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Evaluation of Transboundary Environmental Issues in Central Europe

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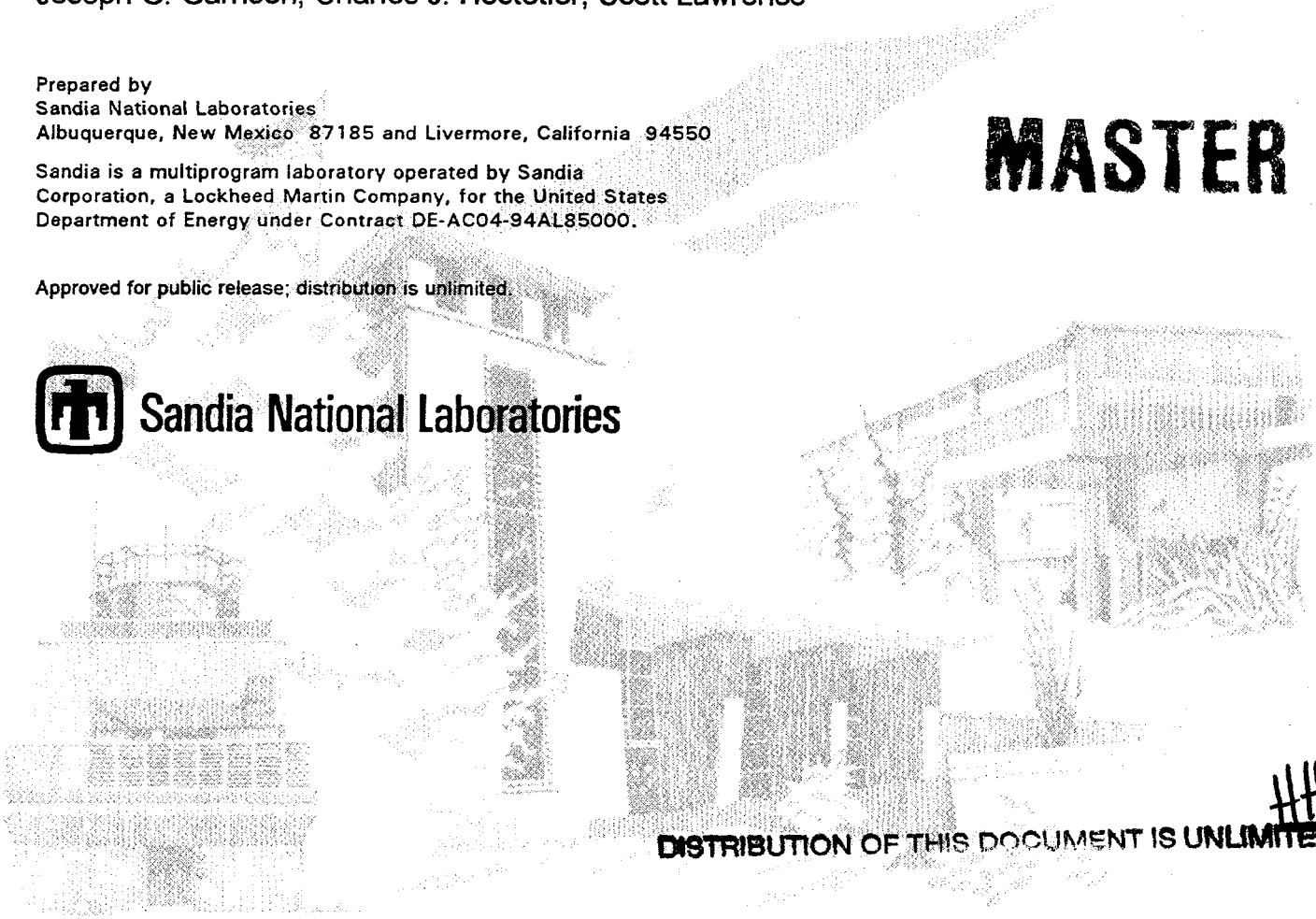

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Evaluation of Transboundary Environmental Issues in Central Europe

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Abstract

Central Europe has experienced environmental degradation for hundreds of years. The proximity of countries, their shared resources, and transboundary movement of environmental pollution, create the potential for regional environmental strife. The goal of this project was to identify the sources and sinks of environmental pollution in Central Europe and evaluate the possible impact of transboundary movement of pollution on the countries of Central Europe. In meeting the objectives of identifying sources of contaminants, determining transboundary movement of contaminants, and assessing socio-economic implications, large quantities of disparate data were examined. To facilitate use of the data, we refined mapping procedures that enable processing information from virtually any map or spreadsheet data that can be geo-referenced. Because the procedure is freed from *a priori* constraints of scale that confound most Geographical Information Systems, we have the capacity to generate new projections and apply sophisticated statistical analyses to the data. Our analysis indicates substantial environmental problems. While transboundary pollution issues may spawn conflict among the Central European countries and their neighbors, it appears that common environmental problems facing the entire region have had the effect of bringing the countries together, even though opportunities for deteriorating relationships may still arise.

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Executive Summary

Central European countries have experienced environmental degradation for hundreds of years. The transboundary nature of environmental pollutants makes this a regional issue that is politically sensitive and potentially contentious. Alternatively, the environmental issues could bring the countries together to solve a common and serious problem. This project focused on collecting data about transboundary pollution in order to facilitate future work on the socio-political dimensions of this issue.

The process of exploring the multiple forms of data including maps, monitoring summaries, and site specific studies, catalyzed development of a methodology to combine environmental data records from regional scale and site-specific projects. The mapping approach refined during this project enables us to process information from virtually any map or spreadsheet data that can be geo-referenced. Because the procedure is freed from *a priori* constraints of scale that confound most Geographical Information Systems, we have the capacity to generate new projections and apply sophisticated statistical analyses to the data. Our mapping approach enables us to combine multiple suites of information, thereby greatly improving the regional characterization of environmental degradation.

Several Central European areas are severely impacted by metals released from mining and smelting operations, air pollutants from burning coal, and many organic pollutants including the so-called hard-chlorinated pesticides. Several isolated studies have documented serious human health effects linked to environmental contaminants. Ecological resources are also injured by a wide range of environmental conditions.

Of the twelve Central European countries, Poland, Hungary, and Bulgaria are among the most affected. The Czech Republic, Romania, Slovakia, and the nations from the former Yugoslavia (Bosnia-Herzegovina, Croatia, Yugoslavia, Slovenia, and Macedonia) are close behind in a second tier of countries severely impacted by environmental contamination. Albania may also be similarly contaminated, but little information was found. The countries most capable of meeting the challenges of environmental management in the face of such severe degradation are the Czech Republic, Poland, and Hungary.

At the beginning of this project, one thesis was that transboundary issues were likely to spawn conflict among the Central European countries and their neighbors. However, the common environmental problems facing the region, may have actually brought the countries together, offering opportunities for enhanced scientific collaboration. Clearly, all is not perfect, and deteriorating relationships leading to specific problems will continue to arise. This, in turn, will necessitate well-defined responses on the part of technical assistance and aid agencies. However, as Central European nations strive for inclusion in the European Union, it appears that environmental concerns will remain an important common denominator that binds them together in striving for regional solutions to shared problems.

As a means of improving the region's ability to respond to common environmental problems, five follow-up activities were identified. Three of the proposed activities will lead to better understanding and management of the technically-based but socio-politically driven institutions and processes for environmental management; the other two on developing data acquisition and management capabilities to support decision-makers.

Introduction

This report is part of a larger project concerned with the socio-economic impacts from existing and potential transboundary environmental degradation in Central Europe. Sources of information on the extent and magnitude of contaminants and contamination data are described. Some implications of transboundary transport of environmental contaminants are also discussed. Extensive data summaries are presented in Appendices A through I to supplement the report.

Central Europe and Environmental Security as a Component of US National Security

A secure, prosperous, and more united Europe in which the new democracies of Central and Eastern Europe (CEE) join our traditional allies as our main partner in world affairs will benefit the U.S. This was the essence of the "commonwealth of free nations" that the Bush administration advanced in its vision of a "new world order."

From the Truman Doctrine to the Marshall Plan and the formation of the Atlantic Alliance, U.S. post-World War II strategy has been to shield Western Europe so that it could recover economically, build democracy, and overcome its national rivalries. Through these changes, Western Europe could become a more cohesive bulwark against further Soviet expansion and a magnet that would ultimately draw the countries of CEE into its field. The strategy has been brilliantly successful, but it is not yet complete. The great unresolved problem for European stability lies in the east yet. Already the war in Bosnia has exposed deep fissures in the European Union and undermined its confidence in continued movement toward European unity.

In short, it is in U.S. foreign policy interests that CEE not be a region of chronic instability because conflict in the east could erode West European unity. Further, if these countries succeed they can be a model for those countries farther east that face even graver problems, and can be a possible route through which Russia, Ukraine, and others, can find their way into the larger community of democratic states. Appendix J contains a position paper that explores potential socio-economic implications for the Central European region of transboundary environmental pollutants.

Both national governments and international organizations recognize that environmental security is important to national and regional stability. The U.S. government response has been to recognize environmental security as a formal initiative because of its potentially profound impacts on U.S. national security interests through a memorandum of understanding (MOU) signed by the Environmental Protection Agency, the Department of Energy, and the Department of Defense.[2] In support of this MOU, the Department of Energy is currently drafting a DOE Framework for the Implementation of the Environmental Security Initiative.[3] In this regard, the data on transboundary contamination described in this report is important for further work in anticipating and ameliorating potential socio-economic impacts in the transition economy countries of Central Europe. As a prelude to further work, this paper includes a section on environmental degradation issues that sets the context for potential impacts. Possibilities for future work are described in the Follow up Activities Section.
Central Europe was defined for this project as the region comprised of the countries of

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[2] Memorandum of Understanding, Environmental Protection Agency, The Department of Energy, and The Department of Defense Concerning Cooperation in Environmental Security. Signed July 3, 1996.

[3] Environmental Security Initiative. U.S. Department of Energy, Office of Policy and International Affairs. Draft dated February 3, 1997.

Albania, Bosnia-Herzegovina, Bulgaria, Croatia, the Czech Republic, Hungary, Macedonia, Poland, Romania, Yugoslavia[4], Slovakia, and Slovenia.

Objectives and Scope

There were three thematic objectives: 1) to identify data sets regarding the major contaminant sources and sinks in Central Europe; 2) to determine the potential for transboundary environmental pollution among Central European states; and 3) to assess socio-economic implications of transboundary movement of contaminants, especially related to water resources. To achieve these objectives, an operational objective evolved; 4) to develop a process that enabled geographical, cross-media, comparisons of environmental data capable of accurately merging both fine-scale (site-specific) and coarse-scale (regional) data on contamination sources and sinks.

Information about the major contaminant sources and sinks in Central European countries is extensive. Dozens of local and regional projects have been instigated and millions of records (individual data points) concerning the geographic, demographic, and environmental conditions in the area have been collected. For the most part, documenting environmental contaminants has proceeded along two distinct paths. One path has led to large regional characterization of air and water quality. The other has featured site-specific characterization. Because of the great differences in scale between the regional and site-specific studies, there has been little opportunity to merge the data and develop meaningful analyses. Conventional Geographical Information Systems (GIS) are constrained by initial decisions on the scale of resolution (i.e., polygon scale and geometry). The methodology developed and refined in this project enables merging large, disconnected data into geographically meaningful comparisons and relationships without the need for *a priori* decisions on resolution. Using this new process, transboundary environmental pollution and effects can be evaluated and presented in new ways.

Environmental Management and Sustainability

Each of the countries constituting Central Europe has specialized problems and concerns related to resources. Despite these differences, they share the common ambition of establishing sustainable economic development.

Environmental sustainability was recognized by the international community at the Rio Conference (UNCED 1992) as an essential goal of any country desiring to produce the maximum economic benefit with the least negative impact on resources and the environment. The effect on environmental quality of economic development can all too easily be negative. Resources required by a modern society include ample supplies of food, water, clean air, energy, and building materials. In turn, the society using these resources contributes waste products that affect the quality of air, water, and soil. Natural processes of decomposition and recycling of waste materials are challenged when large quantities of waste are generated. In addition, as expanding cities encroach into the countryside, the capacity of natural systems to process wastes is further compromised. In turn, diminishing food, water, and clean air supplies may threaten human health and the economic viability of a society.

While local environmental issues are sufficiently complex in themselves, the true nature of environmental problems reflects regional or even global conditions. Air pollutants discharged from one industrialized area may damage air quality for hundreds of kilometers downwind. Toxic wastes released in a freshwater stream may impair ocean fisheries. The simple recognition of

[4] The dynamic political changes during the breakup of Former Yugoslavia have given rise to new alignments and some confusion regarding country names. The current state of Yugoslavia is sometimes referred to as Serbia or Serbia/Montenegro. Many maps of the region use the names interchangeably.

this transboundary nature of environmental and natural resource problems suggests a global approach to environmental planning and management.

The countries of Central Europe face the challenge of arriving at sustainability burdened by decades, even centuries, of environmental neglect. These countries are at a marked disadvantage vis-à-vis other areas, as the magnitude of degradation restricts the amount of recovery possible. It also reduces the likelihood of achieving sustainability. Simple, degraded environmental systems are unlikely to offer sustainability potential, while complex systems, although often damaged, offer the latitude for recovery inherent in their complexity (Figure 1). Though no precise estimates of sustainability can be made, ecologists generally agree that complex systems can absorb more stress than degraded, simplified systems. In this regard, the ecological goods and services sought in sustainable policies are generally more attainable as the environmental condition remains or becomes dynamic and more complex.

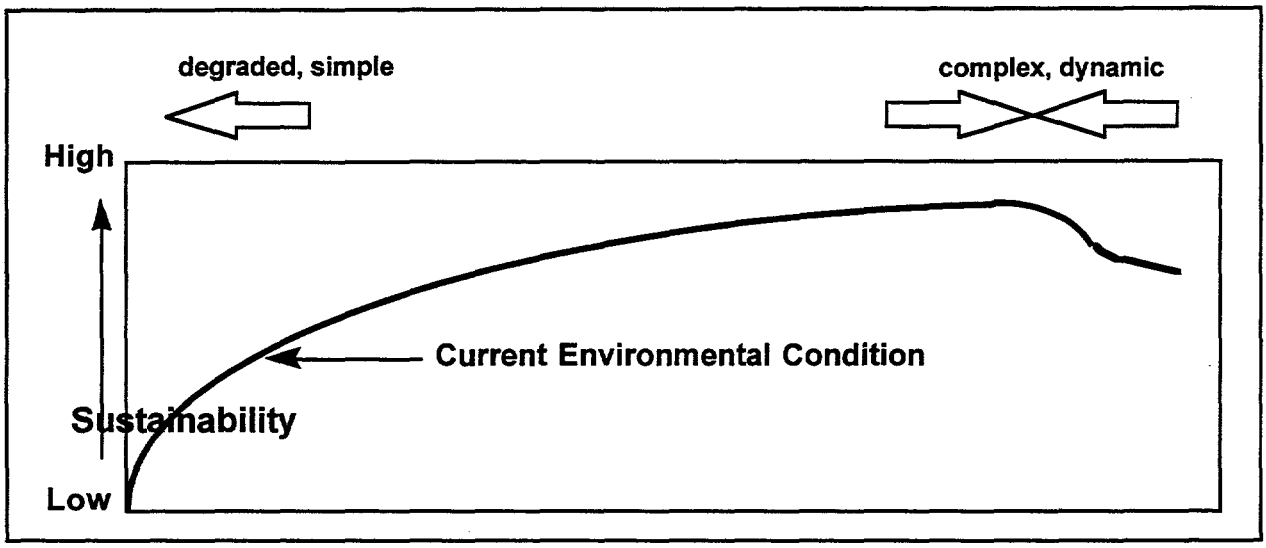

Figure 1. Environmental complexity constrain sustainability (from UNEP-IETC, 1996).

Project Participants

The project team assembled to evaluate the potential for geo-political issues arising from transboundary environmental pollution was constructed from four independent groups (Figure 2). Sandia National Laboratories provided project management and guidance on project focus. Ogden Environmental Services advised Sandia National Laboratories on geopolitical implications. ecological planning and toxicology, inc. organized cultural and environmental information on sources and sinks of pollutants including heavy metals, organic chemicals, radionuclides, air pollutants such as SO_2, NO_x, and other contaminants. Columbia Environmental Services, Inc. (CESI) developed mapping routines to display geo-referenced data from various map projections.

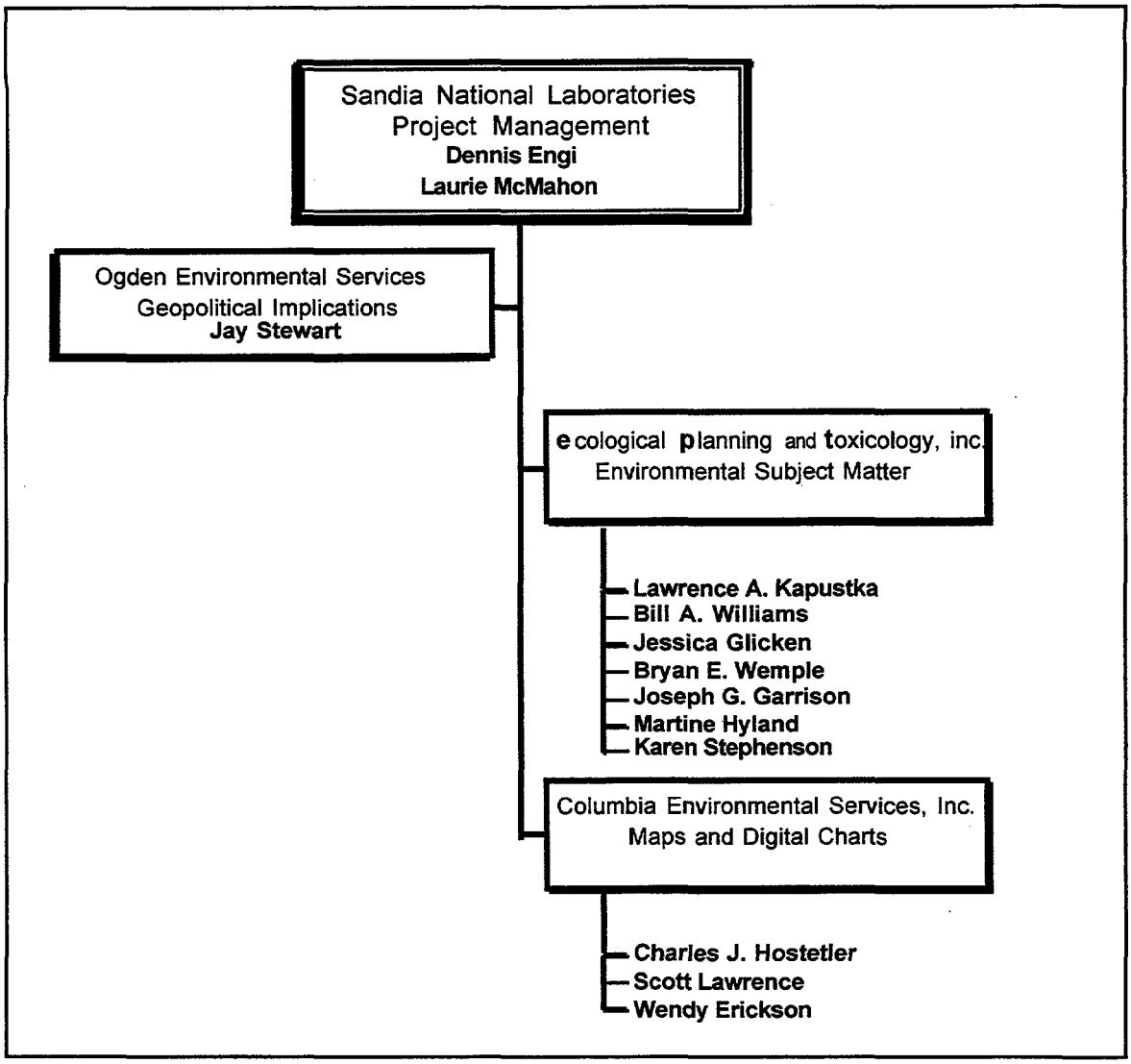

Figure 2. Project team organization and roles.

Approach

Sources of information on environmental pollution, specifically on major sources of pollutants, their likely pathways, major population centers, and land use were identified. Because the data available are in very diverse forms, it was necessary to develop a way to put it all into a single geo-referenced system for comparison purposes. The identification of contamination sources, contaminant pathways, population centers and land use patterns will support future work to identify possible human health, ecological, and economic effects.

Data Sources

Most of the information assembled and reviewed for this project is characterized as "secondary data" (i.e., that obtained from summaries of reports, maps and other existing analyses). No original data was obtained. Similarly, no raw data sets were re-analyzed in arriving at our results.

Regional and national atlases and statistical summaries were used to identify demographic characteristics, summarize water resources, land-uses, geophysical descriptions, and contaminant distribution. Books, project reports, symposium proceedings, and individual scientific papers were examined for pertinent information. Each of these sources of published data is thought to have a high degree of reliability in that prior to publication the works underwent peer review. Much of the older regional data was summarized by country (e.g., Czechoslovakia rather than the current Czech Republic and Slovakia; or the several nations of the former country of Yugoslavia) and does not have sufficiently refined geo-referenced information to assign values to the current countries.

The Internet has recently become a valuable source of programmatic information. Program and project summaries, objectives, and preliminary analyses may be found in the hundreds of Home Pages posted on the World Wide Web. (See Appendix B for a list of Internet addresses that we accessed to gather information.) Most Home Pages forecast "soon to be available" maps and data sets on environmental resources and monitoring. As there is no standardized peer review system governing information posted on the Internet, comparability among data sets and authenticity remain important considerations for use of the information. Nevertheless, we have identified some of the major access points to seek primary data sets. Regional and national monitoring programs for air and water can be searched. Access to specific data requires detailed definition of location, time, and parameters sought. Nominal charges for data searches can be anticipated.

Many of the current maps available, either as geographic references or as supplements to published literature on Central Europe, still lack the appropriate delineation of current national borders. New boundaries create potentially sensitive transboundary issues that may arise along these new borders.

Monitoring Programs

We identified 36 monitoring programs that generate primary data on environmental contamination in Central Europe (Appendix C). Most of these projects began in the last several years to determine the condition of the environment and the magnitude of pollution problems in the region. Collectively, these monitoring efforts have obtained several million records on air, water, soil, and vegetation quality and human health with respect to metals, radionuclides, air toxics, pesticides, and various organic chemicals. From our cursory examination, we suspect that data quality ranges from excellent to poor. Access to these data also varies across projects. Some contain confidential information with restrictions on distribution. In many cases, the sponsoring ministry or institute require "project funding" to cover their costs of collating and distributing the data. Summary reports from these monitoring projects are more

accessible, but most lack the necessary geo-referencing information needed to incorporate them into a larger, overview project.

The U.S. DOE has sponsored three biennial Symposia on Environmental Contamination in Central and Eastern Europe (Budapest-'92, Budapest-'94, Warsaw-'96). The major focus of research, characterization, and remediation of environmental problems in Central Europe has been on metals in soil and sediment (Table 1). Organic pollutants have also received considerable attention. Air quality has been emphasized more than water quality. However, many of the reports on metals and organics pertain to water quality. Hungary, Poland, and Romania have the largest number of records reported in the three Symposia.

Table 1. Site-specific studies by topic.

Topic	'92	'94	'96
Metals and radionuclides	74	87	129
Organics	24	27	37
Water Quality	12	13	7
Air Quality	13	33	22
(See Appendix C)			

Procedures for Gathering Map Data

Three sources of information were used to gather the information to produce the maps of Central Europe used in this report. The information from these sources had to be gathered and rectified into a single data set.

The first source of data was the Digital Chart of the World, a collection of country borders, coastlines, population centers, and waterways on five degree tiles. The second source was an Atlas of Central Europe prepared by the U.S. Central Intelligence Agency. The third source was the 1996 Hammond Citation World Atlas used to define modern borders.

Appropriate tiles from the Digital Chart of the World were converted into *dxf* files (a digital exchange format used by digital cartographic systems) by staff at the University of New Mexico, International Water Resource Association. One file was obtained for each tile for each feature type (i.e., borders, coastlines, population centers, and waterways).

Appropriate maps from the U.S. Central Intelligence Agency's Atlas of Central Europe and the 1996 Hammond Citation World Atlas were scanned into electronic images and relevant features were digitized. From the U.S. Central Intelligence Agency Atlas, the locations of several hundred pollution sources and a number of city and town locations were digitized. The pollution sources included chemical plants, coal-burning plants, ferrous metallurgical plants, non-ferrous metallurgical plants, and nuclear power plants. From the Hammond Atlas, the locations of modern borders in Central Europe were determined.

These three sources of mapping information originated in different map projections and different scales, therefore the coordinate systems had to be rectified before the information could be combined accurately. A new protocol to synthesize the different sources of mapping data was developed (Figure 3). Because of inherent uncertainties in the locations of the potential pollution sources, most of the rectification was accomplished empirically by triangulation techniques. The resulting locations were cross checked by comparing

the final projected locations of population centers obtained from the different sources.

The locations of all of the map features were combined into a layered data structure for display by the SiteAnalyzer® digital cartographic system. The layered data structure allows thematic overlays to be prepared in any combination. The final maps were produced by selecting appropriate overlay combinations, cropping the map to the study area, and generating digital images.

This technique offers flexibility to use any geo-referenced data set, essentially without concern for predetermined sectors or boundaries (tiles or polygons) associated with most Geographic Information System (GIS) techniques. The strength of this approach is that we are able to start with information taken from any accurate map, atlas, or data set that provides geo-referenced or relative positional coordinates of the data of interest. We then reconcile the data according to the projection used, and assign appropriate geo-reference coordinates (in this case longitude and latitude). All positional data are compared to "anchor points" with known latitude and longitude coordinates for reconciliation of the map projection and its position in a larger regional or national context can then be easily extrapolated.

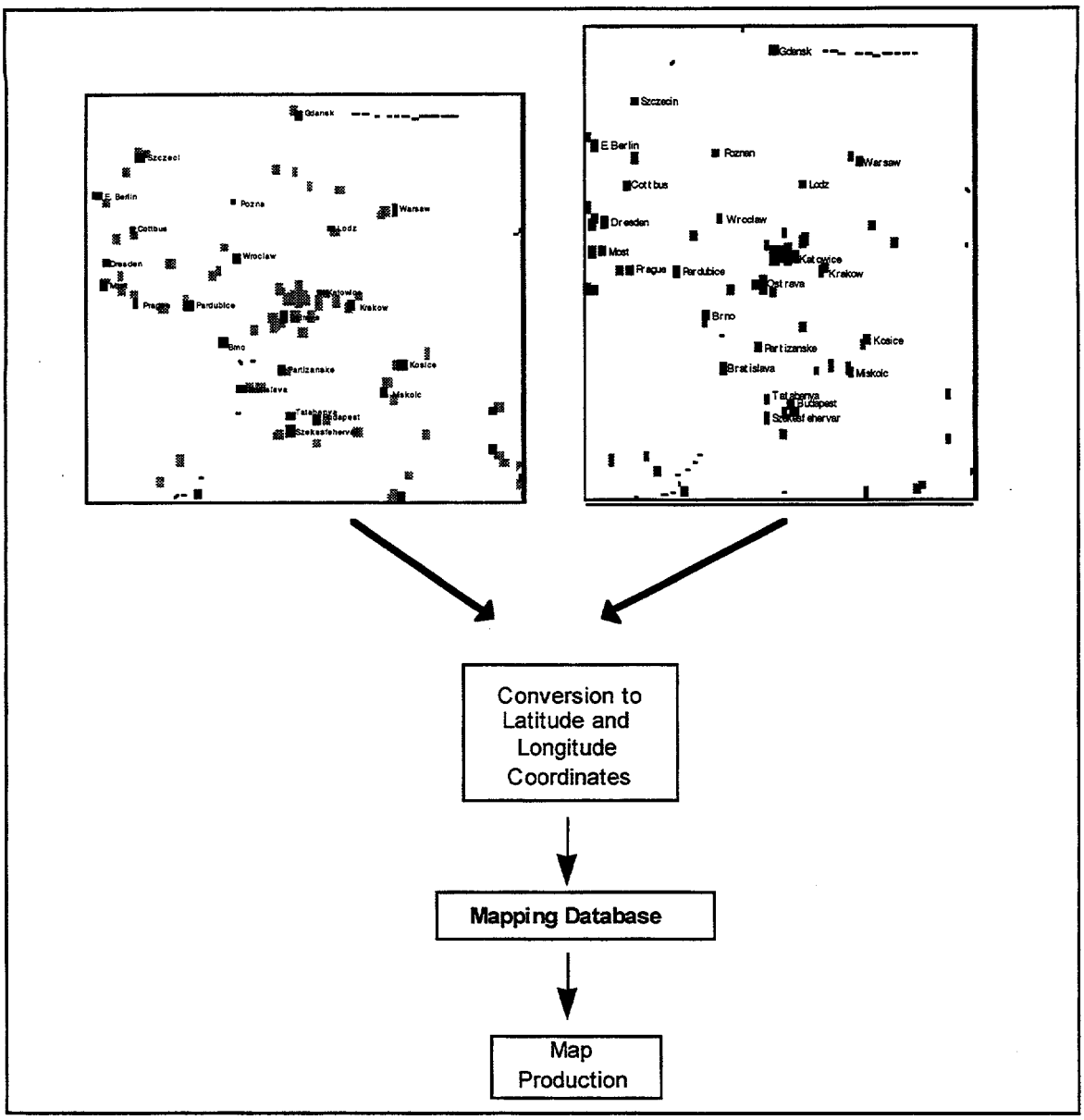

Figure 3. The process of combining information from more than one source to produce thematic overlay maps.

