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USSR STATE COMMITTEE FOR THE PROTECTION OF NATURE

REPORT
ON THE STATE OF THE ENVIRONMENT
IN THE USSR
1988

Moscow 1989

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Foreword

The development of the productive forces of mankind resulting from the modern scientific and technical revolution has reached such a level that virtually the entire planet has been incorporated in the production process. Under such conditions the industrially-developed nations have encountered the problems of severe environmental damage and depletion of natural resources on an ever-increasing scale.

Air and water pollution, which initially began in major cities and industrial centers, has gradually acquired a regional nature: water pollution in the Danube and Rhine River basins, the Great Lakes, the Baltic, Mediterranean, Black Seas, and "acid rain" which has had an effect on virtually all of Europe and North America.

Aside from regional changes, global transformations in the environment are becoming increasingly evident. The nearly universal pollution of the Earth's seas and oceans has affected both its gas and energy exchange with the atmosphere. The increasing emission of "greenhouse gases", the diminishing forestry biomass, and other consequences of anthropogenic activities have produced climatic changes. The extensive use of chlorofluorocarbons in refrigeration technology and domestic applications combined with emissions of the oxides of nitrogen exacerbate efforts to preserve the ozone layer.

Our country has also been affected by ecological problems of a local, regional, and global nature. Such problems have become critical in many cities, industrial centers, and a number of regions of the Soviet Union. Moreover, such issues, from the objective viewpoint, have come to play an integral role in the overall unfavorable socioeconomic conditions that have resulted in the initiation of *perestroika* and have no rapid solution in isolation from other urgent problems facing our society at this critical and difficult juncture. The predominance of institutional interests over regional or national interests, egregious miscalculations in the development and distribution of productive forces, the low level of manufacturing organization and technology dominated by outdated and obsolete equipment: all this has not only been responsible for poor economic efficiency, chronic shortages and poor quality of most products, but also has resulted in an enormous waste of labor, energy, and raw materials and has caused severe and wide-ranging damage to natural systems as well as ongoing sources of pollution from both industrial and domestic human activities.

The ministries and departments have become accustomed to neglecting the interests of the local population. Few resources have been devoted to

environmental protection and there has been a chronic and widespread lack of implementation of plans in this area. Emergencies accompanied by high environmental pollution levels have become more frequent. Official, open information on ecological conditions and human morbidity was virtually unavailable prior to 1987. As a result when such information has now finally become available and has left no room for optimism, the population has begun to actively oppose the construction of new facilities and the expansion of existing plants, particularly chemical, metallurgical, and power plants. Demands for the most severe and radical measures, up through closing or modifying facilities that represent major sources of environmental pollution, are becoming increasingly common.

There remains, however, a shortage of timely and objective official ecological information. Undoubtedly such information is necessary for both proper decision making and for eliminating embellishments of any kind and can be used equally to dramatize ecological conditions.

The present study entitled *Report on the State of the Environment in the USSR* was prepared by the USSR State Committee for the Protection of Nature in conjunction with the State Committee for Statistics, the State Committee on Science and Technology, the State Committee on Hydrometeorology, the State Committee on Forestry, the State Agroindustrial Committee, the State Inspectorate for Mining Safety, the State Committee on Public Education, the Ministry of Foreign Affairs, the Ministry of Reclamation and Water Management, the Ministry of Fisheries, the Ministry of Public Health, the Academy of Sciences and other ministries, departments and organizations (see Appendix 1). This study represents the first domestic document to present systematic and official data on environmental quality and future developmental trends, the current state of natural resources and the relevant influential factors, public health, regional ecological problems, state policy, the ecological social movement, and the participation of the USSR in international cooperation in environmental protection. This document represents the beginning of what will be a systematic series of annual reports on the state of the environment in the USSR.

The interdepartmental commission charged with preparation of this report encountered problems in acquiring and processing an enormous variety and volume of material of different reliability levels as well as disagreement between the ministries and departments with respect to the approaches to methodology and the data collection and analysis techniques as well as assessments of natural resources and the environment.

The format selected for this report makes it possible to present a systematic review of information on the current state of the environment in the USSR for 1988 against the background of the preceding years of this Five Year Plan; this presentation is at the same time as comprehensive as possible (as the material is generalized over the nation as a whole). Appro-

priate sections in the report were assigned to the ministries and departments outlined above. The material contained in this report was analyzed and reviewed to eliminate inaccuracies and omissions.

The desire to see an "ecological picture" that would provide some idea of the current state of the environment in our country was expressed at the first Congress of Peoples' Deputies and Supreme Soviet of the USSR. The present report represents the implementation of this desire in the form of several maps, since incorporating the extensive qualitative and quantitative data on the environment and natural resources combined with a broad variety of ecologic information on a single small-scale map (in a report format) would make such a report very difficult to read.

In submitting this report, the USSR state committee for the protection of nature hopes that this study will be useful not only at the present, but also in the future for use in a comprehensive comparative analysis of future environmental trends in the upcoming period, in assessing the effectiveness of current environmental protection measures as well as for the appropriate modification of practical plans and programs.

To some degree this report can also serve as a model for preparing similar reports on the current state of the environment in the Union Republics, territories [krais] and regions [oblasts] with appropriate delineation of local ecological problems.

SECTION 1

**THE CURRENT STATE AND FUTURE
TRENDS IN THE ENVIRONMENT
AND NATURAL RESOURCES**

1.1. Atmospheric Air

The condition of the atmosphere, which represents a key factor in many ecological problems, also has a substantial effect on the global climatic system and the entire biosphere.

The Soviet Union has focused special attention on atmospheric monitoring and testing in areas of local (particularly industrial) pollution sources as well as the background state of the atmosphere, ecological-meteorological aspects (its effect on the climate and climatic changes as well as the state of the ozone layer) and other consequences of atmospheric pollution.

The National Atmospheric Pollution Monitoring Service

In recent years the technical policy in the field of air basin conservation has been based on the extensive development of efforts to establish maximum permissible pollution emission levels (MPE) for each source and enterprise. Air pollutants are standardized by employing detailed calculations of the maximum concentration fields of pollutants produced by emission sources in a municipal area. The MPE standards are established at a level to prevent pollutant emissions from exceeding the maximum permissible concentrations (MPC) as established by the USSR Ministry of Public Health.

The following All-Union standards were prepared to support such efforts: *Method of Calculating Atmospheric Pollutant Concentrations from Enterprises* and *Interim Method for Standardizing Industrial Atmospheric Emissions*.

The organs of the USSR State Committee for the Protection of Nature supervise the adherence to MPE standards.

The effectiveness of efforts to reduce air pollution is assessed on the basis of data produced by the National Environmental Pollution Monitoring Service (NEPMS) founded in the mid-1960s. This organization includes the subdivisions of the USSR State Committee on Hydrometeorology, the USSR Ministry of Public Health and the laboratories of industrial enterprises.

The National Environmental Pollution Monitoring Service performs the following functions:

- monitoring, assessment, and prediction of pollution levels;
- provision of information to interested organizations.

During the early years of the National Environmental Pollution Monitoring Service the concentrations of four impurities in municipal air were monitored, including dust, sulfur dioxide, carbon monoxide, and nitrogen dioxide. The atmospheric concentrations of all of 80 substances are

monitored in municipal areas today; the concentrations of 8 different components are systematically measured in each city. Atmospheric pollution monitoring is ongoing in 534 cities at 1,167 fixed monitoring stations as shown in Figure 1.

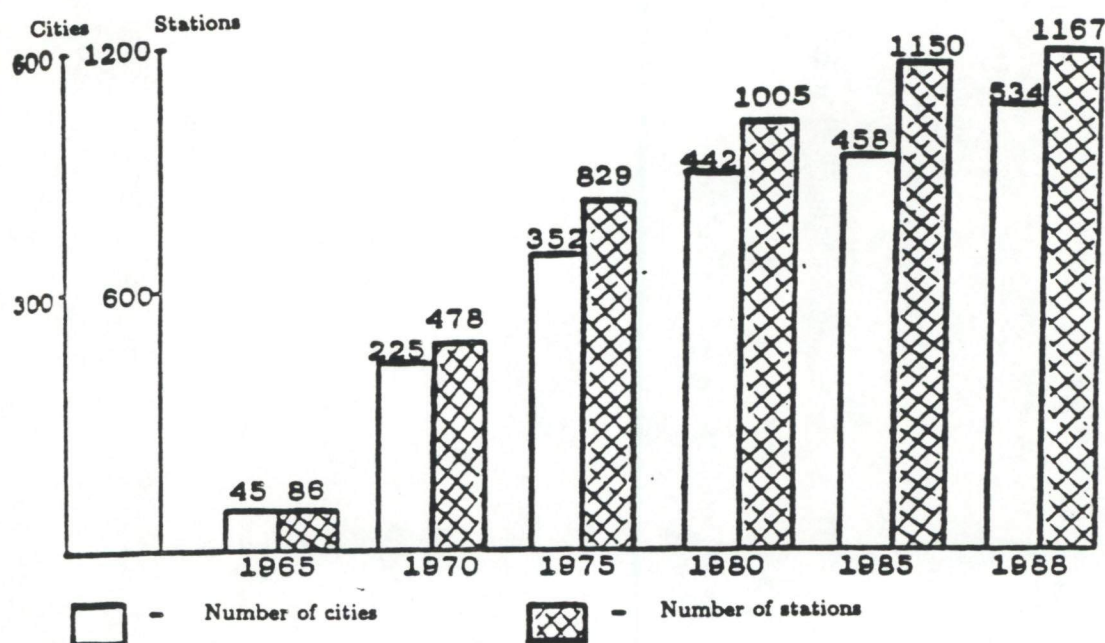


Fig. 1. Development of municipal atmospheric pollution monitoring network.

Such monitoring stations encompass virtually all cities with populations exceeding 100,000 over an area containing over 113 million people, i.e., approximately two-thirds of the municipal population of the country. Air quality is currently monitored in 298 cities in the European section of the USSR and in 236 cities in the Asian section (Figure 2). Such monitoring procedures are performed regularly 3-4 times a day in the majority of cities (423). Each city contains between 1 and 10 fixed monitoring stations (23 in Moscow) with the number of such stations depending on the size of the city and its level of industrial development.

The same fundamental principles underlying the meteorological network are used in the air pollution monitoring system: regularity, uniformity of the monitoring programs and the extent to which the observation sites are representative.

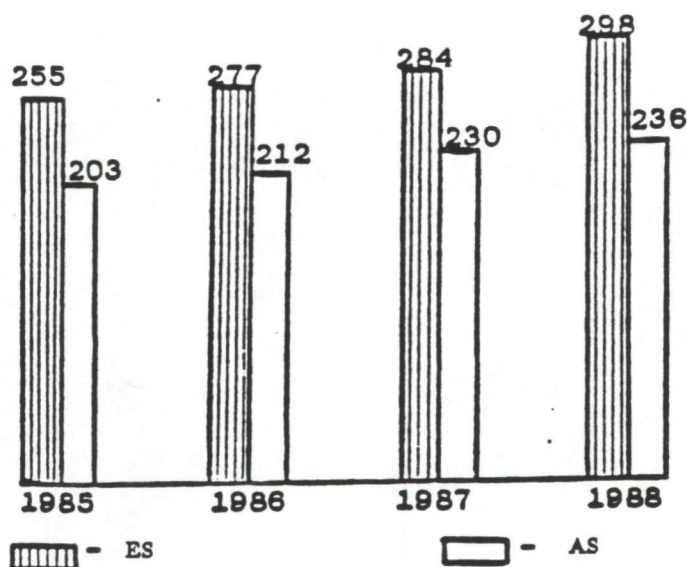


Fig. 2. Number of cities in the European section (ES) and Asian section (AS) with atmospheric pollution monitoring operations.

The pollution level of snow cover and the pollutant concentrations in atmospheric precipitation are also monitored to assess regional atmospheric pollution produced by major cities. Both ground-based and airborne monitoring systems for tracking pollutant flows across boundaries are employed to supervise observance of international obligations.

Municipal Air

The A. I. Voeykov Main Geophysical Observatory (Leningrad) is responsible for the acquisition and generalization of observation results acquired from the NEPMS network stations in various cities. Health standards for air quality are used to assess the degree of atmospheric pollution. These levels include the following maximum concentrations: the maximum one-time concentration MPC_{OT} and the average daily maximum permissible concentration MPC_{AD} . The one-time concentrations obtained over a 30 minute measuring period are compared to the MPC_{OT} while the average monthly and average annual concentrations are compared to the MPC_{AD} .

The state of municipal atmospheric pollution in 1988 has been characterized by the average annual pollutant concentrations as shown in Table 1.

Table 1
National municipal air pollution (excluding metals)

Pollutant	Number of monitored cities	Average concentration mg/m ³	MPC _{AD} , mg/m ³
1	2	3	4
Dust	400	.209	.15
Sulfur dioxide	410	.041	.05
Carbon monoxide	363	1.485	3.0
Nitrogen dioxide	411	.041	.04
Nitric oxide	256	.032	.06
Soluble sulfates	227	.016	(-)*
Hydrogen sulfide	146	.002	-
Carbon disulfide	27	.108	.005
Ammonia	113	.064	.04
Phenol	140	.004	.003
Formaldehyde	130	.009	.003
Hydrogen fluoride	60	.005	.005
Soot	44	.059	.15
Chlorine	28	.013	.03
Sulfuric acid	37	.013	.1
Benz(a)pyrene (mg/M ³ × 10)	267	3.653	1.0

*No MPC_{AD} established

Table 1 clearly indicates that the average sulfur dioxide, carbon monoxide, and nitric oxide concentrations for all cities are within the limits established by health standards. The average dust, phenol, ammonia, and nitrogen dioxide concentrations somewhat exceed the MPC, while the average carbon disulfide, benz(a)pyrene, and formaldehyde levels amount to 3-4X MPC.

