljubljana, Maribor and Celje as well as the Mežica Valley (a center for metallurgy and lead mining in the towns of Črna, Žerjav and Mežica), the outskirts of the Šalek Valley (Zavodnje above Šoštanj), the Celje basin, the Ljubljana basin, the middle Sava Valley (with mining centers of Trbovlje, Hrastnik and Zagorje), and Trata, an industrial district in the city of Škofja Loka.[37]

In most Slovene cities, systematic measurements of air pollution began between 1975 and 1977, while in some of the most polluted areas measurements were carried out as

---

33 RADINJA, Darko: O tehnogenem kroženju žvepla v pokrajinskem okolju SR Slovenije in njegovi bilanci : prispevek k vprašanju zakisanosti naših padavin in okolja sploh. *Geografski vestnik : Časopis za geografijo in sorodne vede = Geographical Bulletin : Bulletin for Geography and Related Sciences = Bulletin géographique : bulletin pour géographie et sciences associées* 60, 1988, pp. 3–19.

34 ŠPES, Metka: Kaj vemo o onesnaževanju zraka?. *Geografski obzornik* 40, 1993, no. 2, p. 14.

35 HRČEK, Dušan: Zelena knjiga o ogroženosti okolja v Sloveniji. In: LAH, A. (ed.): Slovenija 88, pp. 298–299.

36 ŠPES, M.: Kaj vemo o onesnaževanju, p. 14.

37 Ibidem.

early as the late 1960s.[38] Based on the first unsystematic SO_2 measurements, the air in Slovene cities was the most polluted in the late 1960s and early 1970s. Before 1980, the predominantly and moderately industrial cities and urban settlements were among the most polluted cities in terms of air pollution (SO_2, smoke, and particulate matter). The settlements with high industrial emissions and emissions from various heating sources stood out. In general, high SO_2 and smoke emissions prevailed in winter.

The consequences of long-term air pollution were critical in the mid-1980s, with decline of coniferous forests, especially fir and spruce, and of deciduous forests all across Slovenia, despite the fact that damage to forests in certain areas had been present since the 1960s.[39]

In the 1980s, industrial emissions began to decline, because Slovenia gradually switched to natural gas and oil instead of coal and built treatment plants. In the most polluted Slovene cities, average annual SO_2 concentrations ranged from 100 to 250 $\mu g/m^3$ in the 1980s.[40] By the end of the 1980s, average annual SO_2 immisions in the most polluted Slovene cities had decreased by 100–200 % compared to the beginning of the 1970s. Despite the sharp decline in Slovenia, in the Austrian city of Graz, for comparison, annual SO_2 immisions decreased by more than 600 %.[41]

Despite the reduced emissions of SO_2 and smoke, even at the beginning of the 1990s air pollution in Slovene cities was still the most pressing environmental problem – while concentrations of SO_2 and smoke were decreasing, the emissions of nitrogen oxides and of photooxidants were increasing due to growing road traffic.[42] In 1991, two-thirds of the urban population and one-third of the total Slovene population lived in cities and settlements with critical air pollution, or air pollution above the permissible level but not above the critical level, compared to three-quarters in the mid-1970s. Despite the decline in relative proportions over this period, however, the population living in unhealthy residential environments grew by 150,000 between the mid-1970s and the mid-1990s, due to migration to polluted cities, but also in part to the expansion of the monitoring network and stricter regulations.[43]

Air Pollution in Ljubljana, the Slovene Capital

In Ljubljana, systematic measurements began in 1968.[44] Experts who performed measurements were not expecting to record the high figures of pollution they measured, because the polluted air was then believed to be mainly associated with large industrial emissions. However, the measurements in Ljubljana showed that city air even in places

38 HRČEK, D.: Zelena knjiga, p. 298; RAVBAR, M. et al.: Zasnova, p. 105.

39 ŠPES, M.: Kaj vemo o onesnaževanju, p. 10.

40 RAVBAR, M. et al.: Zasnova, p. 105.

41 KLIMONT, Zbigniew et al.: *Emissions of Air Pollutants in the Region of the Central European Initiative – 1988*. Laxenburg 1993. Online, cited on 30 October 2022, accessible at https://pure.iiasa.ac.at/id/eprint/3736/1/SR-93-003.pdf; LAZAR, Reinhold – KAUFMAN, Viktor – BUCHROOITHNER, Manfred: *Stadtklimaanalyse Graz*. Graz 1994, p. 163.