Results

Data were collected on population centers, land-use patterns, movement of water and air pollutants, sources of pollutants, contaminants of concern, and institutional infrastructure in Central Europe.

Population Centers

Central Europe contains many important cultural and ethnic centers of historical and contemporary significance. Many of the newly formed states have formed largely along historic ethnic boundaries. In the rural areas, stratification of cultural and ethnic differences are often more apparent because people in the agricultural regions have less mobility. The diverse nature of the ethnic and religious groups in the countries (Appendix D) may affect political processes and views on environmental management.

Large population centers are generally co-located with concentrated industrialization on or near major waterways (Table 2). At the same time that waterways facilitate transport of materials and goods, they also have tended to be the dumping and point sources for significant volumes of process pollutants and waste. Because adequate industrial water treatment facilities are not widely available, the generation and disposal of waste into waterways has created significant levels of transboundary pollution. Further, because upstream generation of wastes have rarely been dealt with adequately, the movement of waste can create potential conflict between neighboring downstream countries.

Table 2. Population Centers and Size of Countries of Central Europe (CIA 1993).

Country	*Population*	*Total Area (sq. km)*	*Capital or Largest City*	*City Population*
Albania	3,413,904	28,750	Tirane	206,000
Bosnia-Herzegovina	3,201,823	51,233	Sarajevo	448,519
Bulgaria	8,775,198	110,910	Sofia	1,128,859
Croatia	4,665,821	56,538	Zagreb	1,174,512
Czech Republic	10,432,774	78,703	Prague	1,211,000
Hungary	10,318,838	93,030	Budapest	2,115,000
Macedonia	2,159,503	25,333	Skopje	504,932
Poland	38,792,442	312,680	Warsaw	1,649,000
Romania	23,198,330	237,500	Bucharest	1,975,808
Yugoslavia	11,101,833	102,350	Belgrade	1,470,073
Slovakia	5,432,383	48,845	Bratislava	435,000
Slovenia	2,051,522	20,296	Ljubljana	305,211

Land-Use Patterns

Land-use patterns (Table 3) on a macro-scale are closely tied to historical uses and are driven predominately by the characteristics of the land itself. The largest sector of agricultural lands (percentage of basis) is in Croatia, which, in peaceful times, produces large amounts of surplus food, including wheat, corn, sugar beets, sunflowers, alfalfa and clover. Other regions support orchards, vineyards, olives, fruits, and vegetables. Albania has the largest percentage of its land in forests. Arable land in Central Europe ranges from 5% (Macedonia) to 51% (Hungary).

Policy changes do not tend to result quickly in significant changes in the patterns of land use. Nevertheless, political pressures can substantively alter land-use. For example, under the centralized planned economy of the Soviet dominated Eastern Bloc, industrialization was emphasized in Hungary at the expense of fostering its previous position in agriculture.

Table 3. Major Land Use Patterns of Countries in Central Europe (CIA 1993).

Country	*Land Use Description (% use by category)*				
	arable land	*orchards and vineyards*	*meadows and pastures*	*forest and woodland*	*urban or industrial*
Albania	21%	4%	15%	38%	17%
Bosnia-Herzegovina	20%	2%	25%	36%	22%
Bulgaria	34%	3%	18%	35%	10%
Croatia	32%	20%	18%	15%	15%
Czech Republic	n.d.	n.d.	n.d.	n.d.	n.d.
Hungary	51%	6%	13%	18%	12%
Macedonia	5%	5%	20%	30%	40%
Poland	46%	1%	13%	28%	12%
Romania	43%	3%	19%	28%	7%
Yugoslavia	30%	5%	20%	25%	20%
Slovakia	n.d.	n.d.	n.d.	n.d.	n.d.
Slovenia	10%	2%	20%	45%	23%

n.d. = data not available

Movement of Water and Air Pollutants

Central European countries share major water resources (Appendix F) that drain into the Baltic, Black and Adriatic Seas. Water flow, and therefore potential transport of pollutants, links many countries (Figure 4). The borders of many countries are defined by rivers (solid line between countries) presenting potentially significant trans-boundary exchange of pollutants; long distance transport of pollutants (arrows) reach several countries. The contiguous relationship of these countries and their shared water resources open the potential for contentious environmental issues. Alternatively, the sharing of resources can engender cooperation.

The regional watersheds are divided into two meta-basins separated by the Carpathian Mountains and the Sudeten Range on the borders of southern Poland, the Czech Republic, and Slovakia (Table 4). The area south of this line forms the Danube Basin and drains southeastward into the Black Sea. The area north of this line drains northward into the Baltic. The Elbe and Oder Rivers originate in the "Black Triangle" region, (the border areas of the Czech Republic, Poland, and Germany). Several smaller river basins in Croatia and Bosnia-Herzegovina drain to the Adriatic Sea, south of the Danube.

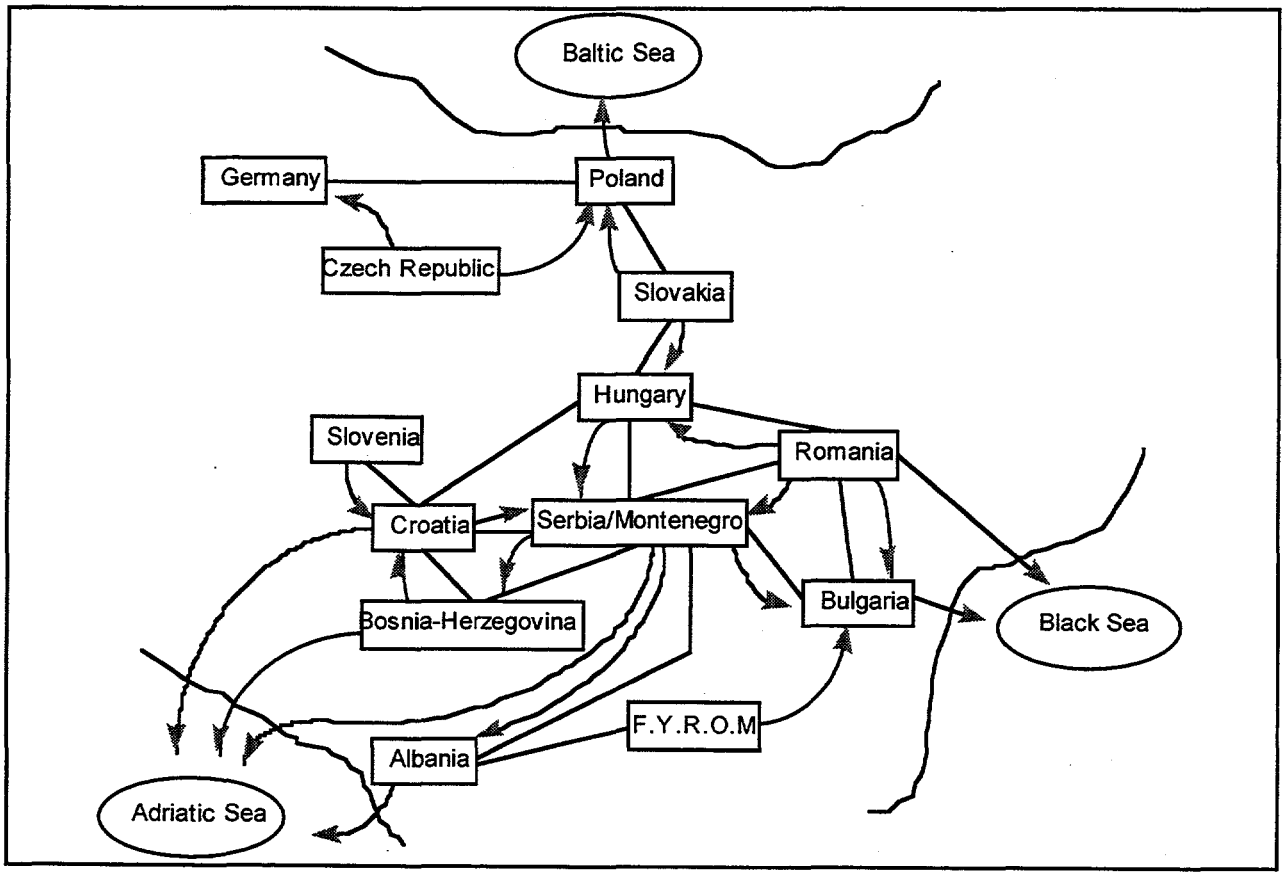

Figure 4. Water flow in Central Europe.

Annual average SO_2 concentrations for all of Europe reach a maximum in the Central European Region. Highest inputs and highest average levels are recorded in Germany, Poland, the Czech Republic, and Slovakia; with significant additional inputs from Hungary, Romania, Yugoslavia, and Croatia. Figure 5 illustrates the primary contributing nations with connected lines; the darker shading identifies the area of the highest concentrations. In addition to westerlies that provide a prevailing upper air flow, there is a northwest to southeast component template for the region. The lighter shaded area shows the general movement of pollutants from the area of highest concentration to the south and east contributing to average SO_2 levels in the region. Seasonal and localized variations in weather patterns, topography, and temperature inversions add to the complexity of this generalized pattern. As with water-transported pollutants, air-borne pollutants become regional rather than just state concerns.

Table 4. Major drainage basins in Central Europe.

River	Area (/1,000 km^2)	Length (km)	Flow ($meters^3$/sec)	Countries
Danube	805	2,850	6,450	Germany, Austria, Slovakia, Hungary, Croatia, Yugoslavia, Romania, Bulgaria, Moldova, Ukraine
Morava	27	350	n.d.	Czech Republic
Drava	40	680	n.d.	Hungary, Croatia
Tisza	157	966	n.d.	Hungary
Sava	95	940	n.d.	Yugoslavia
Velika Morava	37	494	n.d.	Yugoslavia
Timok	5	184	n.d.	Yugoslavia, Bulgaria
Elbe	n.d.	1,160	>300	Germany, Czech Republic
Oder	n.d.	910	>500	Poland, Germany
Vistula	197	n.d.	1100	Poland

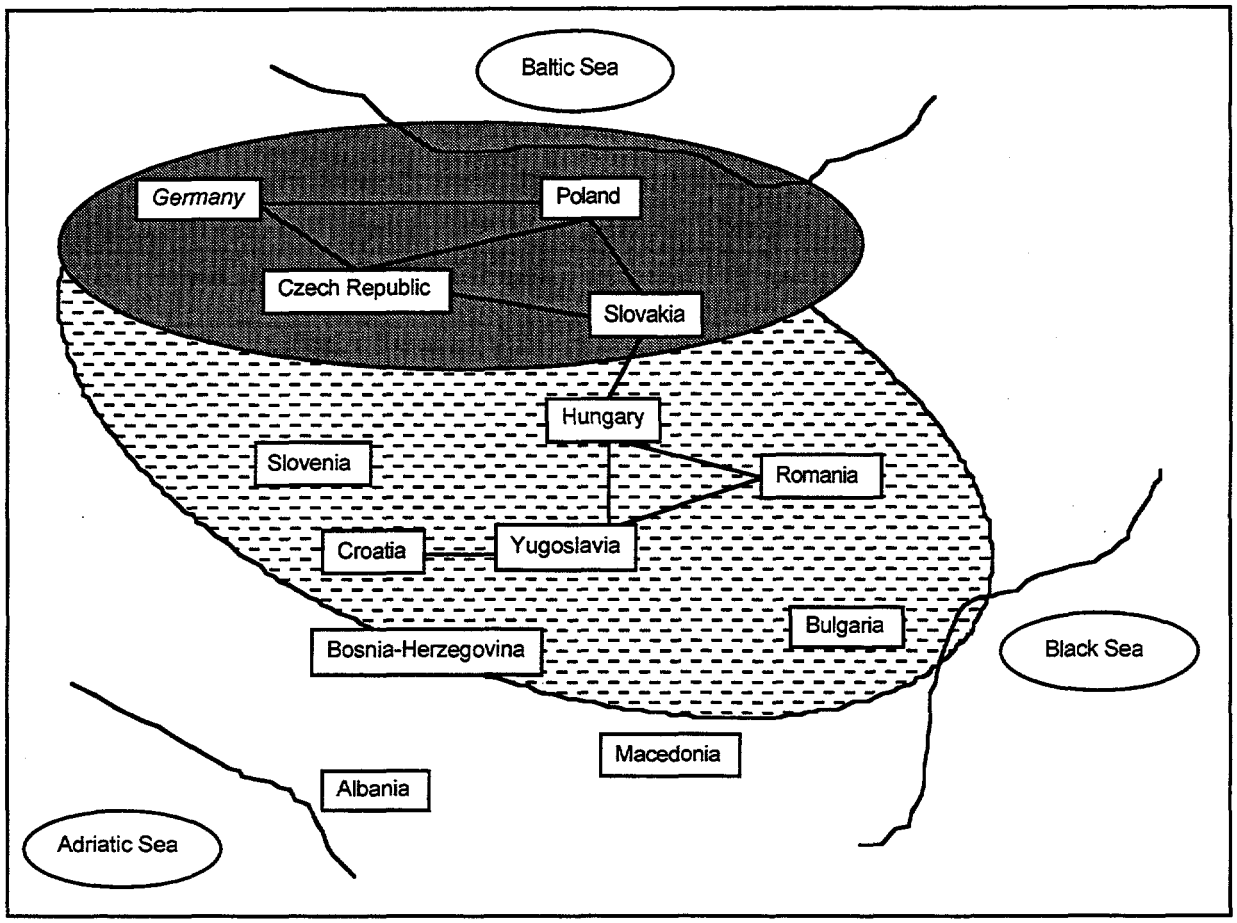

Figure 5. Air flow in Central Europe.

Sources of Pollutants

Many countries in Central Europe produce large quantities of air pollution, with the greatest volume of emissions generated in the Black Triangle of the Czech Republic.

Pollution sources in Central Europe tend to be associated with large urban areas, however, there are also several industrial processing activities such as chemical manufacturing plants, ferrous and nonferrous metallurgical plants, oil refineries, coal burning power plants, and nuclear power plants that are located in less populated areas (Table 5). In addition, numerous military sites have been situated in the region over the last several decades, including many that have been abandoned. Sources of contamination generated at these sites have included, among other things, large volumes of fuels and solvents.

There are more than 110 large chemical production facilities located primarily on rivers in the countries of Central Europe. The largest number (>30) of chemical plants is located in the southern region of Poland, situated contiguous to or on the Oder and Vistula rivers. The production of steel and steel products relies on large-scale use of high-temperature forging and fabrication, usually producing massive amounts of air pollution, including SO_2 and heavy metals. The exhaust and furnace emissions of these facilities generally go unchecked, producing air pollution at local levels far beyond standards deemed acceptable to human health and resulting in significant environmental damage both locally and at

remote distances at the whim of prevailing winds. The location of these mills has almost always been near major waterways in order to provide adequate movement of materials and finished products to other centers. The largest number (>20) of these sites is located in Poland, and the emissions from these sources constitute one of the greatest sources of pollution in the northern region of Central Europe (Carter and Turnock 1993).

Table 5. Number of Sources of Environmental Contamination in Central Europe by type (CIA 1993).

Country	*Chemical plants*	*Coal Burning Power Plants*	*Non-Ferrous Metallurgical Plants*	*Ferrous Met-allurgical Plants*	*Nuclear Power Plants*
Albania	3	1	1	1	0
Bosnia-Herzegovina	4	3	0	2	0
Bulgaria	12	7	3	2	1
Croatia	3	0	0	2	0
Czech Republic	14	14	4	10	1
Hungary	7	4	5	6	1
Macedonia	0	1	2	1	0
Poland	32	21	7	23	0
Romania	32	6	6	9	0
Yugoslavia	3	7	3	3	0
Slovakia	7	3	3	2	1
Slovenia	2	1	1	3	1

Production of non-ferrous materials includes production of the many metal goods and products that are milled and founded from copper, zinc, aluminum, and specialized alloys of heavy metals. Poland, Romania, and Hungary have several industrial sites manufacturing non-ferrous metals. Although many of the waste products generated at these sites are air pollutants, large volumes of heavy metals and other waterborne contaminants find their way to major waterways and the aquatic systems of Central Europe.

Oil refineries are found in virtually all Central European countries. With the exception of the extreme northerly region of Poland, these refineries are distributed throughout the region and are sources of significant pollution. Numerous agreements to import natural crude oil to these sites for production of gasoline and other petroleum based products were signed with the former Soviet Union and remain in force. Modern technologies that could minimize emissions have yet to reach the region.

The coal-burning power plants that have been the primary source of electricity for several decades in this region are some of the dirtiest in the world. Installation of new, cleaner power plants has begun recently. Although most of the countries in Central Europe produce large quantities of air pollution, the greatest volume of emissions are generated in the Czech Republic and

Poland. The uncontrolled emissions of these sites move hundreds of miles from their origin, creating several potential transboundary issues.

The use of nuclear energy as an important power source in the last several decades has been associated not only with industrial centers, but also has been used to provide electrical power to the urban/rural areas of each country. Nuclear power remains a contentious issue worldwide. In part due to the limited supply of clean alternative energy sources in Central Europe, nuclear power has played a significant role in some areas. The contentious issues that arise from the siting and use of nuclear power plants can be traced to the public perception of risk associated with nuclear power (Genov 1993). Although the likelihood of a major nuclear accident is considered to be very low, the consequences are viewed by most people as devastating. The experiences of the Chernobyl explosion in the Ukraine in 1986 frame the opinions of much of the public sector. Nuclear power plants operate in Bulgaria, the Czech Republic, Hungary, Romania, Slovakia, and Slovenia (Appendix G). Probably the most contentious transboundary issues in nuclear power siting occur between the Czech Republic and Slovakia. Before the division of Czechoslovakia, there was considerable debate about the two large reactors at Temelin in southern Bohemia. Arguments for continued construction of the reactors at Temelin were based on the possible closing of coal-fired power plants in northern Bohemia and the associated reduction of sulfur dioxide emissions.

Contaminants Of Concern

The extent and magnitude of contaminant sources and sinks in Central Europe is complicated by the large number of urban and industrial sites that produce and discharge untreated domestic and industrial waste into the air or waterways. The prominent contaminants associated with urban growth, large scale industrialization, thermal and energy production are air pollutants such as SO_2, NO_x, and heavy metals. The most prevalent metals associated with industrial processes include arsenic, cadmium, copper, lead, and zinc. The list of contaminants that are transported by waterways, includes numerous heavy metals, pesticides, and organochlorines that are by products of many industrial processes. Each contaminant has been correlated with impacts on human health and environmental degradation, and has implications for human health and environmental quality associated with the toxicity of these pollutants and ecological resources (i.e., agriculture, fisheries, wildlife). Levels of concern of these pollutants can generally be described as high concern, moderate concern, and low concern. This brief discussion is supplemented by a more technical description of the concern and inherent toxicity of each pollutant in Appendix H.

A qualitative ranking of these selected pollutants places Poland, Hungary, and Bulgaria as having the most severely degraded environment condition of the twelve countries. Romania, the Czech Republic, Croatia, Slovakia, and Slovenia fall into a middle tier. Yugoslavia and Macedonia are close behind the middle group. Bosnia-Herzegovina and Albania rank low, primarily due to minimal information. All of the countries experience problems due to environmental degradation (Figure 6).

In terms of human health issues, substandard water quality, contaminated foods, and severe air pollution have resulted in documented ecological and human health problems. In addition to a myriad of specialized, pollutant-specific symptoms, several studies have reported below-average life expectancy. For example, in Macedonia, the life expectancy of individuals in one particular city was 12 years lower than for other cities of the region.

Ecological injury can also be seen throughout the region. Die-back of trees and restrictions on use of agricultural land due to contaminants pose serious economic and ecological threats to sustainability.

Waterways have depleted fish populations, and when fish do survive they carry high

body burdens of many contaminants. With the contamination of soil, vegetation, water, and various portions of the food chain, the ability of ecological systems to function normally is compromised.

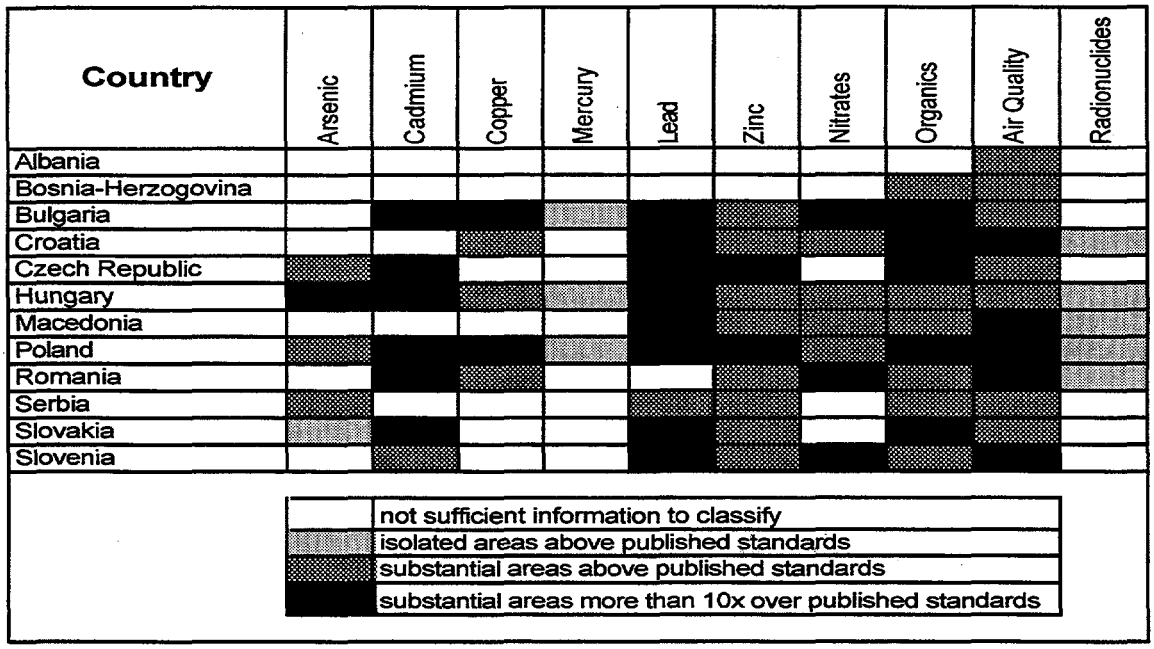

Figure 6. Relative ranking of contamination by country.

Institutional Infrastructure

Except for Yugoslavia and Bosnia-Herzegovina, where interethnic tensions dominate politics, the governments of Central European nations play a large role in environmental clean-up. Most nations have passed extensive legislation regarding environmental regulations, yet the ministries responsible for enforcing these regulations lack both the authority and staff resources for effective implementation. In most cases authority for environmental control is shared by several ministries (Boyd 1994). This fragmentation of authority and cross-jurisdiction could lead to conflicts between ministries, for example between the Ministry of Finance and the Ministry of the Environment. A list of relevant ministries, including currently available names of the environmental ministers and their contact information is included in Appendix I.

The institutional infrastructure differs considerably among the countries. We ranked the countries on their probable capacity to respond to environmental problems based on the existence of a governmental infrastructure (Figure 7). Poland, Hungary, and the Czech Republic appear to have the greatest capacity to respond effectively to the serious levels of environmental degradation in their countries.

Capacity / Degradation	Minimal Degradation	Considerable Degradation	Severe Degradation
Good capacity		Czech Republic	Poland Hungary
Moderate capacity		Bulgaria Croatia Yugoslavia Slovenia	Romania
Limited capacity		Macedonia Slovakia [Bosnia-Herzegovina]	[Albania]

Figure 7. Relationships between the extent and severity of environmental contamination versus the national capacity to respond.

Environmental Degradation Issues

Implementing environmental sustainability challenges managers as they attempt to balance current needs and anticipate expectations of future generations. The options available are constrained by the legacy left from previous resource use activities. In Central Europe, low priority was given to environmental issues for hundreds of years. Extensive use of highly polluting coal coupled with outmoded and inadequate heavy industrial infrastructure has produced severe environmental degradation in the region.

Central Europe faces many environmental challenges. Among them are: 1) establishing responsibility for past pollution; 2) enforcing existing environmental regulations; 3) meeting consumer expectations; 4) encouraging outside investment; 5) creating a national basis for environmental action; 6) creating channels for public participation in government activities; 7) managing transboundary pollution; and, 8) compliance with international conventions.

Political-Social-Technology Linkage

The breakup of the Soviet Union and its resulting impact on the Warsaw Pact economies resulted in the geo-political alignment. The break up of the former Yugoslavia produced the states of Bosnia-Herzegovina, Croatia, Yugoslavia, Slovenia, and Macedonia. Similarly, in Eastern and Northern Europe, the creation of the independent nations of Estonia, Lithuania, Latvia, Belarus, Ukraine, Azerbajian and Kazakhstan dramatically altered regional and global relations. The states derived from the former Soviet Union constitute an eastern European region termed the "Commonwealth of Independent States" and are not addressed in this document. Nevertheless, each of these nations share common experiences with regard to environmental issues.

The emergence of newly independent states coupled with the transition to market-oriented economies has altered socio-political and economic alliances in the region. The industrial, manufacturing, and agricultural sectors under the old Eastern Bloc were not always linked to resources. Also, environmental management was given little attention. Consequently, the new countries must simultaneously establish efficient industries related to their resource base while coping with a legacy of decades (and in some locales centuries) of environmental degradation. Moreover, geographic and climatic conditions lead to transport of airborne and waterborne pollutants across political boundaries. Thus, local industrial areas affect not only the regional environment as pollutants generated in one area (source) migrate to downwind and downstream (sink) areas.

Historic and Cultural Factors

The history of Central Europe is marked by repeated domination by foreign forces dating back at least to the Roman Empire. The past several centuries have seen many upheavals.

Historic Political Periods

Imperialism:	1400s - 1500s
Feudalism:	1600s - 1700s
Nationalism:	1800s - mid 1900s
Soviet Era:	mid-1900s - late 1900s

(See Appendix A)

Exploitation of resources, and the beginning of environmental degradation became locally significant in the Middle Ages. Forests were cut, streams were diverted for irrigation, and agriculture production altered much of the landscape. The industrial age placed increased importance on mineral resources, including metal ores and coal. The geographic position of Central Europe between Western Europe and Asia, bridged by the vast land expanse of Russia, was of great strategic value to the great powers in

the region between the 16th and 19th centuries. The last 450 years was dominated by four general themes: imperialism, feudalism, nationalism, and the Soviet regime. These historic periods continue to influence the economic and socio-political dynamics of the region (Appendix A). The late industrial age was disrupted by two world wars, at the end of which the nations were placed under Soviet domination. Soviet policies that promoted rapid and widespread industrialization exacerbated the region's uneven development, and in 1989, left the region to face the consequences of extensive environmental damage.

