THE CZECH REPUBLIC: ENVIRONMENTAL PROBLEMS IN EASTERN EUROPE

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Jerald L. Schnoor is professor of civil and environmental engineering and co-director of the Center for Global and Regional Environmental Research at the University of Iowa. He recently completed a scientific exchange program for the National Academy of Sciences with former Czechoslovakia.

Schnoor has directed a number of water quality modeling and toxic substance research projects. These projects have covered a wide variety of water quality problems including: acid deposition to lakes and forests in the United States and Europe, toxic chemical fate and transport, nonpoint source pollution, and biogeochemical feedback effects of global atmospheric change. His mathematical model for acid precipitation risk assessments was one of only three applied to lakes in the eastern United States as a part of the National Acid Precipitation Assessment Program. His research interests lie in the areas of surface water and ground water quality modeling, exposure assessments, hazardous substances remediation, and global climate change.

THE CZECH REPUBLIC: ENVIRONMENTAL PROBLEMS IN EASTERN EUROPE

Emerging from a peaceful revolution in November 1989, Czechoslovakia faced a myriad of environmental problems with few resources to solve them. After 42 years of Communist rule, the country struggled with economic change to a free market economy. It recognized that environmental recovery directly relates to economic improvement.

Now Czechoslovakia's break-up into two distinct countries on Jan. 1, 1993, is jeopardizing some of that progress. Like the peaceful "velvet revolution," the division was a "velvet divorce." The western part is the Czech Republic with Prague as its capital, and the east is Slovakia with the capital of Bratislava. The separation leaves other countries, financial institutions, and granting agencies unsure of the future of these fledgling democracies and uncertain about who's in charge. These two republics constitute one of the most environmentally damaged areas in all of Europe. It is a part of the "black triangle" of industrial/mining areas that encompasses southern Poland, southern former East Germany, and northern Bohemia in the Czech Republic. Polluted atmosphere, water, and food; deteriorated soil quality; and damaged forests are the norm. The landscape has lost its ecological integrity, and some endangered species are now extinct.

The Czech Republic is one of the biggest exporters of pollution to neighboring and distant countries. Because of their deteriorated environment, people in both republics have poor health and a life expectancy 3 to 6 years below the average for Europe. Once Czechoslovakia was one of the most prosperous democratic countries in all of Europe. The economic decline of the republics is deep, but the ecological decline is even worse (Moldan and Schnoor, 1992).

Years of neglecting environmental regulations, not considered a high priority, have brought on this predicament. Some of the problems are common to other Central and Eastern European countries. They are: 1) severe air pollution including sulfur dioxide, nitrogen oxides, particulate matter, and acid rain; 2) water pollution including agricultural runoff of soil, nitrates, pesticides, and industrial contamination by toxic organics and metals; 3) untreated or poorly treated wastewater discharges of biochemical oxygen demand (BOD), nutrients, and total suspended solids (TSS); and 4) solid and hazardous wastes at an unknown number of sites containing metals, organics, and radioactive contaminants.

These types of pollution can cause decreased life expectancy, polychlorinated biphenyls (PCBs) in breast milk, excessive chronic illness among children during atmospheric inversions, and lead in children's blood. Metals extensively contaminate food crops, and chlorinated hydrophobic organics pollute pork, beef, and poultry items.

Much of the pollution stems from a policy that subsidized the price of energy, water, and agricultural chemicals. Industries

failed to invest in pollution control or prevention. They either did not enforce environmental regulations or, in some cases, found it was cheaper to pay the fine than to fix the problem.

Mining, smelting, heavy industry, chemicals, and building materials production formed the base of the economy. The country emphasized these extractive and polluting industries because of plentiful deposits of easily extractable low-grade ores. Industries did not develop many high-tech or value-added products. They used domestic materials and exported armaments, ceramics, chemicals, crystal, metals, and lumber to the Soviet Union and Eastern-bloc countries. The following data from the Czech Republic highlights major environmental problems facing Eastern Europe.

Air Pollution and Forest Decline

The root of many of the environmental problems in the republics is the poor quality of coal available between 1948-1989. After World War II, the mining and combustion of soft brown lignite coal increased from 15 to more than 100 million metric tons per year (See graph, Moldan and Schnoor, 1992).

It was cheap and available by surface mining, but it was also high in ash content, up to 40% by weight, and in sulfur content, 1 to 15%. (In the United States, power plants use coal with 5 to 10% ash and between 0.5 and 4.0% sulfur.) Poor quality coal brought on many of the environmental problems such as atmospheric pollution with sulfur oxides and particulate matter. The country also needed huge waste disposal ash ponds, which eventually leak toxic metals to surface and groundwater.