42 CHIRAS, Daniel: *Environmental Science : A Framework for Decision Making*. Menlo Park 1988, p. 531; RAVBAR, M. et al.: Zasnova, p. 107.

43 RAVBAR, M. et al.: Zasnova, pp. 105–106.

44 HRČEK, Dušan: Onesnaženost zraka v Sloveniji : Stanje in usmeritve za izboljšanje. In: LAH, Avguštin (ed.): *Okolje v Sloveniji : zbornik*. Ljubljana 1994, pp. 345–355.

without noteworthy industrial emissions was very polluted. Results indicated that the level of air pollution in the winter was of worse quality even compared to highly industrial areas abroad. Thus, experts suspected first that their measurements could not be correct.[45]

In the early 1970s, fourteen air pollution measurement stations out of the total of sixteen stations in Ljubljana measured two-times higher monthly average concentrations of SO_2 in the winter than the maximum average daily concentration of 150 μg/m^3, a standard, proposed by the federal institute for health care in 1965 as the maximum permissible concentration. Six of the Ljubljana air pollution measurement stations recorded three times greater monthly averages than the maximum permitted daily concentration. During the summers all measuring stations but one reported monthly averages below the maximum permitted level.[46]

Unfavorable weather conditions in the Ljubljana basin, such as poor air ventilation and temperature inversions, were the main reasons for the difference of air quality in winter and summer. High SO_2 concentrations in winter also indicated that the main cause of high SO_2 concentrations was heating.[47]

In January 1967 a record-level of daily SO_2 concentration was measured in Ljubljana at 2400 μg/m^3, the average 24-hour concentration exceeded the permissible limit by a factor of 16.[48]

At the end of 1967, the Thermal Power Plant – Heating Plant Ljubljana (TE-TO LJ) began to operate. As a result, SO_2 emissions tripled in Ljubljana due to the use of coal with a high, 3–5 % content of sulfur. However, at the same time air pollution with sulfur dioxide and smoke decreased by 30 % due to the abandonment of fireplaces with low chimneys in Ljubljana. With the expansion of TE-TO LJ in the 1980s, emissions continued to increase until the 1990s, but the concentrations of SO_2 and smoke were decreasing since the end of the 1960s.[49] Despite that, in 1984 according to the data of the annual concentration of SO_2 in various European and North American cities, Ljubljana with an average concentration of 120 μg/m^3 was still ranked among the most polluted cities in the world.[50] Even in the 1991–1992 heating season, daily SO_2 concentrations, with a maximum daily value of 390 μg/m^3 measured in December 1991, still exceeded the Slovene permissible daily limit value of 150 μg/m^3.[51]

The Case of the Upper Sava Valley

It was not only in the Ljubljana basin, that climatic features played an important role in the discrepancy between the emissions of the pollutants and air quality. In 1999 geographer

---

45 PARADIŽ, Bojan: Posledice onesnaževanja zraka v lokalnih in planetarnih razsežnostih. In: LAH, A. (ed.): Okolje, p. 345.

46 KROMM, David E.: Response to Air Pollution in Ljubljana, Yugoslavia. *Annals of the Association of American Geographers* 63, 1973, no. 2, pp. 209–210.

47 PEČENKO, Andrej – PLANINŠEK, Anton: Onesnaženost zraka z SO_2 v zadnjih dvanajstih letih. In: LAH, A. (ed.): Slovenija 88, p. 305.

48 PARADIŽ, Bojan: Zrak. In: PETERLIN, Stane (ed.): *Zelena knjiga o ogroženosti okolja v Sloveniji*. Ljubljana 1972, p. 57.