The average nitric oxide concentration exceeded the MPC in 7% of the cities, while the nitrogen dioxide level exceeded the MPC in 38% of the cities and the carbon monoxide level was over the MPC in Yerevan only.

The primary municipal atmospheric pollution problem derives from elevated concentrations of ammonia, benz(a)pyrene, carbon disulfide, formaldehyde and certain other pollutants (see Figure 3).

Airborne metal concentrations are also monitored; the average annual concentrations for most cities are within the limits established by health standards; see Table 2.

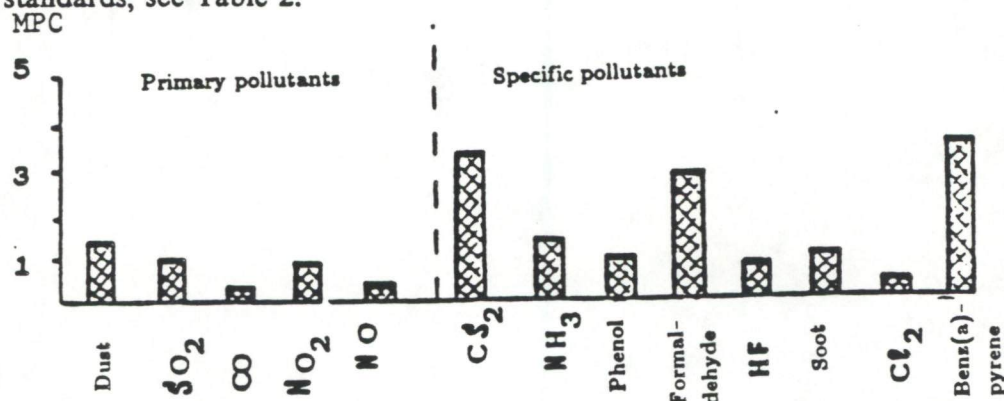


Fig. 3. Overall average pollutant concentrations (in MPC) for USSR cities: 1988.

The airborne metal concentration in several cities exceeded the MPC. The highest average monthly concentration of cadmium was three times MPC in Odessa; the average annual manganese concentration was 3-5X MPC in Dneprodzerzhinsk and Rustavi, while the highest average monthly concentration in Rustavi was 42X MPC; the average annual nickel concentration exceeded 1 MPC in Alma-Ata, Leninogorsk, and Ust'-Kamenogorsk; the highest average monthly concentration in Vitebsk, Gorki, Dzerzhinsk, Leninogorsk, and Yaroslavl was 3X MPC; the average annual lead concentration was on the order of 2-3X MPC in Balkhash, Komsomolsk, Kursk, Leninogorsk, Magadan, Ordzhonikidze, and Chimkent; while the highest average monthly concentration was 15X MPC in Komsomolsk, and 9-13X MPC in Balkhash and Chimkent.

Table 3 shows the atmospheric pollution level for several pollutants as a function of the level of industrial development of the respective cities.

The highest average maximum one-time concentration of dust, carbon monoxide, sulfur dioxide, and nitrogen dioxide are characteristic of cities with populations exceeding 500,000, see Figure 4. An analogous relation is observed for the average annual nitrogen dioxide concentrations.

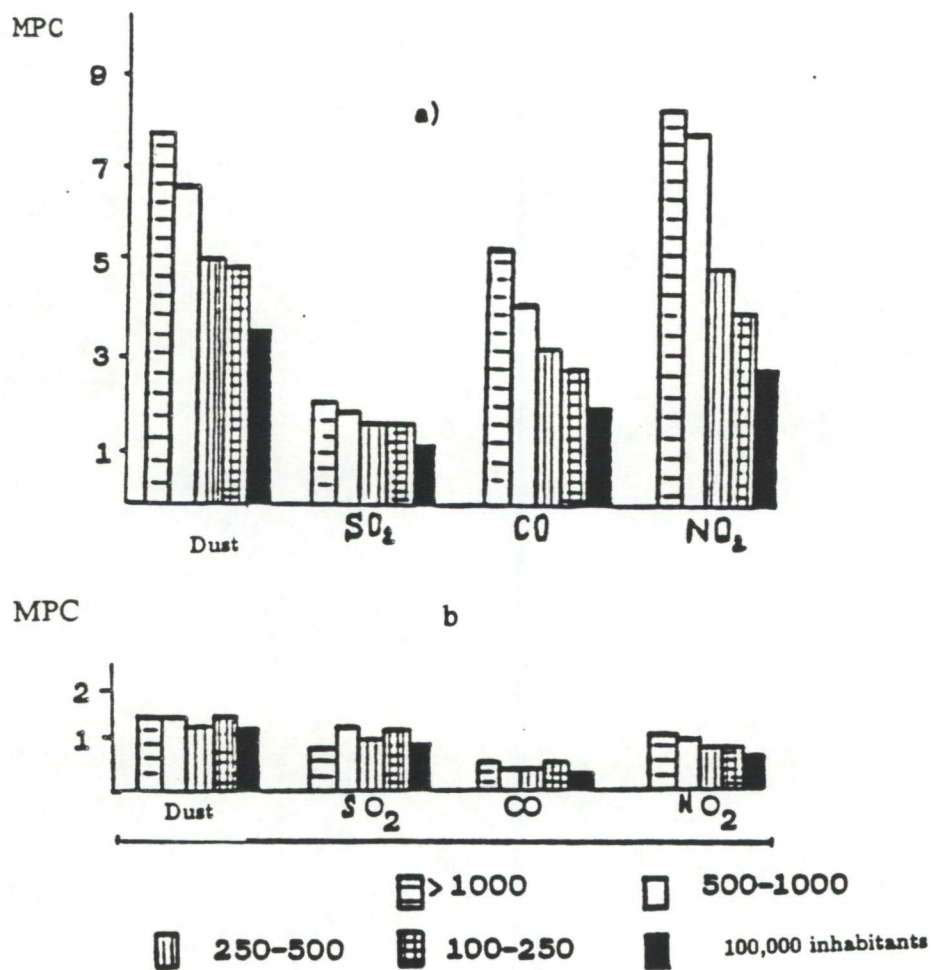


Fig. 4. Maximum (a) and average (b) pollutant concentrations (MPC) in cities classified according to population

Table 2
Overall airborne metal atmospheric pollution level: USSR

Metal	No. of monitored cities	Average concentration $\mu\text{g}/\text{m}^3$	$\text{MPC}_{\text{AD}} \mu\text{g}/\text{m}^3$
Vanadium	41	.120	(-)*
Bismuth	7	.0	(-)*
Iron	133	8.7	(-)*
Cadmium	68	.03	1.0
Cobalt	10	.003	1.0
Manganese	196	.17	1.0
Copper	190	.51	2.0
Nickel	196	.31	1.0
Lead	196	.15	.3
Rubidium	99	.01	(-)*
Chromium	179	.26	(-)*
Zinc	198	.47	(-)*

* MPC_{AD} not established.

Over the last three years the number of cities with high atmosphere pollution levels on isolated days (above 10X MPC) has stabilized somewhat and numbered 103 cities in 1988. However, the number of cases of high atmospheric pollution levels has diminished consistently from more than 3,500 in 1985 to 1,750 in 1988. The number of cases of high level airborne lead pollution in Ust-Kamenogorsk and the chloroprene pollution level in Yerevan have both diminished significantly (although the atmospheric pollution level attributable to such pollutants is still within the standards).

Atmospheric conservation measures have resulted in nearly a halving of the total air pollution levels according to data from 140 industrial cities since 1972 in spite of an increase in manufacturing volume, see Figure 5.

The period between 1985 and 1988 was marked by diminishing average concentrations of dust, sulfur dioxide, ammonia, carbon monoxide, chlorine, and hydrogen sulfide, see Figure 6. At the same time there has been a noticeable increase in the average concentrations of nitrogen dioxide in major cities due to increasing automobile emissions.

Table 3
Average primary atmospheric pollution levels (av. concentration mg/m³) for cities of various populations

Type of city	Population, ths.	av. concentration	No. of cities	av. concentration	No. of cities
Dust					
1	1000	.21	22	.033	22
2	500-1000	.24	29	.040	29
3	250-500	.20	61	.038	62
4	100-250	.24	93	.047	93
5	30-100	.22	34	.042	33
USSR Total		.21	400	.041	410
Carbon monoxide					
1	1000	1.92	22	.057	22
2	500-1000	1.66	28	.050	29
3	250-500	1.47	60	.040	62
4	100-250	1.53	92	.045	93
5	30-100	1.36	26	.042	34
USSR Total		1.48	363	.041	411
Nitric oxide					
Benz(a)pyrene mg/m³ × 10					
1	1000	.040	22	3.3	22
2	500-1000	.040	28	4.2	28
3	250-500	.029	57	2.9	58
4	100-250	.033	64	3.0	79
5	30-100	.037	15	2.3	20
USSR Total		.032	232	3.6	267

In recent years there has been a recovery in the air basins of the following regions: near the "Yasnaya Polyana" museum-estate, in Ararat, Baku, Balakovo, Barnaul, Gomel, Dalnegorsk, Yerevan, Zestafoni, Kalinin, Kemerovo, Leninogorsk, Mogilev, Monchegorsk, Norilsk, Orsk, Rudnaya Pristan', Tbilisi, Ust'-Kamenogorsk, and Chirchik.

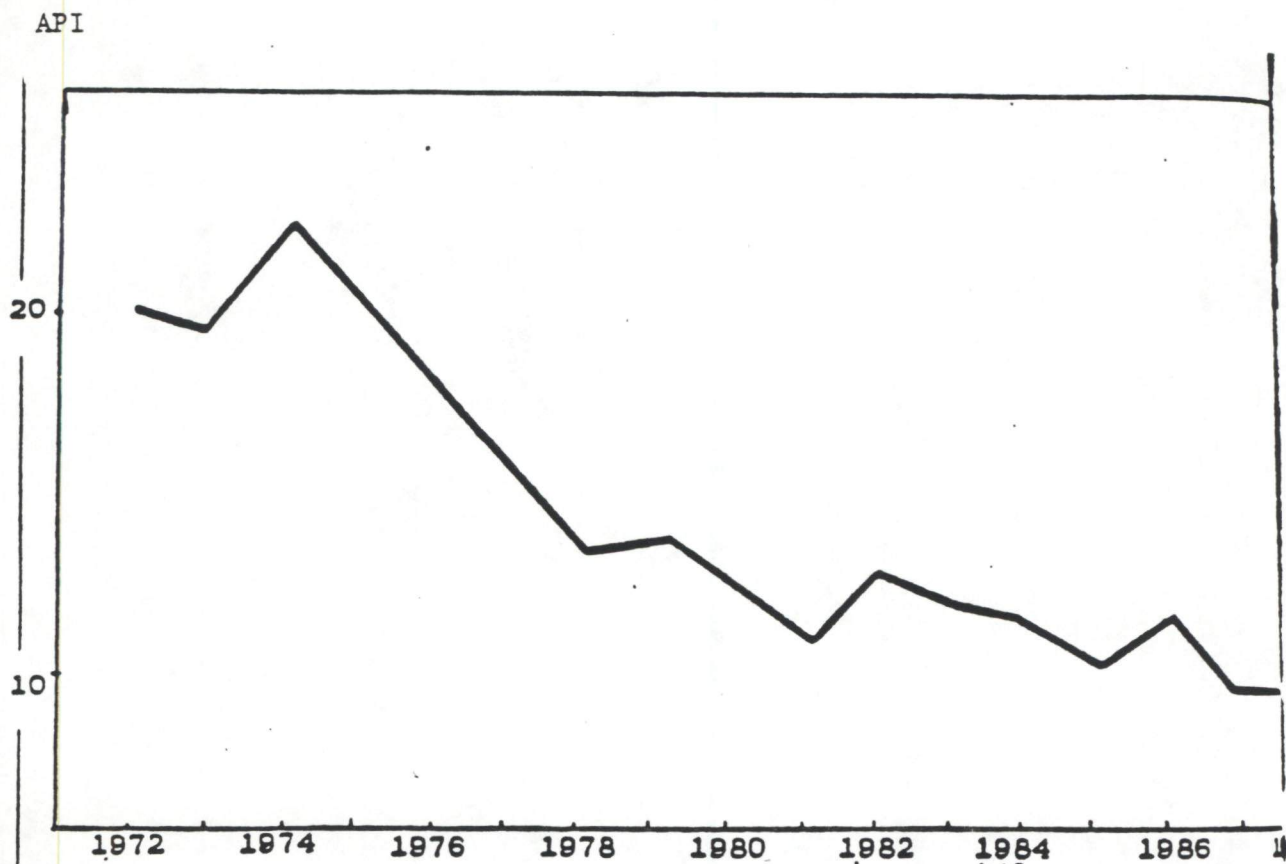


Fig. 5. Variation in the average atmospheric pollution index for 140 cities.
 Note: The atmospheric pollution index (API) is calculated based on the sum of the five highest municipal relative average annual pollutant concentrations (MPC) accounting for their risk classification.

