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ENVIRONMENTAL POLICY AND TECHNOLOGY PROJECT

Relative Risk Managment Assessment
Novokuznetsk Project

by

Steffen Plehn

Project Manager
Novokuznetsk Project

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RELATIVE RISK MANAGEMENT ASSESSMENT

Novokuznetsk Subproject

I. Introduction

Under Task 2 of the Novokuznetsk (NVK) component of Delivery Order 10, the contractor is to carry out a relative risk management assessment.

As background, a major focus of the NVK Subproject is directed at the goal of improving public health by reducing disease related to air pollution and drinking water. The judgement that these create the primary health risks in NVK was reached during the Planning Team visit in April 1994. The Work Plan was developed on that basis.

USAID wishes to have assurance that air pollution and drinking water are in fact the appropriate focus of the pollution-related health component of the NVK Subproject. During the development of Delivery Order 10 during the fall of 1994, USAID proposed that risk assessment specialists from HIID, assisted by Russian specialists, undertake a significant examination of relative risks. A task involving extensive data gathering in Novokuznetsk was proposed under Task 2 of the draft Delivery Order.

Subsequently, it became evident that there were insufficient resources available in Delivery Order 10 to fund the various activities proposed to be undertaken in NVK. Therefore the resources for the relative risk assessment under Task 2 were reduced to 0.5 person-months, and a more limited scope of work was agreed upon. Under the new scope, the assessment was to be carried out by the Novokuznetsk Manager, the Task Managers and Russian counterparts. The objective of the relative risk assessment was for the contractor to use its best professional judgement to confirm or adjust the program so that it is directed at the high-priority pollution related health risks. Specifically, the question to be addressed during the assessment was whether extensive air pollution and inadequately treated drinking water are the appropriate targets for the EPT Project in NVK.

II Methodology

The methodology for the assessment was determined by the level of resources available for the task.

1. The first step is to set forth the reasoning following by the Planning Team in selecting extensive air pollution and inadequately treated drinking water as the targets of the EPT Subproject.

2. The second step is to analyze whether subsequent data confirms or contradicts this selection. The sources of data used in the relative risk assessment are:

- "Novokuznetsk: Environmental Situation and Environmental Protection Measures", 1993. (Attachment 1) This document is the Executive Summary of a multi-volume study developed by the City Administration. (It was also known as the Local Environmental Action Plan, or LEAP). Only the Executive Summary has been translated.

- "Environmental Pollution and Population: Health in Russia; Analytic report N 4; Western Siberia - Kemerovo, Omsk, Tomsk, and Tyumen Regions", 1994. (Attachment 2) This paper was prepared by E. Gurvich and B. Revich in Moscow. E. Gurvich is an environmental health consultant to USAID/Moscow.

- "The Impact of Air and Water Pollution on Public Health Indicators in Novokuznetsk City, Kemerovo Oblast", 1995. (Attachment 3) This paper was prepared by Dr. Richard Day of the Department of Biostatistics of the University of Pittsburgh expressly for this assessment. Dr. Day has been working with health officials in NVK since 1993. He is the U.S. analyst for the Working Group on Public Health under the Novokuznetsk 2010 program, and he also designed and is managing the development by Russian specialists in NVK of the public health baseline for the NVK Subproject. His paper draws on data being developed for that baseline.

- "Environmental Action Programme for Central and Eastern Europe", 1994. (Attachment 4) This is an abridged version of the document endorsed by the Ministerial Conference in Lucerne, Switzerland on April 28-30, 1993.

All data specific to Novokuznetsk were developed by Russian technical specialists. None of that data have been critically reviewed by U.S. specialists.

III Structure of the Assessment

The assessment has three parts:

- Section IV -- Planning Team's Analysis -- describes the process through which air pollution and drinking water were selected during the visit of the Planning Team in April 1994.

- Section V -- Subsequent Data -- presents subsequent data that bear on the validity of the selection.

- Section VI -- Conclusions -- sets forth the results of the relative risk assessment

IV Planning Team's Analysis

This section first describes the background data available to the team prior to its visit. It then explains, first for air pollution and then for drinking water, the additional information that was

developed during the visit to NVK, and the reasoning process that was followed in making the judgement that air pollution and drinking water represent the most serious environmental health risks.

A. Background data

The Planning Team was fortunate to have an English translation of the Executive Summary of "Novokuznetsk: Environmental Situation and Environmental Protection Measures", a major environmental report developed by a team of specialists in Novokuznetsk and released during 1993. (Attachment 1) This document provides a useful overview of environmental conditions in the city. From this document the Planning Team learned that Novokuznetsk had been named as one of Russia's 84 most polluted cities (page 15), and also obtained insights into particular issues:

- **Air:** A table presents data showing that particulates (dust) and nitrogen oxides were the most serious bulk pollutants, and isopropyl and benzopyrene were the most serious toxic pollutants, with average concentrations ranging from 12 to 100 "percent higher than acceptable" (page 15). Another table shows that the major enterprises are the major emitters of bulk and toxic pollutants (page 16).

- **Water:** The Tom River and its tributaries are identified as the most polluted in south Western Siberia. The main polluters of groundwater are the city trash dump and sludge collecting enterprises. Pollution downstream of the city is getting worse because of untreated discharges (page 17). The condition of the city's potable water system "cannot be called comfortable" as 30 percent comes from stations where it is impossible to locate sanitary protection zones, and the system of water purification "does not guarantee the necessary level of purity" (page 18).

- **Soil:** The report points out that chemical pollution of soil is an important consequence of air pollution in Novokuznetsk. A table shows that heavy metal concentrations have increased significantly since 1987 (page 18).

A section on children's health cites a variety of negative effects from pollution. Information on workers' health also shows major pollution impacts (page 22-23).

The report also contains data on environmental impacts on public health. It cites "a frightening growth of intestinal diseases in Novokuznetsk", with the main routes of transmission through water and food. The water intake areas on the Tom River have a bacteria content of from 10 to 100 million intestinal bacillli (including pathogenic and conditionally pathogenic bacilli) per milliliter. The city landfills are "open waste storage plots", and pathogens of typhoid, dysentery and other diseases have been discovered in the area. Sewage waste discharge exceeds 300,000 cubic meters per day, with inadequate treatment and no chlorination (page 20-21). Various studies of the impact of air pollution are mentioned. Health impacts on the bronchial-lung system of educational and trade personnel

are cited, as well as the increase in cardiovascular and respiratory problems during periods of high air pollution levels. (page 22). Impacts of workplace exposures are also discussed (page 23).

B. Air Pollution

The Planning Team encountered air pollution on arriving at the outskirts of NVK, and it was a part of the daily existence thereafter. In all directions one sees stacks and plumes. The air pollution is worsened by the topography (hills that surround the city) and meteorology (inversions and still air). We experienced an inversion on one of our first days (we were told these occur approximately 100 days a year, mostly in cold weather), and visibility became minimal.

An important fact about air pollution is that it affects all residents of the city. Data indicates that some neighborhoods are more heavily impacted, but all citizens are exposed to it.

Accordingly, we were never in doubt that air pollution constituted the major risk to health in NVK. The important question was what aspect of the air pollution problem should be addressed in order to have the most impact within the resources and time-frame of the EPT Project.

The data from the environmental report showed that the major enterprises are the major air pollution sources. The two steel complexes (KMK and ZapSib) plus the ferro-alloy and aluminum plants produce nearly 65 percent of the particulates, 83 percent of the carbon monoxide, and 39 percent of the nitrogen oxides. The report also states that the enterprises are the major emitters of chemical pollution since they are the primary sources of poli-cycled aromatic carbon hydrides.

During the course of the visit, however, we came to the conclusion that the major enterprises should not be the major focus of the EPT air pollution reduction effort, for three reasons:

- First, air pollution emissions from the major enterprises are for the most part discharged from tall stacks. That means that the primary health impact occurs downwind, away from NVK.

- Second, reductions in air pollution emissions from these major industrial facilities will only come about when investment capital is secured to modernize their production processes (or, conversely, when the facilities go bankrupt and are forced to close down). Without significant outside investment, the enterprises will not have capital (or will not chose to invest available capital) for environmental improvement; if outside investment does permit modernization, more advanced production facilities will be inherently less polluting.

- Third, resources available to EPT are insufficient to facilitate any significant change in air emissions from the enterprises.

The Planning Team decided instead that the EPT effort should focus on the 160 coal-fired boilers scattered throughout the city. These boilers served as district heating plants and as sources of heat or steam for hospitals, factories, laundries, bathhouses, and schools. The City Administration and others drew our attention to these boilers because most were old and lacked effective air pollution control equipment, most burned the least expensive (powdered) coal, and the releases of particulates were through low stacks located in and near residential areas. Importantly, resources available to EPT clearly had the potential to have an immediate impact in reducing the health impacts from these boilers.

Even though the Planning Team did not include an air pollution specialist, the group was clear from the data and its own experience that air pollution had to be a focus of the health risks component of the NVK project. The Planning Team concluded that the combination of extensive pollution emissions on the one hand and the exposure of the entire city population on the other made air pollution a priority target for EPT attention. Further, the team could see that the 160 boilers had a disproportionate impact on public health, and that the resources available to EPT were sufficient to bring about measurable improvement in one or more ways: substitution of coal bed methane for coal; utilization of higher quality coal; briquetting; increased energy efficiency; or improved air pollution control.

The team recommended that an air pollution planning team should visit NVK during the summer to develop a fuller understanding of the boiler issue and develop a strategy to address it, and that recommendation was subsequently accepted and implemented.

C. Drinking Water

In addition to the report on the environmental situation, the Planning Team had received helpful information developed by an environmental team from Pittsburgh on the drinking water treatment system in NVK. Their report identified some important issues, including questions about the filter media and chlorination practices at the city's water treatment plants.

Randy Hoffman, the drinking water specialist, met with representatives of Vodokanal and city and oblast regulatory agencies and visited several of the city's treatment facilities.
His most significant health finding was that drinking water treatment in NVK generally removes only about 80 percent of the bacteria and pathogens. This compares to Western removal rates of over 99 percent. As a result, all residents of NVK routinely receive unhealthy water in apartments and houses.

The reasons for the low level of treatment are many. The drinking water source, the Tom River, is heavily polluted. The treatment processes are uncontrolled. The filtration and chlorination practices are questionable. The distribution system has a leakage rate of 40 percent.

What was encouraging was that many of these deficiencies could be significantly improved with the resources available to EPT by providing laboratory equipment, computer hardware and software, technical assistance, and training. The Planning Team therefore concluded that health risks from drinking water should be the second focus.

D. Other environmental risks

The Planning Team considered other environmental issues in NVK, but concluded that the nature of the health risks and especially the number of people exposed to these risks were less significant than those represented by air pollution and drinking water:

- Solid waste is disposed of in an open dump on the bank of the Tom River. Toxic chemicals from the dump leach or run off into the river. This is clearly an undesirable practice. However, the health risks presented by the dump have limited effect on NVK residents.

- The wastewater treatment plant is overloaded. Its treatment technologies are fairly archaic. The effluent is not chlorinated. But again, the health risks presented by the plant have limited effect on NVK residents.

- Ground water in NVK receives pollution from a variety of industrial operations, and particularly from the open solid waste dump and hazardous industrial waste piles. Ground water is not currently used as a drinking water source, so there are at present limited health risks created by contaminated ground water.

- Soil in NVK is heavily contaminated by fallout of heavy metals and other contaminants from air pollution. A limited amount of food is grown within the city boundaries. Again, this is a serious problem, but the number of people exposed are limited.

The Planning Team concluded that each of these environmental issues is serious, but exposure to these risks is limited as compared to air pollution and drinking water.

V. Subsequent Data

Since the Planning Team visit in April 1994, additional data on air and drinking water issues in NVK has been obtained.

A. Gurvich/Revich Paper

The Gurvich/Revich paper deals only with air pollution issues:

- Tables present air pollution emissions for 1991 and average annual concentrations of pollutants in ambient air from 1982 to 1992. (pages 12 and 13) Emissions of particulates (dust) declined from 138.7 to 124.6 tons, no doubt as a result of decreased production. (We have learned that there is no emission monitoring in NVK. Estimates of emissions are based on engineering calculations. All data on air pollution emissions are probably understated since

the calculations assume that air pollution equipment is operating at design capabilities.) Table of ambient concentrations shows declines beginning in 1990, again from reductions in production.

- Table 7 (page 14) shows that for particulates (dust), 81.7 percent of 7200 air samples exceeded the MAC (maximal allowable concentration). There is also data showing that concentrations of benzpyrene are very high.

- Table 9 (page 16) presents data on pollution concentrations in different parts of the city. A study has shown that residents of an intensely polluted district (southwest) has 2.1 and 2.7 times higher occurrence of respiratory diseases and disorders of skin and subcutaneous fat than a less polluted district.

- Data on health effects of pollution on children and adults can be found on pages 16-19.

B. Day paper

The focus of the Day paper is on the collected evidence for a significant impact of current levels of air and water pollution on the public health of NVK residents and the operation of the city's health delivery system. The paper is based on an exploratory investigation of available health statistics maintained by several public health agencies in NVK. On page 2, Dr. Day cites various methodological issues inherent in this data.

B.1 Air-related respiratory data

Figure 2 compares the mortality of children under 5 from non-malignant respiratory disease in NVK and the U.S. The table shows an overall drop in the NVK rate of about 580% between 1960 and 1990, but the NVK mortality rates continue to exceed U.S. rates by about 6 to 10 times.

Figure 3 shows that air-related respiratory complaints (i.e., acute respiratory distress, pneumonia, bronchitis, and bronchial asthma) account for about 55-60 percent of all childhood cases handled at the local polyclinics. Figure 4 shows that 30-35 percent of treated cases of adults are also air-related respiratory complaints. Accordingly, respiratory symptoms in adults and children are the category of illness most frequently treated by physicians in NVK.

Day cites studies (page 8) that show that morbidity rates among children were closely connected to air pollution levels; that in the most polluted districts, rates of respiratory disorders were 2.1 times higher and rates of skin disorders 2.7 time higher than among children in cleaner districts; that air pollution was found to have the greatest effect on children less than seven years of age; and that rates of allergies in children were found to be 4.2-5.6 times higher in the most polluted districts. The air pollution agents found to provoke the greatest adverse effects were dust, sulphurous anhydride, and sulfuric acid.

For adult populations, non-specific pulmonary pathology was found to be 1.58 percent greater in the most polluted districts than in the least polluted districts. In the most polluted districts, the three major categories were chronic bronchitis (33 percent), pneumonia (25 percent), and bronchial asthma and acute bronchitis (42 percent).

Day also concludes that treated rates of respiratory disorders are likely to be only a small portion of the problem in NVK because of the continuing decline in the capacity of the medical system and its current transitional state resulting from the introduction of new health insurance legislation.

B.2 Water-related gastrointestinal disorders

The frequency of gastrointestinal complaints is approximately 25 percent of the frequency of respiratory complaints among both children and adults. However, the frequency of gastrointestinal complaints have tended to increase in the years since 1990. (Page 4)

The vast majority of treated complaints for symptoms related to water and food borne exposures were for acute intestinal infections and dysentery. The increase since 1992 suggest a growing difficulty with everyday drinking water supplies and point to the possibility of a much larger, undocumented increase in rates of untreated cases over the same period. (Page 4)

Records also indicate a steady increase (5.6% to 8.8%) since 1992 in the proportion of non-standard samples found in the water samples taken from the local water mains. (Page 4)

C. Environmental Action Programme of the Ministerial Conference

In the chapter on "How to set Priorities", airborne dust is cited as one of the three most important environmental causes of health problems. Sources cited include household coal burners, power and heat plants, and metallurgical industries. (Page 7)

The report cites large and growing body of scientific evidence that fine particle air pollution causes serious health damage and significantly raises the risk of death. A longitudinal study of over 8,000 adults concludes that mortality is most strongly associated with air pollution with fine particles. (Page 7)

Pages 8-11 focus on air pollution from stationary sources. Major relevant points are:

- "Air pollution is potentially the most serious short-to-medium term environmental problem for human health.... Treating air pollution should be the top priority for environmental policy." (page 8)

- "A principle cause of urban air pollution in Central and Eastern Europe is the heavy reliance of households and small enterprises upon poor-quality coal. Smoke and soot from low chimneys (or "stacks") are especially harmful to health." (page 10)

Page 12 discusses municipal water supply. The report finds that in most CEE counties drinking water is treated adequately to prevent large outbreaks of infectious diseases, but if "the combination of inadequate supply and patchy treatment persists, increasing amounts of investment may be required to ensure the availability of acceptable drinking water."

VI Conclusions

There can be no question that air pollution constitutes the major environmental risk to public health in NVK. The support for this conclusion is overwhelming.