49 Idem: Posledice, pp. 12–18.

50 RAVBAR, M. et al.: Zasnova, p. 105.

51 PARADIŽ, B.: Posledice, p. 336.

Metka Špes discussed the degradation of the environment in two Slovene Alpine valleys: the Upper Sava Valley and the Mežica Valley. In the late 1960s and early 1970s, when air pollution was at its highest in Slovenia, the two valleys were among the most degraded Slovene regions. However, due to the different self-cleaning abilities of the local environment, there was still a difference between the two valleys in the degree of environmental degradation. Until 1970, the Upper Sava Alpine Valley with the metallurgically oriented Jesenice locality had the highest emissions in Slovenia. However, SO_2 concentrations in 1969, for example, were as much as 30 % lower than in the Slovene capital Ljubljana, which did not have such high emissions. The lower SO_2 concentrations in Jesenice were due to relatively good air exchange in the narrow valley. Temperature inversions were less pronounced, which allowed relatively satisfactory natural air cleaning. In Jesenice, red iron smelter dust, which settled in the immediate vicinity of the iron smelter, represented an important environmental-, and health concern.[52] In adjacent areas around the ironworks, the conifers stopped thriving; instead, a poor, sparse birch forest and scrub began to grow. But there were almost no wastelands or severely damaged forests, as was the case in Mežica Valley with lower emissions. In the town of Jesenice, measurements of dust deposits, which in the mid-1960s were up to fourteen times higher than prescribed standards, fell in the 1990s below the maximum permissible concentrations, despite standards for residential environments being stricter.[53]

Environmental Policy: The Yugoslav Framework

Despite severe environmental pollution, which in the decades after World War II was in a large part caused by the communist government's orientation towards accelerated industrialization, with an emphasis on heavy industry for many years, several laws were adopted and many international conventions were signed for the protection of the environment in Yugoslavia.

Yugoslav constitutions of 1946, 1963 and 1974 included the idea of the protection of nature, and each successive constitution included new environmental aspects. Nature protection laws were adopted at the federal level in 1946, and by republics and autonomous regions in 1949. Later, the nature protection laws were improved and in the mid-1960s expanded to include requirements of conservation, general protection of nature, and promotion of nature and the environment. The Yugoslav constitution of 1974 transferred the responsibility for adopting environmental laws to the republics and autonomous regions. Based on that, all six Yugoslav republics adopted new laws on the establishment of national parks, protection of forests and waters, hunting and fishing, air pollution, and spatial planning. In accordance with these laws, Yugoslavia placed many natural areas and habitats under protection, including 22 national parks established between 1948 and 1986.[54]

In the 1960s, when the measurements showed bad air quality in several Yugoslav localities, air pollution became a topic of scientific and political discussion. The Air Protection Act at the federal level, has been debated and planned, but has never been adopt-

[52] Idem: Zrak, p. 61.

[53] ŠPES, M.: Vpliv, p. 140.

[54] PETRIČ, Hrvoje: About Environmental Policy in Socialist Yugoslavia. In: MIGNON KIRCHHOF, A. – McNEILL, J. R. (eds.): Nature, pp. 170–172.

ed.[55] In 1973 the Yugoslav Society for Clean Air was formed in Sarajevo, and in 1983 it transformed into the Association of Yugoslav Clean Air Societies.[56]

Environmental Policy, Environmental Awareness and the Environmental Movement in Slovenia

In Slovenia, efforts to preserve endangered symbols of nature began in the early 1960s and continued via nature conservation activities, such as Nature Conservation Week in 1967 and the Slovene program for the European Year of Nature Conservation in 1970.[57] For most of the 1960s, environmentally related activities were limited to the protection of pristine nature; and the pollution of human habitat, especially cities, has not yet been adressed. When early measurements showed a high degree of air pollution in Slovene cities, the chamber of commerce initiated a Commission for the Study of Issues in the Field of Air Pollution Protection within the ministry for urban planning at the end of 1969. The commission's task was to determine the state of air pollution in Slovenia and to design measures for improving the air pollution situation.[58]

A clear sign of the awakening environmental awareness was the preparation of the Green Book on the Threat to the Environment in Slovenia in 1972, which already used the information from the report of the newly established air pollution commission. The Green Book presented scattered and isolated data on environmental degradation, collected by experts at various institutes and state institutions (doctors, biologists, geographers, architects, urban planners, chemists, foresters, etc.), most of whom were at the same time functioned as environmental enthusiasts – nature lovers, members of mountain and camping associations etc. The book consisted of six substantive chapters with a total of 67 author reports. The preparation of the book began in the spring of 1970 during the European Year of Nature Conservation, as part of the preparations for participation in the United Nations Conference on the Human Environment in Stockholm in 1972. In addition, the Association for the Protection of the Environment in Slovenia, a unifying body of social organizations and individuals was founded in May 1971, which in the same year achieved that the Slovene assembly established the commission for environmental protection as its consultative body in environmental matters.[59]