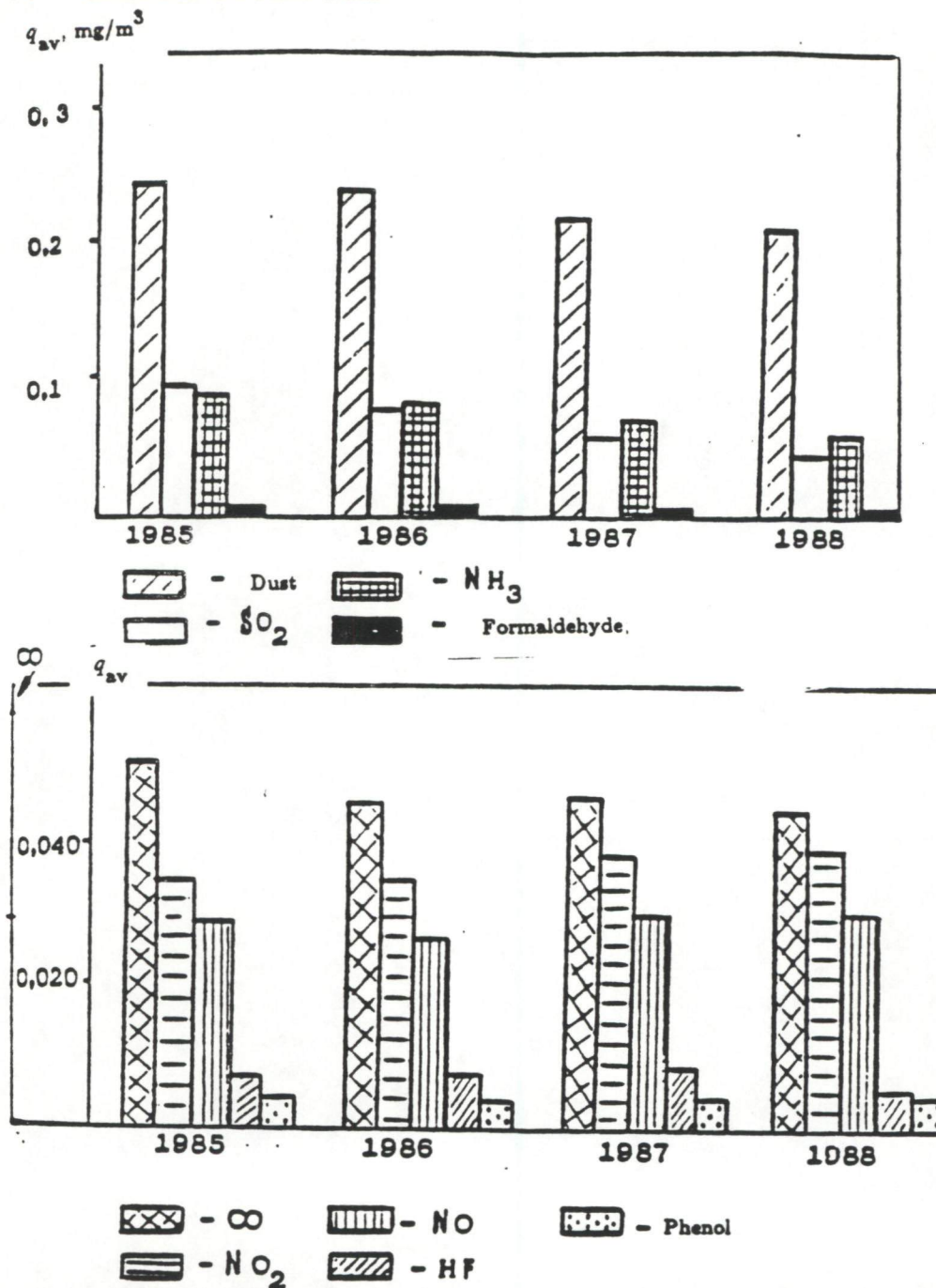


Fig. 6. Total average Pollutant concentrations for 1985-1988 averaged over USSR cities.

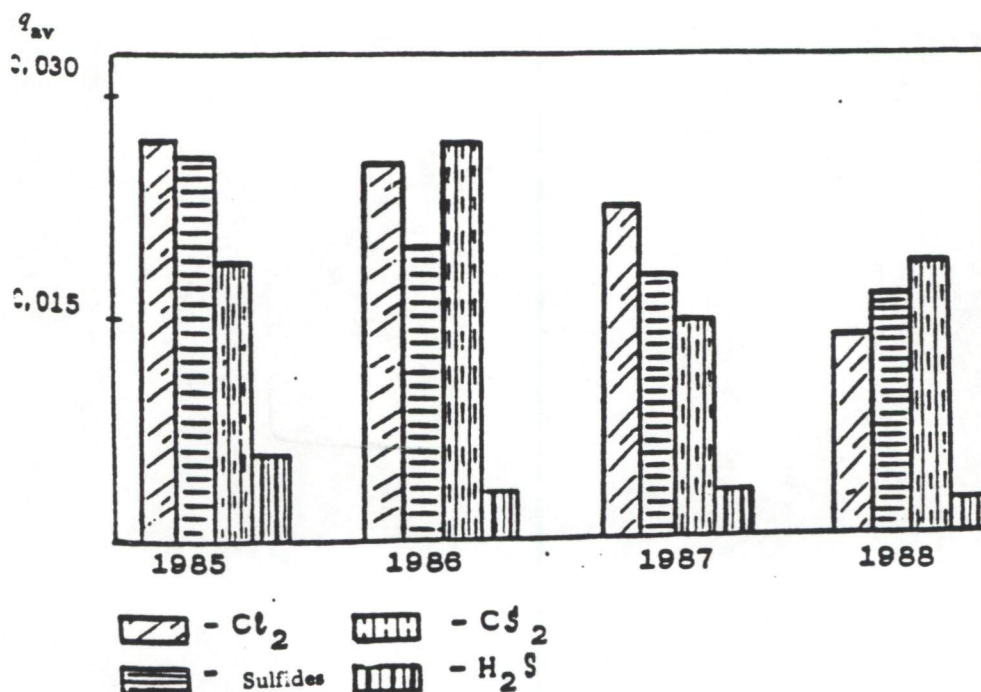


Fig. 6. Continued

In addition to positive trends there has been an increase in atmospheric pollution in isolated cities, including Alaverdi, Andizhan, Ventspils, Kokand, Magnitogorsk, Nizhni Tagil, Perm, and Fergan, although these cities have traditionally had high pollution levels.

Sixteen cities around the nation had atmospheric pollution concentrations exceeding 50X MPC in 1988. Extremely high pollution levels were commonly registered under such conditions in Archangel, Baykalsk, Volzhskiy, and Kirovokan, revealing the chronic nature of the significant pollution emission levels at these sites.

Cases of accidental warehouse spills (particularly ammonia from cooling systems) and in transport increased in frequency in 1988.

The highest atmospheric pollution level based on the API was observed in 68 cities (13% of the total number of monitored cities) in 1988; see Table 4. The majority of such cities are concentrated in the Donetsk-Dnepr region of the Ukraine, in the Urals, the Kuzbass, in Transcaucasia, and in Eastern Kazakhstan. This list includes the capitals of union republics: Alma-Ata, Dushanbe, Yerevan, Kiev, Funze, as well as the southeastern district of Moscow and cities with populations exceeding 1 million: Dnepropetrovsk, Donetsk, Kuibyshev, Novosibirsk, Odessa, Omsk, Perm, Rostov-on-Don, Sverdlovsk, and Chelyabinsk.

Cities with the highest atmospheric air pollution level and elevated human morbidity (see Section 1.10) are shown in Figure 7. Cities with an elevated morbidity were selected from the 130 cities included in the "Asia-Health" automated state information system.

Table 4
List of cities with the highest atmospheric pollution levels: 1988

City		Relevant atmospheric pollutants
1	2	3
1	Abakan	BP*, dust, formaldehyde
2	Alma-Ata	BP, lead, formaldehyde, dust
3	Almalyk	BP, hydrogen fluoride, dust, ammonia
4	Angarsk	BP, formaldehyde, dust
5	Arkhangel'sk [Archangel]	Methyl mercaptan, formaldehyde, methanol
6	Barnaul	BP, formaldehyde, dust
7	Bratsk	BP, methyl mercaptan, carbon disulfide
8	Volzhskiy	Methyl mercaptan, formaldehyde, carbon disulfide
9	Grozny	Formaldehyde, BP, nitrogen dioxide, phenol
10	Dzhambul	BP, dust, hydrogen fluoride
11	Dneprodzerzhinsk	BP, formaldehyde, phenol, ammonia
12	Dnepropetrovsk	Formaldehyde, BP, dust, ammonia
13	Donetsk	BP, dust, phenol, ammonia
14	Dushanbe	BP, formaldehyde, dust, nitrogen dioxide, nitric oxide
15	Yerevan	Dust, lead, nitrogen dioxide, ozone
16	Zaporozh'ye	BP, nitrogen dioxide, formaldehyde, phenol
17	Zestafoni	Manganese dioxide, BP
18	Zyryanovsk	BP, nitrogen dioxide, lead, manganese
19	Irkutsk	BP, formaldehyde, nitrogen dioxide
20	Kaliningrad	BP, carbon disulfide
21	Kamensk-Ural'skiy	BP, hydrogen fluoride
22	Kemerovo	BP, lead, formaldehyde, ammonia, nitrogen dioxide, carbon disulfide
23	Kiev	BP, formaldehyde, carbon disulfide, nitrogen dioxide
24	Kirovakan	Nitrogen dioxide, ammonia
25	Kommunarsk	BP, nitrogen dioxide, dust
26	Komsomol'sk	BP, lead, formaldehyde, dust, phenol

	(na-Amure)	
27	Krasnoyarsk	BP, dust, nitric oxide, hydrogen fluoride
28	Krivoy Rog	BP, formaldehyde, dust, nitrogen dioxide
29	Kuibyshev	Formaldehyde, hydrogen fluoride, dust,
30	Kurgan	BP, formaldehyde, dust
31	Leninogorsk	BP, lead, nickel
32	Lipetsk	Formaldehyde, BP, phenol, dust
33	Lisichansk	Formaldehyde, phenol, ammonia
34	Magnitogorsk	BP, carbon disulfide, dust, nitrogen dioxide
35	Makeyevka	BP, carbon disulfide, dust, phenol
36	Mariupol' [Zhdanov]	BP, formaldehyde, hydrogen fluoride, ammonia
37	Mogilev	Carbon disulfide, hydrogen sulfide
38	Moscow (south-eastern district)	Dust, nitrogen dioxide, nitric oxide, phenol, formaldehyde, ammonia
39	Nizhni Tagil	BP, formaldehyde, phenol, ammonia
40	Novokuznetsk	BP, formaldehyde, dust
41	Novosibirsk	BP, formaldehyde, nitrogen dioxide
42	Novotroitsk	BP, phenol, dust
43	Odessa	BP, formaldehyde, hydrogen fluoride, phenol
44	Omsk	BP, formaldehyde, ammonia, acetaldehyde
45	Orenburg	BP, dust, nitrogen dioxide
46	Osh	BP, dust, nitrogen dioxide
47	Perm	BP, formaldehyde, hydrogen fluoride
48	Prokopyevsk	BP, formaldehyde, dust
49	Rostov-on-Don	BP, formaldehyde, soot, dust
50	Rustavi	BP, dust, ammonia, phenol, copper
51	Sverdlovsk	BP, formaldehyde, nitric oxide, nitrogen dioxide, ammonia
52	Severodonetsk	BP, formaldehyde, phenol, ammonia
53	Semipalatinsk	BP, dust, nitrogen dioxide
54	Temirtav	BP, phenol, dust
55	Tyumen	BP, formaldehyde, dust
56	Ulan-Ude	BP, formaldehyde, phenol, dust
57	Usolye-Sibirskoye	BP, formaldehyde, nitrogen dioxide, dust
58	Ust'-Kamenogorsk	BP, lead, formaldehyde, sulfur dioxide, nickel
59	Fergana	BP, formaldehyde, ammonia, phenol
60	Frunze	BP, formaldehyde, dust, nitric oxide
61	Khabarovsk	BP, formaldehyde, ammonia, nitrogen dioxide
62	Chardzhou	BP, hydrogen fluoride, dust
63	Chelyabinsk	BP, formaldehyde, sulfur dioxide
64	Cherepovits	BP, carbon disulfide, formaldehyde, ammonia

65	Chimkent	BP, lead, dust
66	Chita	BP, formaldehyde, dust
67	Shelekhov	BP, hydrogen fluoride
68	Yuzhno-Sakhalinsk	BP, soot, nitrogen dioxide
* BP - Benz(a)pyrene		

Deposition of Sulfur and Nitrogen Components, Acid Precipitation

Pollutant deposition derives not only from source emissions themselves but also from cross-boundary transport. Two specialized monitoring systems within the National Environmental Pollution Monitoring Service are charged with analyzing such deposition:

- the cross-boundary pollutant transport monitoring system;
- the snow cover and atmospheric precipitation monitoring system.

The first system runs along the western boundary of the USSR and includes 11 stations operating within the framework of the Joint European Long-Range Pollutant Transport Monitoring Program, 90 snow cover pollution monitoring stations and airborne pollutant stream measurements.

The second system covers virtually all areas of the country and includes approximately 1000 snow cover pollution monitoring stations and approximately 300 stations used to measure the chemical composition of atmospheric precipitation.

Figures 8-10 provides maps of the average annual distribution of sulfate sulfur, nitrate nitrogen, and ammonia nitrogen deposition (for areas with a stable snow cover). These maps clearly reveal that pollution to the European section of the nation attributable to anthropogenic causes exceeds the pollution in the Asian section by a factor of several times. The elevated levels are characteristic of industrial centers and cities. The cleanest areas are in the northeastern sections of the nation and the Soviet Arctic. Quantitative assessments of deposition on the continental region of the nation are provided in Table 5.

The level of sulfur deposition onto the continental region of the nation as well as the coastal and inland seas amounts to nearly 15 million tons per year. Approximately 20% of this total (approximately 3 million tons per year) derives from cross-boarder transport over the western boarder; in adjacent regions the "contribution" of cross-boarder transport to local pollution runs to 30-50%.

No elevated acid concentrations in atmospheric precipitation has been identified over the majority of the USSR; standard pH levels of runoff water are 5.5-6.. Elevated acidity is observed irregularly in many industrial regions and along the western boundary, see Figure 11.