The case for drinking water is less strong but is still compelling in comparison to other environmental risks:

- first, all residents of NVK are exposed to drinking water. The other environmental risks effect only a relatively small proportion of the population.

- second, it is clear that the NVK drinking water is often unhealthy, and cases in which people seek treatment for gastrointestinal disorders are on the rise. (It is very likely that many others are incapacitated but never seek medical assistance.)

- third, the drinking water task, by concentrating on improvements that can be achieved through laboratory equipment, computer hardware and software, technical assistance, and training, has the potential of significantly improving drinking water quality fairly rapidly. Furthermore, the improvements can readily be extended to other drinking water systems in Siberia.

Accordingly, the assessment establishes that the current focus on air pollution and drinking water is sound.

ATTACHMENT 1

RUSSIAN-AMERICAN JOINT VENTURE "EVRICOM"

LOCAL BRANCH "EVRICOM-KUZBASS"

NOVOKUZNETSK: ENVIRONMENTAL SITUATION AND ENVIRONMENTAL PROTECTION MEASURES

Notes and Explanations

Director, "Evricom-Kuzbass"	Anatoly V. Pintov
Main Editor	Boris N. Kolesnikov
Author	Alexander G.Mirolyubov
Translators	Mark E. Houser
	Yelena E. Shepeleva

Novokuznetsk 1993

Novoilinsk district was about 15 times greater than acceptable. The maximum for ammonium was 10 times higher than acceptable.

The most polluted air is in the Kuznetsk district, where maximum levels of benzopyrene have been up to 48 times greater than acceptable levels, fluorine 2.7 times higher, soot 7 times higher and isopropylene 12 times higher.

Annual amount of dispersed pollutants is shown in Table 3.2.

Table 3.2 -- Gross Annual Dispersion of Pollutants for Certain Enterprises and Percentage of Total for Each Pollutant as of January 1, 1990 (Tons/Year, % of total amount)

Enterprise	Suspended Particles		CO		Sulphur - Anhydride		Nitrogen Oxides	
KMK	26,388	(19.03)	42,930	(6.43)	6066	(6.26)	9802	(19.21)
Abagurskaya (sintering plant)	17,315	(12.48)	159,382	(23.89)	35,398	(36.5)	1799	(3.53)
ZapSib	31,646	(22.81)	334,589	(50.14)	29,194	(30.1)	7660	(15.01)
Ferro-Alloy	2379	(1.71)	--		1051	(1.03)	552	(1.08)
Aluminum	11,566	(8.34)	19,703	(2.95)	658	(0.68)	0.2	(0.0)
Santekhlit	435	(0.32)	706	(0.11)	58.7	(0.06)	0.4	(0.0)
Cement	6220	(4.48)	7.8	(0.0)	197.6	(0.2)	345.1	(0.68)
Coal	3557	(2.58)	514	(0.08)	297	(0.31)	596	(1.17)
ZapSib TEPS	12,165	(8.77)	--		9887	(10.19)	11,758	(23.04)
Kuznetsk TEPS	9122	(6.58)	--		6536	(6.74)	3750	(7.35)
Boilerhouses	13,224	(9.53)	35,982	(5.39)	7154	(7.38)	5230	(10.25)
Furnaces (Heat)	1169	(0.84)	1976	(0.3)	378	(0.39)	176	(0.35)
Transport	215	(0.16)	64,406	(9.65)	--		9249	(18.13)
Other	3319	(2.38)	7090	(1.06)	1053	(1.08)	106	(0.2)
TOTAL	138,720	(100)	667,285	(100)	96,982	(100)	51,024	(100)

Looking at the table, it is obvious that the majority of air pollution in the form of dust, carbon monoxide, sulfur anhydride and nitrogen oxides comes from ZapSib, Abagurskaya, KMK, power stations, and transportation. As far as specific substances, for each one there are corresponding enterprises that emit the given substance and contribute to the general air pollution levels. Exact data are given in Appendix 6.

The leading role in chemical air pollution is played by substances in the poli-cycled aromatic carbon hydrides (CH_4) group, the indicator of which is 3.4 benzopyrene.

The following constitute the largest contributors to

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benzopyrene atmospheric pollution.

-coke production, during coal charge loading and also due to poorly-seated furnaces;

-steel production, from ingot lubricants mixed with pitch and anthracene oil;

-ferro-alloy and aluminum production, because of burn-out of the electrode masses, made of coke and pitch;

-formation of benzopyrene during burning of various types of fuel.

3.2 Water Supply

Novokuznetsk is situated in the basin of the Tom River, the main tributary of the Ob. The Tom and its tributaries are the most polluted rivers in south Western Siberia.

The main polluters are coal industries, ferrous and non-ferrous metallurgy, and residential-communal services (such as sewage, heating, and electricity).

The main polluters of groundwater are the city trash dump, where pollutants filter down from the surface, and sludge collecting enterprises.

The city's current waster consumption is 1,923,550 m^3 a day, of which 367,500 m3 a day is potable water and 1,556,050 m^3 a day is technical water. 190,800 m^3 a day of potable water consumption is for private/residential use, while industry uses 176,700 m^3 a day for production purposes.

The city's current water outflow is 943,070 m^3 a day. Enterprises discharge 623,195 m^3 a day in to reservoirs, storm drains or into the local area using their own outflow pipes. 319,875 m^3 a day flow into water treatment plants, of which 129,075 m3 a day come from city enterprises and 190,800 come from homes.

The imbalance between water consumption and water outflow of 980,480 m^3 a day is result of non-recycled water use at heat plants, and factory circulation systems, and water lost in prepared goods production, street cleaning, and watering parks and gardens.

Analysis of the city's water consumption and outflow systems shows that they are not perfect. There are losses of 13 percent, and the rationality coefficient for the use of water taken from the source by production industries is 0.56. Most small and medium sized enterprises lack a system for water circulation and reuse.

Water quality indexes for the Tom river, downstream from the city, are getting worse in comparison to upstream in terms of chemical oxygen demand, nitrogen, phosphorus, petroleum, phenol, copper (twice as high), hydrochloroclohexon (5-10 times higher). This occurs because the city and individual enterprises lack water purification networks and stations -- for residential, industrial, and storm drainage purposes -- that correspond to the "Laws on Protection of Surface Water from Waste Water Production" in terms of both capacity and purification quality. 943,070 m3 of pollutants enter the Tom river per day in the form of residential and industrial waste water, which is comprised of 25.7 tons of suspended particles, 15.5 tons of biological oxygen 20 demand, 500

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kg of synthetic surface active substances, 64.5 tons of chloride, 13.3 kg of phenol, 24.2 kg of cyanide, 47.1 kg of sulphur cyanide, 40 tons of ammonium nitrogen, 171 kg of formaldehyde, 165.3 kg of methanol, 74.1 kg of acetone, 277 kg of iron, 81 tons of sulfates, 498.8 kg of phosphates, 85.3 kg of fluorine, 16.5 kg of copper, 2.2 tons of calcium, and 8.7 tons of magnesium. Of the 13,760,00 m^3 of surface water pollution each year, 27,520 tons are suspended particles, 275 tons are biological oxygen 20 demand, and 137.6 tons are petroleum products.

Furthermore, the present condition of the city's potable water consumption system cannot be called comfortable, as 30 percent of the city's drinking water demand is met by water receiving stations where it is impossible to organize class 1 and 2 sanitary protection zones, and the system of existing water purification stations does not guarantee the necessary level of purity.

3.3 Soil

Chemical soil pollution is a real consequence of atmospheric pollution by hazardous substances. In Novokuznetsk, more than 800,000 tons/year of this pollution comes from stationary sources, and 75,000 tons come from auto transport.

In 1990 a geochemical survey of the territory of Novokuznetsk was carried out with the goal of locating the main areas of soil pollution. This research revealed areas of increased concentrations of chemical elements. With this in mind, the pollution levels vary widely. For instance, sulphur pollution levels near the agglomeration plant oscillates from 3.3 to 312 times higher than acceptable levels, phosphorous pollution -- from 1.2 times in the Zavodskoy district to 15.7 times near the railway station, fluoride -- from 20 times in the Central district to 300 times near the Organika complex.

Accumulation of heavy metals, especially lead, cadmium, zinc, copper, and chromium in market garden soils, is extremely hazardous. The amount of these metals in market garden soils is given in Table 3.3.

Table 3.3 -- Amount of Heavy Metal in Novokuznetsk Market Garden Soil (mg/kg of soil)

Substance	Range of Concentration	Arithmetic Mean	1987 Ilyn Study Background Conc.	% Increase from Background Conc. (Min-Max/A
Zinc	102-646	323	85.5	119-755/270
Lead	15.5-95.5	26.1	16.4	094-582/155
Cadmium	0.04-3.05	0.23	0.13	030-2346/177
Nickel	17.4-83.2	44.7	25.9	067-321/173
Chromium 3	16.9-166	135.7	58.5	023-284/232

Research of vegetable growing in Novokuznetsk has shown

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evidence of heavy metal accumulation in the edible parts of the vegetables. The majority of pollutants accumulate in the underground root structures of the plants.

As a result, the entire level of soil pollution is classified as either dangerous or extremely dangerous (Appendix 7).

4. NOVOKUZNETSK: ENVIRONMENTAL AND PUBLIC HEALTH

4.1 Demographic Situation

According to the 1989 census, the population of the city of Novokuznetsk is617,000 according to the 1989 census. The breakdown of age groups is typical for a Siberian city and the city has a tendency toward aging. Since 1970, the mortality rate has been constantly rising, which is connected with the population's aging.

Assessing life expectancy dynamics yields the following statistics: in 1970, the average life expectancy in Siberian cities was lower than that in the Russian Soviet Federative Socialist Republic as a whole. However, in Novokuznetsk this index was higher than in other Siberian cities (Barnaul, Krasnoyarsk, Novosibirsk, Omsk and Tyumen) and even higher than the average life expectancy in the RSFSR. From 1970 to 1984 life expectancies in Novokuznetsk, as well as in other Siberian cities, decreased.

Since 1985 the average life expectancy in Siberia has started to increase, but the life expectancy of citizens of Novokuznetsk is still lower than in other regions of Siberia. In the 1970's and the early 1980's, the food supply in Novokuznetsk was better than in other Siberian cities. This period of adequate nourishment played a positive role in increasing the average life span and, to some extent, countered the negative effects of environmental pollution and poor sanitary-hygienic conditions in the workplace. In recent years the food supply has decreased appreciably; this might serve as a reason for the lower life expectancy, but this is only a hypothesis. The rising life expectancy since 1986 has been connected with a decrease in work place injuries and poisonings, both a result of anti-alcohol governmental programs.

In connection with this, some of the most important future plans for raising the average life expectancy are improving food quality and everyday sanitary conditions.

4.2 Epidemiological Situation

Epidemiological situations in the city are chiefly agitated by air and water pollution. In the last 5 years there have been 200,000-250,000 contracted cases of infectious diseases.

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Approximately 57 percent of those cases of infectious diseases that have been diagnosed (at various stages of development) have been cured, at a cost of 30 million rubles, which does not take into consideration lost work hours.

There is a frightening growth of intestinal diseases in Novokuznetsk, including shingles, salmonella, and other severe intestinal diseases. The city districts most severely affected by intestinal disease are the Zavodskoy and Central districts.

Studies on the spread of these diseases show that the main routes are through water and food. The water intake areas on the Tom River have a bacteria content of from 10 to 100 million intestinal bacilli (including pathogenic and conditionally pathogenic bacilli) per milliliter. The most dangerous water receiving stations are the Dragoonsky and Abashevsky because of their proximity to the heated water discharge stations of the Tom-Usinsky power plant. Intestinal bacteria propagate extensively in such warm places. It should be mentioned that the main victims of disease are preschool and elementary school age children. Of the city's 527 public eating establishments, 88 have insufficient sanitary-hygiene conditions in food preparation areas. The establishments with the most serious problems of bacterial contamination are the canteens.

The city itself is considered to be one of the worst regions in the country for pseudo-tuberculosis and irsinius.

As for diseases contracted in the wilderness, the most dangerous are tick encephalitis, tick typhoid (spotted) fever, system tick borellius, leptospirosis, and hydrophobia. The main victims of tick encephalitis are gardeners. During the last five years, the mortality rate from this disease has doubled.

Fifty areas dangerous for leptospirosis have been located near water reservoirs.

4.3 Sanitary Conditions

The unfavorable situation regarding infectious diseases is directly connected with the city's overall sanitary conditions. This is first and foremost related to the problems of unsanitary waste storage. City landfills are open waste storage plots lacking any measures for rendering the waste harmless, utilizing it, treating it, or even plowing it under. Water from rain and melted snow washes the waste away and creates a high level of water and soil bacterial contamination. For this reason, pathogens of typhoid, paratyphus, tuberculosis, dysentery, helminth ova, and Siberian ulcer have been discovered in the area.

City sewage is also a hot point. Sewage waste discharge exceeds 300,000 cubic meters per day, of which 84 percent is biologically treated, 9.8 percent is mechanically treated, and 5.7 percent (17,100 cubic meters per day) is not treated at all. During some periods, the main collectors' capacity is overloaded 200 percent. Additionally, the overload situation is worsened because of industrial and household waste mixing, which decreases the efficiency of biological treatment.

Wastewater in the city water recycling stations is not

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chlorinated. As a result, following treatment the wastewater remains epidemiologically dangerous. The existing local system of storm drainage also fails to meet sanitary regulations and water surface control standards.

Sanitary city conditions depend upon the organization of sanitary defense zones. It is unfortunate that none of the corporations have sanitary zones that meet sanitation standards. Furthermore, within the sanitary defense zones of the KMK there is another form of potentially dangerous production -- the Kuznetsk cement plant. This same problem also exists within the Kuznetsk production quarter, which houses the aluminum plant, the ferro-alloy plant and Kuznetsk TEPS all in one sanitary defense zone.

The organization of the zones include population resettlement and planting trees and gardens on 28 percent of the projected design area. In January 1991, more than 18,000 people lived in sanitary defense zones.

4.4 Radiation Conditions

The measuring of gamma levels both outside and inside public areas and living quarters as well as in the working area of miners showed that annual radiation dosages can be as high as 100 millirentgens. However, this is not higher than the acceptable yearly norm.

The greater danger is from the impact of X-ray radiation due to medical diagnostic procedures. Because of these procedures, a patient receives radiation dosages 3 times higher than natural background levels. The medical establishment needs to change over from these over-used apparatuses, re-equip their X-ray departments, and limit the use of X-rays to areas of clinical interest.

4.5 Electromagnetic Radiation

Unfortunately, as of now there is no precise monitoring of electromagnetic radiation being undertaken within the city borders or in separate working areas. The sanitary-epidemiological services need to obtain necessary electromagnetic field monitoring devices.

4.6 Environmental Pollution and Migration Patterns

Socio-psychological studies of population migration conducted in 1979 revealed that likely factors in the exodus of residents from the city were environmental conditions that created psychological discomfort. It must further noted that environmental conditions were cited more often than professional reasons as incentives for leaving the area. In fact, of the number of people leaving the city due to environmental pollution increased from 28 percent to 41.2 percent in the last 10 years.

A profile of the people leaving the city reveals that they are of working age (25-50 years) with a high educational level and have lived in the city an average of 10 years. This indicates that the high level of environmental pollution is negatively affecting the number of highly qualified working professionals living in the

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city.

4.7 Children's Health

An analysis of physical development of Novokuznetsk children compared to other cities in the region revealed that processes of acceleration and asthenization are typical. A comparative analysis of physical development in the different residential areas of the city shows higher percentages of disproportionate somatic types and extremely pathological variants of development in districts with high air pollution rates. In these districts there are frequent cases of diseases of the ear, nose and throat and central nervous system, hypertension, and hyperplasia of the thyroid glands.

A comparison of the data collected in the AGIS-health system on infant mortality among 150 cities of the former USSR showed the following: children's mortality rates in Novokuznetsk due to blood and hemopoietic organ diseases, eye and ear diseases, mastoid process diseases, malignant tumors, endocrine diseases, and metabolic disorders far exceeds the average rate for cities of the former USSR and the RSFSR, especially for children between the ages of 4 and 6.

The highest mortality rates are the results of ear and eye diseases, mastoid process diseases and respiratory diseases. The mortality rate of children in the Kuznetsk district is especially high -- 22 percent higher than in the Central district.

4.8 Health of the Work Force

A comparative study of illnesses and temporary loss of work capability was conducted among production workers (miners and steel workers) and non-production workers (education and trade). Adverse working conditions, such as unsanitary and unhygienic conditions at the worksite, were considered in determining the health levels of steel workers and miners. Yet none of the data revealed any additional impact of air pollution on the comparison of illness rates with temporary work loss in either of the productive or non-productive worker study populations.