In 1975, the Air Protection Act was adopted, and consequent by-laws regulated standards for emissions and permissible concentrations as well as the classification of air pollution from I. (with clean air) to IV. degree (with critically polluted air) between 1976–1979.[60] The stringency of the new Slovene regulations corresponded with the standards of Western European countries at the time. Requests were also made to prepare remediation programs for some of the biggest industrial polluters. The law was in force until 1993, and decrees in 1988 and 1990 further tightened the standards.[61] Based on the

55 LIČINA RAMIĆ, A.: Od ekološke katastrofe, p. 119.

56 Ibidem, p. 120.

57 PETERLIN, Stane: Zelena knjiga o ogroženosti okolja v Sloveniji : Spomini na izid pred štiridesetimi leti. *Proteus* 74, 2012, no. 9–10, p. 464.

58 PARADIŽ, B.: Zrak, pp. 55–79.

59 PETERLIN, S.: Zelena knjiga, p. 464.

60 HRČEK, D.: Onesnaženost, pp. 345–346.

61 Ibidem, p. 346.

provisions of the Air Protection Act in 1976–1977, a network of air pollution monitoring stations started to operate. In addition to the republic monitoring station network, there were also measurements financed by municipalities and large polluters, or carried out by various state institutions.[62] Also, the Analytical Monitoring and Alarm System (ANAS) began to operate in 1980 with the aim of collecting accurate data on air pollution and meteorological conditions for the needs of remedial programs.[63]

By the end of the 1980s, the network of monitoring stations had expanded, and in 1990 there were 50 monitoring stations in Slovenia. Thus by 1988, a continuous twelve--year set of SO_2 and smoke concentrations data was available for research in most major cities. During the 1980s, monitoring results showed that air pollution in Slovene cities mostly decreased due to the introduction and expansion of the remote heating systems, the increasing share of natural gas in the total energy consumption, and the greater availability of liquid fuels for heating, as well as due to warmer winters.[64]

Despite measures taken to abate air pollution in Slovenia, the public debate in the 1960s and 1970s was still limited to the scientific circles and in the 1970s some of the popular science magazines, such as the "*Proteus*". It was not until the 1980s that air pollution was widely discussed and the ecological movement gained momentum, especially due to three events. The first of these events was the so-called Krupa affair in 1983, when information was made public that polychlorinated biphenyls[65] exceeded legal limits by 400 times in Slovenia's largest karst spring and a crucial local water source. The contamination was caused by the disposal of used capacitors in a karst sinkhole near the spring. The second event was the nuclear disaster in Chernobyl three years later. A series of articles on the responsibility for dying forests in central Slovenia represented the third milestone. In 1989, the environmental movement gave rise to the environmental party, The Greens of Slovenia (Zeleni Slovenije), which in April 1990 received 8.8 % of the votes at the first multi-party elections in Slovenia after World War II. The Greens of Slovenia was the green party with the highest election result in Europe at the time.[66]

Conclusion

After World War II, Slovenia battled with heavy air pollution, emitting 98 kg of SO_2 per capita in the early 1990s. In 1975, 28 Slovene settlements ranked Air Pollution Class III. and IV., on a four-level scale, where Class IV. represented critically polluted air.

Because industrialization dominated economic goals for ideological reasons, concern for the environment remained in many respects only at the declaratory level until the second half of the 1970s. But the Slovene scientific debate was strengthening and environmental awareness was emerging already in the 1960s.