Central Europe can be distinguished by two general cultural alignments. The northern countries of Poland, the Czech Republic, Hungary, Slovakia, Slovenia, and Croatia were historically linked to Western Europe. These countries participated for much of the past five centuries in the developing religious, scientific, economic, and political systems now dominant in the west. By contrast, the southern countries of Romania, Bulgaria, Yugoslavia, Macedonia, and Albania have historically been linked with Middle-Eastern developments for at least the same length of time. The cultural religious philosophy of the north is dominated by Christianity, whereas the southern religious philosophy is dominated by Islam. In considering the importance of environmental issues, differences in these religious philosophies (Christianity vs. Islamic) may be significant. Secondly, the closer ties between the northern countries and the West are instrumental in identifying financial resources and solidifying commitment to help improve the environment.

These two contrasting cultural alignments have influenced the progress of environmental remediation in Central Europe. The northern states are better prepared for the transition to privatization and democracy than those in the south. They already have closer ties with the West, and capital, including funds for environmental remediation, is more readily available. Environmental officials and activists from environmental grassroots organizations readily move between the major West European cities and Prague, Warsaw and Budapest. By contrast, the South appears to be at a disadvantage because of ethno-cultural differences with those who provide external funds and support for environmental issues.

Technological Factors in Environmental Issues

Under communist control, the Eastern Bloc countries emphasized output by heavy industry. Efficiency in production and environmental protection received little or no attention. The result was rapid and widespread ecological damage. Environmental damage continued essentially unchecked for decades. An example of long-term environmental damage is the soil degradation that occurs across Central Europe. Soil pollution has resulted from fertilizer and pesticide use as well as heavy metals and acid deposition from industry. Opencast mining has led to the destruction of topsoil and arable land, where mining and quarrying located in rural areas has been supplemented by local thermal power-stations fueled by lignite. The countryside around these areas has been subjected to substantial fly ash deposition. The dumping of municipal and industrial waste adds to this problem, along with wind and water erosion.

With the spawning of democracies in the former Eastern Bloc nations, information on pollution effects on health, agriculture, forestry, and the quality of life became accessible to the general public. As a result, national environmental mitigation programs have been initiated in many of the countries of Central Europe.

The low priority given to environmental issues for hundreds of years in these regions combined with large natural deposits of sulfurous brown coal, and the adherence to an outmoded and inadequate heavy industrial infrastructure contributed to severe environmental degradation. During the decades of the 1970s and 1980s there was increasing awareness placed on pollution control, although there was often a lack of accompanying legislative support.

Although slow in coming, even before the geopolitical transitions of 1989, new environmental legislation was being introduced in many central European countries.

The Environmental and Political Movements

Environmental issues played a political, albeit primarily rhetorical, role in the 1989 revolutions that redefined Central Europe. Environmental movements across Central Europe acted as umbrella organizations for people frustrated with the state socialist regimes. Demonstrations in Budapest against the construction of the Gabcikovo-Nagymaros dam brought together reform-minded communists, nationalists, socialists, social democrats, liberals, and Christian democrats (Fisher 1993). Environmental concerns also played a large role in the political activities that led to Slovenia's secession from Yugoslavia. The independence movement was led by a seven party coalition called DEMOS, which included the Green Party. Slovenia's Green Party achieved the greatest electoral success of an environmental party in Central Europe. It is important to note that, in Slovenia as elsewhere across Central Europe, environmental issues were often used merely to mobilize anti-Communist sentiment as support of environmental issues was less politically dangerous under the communist regimes than was advocacy of economic change (Frankland 1995). When communist opposition was no longer a primary issue, the focus of the party shifted to economic development concerns. Three years after Bulgaria's environmental organizations played a pivotal role in the breakdown of state socialism, there was no environmental representation left in Parliament. In fact, environmental movements have generally suffered a loss of credibility since the transition, because leaders often left these grassroots organizations for government positions and became pre-occupied with other political struggles rather than striving for effective environmental management. This has been exacerbated by the general lack of trust in government or institutions felt by many Central Europeans, a distrust inherited from the experience of state socialism. Both these factors (the decline of environmental issues as useful political rhetoric and the general lack of trust in formalized government) led to such trends as the sharp decline in the Romanian Ecological Movement (MER) in Romania following its early success.

In many democracies, informal public participation, through non-governmental organizations (NGOs), is key to populist environmental movements. Public involvement is in its infancy in the most prosperous Central European countries such as the Czech Republic, Poland, and Hungary. In the other countries of Central Europe, non-governmental organizations are yet to be established as viable entities for political discussion.

Nations in Central Europe have engaged in dialogue to address trans-national environmental issues. For example, solutions are being sought for a chlorine factory in Giurgiu, Romania that causes health problems in Ruse, Bulgaria. Romania has expressed concern about the Bulgarian nuclear power station at Kozloduj; Romania and Yugoslavia struggle to define equitable use of irrigation water. It is too early to say how these issues will be resolved.

The assignment of responsibility for pollution in the Soviet-era is a significant problem as new governments privatize state-owned industry and other ventures. Poland has required environmental assessments as part of the privatization process, but many privatization officers tend to see environmental reviews as an obstacle rather than a help in their efforts to sell state property. Assignment of responsibility for environmental degradation and pollution that occurred under a regime that no longer exists and which did not assume responsibility for pollution is a recurring problem in Central Europe. Establishing liability for past environmental degradation has been confounded by the fact that the Central European economies are generally incapable of paying the massive costs of cleanup (Boyd 1994).

Regional Issues

It is necessary to recognize that environmental pollution is a regional rather than a national issue because pollutants cross national boundaries so readily. This is true not only for airborne pollutants but waterborne, as few waterways lie wholly within one Central European country. For example:

1. The loss of the forests in the Krkonose National Park, part of the "Black Triangle" on the frontier of Northern Bohemia affect Poland, the Czech Republic, and Germany.
2. The radioactive fallout from Chernobyl provides the most dramatic evidence of the region's cross-boundary vulnerability to pollution generated outside the area.
3. The Elbe rises in the Czech Republic and empties into the North Sea at Hamburg, Germany, carrying massive amounts of pollutants.
4. The Danube rises in Germany, and flows through six European countries before it empties into the Black Sea in Romania. Conflicting national demands upon the use of these waterways have increased rather than abated pollution.

Since environmental degradation transcends national borders, the economic and social problems it produces are also regional in character. However, issues of state sovereignty prevent one state from compelling neighboring polluters to take action.

Economic Factors

The development of industrial centers depends on availability of natural resources and financial markets, technologies, transportation (including waterways), and a skilled workforce (see Appendix E). National and regional policies also play an important role in siting specific industries. The new geo-political boundaries have substantially altered the production and market balance of agricultural, energy, and mineral resources. This is particularly true in the division of Czechoslovakia, where the western region of the Czech Republic inherited substantially more industrial capacity than the eastern region of Slovakia. More profound market realignments are likely among Macedonia, Croatia, Bosnia-Herzegovina, Yugoslavia, and Slovenia.

Central Europe is aligned by a North-South economic dichotomy. In the North, Poland, the Czech Republic, and Hungary are making steady progress towards a market economy. The countries in the South are, in general, more centralized and as a result have had a more difficult transition to a market economy. Slovakia, Bulgaria, Romania, and Yugoslavia were to a large extent industrialized under communist regimes, and as a result, privatization has been considerably slower in these countries. Bulgaria's stabilization program has been hampered by difficulties in constructing the institutional infrastructure necessary to make a capitalist system work. Romania has been faced with triple-digit inflation; almost one half of the population of Romania is considered to be living below the poverty level. War has impeded any moves towards economic improvement in all the republics of the former Yugoslavia.

Environmental issues understandably play only a secondary role in such an economic setting. In the southern states, the struggle for survival precludes significant concern for environmental issues. In the northern states, concerns focus on attempting to improve the sluggish economy. Despite the resolutions of the Rio Conference, western economic strategies often discount the importance of the linkage between sustained economic prosperity and environmental stewardship.

Commentary

Overview

At the beginning of this project, one thesis was that transboundary issues were likely to spawn conflict among the Central European countries and between them and their neighbors. Currently, however, the common environmental problems facing the region, have brought the countries together. The scientific community recognizes the interlocking nature of environmental issues. Under the umbrella of sustainable development, political and financial forces are uniting with the environmental sector to halt degradation and improve overall conditions.

Clearly, all is not perfect, and opportunities for deteriorating relationships will arise. As Central European nations strive for inclusion in the European Union, environmental concerns will remain an important common denominator that bind them together. Developing regional projects for environmental improvements and securing financing can become a catalyst to proactive collaboration among nations.

Technology Development

The geo-referencing technique refined in this project provides an effective means to collate and compare large volumes of complex local, regional, and national information of dissimilar types, media, and sources for analysis. The ability to collate and compare such diverse data sets will be instrumental in displaying and analyzing new interactive relationships between normally dissociated data sets. The immense volume of existing data, until now, has remained isolated in individual reports. This new technique allows use of techniques such as cluster analysis to provide the relationships between pollutants and effects that may not generally be seen in other comparisons. Using this technique, sources and sinks of environmental pollution can be graphically overlaid on rivers, population sources, socioeconomic, or even cultural information to estimate causal relationships between these factors.

Two aspects of the technique that proved important to its success include the digitization process and coordinate transformations.

Digitization Process - A manual digitization process was used to determine the locations of map features on scanned images. Columbia Environmental Services Inc. (CESI) has recently developed a more automated scan digitization software package that can be incorporated into the mapping protocol that will reduce digitization labor by fifty to seventy-five percent. Digitization labor accounted for about a quarter of the labor involved in producing the final maps.

Coordinate Transformations - An empirical triangulation process was used to convert digitized coordinates across map projections and scales. CESI has developed a set of projection transformation equations that can now accomplish this step automatically given the scale and projection information. This improvement can be automatically incorporated into the digitization process, resulting in a further reduction in labor. Furthermore, this improvement will result in the ability to select the best projections for the final maps.

Follow up Activities

The analyses undertaken and methods developed in preparing this report lead to five logical follow-up actions. These actions are aimed at providing both the technical capability to compare large amounts of site specific and regional data, as well as an understanding of the institutional context in which solutions are to be implemented. While discrete activities, they are interrelated and have the potential for a more in-depth understanding about alternate and feasible solutions to regional environmental problems. Activities one through three will lead to better understanding and management of the technically-based but socio-politically driven institutions and processes for environmental management; activities four and five focus on developing data acquisition and management capabilities to support decision-makers. The two sets of activities thus are complementary. Both are necessary; neither alone is sufficient.

1. Decision Support System - Effective use of the substantive information presented in this report is best achieved as part of a decision support system related to the identification and resolution of environmentally related transboundary conflict issues. A decision support system must have information from the decision makers as to the types of decisions they need to make and the information related barriers they see as impediments in that decision making process. We propose a series of Vital Issues panels with key in-country decision makers as the most effective way to identify those barriers. This, combined with input from secondary research on related international conventions (see item 2 below), data availability, and available technical tools will provide guidance for technology development activities that can help reduce the likelihood of transboundary, environmentally related conflict.

2. Review of International Environmental Conventions and Protocols - Many countries in the region under review have signed and ratified existing Conventions and Protocols which influence the direction of investment and assistance programs. Such Agreements, addressing broad environmental issues such as desertification, biodiversity, climate change, the movement of hazardous chemicals, etc., facilitate development of regional projects. In addition, funding mechanisms such as the Global Environment Facility (jointly administered by UNEP, UNDP and the World Bank) specifically support regional development projects. Many bilateral assistance organizations are partnering with other similar groups given the scale of the problems being addressed and the necessary level of funding required. Therefore a review of all such Agreements will greatly facilitate understanding of feasible technical options as well as improve the chances for funding for implementation.

3. Institutional Analysis - Once environmental problems are identified and prioritized, most nations of the region look to bilateral and multilateral technical assistance and financing entities to help organize and secure required funding to implement effective solutions. A clear understanding of those organizations active in the region is therefore mandatory if they are expected to collaborate in addressing regional problems. We recommend that such an analysis be completed in order to identify investment opportunities leading to implementation of cost-effective, long-term solutions.

4. Data Structures - The map features are currently structured as points and line segments. No information is stored about adjacency or direction. This is particularly important in working with

the waterway layer. In order to study the downstream migration of pollutants through the surface water system, the connectivity and direction of the river segments must be included. We have developed an algorithm that will knit the individual pieces of the waterways into a watershed type of data structure (Figure 8). This procedure will allow the waterways to be dealt with in a watershed context, rather than as individual map features.

5. Map Simplification - The Central Europe map database currently has about 40,000 features. Not all of these features are visible at all map scales. We recommend the development of an adaptive simplification algorithm that simplifies the features appropriate to the zoom level. This improvement will result in faster map processing and printing.

These improvements can be easily made within the context of the SiteAnalyzer® digital cartographic system. We recommend that the new process algorithms be implemented as SiteAnalyzer® plug-in modules. The SiteAnalyzer® system was designed to accommodate any number of plug-in modules to allow for customized map production. Our review of current and continuing research, characterization, and remediation projects in Central Europe shows great progress over the past decade. In many locales, evidence of improving environmental conditions has been developed. Even more important, the institutional capacity to embark on modern environmental management strategies has begun to take hold in several countries. Perhaps the most advanced groups are found in the Czech Republic, Poland, and Hungary.

The many efforts underway have generated millions of environmental data records, both on regional scales and site-specific projects. The mapping approach perfected on this project enables us to process information from virtually any map or spreadsheet data that can be geo-referenced. Because the procedure is freed from *a priori* constraints of scale that confound most Geographical Information Systems, we have the capacity to generate new projections and apply sophisticated statistical analyses to the data.

We believe this offers an opportunity to pursue three important problems facing the individual countries and the broader region of Central Europe.

a) The multiple efforts underway have tended to serve rather narrow project objectives dictated by the funding agencies, private investors, and the individual researchers. Whereas large-scale monitoring programs are important for regional planning, the information has limited value for many local environmental decisions that must be made. Conversely, site-specific projects yield high quality data for the special needs of each project, but are not easily integrated into a broader regional context. Our mapping approach enables us to combine both suites of information, thereby greatly improving the regional characterization of environmental degradation.

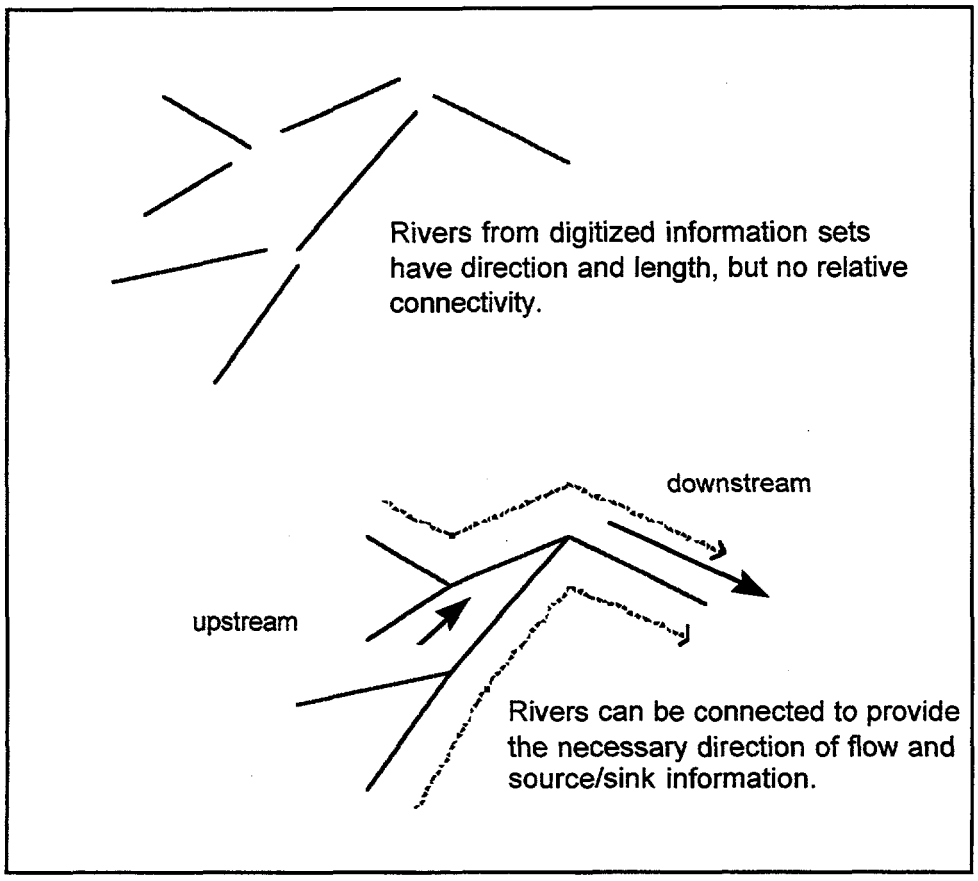

Figure 8. Illustration of the incorporation of connectivity and direction of flow to digitized river information.

b) Several isolated studies have documented serious human health effects linked to environmental contaminants. This includes significant reductions in life expectancy in some locales. After assembling the site-specific and regional data sets described above, it would be feasible to add in critical epidemiological data from Central Europe. Statistical procedures could be used to assign different categories of contaminants, ethnicity, life styles, etc., in an effort to identify the extent to which environmental degradation is responsible for the lowered life expectancy. For example, it may be possible to show that ethnic origin accounts for 2 years, diet accounts for 3 years, and environmental contaminants for 5 years of a 10-year shorter life expectancy. Such information would be very useful in gauging the risks and potential solutions associated with various contaminants.

c) Similarly, the approach could be used to document actual and likely injury to ecological resources. Inventories of forest condition, agricultural production, fisheries, and wildlife could be subjected to statistical analyses relating contaminants to ecological conditions.

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Appendices

Appendix A. Description of Historical Periods.

IMPERIALISM:

Ottoman Empire

Ottoman rule was established in the Balkans during the 15th century. Their ultimate goal was to capture Vienna and to interrupt the trade routes between Western Europe and the Orient (Turnock, 1989). In 1526 they won a decisive battle in Hungary, but were stopped at Vienna. For 150 years they occupied central Hungary (the Great Plain and Transylvania), while the western regions of Hungary remained under Habsburg control. The Habsburgs began to develop industry in western Hungary, but the lands under Turk control remained relatively undeveloped. These two regions today are still unevenly developed in economic terms (Borsody, 1988).

Ottoman policy did not succeed in integrating the Central European territories into a single national identity. Rather, Ottoman power was laid on top of ethnic identities that were never lost. They retained control of the Primorie salt mines in Bulgaria, the mining of sulfur in Macedonia, and heavily taxed agricultural land. The collected taxes were spent on "non-productive instruments of government and state oppression" (Grozdanova, 1984) rather than on economic infrastructure. Industrial production in the Balkans was not strong due to technological stagnation, inflation, and currency devaluations (Zdraveva, 1980). The Empire also failed to instill a unified language, religion, or system of education for its far flung possessions (Wagner, 1970). The mountainous relief of the area kept peoples isolated and prevented full penetration of Ottoman influence.

The rise of nationalist ideology in Central Europe in the 19th century, which gave political expression to these ethnic groups, was ultimately disastrous for the Ottomans. Nationalist demarcations and accompanying tensions often were exacerbated by an uneven distribution of resources along ethnic lines (Szajkowski, 1993).

Habsburg Empire

The Habsburg Empire devoted most of its resources to war and tax collection, and like the Ottoman Empire, failed to develop any feeling of unity among its peoples. Because of its position on the Danube, Vienna (the capital of the empire) controlled the flow of goods throughout the Empire, the majority of whose lands were remote from major shipping lanes (Borsody, 1988). The most productive areas in Bohemia and Hungary only prospered as suppliers since they did not control the trade routes. Lacking the resources to develop communication links throughout its extensive territories, the Empire was marked by a "contrast between center and periphery" (Turnock, 1989). High transportation costs virtually ensured that new industries would generate a "small advanced region probably in and around the capital city or chief port" (Turnock, 1989). Croatian and Slovenian lands that lay along the Habsburg military frontier were particularly under-developed (Erceg, 1989). The uneven degree of development often provoked conflicts among the various ethnic groups. The 1867 Compromise created the Dual Monarchy of Austria and Hungary, under which the Hungarians sought to suppress and "magyarize" the Ruthenians, the Slovaks, and the Romanians. A prosperous Czech nobility continuously sought similar recognition within the monarchy but was unsuccessful. (Szarka, 1989).

As the demand for Western European grain increased between the 16th and 17th centuries, the Habsburgs intensified agricultural production by the diversion and drainage of the Tisza River which brought more land under cultivation but brought about environmental changes (Refi,1987). However, despite this increase in agricultural intensity, industry surpassed agriculture as the chief means of production in the last third of the 19th century. At this time, the Czech lands were rapidly developed (Szarka, 1989). However, industrialization in Central Europe lagged behind that of Western Europe (Schramm, 1990).

Poland (divided among empires)

Poland's unfortunate position between Russia, constantly seeking access to the warm water ports of the Baltic, and Germany, whose desire for expansion led eastward into the undeveloped lands, precipitated its disappearance from the map in 1795. Partitioned between the powerful Prussian, Austrian (Habsburg), and Russian empires, Poland's development was thwarted due to the economic interests of her conquerors. Prussia sought to draw Poland's trade into the German orbit of Hamburg, Bremen, and Stettin which led to the decline of Danzig (also known as Gdansk) and also sought access to the Moravian Gate--one of the only openings in the mountainous belt which stretches across Europe from the Rhineland to the Black Sea. Russia and Austria, similarly sought to direct all means of communication within Poland toward the centers of their respective empires. In fact, the Austrian parts of Poland were seriously impoverished, and "Galician Misery" (Galicia was the Habsburg possession in what would be south-eastern Poland today) was often referred to among the ruling elite. When Poland was "resurrected" after World War I, this sporadic and uneven development proved to be a huge obstacle to successful reunification. (Taylor, 1952).

We begin to see the emergence of a pattern of uneven economic development and political fragmentation across Central Europe. This sets the stage for the emergence of feudalism with its downward and extremely local focus of activity and authority.

FEUDALISM: In the 16th and 17th centuries Central Europe became "a land apart," and the dynamic development taking place in Western Europe "tended to reduce Eastern Europe to the level of provider of raw materials, chiefly grain, to an expanding West" (Okey, 1986). While Western Europe was moving towards capitalism, in Central Europe there was a revival of serfdom. In order to meet the demand for grain coming from the West, the nobility seized peasant land to monopolize the grain profits, reversing the growth of towns and the freedom of the peasants (Stahl, 1980). This perpetuation of a feudal economy kept the Central European rulers dependent on the lords for political and economic support and prevented the development of modern state systems (Rugg, 1985). Modern states rely on the diffused authority of a bureaucratic machinery, but in Central Europe authority was characterized by patron-client relations (Jowitt, 1992). This "economy of privilege" (Speilman, 1994) revolved around the exchange of social status, private rights, and exemptions from legal procedure. This legacy was particularly damaging because it prevented the development of a national consciousness or sense of collective identity and instead developed a perception of the state as serving the private interests of the elite (Genov, 1993). This also precluded the development of, and the belief in, abstract legal or regulatory systems, and continued the movement toward political fragmentation.

NATIONALISM: In many respects the 20th century in Central Europe has been characterized by nationalism. The borders created after World War I through the Paris peace treaties were meant to grant national self-determination to peoples long subjugated by empires. However, the complex mixture of peoples in Central Europe made it impossible to draw borders according to national/ethnic lines. (For example, pockets of Hungarians were left in the new states of Romania and Czechoslovakia.) The ethnic/linguistic definition of the "nation" dominant in Central Europe made the post World War I borders unacceptable to those nations affected, and Central Europe's involvement in the second World War was largely motivated by the hope for territorial revisions of the Paris treaties (Rothschild, 1993). Nations allied themselves with Hitler mainly because of promises to return their lost lands. They also pursued the Western powers to endorse their national aims, often in secrecy from Nazi puppet regimes (Szajkowski, 1993). This experience was deeply damaging to the region because it set a precedent for seeking international backing for national aims--setting the nations at competition with each other for Western support rather than encouraging discussion among the countries themselves (Rothschild, 1993).

THE SOVIET REGIME: After World War II, Central Europe fell under Soviet control. The Soviets gave exclusive priority to heavy industry, and huge industrial complexes in countries that were previously under-developed (like Bulgaria, Romania, and Albania) became symbols of national prestige and progress. Emphasis was placed on achieving economic self-sufficiency which encouraged heedless industrialization, as well as leading to construction of many nuclear power plants (Brown, 1988). Even today ex-communists in government positions cling to the notion of economic self-sufficiency. This explains Slovakia's insistence on the construction of the Gabcikovo-Nagymaros dam, whose completion would free Slovakia from any dependence on the Czech Republic for energy (Carter, 1993). Furthermore, many states still rely heavily on nuclear power--for example, in 1992 the facility in Kozloduy, Bulgaria, produced 35% of the net electric power for the country; the Paks facility provided 43% of Hungary's power (data gathered from http://www.ecn.cz/private/c10/koz.html and http://www.ecn.cz/private/c10/paks.html, respectively). Recent environmental concern regarding the safety of reactors in Central Europe (often voiced from the West) tends to favor the immediate shut-down of certain dangerous plants which would seriously threaten these nations' energy sources. The "Reply to Europe from Bulgarian Institutions" (http://www.osf.acad.bg/dg- piper/dg2/insider/ins1.htm) reflects the sensitivity of the issue, "We consider it unacceptable that a number of western officials have tried to describe the present operation at Kozloduy NPP as a prerequisite for an accident comparable to the Chernobyl accident..."

Concentration of industrial development in so-called "hot spots" was the result of Soviet military policy that kept zones near national borders less industrialized (a Cold War tactic), authoritarian decision making that allocated large industrial plants without regard to potential pollution problems or the absorption capacities of local environments, and the whims of high level Party officials for whom it was a matter of prestige to keep their own native villages/cities free from "dirty industry" (Kabala, 1993).

Even when pollution became a daily reality for Central European peoples, there was little action taken because the fate of any given factory was dependent on whether it met the production goals set out in the 5-year plans sent down from the Central Party. If a factory took the time to install pollution-prevention mechanisms, production would slow and would put the factory at risk of not meeting the requirements of these plans. Failure to meet plan criteria would result in wage reductions for manager and worker alike, so that "at all levels of the production process there was a conspiracy to avoid taking the necessary steps [for pollution prevention or mitigation]" (Brown, 1988). Furthermore, since resources were socialized and, therefore had no market value, they were used with no regard for efficiency (Zvosec, 1984). Increasingly during the eighties, the Party was unable to ignore public discontent with pollution and the associated health hazards of living in heavily impacted areas, but these concerns were primarily addressed by assessing the "relative political weight and interests of the contenders rather than the merits of the case" (Zvosec, 1984).

Appendix B: Data Resource Centers.

Much of the information presented in this report has been developed from the numerous sources on internet websites.