An analysis of illness rates and temporary work loss rates among educational and trade personnel did reveal an impact of air pollution on health. The most unfavorable impact witnessed was connected with the bronchial-lung system. Thus, the health of these 90,000 people is constantly decreasing as a result of high air pollution levels.

A review of data from ambulance records showed that during periods of high air pollution levels, the number of patients with cardiovascular and respiratory problems increased. In addition to this, the population of Novokuznetsk includes a large number of people who qualify for a special dispensary list which entitles them to medication at half cost and regular medical examinations, further reflecting the large scale of air pollution.

Two of the most telling indicators revealing the impact of poor environmental conditions on the population of Novokuznetsk are the level of genetic risk in pregnant women and the overall character of the reproductive process within the city. These

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factors directly speak toward the quality of reproductive conditions.

An analysis of pregnancies ending in miscarriage, spontaneous abortion, and stillbirth, as well as the frequency of congenital malformation indicated that women working at KMK, ZapSib, the Kuznetsk ferro-alloy plant and the Organika complex were especially vulnerable to such problems. These women work in conditions where high levels of chemical pollution and poor conditions of physical surroundings (high temperatures and noise levels, etc) contribute to pregnancy problems. Of chemical pollutants, it has been found that chlorine organic compounds, formaldehyde, chlorobenzol, and various acids and spirits have the most adverse impact on the health and life of the fetus. Stillborn infantsoften had congenital malformations of the central nervous system and urinogenital systems.

The results of cytogenetic research found no significant genetic mutation resulting from air pollution containing technological emissions from Novokuznetsk enterprises but did find an increased cytogenetic effect from steel manufacturing. electrolyzation and blast furnace production. The combination of all this data makes it possible to state that, for the most part, the largest amount of adverse pregnancy outcomes are a result of many complex factors, both internal and external, that might not exist if environmental conditions were more favorable.

4.9 Prioritizing Environmental Factors

In a recent poll, experts were asked to prioritize factors determining the health of a population. Teachers and lecturers from different departments of the Novokuznetsk Institute for Advanced Medical Training (Pediatrics, Hygienics, Occupational Pathology, Obstetrics and Gynecology), specialists from the Institute for Complex Problems of Hygiene and Occupational Diseases of the Siberian Division of the Russian Academy of Medical Sciences, and general practitioners (including specialists for workers, children, and teenagers) were all involved in this poll.

They were given the task to prioritize various factors according to the significance of their effect on different population groups (adults of working age, pensioners, and children of different age groups). The following factors were evaluated:

Sanitary-Hygienic Work Conditions
Air Pollution
Water Quality
Bacterial Factors
Noise Pollution
Radiation
Climatic and Geographical Peculiarities
Quality of Medical Service
Social/Domestic Conditions
Daily Life Routine
Nourishment

The experts' analysis ranked sanitary-hygenic work conditions as the factor most adversly affecting the adult population, and nourishment as the factor most adversly affecting children.

5. MAIN AREAS OF ENVIRONMENTAL CONSERVATION

5.1 General Position

The current poor condition of Novokuznetsk's environmental surroundings is a result of years of irrational development of all elements of the economic complex, including defects in the city's layout, intensive industrial development without the necessary amount of environmental defense measures, poor condition of the transportation network and weak city maintenance, and irrational fuel-energy resource usage.

This work has determined a set of measures for industry, heating and energy, transportation, construction, water and electric supplies, etc., that would guarantee strict limitations on production that pollutes the environment and would allow enterprises to meet a permissible level of waste output, therefore improving the quality of the city's environment.

In accordance with this, the following constitute the main trends of environmental protection activity.

5.2 Air Pollution Control

Structural changes for industry directed toward reducing material and energy losses and corresponding high level of waste discharge during the production process are being considered or are already being enacted. Such measures include KMK upgrading its steel production by replacing the Marten process with converters and uninterrupted casting of all steel at KMK and ZapSib. This will make it possible to reduce the relative outlay of steel for rolled steel production by 10-15 percent. Correspondingly, at ZapSib it will no longer be necessary to set aside 1.9 million tons of semi-processed metal per year, and at KMK a plan to reduce fully-processed steel output is being considered. Also being considered is a plan to reduce the production of steel, iron, and sinter and remove from operation a corresponding part of the main machinery. These transformations are laid out in the appendices.

The aluminum plant is considering closing electrolyzing corpuses Nos. 5-6 and anode mass station No. 1 and switching over corpuses Nos. 7-8 to produce secondary aluminum.

At the cement factory, the sludge granulization installation is being closed and the burnout, drying, and grinding situations and clinker storehouse are undergoing reconstruction.

Additional trends in reducing air pollution include:

-- centralization of heating to eliminate some of the small boilerhouses; for the remaining boilerhouses, plans for sorting coal and building coal briquetting stations are under consideration;

-- switching over automotive transport to natural gas, introducing transport with electric motors, rebuilding roads, constructing highways and around cities;

-- creating sanitary-defense zones and removing housing from these zones, planting trees and shrubs along roads to serve as a buffer between sidewalks and roads;

-- reducing the relative atmospheric pollution levels by constructing highly-effective particle and gas cleaners;

-- creating an atmospheric monitoring system.

The largest and the most effective systems for environmental protection are presented in Appendices 8-20.

As a result of the above measures, the total amount of pollution from all sources is shrinking, ensuring the eventual achievement of sanitary norms for the atmosphere. The amount of pollution created by certain enterprises is given in Appendix 6.

5.3 Water Pollution Control

An orientative analysis of the projected condition of the city's water supply and outflow system for the years 1993-2000, which was based on questionnaire data about enterprise development and growth and on figures assuming a population growth to 800,000, indicates that the city has the ability to carry out more modern work on these systems. For this it will be necessary to put into effect a number of scientifically-based recommendations that would make it possible to use industrial and surface waste water that has been purified to sanitary norms for enterprises' industrial water supply without infringing on technological production processes, or to use it for solving other problems connected with protecting the city water supply. The use of 83,000 m^3 per day of purified surface waste water would permit a considerable reduction in industrial demand for river water. ZapSib might similarly use 50,000-200,000 m^3 a day of waste water cleaned at city water purification facilities after the year 2000.

Given space limitations for placing water purification facilities, it is necessary to consider the question of allotting land near the Sidrovsky collective farm for constructing Phase III purification facilities.

In order to improve the city's ecological situation by 1995, the "Plan for Environmental Protection Measures for Novokuznetsk" proposes that the majority of enterprises discharging their waste water into the city purification system and those enterprises possessing independent outlets into reservoirs provide for local facilities to purify their waste water to the maximum allowable

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concentration for fish-sustaining water or to concentration levels that allow their organic production waste
water to be purified to sanitary norms at city facilities. Additionally it is necessary to build a network of storm drains and purification facilities to clean the yearly rain runoff to maximum available concentration for fish-sustaining water both for the city and for enterprises, by 1995.

By 1995 it will also be necessary to close a number of water receiving and purifying stations throughout the city which do not have sanitary protection zones. In order to make up for the shortage, the Dragoonsky ladle-pump receiving station will be expanded and ozonized for potable water preparation. This will make it possible to eliminate viral, bacteriological, and difficult-to-oxidize organic water pollution and to reduce the formation of volatile chlorine organic compounds, which present cancer and mutation risks, by 90 percent.

To guarantee the reliability of the water supply, it is being proposed that existing reservoir complexes and pumping stations be repaired and new ones be constructed and that 231 km of primary water mains be built, all by the year 2000.

Additionally, it is necessary to put the following planned measures into effect:

-- creation of a Phase II city sewer system with a daily capacity of 380,000 m^3;

-- limitation of timber transport on the rivers;

-- enacting of measures for surface water protection against river transport;

-- creation of an automatic quality control system to monitor water sources and waste water.

Given the enactment of the above measures, the completion of construction of a Phase II city sewer system, and increased effectiveness in removing nitrates and phosphates at city purification stations, etc., the amount of waste water pollutants discharged into the city water supply will be reduced according to the data in Table 5.1.

Table 5.1 -- Amount of Pollutants Discharged in City Water Supply Following Enactment of Measures

Pollutant	1993 Amount Discharged	1993 Reduction City Stations	1993 Reduction Local Stations	2000 Amount Discharged	2000 Reduction City Stations	2000 Reduction Lo Sta
(tons/day)						
Suspended Particles	2.77	91.16	14.39	2.63	90.65	
Biological Oxygen$_{20}$ Demand	2.57	104.4	3.08	2.52	103.9	
Petroleum Products	10.62	1609.55	312.34	4.6	11.0	3
Sulphates	50.8	30.4	35.9	48.1	21.6	
Chlorides	47.3	27.7	34.1	67.6	.66	
Nitrates	1.0	17.57	837.6	.93	77.3	
Nitrogen Ammonium Salts	7.6	14.9	42.6	.418	22.04	4
Magnesium	3.0	.2	--	1.808	.645	
Calcium	11.6	.86	--	6.924	2.461	3
(kg/day)						
Phenols	.28	66.41	1.03	.23	66.3	
Fluorene	37.0	1.4	64.3	26.2	3.1	
Methanol	14.4	2987.8	--	16.74	2985.4	
Iron	2.5	1131.5	145.8	2.3	1131.5	1
Acetone	.32	2306.31	--	.34	2306.3	
Copper	.46	45.11	18.81	1.0	44.5	
Sulfur Cyanide	6.1	145.4	3.8	3.1	147.3	
Formaldehyde	.156	1131.81	.04	.07	1151.9	
Grease	6.0	66.5	--	6.15	54.5	
Cyanide	1.7	32.6	--	7.9	30.5	
Dichloritan	14.7	215.7	--	14.9	189.4	

Stirol	32.6	18.0	--	32.98	17.6
Synthetic Surface Active Substances	71.24	1442.52	86.0	118.0	1350.3
Nitrates	55.5	10.0	8.6	31.0	6.4
Phosphates	991.6	1188.7	--	196.9	1983.4

5.4 Soil Pollution Control and Waste Utilization

Two of the main tasks of environmental protection are introducing waste-free and low-waste technologies and applying measures for detoxifying and isolating toxic wastes for which there are not developed treatment processes at the present time.

Taking into account that most soil contamination comes from industrial gas and dust emissions, reducing and eliminating these emissions is the main factor in reducing technogenic influence on soil in the city's industrial district. A large part of dust emissions lies on soil within the city borders, and in winter there is extensive accumulation of dust on the surface of the snow.

To prevent this dust-laden snow from running into water reservoirs it is necessary to organize the storm drainage system in such a way that all surface flow coming from an enterprise's premises goes to the recycling watersupply system of that enterprise and all rain flow from the city territory goes to special cleaning facilities.

To reduce the mobility (ability to get into vegetation) of the heavy metals in the surface level of garden and market-garden soil located in and around the city borders it is necessary to keep the soil's pH level close to neutral (pH 6.5-6.9) and also add agriculturally approved types of organic fertilizers.

Another means of reducing ecologically pure agricultural produce and preventing soil contamination is by applying biological methods for vegetation protection and consequently using herbicides.

There is nothing useless in nature. For this reason, production waste, as a rule, needs to undergo certain additional processes in order to acquire the necessary properties of secondary material resources or to clearly fixate these properties.

The blast furnace sludge of KMK and ZapSib, ash-sludge wastes from the thermal energy power stations, and waste from the Abagurskaya and Kuznetskaya sinter plants are of great interest from the point of view of construction material production. Blast furnace sludge of KMK and ZapSib is used for producing granulated sludge for further usage in the cement industry or for producing high-quality sand for concrete. While bulking the blast furnace sludge it is possible to produce sludge pumice -- high-quality concrete filler. Additionally, it is possible to produce new types of materials for example, sludgestial (a sludge/silicon alloy). Slabs made of sludgestial can be used for internal and external facings for buildings.

Sinter plant tailings can be used as filler. In the future it will be possible to completely switch over from using crushed stone and sand to using blast furnace sludge for coarse filler and making

fine filler from a mixture of iron ore enrichment tailings and a small amount of sludge; the fillers can then be used to make concrete of grades 100-700. However the presence of precious metals in the sinter plant tailings have caused the ZapSib Zoloto (ZapSib Gold) company to prohibit their usage in the construction industry.

Wastes containing coal are successfully used in the production of construction materials. The Abashevskaya sinter plant, with the capacity of 10 million bricks per year, is an excellent example of this.

After converting the Kuznetsk thermal energy power station to dry removal of sludge it will be possible to use the latter as a raw material for porous filler.

The main trends in utilizing ash-sludge materials from the ZapSib and Kuznetsk thermal energy stations for the construction industry are shown in Table 5.2.

Table 5.2 -- Main Trends in Utilization of Ash and Sludge from Thermal Power Stations in the National Economy

Type of Utilization	Type of Ash-Sludge Wastes	Utilization Effect	
		Technical	Economi
Heavy Concrete (including Hydrotechnical)	from thermal power stations-a part of cement substitute	15-30% improvement of molding ability, increased corrosion resistance, decreased heat release while solidifying	reduces of pri by .6-2.3 Rub per 1m³
Ash Sludge Concrete	taken from dumps-substitute of natural filters	saves expensive expensive filters, transportation costs, reduces avg. concrete density	reduces concr costs by 2-2. Rubles per 1m³
Light Concrete with porous fillers	Thermal power station ash- a small scale fillers	cement savings 10-20%, density reduced by 100-300 kg/m³ compared with expanded clay lightweight concrete made with quartz sand	reduces expand clay lightwei concrete co by 2-4 Rub per 1m³
Cellular Concrete	thermal power station ash- sand substitute and ingredient of composed cementing	reduces electric energy consumption, reduces wall thickness by 1.5-2x in comparison with brick wall	reduces costs production b 2.0-2.5 Rubl per 1m³
Dense Lime Concrete	" "	lime saving by 10-20% sand saving by 20-30% reduces average density by 150-300 kg/m³	reduces cost production b 2.0-2.5 Rubl per 1m³
Lime Concrete	thermal power station ash- sand substitute	sand saving by 20-50% lime saving by 50-70	reduces cost production

		kg per 1000 pieces of brick, fuel saving 8-12%	1.5-2 Ruble 1000 piec brick
Construction	thermal power station ash- substitute for sand, lime, cement	reduces consumption of cement and lime by 30-50 kg/m^3, sand by 200-300 kg/m^3, increase of shaping ability	saves .6 Rubles p
Portland Cement (with mineral mixtures, crimson lacquer, sludge portland cement)	thermal power station ash and sludge-active mineral admixtures	saves clinker 15-60%, reduces fuel consumption by 30-40%, saves electric energy by 10-15%, increase corrosion resistance, decreases heat release while solidifying	reduces cos productic 3-5 Rub per to
Lime Cementing	ash and sludge-ingredients of	reduces by 30-60% lime consumption, fuel reduced 2-3.5x, electricity reduced 50-60%	saves 2-3 Ru 1m of cemen
Cement Clinker	thermal power station ash- used in place clay	reduces fuel consumption by 10-15%, reduces main raw material consumption by 20-30%	Total savin in the cou by 150-300 Rubles/ye

Studying the country's experience in industrial waste usage has made it possible to recommend utilization for certain industrial wastes (see Table 5.3).

Table 5.3 -- Recommendations on Waste Usage in Construction Material Production

Enterprise	Wastes	Possible Uses	Research Organizat
KMK (Kuznetsk Steel Works)	blast furnace	granulated sludge: for mineral wood, sludge pumice, crushed rock as substitute in concrete	UralNIIStroMProyek
ZapSib	" "	" "	" "
Abagurskaya Sinter Plant	wet separation tailings	as small scale filler in concretes, asphalt	" "
Abashevskaya Central Enrichment Plant	sedimentary rock flotation tailings	ceramic tile powder, raw material for bricks, aggloporite production	Skochinsky Institut (Moscow)
Kuznetskaya	sedimentary rock	brick production with processes used at Abashevskaya	Siberian Steel ar Iron Institute (S
West-Siberian	ash-sludge wastes	partial substitution	UralNIIStroMProye

			of small scale fillers in concrete	
Kuznetsk Thermal Power Station	ash-sludge wastes	"	"	" "

*UralNIIStroMProyekt--Construction Material Project of the Ural Scientific Research Institute.