In the following years, Slovenia had gradually developed a relatively progressive environmental protection legal framework with concrete results. The Air Protection Act in 1975 and its by-laws regulated standards for emissions and permissible concentrations,

---

62 Idem: Zelena knjiga, pp. 299–300.

63 Ibidem, p. 300.

64 PEČENKO, A. – PLANINŠEK, A.: Onesnaženost, pp. 305–306.

65 Polychlorinated biphenyls are one of the most toxic man-made chemicals and are highly carcinogenic.

66 POLAJNAR HORVAT, Katarina: Razvoj okoljske miselnosti v Sloveniji. *Geografski vestnik* 81, 2009, no. 2, pp. 71–81.

with a stringency that corresponded with Western European standards. New regulations enabled the first phase of remediation in the period 1978–1988, during which the biggest polluters in places with critical air pollution implemented measures to reduce emissions. The zinc plant in Celje by 1986 reduced SO_2 emissions by 47 %, and the Jesenice ironworks by 40 %. After the air protection decrees tightened in 1988 and 1990, a second phase of rehabilitation took place. Larger cities, which were in the most polluted group, banned the use-, and sale of fuels with a higher sulfur content through special legal acts. By 1992 the Šoštanj Thermal Power Plant, Slovenia's biggest SO_2 emitter, decreased emissions by 20 % through ecological remediation with desulfurization.

However, in 1988, with 131 kg of harmful sulfur dioxide per inhabitant, air in Slovenia still ranked as one of the most polluted among European countries. Compared to Slovene SO_2 emissions, the precipitation in Slovenia then contained 2.5 times more sulfur. Non-anthropogenic factors seemed to play a decisive role in maintaining the unfavorable air pollution situation in Slovenia. The dissection of the relief with many deep alpine and pre-alpine basins and valleys, which have a low self-cleaning capacity due to poor ventilation as well as temperature inversion in winter and the unfavorable location in terms of transboundary transmission of air pollution, jointly contributed to the high concentration of SO_2 in the air in many Slovene cities and localities.

Bibliography

Online sources

KLIMONT, Zbigniew et al.: *Emissions of Air Pollutants in the Region of the Central European Initiative – 1988*. Laxenburg 1993. Online, cited on 30 October 2022, accessible at https://pure.iiasa.ac.at/id/eprint/3736/1/SR-93-003.pdf.

MAZURSKI, Krzysztof R. : Communism and the Environment. *Forum for the Applied Research and Public Policy* 5, 1991, no. 4, pp. 39–44. Online, cited on 12 December 2022, accessible at http://www.mazurski.tomy.webd.pl/krm/files/Communism_and_the_Environment.pdf.

VOUK, Velimir B. – FUGAŠ, Mirka: *A Short Review of Clean Air Problems in Yugoslavia*. Geneva 1963. Online, cited on 23 April 2023, accessible at https://apps.who.int/iris/bitstream/handle/10665/326338/WHO-AP-10-eng.pdf?sequence=1&isAllowed=y.

Literature

BERIČ, Karel: Dvajsetletni razvoj industrijske proizvodnje SR Slovenije. *Prikazi in študije* 7–8, 1965, pp. 1–29.

BRAIN, Stephen – PÁL, Viktor (eds.): *Environmentalism under Authoritarian Regimes : Myth, Propaganda, Reality*. London 2019.

BRGLEZ, Franček (ed.): *Družbeni razvoj Slovenije 1947–1972*. Ljubljana 1974.

BUSSIÈRE, Jane (ed.): Environmental Policy in Yugoslavia. *The OECD Observer* 142, 1986, no. 5, pp. 31–33.

CHIRAS, Daniel: *Environmental Science : A Framework for Decision Making*. Menlo Park 1988.

DUPUY, Michel: Retention of Sulfur Dioxide Emission in the GDR : Between Technology, Economics, Diplomacy, and Public Opinion. In: BRAIN, Stephen – PÁL, Viktor (eds.): *Environmentalism under Authoritarian Regimes : Myth, Propaganda, Reality*. London 2019, pp. 162–179.

EHRHARDT, Hendrik: Keeping the Air Clean? : Environmental Policy, Utility Companies, and Social Movements in West Germany since the 1970s. In: MIGNON KIRCHHOF, Astrid – McNEILL, John R. (eds.): *Nature and the Iron Curtain : Environmental Policy and Social Movements in Communist and Capitalist Countries 1945–1990*. Pittsburgh 2019, pp. 73–86.

ELSOM, Derek M.: *Atmospheric Pollution : A Global Problem*. Oxford – Cambridge 1992.

HRČEK, Dušan: Onesnaženost zraka v Sloveniji : Stanje in usmeritve za izboljšanje. In: LAH, Avguštin (ed.): *Okolje v Sloveniji : zbornik*. Ljubljana 1994, pp. 345–355.