Title/Description	Web Address	Date
Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal	http://www.unep.ch/sbc.html	
Belene	http://www.ecn.cz/private/c10/belene.html	
Beyond Borders - Summary	http://www.rec.hu/REC/Publications/Beyond Borders/summary.html	
Bibliographic Databases for Water Quality and Related Subjects	http://www.inform.umd.edu:8080/EdRe/Topic/AgrEnv/Water/path.txt	
Bohunice	http://www.ecn.cz/private/c10/bohunice.html	
Bulgaria-The State of the Ecological Situations in the Republic of Bulgaria and the Ministry of Defence's Programme for Identifying Problems Resulting from Military Engineering Activities	http://echs.ida.org/pilot/subg0/meeting/defense95/d13.html	1995
Bulgaria-Irrigation Restructuring & Rehabilitation	http://www.worldbank.org/cgi-bin/w...etrieve&waisdocid=9718018633+1+0+0	
Bulgaria-Municipal Development	http://www.worldbank.org/cgi-bin/w...etrieve&waisdocid=9718018633+2+0+0	
Catchments Division of Poland	http://www.grid.unep.no/ward0010.htm	
Cernavoda	http://www.ecn.cz/private/c10/cern.html	
Czech Temelin Nuclear Power Plant (TEMELIN)	http://gurukul.ucc.american.edu/TED/TEMELIN1.HTM	
Danis Info File	http://www.cedar.univie.ac.at/cgi-...t/msg00009.html?Bulgaria#first_hit	
Danube River Pollution in Romania (Danube Case)	http://gurukul.ucc.american.edu/TED/DANUBE.HTM	
Dukovany	http://www.ecn.cz/private/c10/duko.html	
East-East Cooperation - four or more to score	http://www.rec.hu/REC/Bulletin/Bull61/eastcoop.html	1996
Ecological Hazards in Poland	http://www.grid.unep.no/ward0011.htm	
EEA Environmental Monographs 1: European Rivers and Lakes-Assessment of their Environmental State	http://www.eea.dk/frames/docu/reports/rivers_and_lakes.html	1994
Environment and Ministers	http://www.osf.acad.bg/dg-piper/dg2/insider/illrcofo.htm	
Environment in the European Union 1995 - Report for the Review of the Fifth Environmental Action Programme	http://www.eea.dk/frames/docu/Env95/EN/0013-95-en.title.htm	
Environment in the European Union 1995 - Summary	http://www.eea.dk/frames/docu/Env95/Env95.htm	
Forget the West: NGOs in CEE are looking to each other for support	http://www.rec.hu/REC/Bulletin/Bull61/coop.html	1996
Ground Water in Poland	http://www.grid.unep.no/ward0008.htm	
Hungary-Environmental Strategy Study	http:///www.worldbank.org/cgi-bin/w...254+/pub20/internet/pic/neap/10882	
Hungary-Kis-Balton Environment	http://www.worldbank.org/cgi-bin/w...etrieve&waisdocid=9726918690+1+0+0	

Title/Description	Web Address	Date
Hungary-Municipal Wastewater	http://www.worldbank.org/cgi-bin/w...etrieve&waisdocid=9726918690+2+0+0	
Industrial Pollution Prevention & Abatement Handbook	http://www.worldbank.org/html/pic/GUIDE.html	
Kozloduy	http://www.ecn.cz/private/c10/koz.html	
Land Use Division in Poland	http://www.grid.unep.no/ward0004.htm	
Libraries and Environmental Information Centers in Central Eastern Europe: A Locator/Directory	http://pan.cedar.univie.ac.at/data/ecodir/about.huml	
Mochovce Nuclear Power Plant	gopher://pan.cedar.univie.ac.at:70/00/MOCH/readme	
Mochovce Nuclear Power Plant - Safety Upgrade and Completion of Units 1 and 2	gopher://pan.cedar.univie.ac.at:70/00MOCH/EIA/preface	
Mochovce	http://www.ecn.cz/private/c10/moch.html	
Nuclear Plant Safe	http:www.osf.acad.bg/dg-piper/dg2/insider/i11kozl.htm	
Paks	http://www.ecn.cz/private/c10/paks.html	
Poland-Bielsko-Biala Water & Wastewater	http://www.worldbank.org/cgi-bin/w...etrieve&waisdocid=9740618760+0+0+0	
Protected Area in Poland	http://www.grid.unep.no/ward0007.htm	
Reply to Europe from Bulgarian Institutions	http://www.osf.acad.bg/dg-piper/dg2/insider/ins1.htm	
Riparian Countries Continue Efforts to Clean Up the Danube	http://www.rec.hu/REC/Bulletin/Bull61/Danube.html	1996
River Catchments	http://www.grid.unep.no/ward0001.htm	
Romania-Bucharest Water	http://www.worldbank.org/cgi-bin/w...etrieve&waisdocid=9751318791+0+0+0	
Soil Types in Poland	http://www.grid.unep.no/ward0003.htm	
Surface Waters in Poland	http://www.grid.unep.no/ward0009.htm	
Temelin	http://www.ecn.cz/private/c10/temelin.html	
The Danube: Dams Over Troubled Waters	Nature, Vol. 355	1992
The Murky Politics of the Danube	The World Today	1993
To the Winners Go the Spoils?	http://www.rec.hu/REC/Bulletin/Bull61/clean.html	1996
Water Quality in Central and Eastern Europe	Geotimes	1994
Water Quality International '94 Part 5: Water Quality Management in Central and Eastern Europe: Integrated Catchment Management: Pollution Prevention/Waste Minimization: Training and Management	http://www.elsevier.nl:80/catalogue/SAG/285/23460/23460/30783/30783.html	1994
Water Rationing Overcome	http://www.osf.acad.bg/dg-piper/pilot/voda.htm	
World Bank Supports Water and Wastewater Management in Poland	http://www.worldbank.org/html/extdr/estme/9650eca.htm	1996

Contacts and Titles of Selected Regional Projects				
Contact (Affiliation/Project)	**Email Name/**	**Project Name**	**Location**	**Project Description**
selevan.sherry@epamail.epa.gov	Sherry Selevan USEPA	Teplice and Prachatice	Czech Republic	Impact of air pollution in the mining districts of Northern Bohemia
hartlage.thomas@epamail.epa.gov	Thomas Harlage USEPA	Teplice and Prachatice	Czech Republic	Impact of air pollution in the mining districts of Northern Bohemia
lewtas.joellen@epamail.epa.gov	Joellen Lewtas USEPA	Teplice and Prachatice	Czech Republic	Impact of air pollution in the mining districts of Northern Bohemia
metcalfe.jane@epamail.epa.gov	Jane Metcalfe USEPA	Teplice and Prachatice	Czech Republic	Impact of air pollution in the mining districts of Northern Bohemia
phillips.anna@epamail.epa.gov	Anna Phillips USEPA	Teplice and Prachatice	Czech Republic	Impact of air pollution in the mining districts of Northern Bohemia
sram@biomed.cas.cz	Radim Sram, PIAS, (Prague)	Teplice and Prachatice	Czech Republic	Impact of air pollution in the mining districts of Northern Bohemia
Breymeyer and Noble (Steering Committee) Stan Krugman USDA FS Reginald Noble 419-372-2732	Roger Blair Coop Bowling Green State U	Consortium for International Earth Science Information Network (CIESIN)	Poland-data sets may be available	Air pollution, Forest health monitoring in a gradient based system of climate and atmospheric deposition
Dr. Ruzena Kubinova, tel. 422-741955 or 422-6708 2623			Czech Republic-data sets may be available several selected districts	Monitoring of pollution and human health, monitoring the air, water pollution, food contaminants, impact on human health

Local Environmental Contamination Issues in Central Europe.				
Country	**General Issues**	**Projects**	**Metals**	**Radionuclides**
Albania	Deforestation; soil erosion; water pollution from industrial and domestic effluents			
Bosnia-Herzegovina	Air pollution from metallurgical plants; sites for disposing of urban waste are limited; widespread casualties, water shortages, and destruction of infrastructure from civil strife			
Bulgaria	Air pollution from industrial emissions; rivers polluted from raw sewage, heavy metals, detergents; deforestation; forest damage from air pollution and resulting acid rain; soil contamination from heavy metals from metallurgical plants and industrial wastes			Belene Kozloduy
Croatia	Air pollution (from metallurgical plants) and resulting acid rain is damaging the forests; coastal pollution from industrial and domestic waste; widespread casualties and destruction of infrastructure by civil strife			
Czech Republic	Air and water pollution in areas of northwest Bohemia centered around Zeplica and in northern Moravia around Ostrava present health risks; acid rain damaging forests	Teplice and Prachatice (GIS)		Dukovany Temelin
Hungary	Air pollution; industrial and municipal pollution of Lake Balaton			Paks
Macedonia	Air pollution from metallurgical plants			
Poland	Forest damage due to air pollution and resulting acid rain; disposal of large amounts of hazardous and industrial waste; severe water pollution from industrial and municipal sources; severe air pollution from emissions of sulfur dioxide from coal-fired power plants	Consortium for International Earth Science Information Network (CIESIN)(GIS)		Zarnowiec
Romania	Soil erosion and degradation; water pollution; air pollution in south from industrial effluents; contamination of Danube delta wetlands			Cernavoda

Local Environmental Contamination Issues in Central Europe.				
Country	**General Issues**	**Projects**	**Metals**	**Radionuclides**
Yugoslavia	Pollution of coastal waters from sewage outlets, especially in tourist-related areas such as Motor; air pollution around Belgrade and other industrial cities; water pollution from industrial wastes dumped into the Sava which flows into the Danube			
Slovakia	Air pollution from metallurgical plants/human health risks; acid rain damaging forests			Bohunice Mochovce
Slovenia	Sava River polluted with domestic and industrial waste; pollution of coastal waters with heavy metals and toxic chemicals; forest damage near Koper from air pollution (originating at metallurgical and chemical plants) and resulting acid rain			Krsko

Appendix C. Environmental Programs and Site-Specific Projects.

Country of Focus	Locale	Type of Data	Type of Study	Primary Contact/Information Source
Bulgaria	12 sites on shore of Black Sea, Siutghiol, Tatlageac, Albesti,	Water samples of underground water	Over 20 elements and pollutants in the water	Dinescu, Instit. Physics and Nuclear Engineer ISECCEE 1992 (530) Tel: n/a
Croatia	Sites in central/eastern regions	Soil samples from several soil types	Cesium from the Chernobyl accident	D. Barisic, Center for Marine Research, Bijenicka, Zagreb ISECCEE 1992 (179) Tel: 38-41 425-747 FAX: 38-41 425-747
Croatia	Plitvice	Tree ring samples 1975-1986	Carbon 14 and tritium in rings to compare to global standards	B. Obelic, Ruder Boskovic Institute, Zagreb ISECCEE 1992 (505) Tel: 38-41-425-809
Croatia	Zagreb, Zadar, and Osijek	Samples of foods and milk	Radioactivity in food chain	N. Lokobauer, Institute for Medical Research and Occupational Health, Zagreb ISECCEE 1992 (848) Tel: 038-41-434188
Czech Republic	Teplice and Prachatice	Monitoring	Impact of air pollution in the mining districts of Northern Bohemia	Dr. Ruzena Kubinova, tel. 422-741955 or 422-6708 2623
Czech Republic	Teplice and Prachatice	Monitoring (data sets may be available several selected districts)	Monitoring of pollution and human health, monitoring the air, water pollution, food contaminants, impact on human health	Dr. Ruzena Kubinova, tel. 422-741955 or 422-6708 2623
Czechoslovakia	Czechoslovakia, Poland	Monitoring of air pollution	SO_2, NO_x , O_3, and heavy metals	Mejstrik, Czechoslovakia Academy of Sciences Budejovice ISECCEE 1992 (136) Tel: 42 38 40 183 FAX 42 38 45 719
Czechoslovakia	Danube (left bank)	Water dynamics as affect drinking water	Dynamics and hydrological conditions	J. Lehocky, Water Research Institute, Bratislava ISECCEE 1992 (191) Tel: n/a
Czechoslovakia	974 sites of water	Water samples taken	Bacteriological, colliforms	P. Hucko, Water Res. Institute, Bratislava ISECCEE 1992 (865) Tel: 343-111, Fax 315-743
Hungary	Hungary, Austria, Croatia, Slovenia, Poland cooperative effort	Monitoring and air sampling weekly (1988-1992)	Tritiated water, tritiated hydrogen gas	G. Uchrin. Hungarian Academy of Sciences, Budapest, ISECCEE 1992 (502) Tel: (361) 169-94-99

Country of Focus	Locale	Type of Data	Type of Study	Primary Contact/Information Source
Hungary	24 project areas	Inventory of water pollution sources	Water pollutants, including most metals, and organics.	M. Lodder, BKH Engineers, Delft ISECCEE 1992 (199) Tel: 31-15 625299
Hungary	46 sites, Domsod, Alsonemedi, Oicsa, Forte, Metallokemia	Soil and plant samples from sites	Cadmium	L. Vermes, Ministry of Agriculture, Budapest ISECCEE 1992 (409) Tel: 36-1-1220-860
Hungary	Ozd, Diosgyor	Soil samples close to industrial sources	Cd, Co, Cr, Cu, Fe, Ni, Pb, Zn	Kovacs, Agricultural University, Godollo ISECCEE 1992 (477) Tel: n/a
Hungary	Toka brook, Gyongyos	Downstream of milling operations	Heavy metals (As, Cd, Cu, Pb, Zn)	G. Turcsanyi, Agricultural University, Godollo ISECCEE 1992 (515) Tel: 36-28-10683
Macedonia	Kocani plain	Samples of groundwater	Hydrological, radiological, water chemistry	Z. Bozinovski, Center for Application of Radioisotopes in Science and Industry, Skopje ISECCEE 1992 (865) Tel: 343-111, Fax 315-743
Macedonia	Vardar river region, Krivolak, and Nogaevci river regions	Sediment and soil samples	Radionuclides	T. Anovski, University of Kiril I Metodij, Skopje ISECCEE 1994 (107) Tel: n/a
Macedonia	Novi Sad region	Samples of milk	Organochlorines in milk	R. Vukavic, Univ. Of Novi Sad, Novi Sad ISECCEE 1994 (73) Tel: 381-21-20-182
Poland	Mountains, forests, within many areas of Poland	Large scale monitoring	Air pollution, Forest health monitoring in a gradient based system of climate and atmospheric deposition	Consortium for International Earth Science Information Network (CIESIN) (Stan Krugman, USDA FS Reginald Noble) Tel: 419-372-2732
Poland	Tatra Mountains water sites	Water sampling 1991	Acidic deposition, transboundary pollution	D. Rzychon, Institute of Envir. Protection, Katowice ISECCEE 1992 (197) Tel: 48-3-1540 005
Poland	Upper notec catchment (4000 km2)	Water samples	Pilot studies to define water samples in areas	W. Plenzler, IMGW, Poznan ISECCEE 1992 (495) Tel: 48-6145440
Poland	Upper Silesia Industrial Region Przemsza river	Samples of water and river sediments	Cadmium, lead, zinc,	S. Ryborz, Instit. Environ Protection, Katowice ISECCEE 1992 (660) Tel: 1546-031

Country of Focus	Locale	Type of Data	Type of Study	Primary Contact/Information Source
Poland	340 sampling points along Wisla, Odra, Warta and Bug rivers	Samples of water and sediments once a year	Cd, Cu, Co, Ni, Pb, Zn,	I. Bojakowska, Polish Geological Institute, Warsaw ISECCEE 1994 (105) Tel: n/a
Poland	Konin aluminum smelter	Samples of air, plants, soil, water	Flourine	T. Staszewski, Instit. Ecology Ind Areas, Katowice ISECCEE 1994 (44) Tel: 48 3 1546031
Poland	Irizab	Soils	Radiochemistry	Mitrega, Polish Geological Institute, Warsaw ISECCEE 1994 (242) Tel 48 2 49 53-51
Romania	Southern Romania and Danube river	Water samples twice a year	Metals, pesticides, drinking water standards	M. Vasilescu, Instit. Hygiene & Public Health, Bucharest ISECCEE 1992 (436) Tel:
Romania	Ploiesti	Groundwater samples	Water pollutants, Organochlorines, TPHs, etc	Georgescu, Res. Inst. For Petroleum Processing and Petrochemistry, Ploiesti ISECCEE 1994 (458) Tel: (40-44) 164 738
Romania	Cluj Napoca	Soil samples	Radionuclides	I. Mocsy, Inst. Public Health & Med Res, Cluj Napoca ISECCEE 1994 (862) Tel: (40-64) 194 252
Romania, Bulgaria, Hungary, Poland, Czechoslovakia	Transylvania, Tsalapitsa, Ujkigyos, Liwiec, Zelivka	Water quality in selected sites of each country	Cadmium, copper, arsenic, sewage, pesticides, nitrates	S. Vitorovic, University of Belgrade, Belgrade ISECCEE 1992 (204) Tel: 11-215-315
Yugoslavia	Zajaca, Bor, near smelter plants	Honeybee samples	As, Antimony, Pb	M. Krunic, Univ. Of Belgrade, Belgrade ISECCEE 1994 (37) Tel: 993 81 11 187 823
Slovakia	Northern Slovakia	Forest samples of trees	Forest health monitoring	J. Oszlanyi ISECCEE 1994 (96) Tel: 427/332016
Slovenia	Celje County (230km^2)	Monitoring, laboratory greenhouse, field experiments	Monitoring of heavy metals and organics in soils from air pollution and other sources	V. Hudnik and Franc Lobnik Institute of Chemistry Ljubljana, Hajdrihova ISECCEE 1992 (60) Tel: 38 61 263 061 FAX 38 61263 285

Country of Focus	Locale	Type of Data	Type of Study	Primary Contact/Information Source
Slovenia	50-75 sites in Slovenia	Air pollution (SO_2) monitoring since 1977	SO_2 relationship to lung disease (1.7x disease in areas of high SO_2)	D. Hrcek, Hydro Meteorological Institute of Slovenia ISECCEE 1992 (158) Tel: 061-115-208
Slovenia	Zavodnje region	Bulk samples of soil and water for movement of pollutants	Air pollutants (SO_2, nitrates, ammonia, heavy metals)	M. Gros, University of Ljubljana ISECCEE 1992 (160) Tel: 063-371-321
Slovenia	20 sites across Slovenia,	Ground water samples since 1987	Water pollutants, nitrites, chromium, solvents, pesticides	D. Lovincic, University of Ljubljana ISECCEE 1992 (188) Tel: 38-61-212-904
Slovenia	Drava River Basin	Water samples	Air pollution,	U. Krajnc, Institut za Ekoloski Inzeniring, Jadranska, Maribor
Yugoslavia	Kosovska Mitrovica	Air pollution samples	SO_2, Pb, zinc, iron, arsenic, cadmium, copper	B. Nikolic, Institute Kirilo Savic, Belgrade ISECCEE 1994 (115) Tel: n/a

abstract #	country	locality	medium	pollutant	comments and findings
115	Bulgaria	Russe (Danube and Lom Rivers)	Sediment	Hg, Cd, Pb, Cu, Zn, Cr, Ni, As, PAHs, PCbs, HCB, DDTs and HCHs	Enrichment factors (multiples of "background" concentrations) reached 12, though Pb in one harbor was 50x. Some organics reached 4x. Contaminants were not related to a decrease in the pelican population of Lake Srebama (a UNESCO Nature and Biosphere Reserve).
253	Bulgaria	Pirdop & Asenovgrad	Small mammals	Cu, Cd, Zn, Pb	Tissue concentrations of Pb and Cd among the highest recorded in wild small mammals.
043	Croatia	Kastel Sucurac (Adriatic Coast near Split)	Soil	Slag, ash, and radioactivity	PVC synthesis plant produces wastes with elevated radioactivity.
85	Croatia	Zagreb	Geothermal water	Radon-226	Spa exposure.
87	Croatia	Jukusevec Dump site (Sava River)	Groundwater	Domestic and industrial waste	A significant portion of the base of the dump occasionally contacts groundwater. The dump has affected groundwater quality and has endangered existing and planned wells surrounding Zagreb.
126	Croatia	Zagreb	Soil	Radionuclides (^{238}U, ^{232}Th, and ^{40}K)	Exposures to radionuclides from phosphate rock processing to make fertilizers and the use of fertilizers was examined.
338	Croatia	Kastela Bay and Trogir (near Split)	Sea water, phytoplankton, zooplankton	Heavy metals	The bay is particularly threatened by organic matter and nutrient inputs causing extreme phytoplankton blooms. The bay is also heavily polluted with highly toxic metals discharged through untreated industrial wastes. Near shore samples show significantly higher metal concentrations than do offshore samples.
251	Czech Republic	Ostrava City	Soil, groundwater	Metals, acids, industrial chemicals	The Karolina Site was described as a model case for using risk assessment to manage the remediation of an abandoned industrial area comprised of multiple industrial enterprises.
215	Czech Republic and Slovakia	Nation	Soil, water	Oils, petrol, chlorinated hydrocarbons, PAHs, PCBs, heavy metals	Former Soviet military bases were surveyed in 46 sites within 10 regions of the former Czechoslovakia. Most were polluted with various fuels, sometimes as much as 2 m free-product floating on the water table surface. The search for highly toxic chemicals did not identify any such areas.
102	Hungary	Budapest	Air	Pb	In Central and Eastern Europe, airborne lead concentrations are increasing.
248	Hungary	Mecsek mountains in South Transdanubia	Water, air	Radionuclides	Uranium mining occurred from 1954, but will be terminated in 1997. The following environmental problems have been identified: seepage of high TDS into aquifers; radon and particulate emissions; and salinity.
493	Hungary	Nagyteteny (Budapest)	Soils/sludge	Pb, Cu, An, Cd	Characterized soil contamination in the surrounding area.
019	Macedonia	Titov Veles	Air	Lead and zinc smelter	SO_2, hydrogen fluoride, chlorine, and smoke along with metals are damaging vegetation of the region.
72	Macedonia	Skopje	Air	SO_2 and smoke	Emission levels in Skopje were significantly higher than the EEC and WHO recommendations.
228	Macedonia	Titov Veles	Soil, vegetables	Pb, Zn	Metals were measured in soil and vegetables in the area surrounding a Pb-Zn smelter. Pb exceeded permissible levels.
364	Macedonia	Macedonia	Air	^{222}Rn	Measured range of radon was 3 to 3,390 Bq/m^3.
367	Moldovia	Moldovia	Soils	PCBs, HCB, HCH, DDT	PCB and HCB levels were low; DDX levels were high.
007	Poland	Debiensko and Budryk Coal Mines	Rivers	Saline waters	Polish mines discharge 1.4 million m^3/day of saline water directly to

abstract #	country	locality	medium	pollutant	comments and findings
					rivers. More than four million tons of salt drain to the Vistula River and one million tons to the Odra River
045	Poland	Central and Southern Poland	Air, soil, water	Heavy industry emissions of SO_2 and heavy metals	Following World War II, the Polish population increased primarily along the Vistula River. Heavy industry, especially steel mills (Warszawa) near Warsaw and the Legnica Copper mill adversely affected rich soils of the area but also spread dusts and gases throughout central Poland. In the 1980s, chemical plants of Celwiskoza in Jelenia Gora (Lower Silesie) and coking plants at Zdzieszowice and the Siechnica steel mill near Wroclaw were closed for environmental reasons.
84	Poland	Lodz	Air	Radon-222	Exposures for miners.
107	Poland	Katowice	Soil	Cd, Zn, Pb	Water and wind erosion of toxic zinc and lead smelter waste is one of the most urgent environmental problems to be solved of the Silesia region of Poland. Over 87 million tons of these materials were disposed of in uncontrolled piles in extensively populated areas leading to soil, water, and air pollution. Two process type wastes (Welz and Doerschel) exist. Welz materials, though high in water soluble Zn, Pb, and Cd were initially stabilized with lime, sewage sludge, and seeding. Doershcel material re-vegetation failed, probably due to high salinity, high water soluble Cd, and heavy compaction.
204	Poland	Warsaw	Air	Metals, petrochemicals	The Kampinos National Park is the largest forest complex in the vicinity of Warsaw. The park is threatened by industry (Petrochemical Plants in Plock, Lucchini Steelworks in Warsaw) and local pollution sources which persist due to insufficient development of environmentally clean infrastructure in the communities within the park and its protection zone.
222	Poland	Warsaw Voivodeship	Soil, water	Contamination	Contamination patterns were analyzed to define three levels of land-use suitability for housing.
294	Poland	Pulawy	Plant and soil	Cd, Cu, Ni, Pb, Zn, SO_4	Elevated levels of metals were found in 17% of soils (20,000 plant and soil samples). Some 2.6% of soils were considered highly contaminated and 0.3% of the arable land should be excluded from crop production.
299	Poland	Warsaw and Plock	Soil	Pb, Cu, Zn, Co, Cd	Metal influence of soil enzyme (dehydrogenase) activity was measured. Pb, Zn, and Cu were negatively correlated with enzyme activity.
300	Poland	Sanniki Village	Soil, vegetables	Cd, Pb	Red beets, carrots, and white cabbage metal concentrations were measured. Cd levels reached 80+% of the Provisional Tolerable Weekly Intake; Pb was 25+%.
386	Poland	Torun	Water	Domestic sewage	Biodegradation of domestic sewage.
391	Poland	Poland	Air, soil	Radionuclides	Vapor and ash deposits were analyzed for radionuclide (^{2385}U, ^{235}U, ^{232}Th, and ^{40}K).
394	Poland	Bierun, Shawkow, Sosnowiec, Bytom (Katowice)	Air, plants	Cd, Zn, Pb, pH	Wet and dry precipitation, as well as levels of metals in plants were monitored. Soil loading of metals was demonstrated.
396	Poland	Katowice	Soil	Hg	Soil Hg levels were shown to be several hundred ppm in 0-20 cm

abstract #	country	locality	medium	pollutant	comments and findings
					layers of soils near electrolysis factories and combustion sites. Concentrations approached background at depths to 1.6 m.
402	Poland	Sudety Mountains (Black Triangle)	Soil	Acidity	Acid rain in the areas has damaged forests in the Snieznik, Sleza Massifs, and Sowie Mountains.
404	Poland	Swinoujscie	Soil, groundwater	Petroleum	The site is a former Soviet military base. It had significant soil and groundwater contamination. Some 280,000 liter of free product was skimmed from the surface of the water table.
497	Poland	Chorzow (Upper Silesia)	Plants	Pb, Cd, Cu, Zn	Characterized contamination in grapeseed and cereals, (but no leafy vegetables).
498	Poland	Bytomka and Czarnawka Rivers (Upper Silesia)	Soil/sediments	Benzo(a)pyrene	Measured concentrations up to 700 ppb in river sediments.
033	Romania		Well water	Agricultural contaminants	Infant methemoglobinemia was traced to well water nitrate. Incidence rate was 43-277 per 100,000 live births; down from earlier reports of 13,000 per 100,000 (13%).
81	Romania	Baia Mare	Air, water, soil	Fe, Al, Cr, Mn, Co, Ni, and Cd	Mine wastes.
116	Romania	Bucharest	Water	Organochlorines	An urban population of 1.3 million uses the Danube River as the primary source of drinking water. Organochlorinated insecticide levels exceeded maximum allowable concentrations in 47% of the samples taken in 1995; some areas had routine exceedances [Tr. Severin (100%), Calarasi and Oltenita (70%), and Galati (60%)]. The spatial pattern identified that the Danube is polluted by pesticides before it enters Romania and that the Romanian tributaries (Arges, Lalomita and Prut Rivers) add additional contamination.
133	Romania	Cernavoda	Water, soil	Radionuclide wastes (especially ^{134}Cs)	Concern regarding processing of nuclear waste from the Nuclear Station in Cernavoda.
381	Romania	Western region of Romania	Air	Industrial emissions	The life span in some towns is 10 years less than other parts of Romania.
384	Romania	Romania	Mining waste streams	An	Recovery processes.
426	Romania	Tirgu-Mures and Miercurea Ciuc	Indoor air	^{222}Rn	Radon was measured and used with a retrospective carcinogenic risk assessment to assign the mortality of Radon was measured and used with a retrospective carcinogenic risk assessment to assign the mortality percentage related to radon exposure.
430	Romania	Bucharest	Sludge	Cr, Zn, Cu, Ni, Cd, Fe, Pb	Electronics and electrotechnical manufacturing industries
159	Yugoslavia	Bor in the Veliki Krivelj District	Water, sediments, air	Particulates, As	A flotation dump associated with copper mining and smelting has contributed significant levels of heavy metals to the surrounding areas. As was determined to be the main intoxicating pollutant. Restrictions on land use (agriculture/gardening) were imposed.
184	Yugoslavia	Drmno	Groundwater	Mineral oils, sulfates, and heavy metals	Kostolac coal burning power plant wastes including ash have contaminated groundwater.
193	Yugoslavia	Nis	Air, water	Heavy metals	In the last decade environmental quality in Yugoslavia has worsened. Only a few small rivers have first class water quality. Large cites are in short supply of high quality drinking water. Monitoring data

abstract #	country	locality	medium	pollutant	comments and findings
					indicates that 40% of the drinking water does not meet standards. Air pollution is high in cities and industrial areas.
052	Slovenia	Salek Valley	Air, water	Coal fired Sostanj Thermal Power Plant, SO_2, No_x, Cd	High levels of air toxics were measured. Water samples and filtrates showed high levels of Cd in the vicinity of the power plant.
229	Slovenia	Sostanj	Soil	Metals in flyash	Leachates of fly ash exceeded permitted levels of Ni, Al, and B .
382	Slovenia	Slovenia	Water	As, Pb, trihalomethanes	Groundwater and drinking water monitoring has been instituted.
018	Yugoslavia	Obrenovac	Air, water, soil	Ash, misc. Industrial chemicals	The city zones were scored as to ash deposition, groundwater level, and land slide activity to map the quality of living conditions. Some 47% of the population in the industrial zone and near fly ash depositories are in "unsuitable" quarters.
023	Yugoslavia	Belgrade	Soil	Radioactive waste	Storage center.
030	Yugoslavia		Water and soil	Lead refinery waste	Alkali dross is usually stored at a landfill. Atmospheric fall-out dissolves the alkali waste thereby polluting surface water and soil.
032	Yugoslavia	Trepca	Water and soil	Landfill from lead smelter	Atmosphere fallout mobilizes waste and contaminates soil and water
054	Yugoslavia	Pancevo (Danube)	Sediment	Metals	Measurements of Mg, Al, K, Ca, Mn, Fe, Cr, Co, Ni, Cu, Zn, Cd, and Pb were made from sediment samples.
056	Yugoslavia	Belgrade	Air (urban)	Hydrocarbons	Hydrocarbons present a continual adverse environment, especially in areas with fuel pumping stations, terminals, tanks, and petrol stations.
67	Yugoslavia	Belgrade (Rivers Tisa and Danube)	Sediment	Hydrocarbons	Characterized anthropogenic n-alkane distribution patterns in sediments.
68	Yugoslavia	Pancevo	Sediments	Oil refinery – polar non-soluble organics	Characterized migration of refinery wastes into sediments.
75	Yugoslavia	Belgrade	Air, soil	Pb, Cu, Zn, and Cd	Dry deposition fluxes (measured in April to October 1994) reduced to rural area levels due to drastically reduced traffic and industrial emissions.
95	Yugoslavia	Belgrade	Drinking water	Bacteria	E. coli and Enterobacter contamination is frequent. Between 1990 and 1994 in the FR Yugoslavia, 65 hydric epidemics were registered with 8,375 cases of water borne diseases
99	Yugoslavia	Kikinda	Air	SO_2 and soot, Cd, Pb	Morbidity from respiratory diseases, including respiratory organ cancers, during 1989-1995 increased in both adults and children.
103	Yugoslavia	Novi Sad (Danube)	Water, food, humans	Organochlorine Pesticides	Organochlorine pesticides (HCH, lindane, heptachlor, heptachlor epoxide, aldrin, dieldrin, and DDT) were monitored in the Danube (1986-1995). Market basket surveys were used to estimate dietary exposures. Lindane and DDT were found in significant quantities.
104	Yugoslavia	Novi Sad (Danube)	Water	Bacteria, Ba, Pb, Cd, Fe	Microbial requirements for Class II water were not met ~65% of the time and chemical standards for Class III water were exceeded more than 5% of the time.
121	Yugoslavia	Novi Sad	Air	SO_2, soot	Although air quality improved during the period 1989-1995, no significant differences in morbidity from chronic respiratory diseases in either children or adults were observed.
122	Yugoslavia	Novi Sad, Belgrade, Nis, and Kikinda	Air	Pb, Cd, Zn	Environmental contamination with toxic metals in these towns is significant.

abstract #	country	locality	medium	pollutant	comments and findings
124	Yugoslavia	Kolubara-prerada coal processing at Vreoci	Water	Suspended solids	Waste water treatment
125	Yugoslavia	Kolubara-prerada coal processing at Vreoci	Water	Suspended solids	Waste water treatment
203	Yugoslavia	Belgrade	Air	SO_2, No_x, and fumes	A monitoring network was established to provide spatial distributions of air quality parameters.
214	Yugoslavia	Belgrade	Air	SO_2, No_x, CO, formaldehyde, and soot	Air pollution in Belgrade was linked to impaired respiratory function of school children.
260	Yugoslavia	Yugoslavia	Workplace	Benzene	Some industrial workers exposed to >1,000 ppm benzene.
284	Yugoslavia	Boka Kototska Bay (Montenegro Seaside)	Fish	Organochlorine insecticides & PCBs	Levels of organics were measured from fish tissues.