Table 5.4 -- Volumes of Industrial Waste Utilization for 1995 and 2000

Enterprise	Wastes in tons per year					
	1995			2000		
	created	utilized	stored	created	utilized	sto
KMK with sinter plant	4682	4462	220	4438	4211	
ZapSib	7200	6238	962	6839	5869	
Novokuznetsk Aluminum	44,700	27,600	17,100	44,700	44,700	
Kuznetsk Ferro-Alloy	25,000	25,000	---	25,000	25,000	
Coal Enrichment	2045	1900	145	2045	1900	
Coal mines/open-casts	930,700	---	930,700	930,700	--	930,
Energy enterprises	940	240	700	1650	340	1
Kuznetsk machine building	9300	3000	6300	9300	9300	
"Universal"	18,500	17,700	800	18,500	18,500	
"Organika"	21,300	18,800	2500	21,300	18,800	2
Other enterprises	125,500	52,700	72,800	125,500	125,500	
Total in city	1,604,200	12,984,800	3,057,200	1,614,700	12,561,800	3,685,

Nowadays the total quantity of solid residential wastes in the city consists of about 800,000 tons per year. The majority of these wastes is stored in a location near the Tom River bank in the Central district of the city, near residential areas. During the period of rains and floods the hazardous substances are washed into the river by surface and underground water and create increased levels of water reservoir contamination by chemical elements and bacteria.

Because of the high levels of organic substances, paper and textiles in waste materials, cases of self-inflammation at the landfill are not uncommon. In such cases, smoke spreads along the

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river valley, concentrating in the lower layers of the atmosphere. Furthermore, the city landfill is a source of infection diseases and a breeding ground for flies and different types of rodents.

Some non-utilized toxic industrial wastes, which in all total 50,000 tons per year, are taken away and buried at the residential landfill. But most such waste is carried to industrial dumps that are not constructed for this purpose or thrown away illegally at unofficial garbage dumps located throughout the city.

This situation with the storing of residential and toxic wastes in the city could lead to the spread of different kinds of diseases and poisonous contaminations.

In its "Plan of Environmental Protection Measures for Novokuznetsk," SibGIProMeZ (Siberian State Institute for Planning Metallurgical Factories) examined the problem of organizing the city landfill for detoxification and burial of toxic wastes, making it part of a complex that will include a new waste treatment plant to be constructed from 1990-1995. This plan was approved by the USSR State Planning Commission (GosPlan) and State Building Commission (GosStroy) and adopted by the USSR Ministry of Ferrous Metallurgy (letter #LB-765/23-425, 20 May 1985; and protocol # 187, 17 June 1985).

According to the decision of the city executive committee, SibGIProMeZ did the technical-economic calculations for the complex mentioned above, including determining Phase I of construction -- an improved landfill for solid residential wastes. Both a scheme of the equipment showing the sequences of operation and technical-economic data for this plant are given in Appendix 17.

The completion of Phase I of construction will make it possible to prevent the negative influences of residential wastes on the environment before the new waste treatment plant is put into full operation.

But negative reaction from part of the city ecological community about the construction of the waste treatment plant pressed the city executive committee to postpone any decision on this subject. Furthermore, there are definite problems with financing the plant construction. Recently SibGIProMeZ proposed a new technological process for industrial waste elimination by burning them in the liquid phase reduction (P.Zh.V.) ovens. This would have and extremely low level of technogenic impact on the environment. A technological scheme of this process is given in Appendix 18. Appendix 18 also contains technical and economic data.

5.5 Physical Impact Protection

Characteristics of noise pollution, radiation and electromagnetic radiation defined in the "Plan of Environmental Protection Measures for Novokuznetsk" make it possible to develop plans to protect the population against the adverse effects of these factors on health.

Some measures that have been proposed include prohibiting heavy trucks from using downtown streets, constructing or rebuilding beltways and transport junctions, constructing concrete

barriers and planting trees along the roads, a number of specific measures on prohibiting bus traffic at night, organizing measures to plan and build an acoustic laboratory, and examining the automobile industry with the aim of discovering deficiencies that can increase noise pollution. Additionally, it has been proposed to introduce model projects of noise-insulated homes and window blocks, and to remove a number of apartment complexes and day nursery #162 from the sanitary zone.

Gamma radiation is spread rather evenly throughout the territory of Novokuznetsk and varies form 7-18 microrentgens/hour, averaging 11 microrentgens per hour.

Construction material made from natural and secondary resources are not dangerous in terms of radiation. Maximum levels of gamma radiation are from 6-30 microrentgen per hour while the maximum allowable is 35 microrentgen per hour.

The best way to reduce radiation impact on the population of Novokuznetsk is to reduce the number of X-ray examinations of city residents.

Anomalies of cesium nature with an intensity of 30-45 microrentgens/hour were found in 3 location, more than 70 microrentgens/hour in one location and up to 1500 microrentgens/hour in another location. All were quickly neutralized and further measurement in those places has shown an absence of the anomalies noticed before.

An electro-magnetic radiation study has never been conducted in Novokuznetsk. A bibliographical study has shown that negative impact of electro-magnetic radiation is possible only if power lines possess voltages higher than 200 kilowatts, a voltage that is not typical for city power lines.

ATTACHMENT 2

ENVIRONMENTAL POLLUTION AND POPULATION HEALTH IN RUSSIA

Analytic report N 4

WESTERN SIBERIA - KEMEROVO, OMSK, TOMSK AND TYUMEN REGIONS

E. Gurvich, MD,PhD*)
B. Revich, MD,PhD

*) Environment Health Consultant, USAID/Moscow

Moscow-1994

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TABLE 4. FETO-PLACENTAL COMPLEX IN NEW-BORNS OF KEMEROVO [E. Koskina et al., 1992] [12]

Parameter	Level of air pollution		
	High	Medium	Reference group
New-born's body weight, g	3187∓51.0*	3228.0∓59.3**	3393∓52.4
New-born's body length, cm	51.54∓0.29*	52.24∓0.34	52.7∓0.34
APGAR count	7.30∓0.12*	7.32∓0.12*	7.60∓0.11
Feto-placental coefficient	0.165∓0.0008*	0.164∓0.0005**	0.160∓0.001
Weight of placenta without coating, g	522.7∓7.11*	529.6∓8.78**	540∓5.80

* - $p < 0.01$

** - $p < 0.05$

1.2. **NOVOKUZNETSK** is a major metallurgic centre of Russia. The city gives place to 3 metallurgic plants - Kuznetsky (26,000 workers), West-Siberian (25,000 workers), aluminium (4,300 workers) ones, ferroalloy enterprises, mine machines production, chemical plant, agglomeration factory, 3 coal layers, 12 mines and others.

The city is located on hilly lowland divided by valleys of Tom', Kondoma and Aba rivers. Novokuznetsk comprises 5 municipal districts, each of them exposed to chemicals released by the certain enterprises. For example, 2 districts (Kuznetsky and Ordzhonikidzevsky) in south-western part of the city are separated by aluminium and ferroalloy enterprises, heating power station, chemical pharmacy plant. Other heavy polluter is Kuznetsky metallurgic plant situated in north-western suburb of the city, so

its releases affect mainly Central, Zavodskoy and Kuibyshevsky districts of the city. The experts of German consulting firm IBT (Wolfgang Ruoff + Partner) have estimated that the equipment at Kuznetsky enterprise is completely or mostly exhausted, and the enterprise is not viable in the market environment (newspaper "Segodnya", 21/12/1993).

Industrial area of West-Siberian metallurgic plant lies 12 km apart from large living area and uses up-to-date technology of direct reduction of iron.

Accumulation of pollutants in the air of Novokuznetsk results also from inversion situations. Such processes are especially frequent in winter. Absent or mild (1 m/s) winds in winter cause extensive accumulation of the chemical hazards in lower atmosphere of the city.

Leading place among the pollutants released into the air is occupied by carbon oxide, dust, sulfur and nitrogen dioxides (table 5).

TABLE 5. RELEASES OF CHEMICAL HAZARDS INTO ATMOSPHERE OF NOVOKUZNETSK, 1991.

Chemical	Total releases, 1,000 tons/year
Carbon oxide	536.0
Dust	124.6
Sulfur dioxide	90.2
Nitrogen dioxide	36.0
Ammonium	2.9
Hydrogen fluoride	2.2
Hydrogen sulfide	1.14
Phenol	0.6
Sulfuric acid	0.15
Others	15.6
Total	809.39

TABLE 6. AVERAGE ANNUAL CONCENTRATIONS OF POLLUTANTS IN THE AMBIENT AIR OF NOVOKUZNETSK, μg/cu m [V. Surzhikov, 1994] [10]

Chemical	Years										
	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
Dust	450	390	380	380	390	370	380	340	300	300	200
Sulfur dioxide	80	60	50	70	50	40	20	30	50	40	10
Carbon oxide, mg/m3	2.0	1.5	1.9	1.9	1.8	1.9	1.9	1.2	1.4	1.2	1.0
Nitrogen dioxide	90	50	40	60	80	40	40	40	40	40	40
Hydrogen sulfide	8	8	6	8	5	1	2	4	4	5	2
Phenol	7	8	4	8	5	5	3	3	4	3	3
Carbon black	170	120	110	90	120	110	80	50	60	50	40
Hydrogen fluoride	80	120	120	150	260	160	80	80	90	80	6
Ammonium	20	20	20	20	10	15	40	30	30	40	20
Sulfuric acid	40	40	20	40	20	20	30	40	40	40	-
Formaldehyde	20	15	17	14	9	6	6	5	5	5	6

Air pollution in Novokuznetsk is observed by 12 stationary posts of Russian Meteorologic Committee according to a standardized schedule (20 minutes 3 times a day, 6 days a week). In 1982-1992 the average concentrations of dust varied from 300 to 450 μg/cu m (the MAC equals 150 μg/cu m), those of sulfur dioxide - from 20 to 80 μg/cu m (the MAC - 50 μg/cu m), those of nitrogen dioxide - from 40 to 90 μg/cu m (the MAC equals 40 μg/cu m), those of hydrogen fluoride were 80-260 μg/cu m (the MAC is 5 μg/cu m). Therefore, concentrations of the chemical hazards presented in table 6

significantly exceed the norms. Noteworthy is that the average annual concentrations apparently tend to decrease gradually, markedly evident in 1992. Exceeded MACs were found in 10-82% of air samples extracted in the city and containing higher amounts of dust, nitrogen and sulfur dioxides, hydrogen sulfide and phenol (table 7).

TABLE 7. AVERAGE DIURNAL CONCENTRATIONS OF POLLUTANTS IN ATMOSPHERE OF NOVOKUZNETSK [V. Surzhikov, 1994] [10]

Chemical	Number of samples		Concentration, µg/cu m			Maximal average diurnal concentr.
	Total	% with concentr. >MAC	X∓m	X/MAC	σ	
Dust	7200	81.7	630∓70	4.2	240	1290
SO2	5500	34.6	140∓30	2.8	80	520
CO, mg/cu m	6230	21.2	5.84∓0.6	1.9	1.02	7.9
NO2	5770	38.3	130∓10	3.3	30	240
H2S	6120	48.4	11∓1	1.4	3.0	27
Phenol	4700	48.9	16∓1	5.3	2	36
Carbon black	6300	56.0	210∓50	4.2	10	600
HF	3800	41.3	20∓1	4.0	8	40
Ammonium	3600	33.7	230∓50	5.8	120	330
H2SO4	4720	10.1	150∓8	1.5	30	400
Formaldehyde	2140	29.4	13∓2	4.3	8	25
Benzpyrene 10-3	no data		10.8	10.8		32.4

Concentrations of all 12 listed chemicals exceed the MACs 1.5 to 10.8 times. The air pollution with benzpyrene is extremely high (maximal concentrations exceed the MAC up to 74 times) (table 8).

TABLE 8. AIR POLLUTION WITH BENZPYRENE IN NOVOKUZNETSK
[V. Surzhikov, 1994] [10]

Year	Concentration, µg/cu m 10-3	
	Maximal	Average annual
1987	73.6	13.2
1988	46.7	12.7
1989	35.0	10.4
1990	36.4	11.3
1991	32.4	10.8

Level of air pollution in the city districts varies mainly in concentrations of benzpyrene, sulfur dioxide, hydrogen sulfide. Extremely polluted air is seen in residential area of south-western part of the city, near aluminium and ferroalloys enterprises (table 9). Western part of the city appeared to have the lowest level of air pollution.

High level of air pollution in Novokuznetsk induced considerable changes in health state of the population.

Thorough analysis of various health indicators of the population for past 10 years is presented in dissertation of V. Surzhikov [10]. Residents of intensively polluted district (south-western part) of the city vs. those of the relatively "cleaner" district (western part) demonstrated 2.1 times higher occurrence of respiratory diseases, 2.7 times more prevalent disorders of skin and subcutaneous fat.

Apart from evaluation of the morbidity through the number of claims for medical care, the scientists conducted a special examination of 203 children in the district with the highest pollution, 182 children in the district with the lowest pollution

and 574 children living in Osinniki (reference town). Previously the families answered the questionnaires of 85 questions, that showed no significant differences in social and economic state of the families.

TABLE 9. CONCENTRATIONS OF POLLUTANTS IN ATMOSPHERE OF DISTRICTS IN NOVOKUZNETSK, µg/ cu m [V. Surzhikov, 1994] [10]

Chemical	The city's parts				
	South	South -East	West	South -West	East
Dust	300	400	230	450	340
SO2	90	70	40	130	50
CO	1600	1200	1100	2800	1500
NO2	80	60	40	110	90
H2S	5	6	1	12	5
Phenol	6	6	3	8	5
Carbon black	130	170	140	180	110
HF	20	20	6	50	48
Ammonium	40	20	10	80	40
Sulfuric acid	20	30	8	40	20
Formaldehyde	6	3	3	10	6
Benzpyrene, µg/cu m 10-3	9.4	2.9	1.7	28.9	9.1

Health state of the children was evaluated according to regular Russian recommendations for complex medical examination of children and teenagers during mass screenings [S. Grombakh,

1981][13]. According to the health state and physical development the children were assigned to the following health groups:

I. Healthy, normal development and functioning.

II. Healthy, some functional or morphologic defects, lower resistance against acute and chronic diseases.

III. Having chronic diseases compensated, preserved functional resources.

IV. Having chronic diseases subcompensated, lower functional resources, attending school.

Evaluation of health state in the children aged 7-11 years proves that number of healthy children in the district with the highest pollution totals only 6.6%, that in the district with the lowest pollution - 12.8% and that in the reference city - 19.4% ($p<0.001$). Over one third of the schoolchildren in the polluted districts have functional defects, over a half of those suffer from various chronic diseases (III-IV health groups)(table 10).

TABLE 10. HEALTH GROUPS SHARES OF CHILDREN AGED 7-14 YEARS, LIVING IN VARIOUS DISTRICTS OF NOVOKUZNETSK, % [V.Surzhikov.1994],[10]

Health group	District with ~~high~~ low pollution	District with ~~low~~ high pollution	Reference city
I	12.8	6.6	19.4
II	37.9	32.9	43.5
III	37.5	48.4	31.2
IV	11.8	12.1	5.9

Higher level of the air pollution induces also allergies in the children. Some studies demonstrated that allergic diseases are 4.5-5.6 times more prevalent in polluted districts than in the "cleaner" ones.

To reveal an effect of air pollutants on the children's

health, coefficients of pair correlations were estimated. The strongest correlations appeared to exist between respiratory diseases and the ambient concentrations of dust, sulfur dioxide, sulfuric acid and nitrogen dioxide (table 11).

TABLE 11. CORRELATION BETWEEN TOTAL POLLUTION OF THE AIR AND MORBIDITY OF THE CHILDREN IN NOVOKUZNETSK [V.Surzhikov, 1994] [10].

Disease	Correlation coefficient	F-criterion
Respiratory diseases in children aged		
under 1 year	0.43	7.31
1-2 years	0.59	9.16
3-6 years	0.68	8.82
7-11 years	0.67	8.19
12-14 years	0.33	5.32
Chronic pneumonia	0.73	11.15
Bronchitis	0.33	5.21
Acute pneumonia	0.33	5.34
Acute respiratory infections	0.46	7.61
Chronic tonsillitis	0.47	7.86

Dispersion analysis evaluated contribution of the air pollution into the children's morbidity development. The parameters for chronic pneumonia equals 38.9%, for bronchitis - 24.5%, for acute respiratory diseases - 28.8%, for bronchial asthma - 21.8%.

Fluor in releases of aluminium plants situated in Novokuznetsk produces specific changes in health state of the children. As a

result of higher concentrations of fluor in the air and drinking water, specific changes of dental enamel were diagnosed in 70% of children residing near aluminium plant and in 31% of those children advanced dental fluorosis was seen. Occurrence of congenital abnormalities in the new-borns of the city equals 4.8/100 which is higher vs. international standards (2.0-2.5/100).

Higher level of air pollution in the city results also in elevated morbidity of the adults.

Occurrence of nonspecific pulmonary diseases in the city's adults living in polluted air environment is 1.58 times higher ($p<0.05$) than in those residing in relatively "cleaner" districts. Coefficients of multiple correlation, characterizing effect of the air pollution on nonspecific pulmonary morbidity matched by age and sex, are presented in the table 12.