A map shows the two republics as separate countries. The dashed lines are iso-contours, or constant concentration lines, of annual average regional sulfur dioxide concentrations from daily measurements at more than 200 stations between 1981 and 1985 (Czech Fed. Govt., 1988). Ambient air concentrations in several major cities including Pilsen, Brno, and Ostrava are also greater than 60 micrograms per cubic meter (ug/meters cubed), and annual average concentration in Prague was nearly 100 ug/meters cubed during this period. Typical ambient air quality standards in the U.S. and many countries for sulfur dioxide is 80 ug/meters cubed.

Concentrations during winter inversion periods can be much higher, reaching an average of 400 ug/meters cubed for 19 days in January 1982 in the extreme northwestern part of the Czech Republic. During 1982, Prague and Osek had daily peak concentrations of 3200 ug/meters cubed and 2400 ug/meters cubed (Moldan, 1990). These are among the highest concentrations reported in the world, and they exceed limits designed to protect humans from respiratory diseases such as emphysema, asthma, and bronchitis. During a 4-day episode in London in 1952, 4,000 people died from sulfur dioxide concentrations thought to be only slightly higher than 3000 ug/meters cubed.

Another environmental problem stemming from the use of soft coal is the direct effect of sulfur dioxide gas on vegetation.

Forests began to decline in the 1950s and 1960s in the Erzegebirge mountains in the northwestern Czech Republic. Now more than 100,000 hectares of spruce forests have died within the 60 ug/meters cubed iso-concentration line shown on the map. About 54% of the forests in the Czech Republic show signs of decline, primarily the northern areas (Moldan, 1990).

The combustion of soft coal damages the environment in many ways. Without emission controls, volatile trace metals in coal, mercury, lead, cadmium, and zinc, leave the stack and go into the atmosphere. Cyclone separators, bag house filters, or electrostatic precipitators could capture some toxic chemicals, like arsenate, from the fly ash. Instead, it goes largely uncontrolled into the atmosphere, eventually spreading deposits over the landscape. In the atmosphere, sulfur dioxide turns into acid rain which, in turn, acidifies soil and streams and reduces productivity.

Sulfur oxides and particulate matter, including the fine fraction of particles, less than 10 microns that are respiratory hazards, are at high concentrations above air quality standards. These concentrations result in epidemic respiratory diseases, especially asthma in children. These emissions from coal combustion are the greatest human health, and probably environmental, hazard in the Czech Republic.

Box 1. Air Quality in the Czech Republic and the United States compared to U.S. Ambient Air Quality Standards

	Czech Urban Air Quality*	U.S. Standards	U.S. Urban Air Quality
Sulfur Dioxide			
Annual Average	100mg/m cubed	80mg/m cubed	30mg/m cubed
24-hr. duration	400	365	80
3-hr. duration	>1000	13000	100
Total Suspended Particulates			
Annual Average	100	75	50**
24-hr. duration	400	260	100

* Worst urban air quality in towns of Most, Sokolov, Prague, Decin

** However, 30 million people in the U.S. live in areas that exceed the U.S. standard of 75 mg/meters cubed.

(Moldan, 1990; U.S. Environmental Protection Agency, 1990).

Food Supply

One of the biggest problems facing the Czech Republic is the contamination of its food supply with toxic organics [benzo(a)pyrene, PCBs, hexachloro-benzene] and metals (lead, cadmium, mercury, and arsenic), which then threaten human health.

The concentration of cancer-causing PCBs in the breast milk of Czech women is 3 mg kg(power of -1), more than three times that found in Yugoslavia or Scandinavian countries. Concentrations of lead in the blood of children were 30-45 micrograms per deciliter in a recent study, more than twice what it was in control groups. Lead, a neurotoxin, causes developmental disabilities and mental retardation in children.

People constantly consume contaminated food and water with high concentrations of toxins such as the metals in the streams and small rivers of northern Bohemia (Veseley et al., 1990). High concentrations of cadmium and arsenic occur from industrial wastewater, mine drainage runoff, phosphate fertilizers, and fly ash leaching from power plants. Beryllium and aluminum come from acid rain seeping into the soil.

As fruits, vegetables, and grains grow, they absorb these toxic metals, especially lead, cadmium, mercury, and the metalloid arsenic. In turn, hogs, cattle, and poultry eat the contaminated grain and pass on the metals and persistent hydrophobic organic chemicals such as polychlorinated biphenyls (PCBs) into pork, beef, and poultry food supplies.