Appendix D. Religious and Ethnic Breakout of Countries of Central Europe (CIA 1995).

Country	Ethnic Groups	Religious Groups
Albania	Albanian 95%, Greeks 3%, other 2% (Vlachs, Gypsies, Serbs, and Bulgarians) (est.)	Muslim 70%, Albanian Orthodox 20%, Roman Catholic 10% (Note: all mosques and churches were closed in 1967 and religious observances prohibited; in November 1990, Albania began allowing private religious practice.)
Bosnia-Herzegovina	Muslim 38%, Serb 40%, Croat 22% (est.)	Muslim 40%, Orthodox 31%, Catholic 15%, Protestant 4%, other 10%
Bulgaria	Bulgarian 85.3%, Turk 8.5%, Gypsy 2.6%, Macedonian 2.5%, Armenian 0.3%, Russian 0.2%, other 0.6%	Bulgarian Orthodox 85%, Muslim 13%, Jewish 0.8%, Roman Catholic 0.5%, Uniate Catholic 0.2%, Protestant, Gregorian-Armenian, and other 0.5%
Croatia	Croat 78%, Serb 12%, Muslim 0.9%, Hungarian 0.5%, Slovenian 0.5%, other 8.1%	Catholic 76.5%, Orthodox 11.1%, Slavic Muslim 1.2%, Protestant 0.4%, other and unknown 10.8%
Czech Republic	Czech 94.4%, Slovak 3%, Polish 0.6%, German 0.5%, Gypsy 0.3%, Hungarian 0.2%, other 1%	Atheist 39.8%, Roman Catholic 39.2%, Protestant 4.6%, Orthodox 3%, other 13.4%
Hungary	Hungarian 89.9%, Gypsy 4%, German 2.6%, Serb 2%, Slovak 0.8%, Romanian 0.7%	Roman Catholic 67.5%, Calvinist 20%, Lutheran 5%, atheist and other 7.5%
Macedonia	Macedonian 65%, Albanian 22%, Turkish 4%, Serb 2%, Gypsies 3%, other 4%	Eastern Orthodox 67%, Muslim 30%, other 3%
Poland	Polish 97.6%, German 1.3%, Ukrainian 0.6%, Byelorussian 0.5% (est.)	Roman Catholic 95% (about 75% practicing), Eastern Orthodox, Protestant, and other 5%
Romania	Romanian 89.1%, Hungarian 8.9%, German 0.4%, Ukrainian, Serb, Croat, Russian, Turk, and Gypsy 1.6%	Romanian Orthodox 70%, Roman Catholic 6% (of which 3% are Uniate), Protestant 6%, unaffiliated 18%
Yugoslavia	Serbs 63%, Albanians 14%, Montenegrins 6%, Hungarians 4%, other 13%	Orthodox 65%, Muslim 19%, Roman Catholic 4%, Protestant 1%, other 11%
Slovakia	Slovak 85.7%, Hungarian 10.7%, Gypsy 1.5% (the 1992 census figures under report the Gypsy/Romany community, which could reach 500,000 or more), Czech 1%, Ruthenian 0.3%, Ukrainian 0.3%, German 0.1%, Polish 0.1%, other 0.3%	Roman Catholic 60.3%, atheist 9.7%, Protestant 8.4%, Orthodox 4.1%, other 17.5%
Slovenia	Slovene 91%, Croat 3%, Serb 2%, Muslim 1%, other 3%	Roman Catholic 96% (including 2% Uniate), Muslim 1%, other 3%

Ethnic Political Issues in Central Europe	
Country	
Albania	The Albanian Government supports protection of the rights of ethnic Albanians outside of its borders; Albanian majority in Kosovo seeks independence from Yugoslav Republic; Albanians in Macedonia claim discrimination in education, access to public sector jobs and representation in government; Albania is involved in a bilateral dispute with Greece over border demarcation, the treatment of Albania's ethnic Greek minority, and migrant Albanian workers in Greece.
Bosnia-Herzegovina	Bosnian Government and Bosnian Serb leaders remain far apart on territorial and constitutional solutions for Bosnia; the two sides did, however, sign a four-month cessation of hostilities agreement. The Bosnian Serbs continue to reject the Contact Group Plan submitted by the United States, United Kingdom, France, Germany, and Russia, and accepted by the Bosnian Government, which stands firm in its desire to regain lost territory and preserve Bosnia as a multiethnic state within its current borders; Bosnian Serb forces control approximately 70% of Bosnian territory.
Bulgaria	TBD
Croatia	Ethnic Serbs have occupied UN-protected areas in eastern Croatia and along the western Bosnia and Herzegovinian border.
Czech Republic	Liechtenstein claims restitution for 1,600 square kilometers of Czech territory confiscated from its royal family in 1918; Sudeten German claims for restitution of property confiscated in connection with their expulsion after World War II versus the Czech Republic claims that restitution does not precede before February 1948 when the Communists seized power; unresolved property issues with Slovakia over redistribution of property of the former Czechoslovak federal government.
Hungary	Gabcikovo Dam dispute with Slovakia.
Macedonia	Gabcikovo Dam dispute with Slovakia.
Poland	TBD
Romania	TBD
Yugoslavia	Sandzak region bordering northern Montenegro and southeastern Serbia - Muslims seeking autonomy; disputes with Bosnia and Herzegovina and Croatia over Serbian populated areas; Albanian majority in Kosovo seeks independence from Yugoslav Republic.
Slovakia	Gabcikovo Dam dispute with Hungary; unresolved property issues with Czech Republic over redistribution of former Czechoslovak federal property.
Slovenia	Dispute with Croatia over fishing rights in the Adriatic and over some border areas; the border issue is currently under negotiation.

Appendix E: Economic Conditions in Central Europe.

Import/Export Commodities of Countries in the CE	
Country	**Commerce**
Albania	**Exports**: $112 million (1993) commodities: asphalt, metals and metallic ores, electricity, crude oil, vegetables, fruits, tobacco partners: Italy, The Former Yugoslav Republic of Macedonia, Germany, Greece, Czech Republic, Slovakia, Poland, Romania, Bulgaria, Hungary **Imports**: $621 million (1993) commodities: machinery, consumer goods, grains partners: Italy, The Former Yugoslav Republic of Macedonia, Germany, Czech Republic, Slovakia, Romania, Poland, Hungary, Bulgaria, Greece
Bosnia-Herzegovina	War has made reasonable estimates of export/import conditions unreliable.
Bulgaria	**Exports**: $3.6 billion (1993) commodities: machinery and equipment 30.6%; agricultural products 24%; manufactured consumer goods 22.2%; fuels, minerals, raw materials, and metals 10.5%; other 12.7% partners: former CEMA countries 57.7% (FSU 48.6%, Poland 2.1%, Czechoslovakia 0.9%); developed countries 26.3% (Germany 4.8%, Greece 2.2%); less developed countries 15.9% (Libya 2.1%, Iran 0.7%) **Imports**: $4.3 billion (1993) commodities: fuels, minerals, and raw materials 58.7%; machinery and equipment 15.8%; manufactured consumer goods 4.4%; agricultural products 15.2%; other 5.9% partners: former CEMA countries 51.0% (FSU 43.2%, Poland 3.7%); developed countries 32.8% (Germany 7.0%, Austria 4.7%); less developed countries 16.2% (Iran 2.8%, Libya 2.5%)
Croatia	**Export**: $3.9 billion (1993) commodities: machinery and transport equipment 30%, other manufacturers 37%, chemicals 11%, food and live animals 9%, raw materials 6.5%, fuels and lubricants 5% partners: EC countries, Slovenia **Imports**: $4.7 billion (1993) commodities: machinery and transport equipment 21%, fuels and lubricants 19%, food and live animals 16%, chemicals 14%, manufactured goods 13%, miscellaneous manufactured articles 9%, raw materials 6.5%, beverages and tobacco 1% partners: EC countries, Slovenia, FSU countries
Czech Republic	**Exports**: $13.4 billion (1994) commodities: manufactured goods, machinery and transport equipment, chemicals, fuels, minerals, metals, agricultural products partners: Germany 28.7%, Slovakia 15.5%, Austria 7.9%, Italy 6.4%, France 3.2%, Russia 3.2%, Poland 3.1%, UK 2.9%, Netherlands 2.4%, Hungary 2.2%, US 2.1%, Belgium 1.3% **Imports**: $13.3 billion (1994) commodities: machinery and transport equipment, manufactured goods, chemicals, fuels and lubricants, raw materials, agricultural products partners: Germany 24.1%, Slovakia 15.6%, Russia 9.8%, Austria 7.6%, Italy 4.9%, France 3.6%, US 3.2%, Netherlands 2.9%, UK 2.8%, Poland 2.7%, Switzerland 2.2%, Belgium 2.0%

Import/Export Commodities of Countries in the CE	
Country	**Commerce**
Hungary	**Exports**: $10.3 billion (1994) commodities: raw materials and semi-finished goods 30.0%, machinery and transport equipment 20.1%, consumer goods 25.2%, food and agriculture 21.4%, fuels and energy 3.4% partners: Germany 25.3%, Italy 8.3%, Austria 10.5%, the FSU 14.0%, US 4.3% **Imports**: $14.2 billion (1994) commodities: fuels and energy 12.6%, raw materials and semi-finished goods 27.3%, machinery and transport equipment 33.0%, consumer goods 21.2%, food and agriculture 5.9% partners: Germany 21.5%, Italy 6.1%, Austria 11.8%, the FSU 20.9%, US 4.3% (Note - about one-fourth of the imports from the FSU were MiGs delivered as a debt payment.)
Macedonia	**Exports**: $1.06 billion (1993) commodities: manufactured goods 40%, machinery and transport equipment 14%, miscellaneous manufactured articles 23%, raw materials 7.6%, food (rice) and live animals 5.7%, beverages and tobacco 4.5%, chemicals 4.7% partners: principally Yugoslavia and the other former Yugoslav republics, Germany, Greece, Albania **Imports**: $1.2 billion (1993) commodities: fuels and lubricants 19%, manufactured goods 18%, machinery and transport equipment 15%, food and live animals 14%, chemicals 11.4%, raw materials 10%, miscellaneous manufactured articles 8.0%, beverages and tobacco 3.5% partners: other former Yugoslav republics, Greece, Albania, Germany, Bulgaria
Poland	**Export**: $16.3 billion (1994) commodities: intermediate goods 26.5%, machinery and transport equipment 18.1%, miscellaneous manufactures 16.7%, foodstuffs 9.4%, fuels 8.4% (1993) partners: Germany 33.4%, Russia 10.2%, Italy 5.3%, UK 4.3% **Imports**: $18.1 billion (1994) commodities: machinery and transport equipment 29.6%, intermediate goods 18.5%, chemicals 13.3%, fuels 12.5%, miscellaneous manufactures 10.1% partners: Germany 35.8%, Italy 9.2%, Russia 8.5%, UK 6.6%
Romania	**Exports**: $6 billion (1994) commodities: metals and metal products 17.6%, mineral products 11.9%, textiles 18.5%, electric machines and equipment 8.4%, transport materials 6.5% partners: EC 36.1%, developing countries 27.4%, East and Central Europe 14.9%, EFTA 5.1%, Russia 5%, Japan 1.4%, US 1.3% **Imports**: $6.3 billion (1994) commodities: minerals 21.1%, machinery and equipment 19.7%, textiles 11.5%, agricultural goods 9.2% partners: EC 45.8%, East and Central Europe 8.6%, developing countries 22.6%, Russia 11%, EFTA 6.2%, US 5.0%, Japan 0.8%

Import/Export Commodities of Countries in the CE	
Country	**Commerce**
Yugoslavia	**Exports**: $NA commodities: prior to the breakup of the federation, Yugoslavia exported machinery and transport equipment, manufactured goods, chemicals, food and live animals, raw materials partners: prior to the imposition of UN sanctions, trade partners were the other former Yugoslav republics, Italy, Germany, other EC, the FSU countries, East European countries, US **Imports**: $NA commodities: prior to the breakup of the federation, Yugoslavia imported machinery and transport equipment, fuels and lubricants, manufactured goods, chemicals, food and live animals, raw materials including coking coal for the steel industry partners: prior to the imposition of UN sanctions, trade partners were the other former Yugoslav republics, the FSU countries, EC countries (mainly Italy and Germany), East European countries, US
Slovakia	**Exports**: $6.3 billion (1994) commodities: machinery and transport equipment, chemicals, fuels, minerals, and metals, agricultural products partners: Czech Republic 37.7%, Germany 17.1%, Hungary 5.3%, Austria 5.3%, Italy 4.6%, Russia 4.0%, Poland 2.6%, Ukraine 1.8%, US 1.6% **Imports**: $6.1 billion (1994) commodities: machinery and transport equipment, fuels and lubricants, manufactured goods, raw materials, chemicals, agricultural products partners: Czech Republic 29.9%, Russia 19.0%, Germany 13.2%, Austria 5.8%, Italy 4.3%, US 2.6%, Poland 2.4%, Ukraine 1.9%, Hungary 1.6%
Slovenia	**Exports**: $6.5 billion (1994) commodities: machinery and transport equipment 27%, intermediate manufactured goods 26%, chemicals 9%, food 4.8%, raw materials 3%, consumer goods 26% partners: Germany 29.5%, former Yugoslavia 15.8%, Italy 12.4%, France 8.7%, Austria 5.0% **Imports**: $6.5 billion (1994) commodities: machinery and transport equipment 30%, intermediate manufactured goods 17.6%, chemicals 11.5%, raw materials 5.3%, fuels and lubricants 10.8%, food 8.4% partners: Germany 25.0%, Italy 16.1%, former Yugoslavia 10.7%, France 8.0%, Austria 8.5%

Industrial and Agricultural Productivity of Central European Countries		
Country	**Industrial Products**	**Agricultural Productivity**
Albania	food processing, textiles and clothing, lumber, oil, cement, chemicals, mining, basic metals, hydropower	accounts for 55% of GDP; arable land per capita among lowest in Europe; 80% of arable land now in private hands; 60% of the work force engaged in farming; produces wide range of temperate-zone crops and livestock

Industrial and Agricultural Productivity of Central European Countries

Country	Industrial Products	Agricultural Productivity
Bosnia-Herzegovina	steel production, mining (coal, iron ore, lead, zinc, manganese, and bauxite), manufacturing (vehicle assembly, textiles, tobacco products, wooden furniture, 40% of former Yugoslavia's armaments including tank and aircraft assembly, domestic appliances), oil refining	Agriculture accounted for 9.0% of GDP in 1989 and regularly produces less than 50% of food needs. The foothills of northern Bosnia support orchards, vineyards, livestock, and some wheat and corn. Long winters and heavy precipitation leach soil fertility reducing agricultural output in the mountains. Farms are mostly privately held, small, and not very productive.
Bulgaria	machine building and metal working, food processing, chemicals, textiles, building materials, ferrous and nonferrous metals	Climate and soil conditions support livestock raising and the growing of various grain crops, oilseeds, vegetables, fruits, and tobacco. More than one-third of the arable land devoted to grain. Bulgaria is the world's fourth-largest tobacco exporter and also regularly produces a surplus of food.
Croatia	steel production, mining (coal, iron ore, lead, zinc, manganese, and bauxite), manufacturing (vehicle assembly, textiles, tobacco products, wooden furniture, 40% of former Yugoslavia's armaments including tank and aircraft assembly, domestic appliances), oil refining	Croatia, where most agricultural land is in private hands, normally produces a food surplus. Most arable land is concentrated in Croat-majority districts in Slavonia and Istria. Due to recent conflicts, much of Slavonia's land has been put out of production. Wheat, corn, sugar beets, sunflowers, alfalfa, and clover are main crops in Slavonia. The central Croatian highlands are less fertile but support cereal production, orchards, vineyards, livestock breeding, and dairy farming. Coastal areas and offshore islands grow olives, citrus fruits, and vegetables.
Czech Republic	fuels, ferrous metallurgy, machinery and equipment, coal, motor vehicles, glass, armaments	The Czech Republic is largely self-sufficient in food production. Crop and livestock sectors are diversified including grains, potatoes, sugar beets, hops, fruit, hogs, cattle, and poultry. The Czech Republic also exports forest products.
Hungary	mining, metallurgy, construction materials, processed foods, textiles, chemicals (especially pharmaceuticals), buses, automobiles	The Agriculture sector, which includes forestry, accounts for 15% of GDP and 16% of employment. Hungary, which is self-sufficient in food production, has a highly diversified crop and livestock farming industry including wheat, corn, sunflower seeds, potatoes, sugar beets; livestock: hogs, cattle, poultry, dairy products.
Macedonia	low levels of technology predominate, such as oil refining by distillation only; produces basic liquid fuels, coal, metallic chromium, lead, zinc, and ferro-nickel; light industry produces basic textiles, wood products, and tobacco	A labor intensive agricultural sector meets the basic needs for food; principal crops are rice, wheat, corn, millet as well as tobacco. In addition, limited amounts of cotton, sesame, mulberry leaves, citrus fruit, and vegetables are also produced. Agricultural production is highly labor intensive.
Poland	machine building, iron and steel, extractive industries, chemicals, shipbuilding, food processing, glass, beverages, textiles	Agricultural output accounts for 7% of GDP, 75% from private farms, 25% from state farms. Although normally self-sufficient in meeting national demands, overall productivity remains low by European standards. However, Poland is the leading European producer of rye, grapeseed, and potatoes. Poland produces a wide variety of other crops and livestock and is a major exporter of pork products.

Industrial and Agricultural Productivity of Central European Countries

Country	Industrial Products	Agricultural Productivity
Romania	mining, timber, construction materials, metallurgy, chemicals, machine building, food processing, petroleum production and refining	Agriculture accounts for 18% of GDP and 28% of labor force. Romania is a major wheat and corn producer; other products include sugar beets, sunflower seed, potatoes, milk, eggs, meat, grapes.
Yugoslavia	machine building (aircraft, trucks, and automobiles; armored vehicles and weapons; electrical equipment; agricultural machinery), metallurgy (steel, aluminum, copper, lead, zinc, chromium, antimony, bismuth, cadmium), mining (coal, bauxite, nonferrous ore, iron ore, limestone), consumer goods (textiles, footwear, foodstuffs, appliances), electronics, petroleum products, chemicals, and pharmaceuticals	The fertile plains of Vojvodina produce 80% of the cereal production of the former Yugoslavia and most of the cotton, oilseeds, and chicory. Vojvodina also produces fodder crops to support intensive beef and dairy production. Yugoslavia proper, although hilly, has a well-distributed rainfall and a long growing season; produces fruit, grapes, and cereals. In this area, livestock production (sheep and cattle) and dairy farming also prosper. Kosovo produces fruits, vegetables, tobacco, and a small amount of cereals. The mountainous pastures of Kosovo and Montenegro support sheep and goat husbandry. Montenegro has only a small agriculture sector, mostly near the coast where a Mediterranean climate permits the culture of olives, citrus, grapes, and rice.
Slovakia	metal and metal products; food and beverages; electricity, gas, and water; coking, oil production, and nuclear fuel production; chemicals and manmade fibers; machinery; paper and printing; earthenware and ceramics; transport vehicles; textiles; electrical and optical apparatus; rubber products	Solvakia is largely self-sufficient in food production. The agriculture sector is diversified including grains, potatoes, sugar beets, hops, fruit, hogs, cattle, and poultry. The country exports forest products.
Slovenia	ferrous metallurgy and rolling mill products, aluminum reduction and rolled products, lead and zinc smelting, electronics (including military electronics), trucks, electric power equipment, wood products, textiles, chemicals, machine tools.	Agriculture productivity accounts for 4.8% of GDP. The sector is dominated by stock breeding (sheep and cattle) and dairy farming. Main export crops include potatoes, hops, hemp, and flax. Slovenia must import many other agricultural products and has a negative overall trade balance in this sector.

Economic Conditions

Albania

An extremely poor country by European standards, Albania is making the difficult transition to a more open-market economy. The economy rebounded in 1993-94 after a severe depression accompanying the collapse of the previous centrally planned system in 1990 and 1991. Stabilization policies (including a strict monetary policy, public sector layoffs, and reduced social services) have improved the government's fiscal situation and reduced inflation. The recovery was spurred by the remittances of some 20% of the population which works abroad, mostly in Greece and Italy. This source of income supplements GDP and helps offset a large foreign trade deficit.

Bosnia-Herzegovina

Bosnia and Herzegovina rank next to The Former Yugoslav Republic of Macedonia as the poorest republic in the old Yugoslav federation. Although agriculture has been almost all in private hands, farms have been small and inefficient, and the republic traditionally has been a net importer of food. Industry has been very inefficient, a reflection of the general over staffing of the bureaucracy by prior Communist central planning and management. The development of military industries in the Republic became a large focus with the result that Bosnia hosted a large share of Yugoslavia's defense plants. Bosnia and Herzegovina continues to be torn apart by the continued bitter interethnic warfare that has caused production to plummet, unemployment and inflation to soar, and widespread human dislocation and misery. Economic statistics are not generally available, although productivity and output clearly has fallen substantially in these war years. The country receives substantial amounts of humanitarian aid from the international community.

Bulgaria

The Bulgarian economy continues its painful adjustment from the misdirected development undertaken during four decades of Communist rule. Many aspects of a market economy have been put in place and have begun to function, but much of the economy, especially the industrial sector, has yet to re-establish market links lost with the collapse of the other centrally planned Soviet Bloc economies. The prices of many imported industrial inputs, especially energy products, have risen markedly. The government plans more extensive privatization to improve the management of enterprises and to encourage foreign investment.

Croatia

Before the dissolution of Yugoslavia, the republic of Croatia, after Slovenia, was the most prosperous and industrialized area, with a per capita output perhaps one-third above the Yugoslav average. At present, Croatian Serb Separatists control a substantial amount of the Croatian territory, and one of the overriding determinants of Croatia's long-term political and economic prospects will be the resolution of this territorial dispute. Croatia faces serious economic problems stemming from the remnants of longtime Communist mismanagement of the economy. Croatia still must deal with a large foreign debt, extensive war damage to bridges, factories, power lines, buildings, and houses, the large refugee population (both Croatian and Bosnian); and the disruption of economic ties to Yugoslavia and the other former Yugoslav republics. Extensive aid and investment, especially in the tourist and oil industries, would seem necessary to revive the moribund economy. However, peace and political stability must come first; only then will recent government moves toward a "market-friendly" economy restore old levels of output. Unfortunately, fighting continues among Croats, Serbs, and Muslims, and national boundaries and final political arrangements are still in question.

Czech Republic

The government of the Czech Republic, using successful stabilization policies to bolster its claims to full membership in the western economic community, has reduced inflation to 10%, kept unemployment at 3%, balanced the budget, run trade surpluses, and reoriented exports to the EU since the breakup of the Czechoslovak Federation in 1993. GDP has grown relatively steadily since 1994. Prague's mass privatization program, including its innovative distribution of ownership shares to Czech citizens via "coupon vouchers" has made the most rapid economic progress in this region of Europe. Currently, 75%-80% of the economy is in

private hands or partially privatized. Privatized companies still face major problems in restructuring as indicated by the large number of annual bankruptcies. In 1994, Prague repaid $471 million in IMF loans five years ahead of schedule, making the Czech Republic the first central European country to pay off all International Monetary Fund debts. The Republic's credit rating is substantially better than Hungary's and Greece. Prague is on the road to a balanced budget, a 3% GDP growth, 5% unemployment, and single-digit inflation. Continuing economic recovery in Western Europe should boost Czech exports and production, but a substantial increase in prices could erode the Republic's comparative advantage in low wages and exchange rates. Prague has increased control over banking policies to neutralize the impact of foreign inflows on the money supply. Czech unemployment is currently one of the lowest in Central Europe.

Hungary

Since 1989 Hungary has been a leader in the transition from a socialist command economy to a market economy; due in large part to its initial economic reforms during the Communist era. The private sector now accounts for a substantial portion of GDP. Strong growth is indicated by real GDP increases of approximately 3%. This growth has helped to reduce unemployment to approximately 10%. However, inflation remains an issue at about 20%. Underlying Hungary's other economic problems is a large budget deficit. The government has pledged to accelerate privatization and lower the budget deficit to attempt to reduce the account deficit.

Macedonia

The Former Yugoslav Republic of Macedonia, although the poorest republic in the former Yugoslav federation, can meet basic food and energy needs through its own agricultural and coal resources. Its economic decline will continue unless ties are strengthened with its neighbors Yugoslavia, Albania, Greece, and Bulgaria. The economy depends on outside sources for all of its oil and gas and most of its modern machinery and parts. An important supplement of GDP is the income from thousands of Macedonians working in Germany and other West European nations. Continued political turmoil, both internally and in the region as a whole, prevents any swift readjustments of trade patterns and economic programs. The Former Yugoslav Republic of Macedonia's geographical isolation, technological backwardness, and potential political instability place it far down the list of countries of interest to Western investors. Resolution of the dispute with Greece and an internal commitment to economic reform would encourage foreign investment over the long run. In the immediate future, the worst scenario for the economy would be the spread of fighting across its borders.