HRČEK, Dušan: Zelena knjiga o ogroženosti okolja v Sloveniji. In: LAH, Avguštin (ed.): *Slovenija 88 : Okolje in razvoj : zbornik*. Ljubljana 1989, pp. 297–304.

KABALA, Stanley J.: Economic Growth and the Environment in Yugoslavia : An Overview. *Ambio* 17, 1988, no. 5, pp. 323–329.

KROMM, David E.: Response to Air Pollution in Ljubljana, Yugoslavia. *Annals of the Association of American Geographers* 63, 1973, no. 2, pp. 208–217.
LAZAR, Reinhold – KAUFMAN, Viktor – BUCHROOITHNER, Manfred: *Stadtklimaanalyse Graz*. Graz 1994.
LIČINA RAMIĆ, Aida: Od ekološke katastrofe do olimpijskog grada : Sarajevo 1971–1984. In: DURANOVIĆ, Amir (ed.): *Poplava, zemljotres, smog : Prilozi ekohistoriji Bosne i Hercegovine u 20. stoljeću*. Sarajevo 2017, pp. 115–147.
MIGNON KIRCHHOF, Astrid – McNEILL, John R. (eds.): *Nature and the Iron Curtain : Environmental Policy and Social Movements in Communist and Capitalist Countries 1945–1990*. Pittsburgh 2019.
MOSLEY, Stephen: Environmental History of Air Pollution and Protection. In: AGNOLETTI, Mauro – NERI SERMERI, Simone (eds.): *The Basic Environmental History*. Florence 2014, pp. 143–169.
OSET, Željko: Environmental Activism During Communist Era in Slovenia. *Review of Croatian History = Revue für kroatische Geschichte = Revue d'histoire croate* 15, 2019, no. 1, pp. 63–79.
OŠTRIĆ, Zoran: Ekološki pokreti u Jugoslaviji : Građa za proučavanje razdoblja 1971–1991. *Socijalna ekologija* 1, 1992, no. 1, pp. 83–104.
PÁL, Viktor: Like Industrious Bees : Paper Waste and Recycling in Communist Hungary, 1950–1990. *Environmental History* 28, 2023, no. 2, pp. 335–360.
PÁL, Viktor: *Technology and the Environment in State-Socialist Hungary : An Economic History*. London 2017.
PÁL, Viktor: Toward Socialist Environmentalism? : Scientists and Environmental Change in Modern Hungary. *Environment and History* 29, 2023, no. 2, pp. 239–259.
PARADIŽ, Bojan: Posledice onesnaževanja zraka v lokalnih in planetarnih razsežnostih. In: LAH, Avguštin (ed.): *Okolje v Sloveniji : zbornik*. Ljubljana 1994, pp. 330–345.
PARADIŽ, Bojan: Zrak. In: PETERLIN, Stane (ed.): *Zelena knjiga o ogroženosti okolja v Sloveniji*. Ljubljana 1972, pp. 55–79.
PEČENKO, Andrej – PLANINŠEK, Anton: Onesnaženost zraka z SO_2 v zadnjih dvanajstih letih. In: LAH, Avguštin (ed.): *Slovenija 88 : Okolje in razvoj : zbornik*. Ljubljana 1989, pp. 305–308.
PETERLIN, Stane: Zelena knjiga o ogroženosti okolja v Sloveniji : Spomini na izid pred štiridesetimi leti. *Proteus* 74, 2012, no. 9–10, pp. 462–464.
PETRIČ, Hrvoje: About Environmental Policy in Socialist Yugoslavia. In: MIGNON KIRCHHOF, Astrid – McNEILL, John R. (eds.): *Nature and the Iron Curtain : Environmental policy and Social Movement in Communist and Capitalist Countries 1945–1990*. Pittsburgh 2019, pp. 169–178.
PLUT, Dušan: Industrija in degradacija okolja v Sloveniji. *Geographica Slovenica* 18, 1978, pp. 85–102.
PLUT, Dušan: Naravnogeografski vidiki degradacije okolja in razvoja v SR Sloveniji. In: LAH, Avguštin (ed.): *Slovenija 88 : Okolje in razvoj : zbornik*. Ljubljana 1989, pp. 61–81.
PLUT, Dušan: Onesnaženje in prostorski razvoj Slovenije. In: PLUT, Dušan (ed.): *Geografija in aktualna vprašanja prostorskega razvoja : 70 let geografije na ljubljanski univerzi = Geography and Current Questions of Spatial Development : 70th Anniversary Year of Geography at the University of Ljubljana*. Ljubljana 1989, pp. 174–184.
POLAJNAR HORVAT, Katarina: Razvoj okoljske miselnosti v Sloveniji. *Geografski vestnik* 81, 2009, no. 2, pp. 71–81.
PRINČIČ, Jože: *Kapitalna, ključna kapitalna in temeljna investicijska izgradnja v Sloveniji 1945–1956*. Novo mesto 1992.
RADINJA, Darko. Pokrajinske razsežnosti in značilnosti industrializacijske onesnaženosti v Sloveniji. In: *Geografski problemi življenjskega okolja = Geographical Problems of Human Environment*. Ljubljana 1979, pp. 75–83.
RADINJA, Darko: O tehnogenem kroženju žvepla v pokrajinskem okolju SR Slovenije in njegovi bilanci : Prispevek k vprašanju zakisanosti naših padavin in okolja sploh. *Geografski vestnik : Časopis za geografijo in sorodne vede = Geographical Bulletin : Bulletin for Geography and Related Sciences = Bulletin géographique : Bulletin pour géographie et sciences associées* 60, 1988, pp. 3–19.
RAVBAR, Marjan et al.: *Zasnova poselitve v Sloveniji*. Ljubljana 1995.
RENDLA, Marta: *"Kam ploveš standard?" : Življenjska raven in socializem*. Ljubljana 2018.
Statistički godišnjak Jugoslavije 1989. Beograd 1989.
Statistički godišnjak Jugoslavije 1990. Beograd 1990.
ŠPES, Metka: Kaj vemo o onesnaževanju zraka?. *Geografski obzornik : Časopis za geografsko vzgojo in izobraževanje = Geographical Horizon : Newspaper for Geographical Teaching and Education* 40, 1993, no. 2, pp. 10–16.
ŠPES, Metka: Vpliv lokalnih virov emisij in čezmejnega zraka na kakovost okolja v Alpskem ekosistemu Slovenije. In: GOSAR, Anton (ed.): *Sonaravni razvoj v slovenskih Alpah in sosedstvu = Sustainable Development in the Slovene Alps and its Neighbouring Regions*. Ljubljana 1999.