USSR cities with the highest
atmospheric pollution levels
for individual components: 1988

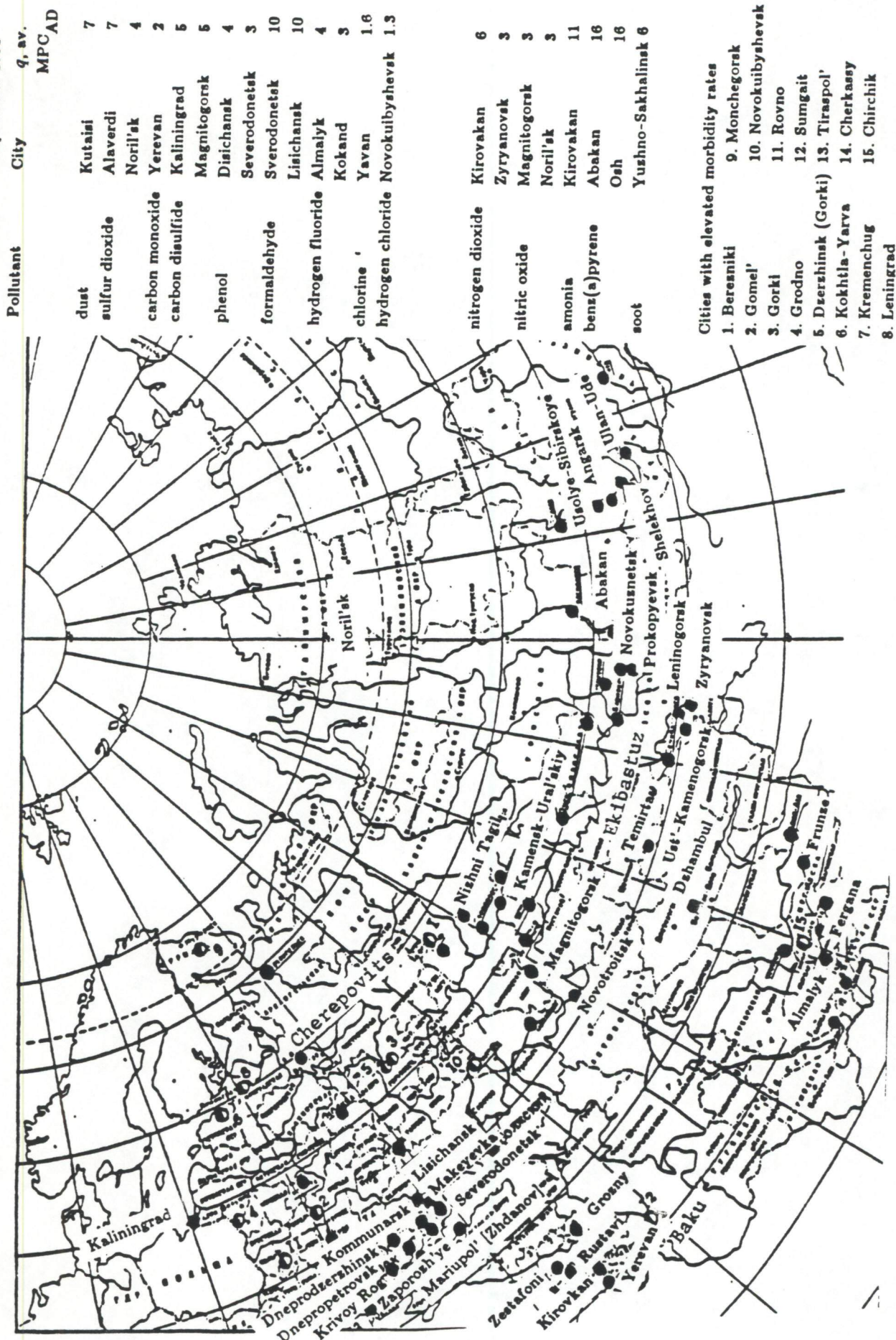


Fig. 7. Cities with the highest atmospheric pollution and elevated population morbidity rates.

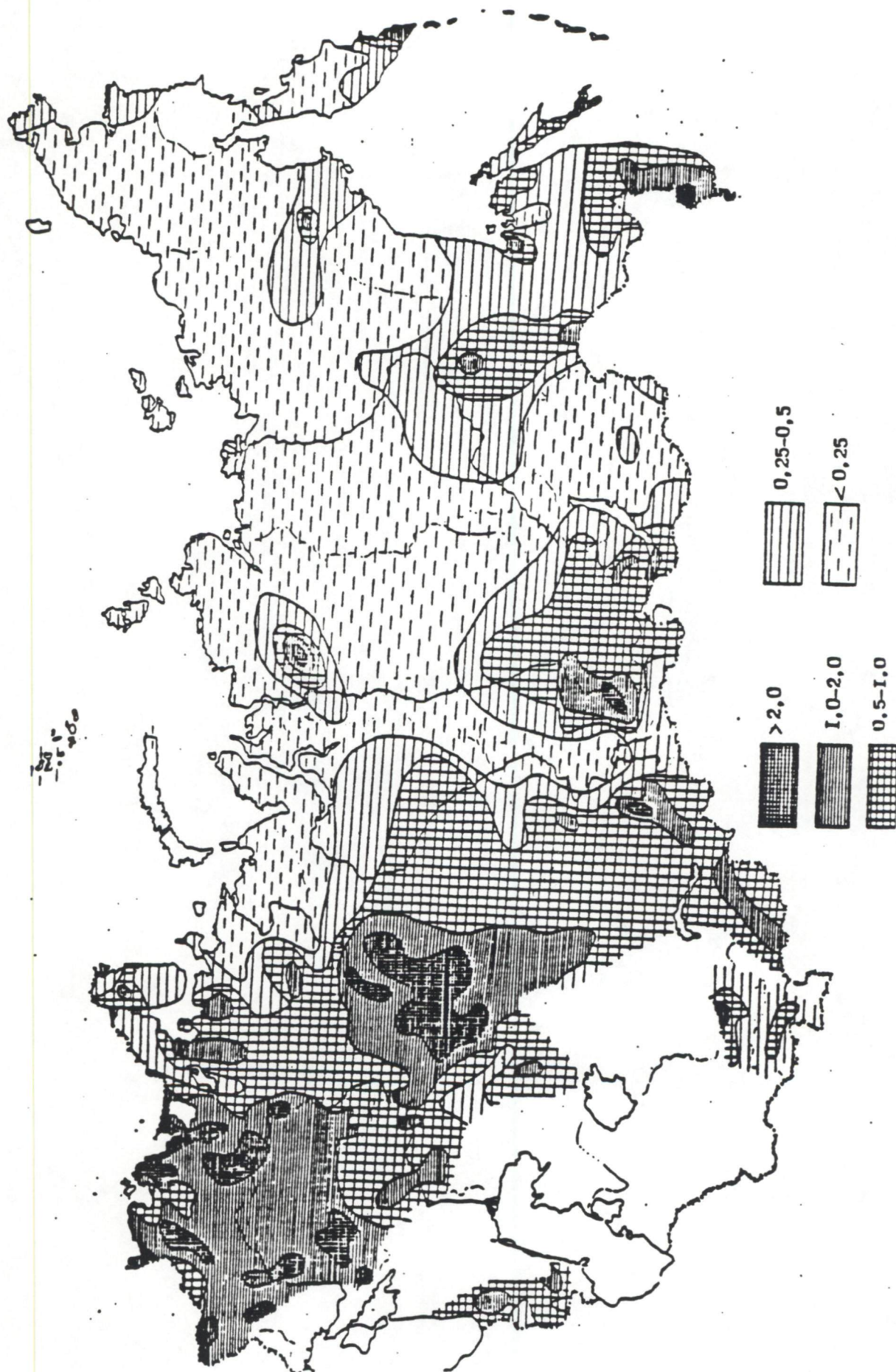


Fig. 8. Map of average annual sulfur sulfate deposition distribution (in units of sulfur), $T/\text{km}^2/\text{year}$.

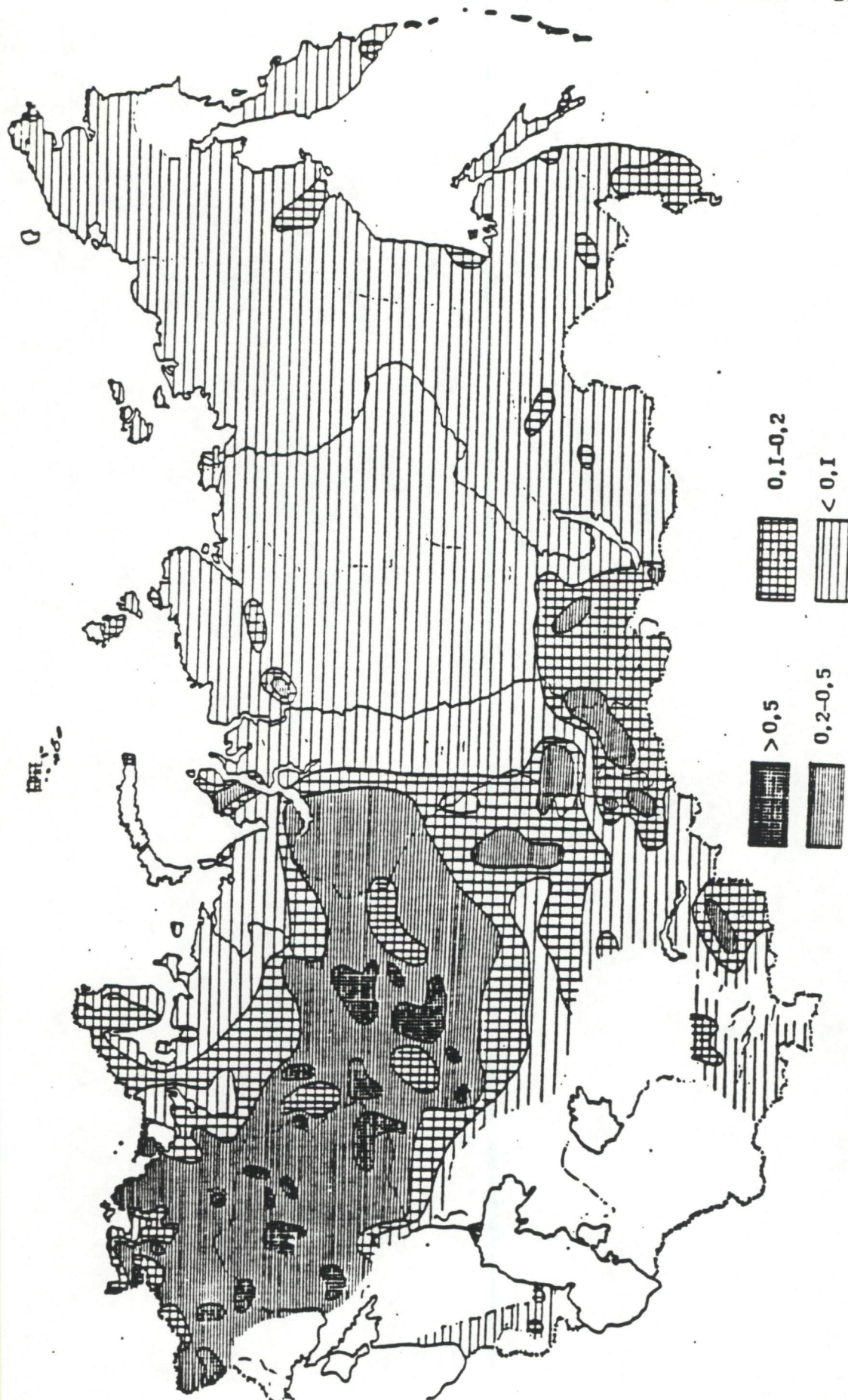


Fig. 9. Map of average annual nitrate nitrogen deposition distribution (in units of nitrogen), $T/km^2/year$.