Poland

Poland continues to make good progress in the difficult transition to a market economy that began in 1990, when the new democratic government instituted "shock therapy" by decontrolling prices, slashing subsidies, and drastically reducing import barriers. Real GDP fell sharply in 1990 and 1991, but in 1992 Poland became the first country in the region to resume economic growth and maintains the highest rate in Europe with the exception of Albania. All of the growth since 1991 has come from the private sector, which now accounts for at least 55% of GDP, even though privatization of the state-owned enterprises is proceeding slowly and most industry remains in state hands. Industrial production has increased markedly, including large increases in the output of motor vehicles, radios and televisions, and pulp and paper. After five years of steady increases, unemployment has leveled off nationwide, although it remains inappropriately high in some regions. The trade

deficit has been reduced significantly, due mainly to increased exports to countries of Western Europe.

Romania

Despite the continuing difficulties in moving away from the former command system, the Romanian economy appears to be on the rebound. Market reforms have been introduced without success since 1989, resulting in a growing private sector, especially in services. The slow pace of structural reform has worsened Romania's high inflation rate and eroded real wages. Agricultural production has rebounded from the drought-reduced harvests of the early 1990s. The economy has continued to recover, with further gains seen in agriculture, construction, services, and trade. Food supplies are adequate for the populace, but are expensive. Romania's infrastructure had deteriorated over the last five years due to reduced levels of public investment. Residents of the capital reported frequent disruptions of heating and water services. The slow and painful process of conversion to a more open economy will continue in this decade.

Yugoslavia

The swift collapse of the Yugoslav federation in 1991 has been followed by bloody ethnic warfare, the destabilization of republic boundaries, and the breakup of important inter-republic trade flows. Yugoslavia faces major economic problems; output has dropped sharply. Similarly to other former Yugoslav republics, it depended on its sister republics for large amounts of foodstuffs, energy supplies, and manufactures. Wide differences in climate, mineral resources, and levels of technology among the republics accentuated this interdependence, as did the communist practice of concentrating much industrial output in a small number of giant plants. The breakup of many of the trade links, the sharp drop in output as industrial plants lost suppliers and markets, and the destruction of physical assets in the fighting all have contributed to the economic difficulties of the republics. One singular factor in the economic situation of Yugoslavia is the oversight by a communist government that appears to be primarily interested in political and military mastery, not economic reform. A further complication is the imposition of economic sanctions by the UN early in this decade. Wild inflation rates ended with the establishment of a new currency unit in 1993. Output and productivity seem to have leveled off since then.

Slovakia

Recent economic performance has improved steadily, but privatization has progressed with less predictability. Most of Slovakia's IMF-approved targets were met by an interim government. Inflation and unemployment remain well below forecasts, and the budget deficit has decreased substantially. Slovakia enjoys a large trade surplus which appears to be growing steadily. Privatization and contracting has resulted in steady growth of GDP. Bratislava received an IMF stand-by loan and its Systemic Transformation Facility received approval for a European Union loan worth about $160 million. The Central Bank's foreign currency reserves have tripled since 1994. Slovakia has continued to have difficulty attracting foreign investment, however, because of perceived political instability and halting progress in privatization. The interim government prepared property for the second wave of privatization and participation in the program is over 80%. Continuing economic recovery in western Europe should boost Slovak exports and production, but Slovakia's image with foreign creditors and investors could suffer setbacks if progress on privatization stalls.

Slovenia

Slovenia appears to be making a solid economic recovery since the time of Yugoslavia's breakup. It was by far the most prosperous of the former Yugoslav republics, with a per capita income more than twice the national average. It also benefited from strong ties to Western Europe and suffered comparatively small physical damage in the geopolitical restructuring process. The early years were difficult with GDP falling and inflation and unemployment increasing before a relative turnaround in 1993 when real GDP grew, unemployment leveled off, and inflation slowed dramatically. This recovery and growth was accomplished without balance-of-payments problems. The Slovenian government is relatively strong, particularly with regard to fiscal policy, since the budget deficit has declined markedly and in fact has recently enjoyed several years of small surpluses. Prospects for the future appear good, with economic growth expected to remain strong while unemployment and inflation may decline slightly. Privatization, sluggish to date, is expected to continue at a slow, but adequate pace.

Appendix F: Water Resources.

Albania

Albania has a significant water resource in its rivers that flow from the Albanian Alps west into the Adriatic. Annual precipitation is among the highest in Europe with approximately 1,500 mm annually, with an annual water flow of 42,000,000,000 cubic meters. Due to river origins in mountainous regions, rivers typically flow fast over short routes to the ocean providing large hydroelectric potential. Rainfall distribution is typically Mediterranean, with uneven distribution skewed to the winter months, and a relative shortage between April and September (Frasheri, 1988).

Mineral and hydroelectric resources are generally more distributed in the northern half of the country. Hydroelectric power production accounts for about 80% of the country's electricity use. The River Drin provides about 50% of the total, with Lakes Vau I Dejes, Koman and Fierze resulting from the damming of the 285-km long White and Black Drin Rivers (Karadimov, 1989). Other major water resources include Lake Scutari on the border and shared with Montenegro to the north, and the Mat, Shkumbin, Devall, Osum and Vijose rivers. Two of the country's four natural lakes are shared with Montenegro; the Shkoder (386 km^2) and the Ohrid (363 km^2) and the other two with Greece; Little Prespa (23.5 km^2) and Prespa (285 km^2).

The Elbasan metallurgical complex, located in the central Shkumbin River region, is the countries largest industrial plant and directly employs 10,000 people. The Chinese initiated the project, but was abandoned when Sino-Albanian political relations ended in 1978. Without the original plans and access to pollution control technology, Albania finished the plant over a number of years. The plant is considered a major polluting factor in the Elbesan Valley (Atkinson, *et al.* 1991).

Heavy atmospheric inputs of SO_2 and other air pollutants are located in the industrial concentration areas of Tirana, Shkoder, Korce, the Elbasan complex, Berat and Gramsh; and a number of these major settlements are located in valley basins, where temperature inversions prevent adequate mixing from atmospheric dilution. While very little specific data is available, cities such as Korce, the countries highest (800 m) have extreme problems with industrial atmospheric pollutants (Trojani, 1991).

Acute river pollutant problem areas include the Bune on the border with Montenegro, the Mat south of Lezhe, and the Shkumbin, Semani and Vijose Rivers flowing west into the Adriatic Sea. Waste treatment is not common, and fertilizer and pesticide use contribute to contaminant runoff. Mining activities, for example in Librazhd and Prenjas, have led to descriptions of the Shkumbin "running red downstream" from ferro-nickel plants in the area (Tartari, 1988).

Bulgaria

The lower Danube River forms the border between Bulgaria and Romania. Bulgaria's northern rivers flow into the Danube and in turn into the Black Sea. Significant tributaries to the Danube include the Ogosta, Iskur, Vit, Osum, Yantra, and Beli Lom Rivers. The Stara Planina Range divides the country in approximate north and south halves. Major river courses in the south include the Struma, Mesta, Maritsa, Arda, Tundzha, Ropotamo, and Kamchija Rivers. The Struma and the Mesta flow generally

south to the Aegean Sea, through Greece. The Maritsa, Arda and Tundzha flow eastward and then south, where they meet forming the boundary between Greece and Turkey. The Ropotamo and Kamchija Rivers flow eastward into the Black Sea south of the delta of the Danube.

Although Bulgaria's power production and industry have been relatively lower level emitters of SO_2 than its former Eastern Bloc neighbors, annual increases have been high. The nation is a net exporter of SO_2, ranked twelfth among European countries (Dampier, 1983). The post-war drive to industrialize rapidly, and the country's limited energy resources, have been critical factors in this increase.

Serious air pollutant areas include Sofia-Pernik on the Iskur River, and Maritsa-Istok on the Maritsa River in south central Bulgaria. Sofia is located in a valley area with common temperature inversion problems and the primary industrial zone is located upwind of the city, with major input problems to residential and urban areas. A primary contributor to these point source inputs is the Kremikovtsi metallurgical complex, with Bulgaria's largest iron and steel works. Locally used ores, with a low iron content and a high burnoff rate, produce large quantities of SO_2, NO_x, as well as carbon oxides, phenols, cyanides, lead aerosols, and mercury. The residential water supply for the suburbs downwind reputedly contains high concentrations of zinc, copper, chrome, lead, manganese, and arsenic (Tishkov, 1974; Carter, 1984).

Maritsa-Istok, in the eastern Upper Thracian plain, provides opencast strip-mined brown coal supplying three power stations. The coal is high in ash, moisture, and sulfur (3-5%). Resulting air and water pollution is significant in this area. Pernik, another major industrial area, produces power from a thermal power-station that utilizes low caloric value lignite, causing significant air contaminants along with cement and metallurgical industries (Khristov and Popov, 1976). Plovdiv, Gabrovo and the Black Sea Coast are likewise areas with dense air contaminant issues. Transboundary air problems emanate from Giurgiu, Romania, on the Danube across from the town of Ruse. Ruse, the fourth largest city in Bulgaria, receives emissions from a chlorine and sodium plant that greatly exceed recognized safety levels (Manolov, 1985; Carter, 1989).

Although the country contains numerous lakes and dams, the Danube is the primary large-scale fresh water resource for Bulgaria. In addition, the coastal zone along the Black Sea provides a rich water resource for the industrial centers supported by local supplies of coal, copper, manganese, natural gas, quartzite, rock salt, and marble. Sea transport and shipping links with the Soviet Union, Arab States, and Africa, contribute to the benefits of this resource and industrial contaminant problems. Two major centers of settlement and industrial activity provide the most of the coastal input into the Black Sea; Varna-Devnja in the north and Burgas-Kameno in the south (Carter, 1989).

Chemical plants may provide the greatest water pollutant input in Bulgaria. Examples include the large industrial complexes around Stara Zagora and Razgrad and the newer industrial areas of Burgas, Pleven and Varna-Devnja. Other industrial operations have also caused serious water degradation issues in the Yantra Valley that drains into the Danube. These include paper manufacture and sugar beet refining; and industrial agglomerations in Gabrovo, Gorna Oryahovitsa, Lyaskovets and Veliki Trnovo. Plovdiv, in the southern region of the Maritsa River, has an industrial region with a non-ferrous metallurgical plant, a storage battery combine and a nearby cellulose/paper factory. There is a lead and zinc works at Asenovgrad; and a chemical works and uranium factory at Rakovski (Khristov and Stankov, 1982; Khristov and Dancheva, 1983).

Czech Republic and Slovakia

The Czech Republic and Slovakia inherited a strong industrial heritage from the former Czechoslovakia, where the *Nomenclature* personified the Soviet system and greatly intensified heavy industrial investment in the 1940s. Additional contributions of transboundary pollutant input from Poland to the north and Germany to the west (the borders of the three countries describing the "Black Triangle") have produced major concentrations of environmental problems, especially for the Czech Republic.

Industrial production is particularly concentrated in the North Bohemian Coal Basin in the northwestern part of the Czech Republic, where SO_2 is a primary air pollutant. Thermal power plants and industrial boilers burning low quality brown coal (lignite) are the main contributors to the problem, along with regional concentration of industries and lack of alternative hydrocarbon fuels. North Bohemia produces two thirds of the old Czechoslovakia's brown coal and about half of the thermally generated power plants (Klatsterska, 1991). Other major areas with high SO_2 air concentrations include the capital, Prague, the cities of Brno (in the southeastern Czech Republic), Bratislava (western Slovakia), the industrialized areas of north Moravia (western Czech Republic, near Ostrava), and central Bohemia (Czech Republic).

Mountain regions of the Czech Republic and Slovakia have been heavily impacted by SO_2 emissions, causing the most profound forest damage in the mountainous regions of Bohemia and Moravia, in the Czech Republic. The Ore Mountains and the once thickly forested region along the former East German-Polish-Czechoslovakian show severe signs of SO_2 pollution. Forest damage is extensive in the Krkonose Mountains, the Jezerske Hory Mountains, and the Snezka Massif, from a combination of in-country and transboundary emissions, particularly from Poland's Silesian Industrial Zone. Slovakia, about 40% forested, is impacted by the Polish Katowice industrial complex, and eastern Slovakia there has a magnesium dust problem from factories in Roznava and Kosice. The most heavily impacted Slovakian forest areas are in the Beskindy Mountains on the Morvian-Slovakian border and in the area of Ziar and Hronom in central Slovakia (Konopka, 1988).

Czechoslovakia was historically referred to as the "roof of Europe," forming part of the main watershed of the continent. The Danube separates Slovakia and Hungary. Primary watersheds in the Czech Republic include the Elbe, Bilina, Neisse, Dyje, Svartka, Oder, and Morava rivers. In Slovakia, the main rivers are the Danube, Hron, Vah, Ipel, Slana, and Hornad.

Approximately 80% of water demands of the Czech Republic and Slovakia are from surface water. Industrial and non-point source pollution contaminates approximately half the water supply (Kopecny, 1988; Vavrousek and Moldan, 1989). Groundwater contamination is of growing concern, particularly in heavily industrialized areas of Northern Bohemia. Major contaminants to surface and groundwater include pesticides and nitrates, viruses, bacteria, radionuclides, thermal pollution, and heavy metals.

Hungary

Hungary's water resources average approximately 120 km^3 annually, with about half from direct precipitation. More than 90% of the water resources comes from the Danube, making the nation dependent on its neighbors. Only two percent of the Danube and thirty-seven percent of the Tisza, Hungary's largest river resources, are in Hungary (Hock and Somlyody, 1990: 68).

Primary river systems include the Danube, Bodva, Raba, Szamos, Tisza, and Zagyva. Lake Balaton, in western central Hungary, represents its largest lake resource. As with all the countries located south of the Carpathian Mountains, river drainages in Hungary flow generally south and east, into the Danube Basin.

An industrial "crescent" exists in northern Hungary from its borders with Austria across the northern border of Slovakia, where many of the country's large-scale pollutants originate. SO_2 inputs from Ajka, Gyor, and Tatabanya in western Hungary, and Miskolc and Ozd in the east provide severe air pollutants. Plumes over the capital, Budapest, and Miskolc, Pecs, Tatabanya and the Matra Mountains were observed to 2,000-3,000 meters in altitude in the 1960s (Varkonyi and Kiss, 1990: 50). Power plants, iron and aluminum production, cement and chemical plants, and other industrial operations, home heating, and transportation vehicles were primary contributors. With the exception of Pecs, in southwest Hungary, areas heavily affected by SO_2 are in the northern regions of the country. Forest lands in northern Hungary are considered at high risk from SO_2.

The Danube, Kapos, Tisza and Zala Rivers have received alarming increases in nitrate, phosphate, lead, ammonium, iron, and mercury. This has raised concerns of contaminant leaching into bank-filtered groundwater reserves crucial to Hungary. North and south of Budapest this groundwater resource is degrading. Hungary has about 3,000 population centers with large populations, and about 700 of them now rely on bottled or imported water from nearby communities, due to contamination (Stefanovits, 1984).

Poland

The major river resources in Poland include Vistula River, the Oder River, Bug, Natec River, Narew River, San River, and Warta River. Poland's rivers generally flow north to the Baltic Sea. The northern one-third of Poland has a large resource of more than 500 large lakes in the physiographic region of the European Plain.

After air pollutant input, direct pollution of water resources is considered a primary environmental concern in Poland as in the other Central European countries. As elsewhere, prime industrial locations are provided by major river systems. The Vistula River, Poland's major river, had 238 large industrial plants built on its banks between 1945 and 1970. Chemical plants, Cellulose plants, and thermal power stations contributed to contaminant loads (Carter and Turnock, 1993). Primary industrial regions in Poland include the Upper Silesian Industrial Region (including the Katowice province) and the Krakow region in a basin of the upper Vistula River. Combined, these produce half the nations gaseous atmospheric pollution and a third of its particulates (Kabala, 1991b).

In 1975, more than 90% of Poland's water supply for industry came from surface water resources. Contributions to pollutant problems has come from transboundary contributions as well as from in-country industries (Grzesiak, 1990: 75). In 1983, approximately two thirds of all rivers in Poland were characterized as Class III or worse, with heavy metals posing serious problems. In the second half of 1980, mercury content of the Vistula River below Krakow was more than 200 times the permitted amount. There were also high levels of chrome, lead, and iron (Survey of World Broadcasts, 1983).

Transboundary contributions to river pollution in Poland are made by Czechoslovakia via the Odra and Nisa rivers. A 1986 heating oil spill of 190 tons from a factory in Ostrava (Northern Moravia) reached the Odra River in Poland causing a major disaster in the region. In 1988, Poland requested compensation for a 30,000 liter diesel oil spill from Czechoslovakia into the Nisa River (Gesing, 1986).

Romania

Romania is encompassed by the eastern half of the Carpathian Range, the Transylvanian Alps and the Walachin Plain. Drainage is to the south into the lower Danube River valley where it empties into the Black Sea on the eastern shore of the country. Major river resources include the Mures, Crisu Alb, Crasna, Somes (Szamos in Hungary), and Timava Mica draining generally westward to the Tisa and eventually to the Danube in Hungary and Yugoslavia. The Moiru, Jiu, Oltet, Olt, Vedea, Teleorman, Arges, Lalomita, Buzau, and Siret rivers all drain into the Danube basin in the south and west of Romania. The Prut River forms much of Romania's border with the Ukraine, and drains south into the Danube Delta area. Typical of plains areas draining large mountainous areas, the Bucharest and southern Romania suffer seasonally from floods and droughts.

High input from industrial and other sources of SO_2 are found around Bucharest in the industrial areas of Pandure, Obor, and Acumulatorul. Other "hot spot" industrial areas include the Bicaz-Tasca cement complex in the Bistrita Valley in the mountainous north, the carbon factory at Copsa Mica, and a fertilizer plant at Valea Calugareasca. These areas have temperature inversions that trap heavy concentrations of SO_2 and other air pollutants. The Giurgiu chlorine plant in southern Romania on the Danube, presents transboundary contaminants to Ruse; Bulgaria to the south (Constantinescu, 1990).

Waterways particularly at risk from atmospheric and direct chemical inputs include the lower reaches of the Bahlui, Birlad, Bistrita, Olt, and Trotus rivers. Drinking water contamination is considered extensive at the Roznov-Savinesti complex in the Bistrita Valley near Piatra Neamt, and at Arad in the Mures Valley, where large groundwater alluvium reserves are at risk. The industrial complex at Arad discharges ammonia, nitrates and phosphates four km from the city's main groundwater resource (Cineti, 1990). Sulina, on the delta of the Danube, has been a toxic waste storage facility. A contract with a Liechtenstein chemical firm resulted in the disposal of 300,000 tons of dye and paint production materials that damaged the tourist industry along the Black Sea coast in 1988 (Vinicius, 1990). Other inputs in the Black Sea include the oil refining and petrochemical complex at Midia-Navodari, where canal water discourages tourism at Mamaia and the city of Constanta's drinking water supply.

Bosnia-Herzegovina, Croatia, Macedonia, Yugoslavia, and Slovenia

Very little hydrologic and pollution information is available for the individual countries of the former Yugoslavia. Also, due to major political changes and population shifts within the country (primarily into the smaller Yugoslavia from Bosnia-Herzegovina), urbanization and industrialization have been unusually rapid. However, information on the larger scale is accessible to provide the major areas of risk to hydrologic resources.

The major rivers in Bosnia-Herzegovina are the Vrbas, Bosna, Neretva, and Drina. The Uno and Sava rivers form much of its northern border with Croatia. The Drina forms

part of the border with Yugoslavia and the southeastern border with Montenegro. Montenegro contains the headwaters of the Drina, Tara, and Moraca rivers; the latter which flows into Lake Scutari and the Adriatic Sea on its border with Albania to the south. Macedonia's (F.Y.R.O.M.) main river is the Vardar, with the Crna and the Breguinica rivers as major tributaries. Yugoslavia contains parts of the Danube (which flows through Belgrade), the Drina River, and the Sava River. Both Croatia and Slovenia have portions of the Drava and Sava rivers within their borders. Slovenia, Croatia, Bosnia-Herzegovina, and Montenegro all share coastal land on the Adriatic Sea. Yugoslavia and Macedonia are landlocked.

In 1990, Belgrade was considered the city with the highest concentration of SO_2 and NO_x of all capitals in the world, including Brussels, Lisbon, Prague, and Tokyo (Dnevik, 3 September 1990). The main air contaminant, as elsewhere in the industrialized world, is SO_2 and, although localized in the larger industrial cities of the former Yugoslavia, it is considered a serious risk to water supplies and soils. Belgrade, Kraljevo, Skopje, Rijeka, and Nis have serious SO_2 and air pollution problems.

The Sava, as the former Yugoslavia's major river resource, contains a large percentage of the major modern industrial complexes of the region. Its water supply is also used for household consumption. Industrial contaminants in the Sava include nitrates, ammonium, cadmium, chromium, copper, oils, and raw sewage. The Neretva is polluted by similar discharges along its length, and contributes its contents into the Adriatic Sea.

Major Water Resources of the Central European Countries

Country	Major Water Systems
Bosnia-Herzegovina	**Tributaries to the Sava (defines border to the north with Slovenia):** Una, Sana, Unac, Vrbas, Ukrina, Bosna, Krivaja, Spreca; **West to Adriatic Sea:** Neretva
Bulgaria	**Tributaries to the Danube (flowing northward):** Lom, Ogosta, Iskar, Vit Osam, Jantra, Rosica; **South into the Aegean:** Marica Mesta, Arda, Tundza, Sezliika, Mocurica; **East to the Black Sea:** Luda Kamcija, Goljama Kamcija
Croatia	**Tributaries to the Danube (border with Yugoslavia to the east):** Drava, Sava (border with Bosnia-Herzegovina to the south), Lonja, Kupa (border to Slovenia to the north), Dobra, Glina; **Rivers flowing west to the Adriatic Sea:** Zrmanja, Cetina, Neretva
Czech Republic	**Tributaries to the Labe [Elbe] (Eastern Czech Republic, flowing north to the North Sea):** Ohre, Berounka, Vitava, Jizera; **Tributaries to the Danube (south flowing):** Dyje, Jihava, Oslava, Svartka, Svitava, Morava, Odra; **Major Lakes** udolni nadiz Lipno (shared on border with Austria)
F.Y.R.O.M.	**Rivers flowing south to the Aegean Sea (through Greece):** Bregalnica, Vardar; **Lakes:** Ohrid, Prespa (both shared on border with Albania); Little Prespa, Doiran (both shared on border with Greece)
Hungary	**Tributaries to the Danube:** Raba, Marcal, Kapos Koppany, Sio, Sarviz, Duna; **Tributaries to the Tisza (Tributary to the Danube in Yugoslavia):** Tarna, Zagyva, Hernad, Sajo, Szamos Kraszna, Berettyo, Koros; **Lakes:** Neusiedler (border with Austria), Balaton
Montenegro	**Rivers flowing north to Drina and the Sava:** Piva, Tara; **Lakes:** Lake Scutari (shared border with Albania to the south)
Poland	**Rivers flowing into Baltic Sea:** Odra (Oder, N. border w/ Germany; major tributaries Nysa, Warta, Bobr, Klodska), Rega, Parseta, Wieprza, Gwda, Stupja, Leba; Wisla (major tributaries, Srda, Wda, Notec, Wiezyca,

	Drweca, Wkra, Narew, Bug, Pilica, Wieprz, San, Wistoka, Dunajec, Nida)
Romania	**Tributaries to the Danube (west, south, and east flowing):** Somes (Szamos), Crasna, Beretau, Crisu Repede, Crisu Negru, Crisu Alb, Mures, Bega, Poganis, Birzava, Timis, Bistra, Jiu, Oltet, Olt, Tirnava Mica, Tirnava Mare, Vedea, Teleorman, Neajlov, Arges, Dimbovita, Praltova, Calmatui, Buzau, Rimna, Siret, Trotus, Zabala, Rimna, Zeletin, Tutova, Multova, Sitna, Biseu
Yugoslavia	**Tributaries to the Danube:** Tisa (Tisza in Hungary), Begij, Tamis, Sava Kolubara, Velika Morava, Zapadna Morava, Rasina, Topilica, Jablanica, Nisava, Mlava, Pik, Beli Drim, Sitnica, Ibar, Danube and Iron Gate Reservoir on shared border with Romania.
Slovakia	**Rivers flowing south to the Danube:** Vah, Nitra, Hron, Torysalpel (shared border with Hungary), Torysa, Poprad, Topla, Ondava, Laborec, Uh, Maly Dunaj - Danube on southwest border with Hungary
Slovenia	**Rivers flowing into the Danube River Basin:** Sava, Drava (portion of border to the north with Austria), Dravinja, Mura, Kupa (part of border to the south with Croatia)

Contiguous Boundaries and Shared Waterways of the Countries of Central Europe

Country of Focus	Common National Borders	Shared Water Resources
Albania	Macedonia	Lake Ohrid, Lake Prespa
	Montenegro	Lake Scutari, Drini River
	Yugoslavia	Drini River
	(Greece)	Vjosa River
Bosnia-Herzegovina	Croatia	Sava River, Una River, Neretva River
	Yugoslavia	Drina River, Tara River
Bulgaria	Romania	Danube River
	Yugoslavia	Nisava River, Tunok River
	(Greece)	Struma River, Mesta River (Nestos in Greece), Vucha River, Arda River
	(Turkey)	Tundzha River, Maritsa River, Meric River
Croatia	Bosnia-Herzegovina	Sava River, Una River, Neretva River
	Hungary	Danube River, Drava River
	Yugoslavia	Drava River, Danube River
	Slovenia	Sava River
Czech Republic	Poland	Morava River, Neisse River
	Slovakia	
	(Austria)	Dyje River, Luznice River, Morava River, Danube River
	(Germany)	Ohre River, Saale River, Elbe River, Neisse River
Macedonia	Albania	Lake Ohrid, Lake Prespa, Drini River
	Bulgaria	
	Yugoslavia	Morava River, Vardar River
	(Greece)	Lake Prespa, Vardar River
Hungary	Croatia	Danube River, Drava River
	Romania	Szamos River, Crasna River, Crisu Alb River, Mures River
	Yugoslavia	Danube River, Tisa River
	Slovakia	Danube River, Ipol River, Bodva River, Hernad River, Tisza River
Hungary	Slovenia	Mura River
	(Austria)	Neusiedler (Ferto) Lake
	(Ukraine)	Tisa River, Latoritsa River

Contiguous Boundaries and Shared Waterways of the Countries of Central Europe

Country of Focus	Common National Borders	Shared Water Resources
Poland	Czech Republic	Morava River, Neisse River
	Slovakia	
	(Belarus)	Narew River
	(Germany)	Oder River, Odra River, Neisse River
	(Lithuania)	
	(Russia)	Lyna River
	(Ukraine)	Bug River, San River
Romania	Bulgaria	Danube River
	Hungary	Szamos River, Crasna River, Crisu Alb River, Mures River
	Yugoslavia	Tamis River, Danube River (Iron Gate Reservoir)
	(Muldova)	Prut River, Danube River
	(Ukraine)	Tisa River, Prut River, Suceava River, Siret River
Yugoslavia	Albania	Lake Scutari, Drini River
	Bosnia-Herzegovina	Drini River, Tara River
	Bulgaria	Nisava River, Tunok River
	Croatia	Drava River, Danube River
	Macedonia	Morava River, Vardar River
	Hungary	Danube River, Tisa River
	Romania	Tamis River, Danube River (Iron Gate Reservoir)
Slovakia	Hungary	Danube River, Ipol River, Bodva River, Hernad River, Tisza River
	(Austria)	Dyje River, Morava River
	(Ukraine)	Uh River, Latoritsa River
Slovenia	Croatia	Sava River
	Hungary	Mura River
	(Austria)	Lavani River, Mura River, Drava River
	(Italy)	Isonzo River

Appendix G: Sources and Sinks of Environmental Pollution.