The most long-lasting legacy of the past 42 years of environmental degradation is the build-up of toxic metals in acidified soils preventing revegetation and threatening future agricultural production. The excessive use of nitrogen fertilizers flowing into streams is contaminating nearly half of all drinking water supplies, both in surface and groundwater.

As people eat contaminated food, the toxins accumulate and help bring on liver disease, kidney stones, and stomach cancer. Although medical data show especially high occurrence of these diseases in Central and Eastern Europe, there is no proof that food contamination is the cause. Certainly, heavy smoking and a diet rich in fats and salts contributes to the problem.

As the table below shows, the daily intake of mercury, lead, cadmium, PCB, and benzo(a)pyrene from food alone approaches the allowable daily limits. And, in the Czech Republic, benzo(a)pyrene averages above the limit. A rudimentary risk assessment showed it is one of the problems that poses the most risk to the health of Czech citizens. The government has ranked it as a high priority concern, second only to the respiratory diseases caused by air pollution.

Although there are high lead levels in children's blood, probably only a small amount comes from contaminated food. A much greater intake comes from lead in paint dust, air pollution from leaded fuels in gasoline, and trace lead in coal dust.

Box 2. Toxic Chemicals in Food in the Czech Republic based on a 60 kg person

Chemical	Czech Average (mg/day/per.)	Daily Intake W.H.O. Allowable (mg/day/per.)	U.S. Typical (mg/day/per.)
Mercury	0.015	0.04	0.004
Lead	0.287	0.50	0.05
Cadmium	0.04	0.05-0.07	0.01
PCB	0.45	0.50	0.05
B(a)P	0.003	0.002-0.003	0.0003

(Moldan, 1990)

Human Health

Because many things affect people's health, it is difficult to separate pollution-caused health effects from other environmental and genetic influences. Czechs smoke heavily and eat a fatty, high-salt diet. These habits worsen diseases and increase the incidence of cancer, kidney stones, hypertension, and heart disease. Unlike most Western European countries, life expectancy in both republics since 1964 appears to be decreasing rather than increasing (Moldan, 1990).

In 1988, life expectancy for both men and women was 71.6, but for men in the extremely polluted areas, Most and Sokolov in the northwest, it was only 64.2 years. In 1985, a comparison of mean life expectancy in 25 European countries showed that Czechoslovakia, at 71.0 years, was only higher than four others: Hungary at 69.4 years; Yugoslavia, 68.4 years; Poland, 70.6 years; and the USSR, 67.8 years. The longest life expectancies were in Iceland with 77.4 years and Sweden with 76.6 years (Czech Fed. Govt. 1989).

Chronic respiratory diseases, including asthma, emphysema, and bronchitis are epidemic among children up to age 14. The 1983-86 average winter concentrations of sulfur dioxide in Prague and Most were 150 micrograms per cubic meter. Medical personnel cited a 320% increase of respiratory diseases in children under 14 compared to spring and summer conditions. In 1990-91, Most officials issued children face masks so that they could play outside.

Based on the health hazards of sulfur dioxide, total suspended particulates (breathable particulate matter), and radioactive materials, the government has classified 6.9% of the Czech Republic with its 2.5 million people as an "extremely disturbed environment" (Dupal, 1987). Recently, Bobak and Leon (1992) have shown a positive statistical correlation between infant mortality and breathable particles less than 10 microns in size TSP-10).

Although the ecology has gravely deteriorated, governments will usually decide to improve human health when confronted with decreasing life expectancy. When the government is trying to expand the economy, it is hard to place a high priority on environmental recovery. Nevertheless, most people and government officials recognize it is not logical to continue to expand the economy at the expense of the environment.

The legacy of the communist years is that people now understand that they cannot allow economic development to destroy their resource base. Also, the government cannot protect the environment without a vigorous economy and program for sustainable development. The situation is even more challenging when deciding what environment and economic trade-offs to make when they operate on different time scales and pay-back periods.

Policy

The Czech Republic is shaping its environmental policy by the urgent need to build the post-communist economy and create a sustainable way of life. It is focusing on the clean-up of serious pollution. It needs to: clean coal by removing the sulfur, use clean-coal technology (using fluidized bed combustion), close outdated and inefficient plants, and desulfurize flue gas. In addition, it is vital to provide adequate sewage treatment and a secure place to store toxic wastes. One of the first priorities to protect the environment will be mandatory environmental impact assessments.