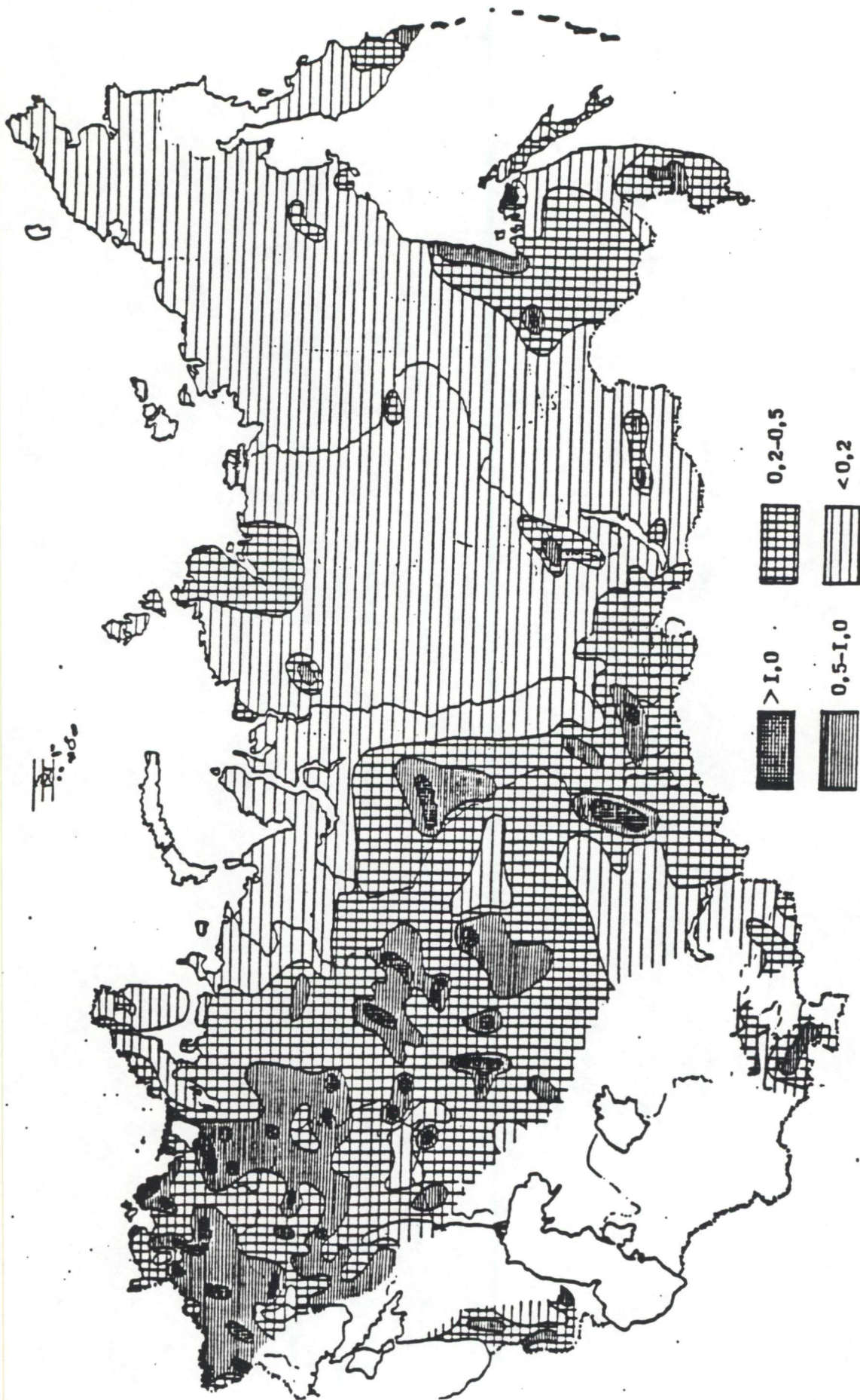


Fig. 10. Map of average annual ammonia nitrogen deposition distribution (in units of nitrogen), T/km²/yr.

Table 5
 Estimate of the density (tons/km²) and weight (millions of tons) of annual pollutant deposition onto the continental USSR

Pollutant	ES		AS		Total	
	Density	Weight	Density	Weight	Density	Weight
Sulfur	1.04	$\frac{5.6^*}{6.7^{**}}$	.45	$\frac{7.4}{8.1}$	.59	$\frac{13.0}{14.8}$
Nitrate nitrogen	.23	$\frac{1.25}{1.5}$	.09	$\frac{1.5}{1.65}$	.13	$\frac{2.75}{3.15}$
Ammonia nitrogen	.4	2.17	.24	3.6	.26	5.77
Total* nitrate and ammonia nitrogens	.63	3.42	.33	5.1	.39	8.52

* Excluding cities

** Incorporating municipal deposition

The maximum permissible load (MPL) of nitrate and ammonia nitrogen on woodland ecosystems is largely dependent on the productivity of the woodlands: the higher the productivity the higher the MPL. Data produced by Swedish scientists for Scandinavian woodlands suggests that the MPL ranges from .5 to 4.5 tons·km²·yr (depending on forest growing conditions). The MPL equals 1 ton·km²·yr for low-yield northern woodlands, primarily arctic woodland ecosystems, while the MPL is 2 tons·km²·yr for the more extensive medium-yield forest areas. High-yield woodlands under optimum conditions have an MPL of 4 tons·km²·yr.

In order to characterize the nitrate and ammonia nitrogen loads for the woodland areas of the USSR, the forests are divided into two arbitrary productivity classes: low-yield and medium-yield areas. The USSR contains virtually no high-yield forests (total biomass 400-600 tons/hectare). Woodlands in the following areas are classified as low-yield forests (biomass: 30-150 tons/hectare): the subarctic/tundra forest regions, the northern taiga subzones, forest and mountain zones in areas of rocky, low-yield soils. The medium-yield forests are located in the central and southern taiga subzones

and include mixed woodlands in the forest region and forest steppe stock (biomass of 150-400 tons/hectare).

Table 6 shows the distribution of woodland ecosystems as a function of the nitrate and ammonia nitrogen deposition levels. This figure clearly indicates that for low-yield forests the MPL of 1 ton·km²·yr is exceeded only in the northern taiga region over an area of .6 million hectares, comprising .35% of its range. For medium-yield forests the MPL of 2 tons·km²·yr is exceeded only in the southern taiga and in mixed woodlands over a 3.7 million hectare area and the forest steppe covering 1.2 million hectares in the European section of the country, comprising 1.4 and 2.8%, respectively.

Table 6

Distribution of woodland ecosystems in terms of nitrogen deposition levels

Woodland zones	Forest area, millions of hec.	Deposition level, tons·km ² ·yr					
		.05	.1	.5	1	2	3
		(MPL)					
Forest area, millions of hectares							
1	2	3	4	5	6	7	8
<u>Low-yield:</u>							
Tundra forest	30.6	10.0	8.11	0.8	1.7	-	-
Northern taiga	173.3	70.8	28.1	66.9	6.9	<u>0.6</u>	-
TOTAL	203.9	80.8	36.2	77.7	8.6	0.6	-
<u>Medium-yield:</u>							
Northern taiga	240.5	59.4	21.9	121.1	30.6	7.5	-
Southern taiga and mixed woodlands	262.0	10.0	61.9	158.9	21.9	5.6	<u>3.7</u>
Forest steppe	42.5	-	0.6	29.4	8.8	2.5	<u>1.2</u>
TOTAL	545.0	69.4	84.4	309.4	61.3	15.6	4.9

GRAND TOTAL	748.9	150.2	120.6	387.1	69.9	16.2	4.9

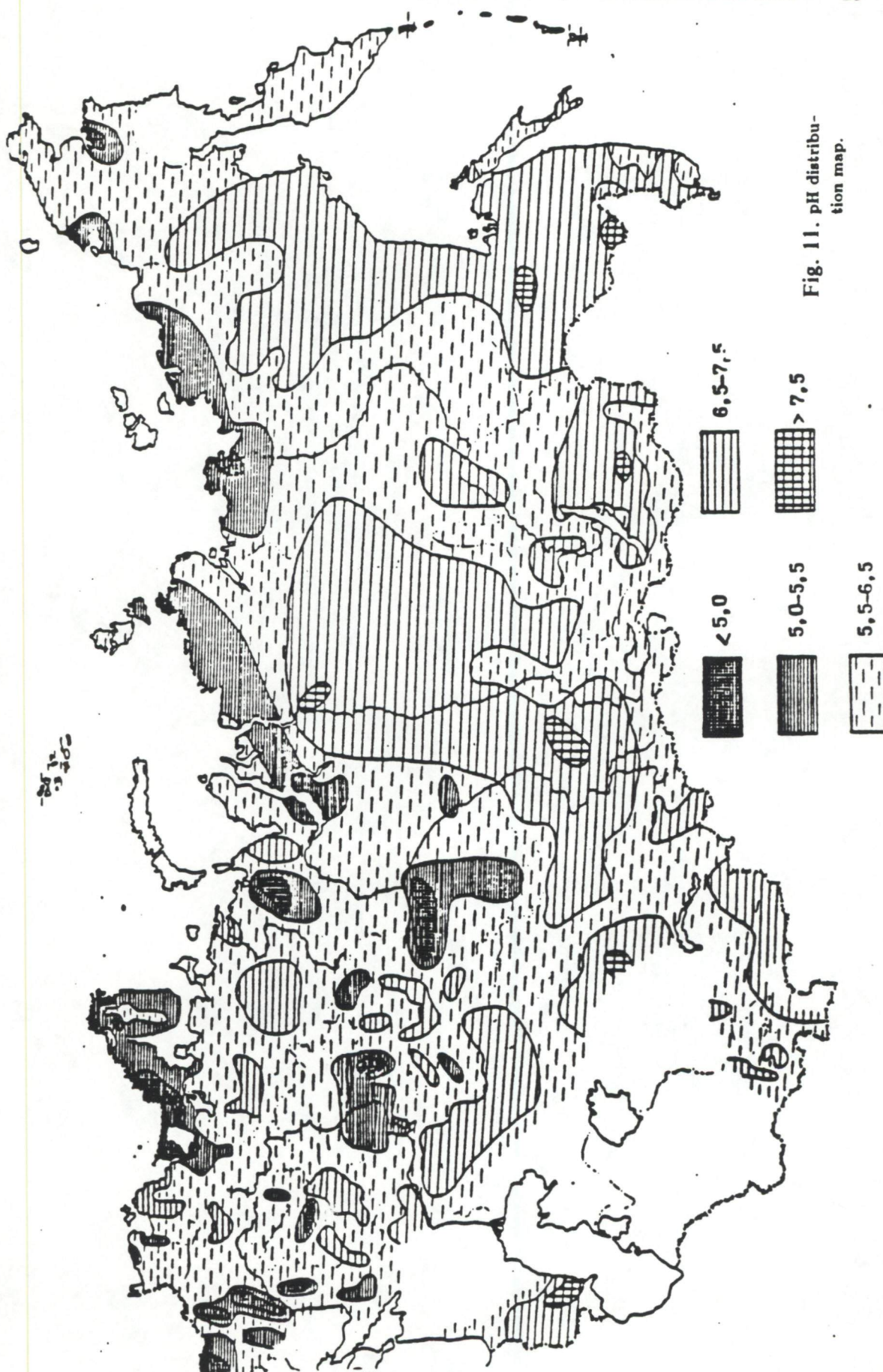


Fig. 11. pH distribution map.

Critical hydrogen acid loads ordinarily are 10-20 kg·km²·yr. The MPL for Calcareous soils is 500 kg·km²·yr, i.e., these soils are virtually free of any effect from anthropogenic acidic deposition: the majority of the country has a deposition rate of up to 5 kg·km²·yr, which represents the natural ambient level. The deposition level approaches the critical point in only a few local regions. Some of these areas are on the western border on the Soviet side: Karpat, Svetlogorsk, Brest, Lutsk, and Rovno where the elevated concentrations are the result of cross-border pollutant transport. The remaining regions border on industrial cities: Minsk, Mozyr', Murmansk, Petrozavodsk, Surgut, Kharkov, as well as the Taimyr and Yakut coastlines.

Ambient Atmospheric Pollution

In addition to environmental pollution monitoring in major cities similar monitoring routines are used in background regions, i.e., outside urbanized zones, across the entire nation. Such monitoring programs have been implemented at stations in national parks and reserves, including biosphere reserves and on the monitoring network for such applications as ambient atmospheric and precipitation (including snow cover) monitoring, as well as observation and monitoring of natural waterways, soils, and seas together with cross-border pollutant transport.

The information recovered from this process is also used in international cooperation to assess the state of the biosphere and its components within the framework of the United Nations Environment Program, the World Meteorological Organization, UNESCO, the European Economic Commission, the Council for Mutual Economic Assistance, etc.

Long-term observations have been used to establish that anthropogenic pollution resulting from long-range atmospheric pollutant transport from urbanized regions can be detected in virtually all areas and roughly corresponds to the distribution density of the pollutant sources.

The mechanisms behind the annual (cyclic) variability of pollutant concentrations in the ground-close air layer have been determined. Higher atmospheric concentrations during the cold months are characteristic of nitrogen and sulfur oxides, benz(a)pyrene, and heavy metals (aside from mercury), while higher concentrations of chlorocarbon pesticides, ozone, mercury, and dust are characteristic of the warmer months.

The USSR can be divided into three primary regions in terms of ambient atmospheric pollution levels; these regions include: the European section (ES), Kazakhstan and Central Asia along with Siberia and the Far East.

The European section has the highest ambient atmospheric pollution levels; during the winter months the average monthly airborne

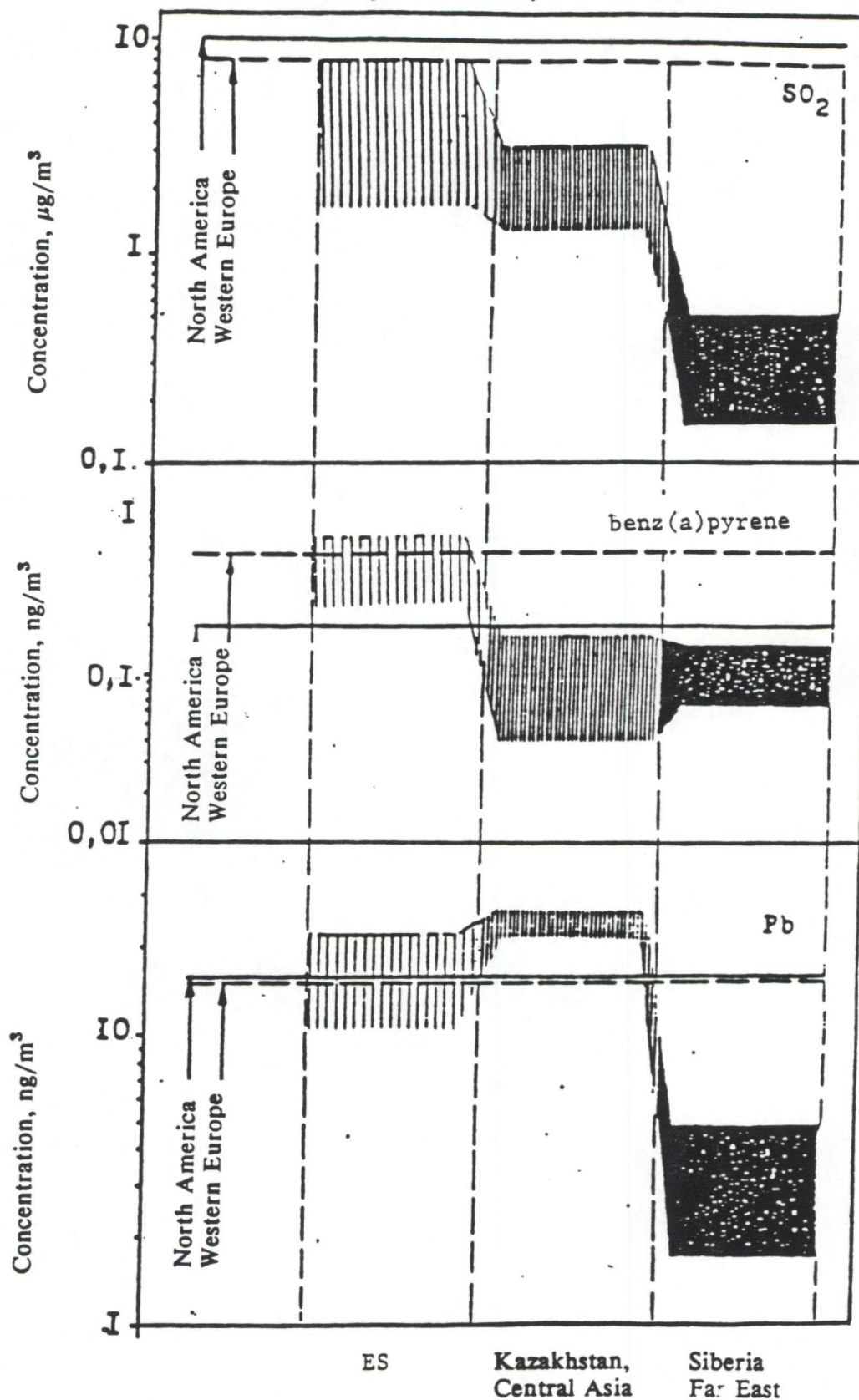


Fig. 12. Range of average seasonal atmospheric pollutant concentrations in the ambient regions of the USSR compared to North America and Western Europe.