With ageing all respiratory diseases in both sexes tend to increase, and the effect of air pollution tends to manifest more distinctly. Analysis of morbidity with transitory disablement among the teachers residing in the zones with various levels of air pollution proved that the air pollution is responsible for a share of 28-39.7% in respiratory morbidity.

TABLE 12. CORRELATION RATES BETWEEN THE AIR POLLUTION AND NONSPECIFIC PULMONARY DISEASES IN ADULTS OF NOVOKUZNETSK [V. Surzhikov, 1994] [10]

Disease	Age, years							
	under 19		20-29		30-59		over 60	
	m	f	m	f	m	f	m	f
Acute bronchitis	0.46	0.48	0.46	0.47	0.54	0.52	0.49	0.47
Acute pneumonia	0.60	0.57	0.59	0.58	0.60	0.59	0.54	0.52
Chronic bronchitis	0.51	0.49	0.54	0.58	0.80	0.62	0.90	0.60
Chronic pneumonia	0.49	0.42	0.56	0.47	0.70	0.87	0.71	0.60
Bronchial asthma	0.65	0.43	0.50	0.55	0.52	0.70	0.60	0.74

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ATTACHMENT 3

The Impact of Air and Water Pollution on Public Health Indicators in Novokuznetsk City, Kemerovo Oblast

prepared by

Richard Day, Ph.D.
Department of Biostatistics
Graduate School of Public Health
University of Pittsburgh

for

Mr. Steffen Plehn
Project Director
USAID Environmental Policy and Technology Project
Washington, D.C.

1. Introduction

The data reviewed in this paper focus on the evidence for a significant impact of current levels of air and water pollution on the public health of Novokuznetsk residents and the operation of the city's health delivery system. These data are not the results of a formal EPT/USAID epidemiological study of this problem; instead, the data have been collected in the course of an exploratory investigation of available health statistics maintained by several public health agencies in Novokuznetsk.

2. Data Types and Sources

Information has been collected on the availability of morbidity (sickness) and mortality (death) statistics in Novokuznetsk and the larger Kemerovo Oblast region. Three major sources of information have been identified:

a. The **Novokuznetsk City Medical Computer Center** (CMCC, Dr. G. Chechenin, Director) - The CMCC is the primary repository for health system data on Novokuznetsk. The CMCC maintains routine computer files that cover treated cases of disease and mortality in the Novokuznetsk administrative boundaries. Much of there current computer hardware and software is antiquated and needs replacement. This limits the current capacity of the CMCC to provide extensive longitudinal analyses of detailed health indicators.

b. The **Novokuznetsk Sanitary Epidemiological Service** (SES, Dr. Y. Ruseav, Head Doctor) - The SES is the equivalent of a county department of public health in the United States. The SES has responsibility for routine air, water

and food quality monitoring and for the control of infectious diseases through the authority of the Health Ministry in Moscow. The capacities of the SES are currently limited due to poor laboratory facilities, which are presently housed in an apartment building.

c. The **Institute for Complex Problems in Health and Occupational Medicine** (ICP, Dr. V. Surzhikov, Deputy Director) - This institute was established under the authority of the Siberian Branch of the All Union Academy of Medical Sciences. The ICP serves as a research and service organization focusing on problems of industrial and environmental health. This institute has a charter to study problems in the whole of the Kuzbass region and is not restricted to Novokuznetsk. Many of the researchers in this institute are highly qualified and are capable of providing sophisticated demographic and population morbidity data. The ICP is currently in a period of transition, seeking a new director and suffering from desperate lack of funding.

3. Methodological Issues

Initial work with the representatives of the above agencies have demonstrated a number of methodological limitations involved in the availability, production and use of Novokuznetsk public health statistics.

At the present time, various agencies lack the technological capacities (both computer and laboratory) to produce the data to answer health questions that might be routinely dealt with in a Western setting. Beyond these technical problems, the Novokuznetsk public health agencies oftentimes utilize different reporting standards and medical nomenclature than are used in Western statistical reports. Similarly, much of the health research draws on indices and cumulative categories that are not internationally standardized and validity of which is unknown in the West.

In terms of the data that is available, the largest problems are in the area of morbidity (i.e., sickness) as opposed to mortality (death) statistics. Statistical rates for health indicators depend upon good numerator (morbidity/mortality) and good denominator (census) data. Mortality and census information seems to be collected in a technically reliable and standardized fashion in Novokuznetsk and key problems in this area involve the processing and presentation of the results (e.g., sufficient computer resources to carry out requested analyses). Larger problems occur in the area of morbidity statistics. For the most part, all that is available are statistics on treated rates of disease (i.e., conditions that reach a clinic). The overall completeness, reliability and validity of these treatment statistics is largely unknown. There is a serious lack of population based epidemiological studies focusing on the rates of untreated symptoms in Novokuznetsk. This is particularly significant in the case of acute respiratory

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and gastrointestinal conditions which tend to be self-limiting in nature and the majority of which never appear for formal treatment.

4. General Population Trends

Figure 1 summarizes population trends for adults and children in Novokuznetsk between 1979 and 1994. Population reached its overall maximum in 1991, with peaks for adults occurring in 1993 and for children in 1991. Overall population mortality rates have shown a general increase since the late 1980's, reaching a maximum of 16.3 per 1000 population in 1994, while birth rates have continuously declined since 1986. The general effect as shown in Figure 1 has been to produce an overall negative rate of population growth since 1991.

5. Mortality Data

Interpretable mortality data relevant to air borne exposures is available for children less than five years old and is derived from life tables provided by the ICP. Figure 2 compares the mortality of children (<5 years) from non-malignant respiratory disease in Novokuznetsk and the United States. The rates for children are particularly important for two reasons: first, children in this age group are the most sensitive to the effects of air borne exposures; and, second, the effects of air borne exposures in children are minimally confounded with tobacco use and occupational exposures.

The data summarized on Figure 2 indicate that the Novokuznetsk authorities have made significant progress in reducing childhood mortality from non-malignant respiratory disorders since 1960, whereas rates in the United States started at a lower level and have remained more stable. Despite an overall drop of about 580% between 1960 and 1990, Novokuznetsk mortality rates for children's non-malignant respiratory disease continue to exceed U.S. rates by about 6 to 10 times.

Similar comparative data for water borne exposures, particularly gastrointestinal disorders (e.g., childhood mortality rates for diarrheal disease), are currently unavailable.

6. Morbidity Data

Basic data is available on the comparative frequency among adults and children of air-related and water and food-related complaints in the local polyclinics. Figure 3 summarizes air and water-related complaints as a percentage of all childhood cases handled at the local polyclinics. It is clear from this figure that respiratory complaints (i.e., acute respiratory distress, pneumonia, bronchitis, and bronchial asthma) predominate over gastrointestinal complaints at a rate of about 4:1, and, together, these two kinds of complaints account for 70% to 80%

of all treated cases in children. Similar trends, but at reduced levels, can be observed among adults (see Figure 4). In the adult case, the ratio remains about 4:1, but overall the two types of complaints only account for 40% to 50% of all treated cases. It is worth noting that frequency of gastrointestinal complaints has tended to increase in the years since 1990 for both adults and children, while the relative frequency of respiratory complaints has declined or remained stable over the same period. These data indicate that respiratory symptoms in adults and children are the category of illness most frequently treated by physicians in Novokuznetsk. Although water and food-related disorders remain secondary to respiratory complaints in Novokuznetsk, they have undergone a small, but steady increase in frequency in recent years.

Additional data bearing on the observed increases in water and food-related complaints has been collected by the SES. Table 1 shows that the vast majority of treated complaints for symptoms related to water and food borne exposures were for acute intestinal infections and dysentery. Both the overall numbers of cases and rates of acute infections have increased since 1992, while more serious conditions like salmonallosis have declined or remained stable. These data suggest a growing difficulty with everyday drinking water supplies and point to the possibility of a much larger, undocumented increase in the rates of untreated cases over the same time period. SES records also indicate a steady increase (5.6% to 8.8%) since 1992 in the proportion of non-standard samples found in the water samples taken form the local mains.

Research has been carried out by the staff of the ICP studying the association between general health levels, respiratory disorders and air pollution levels in Novokuznetsk. This work has yet to be fully translated and the current discussion draws upon summaries provided by the authors. Studies relating respiratory disorders to air pollution will be emphasized in this discussion because of the known causal relationship existing between these two factors.

The ICP staff divided the city's five districts into three groups on the basis of air pollution levels: highly polluted (Kuznetsky); moderately polluted (Central, Kuibishevsky, and Zavaodsky); and relatively clean (Ordzhonikidzevsky and Ilyinsky). It was found that morbidity rates among children living in the three groups of districts were closely connected to air pollution levels. In the most polluted districts, the rates of respiratory disorders (i.e., acute respiratory distress, pneumonia, bronchitis, and bronchial asthma) were 2.1 times higher and the rates of skin disorders 2.7 times higher than among children living in the cleaner districts. As would be expected, air pollution was found to have the greatest effect on the rates respiratory disorders observed among children less than seven year of age. Air pollution levels were also found to have an clear allergenic effect on children. The rates of allergies in children were found to be 4.2-5.6 times higher in most polluted as compared to the least polluted city districts.

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The agents found to provoke the greatest adverse effects were dust, sulphureous anhydride, and sulfuric acid. Table 2 summarizes the ICP findings regarding the impact of a 10% increase in the average concentrations of dust and sulphureous anhydride on age specific childhood respiratory morbidity rates.

As for the adult population, non-specific pulmonary pathology was found to be 1.58 times greater in the most polluted districts than in the least polluted districts. In the most polluted districts, chronic bronchitis constitutes about 33% of the cases, pneumonia about 25% and bronchial asthma and acute bronchitis the remaining 42% of all cases. The rates of non-specific pulmonary pathology in adults also increases with age, have the greatest impact on members of the population over 60 years of age. Table 3 summarizes the age specific data (i.e., correlation coefficients) for the association between air pollution levels and the number of emergency care requests for disorders of the respiratory tract.

7. Conclusions

The following are the most important general conclusions to be drawn from the data reviewed in this paper:

a. Non-malignant respiratory disorders (i.e., acute respiratory distress, pneumonia, bronchitis, and bronchial asthma) among children and adults are the most frequently reported reason for seeking medical treatment in Novokuznetsk.

b. There is substantial evidence for a strong positive relationship between measured levels of air pollution and treated rates of respiratory disorders in the youngest and oldest groups of Novokuznetsk citizens.

c. Even though mortality rates for infants and young children resulting from non-malignant respiratory disorders have dropped substantially in Novokuznetsk over the past 35 years, they still are 6 to 10 times higher than the rates observed in the United States.

d. Acute gastrointestinal disorders and dysentery compose the vast majority of treated complaints among adults and children resulting from water borne exposures.

e. In contrast to respiratory disorders, the treated rates of gastrointestinal disorders and dysentery are increasing among children and adults in Novokuznetsk. This is likely to result from a continued deterioration of the city's drinking water quality.

f. The treated rates of respiratory and gastrointestinal disorders discussed in this paper are likely to be only a small portion of the problem in Novokuznetsk. It is likely that a large reservoir of untreated and undocumented cases exist throughout the city. The size of this reservoir may be increasing due to a continuing decline in the capacity of the medical system and its current transitional state resulting from the introduction of new health insurance legislation.

Together, these data support the final conclusion that current levels of air and water pollution have a substantial negative impact of on overall levels of public health among Novokuznetsk citizens. They also support the need for new environmental legislation and engineering controls in order to reduce the size of the current health problem.

Table 1
Frequency and Types of Illness In Novokuznetsk
Linked to Water Borne Exposures (1992-1994)
Source: NVK Sanitary-Epidemiological Center

Condition	1992	1993	1994
Acute Intestinal Infections, including dysentery			
total treated cases	3322	4213	3763
rate per 100,000 population	539.9	688.7	619.8
percent of total cases	84.3%	87.8%	87.5%
Typhoid and Paratyphoid			
total treated cases	4	2	1
rate per 100,000 population	0.6	0.4	0.02
percent of total cases	0.1%	0.05%	0.02%
Salmonalloses			
total treated cases	614	584	524
rate per 100,000 population	99.8	95.5	86.3
percent of total cases	15.5%	12.1%	12.2%
Rickettsioes			
total treated cases	0	0	8
rate per 100,000 population	0.0	0.0	1.3
percent of total cases	0%	0	0.2
Leptospirosis			
total treated cases	3	2	3
rate per 100,000 population	0.5	0.3	0.5
percent of total cases	0.1%	0.05%	0.08%
Totals			
total treated cases	3943	4801	4299
rate per 100,000 population	644.58	784.9	708.0
percent of total cases	100%	100%	100%

Table 2
Estimated Age Specific Increases in Rates of Respiratory Disorders Resulting from a 10% Increase in Average Levels of Dust or Sulphureous Anhydride
Source: Institute for Complex Problems

Age Groups	increase in respiratory disease morbidity for a 10% increase in average dust levels	increase in respiratory disease morbidity for a 10% increase in average sulphureous anhydride levels
less than 1 year	1%	1%
1-2 years	5.6%	3.4%
3-6 years	5.3%	4.5%
7-14 years	2%	1.2%

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Table 3
Associations Between Measured Levels of Air Pollution and the Number of Emergency Medical Calls for Treatment of Respiratory Disorders
Source: Institute for Complex Problems

Age Groups	Pearson's Product Moment Correlation (r)	F Value
less than 1 year	.56	7.4
1-2 years	.70	15.1
3-6 years	.88	14.7
7-14 years	.76	8.11
15-19 years	.46	24.6
20-59 years	.57	16.5
60 years and greater	.79	20.1