The country must base lasting environmental improvement on prevention, modern technologies, restructuring an obsolete industrial infrastructure, and reducing the extremely high energy consumption. Initially, the government plans to use the "polluter pays principle" to encourage companies to reach ecological goals. Penalties such as dues, charges, and taxes should have both punitive and stimulating characteristics.

These fiscal measures are probably the most important part of new economic and legal principles, replacing outmoded laws written during the communist regime. The Czech Ministry of the Environment, charged with rule-making and environmental action, came into existence only on Jan. 1, 1990. There is a rudimentary administrative and inspection system and self-reporting by industry of environmental discharges. In the past, it has been cheaper to pay the fine than to abide by the environmental regulation or permit.

A key factor for further shaping the quality of the environment will be the success of the change to an effective market economy with fast economic growth. However, the future must be sustainable. Economic and societal development must provide prosperity without endangering human well-being. It must not reduce or waste nature's production of environmental services but save it for future generations.

The challenge is to preserve the good and less affected locations and to recover severely depleted regions and resources. Many of these problems are common to several Central and East European countries. But the Czech Republic is in a good position to affect recovery because of its low foreign debt, excellent universities, central location, historic beauty, and democratic traditions before 1948.

The Czech Republic, Hungary, former East Germany, and perhaps Poland, may be the first Eastern European countries to recover economically and environmentally over the next 10-20 years. Eventually, they may become integral members of the European Economic Community. They can fix their environmental problems but will need billions of dollars for clean-up, restoration, and capital investments in new technologies.

Initially, the priority for clean-up and enforcement must be to reduce the risk to human health. Funding should go to projects that provide the largest reduction in human health risk per dollar invested. However, ecological concerns should not be far behind. For now, the government will focus on air pollution and food contamination. They may have to close the oldest plants and convert some newer ones to cleaner coal use. To decrease the wasteful and inefficient use of resources, the government will need to tax diesel fuel, leaded gas, energy, and water.
The Czech Republic is trying to rely on market forces for wise pricing of natural resource use. It will need a mixture of "command-and-control" legislation, regulations, and market incentives (See box on p. 5).

The country needs legislation requiring environmental impact assessments on new construction projects, a phased permitting of existing discharges, restrictions on fertilizer and pesticide use (and removing subsidies), and air quality management regions. The government will need to vigorously enforce existing ambient air and water quality standards or make them more realistic.

Box 3. Environmental Plan for the Czech Republic includes:

- Phaseout of subsidies for soft coal, gasoline, water, and agricultural inputs

- Privatization of a few key large enterprises and sale to multinational companies

- Creation of a stock market and division of shares to citizens via a voucher system

- Closing of some out-moded factories and power plants

- Environmental industrial audits and training

- Least-cost mitigation measures such as coal washing

- Food monitoring and inspection

- Public participation in the setting of fees, standards, enforcement and monitoring

- Establishing target industries for compliance, regulatory priorities and information

- Inventory of hazardous waste dump sites

- Development of specific policies for endangered species

- Conservation of soil and original forest species

- Reclamation of mined lands in Bohemia

- Indexing air and water pollution charges and fines to industrial price index

- Establishing an environmental impact assessment process

- Making pollution charges correspond to marginal abatement costs and analyzing the effects of those charges on employment, inflation etc.

(Czech Fed. Gov. 1991)

Progress and Problems

The largest uncertainty on the horizon is the unknown long-term effect of the break-up of Czechoslovakia. Even the peaceful separation will likely slow investment and increase bureaucratic time lines. However, the strong governments of both republics may shorten the adjustment period.

The Czech government has removed subsidies by increasing prices on polluting energy sources and fertilizers. Inflation has been on the rise. In the past two years, average wages have almost doubled, but prices have roughly tripled. Most people still hope that economic reforms will work and also allow for environmental restoration. But clearly, economic well-being is uppermost in their minds. The democratic reforms would seem to be irreversible, especially in the Czech Republic where new shops and availability of goods are increasing everywhere. The currency is almost interconvertible now and is holding steady against the U.S. dollar.

Vaclav Klaus, formerly the Finance Minister and now Czech Republic President developed a widely-accepted voucher system. Earlier, people speculated that many Czech citizens would be skeptical of the plan. Perhaps they would be unwilling or unable to invest 1000 Czech Crowns (about $40) to receive a stamp to participate in the first wave of privatization of medium-sized state-owned companies. But 90 percent of about 9.5 million eligible people participated in the first two offerings.

In addition, companies will need to be designated as Slovak or Czech, and it needs to be clear whether Slovak citizens can bid

on Czech companies and vice versa. Each citizen could gain stock holdings worth a couple of thousand dollars in formerly state-owned companies.