benz(a)pyrene concentrations ($.7-.9 \text{ ng/m}^2$) in the central regions remain consistently near the maximum permissible levels, while the sulfur dioxide concentration is as high as $10-20 \text{ } \mu\text{g/m}^3$ at isolated sites. The western regions of the European section are most strongly affected by the anthropogenic load; the existing pollution sources are supplemented by cross-border pollutant transport via air masses.

Atmospheric pollution in Kazakhstan and Central Asia is less severe for many pollutants than in the European section. Nonetheless, elevated sulfur dioxide and lead concentrations have been occasionally recorded in these areas.

Estimates suggest that the anthropogenic "contribution" to atmospheric pollution by sulfur dioxide, benz(a)pyrene and lead runs to 90% in the European section, in Kazakhstan, and in Central Asia, while cadmium and arsenic pollution from anthropogenic causes accounts for 60-70%.

The lowest ambient atmospheric pollution level is found over the extensive territories of Siberia and the Far East. The minimum ambient concentration of sulfur compounds, benz(a)pyrene, chlorocarbon pesticides and heavy metals has been recorded in the arctic regions and in Eastern Siberia.

A comparative analysis reveals that the ambient atmospheric pollution levels for such pollutants as sulfur compounds, organic matter and heavy metals in the more heavily polluted regions of the USSR closely correlate with the ambient pollution levels in North America and Western Europe; see Figure 12.

Climate

The First World Climate Conference organized by the World Meteorological Organization was held in Geneva in 1979. During a presentation at this conference E. K. Fedorov claimed that certain climatic changes will be unavoidable in the future and will become noticeable in the next few decades. Fedorov proposed developing a system of planned measures to spare mankind from the negative consequences of this process.

Indeed, the last decade has witnessed detectable climatic changes in cities and industrial regions attributable to urbanization effects: local variations in the state of the terrestrial layer, on the one hand, and both thermal and aerosol atmospheric pollution over such regions, on the other. Generally this has resulted in an elevation of the nighttime and average daily air temperatures (particularly during the cold months), as well as an increase in atmospheric precipitation on the windward side of cities and diminishing precipitation levels on the leeward side and have also produced systematic, local changes in air humidity and cloud cover over urbanized areas.

precipitation levels on the leeward side and have also produced systematic, local changes in air humidity and cloud cover over urbanized areas.

Changes in atmospheric chemical composition which have accelerated in recent decades are manifested as an increasing atmospheric concentration of the so-called "greenhouse gases" (carbon dioxide gas, methane, freons, and certain other trace gases in the atmosphere). This has resulted in an increase in the world-wide average terrestrial air temperature of approximately .5 K over the last century.

Scientists believe that certain regional climatic changes in the USSR are associated with the global warming process. The fundamental trends are forecast to account for changes in the atmospheric chemical composition and corresponding variations in global temperature conditions over the next few decades.

A diminishing summertime air temperature (averaging .5 K) has occurred in the last century in the European section of the USSR, while there has been a substantial increase (up to 3 K) in the Asian section; an increase of 5-10% in annual atmospheric precipitation levels has been observed across virtually the entire country. The recurrence of severe droughts in both the steppe and forest steppe regions has also risen. At least some of these changes are generally attributed to anthropogenic changes in the global climate.

Refined assessments of regional changes in climate conditions across the USSR through the year 2000 have recently been issued. These assessments apply to five-year intervals and are based on an analysis of empirical data on modern climatic changes as well as paleoclimatic reconstructions of natural conditions in past epochs. Such analyses were used as the basis for the following predictions:

- the temperature of the lower atmospheric layer will rise by 3-5°C in winter and approximately 2° in winter at upper latitudes, with a rise of 2-3°C in winter and approximately 1° in summer at mid-latitudes. A moderate reduction in air temperature is possible in some sections of Central Asia;
- the annual atmospheric precipitation level in the northern regions of the country will rise by 5-10 cm while the arid valley regions of Kazakhstan and Central Asia as well as the Southern Ukraine and the Northern Caucasus will have a 10-15 cm rise in precipitation; a slight decrease in precipitation levels will, on the other hand, occur in the central regions of the European section and Western Siberia.

The rise in air temperature and the changes in atmospheric precipitation predicted to occur by the year 2000 may result in substantial changes in water runoff levels. The annual runoff of small- and medium-scale rivers will diminish by 10-20% from the standard level in the forest steppe and along the southern region of the woodland zone of the European section and

Western Siberia; the soil moisture level to a 1 m depth will also diminish in summertime (by 5-15%). The average annual river runoff will increase by 10-20% in the more southerly steppe regions while the rivers in the Northern European section and Northern Siberia will rise by 10-15 cm over the standard level.

The effect of climate changes on the dynamics of grain harvesting in the primary agricultural regions in the first half of the 1990s will be determined by the higher year-to-year variability in atmospheric precipitation. In other words, a higher drought probability (analogous to the first half of the 1980s) will continue in the grain belt.

The conditions characteristic of the favorable period of 1964-1974 will likely reappear in the major grain-producing regions in the second half of the 1990s as a result of the development of global warming.

The catastrophic droughts in Africa (in the Sahara in the 1970s and subsequently in Ethiopia and a number of other nations, costing many human lives), in the USSR in the 1970s and early 1980s and in the US and Canada in 1988 represent a confirmation of changes occurring in climate.

Analysis of monitoring data for the last 100 years reveals that the following were the warmest years during this period: 1980, 1981, 1983, 1987, and 1988. The present average surface temperature in the northern hemisphere is .4°C higher compared to the 1950-1980 period. A further increase in temperature is anticipated: an average of 1.3°C by the year 2000 and 3-4°C by the year 2050.

Such climatic warming may not only have a negative effect on agriculture but also will be detrimental to many other fields of the economy, including energy, construction, transportation, and the overall biosphere. Such changes could also raise the level of the seas and oceans around the world by a half meter, which could result in flooding of heavily-populated coastal regions. Therefore the climate problem which is presently an ecological problem is becoming a severe economic, social, and political issue. The solution to this problem will require active and coordinated efforts on the part of a variety of nations around the world.

Scientists at the All Union Academy of Agricultural Scientists have developed a climate program based on forecasts of climatic changes; this program proposes a system of measures for maintaining climatic stability as conditions develop.

There are a number of different alternative solutions to incorporating changes in the climate and its consequences. One solution is to adapt the economy to the changing climatic conditions, make broad use of low energy-consumption technologies, reduce CO and other gas emissions, etc. Aside from developing energy conservation technologies this means developing areas of power and energy production outside of organic fuel combustion: atomic and hydroelectric power engineering, as well as solar and wind

energy although the latter are not traditional sources and will not likely replace the major sources in the near future. The traditional hydrocarbon fuels will most likely retain their dominant position in the fuel-power production balance through the mid-twenty-first century. The organic fuel demand is also likely to become more "coal-intensive" due to the increasing percentage of coal. Therefore, even as the total organic fuel consumption level stabilizes due to a diminishing oil consumption level, the annual carbon dioxide gas emission level will grow and the greenhouse effect will therefore be magnified.

Another method of dealing with rising temperatures resulting from changes in climate may lie in delivering neutral aerosol particles into the upper atmospheric layers (to function as a solar radiation "shield"). However, this method requires very thorough analysis.

The international scientific community has concluded in developing proposals for joint measures that it is necessary above all to reduce carbon dioxide gas emissions.

A proposal to reduce carbon dioxide emissions by 20% by the year 2005 was therefore introduced at an international conference in Toronto (Canada) in June of 1988, while a 30% reduction by the year 2000 was called for at a conference in Hamburg (FRG). The adoption of such proposals would pose a number of serious problems for power engineering.

An "Internal Atmospheric Fund" relying on a monetary "tax" on the industrial nations most responsible for damaging the atmosphere has been proposed.

Issues involved in maintaining economic stability under conditions of possible climatic changes are undergoing comprehensive analysis today.

The World Meteorological Organization and the United Nations Environment Program founded an Intergovernmental Council in June of last year; this council includes representatives of over 40 states, including the USSR. This council established three groups to analyze issues and prepare a report and recommendations.

These groups have held their first sessions which led to a lively discussion regarding the consequences of the evolving climate on the economy and alternative approaches to the fundamental measures of avoiding possible harm.

The Ozone Layer

Concern over the fate of the ozone layer began to mount in the early 1970s in connection with the development of supersonic aviation and the increasing emission of pollutants, many of which were capable of causing a breakdown of the atmospheric ozone. Ambient monitoring data for the

northern and southern hemispheres indicate an annual increase in the global atmospheric concentration of industrial gas pollutants of between a few percent and 10-15% over the last decade. The greatest potential danger for the stratospheric ozone layer lies in the accumulation of chemically inert compounds in the atmosphere as well as chlorine- and bromine-containing compounds (chlorofluorocarbons and halogens) in the lower atmospheric layers. The latter are widely used in industry as cooling agents, solvents, fire fighting agents, in the manufacture of polyurethane materials, and for domestic consumption for applying lacquers, dyes, and aerosol products. The increasing total world production of chlorofluorocarbons exceeded 1 million tons in 1988. The largest quantity of chlorofluorocarbons are found in the following nations: The EEC: 520,000 tons (40%); the US: 455,000 tons (35%); Japan: 130,000 tons (10%); and the USSR: 123,000 tons (9.5).

By slowly diffusing into the stratosphere the chlorofluorocarbons release the chlorine (or bromine) atoms due to solar UV radiation with a wavelength of near 120 nm; this results in catalytic breakdown of the ozone in gas-phase reactions. In this case UV radiation grows in proportion to the diminishing ozone level, thereby producing skin cancer in humans, reducing the yield of agricultural crops, and the seas and oceans, while damaging ecosystems and isolated species of flora and fauna, etc.

Modeling calculations reveal that a further uncontrolled increase in chlorofluorocarbon atmospheric emissions may result in a significant depletion of the ozone layer by the mid-twenty-first century. The total ozone concentration at mid-latitudes in the northern hemisphere will diminish by 4-8%, while the drop in the polar regions of the Arctic and Antarctica will amount to 12-15% of the current level. However, even today the ozone layer over Antarctica does not diminish by 12-15% during the spring months but rather drops by 40-50% during this period.

Some researchers have attributed this to the natural cyclic behavior of the ozonosphere, while others claim that the primary cause is an increase in freons whose derivatives have very high heterophase reaction rates with particles in the polar stratospheric clouds at the very low temperatures of the Antarctic atmosphere. On the one hand the nitrogen compounds that could bind to the chlorine responsible for ozone breakdown will assume a solid phase in such reactions and will fall out, while the chlorine compounds, on the other hand, will assume a form suitable for dissociation upon earliest exposure to the spring sun. The diminishing ozone layer over Antarctica may also be related to some degree to the greenhouse effect, i.e., a warming in the terrestrial layer will be accompanied by cooling in the stratosphere. The effect is more strongly manifested at higher latitudes and may be sufficient to increase the frequency and density of polar stratospheric clouds where heterophase reactions occur. Cloud formation probabilities may further increase due to the continuous increase in the concen-

tration of methane which becomes water in the stratosphere. There is also a threat that the heterogeneous ozone breakdown chemistry characteristic of Antarctic temperatures may also encompass other areas of the world.

Ozone layer changes are also related to the solar activity cycle and natural atmospheric processes.

A report of the spread of the "ozone hole" from Antarctica into a populated region encompassing Melbourne, Perth, Hobart, and Macquarie Island appeared in 1988. The diminishing ozone level continued for a one month period and amounted to 10%.