Sources of Environmental Pollutants

Types and Sources of Environmental Contamination in Central Europe

Country	Chemical Plants	Coal Burning Power Plants	Non-Ferrous Metallurgical Plants	Ferrous Metallurgical Plants	Nuclear Power Plants
Albania	3	1	1	1	0
Bosnia-Herzegovina	4	3	0	2	0
Bulgaria	12	7	3	2	1
Croatia	3	0	0	2	0
Czech Republic	14	14	4	10	1
Hungary	7	4	5	6	1
Macedonia	0	1	2	1	0
Poland	32	21	7	23	0
Romania	32	6	6	9	0
Yugoslavia	3	7	3	3	0
Slovakia	7	3	3	2	1
Slovenia	2	1	1	3	1

Locations and Status of Reactor Sites

Country	Location/Name	Status of Facility
Albania	None	n/a
Bosnia/Herzegovina	None	n/a
Bulgaria	Belene 1	Under Construction/Suspended
	Belene 2	Under Construction/Suspended
	Belene 3	Planned/Canceled
	Belene 4	Planned/Canceled
	Kozloduy 1	Operating
	Kozloduy 2	Operating
	Kozloduy 3	Operating
	Kozloduy 4	Operating
	Kozloduy 5	Operating
	Kozloduy 6	Operating
Croatia	None	n/a
Czech Republic	Dukovany 1	Operational
	Dukovany 2	Operational
	Dukovany 3	Operational
	Dukovany 4	Operational
	Temelin 1	Under Construction
	Temelin 2	Under Construction
	Temelin 3	Under Construction/Suspended
	Temelin 4	Under Construction/Suspended
Hungary	Paks 1	Operating
	Paks 2	Operating
	Paks 3	Operating
	Paks 4	Operating
	Paks 5	Planned/Canceled
	Paks 6	Planned/Canceled
Macedonia	none	n/a

Locations and Status of Reactor Sites		
Country	**Location/Name**	**Status of Facility**
Poland	Zamowiec 1	Under Construction/Suspended
	Zamowiec 2	Under Construction/Suspended
	Zamowiec 3	Planned/Canceled
	Zamowiec 4	Planned/Canceled
Romania	Brasnov	Operating
	Cemavoda 1	Under Construction
	Cemavoda 2	Under Construction
	Cemavoda 3	Under Construction
	Cemavoda 4	Under Construction
	Cemavoda 5	Under Construction
	Pitesti Fuel Fabrication Plant	Operating
Yugoslavia	None	n/a
Slovakia	Bohunice	
	Mochovce	
Slovenia	KRSKO	
	Zirovski Vrh (milling)	Operating
	Zirovski Vrh (mining)	Unknown

Environmental Sinks (deposition of heavy metals)

Characteristics of Deposition of 4 Metals in Countries of Central Europe (Data from RIVC

Arsenic (As)		
Country	**Depositional Rate (mol/hectare/yr)**	**Rivers and Tributaries Affected by Metal Depositions**
Albania	0.020-0.040	Drin, Mat, Drin-i-zi, Beli Drim, Ezren
	0.010-0.020	Seman, Devoll, Osum, Vjose
Bulgaria	0.080-0.160	Maritsa
	0.040-.0080	Arda, Vucha, Marista, Stryama, Tundzha, Iskur, Fakiyska, Osum, Yantra, Lom, Kamchiya, Danube
	0.020-0.040	Ogosta, Iskur, Danube, Mesta, Vucha, Maritsa
Czech Republic	0.080-0.160	Elbe, Morava
	0.040-.0080	Elbe, Vltava, Morava, Oder
Hungary	0.040-.0080	Danube, Tisza
	0.020-0.040	Zala, Danube, Raba, Tisza, Koros, Szamos
Poland	0.080-0.160	Vistula, Warta (headwaters)
	0.040-0.080	Warta, Notec, Oder, Vistula
	0.020-0.040	Vistula, Bug
Romania	0.040-.0080	Unnamed Tributary
	0.020-0.040	Siret, Danube, Arges, Olt
Slovakia	0.080-0.160	Vah (headwaters), Hornad (headwaters)
	0.040-.0080	Vah, Hornad, Danube

Cadmium (Cd)		
Country	**Depositional Rate (mol/hectare/yr)**	**Rivers and Tributaries Affected by Metal Depositions**
Albania	0.004-0.008	Beli Drim, Drin, Mat, Drin-i-zi
	0.002-.004	Erzen, Seman, Devoll, Osum, Vjose

Cadmium (Cd)		
Country	**Depositional Rate (mol/hectare/yr)**	**Rivers and Tributaries Affected by Metal Depositions**
Bulgaria	>0.024	Tundzha, Maritsa, Arda, Yantra
	0.016-0.024	Marista, Lom, Kamchiya, Fakiyska, Stryama, Ogosta, Iskur, Osum, Yantra, Danube
	0.008-0.016	Kamchiya, Iskur, Struma, Mesta, Vucha, Marista, Danube
Czech Republic	0.016-0.024	Elbe
	0.008-0.016	Elbe, Vltava, Morava, Oder
Hungary	0.016-0.024	Danube, Drava
	0.008-0.016	Zala, Danube, Raba, Tisza, Koros, Szamos
	0.004-0.008	Raba
Poland	>0.024	Vistula, Oder, Warta
	0.016-0.024	Oder, Warta, Notec, Bug
	0.008-0.016	Vistula, Notec, Oder
Romania	0.016-0.024	Olt, Arges, Danube
	0.008-0.016	Olt, Arges, Danube
	0.004-0.008	Siret, Danube
Slovakia	>0.024	No Rivers
	0.016-0.024	Hornad (headwaters), Vah (headwaters)
	0.008-0.016	Hornad, Vah, Danube

Lead (Pb)		
Country	**Depositional Rate (mol/hectare/yr)**	**Rivers and Tributaries Affected by Metal Depositions**
Albania	0.15-0.35	Drin, Mat, Drin-i-zi, Beli Drim
	0.05-.015	Erzen, Seman, Devoll, Osum, Vjose
Bulgaria	0.35-0.60	Stryama, Marista, Arda, Tundzha
	0.15-0.35	Marista, Lom, Kamchiya, Fakiyska, Ogosta, Iskur, Osum, Yantra, Danube, Struma, Mesta, Vucha, Marista, Danube, Stryama (headwaters)
Czech Republic	0.35-0.60	Elbe, Vltava, Morava
	0.15-0.35	Morava, Oder
Hungary	0.35-0.60	Raba
	0.15-0.35	Zala, Danube, Raba, Tisza, Koros, Szamos
Poland	0.35-0.60	Warta, Notec, Oder, Vistula (headwaters)
	0.15-0.35	Vistula, Bug, San, Dnestr (headwaters)
Romania	0.15-0.35	Olt, Arges, Danube, Siret
Slovakia	0.35-0.60	Vah, Danube
	0.15-0.35	Vah (headwaters), Hornad, Danube

Zinc (Zn)		
Country	**Depositional Rate (mol/hectare/yr)**	**Rivers and Tributaries Affected by Metal Depositions**
Albania	0.16-0.32	Drin, Mat, Drin-i-zi, Beli Drim, Erzen, Seman, Devoll
	0.08-0.16	Osum, Vjose
Bulgaria	0. 32-0. 64	Struma, Mesta, Iskur, Marista (headwaters)
	0.16-0.32	Arda, Vucha, Marista, Stryama, Tundzha, Iskur, Ogosta, Osum, Yantra, Lom, Kamchiya, Danube
	0.08-0.16	Marista, Arda, Tundzha, Fakiyska, Kamchiya

Zinc (Zn)		
Country	**Depositional Rate (mol/hectare/yr)**	**Rivers and Tributaries Affected by Metal Depositions**
Hungary	0. 32-0. 64	Zala, Danube, Raba, Tisza, Koros, Szamos
Poland	<1.28	Vistula, Warta, Oder, Notec
	0. 64- 1.28	Vistula, Bug, Notec
Romania	0. 32-0. 64	Arges, Danube
	0.16-0.32	Siret, Danube, Arges, Olt
Slovakia	0.64-1.28	Vah (headwaters), Hornad (headwaters)
	0. 32-0. 64	Vah, Hornad, Danube

Appendix H: Human Health and Ecological Resource Risk Summaries.

Human Health Hazard and Concern Levels for Pollutants

Pollutant	Priority Pollutant	Carcinogen	Water And Fish Ingestion units per liter	Fish Consumption Only units per liter	Drinking Water MCL units per liter
Arsenic	Y	Y	2.2 ng	17.5 ng	0.05 mg
Arsenic (pent)	Y	Y			
Arsenic (tri)	Y	Y			
Cadmium	Y	N	10 µg		0.010 mg
Copper	N	N			
Lead	Y	N	50 µg		0.05 mg
Mercury	Y	N	144 ng	146 ng	0.002 mg
Zinc	Y	N			
Radionuclides		Y	n/a	n/a	n/a
Organochlorines		Y			

Relative Wildlife Concern Levels for Pollutants (NOAEL, LOAEL)

Pollutant	NOAEL (ppm)	LOAEL (ppm)	Fresh Water Acute Criteria µg L	Fresh Water Chronic Criteria µg L	Marine Acute Criteria µg L	Marine Chronic Criteria µg L
Arsenic						
Cadmium			3.9+	1.1+	43	9.3
Copper						
Lead			82+	3.2+	140	5.6
Mercury			2.4	0.012	2.1	0.025
Zinc			120+	110+	96	96
Radionuclides			n/a	n/a	n/a	n/a
Organochlorines						

ARSENIC (As)

Maximum Tolerable Arsenic Concentration (NOAEL) and Effects (LOAEL) for Wildlife (ppm)

	No Observable Adverse Effect Level (NOAEL)	Lowest Observable Adverse Effect Level (LOAEL)
Herbivorous birds	112	200
Insectivorous birds		
Carnivorous birds		
Ruminants	285	570
Other herbivorous mammals	50	
Insectivorous mammals		
Carnivorous mammals		10
Invertebrates		

Cadmium (Cd)

Maximum Tolerable Cadmium Concentration (NOAEL) and Effects (LOAEL) for wildlife (ppm)

	No Observable Adverse Effect Level (NOAEL)	Lowest Observable Adverse Effect Level (LOAEL)
Herbivorous birds	10	12
Ruminants	15	30
Carnivorous mammals		
Other mammals	47.1	50
Amphibians[1]	2	2.25
Soil organisms	4	11

[1] Values reported for amphibians are water concentrations

Copper

Maximum Tolerable Copper Concentration (NOAEL) and Effects (LOAEL) for Wildlife (ppm)

	No Observable Adverse Effect Level (NOAEL)	Lowest Observable Adverse Effect Level (LOAEL)
Herbivorous birds	500	800
Insectivorous birds		
Carnivorous birds		
Ruminants	7.3 - 30	26.6 - 38
Other herbivorous mammals	250	425
Insectivorous mammals		
Carnivorous mammals	110	160
Invertebrates	300	355

*Range is given for low molybdenum and high molybdenum diets.

Lead (Pb)

Maximum Tolerable Lead Concentration (NOAEL) and Effects (LOAEL) for Wildlife (ppm)

	No Observable Adverse Effect Level (NOAEL)	Lowest Observable Adverse Effect Level (LOAEL)
Herbivorous birds	100	1,000
Insectivorous birds	94	
Carnivorous birds	448	
Ruminants	1,000	
Other herbivorous mammals	30	325
Insectivorous mammals	250	
Carnivorous mammals	6	38
Invertebrates	550	

Zinc (Zn)

Maximum Tolerable Zinc Concentration (NOAEL) and Effects (LOAEL) for Wildlife (ppm)

	No Observable Adverse Effect Level (NOAEL)	Lowest Observable Adverse Effect Level (LOAEL)
Herbivorous birds	125	250
Insectivorous birds		
Carnivorous birds		
Ruminants	692	750
Other herbivorous mammals	500	1,000
Insectivorous mammals		
Carnivorous mammals	500	1,500
Invertebrates	150	5,000

Chemicals of Concern.

Heavy metals are associated with numerous forms of industrial production and constitute a significant portion of the waste produced by municipal treatment facilities. Some of the most common metals that are by-products of industrial sites include arsenic (As), cadmium (Cd), copper (Cu), lead (Pb) and zinc (Zn).

Arsenic (As)

Arsenic occurs in most rock types and has high affinity to clays, hydroxides, and organic matter. Background concentrations in U.S. soils range from <0.1 to 93 ppm. Average soil As concentrations in the U.S. range from 5.1 to 8.8 ppm (Kabata-Pendias & Pendias, 1992). Arsenic can produce teratogenic, mutagenic, and carcinogenic effects in animals and has long been associated with poisoning and multiple chronic effects on the central nervous system. Arsenic can be fatal when uptake exceeds approximately 15-25 mg/kg of inorganic As. Exposure to As occurs through air (from smelters, coal-fired power plants), and from water (mine tailing runoff, smelter wastes).

Cadmium (Cd)

Cadmium is associated with Zinc. Background soil concentrations in the U.S. range from 0.08 to 1.5 ppm. The background mean values for various soils range from 0.21 to 0.73 ppm (Kabata-Pendias & Pendias, 1992). Cadmium is a relatively rare metal in nature and there is no evidence that it is biologically essential or beneficial. Tissue residues have been measured in over 1,000 species of freshwater and terrestrial biota (Eisler, 1985). Elemental Cd is insoluble in water and, consequently, has a low toxicity. However, its chloride and sulfate salts are freely soluble. Anemia, bone demineralization, and kidney damage are the principal adverse effects of Cd (NAS, 1980). Cadmium is a known carcinogen and teratogen. There is currently no evidence that Cd is biologically essential or beneficial. Cadmium concentrations as low as 4 ppb in water, 100 ppb in diet, and 100 $\mu g/m^3$ in air can cause adverse effects in fish and wildlife, while uptake of approximately 100-200 ppm Cd/kg body weight will produce mortality in many animals.

Copper (Cu)

Copper is a constituent of many ubiquitous minerals. The Cu-containing minerals are readily soluble in mild acids and thus are part of most soils. In the United States, background concentrations of Cu range from 1 to 300 ppm with the mean varying from 13 to 29 ppm (Kabata-Pendias & Pendias, 1992). Copper can be toxic at levels approaching 100 ppm in diet. Although the toxicity to Cu is fairly low, it has been associated with heart disease, respiratory damage, and generalized oxidative damage to liver, brain, and kidney. Humans have relied on Cu for ornaments and tools since the Stone Age and, more recently, as a conductor of electricity. The literature on the biological essentiality of Cu and its toxicity is voluminous and several excellent comprehensive reviews are available (e.g., McDowell, 1985; NRC, 1977, 1980; Osweiler *et al.*, 1985; Schroeder *et al.*, 1966). The metabolism of Cu is closely interrelated with molybdenum (Mo) an inorganic sulfate with a deficiency of one of these three elements resulting in a syndrome suggestive of a toxicity of another. For the purposes of the current exercise, Mo and S will be considered as present in adequate amounts and only the toxicity (excess) of Cu will be discussed. Copper toxicity is evidenced by hemolysis, icterus, and anemia with accompanying hepatic and renal necrosis. Chronic Cu toxicosis resembles acute cuprosis with a sudden release of large amounts of Cu from the liver resulting in a hemolytic crisis and sudden death.

Lead (Pb)

Background lead levels in the United States range from <10 to 70 ppm. Mean concentrations in various U.S. soils range from 17 to 26 ppm (Kabata-Pendias & Pendias, 1992). Lead and Pb poisoning have been a part of human history since at least 4,000 BC. Lead still is one of the most common causes of poisoning in humans, domestic animals, and wildlife. It is not an essential mineral and can cause both acute and chronic toxicosis. Lead modifies the function and structure of kidney, bone, the central nervous system, and the hematopoietic system. Toxic signs include anemia, vomiting, nephropathy, irritability, peripheral neuropathy, blindness, weight loss, abortion, kidney tubular necrosis, and liver degeneration. "Roaring" in horses is caused by Pb-induced laryngeal paralysis leading to loud respiratory sounds. Lead poisoned cattle frequently are observed grinding their teeth. The deaths of thousands of waterfowl over the past 75 years have been attributed to ingestion of spent Pb shot (Sanderson and Bellrose, 1986). Less well documented are chronic effects on wildlife from continuous ingestion of low levels of Pb in soil and food. Lead is a mutagenic, teratogenic, carcinogenic pollutant that acts primarily on the central nervous system to cause chronic CNS disorders and especially neurological/neurobehavioral effects. Lead levels in blood approximating 80 µg/dl and some renal and blood effects at approximately 40 µg/dl. Lead toxicity can cause sterility, abortion, neonatal mortality, and morbidity.

Zinc (Zn)

Zinc is a common constituent of minerals that readily weather and form soil. Background Zn levels can range from 3 to 300 ppm. Mean background Zn concentrations in various types of soils lie between 34 and 84 ppm (Kabata-Pendias & Pendias, 1992). Zinc has been used by humans for over 2,000 years for utilitarian or ornamental purposes, particularly as a component of alloys (bronze, brass, and others) for galvanizing steel to prevent it from rusting, and dyes. Two fungicides (zineb and ziram) are organo-zinc compounds. Zinc is an important essential mineral, for most animal species dietary requirements range from 40 to 100 ppm. Signs of Zn toxicity include decreased growth rates, anemia, decreased bone mineralization, bone deformities, and decreased feather pigmentation (NRC, 1980). Zinc is an essential element in low concentrations, but can cause poisoning in animals at higher levels approaching 90-300 mg/kg uptake in foodstuffs in birds and mammals, 1 mg/m^3 air, and 300 mg/L drinking water. Some plants

are known to die when soil Zn exceeds 100 ppm. Zinc is produced worldwide and is associated primarily with smelter activity.

Air Pollutants (SO_2, NO_x, and O_3)

Air pollution is one of the most prominent contaminants produced in Central Europe. The air pollution produced by power plants and large scale industrial operations is emitted essentially unchecked. Of the numerous airborne pollutants, sulfur dioxide (SO_2), nitrous oxide (NO_x), and ozone (O_3) are most prominent. Many countries in Central Europe produce large quantities of air pollution, with some of the largest volumes of emissions generated in the Czech Republic.

Radionuclides

Radiation toxicity is generally manifest as injury to the bone marrow, gastrointestinal system, cardiovascular system, central nervous system, gonads, and skin. Although exposure rate and final dose are complex factors, severe effects are known to occur when dose exceeds approximately 150-300 microcurries (cGy), and death to humans is certain at doses above 500 cGy. Effects of radionuclides on reproductive systems and developing embryos occurs above 5-6 cGy. Radiation toxicity in wildlife, as in humans, is generally manifest as injury to the bone marrow, gastrointestinal system, cardiovascular system, central nervous system, gonads, and skin. Although exposure rate and final dose are not easily estimated for wildlife, some of the similar severe effects are known to occur when dose exceeds approximately 150-300 cGy, and death generally occurs at doses above 500 cGy. Effects of radionuclides on reproductive systems and developing embryos occurs above 5-6 cGy.

Other Chemicals

Chemicals classified as organochlorines and PCB include numerous "early" pesticides and herbicides that were widely used and demonstrate exceptional persistence. Organochlorines generally move in aquatic systems quite well, can become high concentrations and can bioaccumulate (organochlorines) in the food chain. Water associated with application areas that contain large quantities of organochlorines can move across boundaries quickly and can remain a problem for decades.

Relative Hazard and Concern Levels for Pollutants									
Pollutant	**Priority Pollutant**	**Carcinogen**	**Fresh Water Acute Criteria** µg L	**Fresh Water Chronic Criteria** µg L	**Marine Acute Criteria** µg L	**Marine Chronic Criteria** µg L	**Water And Fish Ingestion** units per liter	**Fish Consumption Only** units per liter	**Drinking Water MCL** units per liter
Arsenic	Y	Y					2.2ng	17.5ng	0.05mg
Arsenic (V)	Y	Y	850	48	2319	13			
Arsenic (III)	Y	Y	360	190	69	36			
Cadmium	Y	N	3.9+	1.1+	43	9.3	10µg		0.010 mg
Copper	N	N							
Lead	Y	N	82+	3.2+	140	5.6	50µg		0.05 mg
Mercury	Y	N	2.4	0.012	2.1	0.025	144 ηg	146 ng	0.002 mg
Zinc	Y	N	120+	110+	96	96			
Radionuclides		Y	n/a	n/a	n/a	n/a	n/a	n/a	n/a
Organochlorines		Y							

Appendix I. Government Role In Environmental Management.

Regional/Governmental/Local Data Sources

Many countries and regions have initiated monitoring programs to identify areas of environmental concern, and others have actually supported environmental research programs that are conducted internal to the country or in concert with a cooperative partner from regulatory or research groups in Europe or the United States (Appendix A). Some of these projects are listed in Appendix E. Many of these contacts are affiliated with regulatory agencies within the United States or the country of interest.

Institutional infrastructures in Central Europe.

Country	Government Type	Lead Environmental Unit
Albania	emerging democracy	*Minister for Environment*: Markism Cikuli tel: 355 42 62937 fax: 355 42 62854
Bosnia-Herzegovina	emerging democracy	*Minister for Environment*:
Bulgaria	emerging democracy	*Minister for Environment*: Georgi Georgiev tel: 359 2 876 151 fax: 359 2 521 634
Croatia	parliamentary democracy	*Minister for Environment*: Dr. Ante Kutle tel: 385 1 613 3444 fax: 385 1 537 203
Czech Republic	parliamentary democracy	*Minister for Environment*: Jiri Saalicky tel: 42 2 6712 1111 fax: 42 2 6731 0308
Hungary	republic	*Minister for Environment*: Ferenc Baja tel: 36 1 457 3300 fax: 36 1 201 2125
Macedonia	emerging democracy	Minister of Urban Planning, Construction, and Environment (MUCEP);
Poland	democratic state	*Minister for Environment*: Stanislaw Zelichowski tel: 48 22 250 001 fax: 48 22 253 332
Romania	republic	*Minister for Environment*: Aurel Constantin Ilie tel: 40 1 631 6146 fax: 40 1 312 4227
Yugoslavia	republic	*Minister for Environment*:
Slovakia	parliamentary democracy	*Minister for Environment*: Jozef Zlocha tel: 42 7 492 451 tel: 42 7 492 002
Slovenia	emerging democracy	*Minister for Environment*: Dr. Pavel Ganpar tel: 386 61 178 5507 fax: 386 61 224 548

Albania

Main Issues: deforestation, soil erosion; water pollution from industrial and domestic effluents

Ministries Concerned with Environmental Protection: Ministry of Health and Environmental Protection; Ministry of Food and Agriculture; Ministry of Transport and Communication; Ministry of Energy and Mineral Resources; Ministry of Tourism; Ministry of Trade and Industry; Ministry of Construction, Housing, and Territorial Planning

Ministries Concerned with Enforcement of Environmental Regulations: Ministry of Health and Environmental Protection; Ministry of Food and Agriculture; Ministry of Energy and Mineral Resources; Ministry of Construction and Tourism; Ministry of Trade and Transport

Minister for Environment: Marxism Cikuli tel: 355 42 62937 fax: 355 42 62854

Bosnia/Herzegovina

Main Issues:

Ministries Concerned with Environmental Protection:

Ministries Concerned with Enforcement of Environmental Regulations:

Minister for Environment:

Bulgaria

Main Issues: air pollution from industrial emissions; rivers polluted from raw sewage, heavy metals, detergents; deforestation; forest damage from air pollution and resulting acid rain; soil contamination from heavy metals from metallurgical plants and industrial wastes

Ministries Concerned with Environmental Protection: Ministry of Environment; Ministry of Health; Ministry of Education, Science, and Technology; Ministry of Territorial Development, Housing Policy and Construction; Ministry of Finance; Ministry of Agriculture; Commission of Water

Ministries Concerned with Enforcement of Environmental Regulations: Ministry of Environment; State Inspectorate for Environmental Protection (sixteen regional environmental protection inspectorates)

Minister for Environment: Georgi Georgiev tel: 359 2 876 151 fax: 359 2 521 634

Croatia

Main Issues: air pollution from metallurgical plants and resulting acid rain is damaging the forests; coastal pollution from industrial and domestic waste; widespread destruction of infrastructure in border areas affected by civil strife

Ministries Concerned with Environmental Protection: State Directorate for Environmental Protection; Ministry of Health; Ministry of Agriculture and Forestry; Minister of Economic Affairs; Ministry of Maritime Affairs, Transport, and Communications; Ministry of Foreign Affairs; Ministry of Labor and Social Welfare; Ministry of Defense; Ministry of Education and Sport; Ministry of Science and Technology; Ministry of Finance; Ministry of Tourism; Ministry of the Interior; Ministry of Development and Reconstruction; Chamber of Commerce; Customs Authority; State Weather Bureau

Ministries Concerned with Enforcement of Environmental Regulations: State Directorate for Environmental Protection

Minister for Environment: Dr. Ante Kutle tel: 385 1 613 3444 fax: 385 1 537 203

Czech Republic

Main Issues: air and water pollution in areas of northwest Bohemia centered around Zeplica and in northern Moravia around Ostrava present health risks; acid rain damaging forests

Ministries Concerned with Environmental Protection: Ministry of Environment; Ministry of Health; Ministry of Agriculture; Ministry of Economy

Ministries Concerned with Enforcement of Environmental Regulations: Ministry of Environment; Ministry of Health; Ministry of Economy; State Inspectorate for Environmental Protection

Minister for Environment: Jiri Saalicky tel: 42 2 6712 1111 fax: 42 2 6731 0308

Hungary

Main Issues: air pollution; industrial and municipal pollution of Lake Balaton

Ministries Concerned with Environmental Protection: Ministry of Environment and Regional Policy; Ministry of Agriculture; Ministry of Transport, Telecommunication, and Water Management; Ministry of Welfare; Ministry of Industry and Trade

Ministries Concerned with Enforcement of Environmental Regulations: Ministry of Environment and Regional Policy; Regional Environmental Inspectorates (under supervision of Ministry of Environment and Regional Policy); Nature Conservation Directorates and National Park Directorates (under supervision of Ministry of Environment and Regional policy); National Inspectorate of Environmental Protection

Minister for Environment: Ferenc Baja tel: 36 1 457 3300 fax: 36 1 201 2125

Macedonia

Main Issues: air pollution from metallurgical plants

Ministries Concerned with Environmental Protection: Ministry of Urban Planning, Construction, and Environment; Ministry of Forestry, Agriculture, and Water Management; Ministry of Economy; Ministry of Development; Ministry of Science

Ministries Concerned with Enforcement of Environmental Regulations: Minister of Urban Planning, Construction, and Environment (MUCEP); Ministry of Forestry, Agriculture, and Water Management; Ministry of Economy; Ministry of Health; Ministry of Science

Poland

Main Issues: forest damage due to air pollution and resulting acid rain; improper means for disposal of large amounts of hazardous and industrial waste; severe water pollution from industrial and municipal sources; severe air pollution results from emissions of sulfur dioxide from coal-fired power plants, which also drifts into Germany and the Netherlands

Ministries Concerned with Environmental Protection: Ministry of Environmental Protection, Natural Resources, and Forestry; Ministry of Industry and Commerce; Ministry of Privatization; Ministry of Finance; Central Office of Planning

Ministries Concerned with Enforcement of Environmental Regulations: State Inspectorate for Environmental Protection

Minister for Environment: Stanislaw Zelichowski tel: 48 22 250 001 fax: 48 22 253 332

Romania

Main Issues: soil erosion and degradation; water pollution; air pollution in south from industrial effluents; contamination of Danube delta wetlands

Ministries Concerned with Environmental Protection: Ministry of Water, Forestry, and Environmental Protection; Ministry of Agriculture and Food; Ministry of Health; Ministry of Industry; Ministry of Public Works and Territorial Planning; Ministry of Transport

Ministries Concerned with Enforcement of Environmental Regulations: Ministry of Water, Forestry and Environmental Protection; State Inspectorate for Environmental Protection

Minister for Environment: Aurel Constantin Ilie tel: 40 1 631 6146 fax: 40 1 312 4227

Yugoslavia

Main Issues:

Ministries Concerned with Environmental Protection:

Ministries Concerned with Enforcement of Environmental Regulations:

Minister for Environment:

Slovakia

Main Issues: air pollution from metallurgical plants presents human health risks; acid rain damaging forests

Ministries Concerned with Environmental Protection: Ministry of Environment; Ministry of Soil Management; Ministry of Transport, Ports, and Communications; Ministry of Economy; Ministry of Health

Ministries Concerned with Enforcement of Environmental Regulations: Ministry of Environment; State Inspectorate for Environmental Protection

Minister for Environment: Jozef Zlocha tel: 42 7 492 451 tel: 42 7 492 002

Slovenia

Main Issues: Sava River polluted with domestic and industrial waste; pollution of coastal waters with heavy metals and toxic chemicals; forest damage near Koper from air pollution (originating at metallurgical and chemical plants) and resulting acid rain

Ministries Concerned with Environmental Protection: Ministry of Environment and Regional Planning; Ministry of Agriculture, Forestry, and Food; Ministry of Health

Ministries Concerned with Enforcement of Environmental Regulations: National Inspectorate for Environment and Space; Ministry of Agriculture, Forestry and Food; Ministry of Transport and Connections; Ministry of Health

Minister for Environment: Dr. Pavel Ganpar tel: 386 61 178 5507 fax: 386 61 224 548

Appendix J. Potential Socio-Economic Impacts of Transboundary Pollutants In Central Europe.