VRIŠER, Igor: *Industrializacija Slovenije*. Ljubljana 1977.
VRIŠER, Igor: Razvoj industrije v Sloveniji. *Geografski vestnik* 48, 1976, pp. 29–45.
ZVOSEC, Christine L.: Environmental Deterioration in Eastern Europe. *World Affairs* 147, 1984, no. 2, pp. 97–126.

Summary

Air Pollution in Slovenia in Socialist Yugoslavia

Slovenia experienced rapid industrial and economic growth after World War II. Industrial production increased tenfold in the period 1939–1972, and Slovenia's economic growth rate in 1953–1972 was among the highest in the world. At the same time, serious environmental problems emerged. With the release of 131 kg of SO_2 per inhabitant in the air, Slovenia was among the most polluted areas in Europe in 1988. Slovenia contributed significantly to sulfur emissions, producing 98 kg of SO_2 per capita in the early 1990s. Out of these emissions, 78 % came from thermal power plants. Gradually, Slovenia has also established a relatively progressive environmental protection legal framework and by the end of the 1980s, average annual SO_2 emissions in the most polluted Slovene cities had decreased by 100–200 % compared to the early 1970s. Even at the end of 1980s, the environment in Slovenia as a whole, and in some areas in particular, was more degraded than it would have been expected given the pollutant emissions. This was primarily due to the particular geographic characteristics of Slovenia – the dissection of the relief with many deep alpine and pre-alpine basins and valleys, which have little self-purifying capacity due to poor ventilation and temperature inversion in winter. Slovenia is also characterized by its unfavorable position in terms of transboundary transmission of air pollution. It receives, transforms and releases harmful substance and energy inflows and outflows, e.g. polluted air masses and polluted water.