Information on the chemistry, composition, and dynamics of the ozonosphere collected over a period of 15 years of research proved insufficient in efforts to explain the variability of the surprisingly-sudden appearance of the riddle of the Antarctic ozone "hole." This indicates both the complexity and the importance of accelerating research as well as the need to adopt safety measures. Such problems have been addressed by the Vienna Convention to Protect the Ozone Layer signed in 1985 of which the Soviet Union was a signatory. The USSR participated in the adoption of the Montreal Protocol to the Vienna Conference on substances that destroy the ozone layer; this Protocol was adopted in 1987 and went into effect on January 1, 1989. The Protocol outlines the obligations for a gradual reduction in the manufacturing and consumption of chlorofluorocarbons. Article 3 of the Vienna Conference provides for, specifically, "organization of research and scientific analyses" on the various aspects of ozone layer protection. An Interdepartmental Commission (IDC) was established by a resolution of the USSR Council of Ministers for implementation of obligations outlined by the Vienna Convention. A comprehensive ozonosphere research and monitoring program for 1989-1995 was developed. This program accounts for all aspects of this issue, including analysis of the effects of long-term changes in the ozone layer on human health, the status of ecosystems, climate, the yield of agricultural production, and the seas and oceans, as well as the development of alternative materials and ecologically-safe technologies.

In sum efforts are currently aimed at obtaining scientifically-supported long-term predictions of changes in the ozone layer and assessing the effect of such changes on the earth's ecosystems and climate. The research results will be used in developing environmental protection measures and an ecologically-acceptable developmental strategy for the chemical industry and for developing a reliable ozone layer monitoring system.

Radiation Conditions

An extended network throughout the country is used for monitoring radiation levels. At least 2200 weather stations take daily measurements of

tion levels, and 80 stations record atmospheric aerosol concentrations. Several dozen stations take regular precipitation samples to determine tritium concentrations as well as inland and ocean water specimens for analysis of long-lived strontium-90 and cesium-137 concentrations. The measurement data are sent on the appropriate communications channels to an integrated data acquisition and analysis center.

The radiation conditions in the Soviet Union, including the territories of the Ukrainian, Byelorussian, and Russian Soviet Socialist Republics contaminated by radioactive pollution from the accident at the Chernobyl Nuclear Power Plant (CNPP) stabilized in 1988 and show a trend towards further improvement. Radiation indicators in all areas of the nation (beyond individual regions in the Gomel, Mogilev, Kiev, Zhitomir, and Bryansk oblasts with elevated radiation pollution levels from the CNPP accident) are essentially equal to the ambient levels.

With respect to the radiation conditions in isolated regions of the Ukrainian, Byelorussian, and Russian SSRs following the CNPP accident (Figures 13, 14, 15) the radioactive contamination of the environment over a substantial area remains a severe technical and social problem. It should be pointed out that the accident of April 26, 1986 produced a sudden eruption and expulsion of radioactive particles which spread in a westerly direction, producing a narrow, extended contamination belt across the terrain. The radioactive material then spread as a plume in a northwesterly direction on April 26 and 27, shifting by April 28-29 to an east by northeast track and finally to a south by southeast track by April 29 and 30. The majority of radioactive deposition occurred in the first 4-5 days in the surrounding regions, although the complete formation of a radioactive "track" and individual "spots" continued for the entire month of May.

Extensive measurements to establish levels of atmospheric and terrestrial radioactive contamination and to carry out comprehensive analysis of the radioactivity of natural resources, including vegetation, were given special priority immediately following the CNPP accident. The data derived from this process provided the basis for decisions regarding evacuation of the population (isoline: above 5 mr/hr), as well as the monitoring zone (isoline: 3-5 mr/hr) involving temporary resettlement of a portion of the population (children and pregnant women); see Figure 14. The total contaminated area within the .2 mr/hr isoline was approximately 200,000 km² in the initial days.

The total area of regions with a cesium-137 contamination level about 15 Ci/km³ or above is approximately 10,000 km². A total of approximately 640 populated areas with a population exceeding 230,000 was located throughout this zone (excluding the resettlement zone). Elevated radiation levels were sustained in this area and rigid geophysical and medical moni-

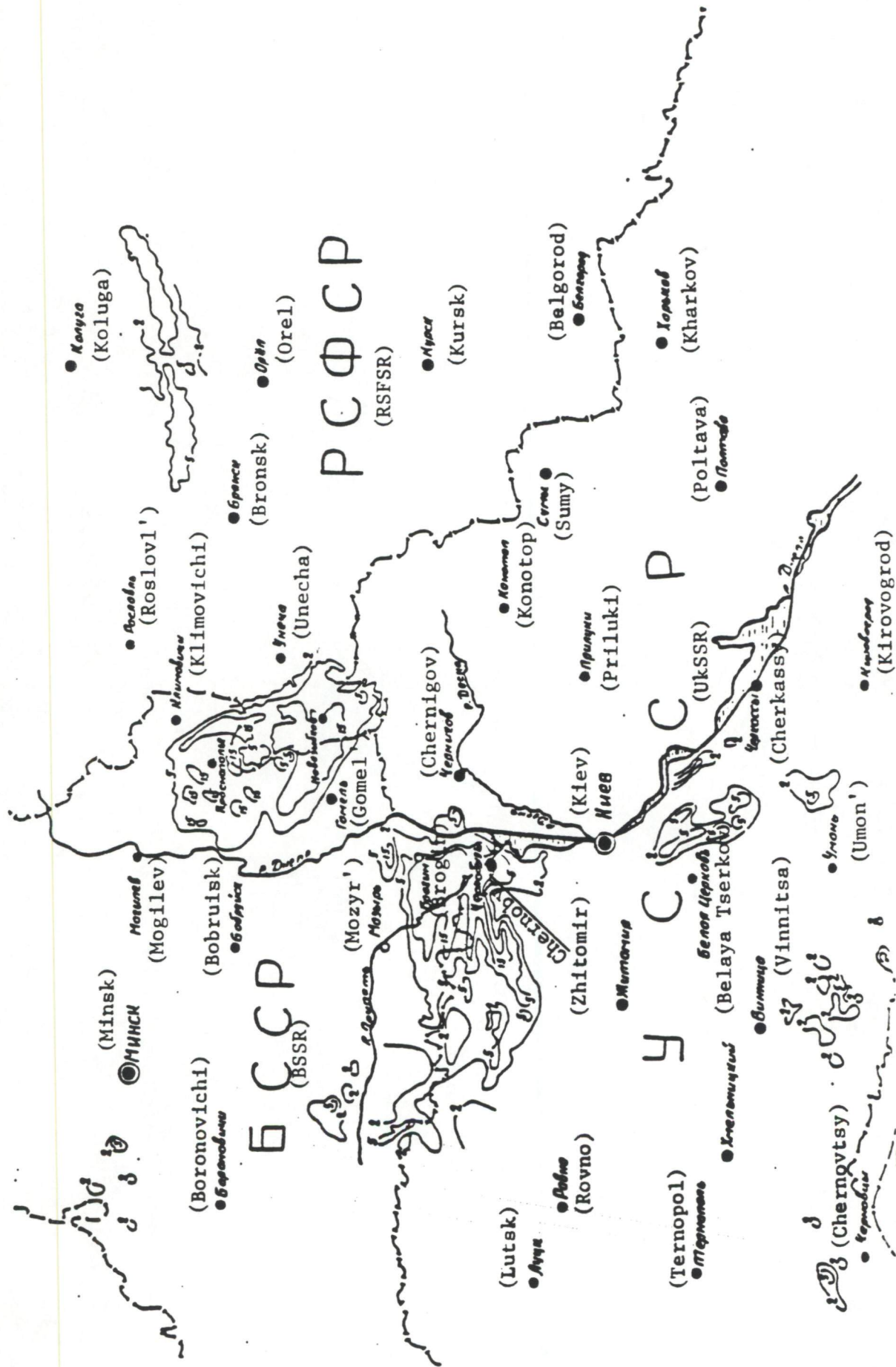
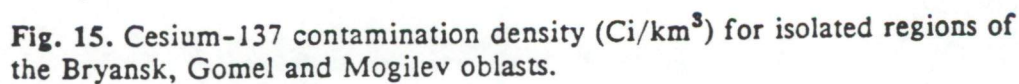


Fig. 13. Cesium-137 contamination density, Ci/km² for various regions of the BSSR, RSFSR and UKR.SSR



toring procedures were required including importation of fresh produce, when necessary.

The radiation levels in the vicinity of Slavutich which was constructed for the power engineers of the Chernobyl Nuclear Power Plant are near the ambient level and currently are .015-.03 mr/hr. The forests to the east and west of the city contain "spots" with somewhat elevated radioactive contamination levels (yet with a density within the permissible range): their maximum radiation levels are .08-.16 mr/hr.

No elevated contamination levels of the terrain (3 Ci/km^3 for strontium-90 and $.1 \text{ Ci/km}^3$ for plutonium-239, -240) have been detected within the resettlement zone (a 30 km zone and certain adjacent regions). In the first year 186 populated areas (116,000 residents) were evacuated from the resettlement zone; the breakdown is as follows: Ukr.SSR: 75 populated areas (90,000 residents), BSSR: 107 populated areas (25,000 residents) and RSFSR: 4 populated areas (1000 residents). Fourteen populated areas (12 in the BSSR and 2 in the Ukrainian SSR) are presently under re-evacuation. There are approximately ten additional villages in the southern region of the 30 km zone which can be safely repopulated (Kupovatoe, Gorodishche, Bychki, Zamoshnya, Rassokha, Raz"ezzhee, etc.).

Radioactive deposition has been detected in many western regions of the European section. Iodine-131 deposition or air pollution has been detected through May of 1986 in the Ukraine: Vinnits, Donetsk, Zaporzh'e, Ivano-Frankovsk, Kerch, Kiev, Krivoy Rog, L'vov, Poltava, and Rovno; in Byelorussia: Brest, Grodno, Minsk, and Mogilev; and in the Baltic region: Vil'nyus, Kaliningrad, Klaypeda, and Riga. In most cases the contamination was a short-term process related to the pollution levels of traveling air masses and posed no danger to the population.

Detectable radioactive particle deposition in rain reached western nations as well: Austria, Italy, Norway, Poland, Romania, Finland, Federal Republic of Germany, and Sweden. The highest contamination in this case for cesium-137 was approximately 1 Ci/km^3 .

Aerial reconnaissance of radiation conditions in the European section of the USSR identified, in addition to the primary zone with relatively high radiation levels, the following contamination zones: northeast of the primary zone at the junction of the Mogilev, Gomel, and Bryansk oblasts, south of Orel and Tula (Plavsk); south of the primary zone in the vicinity of Pinsk and Rovno; south and southwest of the primary zone in the vicinity of Belaya Tserkov, Kanev, and Ivano-Frankovsk; and subsequently along the southern coast of the Gulf of Finland, the Kola Peninsula, and in the Caucasus. Some concern regarding the migration of radionuclides has been expressed. Horizontal migration has been negligible with respect to the scale contamination zones: the isolines have remained virtually unchanged.

Overall the wind lift coefficients for radioactive particulates were insignificant, and hence the airborne concentrations of various isotopes (including plutonium) at wind speeds up to 10 m/s remained very nearly uniformly within the permissible levels even in the evacuation zone.

The CNPP accident resulted in deposition of radioactive products in water reservoirs from both the air and runoff from contaminated terrain. Short-term violations of water pollution standards were therefore observed in the Pripyat' River. The sum β -activity of the water in the Kiev water reservoir during the first two months following the accident was $(1-6) \cdot 10^{-9}$ Ci/l and was within the permitted standards (10^{-8} Ci/l).

The concentration of radioactive substance diminished monotonically downrange throughout the entire network of Dnepr water reservoirs; the strontium-90 concentration in the Kremenchug water reservoir was near $5 \cdot 10^{-12}$ Ci/l (May, 1986) which is substantially below the standard (by a factor of near 100).

An assessment of the contamination level of bottom sediments in the Dnepropetrovsk water reservoirs in mid-May, 1986, revealed that the bottom deposits in the Kiev water reservoir in the region adjacent to the mouth of the Pripyat' River were the most severely contaminated. Such contamination diminishes by a factor of tens and hundreds of times in the southern region of the Kiev water reservoir as well as in the Kanev water reservoir.

Rivers throughout the RSFSR and Byelorussia are continuously monitored for radioactive contamination with special attention given to rivers whose contributing watershed areas have "spots" of cesium-137 contamination. The maximum water contamination levels for sum β -activity following the first spring thaw (April 7-12, 1987) were between 1 and $1.5 \cdot 10^{-10}$ Ci/l (within the standard) for the Iput' and Besed' Rivers.

Forecasts issued by specialists at the USSR State Committee on Hydrometeorology (the first such forecast was issued in May of 1986) state that radioactivity levels in rivers and water reservoirs are not expected to exceed the established standards.

Measurement results not only confirmed the primary conclusions of these predictions but also demonstrated that the actual infiltration of radionuclides in the Kiev water reservoir was below the anticipated level. The radioactive concentrations diminished even further during the spring thaw of 1988.

Even lower concentrations of radionuclides were observed in the Black Sea (near the mouth of the Dnepr).

Mathematical models of radionuclide transport and deposition from airborne radioactive particulates resulting from nuclear power plant accidents were developed in order to further understand the overall physical picture behind the development of the radioactive track, to refine the dynamics of variations in the parameters of the radionuclide source, to esti-

mate the quantity of radionuclides transported outside the USSR and to address the issues associated with the Nuclear Accident Early Warning Convention of the International Atomic Energy Commission (ratified by the USSR). Mesoscale, regional, and cross-border transport models encompass spatial scales from tens to several thousands of kilometers.

1.2. Surface Waters

Water resources represent one of the most important and at the same time most vulnerable components of the environment which can change rapidly under the effects of a number of anthropogenic causes. Industrial and agricultural development is accompanied not only by a very high water intake but also by a substantial increase in the volume of wastewater production, while water composition has degraded due to the rapid growth of such industrial areas as the chemical, petrochemical, mining, pulp-paper, etc. industries. Polluted wastewater discharged into bodies of water cause severe damage to the national economy.