Submitted to Sandia National Laboratories
by John B. Stewart, Jr.
Ogden Environmental & Energy Services Co.
January 29, 1997

For most of its modern history, CEE has been a collection of weak, multi-ethnic, unprotected lands between two large and powerful neighbors--Germany and Russia. This captures the essence of the problem, and our concern, that CEE has posed for a wider stability. The dilemma has been historically threefold: economic and political weakness, a legacy of bitter national conflict, and an international system that did not make room for the nations of this region. To some extent, these three problems, which are interrelated, still plague the region. As we shall see, competition for, and access to, adequate supplies of clean water for residential, industrial and agricultural purposes can serve as precursors for larger economic, ethnic, and political rivalries. To fully understand water, therefore, in its full socio-economic and political potential, one must know how it fits into the region's greater modern history.

Environmental Security - A New Paradigm

The traditional definition of national security which involved the protection of the nation's sovereignty, it's national borders, changed with the end of the Cold War. Such security can no longer be the single, unifying geostrategic principal since there is no longer a unifying threat. Common purposes, not common fears, must provide the cohesion in the new era in which economic and social issues become dominant. Among the emerging new common purposes and goals is the provision of a clean and healthful environment for the world's citizens.

Sandia National Laboratories understands this new definition of national security, which now includes environmental security. Sandia also recognizes that within the Intelligence Community, the National Intelligence Council (NIC) has been the leader in undertaking studies and estimates that recognize and define security concerns about the environment. Most recently, the NIC's leadership was recognized when the Director of Central Intelligence approved its recommendation to create an Intelligence Community (IC) Environmental Intelligence Center which could serve as a multi-disciplined, multi-agency center of intelligence analysis on international environmental developments. and issues.

In terms of U.S. national interests, environmental security was first recognized as an element of U.S. foreign policy when the White House codified its strategic value for the first time in 1994 when it issued its annual "National Security Strategy of Engagement and Enlargement". In this document, the Clinton Administration formally recognized that protection and care of the environment has a clear security dimension. In this sense, environmental security requires breathable air, potable water, safety from toxic and radioactive hazards, an intact atmospheric ozone layer, a stable climatic system, and

protection against the loss of topsoil and the pollution of our oceans, both of which provide us our food.

Environmental security is also concerned about the possibilities that environmental degradation can lead to both political and social stress, and even instability and civil war. Environmental threats that have the potential to lead to instability clearly can upend U.S. foreign and defense policy interests in affected world regions. Although environmental problems alone typically are not grounds for aggression or military conflict, they can serve as a focal point or catalyst when combined with underlying political, economic, or social tensions. Where environmental problems occur in weak states, such as exist in parts of Central and Eastern Europe, their potential for exacerbating other problems is magnified.

Increasing competition for the dwindling reserves of uncontaminated air, arable land, fisheries and other food sources, and water, once considered "free" goods, is already a very real risk to regional stability around the world. The range of environmental risks serious enough to jeopardize international stability extends from man-made or natural catastrophes, such as 'Chernobyl' or the East African drought that eventually required United Nations (and U.S.) military deployment to Somalia, and to large-scale damage caused by industrial pollution such as in the "Black Triangle" of CEE, deforestation as in Haiti, loss of biodiversity such as the North Atlantic cod, water contamination, ozone depletion, and ultimately climate change.

Fresh Water - An Emerging Crisis

Amongst all these environmental issues, lack of access to clean water is one of the world's most pervasive environmental security problems. Nearly a billion people in developing countries suffer from water-borne diseases. The United Nations Children's Fund estimates that 40,000 children die every day, mainly as a result of preventable diseases. Poor quality drinking water is responsible for a large proportion of these deaths. Water shortages created by the world's rocketing population and extravagant use could spark wars in the 21st century, the United Nations (UN) warned at a conference in Beijing in early 1996. "Increasing concern (is) being voiced that the next century may be scarred by wars over water, even as this century has been devastated by wars over oil," Wally N'Dow, secretary-general of Habitat II, the UN Center for Human Settlements, told the meeting.

In terms of water's history lesson, drought was likely the final blow to Mayan civilization in today's southeastern Mexico. Most historians believe that the Mayans exceeded the carrying capacity of their land. To feed their rapidly growing population, they created croplands by clearing dense forests, terracing hillsides and building raised beds in marshlands. Ultimately, as much as three-quarters of the land was used for intensive cultivation. When the Mayan population reached a peak of about 3 million in 800 AD, crop yields began to fall because of extensive soil erosion and silt build-up in the raised beds. Drought further reduced crop yields. The competition for food and water led to warfare and abrupt abandonment of the Mayan cities. By 1000 AD the area had only 500,000 inhabitants; by 1990, only 7,000. Present-day environmentalists warn of modern-day food shortages due to scarcity of food and fish, with water levels falling in all major food producing regions, including in CEE.

In short, as we enter a time of water scarcity--whether due to its inefficient use or its pollution--the world needs to promote efficiency and the protection of water systems in all we do. In the post-Cold War era, the world is beginning to focus on

relations between people in different political systems. Water issues have the potential to span the old and the new world order, for water has become a strategic resource as likely to lead to warfare as it did in 1991. In the years ahead, a new water ethic may become as necessary for ecological reasons as for a country's national security. As Secretary of State Christopher said in his April 1996 Stanford speech, "In the future, the U.S. will need to factor water shortages and other environmental concerns when conducting foreign diplomacy. It has already done that with respect to the Middle East, South Asia, and Central and Eastern Europe, the subject of the current paper.

CEE water quality is likely to trend downward over the next ten years or so, according to a World Bank assessment, owing to the growth of water polluting industries and municipal water use, as well as the high costs of water reclamation. The World Bank estimates that it will take some $50 billion to bring the regional wastewater alone up to EU standards. For example, seventy percent of the Czech and Slovak waterways are heavily contaminated, while about forty percent of Poland's surface water is unfit for even industrial use. All but two of Romania's 41 districts have elevated nitrate levels.

Water Resources

While air quality problems were reported as the top environmental priority by the majority of CEE experts, water resources received the next most mention according to the Regional Environmental Center (REC) in Budapest, Hungary. In some of the Balkan countries surveyed, water was given priority even over air issues. The integrity of ground, surface and marine waters are compromised by pollutants coming from industrial, communal and agricultural sources. Some major waterways in the region are considered dead and a significant portion of surface waters is not fit even for industrial use. Waste water treatment facilities were frequently described in a REC survey as critically needed. Where such plants existed, they were often poorly functioning and having inadequate capacity.

From a transboundary conflict standpoint, the multiple functions of surface waterways such as the Danube, Elba, and Vistula rivers, also create conflicts among their users. This applies as well to the marine environment and coastal zones, such as in the Baltic and Black Seas. In addition, there is a rapid deterioration of underground water reservoirs in certain parts of CEE. Bulgaria and Hungary both are severely water deficient and aquifers in each country are highly stressed. Threats from pollution, increasing demands for supply, and drought are all placing regional groundwater reserves in jeopardy. Protection of underground water is placed very high on the list of priorities for action by the CEE countries themselves.

The shortage of clean water has evolved into a shortage of any water in the CEE countries. The availability of clean water for economic (agricultural, fishing and industrial) purposes has become a topic of intergovernmental and international disputes, according to the REC. In a 1994 interview with Dr. Stanislaw Sitnicki, Executive Director of the REC, he said that the availability of clean water was perhaps the region's second-most contentious transboundary environmental issue. (Concerns about nuclear safety were first.) The growing demand for water can only be resolved through more efficient consumption and improved quality of existing sources supported by international agreements and better cooperation among the CEE countries.

Municipal and Industrial Waste

Problems related to municipal and industrial waste water compound the region's water challenge. Municipal and industrial waste management is a major environmental issue in most CEE countries. While satisfactory, modern solutions to municipal and industrial waste problems have begun to be developed in some CEE countries, others have not made much progress in addressing these issues. Very few proper disposal facilities exist in the region, and the need for such facilities intensifies as throwaway packaging, high in non-degradable plastic content, makes up a larger portion of the waste stream. Municipal and industrial waste problems are highly ranked as a direct threat to the physical environment in densely populated areas.

In Bulgaria, for example, almost all wastewater treatment plants in use are Soviet vintage. These plants are highly inefficient and unreliable. As a result, Bulgaria suffers both a shortage of water for industrial and agricultural purposes, as well as a lack of adequate supplies of clean water for drinking. Bulgarians are so wasteful that industrial and agricultural users often divert the already short supplies of clean drinking water and use this water for their end purposes, thus creating an even greater misuse of this scarce resource.

In 1995, Poland spent about $1.3 billion on environmental protection projects and programs. Of this money, $700 million went into water projects, mainly the upgrade or construction of water and wastewater treatment facilities. As of 1995, about one third of Poland's wastewater (municipal and industrial) was treated and purified to a level consistent with European Union standards. Another third of Poland's water was only partially treated, and a final third was untreated and dumped directly into the nation's waterways.

The typical solution to the municipal and industrial solid waste problem is to open new dumping sites. However, there is growing resistance from surrounding communities against creating dumping sites nearby. Incineration and composting technologies are alternative solutions. Opponents of municipal waste incinerators argue that they will require excessively large capital outlays. In addition, incineration of municipal waste reduces incentives for employing alternative, sustainable solutions such as waste reduction, requirements for long-life reusable packaging and recycling.

Water Availability

Although water is a renewable resource, it is also a finite one. As a rule of thumb, hydrologists designate water-stressed countries as those with annual supplies of 1,000 to 2,000 meters per person. When the figure drops below 1,000 cubic meters, nations are considered water-scarce--that is, lack of water becomes a severe constraint on fresh water consumption, food production, economic development, and protection of natural systems. Within Western Europe, the average annual supply per person is 5,000 meters.

Today, according to the Worldwatch Institute, 26 countries--collectively home to 232 million people--fall into the water-scarce category. Many of them have high population growth rates, and so their water problems are deepening fast. Africa has the largest number of water-scarce countries, eleven in all. Nine out of fourteen countries in the Middle East already face water-scarce conditions, making it the most concentrated region of water scarcity in the world. Interestingly, Hungary is only one of two European countries on the water-scarce list. Its renewable water supplies are reported to be 580

cubic meters per person, the lowest in Europe and Eurasia. Hungary suffers water stresses associated with shrinking groundwater reserves, falling water tables, and water budgets that are badly out of balance.

Bulgaria, too, suffers from an insufficient supply of clean drinking water. It's capital, Sofia, is in the midst of a major water crisis, having only 500 cubic meters per person available annually. As late as last year, the Bulgarian government had imposed a rationing regime which alternated 18 hours of water service with 54 hours without it in many parts of the city. While the press and Sofia residents seek someone to blame for the crisis, and criticize the belated steps to deal with it, citizens of the Rila Mountain communities protest government plans to extend sources of supply in their direction.

Are water supplies sufficient to meet the needs of the CEE states? Shifts in population and in industrial and economic growth and development can increase both demands on, as well as contamination of, water supplies. While these factors are the most acute in the developing world, the CEE region also has water shortage problems that could be exacerbated if not managed correctly and cooperatively in the years ahead.

Compounding an ongoing water supply problem in CEE is the challenge of new demands on water use. Demands for industrial use are increasing as the region converts from an inefficient command economy to a more growth-oriented capitalist economy. Additionally, increasing demands for environmental uses--wildlife, fisheries, and recreation--can be expected as the region integrates into Western Europe. Agriculture, too, could pose a significant future water-use problem, not to mention one of nitrate and phosphorous contamination. The unknown factor for CEE, and the world at large, is climate change. Water supplies may theoretically increase or decrease across regions under certain global warming scenarios, and present-day uncertainty over where and when these changes might occur makes calculating for climate change a task for the future.

Transboundary Issues

The history of tensions and conflicts over access to nonrenewable mineral and energy resources is long. Thucydides describes the struggle more than 2,400 years ago between the Thasians and the Athenians over control of mineral resources. The drive for access to scarce resources has been a major motive underlying recent conflicts, as the 1990-91 Persian Gulf War demonstrated with respect to crude oil.

While some analysts argue that the link between access to resources and conflict is weakening, there are growing implications that certain resources, particularly energy and water, are becoming more, not less, important in the international arena. Two issues appear likely to exacerbate tensions between haves and have nots; the growing gap between rich and poor nations, characterized by enormous per-capita differences in resource consumption, and the growing global environmental degradation caused by industrialized nations but felt most severely by poorer countries.

Efficient use of shared water resources has long been challenged by the reluctance of some nations to share their water with others, with conflict an often likely result. From Canada to Mexico, from Africa to the Middle East, and from Asia to Europe, conflicts and the potential for conflicts seem to be growing over the availability of water.

Several factors underlie virtually all international conflicts over water and pose problems for managing and allocating it efficiently and equitably. These include the

variability and uncertainty of water supplies, the interdependencies among users, and the increasing scarcity and rising costs of freshwater. Because water is a fugitive resource (naturally flowing from one location and one state--liquid, gas, or solid--to another) individuals and countries have incentives to capture and use the resource before it moves beyond their control but little, if any, incentive to conserve and protect supplies for downstream users.

Also at the root of conflict are other human elements such as the vulnerability of water quality and aquatic ecosystems to human activities, the failure to treat water as an economic resource, the desire for food security and self-sufficiency, and the importance of water to public health and economic development. These factors are making conflicts over water resources within countries increasingly common. When water is shared by two or more countries, the obstacles to achieving efficient, equitable, and conflict-free management can be great. Such have been the situations between Slovakia and Hungary over the Gabcikovo Dam project along the Danube River, disputes between Romania and Bulgaria over pollution of the Danube by industrial concerns, disagreements between states as to responsibility for pollution of the Baltic and Black Seas and loss of fish stocks, and disagreements between Germany and the Czech Republic regarding water spillways and accidents on the Elbe and Oder Rivers.

The Gabcikovo Dam

To date the most bitter transboundary dispute in CEE over water has been between Hungary and Slovakia over the construction of a two dam project on the Danube River. Hungary stopped building its dam in 1989 on environmental grounds, claiming that the project threatened to dry out adjacent farm land and contaminate the area's potable water table, which supplies drinking water to 5 million people. The dispute over the dams also raised concern about the safety of the 680,000 Hungarians who live in Slovakia and the 120,000 Slovaks who live in Hungary, with most of the concern directed at the status of Hungarians in Slovakia.

Opinion polls taken in 1993 in Slovakia indicated that the anti-Hungarian sentiment was very high. Slovak government statements reported in the press at the time illustrate the ease with which linkages can be made between ethnic tensions, water issues as represented by the dam conflict, and the potential for active hostilities. One Slovak government official called Hungarian pressure about the dams a smoke screen to hide Hungary's internal problems and spoke to the possibility of armed conflict, eventually ruling it out. But the spear had been planted.

In the several years since the height of the Gabcikovo dam crisis, Hungary and Slovakia agreed to submit their dispute to the World Court for arbitration, where it now sits. A decision is expected sometime this year.

Ethnic Divisions and Water Conflict

With the end of forty years of communist rule in 1989, there has been an upsurge in ethnically based politics in CEE ever since. Virtually all the CEE states have been racked by some form of ethnic, regionalist or autonomist movements demanding some degree of political self-determination, a stake in national decision making, or more equitable economic distribution. Both minority and majority populations have been affected by this rebirth of ethnicity.

From a resource standpoint, the rise in ethnic conflict is important in that such

groups competing for limited resources--such as clean water--can be manipulated by governments and political movements for self-serving purposes. Such manipulation can even hold up progress toward international integration by fostering isolationism and preventing the surrender of any element of national sovereignty. Also in the international arena, exclusivist and short-sighted nationalism over resource issues such as water may prevent the formation of valuable alliances between neighboring states. The Gabcikovo dam conflict between Hungary and the Slovak Republic is such an example.

The dissolution of the Soviet bloc and the unraveling of the multi-national Yugoslav and Czechoslovak federations several years ago released previously submerged national ambitions and stimulated the formulation of new foreign policies among all the East European states. In this sense, Romania and Bulgaria contain large and vibrant minorities aspiring toward cultural and political self-determination. Increasing minority demands have also been evident in the more ethnically homogeneous CEE states of Hungary and Poland. These potential antagonisms, coupled with the possibility of state repression and inter-communal disputes, have sparked controversies and ignited conflicts even as democracy and capitalism began to develop in the region. While post-Communist nationalism is not likely to repeat all the destructive nineteenth century and inter-war disputes, a number of domestic and international enmities have the potential of escalating into political crises, military threats, and even low-intensity armed conflicts if not managed carefully.

NATO Expansion

For the moment, however, the states of CEE seem single-mindedly focused on their integration into the North Atlantic Treaty Organization (NATO), not on environmental disputes. Many experts believe nothing would stabilize the center of Europe more than a comprehensive plan for full NATO and European Union (EU) membership according to clear conditions and a timetable set in advance. In September 1995, the NATO alliance established such a set of criteria, which included progress toward free market democracy, civilian control of the military, and an absence of border disputes with neighbors. As regards to transboundary environmental disputes, all CEE states know full well that nothing would end their NATO prospects quicker than conflict between CEE countries over such issues.

Clearly the strongest support for expanding NATO has come from the U.S., where both major political parties have committed to the idea. On October 22, 1996, in a speech in Chicago, President Clinton reaffirmed the U.S. commitment to the eastward expansion of NATO and laid out a timetable for admitting new members over the next few years. At the same time he formally endorsed the convening of a NATO summit this coming spring that will select a first batch of candidates.

The three leading candidates for admission are Poland, Hungary and the Czech Republic, all three of whom have made rapid strides in moving from totalitarianism toward democracy and free markets. The real contest for admission is likely to be among the second-tier countries such as Slovenia, Slovakia and possibly Romania.

The main argument in favor of NATO expansion is political rather than military. By extending its security umbrella to former communist countries, the U.S. is hoping to do for Eastern Europe what it did for Western Europe after World War II. Thanks in large measure to American security guarantees, former enemies such as France and Germany were able to put aside ancient border disputes and begin to integrate their economies. Opponents of NATO enlargement fear that such a step is bound to antagonize Russia,

where NATO is still viewed as the cold war enemy. The result, they argue, will be a new division of Europe. Ironically, Germany and France, both of whom benefited from U.S. assistance after World War II, have adopted a more ambiguous position. While they favor NATO expansion in principal, they are nonetheless hesitant, as some other critics are, about unnecessarily inflaming Russia.

While it is difficult to weigh these advantages and disadvantages against each other, it is clear that the hope of NATO and EU membership is already serving as an incentive for CEE states to put aside border and transboundary disputes with their neighbors, such as the Gabcikovo Dam controversy, and improve the conditions for minorities. For the moment, politicians from the former CEE communist countries seem focused on good behavior in order to gain NATO's Good Housekeeping seal of approval. "We all know very well that the precondition for NATO membership is the settlement of disputes with neighboring countries," said Slovakia's Foreign Minister, Pavol Mamzik, whose government last year signed a treaty of good neighbors with Hungary, formally renouncing the kind of territorial gains that led to the Yugoslav conflagration.

Along these same lines, this past September Hungary signed a treaty of friendship with its traditional rival, Romania, smoothing over a long dispute concerning the status of 1.5 million ethnic Hungarians in the Romanian region of Transylvania. While many Hungarian ethnics in Transylvania believe the accord does not give them proper protection, and Romanian nationalists claim it gives the ethnics preferential treatment, the two countries have put aside their differences in the hopes of a better outcome, that being NATO and EU membership. At the end of 1996, Germany and the Czech Republic also agreed to resolution of a fifty-year conflict regarding each nation's claims over the post-World War II displacement of Sudetenland Germans from eastern Czechoslovakia.

As long as NATO and EU membership remain a near-term possibility, and economic growth continues, the likelihood of any significant regional conflict in CEE will remain low, to include disputes over critical resources such as water. If, however, NATO and EU country governments reject CEE requests to join the West, or economic reforms fail to bring visible benefits to sizable segments of the populace, radical forces could very well emerge whose intent might be to exploit popular frustrations, and ethnic, nationalistic or religious divisions. Only then might there be a real likelihood of a return to the internecine CEE and Balkan conflicts of the past. With respect to the more immediate issue of NATO membership, CEE ministers make little effort to hide their sense of the let-down that would be felt in their countries if they are rejected for NATO membership. According to Slovenia's Ambassador to the U.S., "There will be a bad feeling in Slovenia if we don't get in."

It is through the exploitation of water grievances, or conflicts over access to available clean water supplies, that perceived internal and external threats may in turn act as a catalyst for the emergence of conflict. In such instances, social relationships and political interaction can easily become ethnicized and polarized both across borders between states and within a given CEE country. When watching for indicators of the potential for water or other resource or environmental conflict, it is important, therefore, to monitor larger systemic factors such as the region's economy, international issues such as NATO and EU membership, and relations between states, as well as the issue in question. This is important because water and related environmental security issues will likely only become a source of open conflict between states as they serve as a backdrop to, or pretext for, other more impactful socio-political or security factors.

Regional Cooperation

While there is a history of transboundary conflict between and among CEE states over water and other environmental issues, in recent years there have also been many examples of inter-state cooperation. Some examples of such cooperation include:

The Baltic Sea Clean-Up.

- The Wroclaw Agreement on the Protection of the Odra River.
- The ECOFUND, the debt for environment conversion program, provides grants to CEE countries to environmental cleanup and protection.
- Etc.

Conclusions

After atmospheric pollution, degradation of CEE's surface and underground water supplies is the most serious environmental factor threatening the region's natural environment and human health. Water is being increasingly polluted by viruses, bacteria, pesticides, and radionuclides.

Much of recent water deterioration is associated with increased municipal and industrial sewage disposal.

In rural areas, hundreds of small settlements must obtain their drinking and household water from tanker trucks or have it piped in from neighboring areas because their wells are too contaminated with nitrates to be usable.

Human health is in danger in many locations because of poor quality water. The wave of premature and early deaths in certain parts of CEE, like in Russia, will likely eventually have political consequences, for it will affect millions of people's views of the governments under which they live. In this sense, there is increasing evidence, and public awareness, that environmental pollution is a major cause of short life spans.

Communism's disregard for the environment contributed greatly to its collapse, and such outcomes could eventually be repeated if CEE governments do not give sufficient support to environmental concerns. Extreme environmental pollution like that found in the highly industrialized Silesian region of Poland, for example, has been associated with increased cancer and adverse reproductive outcomes. In this sense, public concern about health and the environment seems to be on the rise in Poland, the Czech Republic, and Hungary.

The likelihood of a major health epidemic in CEE due to water-related environmental pollution is low but growing. Raw sewage is seeping into drinking water in some densely populated areas of the region, threatening the health of residents. Rising water levels, due to damaged sewage systems and geophysical changes in groundwater table formations, complicate this problem. Such infected waters may lead to isolated incidents of cholera, dysentery and typhoid fever outbreaks.

Romania and Hungary receive more than 75 percent of their water in river flows from other countries. This means that there will continue to be a source of possible dispute over transboundary water pollution, or disposal of water resources between the two countries for many years to come.

Demand for quality water has increased with the advent of industrialization and privatization. Domestic and industrial use of water has become increasingly important. Additionally, discharge of untreated wastes, excessive application of fertilizers and pesticides in agriculture, and accidental spills of harmful substances (including radioactive substances) have led to increasing pollution of many CEE waterbodies.

Groundwater quality in all of Europe (including CEE) is threatened by pesticides. It has been estimated that, if no remedial action is taken, 1 to 2 percent of the total European area will be potentially polluted by industry, mining, military activities and landfills within 50 years.

With increasing urbanization, and subsequent expansion of sewerage systems without any or adequate treatment, liquid waste loads on CEE waterways threaten large, downstream human settlements.

The Baltic Sea - bordered by Poland to the south - is the largest brackish-water area in the world. Since the 1950s, the areas affected by pollution have grown, and the types of pollutants has changed, as wastes contain more toxic substances. Such pollution has become a threat to its living resources. There has been a clear tendency toward eutrophication. Poland is a major source of Baltic Sea industrial pollution.

The Black Sea - bordered by Bulgaria and Romania to the west - is the world's largest land-locked sea. It is permanently anoxic below a depth of 150 to 200 meters, a condition in which only anaerobic bacteria can exist. Its most important source of pollution is the Danube River. In addition, oil pollution is relatively high in the Black Sea and microbiological contamination of beaches from sewage waste is posing a human health threat.

At present, 16 nuclear power reactors operate in CEE; all built close to a major water source. Discharges of low-active effluents lead to low-level contamination by radionuclides. Information available indicates levels ranging from 0.01 to 0.8 Becquerel/liter. The highest levels are found in rivers adjacent to nuclear reactors in the Czech Republic. Nuclear waste disposal sites are also a potential source of contamination of inland CEE waters. There have already been several reports of careless handling of radioactive waste products leading to contamination.

The possibility of a serious nuclear power accident, accompanied by a catastrophic release of radiation in the region, is deeply feared by the governments and peoples in the region. While the water-related aspects of such an incident would pale in comparison to the atmospheric fallout over populations and farmlands, such an accident could be the most destabilizing of any environmental disaster to the region's fledgling democracies and has the potential to spark serious acts of government protest.

Increasing rates of water contamination have the potential to serve as a catalyst or precursor to broader political stress and instability. Issues worthy of close watch which might signal the advent of some form of transboundary dispute over water, or other environmental issues, include the following:

-- The pending World Court decision regarding the Gabcikovo-Nagymaros Dam and the potential for renewed conflict between Hungary and Slovakia over the dam.

-- Friction between Bulgaria and Romania over transboundary water contamination of the Danube River, particularly the dumping of chemicals and untreated wastes into the river.

-- The outbreak of a health epidemic as the result of disease caused by water-borne transboundary pollution.

-- A major health threat to residents living near a former Soviet military base wherein significant groundwater contamination has occurred (most likely from spilled petroleum products and chemicals).

-- The coupling of major environmental degradation and resource scarcity, with economic decline and large population movements, may give rise to the possibility of civil violence and transboundary conflict. For example, the highly polluted and industrialized Czech Republic (particularly in the north), where children are at serious health risk, is dependent on Russian oil and gas for industry, energy and municipal services. Sixty-five percent of its oil and 92 percent of its gas comes from Russia. Ongoing environmental pollution, coupled with an energy cut-off, an economic collapse, and perhaps major population movement, would be highly destabilizing.

-- Environmental awareness and expectation is highly correlated with education and economic development. As CEE citizens become more educated and better off economically, they will develop more willingness to support environmental controls and expenditures and less willing to accept risks to human health and the natural environment. If environmental improvements do not keep pace with citizen education and economic development, louder demands for action can be anticipated.

-- At present, the morbidity and mortality rates, and infant genetic defects, are among the highest in the world in CEE. These health impacts will continue to exact a high toll unless more resources are expended to clean up existing, and prevent future, water and other pollution. The risks of localized conflict, or anti-government demonstrations and strikes, increases each year these decisions are put off.

-- Finally, Russia could act out its anti-NATO hostility through some environmental pretext; for example, by feigning anger over Polish pollution of the Baltic Sea, a major Russian fishing ground, or Romanian or Bulgarian dumping into the Black Sea. It could fabricate an excuse for some form of intervention in the affairs or one or more CEE state.

One requirement for EU membership for CEE states is compliance with EU environmental protection standards. Poland has perhaps made the greatest effort of all CEE states to meet EU requirements and hopes by the end of 1998 to have met such for EU membership. Most experts believe, however, that it will be many years before Poland, or any of the other CEE states, truly meet such requirements, and expect that those CEE country's that make a "good faith effort" will eventually be admitted to the EU.

Among the many ethnic groups in CEE are the Silesians of Poland, Hungarians in Slovakia and Romania, Germans in Poland and the Czech Republic, the Ruthenians in Poland and Slovakia, Slovaks and Romanians in Hungary, Moravians in the Czech Republic, Italians and Hungarians in Slovenia, Vlachs (Arumuns) in Albania, Pomaks (Slav Muslims) and Turks in Bulgaria, and Roma Gypsies throughout Eastern Europe.

Klaus-Peter Klaiber, German Ministry of Foreign Affairs, said it will be much more difficult when the time comes to bring Central Europe into the trade-based European Union. "EU enlargement is a much bigger step to peace and security in the region than NATO enlargement, because there is still some residual feeling of being threatened by Russia," he said.

These levels are below those considered significant from a human health standpoint.

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