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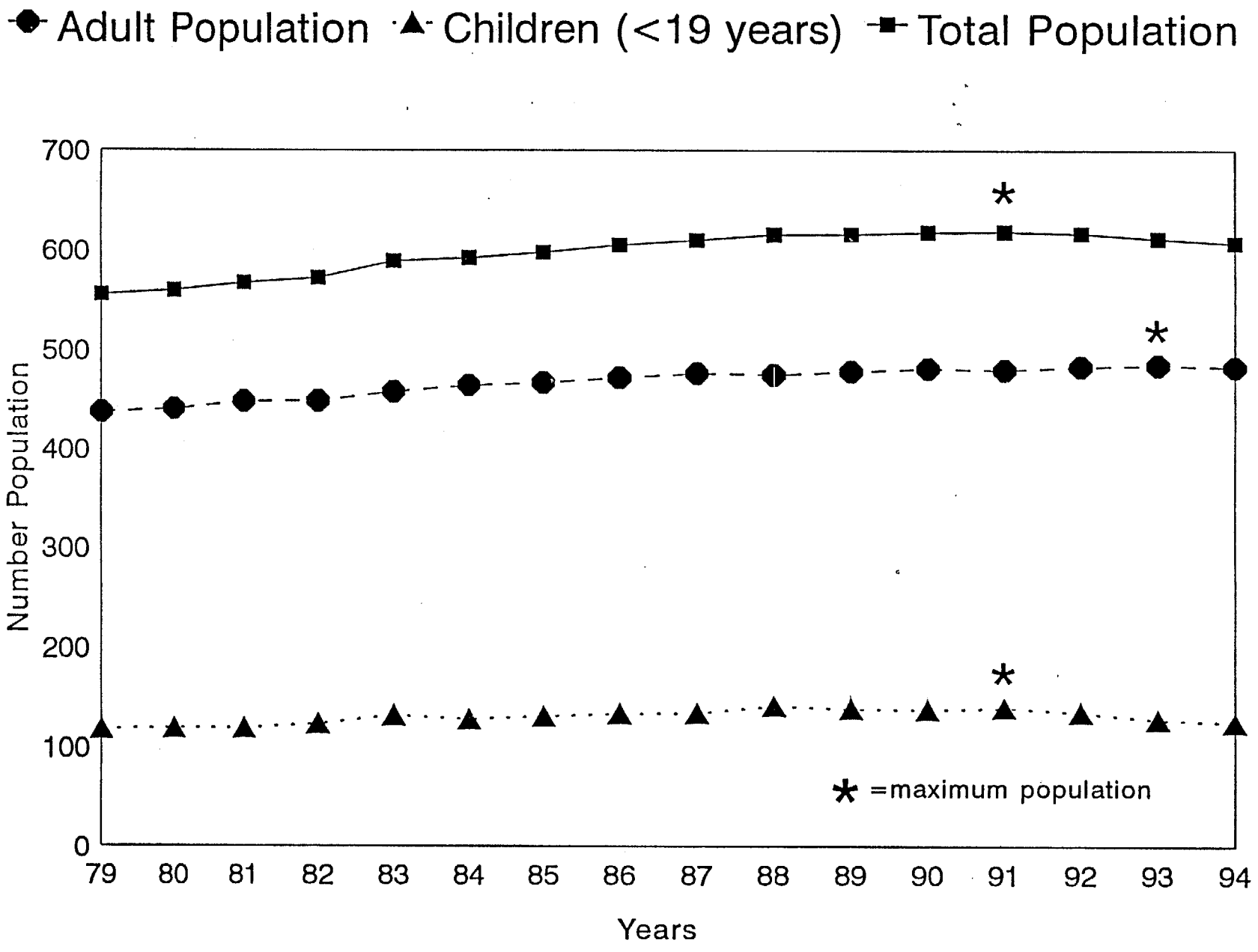
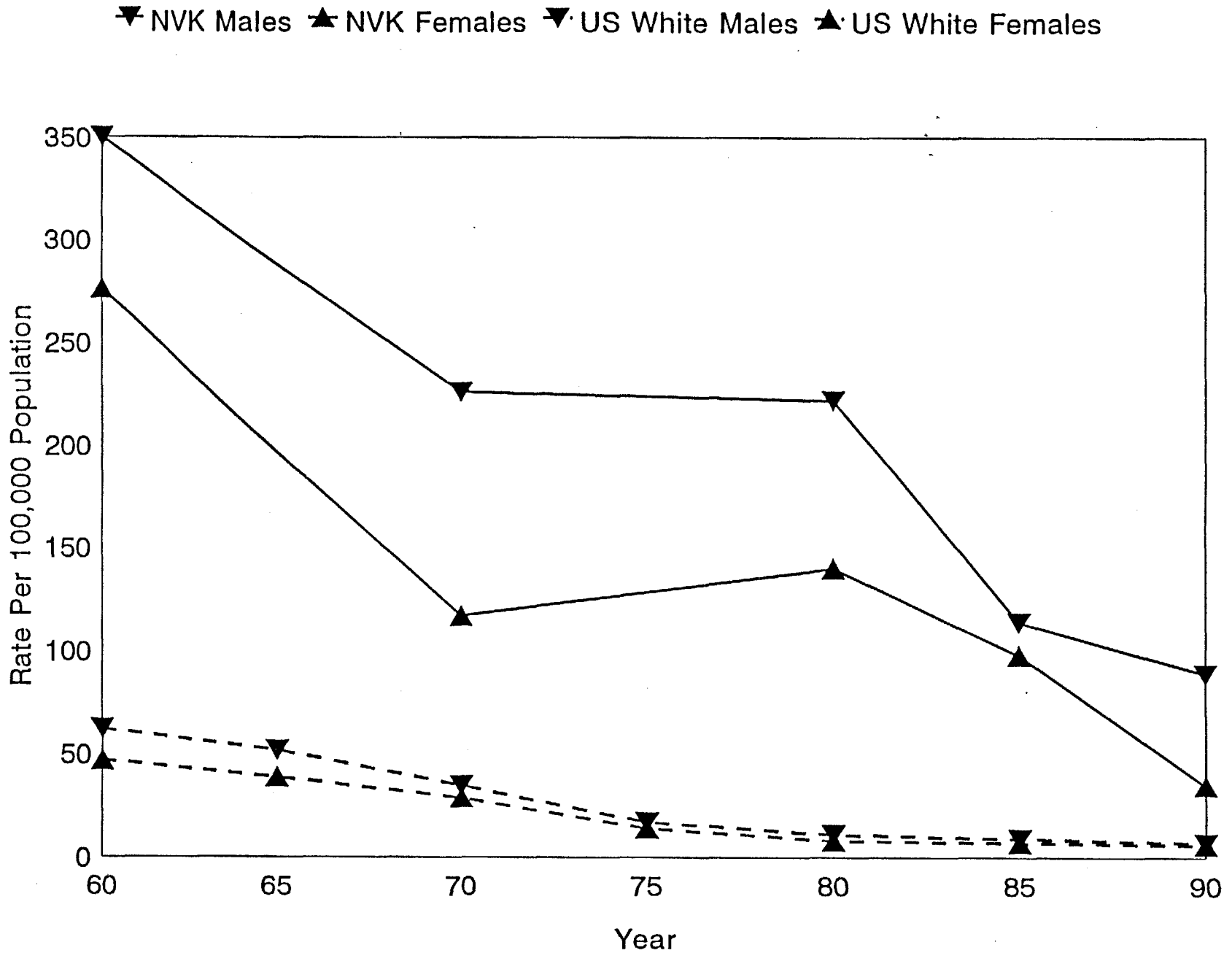
Figure 1: Population Trends for Adults and Children (<19 years) in Novokuznetsk (1979-1994)



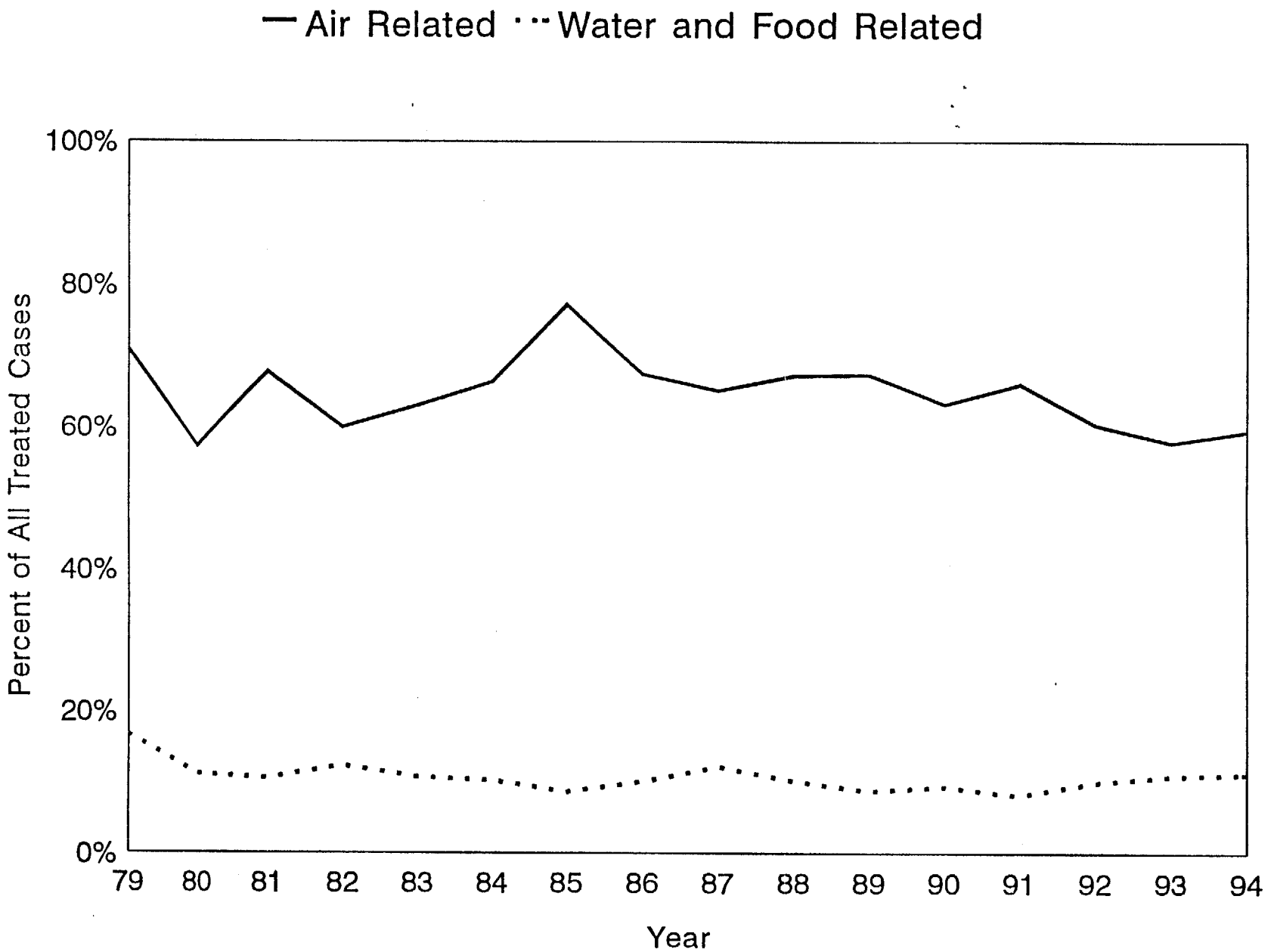
Source: NVK City Medical Computer Center

Figure 2: Estimated Age Specific Mortality from Non-Malignant Respiratory Disease for Novokuznetsk and Amercian Children <5 Years-Old (1960-1990)



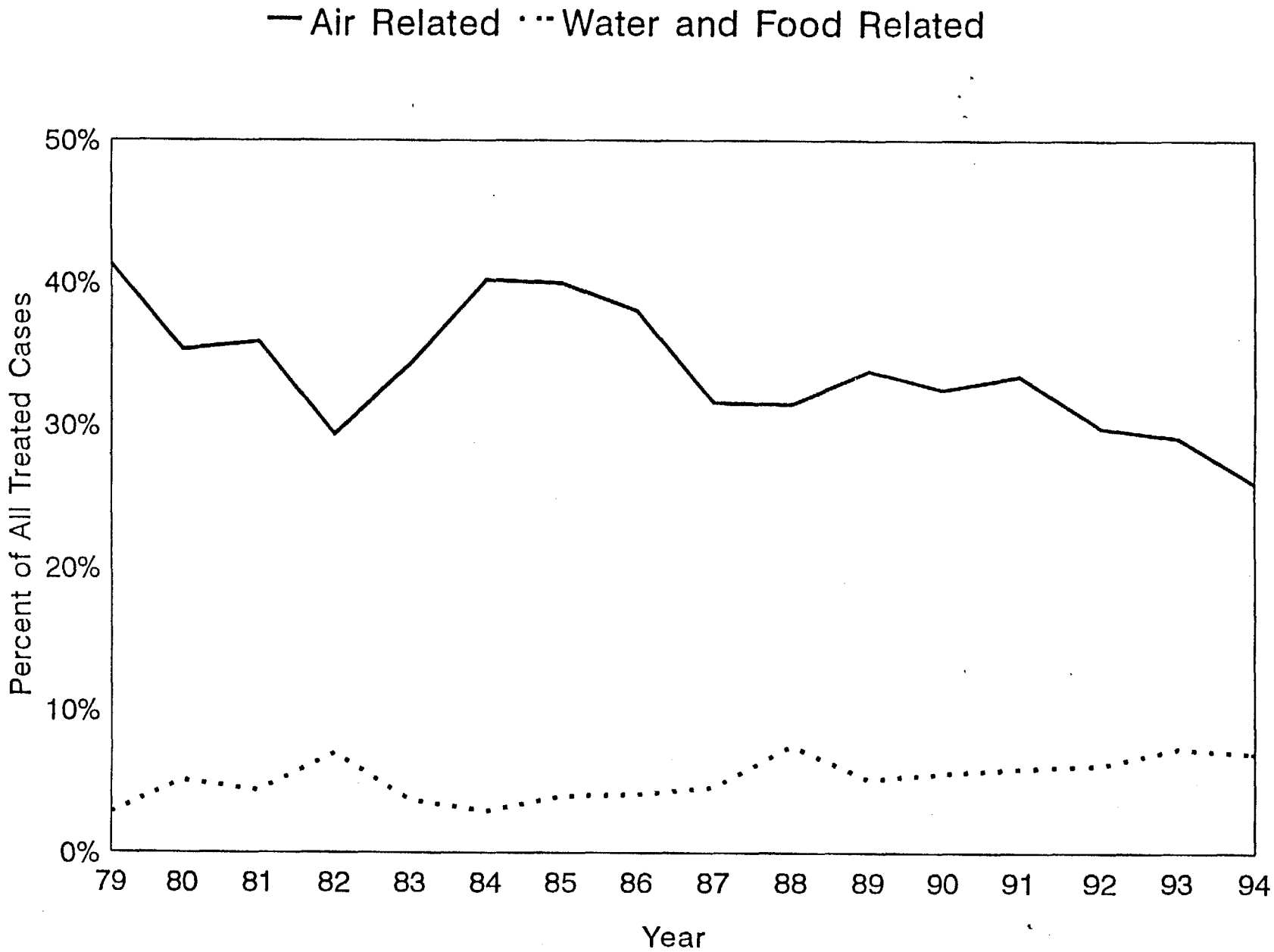
Sources: Institute for Complex Problems (NVK)/NCHS (USA)

Figure 3: Categories of Disease in Children as an Estimated Percent of All Treated Cases in Novokuznetsk (1979-1994)



Source; NVK City Medical Computer Center

Figure 4: Categories of Disease in Adults as an Estimated Percent of All Treated Cases in Novokuznetsk (1979-1994)



Source: NVK City Medical Computer Center

ATTACHMENT 4

UMWELT FÜR EUROPA
ENVIRONMENT FOR EUROPE
UN ENVIRONNEMENT POUR L'EUROPE
UN AMBIENTE PER L'EUROPA
ОКРУЖАЮЩАЯ СРЕДА ДЛЯ ЕВРОПЫ
LUZERN, 28.–30. APRIL 1993

Pre-publication DRAFT

Environmental Action Programme for Central and Eastern Europe

Abridged Version
of the Document endorsed by the
Ministerial Conference
Lucerne, Switzerland
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31 March 1994

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PREFACE

At the Ministerial Conference "Environment for Europe", which took place on 28-30 April 1993 in Lucerne, Switzerland, Ministers "endorsed the broad strategy, with its principles and general priorities, contained in the *Environmental Action Programme for Central and Eastern Europe* (EAP) as a basis for action by national and local governments, the Commission of the European Communities and by international organisations and financial institutions and private investors active in the region" (Paragraph 6 of the Ministerial Declaration, 30 April 1993).

This endorsement was the *culmination* of a two-year process of discussion and consensus building among representatives from about 30 Eastern and Western countries and numerous international institutions in the framework of the Swiss-led Expert Group established after the Dobris Conference in June, 1991. From a different perspective, the endorsement was the *beginning* of a substantive dialogue which is based on a much better understanding of how to achieve tangible results in a situation where serious environmental problems must compete with many other grave social and economic demands.

The great achievement during the two years since the Dobris Conference however goes well beyond the preparation of the *Action Programme*, for there has been a shift in understanding of how it might be possible to achieve the greatest possible environmental improvements with the available resources. There is now a recognition that improvements in the environment are rooted in economic and social change, not in isolated investments. Attendance at the Lucerne Conference reflected this new paradigm; not only were environment ministers from fifty countries represented, but many senior finance, economic, and sectoral ministry officials also attended, especially from the twenty participating Central and Eastern European countries.

This *Action Programme* represents a synthesis of several major studies. As part of a broad consensus building process, they were reviewed by various expert panels and discussed at international meetings prior to the Lucerne Conference. The work was undertaken by the World Bank and OECD under the guidance of a Task Force chaired by the Commission of the European Communities.

The innovative conclusions and fundamental recommendations would not have been possible without the commitment of countless individuals, and generous contributions by several governments and institutions. The major studies were funded jointly by the governments of Denmark, Germany, Italy, The Netherlands, Switzerland, the United Kingdom, and the United States; and by the European Commission, the OECD, and The World Bank. The Netherlands Government also financed the editing of the Action Programme. Most important of all, however, was the dedicated effort of a number of the Central and Eastern European countries, with whom we embarked on a journey that is bringing us ever closer together in our joint quest for a better "Environment for Europe."

Ruth Dreifuss
Federal Councillor
Head of the Federal Department of the Interior
Government of Switzerland

Yannis Paleokrassas
Commissioner
Commission of the European Communities

Jean-Claude Paye
Secretary-General
Organisation for Economic Co-operation and Development

Lewis T. Preston
President
The World Bank

This Report has been prepared by a team led by Richard Ackermann (World Bank) and comprising Gordon Hughes, Clyde Hertzman, László Somlyódy, Kristalina Georgieva, Wendy Ayres, and Gretta Goldenman. The sections on economic and environmental policies and on forecasting draw upon the work of Rob Maas, Johannes Bollen and Jean-Paul Hettelingh (RIVM) and Michael Toman (RFF). The chapter on expenditure priorities is based on the work of Wynne Jones, Mark Ambler, John Marrow and others working under a contract with Coopers & Lybrand. The section on Transboundary and Global Concerns is based on a draft from Martin Uppenbrink (UNEP), and benefitted from extensive comments and review by Anton Eliassen, Harald Dovland, Mari Saether (Norway). The sections on biodiversity and nature conservation are based on contributions from Jean-Pierre Ribaut, Zbigniew Karpowicz and Liz Hopkins (IUCN). Information on the phaseout of Ozone Depleting Substances was provided by Claus Hvashøj Jørgensen and Ulla Blatt Laursen under a contract with COWIconsult. The section on Non-Governmental Organizations includes contributions from John Hontelez, Mara Silina, Martin Kaspar, and Przem Czajkowski. The principal editor was Frances Cairncross.