The separation of the country has also slowed progress of government command-and-control environmental regulations because it is not certain what the new regulations will be in each republic. The Czech Republic closed two large antiquated power plants and, in combination with the European economic recession, this has decreased sulfur dioxide emissions.

The government has also begun a coal washing demonstration. It now must overcome market hurdles and find a use for the poorer leftover coal which is high in sulfur and ash. Although the technology exists to use flue gas desulfurization on large coal-fired power plants near Most in the polluted Erzegebirge region, it is still too expensive to be practical. At a cost of $0.60 per kg of sulfur removed, it is not yet a competitive control option. Before widespread use, the government will likely need grants and credits from other countries who market the technology.

Nevertheless, air and water quality have already improved. Since 1980, the northwestern Czech Republic has observed some dramatic improvements in streamwater chemistry with sulfate concentrations decreasing by 25-50%. Sulfate comes largely from sulfuric acid and the acid rain created by soft coal combustion. Initially, the decrease was due to lower sulfate emissions from surrounding countries, especially West Germany, but now it appears to be from decreasing in-country emissions.

Air quality in Prague has begun to improve during the winter months because almost 30% of homes have switched from brown coal to natural gas heat from Russia. The number of homes converting to gas continues to increase. This should dramatically improve air quality during inversions.

A government-sponsored beginning risk assessment has guided some decisions and planning at the federal level. The country has also used air monitoring networks and some fate and transport models of sulfur oxides and particulate matter to determine the extent of the problem and human exposure concentrations. However, the government has not yet put together a detailed plan to restore the environment.

The governments could use forecasting tools, such as input-output and dynamic optimization models, because sufficient data bases exist in some cases. Earlier, the pending separation of the nations had stalled the environmental strategic plan (See box on p. 5). However, economic and market reforms, such as the decrease of energy subsidies, are continuing. These may have some long-lasting benefits.

Summary

Developing countries need to create environmental strategic plans to achieve a linkage and balance between economic development and environmental preservation. Because sparse data exist in many countries, governments must first gather available information. Then they can use international agencies and data bases to search for what is missing.

To protect human and ecological health, governments must begin monitoring programs for priority pollutants in air and water. They need to use simple models that are appropriate for the level of information available in future data bases. They will probably need a mixture of command-and-control regulatory approaches and market incentives to effect environmental improvements. They should use the polluter-pays principle so that all costs are accounted for. Otherwise, they will exploit resources by inefficient use of coal, water, and fertilizers and lose them forever.

The Czech Republic case study shows all the uncertainty, including changes in governments, that occur when one embarks on a strategic plan for an emerging country. When human health is deteriorating, health protection needs to be a key priority. But one cannot ignore ecological health and keystone species that are necessary to preserve the resource base.

Rather than an elaborate analysis of what to do (policy objectives), it is better to concentrate on an analysis of the best way to do it (policy alternatives evaluation and cost-effectiveness). Sometimes it is important to begin with a plan that may not be optimal, but it is at least a start in the right direction.

REFERENCES

Bobak, M. and D.A. Leon 1992. "Air Pollution and Infant Mortality in the Czech Republic, 1986-88," THE LANCET, 340:1010-1040.

Czech Federal Government 1988. STATISTICAL YEARBOOK OF THE CSSR, 1987. Prague, Czechoslovakia: SNTL and ALFA Publishing.

Czech Federal Government 1989. AN ANALYSIS OF THE POPULATION DEVELOPMENT IN CZECHOSLOVAKIA, 07/01, No. 1404/26.89. Prague, Czechoslovakia: Federal Statistical Institute.

Czech Federal Government 1991. JOINT ENVIRONMENTAL STUDY. Prague, Czechoslovakia: Czech Ministry of the Environment.

Dupal, J. 1987. ENVIRONMENTALLY AFFECTED AREAS IN THE CZECH REPUBLIC (in Czech). Prague, Czechoslovakia: Institute for Regional Planning (TERPLAN).

Moldan , B. 1990. ENVIRONMENT OF THE CZECH REPUBLIC (in Czech). Prague, Czechoslovakia: Academic Publishing House.

Moldan, B. and J. L. Schnoor 1992. "Czechoslovakia: Examining a Critically Ill Environment," ENVIRONMENTAL SCIENCE TECHNOLOGY, 26(1):14-21.

U.S. Environmental Protection Agency 1990. EPA JOURNAL, September-October, 1990, 16-18, Washington, D.C.

Vasal, J., V. Majer and K. Sevcik 1990. PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ENVIGEO Brno, Czechoslovakia, 138-142.
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