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The work program and the many studies leading up to this Environmental Action Programme for Central and Eastern Europe (EAP) were first described in a document entitled "Setting Environmental Priorities in Central and Eastern Europe." Many of the issues raised in that document are taken up in greater detail in this report and in the technical reports issued separately.

II. HOW TO SET PRIORITIES

Setting priorities basically means ensuring that the policies followed first will achieve the greatest gain relative to given objectives and available resources. That involves choices. The first concern in the region is the damaging effects of pollution on human health -- as it was in the West before the worst environmental health threats had been addressed. Human health in various parts of the CEE seems to have been affected by lead in air and soil, by airborne dust, by sulfur dioxide and other gases, especially when combined with dust, by nitrates in water and by contaminants in food and water. Major expenditures to ensure the proper disposal of waste, especially nuclear waste, and the safety of nuclear plants, are likely to be worries for the future. For now, good operation and maintenance are paramount requirements.

Apart from human health, environmental policy may also need to take account of economic losses caused by damage or destruction of physical capital and natural resources, and of threats to coasts, lakes, forests and mountain habitats. It should give priority to measures that cost little, but are likely to have a big impact on problems which will get worse as time goes by and which may be easiest to solve if action is taken early.

The Costs of Environmental Damage
Environmental Damage and Human Health
The Main Pollution Problems
Degradation of Ecosystems and Biodiversity Conservation
Responding to the Problem:
Finding a Balance between Policies and Investments

To set priorities, policymakers need to ask the following questions:

- *What do people care about?* Are they, for instance, more concerned about dirty rivers, or the conservation of wildlife, or the environment that will pass to future generations? The answers involve value judgments;
- In light of these value judgments, *what are the most serious environmental problems?* This question requires an estimate of the costs of environmental damage (or the benefits of environmental protection and remediation) relative to the gains that policymakers hope to achieve; and
- *What are the most efficient ways to achieve different environmental goals?*

Both the costs of environmental damage and the cost-effectiveness of the solutions will vary considerably over time, and so will environmental priorities.

This chapter first describes some ways to assess the costs of environmental damage. It then uses these methods to give an initial overview of the most serious types of problems. The chapter then looks in detail at human health as a particularly significant short-term worry, and concludes by making recommendations on the most efficient ways to achieve environmental objectives.

The central message is the need to balance the benefits of environmental policy against its costs. That will not be easy: people differ in the value judgments they make about various kinds of environmental damage. But benefit-cost analysis in the broadest sense offers a way to think systematically about choices. When money and management capacity are scarce, as they are in Central and Eastern Europe, that is particularly important.

The costs of environmental damage

The economic and social costs of environmental damage are usually divided into three broad categories:

• *Health costs*. Environmental pollution may lead to sickness and premature death. Human health may be harmed by direct exposure to pollution, or indirectly through the impact of pollution on the physical environment. To assess the health consequences of environmental damage in Central and Eastern Europe means relying mainly upon epidemiological studies from OECD countries since there are relatively few local investigations which control adequately for the contributory influences of factors such as smoking and diet.

• *Productivity costs*. Environmental degradation reduces the productivity of natural resources and physical capital. It may disrupt the services that nature provides, such as the natural cleansing of water, or the yield from fisheries. Or pollution may force people to spend more on cleaning and maintaining houses and other buildings.

• *Loss of environmental quality, or amenity costs*. A clear view, a pristine lake, a mature forest, and clean and quiet neighborhoods all add to the quality of life. People are willing to forgo expenditure on other goods and services in order to protect endangered species and ecosystems, and enjoy the benefits of better environmental quality either for themselves or for future generations. This aspect of environmental quality is hardest to quantify, but its loss particularly conflicts with the principle of sustainable development, in that current generations do not "meet their needs without compromising the ability of future generations to meet their own needs."[1]

While figures for the total cost of environmental damage are often quoted for various Central and Eastern European countries (ranging from 2-10% of GDP), these are rarely based on a systematic assessment. Estimates which have been produced for Poland suggest that environmental damage may have cost 3-4% of GDP in the mid-1980s, 2-3 times as much as comparable costs in Western European countries. The most important single component is thought to be the damage to human health caused by air pollution, especially exposure to high levels of particulates (soot and smoke in the air). The next most important elements are productivity costs imposed by high levels of water salinity (caused by discharges from coal mines) and BOD in the country's principal rivers.[2] Finally, poor air quality in urban areas also imposes amenity costs.

Similar studies have not been carried out for other Central and Eastern European countries. However, as *health damage* is the primary cost of environmental pollution even in some of the wealthiest OECD countries, it is probably the largest component of environmental damage in Central and Eastern Europe as well. Health is also an important concern in public perception: According to a recent Gallup survey, 89% of Russians (80% of Poles) asked indicated they are concerned about the pollution effects on personal health.

The costs of reduced *productivity* of natural resources and physical assets are much more unevenly distributed. Discharges of saline water from mines are a problem in Poland and a small part of the Czech Republic. In the mining areas of Ukraine, the dumping of mine and washery waste and acid mine drainage are serious problems. Exposure to particulates and acid pollutants may damage materials as well as human health. Soil contamination, salinization and acidification all cause considerable loss of agricultural productivity and damage forests and lakes in some places.

Little is known about the *amenity* value of a better environment in Central and Eastern Europe. Economic difficulties seem to have lessened the importance people give to environmental problems. Amenity losses may seem more important once the most severe forms of pollution are dealt with, but they should not be an immediate priority for environmental policies, except in the few instances where there are risks of irreversible sacrifices now. When air and water pollution is cleaned up, that will generally help to maintain healthy and diverse natural ecosystems and landscapes.

Environmental damage and human health

Most governments will give the highest priority to dealing with those aspects of environmental damage which affect human health. Indeed, governments involved in the preparation of the Environmental Action Programme for Central and Eastern Europe have explicitly requested that special emphasis be given to human health concerns. In the past, the links between information on human health and environmental action have been relatively weak in

most CEE countries. So this section looks in more detail at the links between pollution and health.

Since the mid-1960s, life expectancy in Western Europe, North America and Japan has continued to rise, while in Central and Eastern Europe, life expectancy has remained static or has even declined. This gap (of approximately 5 years) is primarily attributable to relative increases in mortality from chronic diseases in mid-life. However, the reasons for this relative increase are not yet clear. The explanation must involve some combination of factors in the socioeconomic and physical environments, behavior patterns and social habits such as smoking and diet, and shortcomings in health care.

The relative decline in life expectancy in CEE has taken place in both heavily polluted and relatively unpolluted parts of the region. That suggests the influence of environmental factors on health is *not* paramount. On the other hand, it may be important. Life expectancies in rural areas in Poland have surpassed those in urban areas in recent years, a highly unusual demographic trend which may be associated with the fact that environmental pollution is concentrated in urban areas. In the Czech Republic, there is good evidence that dust and sulfur dioxide pollution increase the risk of infant mortality. Moreover, declines in life expectancy in the Czech Republic are correlated with the proportion of people living in regions affected by heavy air pollution. Recent evidence from studies done in the West will allow us to estimate the impact of respirable dust on overall mortality in Central and Eastern Europe. Preliminary estimates show that the effect is likely to be substantial.

The Action Programme has looked at exposures that are not related to occupational health problems.[3] Data from ten CEE countries have been used to tentatively identify locations where people are exposed to specific health risks from particular kinds of pollution. The specific locations are described in **Annex 1**.

The most common health problems are the result of exposures to a fairly narrow range of pollutants. The most important are:

- *Lead in air and soil*, which affects especially children whose mental development may be retarded (sources include lead and zinc smelters, and vehicle exhausts);
- *airborne dust*, which may cause acute and chronic respiratory conditions (sources include especially household coal burners, power and heat plants, and metallurgical industries); and
- *Sulfur dioxide and other gases, especially in combination with dust* (sources include power and industrial plants as well as households using high-sulfur coal or high-sulfur fuel-oil).

Maps 1-6 give an estimate of the areas where exposure to these pollutants occurs persistently.

Because of synergistic effects between airborne particulates and gases, the places where environmental health problems are caused by airborne pollutants need to be carefully studied to discover the relative importance of gaseous exposures and of dust. There is a large and growing body of scientific evidence that fine particle air pollution causes serious health damage and significantly raises the risk of death -- even in the most advanced OECD countries. The most recent study, which followed 8,111 adults for 14-16 years and which adjusted for age, sex, smoking, education level, and occupational health risks, concludes that mortality is most strongly associated with air pollution with fine particulates.[4]

Apart from inhaling pollutants, people also eat and drink them. Pollutants in food and water have some effect on health, but are on average less prevalent and/or less clearly related to ill health than lead, dust and airborne gases. Food in several parts of Central and Eastern Europe is a source of exposure to heavy metals, pesticides, polycyclic aromatic hydrocarbons, and chlorinated organics such as PCBs. Many of these substances have well-documented toxic properties and yet the effects on human health of ingesting largely unknown doses is uncertain. Other pollutants are ingested in water contaminated with nitrates or with a variety of other substances. Arsenic, viruses/bacteria, pesticides, radionuclides, and chlorinated organics have all been found in drinking water in various places in Central and Eastern Europe. Nitrate pollution of water is widespread in rural areas throughout the region, and can be particularly harmful to infants (see **Map 7**).

The main pollution problems

Several parts of Central and Eastern Europe suffer from particularly serious environmental damage. However, in many respects, Central and Eastern

Europe is not so unusual: air (and to a lesser extent water) pollution is largely confined to cities where there are concentrations of industries, power plants, homes and vehicles. At the same time, Poland, Ukraine, and especially Russia, contain some of the world's most extensive areas of virtually untouched nature, which are highly sensitive to pollution.

From a historical perspective, it is worth keeping in mind that some of today's "hot spots" in Central and Eastern Europe have had environmental problems since the early part of the century. Central planning under the former regimes only perpetuated and exacerbated old patterns of pollution, preventing the changes that occurred in the market economies. The implication is that the experience in the market economies may be quite useful in helping CEE countries to identify which steps to take and which to avoid. It should also be clear that it will take time -- even under the best of circumstances -- to remedy the problems of the past.

Air quality

Air pollution is potentially the most serious short-to-medium term environmental problem for human health. It is also one that has received relatively little emphasis in the environmental expenditure programs of Central and Eastern European countries. Polluted air is more difficult to avoid than polluted water. Its pervasive effects damage human health, buildings and nature. Treating air pollution should be the top priority for environmental policy.

The most serious effects of air pollution are on human health. Exposure to pollutants will vary greatly from one place to another, depending on a number of factors, such as geography and weather conditions. **Maps 1 and 3** show the places where local exposures to two of the principal air pollutants -- particulate matter and sulfur dioxide -- exceed annual average ambient standards of the European Union.

Occasional peaks in exposure may do more harm than the average level over the year. In Katowice, Poland, for example, maximum 24-hour ambient concentrations of black smoke in the winter heating season are more than six times the EU standards. A London smog in 1952 (which reportedly cost the lives of almost 4,000 people) exceeded the present EU standard more than ten times; and current EU standards are frequently exceeded in many Western European cities during peak smog periods, which has led to the enactment of special smog-alert and smog-control measures. One implication may be that, in the short run, CEE cities need not just general emission controls, but better systems for dealing with air pollution emergencies.

Air pollution also leads to acid rain, which is caused primarily by SO_2 and NO_x emissions from power plants and motor vehicles, and damages forests and lakes. The impact of acid rain, however, is not straightforward, as it depends on climatic, biological and geological conditions which determine patterns of rainfall and the capacity of the soil to buffer acidity.

Box 2.1 Developing Country-Specific Priorities

Although all of the Central and Eastern European countries addressed in this Environmental Action Programme face similar types of problems inherited from the past, the immediate priorities for some countries will be very different than for others. This reinforces the need for countries to develop their own environmental action programs that reflect their particular circumstances. These country-specific EAPs should be flexible and regularly up-dated to match the changing economic and environmental conditions.

Albania, for example, is much less industrialized than other countries in the region, and while there are localized air quality problems near industrial facilities, as a whole the country does not have as serious air pollution problems as its neighbors. Albania's most serious environmental problems are concentrated in its rural areas and include (i) deforestation because of uncontrolled cutting of trees for fuelwood and building materials; (ii) soil degradation due to poorly maintained hillside terraces and overgrazing by livestock; and (iii) contamination of soil and groundwater supplies used for drinking and irrigation. Over 60 percent of Albania's population resides in rural areas and about 50 percent of the country's gross national product is derived from agriculture and forestry, so these problems affect large numbers of people and have significant economic impacts. The most serious problems affecting cities are unsafe and unreliable drinking water supplies, which cause health problems and productivity losses for urban residents.

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Box 2.2 Portraits of Different Kinds of "Hot Spots"

Regional Hot Spot: The mining districts of Northern Bohemia

- Mortality rates from respiratory causes among 1-12 month old newborns in the areas of highest ambient dust and sulfur dioxide levels are 5-8 times higher than in places where air quality meets standards.
- Higher rates of low birth weight and congenital anomalies among newborns.
- Allergies and respiratory diseases are more prevalent among school children than in the rest of the Czech Republic.
- Children temporarily removed from the area to attend "nature school" in an unpolluted area show immediate evidence of improved red blood cell count which reverses when they return home.
- Higher mortality from lung cancer and other causes among both men and women than in the Czech Republic as a whole.

A Town with a limited number of large point sources of pollution: Copsa Mica, Romania

Copsa Mica is home to several poorly maintained industrial facilities, among them two lead smelters. Health problems of particular interest in the community include respiratory problems from exposure to dusts and gases and neurobehavioral problems due to exposure to lead.

Dust and Gases. One study examining pulmonary function in 371 Copsa Mica children aged 7-11 showed that of the exposed children 30% had reduced lung function measured in terms of "peak expiratory flow" and 18% had reduced lung function in terms of "forced expiratory capacity", compared with 10% of the control group.

Lead. Psychological testing was carried out on the same sample, as well as on a group of 12 year-old children. This was done because high lead exposures affect children's neuro-behavioral responses, including IQ. Approximately 30% of children are expected to test "weak or very weak," which means below the first standard deviation of the "normal" distribution. Instead, much higher percentages tested weak or very weak on the tests: 73% on an IQ test; 58% on a concentration test; 52% on a learning test; and 60% on a memory test.

"Bad Town Planning": Dimitrovgrad, Bulgaria

In Dimitrovgrad, thick, acrid smoke containing hydrogen fluoride and hydrogen sulfide comes from a single chimney at a fertilizer plant. High-rise apartments and other settlements are located at the plant gate, their occupants exposed to high levels of these emissions. Studies have shown below normal physical development and lung function in children from Dimitrovgrad.

- 50% of children from Dimitrovgrad have below normal height, weight, and chest expansion for their age.
- Lung function is poor. By age 14, "forced expiratory volumes" averaged approximately 25% below a control group of children from an unpolluted town.
- An overall assessment was made of children's developmental status in Dimitrovgrad, compared to the control town. Whereas 72% of control children had normal development, in Dimitrovgrad only 18% of children were so classified.

This may have important implications in setting priorities for cleanup of transboundary air pollution. Clearly, in some areas of Europe, acid rain has done serious harm to forests and ecosystems, and rapid action may be warranted. This is particularly true where soils are less capable of buffering acid depositions.

In recent years, air pollution in many areas in CEE has been decreasing. In the former Soviet Union, air pollution in the principal cities is reported to have declined by 10% during the 1980s, and the nationwide reduction in emissions in Poland has been 20-30%, and 15-45% in Bulgaria over the past four

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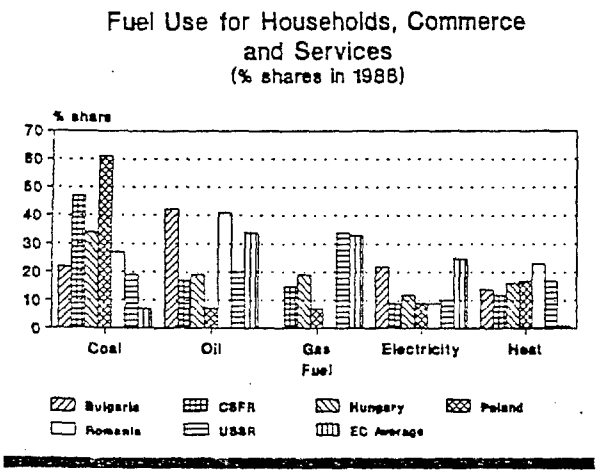
years. In certain urban areas, pollution levels dropped even more.

It is, of course, difficult to identify how far these reductions result from improved pollution controls and/or long-term economic restructuring, and how far the cause is the temporary decline in production. The discussion in chapter III sheds more light on this question.

CAUSES OF AIR POLLUTION. A principle cause of urban air pollution in Central and Eastern Europe is the heavy reliance of households and small enterprises upon poor-quality coal. Smoke and soot

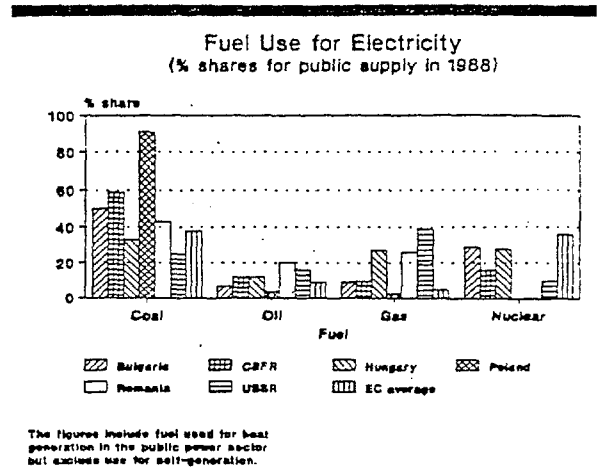
Figure 2.1



from low chimneys (or "stacks") are especially harmful to health. In many towns and cities -- especially in coal producing areas -- more than half the population is exposed to high levels of particulate and gas emissions from thousands of small coal stoves used in homes for domestic heating, and in small- and medium size enterprises burning coal for space heating and process heat.

Local heating and home furnaces tend not to have any systems of pollution control, while large factories most often do, though only for particulates. In Katowice (Poland), for example, 46% of soot and dust emissions come from low stack emissions of high-ash coal. In the republics of the former Soviet Union, the availability of natural gas has helped to reduce air pollution from small stoves in the principal cities, though not in smaller towns in coal producing

Figure 2.2



areas.

Central and Eastern Europe relies heavily on coal, which accounts for 75% of total primary energy supply in Poland and 24% in Hungary, compared with 19% in OECD Europe. **Figures 2.1 and 2.2** (detailing patterns of fuel consumption by sector calculated in tons of oil-equivalent) show that households and the service sector rely far more on coal in the CEE than in the West -- for example, 63% in Poland and 19% in the former USSR, compared with less than 5% in Western Germany and Spain.

Not only do the CEE countries use proportionately more coal than Western Europe; more of the coal that is burnt consists of poor quality brown coals and lignites. In an attempt to achieve greater self-sufficiency, the CEE countries developed reserves of brown coal and lignite during the 1960s and 1970s when the market economies were turning away from coal towards first oil and then gas. As a result, by 1989 brown coal and lignite represented more than 75% by weight of total solid fuel consumption for Bulgaria, the former CSFR, Hungary, Romania, and the territory of the former Yugoslavia, though the shares measured in terms of tons of oil-equivalent are, of course, much lower because of the low calorific value of the solid fuels concerned. Even for Poland and the former USSR -- both countries with large reserves of hard coal -- these shares were 32% and 28%, respectively. In contrast, the highest proportions of brown coal and lignite in total solid fuel consumption in Western

Europe were 58% for West Germany and 45% for Spain, while for most countries the share was less than 10%.

The smoke from poor-quality coal, especially when burnt by households and other small users, is especially harmful to health. This point is demonstrated by the following figures, which compare the *minimum* damage costs from pollution emitted by high and low chimney stacks in Poland (**Table 2.1**).[5]

A recent re-calculation of the numbers suggests that the damage costs from emissions of particulates may in fact be as much as three times the amounts indicated, i.e. US$180 and US$2160 per ton of particulate emissions from high stacks and households, respectively.

The example of West Germany shows that, given appropriate equipment and good maintenance -- neither condition being satisfied in most CEE countries -- it is possible to burn lignite and low grade coal in power stations and some large industrial plants without causing significant pollution problems. However, the only way of controlling pollution from burning coal in smaller boilers and open grates is to require the use of expensive smokeless fuels. This undermines the economic attractiveness of using coal, so that most households and small or medium sized enterprises will prefer to switch to electricity, gas or petroleum products if possible.

ENVIRONMENTAL IMPACT OF MOTORIZED TRANSPORT. With the exception of some large cities, such as Budapest, Kiev, Kharkov, Krasnodar, Moscow and St Petersburg, air pollution from transport is not yet a serious problem. Car ownership is still low compared with Western European countries: in CEE in 1990 the number of passenger cars per one thousand persons was on average only one-third that of Western Europe (**Figure 2.3**). Growth rates for passenger car fleets, however, are among the highest in the world, and demand for motorized transport is likely to increase as incomes rise and markets are liberalized (**Figure 2.4**). In addition, the proportion of freight carried by road (including multi-modal and container transport) in CEE is still much lower than in Western Europe and is likely to grow rapidly with the development of new export markets. Thus, as emissions from stationary sources are brought under control, and as vehicle ownership rises, mobile sources will contribute an increasingly important share of air pollution.

In Central and Eastern Europe, mobile sources (mainly road traffic) are responsible for about 30-60% of emissions of nitrogen oxides, between 40% and 90% of emissions of carbon monoxide, between 35% and 95% of lead emissions, less than 10% of particulate emissions, and less than 5% of sulfur dioxide emissions (vehicles also emit small quantities of a variety of toxins and carcinogens such as benzene and aldehydes). Those proportions are, of course, higher in cities which have little industry and which do not rely upon coal for domestic heating. In Budapest for example, transport

Table 2.1 ***Minimum*** **damage costs from pollution emitted by high and low stacks**

	Sulfur Dioxide	*Particulate Matter*	*Nitrogen Oxides*
Source		*US$ per ton*	
High stacks	265	60	180
Low stacks (households)	650	720	460

Source: Environmental Assessment of the Gas Development Plan for Poland (World Bank)

sources contribute about 80% of carbon monoxide and lead levels, 60% of nitrogen oxides, 75% of hydrocarbons (HC) levels (the precursors to ground-level ozone), and 12% of sulfur dioxide levels. In most cities in the region however, the contribution of home heating, power generation and industry to air pollution still outweighs the contribution from traffic. Thus, while countries with reasonable air quality in most towns and cities should rightly give priority to addressing the pollution associated with urban traffic, this would not be appropriate for the majority of CEE countries where the main threat to health from poor air quality comes from emissions of particulates and sulfur dioxide from industry and home heating.

Figure 2.3

Number of Passenger Cars/1000 Persons 1990

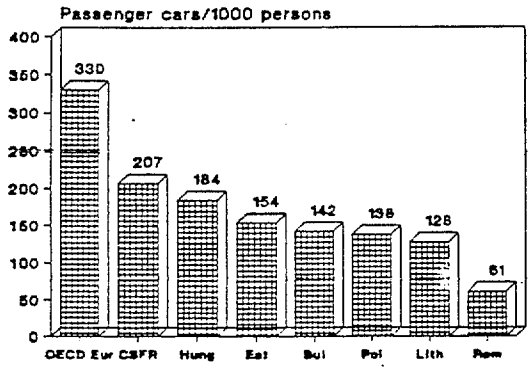
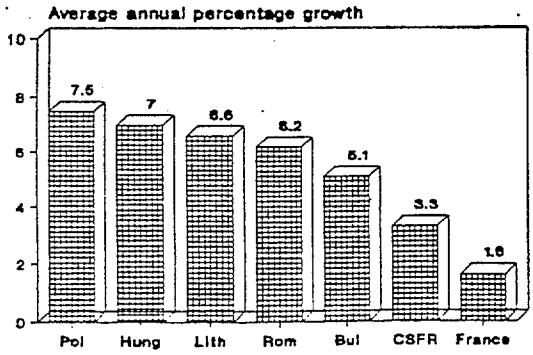


Figure 2.4

Average Annual Percentage Growth in Numbers of Cars/1000 Persons: 1980-90



Water quality

As in Western Europe, many rivers in Central and Eastern Europe are seriously polluted downstream of principal urban areas, especially with organic waste (BOD), and probably heavy metals and micro-pollutants from the discharge of industrial and municipal effluent which has been treated only partially or not at all. However, few of the rivers are biologically "dead" (except for small streams serving as "sewer canals") and, in general, they are probably cleaner than rivers passing the main industrial centers in Western Europe up to 20 or 30 years ago.

While attention has been focused on (large) point sources of water pollution such as industrial plants (including intensive livestock enterprises) or municipal facilities, it is important to remember that non-point sources -- especially storm and agricultural runoff -- account for most discharges of nutrients into rivers and lakes (60-70% of nitrogen, 40-50% of phosphorus). Estimates suggest that at least half the pollution in the rivers draining into the Baltic Sea comes from non-point sources.

MUNICIPAL WATER SUPPLY. In Central and Eastern Europe, water is used much more wastefully than in Western Europe (partly because it is underpriced) and in a number of countries it is frequently in short supply. This problem has often been solved by bringing in additional fresh water resources from increasingly greater distances and at growing cost.

Standards of treatment for drinking water also tend to be lower than in Western Europe. In general, municipal water supplies in most CEE countries have been treated adequately to prevent large outbreaks of infectious disease. This is mostly due to the adequate level of disinfection (chlorination), but it also reflects the temperate climate as well as the widespread reliance -- especially in rural areas -- on bottled water.[6] There is not yet enough evidence to be sure how far water in the CEE is polluted with carcinogenic substances (*e.g.*, chlorinated pesticides). If the combination of inadequate supply and patchy treatment persists, increasing amounts of investment may be required to ensure the availability of acceptable drinking water.

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MUNICIPAL WASTEWATER. In the Central European countries (such as Poland, the Czech and Slovak Republics, Hungary or Bulgaria), the current state of *municipal* water supply and sewage *collection* is generally adequate. This is much less the case in some of the republics of the Former Soviet Union. In the whole region, however, a substantial fraction of wastewater is discharged with little or no treatment. The principal types of water pollution in urban areas are organic wastes, nitrogen and phosphorus compounds, and suspended solids from municipal sewers, and to a lesser degree chemical wastes from industry.[7] To the extent that municipal wastewater treatment plants are available, they tend to be overloaded (more because of the wasteful use of water than because of the volume of actual wastes), improperly maintained and managed, or bypassed. All three Baltic countries have had to close beaches in recent years to prevent inadequate sewage treatment in adjacent settlements causing the spread of infectious diseases.

In the past, many large enterprises traditionally pre-treated the wastewater they discharged into the municipal wastewater systems. Today, as firms are split up and privatized, the costs of industrial pre-treatment are felt to be high, and there is a risk that increasing amounts of industrial discharges (heavy metals, chemicals, PCBs, etc.) will flow directly into municipal sewers which are not equipped to handle such wastes. The metals content in sludge threatens sludge use for agriculture and other means of disposal. On the positive side, the increases in water pricing and the collapse or restructuring of industry often diminish the earlier overload of existing facilities. Also, a past tendency to build unnecessarily large treatment plants means that there is often adequate capacity once water consumption is reduced.

RURAL WATER SUPPLY AND WASTEWATER, AGRICULTURAL AND NON-POINT SOURCE POLLUTION. The problems in rural areas are quite different and potentially more dangerous to human health. First, less than 10% of the population is served by public water supplies, and there is little or no adequate wastewater disposal. Nitrate pollution, in particular, affects a large part of the rural population (about 35% of the total population of Poland, Czech and Slovak Republics, Hungary and Bulgaria). In Borsod County, Hungary, for example, nitrate levels are twenty times Western standards, and in about ten different regions in Bulgaria, an average of 35-45% of the population is exposed to elevated nitrate levels. One of the primary adverse health effects is methemoglobinemia[8] ("blue baby syndrome") which is life-threatening for infants. Recent preliminary evidence suggests that careless and unsatisfactory disposal of wastewater (*e.g.*, septic tank runoff close to village wells) may be contributing significantly to the nitrate problem. The next most important sources of nitrate pollution are agro-industries such as pig farms and feed lots, and of course the runoff from fertilizers applied too heavily and frequently at the wrong time of year. In all of these cases, the solutions will depend critically on educating and training people, making them aware of the effects of their actions.

However, leaching of nitrate in agricultural soils is much more widespread in Western Europe, as shown in **Map 7**. In several countries in Western Europe, a high concentration of cattle and relatively high fertilizer use (on average, double the application rates in CEE) has led to accumulation of nutrients in soil and leaching to groundwater that exceeds EU drinking water standards. In CEE, by contrast, the rural population is more at risk because of the use of heavily contaminated shallow wells for drinking water.

SALINE WATER DISCHARGES AND MINE WASTES. The discharge of highly saline wastewater from a small number of coal mines is an important water quality problem which particularly affects Poland and to some extent the Czech Republic and Ukraine. Such water is highly corrosive if used for industrial or municipal purposes. Corrosion also damages infrastructure. In Poland, especially, much money has to be spent to treat saline water or to transport safer water. The productivity costs of these discharges probably account for the largest component of total losses due to water pollution in Poland (0.5-0.8% of GDP).

Tackling this problem has a high priority in Poland, but the answer is not obvious. Unfortunately, it is likely to be difficult or expensive to deal with discharges of saline water from the mines which are responsible. These are among the most productive mines in Poland, yielding high quality coal from deep but thick seams. Eliminating the discharges altogether would either mean closing

certain mines or require substantial costs to re-inject water into the mines or to desalinize it. New mining techniques together with better management could reduce the volume of water discharged and its impact on the rivers affected, but these are only partial solutions. At present the mines have little incentive to find cheaper solutions, since they do not have to bear the costs of the damage caused by the discharges. This is a clear case where appropriate pollution charges can be implemented in order to provide an incentive to search for low cost solutions. Indeed, recently, an increase in pollution charges is reported to have led to an active search by a consortium of mines for investment finance to install desalination equipment. It is unclear, however, whether all the mines are paying the required pollution charges.

In Ukraine, the iron ore mines of Kryvyi Rib produce almost 50 million m^3/year of effluent, which is not only saline but also contaminated with heavy metals and radionuclides from nearby uranium deposits. Though the volume of water is much less than that discharged from coal mines, it is far more toxic in the short term, given the high concentration of heavy metals.

Box 2.3 Nitrates in Drinking Water in Romania

Elevated nitrate levels are found in local water supplies in all but 2 of the 41 districts of Romania. According to a 1990 survey of water supplies in 2,474 places in the countryside, 7% were above 200 mg/l, 10% were between 100-200 mg/l, and a further 19% were between 45-100 mg/l. In 14 districts (Mehedinti, Dolj, Olt, Teleorman, Calarasi, Constanta and Bucuresti-SAT in the South; Tulcea, Braila, Galati, and Vaslui in the east; Botosani and Suceava in the northeast; and Satu Mare in the northwest), more than half of the water supplies exceed the *standard of 45 mg/l*. In these districts, up to 13% of the newborns a year were reported to develop methemoglobinemia.

Reporting of death from methemoglobinemia is patchy, so it is difficult to provide accurate numbers. Some insights into the impact may be gained from a special study of children in high nitrate areas in the Mehedinti/Dolj area. In 1989, 55% of the children in the study area had elevated methemoglobin in their blood. In 1991, there were 181 cases of methemoglobinemia, including 35 which were associated with diarrhea. In total, there were 9 deaths. If this death rate were to apply to other districts where methemoglobinemia is a common problem, it would make a significant contribution to infant mortality in those districts.

Solid and hazardous waste

Reliable information on the volumes and composition of municipal and hazardous wastes in Central and Eastern Europe is relatively sparse, especially since it is believed that a significant proportion of industrial hazardous wastes is disposed at municipal landfills. This unsafe co-disposal of hazardous and domestic wastes often occurs in unlined landfills with inadequate protection against seepage into groundwater. Toxic wastes stored at industrial sites may also contaminate nearby soil and groundwater. Finally, because of the growing shortage of available landfill capacity, inadequate enforcement procedures, and rising disposal costs, illegal dumping of both hazardous and non-hazardous wastes is increasing (implying potential additional health costs from groundwater pollution).

In some sites, mining wastes and ash from thermal power generation, sometimes with a high radioactive content, are badly disposed of. Former Soviet military installations are also believed to be potentially dangerous sources of toxic wastes, not only in the newly independent republics, but also in Poland, the Czech and Slovak Republics, and Hungary. Not surprisingly, little is known about wastes stored at former military sites, but their implications for environmental quality could be just as serious as that of conventional hazardous wastes.

Mining of coal, lignite, and metals such as chromium, copper, and iron contributes to environmental degradation in areas near mining operations. In addition, spoil heaps of tailings from mining operations (and slag from smelting) contaminate nearby soil. Uranium mining and milling releases radon and radon daughters which are potential occupational hazards. It also releases process effluent and tailings which may contaminate groundwater.

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