River runoff is the primary source of water resources in the country; the average annual runoff in the USSR is $4,740 \text{ km}^3$. The USSR contains a network of rivers ranging from small rivers of 100 km or less in length through large rivers exceeding 2000 km in length. There are 11 major rivers in the USSR that are classified among the largest 34 rivers in the world. These include the Yenesei, Lena, Amur, Ob, Volga, Dnepr, Amu Darya, Syr Darya, Kolyma, Ural, and Olenek. The total watershed area of these rivers is 13.8 million km^2 with a total average annual runoff of 2496 km^3 . On the average 16.5 thousand m^3 of water annually is available per resident with an actual water consumption of approximately $1000 \text{ m}^3/\text{yr}$, i.e., at present the water problem does not lie in a lack of fresh water resources but rather derives from the irregular distribution of such resources throughout the country, as well as quantitative variations in time and water quality. Approximately 16% of the total river runoff in the USSR derives from the southern continental watershed of the nation in the river basins of the Dnest', Dnepr, Don, Kuban, Kura, Terek, Volga, Ural, Amu Darya, Syr Darya, etc., at the same time that approximately 75% of the population and near 70% of industrial and agricultural production are located in this area.

The irregular runoff distribution is also responsible for the varying degree of water resource availability to different regions around the country. If the total specific runoff availability for the USSR is $213,000 \text{ m}^3/\text{yr}\cdot\text{km}^2$, the highest runoff availability is in the Georgian, Tadzhik, and Latvian Republics (877, 667, and 501 thousand $\text{m}^3/\text{yr}\cdot\text{km}^2$, respectively) while the lowest availability is in the Turkmenian SSR (145), the Central-Black Earth region of the RSFSR (125), and in the Kazakh Republic (46).

There is a shortage of water resources in the river basins of a number of major rivers. The resources of the Amu Darya and Syr Darya Rivers are used nearly entirely to satisfy economic requirements, which has resulted in aggradation of the Aral Sea (Lake Aral). Certain difficulties in providing water supplies to a number of cities, industrial and agricultural facilities have arisen in the Dnepr Basin due to the increase in nonrecyclable water consumption. The volume of water intake in the Don and Kuban River Basins represents one-third of the mean long-term runoff volume, which has served to disrupt hydrological conditions and the ecosystems of estuarine waters. The deficit in the water utilization balance in the Ural River Basin is $1.2 \text{ km}^2/\text{yr}$. Some of the industrial-agrarian regions with the poorest water availability conditions include the Sverdlovsk, Chelyabinsk, and Kurgan oblasts in the Tobol River Basin. A severe water resource problem has developed in the Tom', Ishim, and Chulym River Basins in Siberia.

Overall river conditions are undergoing substantial changes today due to the construction of water reservoir networks on rivers throughout the country in the 1950s and 1960s; the total area of such facilities is near 8.5 million hectares, of which 7.5 million hectares are in floodplains.

In 1988 364.9 km^3 of water was used from water bodies, including ocean sources. The breakdown of such water intake is as follows: industry - 111.8; agriculture - 222.9 (including irrigation: 194.5); public utilities - 24.5, and other industries - 5.7. The national economy utilized 286.4 km^3 of fresh water with the breakdown as follows: industrial demand - 99.5 (excluding water used to maintain reservoir pressure or in fisheries management); food services industry - 26.4; regular irrigation - 140; agricultural water supply - 9.6; other requirements - 10.9 km^3 .

A portion of the collected water is lost in transport from the extraction site to the consumption site. The total loss factor in the USSR for 1988 was 50.6 km^3 (in 1987 the figure was 47.8 km^3) with the following breakdown by republic: the Uzbek SSR - 16.9 km^3 ; the RSFSR - 8.8 km^3 ; the Turkmen SSR - 7.4 km^3 ; and the Kazakh SSR - 6.1 km^3 .

Here 27.9 km^3 of water were taken from natural water reservoirs to establish reserves in water tanks (reservoirs) and for redistribution of water runoff.

The largest quantity of water taken from natural sources occurs in the RSFSR (32%), the Uzbek SSR (24%), the Kazakh SSR (11%), and the Ukrainian SSR (9%); see Figure 16.

Agriculture represents the field with the highest water consumption rate as it accounts for 61% of the total water intake; see Figure 17.

The nonrecyclable use of runoff for industrial and, particularly agriculturally, requirements which totaled 182 km^3 for the entire USSR in 1988 is depleting river water.

The industrial fresh water intake would be substantially greater if circulation-recycling systems were not used; the capacity of such systems for 1988 was 274 km³ for the entire country; see Table 7, and Figure 18. The fresh water savings from the use of recirculation-recycling of water supplies in industry amounts to 72%.

Table 7

Fresh water savings from recirculation-recycling water supply systems by ministry*

USSR Ministry	1985		1986		1987		1988	
	volume**	%**	volume	%	volume	%	volume	%
Total	2444423	69	250850	70	2642212	71	274020	72
Including:								
Ministry of Power Engineering and Electrification	114174***	66	109646***	65	121036***	67	104888	65
Ministry of Ferrous Metallurgy	33164	86	33608	87	34462	88	35126	88
Ministry of the Petroleum Pro- cessing and Petrochemical Ind.	17333	91	17455	92	18255	93	18089	93
Union-Republic Ministry of Mineral Fertilizer Production	16590	90	17062	90	17148	90	16831	91
Ministry of Nonferrous Metallurgy	10619	84	10899	86	10998	80	10848	87
Ministry of the Chemical Ind.	9380	82	9825	83	10019	84	10280	84
Ministry of the Lumber and Woodworking Ind.	6492	66	6563	67	6772	68	6898	69
Ministry of the Medical and Microbiological Ind.	2142	80	2894	85	2265	81	2646	84
Ministry of the Coal Ind.	2238	80	2240	81	2252	82	2367	82
Ministry of the Building Materials Ind.	1555	69	1629	71	1719	72	1246	78

* Here and henceforth Ministry titles refer to the titles in force in 1988 (prior to the changes in the USSR legislation "On the USSR Council of Ministers", June 1989).

** Volume of circulation-recycling water utilized (millions of m³); fraction of circulation-recycled water as a percentage of total industrial water consumption volume.

*** Including the individual enterprises of the USSR Ministry for Atomic Energy.

One of the major problems in efficient water management and use is maintaining the desired water quality level at all water sources. However, the majority of rivers flowing through major industrial and populated regions are severely affected by anthropogenic sources due to a substantial influx of pollutants from wastewater. In 1988 152.4 km³ of wastewater, storm water, and water of other origin was discharged into water bodies with the following breakdown by economic division: industrial sources (including thermal power engineering) - 79.4; agriculture - 52.7; public utilities - 19.6; and other industries - 0.7.

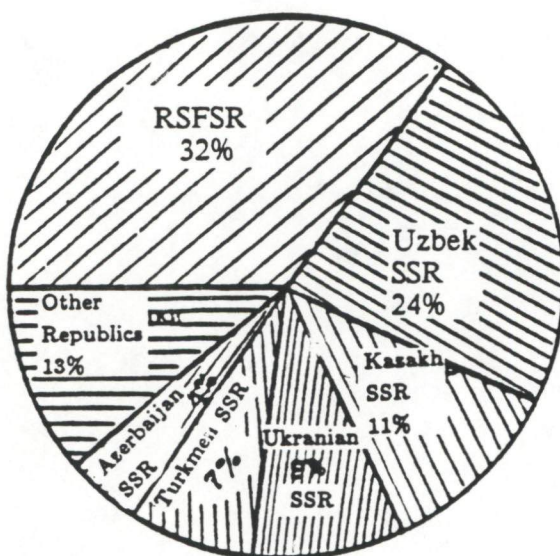


Fig. 16. Water consumption by Union Republic, figures are reported effective 01/01/89.

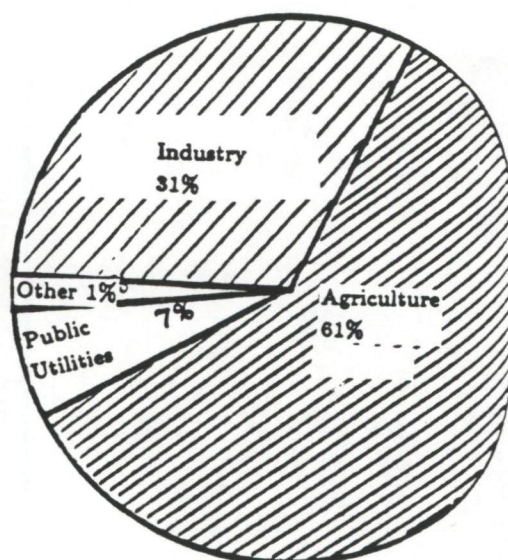


Fig. 17. Water consumption by field, figures reported effective 01/01/89.

The delay in constructing new water storage facilities and updating existing such facilities, given the more stringent wastewater treatment requirements, yielded a polluted wastewater discharge volume of 28 km³ in 1988.

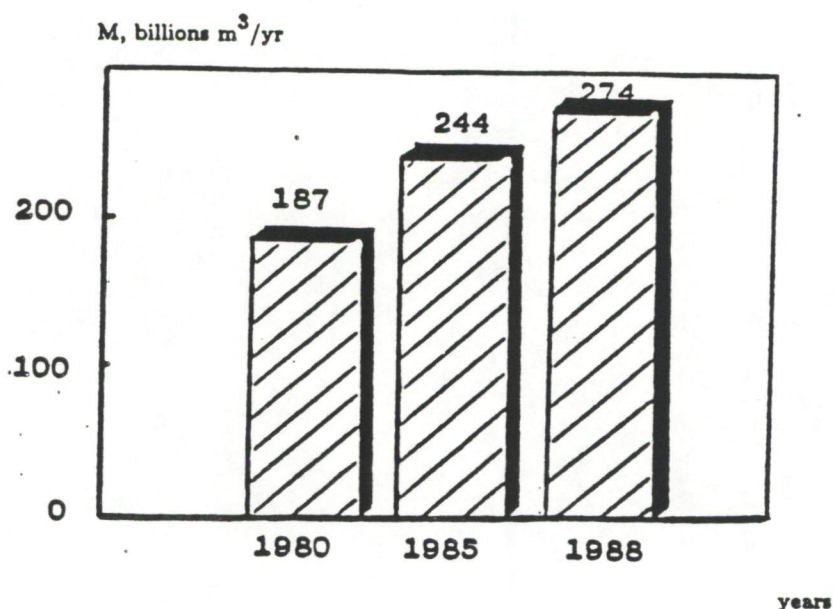


Fig. 18. Circulation-recycling water supply by year.

Surface water pollution levels are monitored on the basis of physical, chemical, and hydrobiological criteria at 2206 water bodies containing 3173 monitoring sites. Up to 106 water quality factors are determined at hydrochemical laboratories, including approximately 40 specific pollutants. Depending on the category of the monitoring site the water sampling process occurs either daily, weekly, monthly, or quarterly at various distances upstream and downstream from the pollution source. The maximum permissible concentrations (MPC) of pollutants for fish ponds and public utilities are used in assessing the degree of surface water pollution (see Table 8).

The most polluted water bodies in the USSR include the Western Bug, Dnestr, Danube, Don, and Sakhalin Island Rivers as well as the rivers and lakes on the Kola Peninsula and the lower Amur. The pollutant concentrations in these rivers exceed the high pollution level (about 10 MPC).

Over the last five years pollution levels have increased in the following river basins for the pollutants and impurities noted: Danube River Basin - ammonia nitrogen, petroleum products, copper and zinc salts; Dnestr River Basin - ammonia and nitrate nitrogen, petroleum products, phenols; Don River Basin - nitrate nitrogen, copper salts, formaldehyde; Irtysh River Basin - petroleum products, iron salts; Volga River Basin - copper salts; Amur River Basin - zinc, nickel, and chromium salts.

Table 8
Surface and sea water pollution assessment criteria for fish ponds

Ingredients and factors	Limiting toxicity factor	Maximum permissible concentrations, mg/l
1	2	3
Dissolved oxygen	General requirements	Winter months: above 4.0; Summer months: above 6.0
Total biochemical oxygen demand (BOD)	General requirements	3.0
NH ammonia salt	Toxicological	0.5 N (NH) = .39
NO ion nitrate	Toxicological/health	40 N (NO) = 9.0
NO ion nitrite	Toxicological	0.08 N (NO) = .02
Oil and petroleum products	Fisheries standard	.05
Phenols	Fisheries standard	.001
SS (synthetic surfactants)	Toxicological	.1
Iron Fe	Organoleptic	.5 (.05)*
Copper Cu	Toxicological	.001 (.005)*
Zinc Zn	Toxicological	.01
Chromium Ch	General requirements	.001 (.05)*
Nickel Ni	Toxicological	.01
Lead Pb	General requirements	.03
Arsenic As	Toxicological	.05 (.005)*
Formaldehyde	General requirements	.05

* MPC for sea water
 BOD biochemical oxygen demand
 SS synthetic surfactants

The petroleum product and copper salt concentrations in the Kuban River Basin exceed the MPC by a factor of 5-7. The phenol and petroleum product concentration in the mid-Volga region is 8-9 MPC while the nitrogen and copper compound impurity level is 3-4 MPC and copper salt pollution levels downstream run to 7-15 MPC.

The pollutant concentrations in the following river basins do not exceed 1-4 MPC: Neman, Lielupe, Western Dvina, Dnega, Northern Dvina, Pechora, Yana, Lena, Indigirka, Kolyma, Amu Darya, and Syr Darya.

The enactment of water conservation measures in 1988 served to reduce pollution levels to some degree in the following river basins: Western Dvina (for all pollutants), Irtysh (phenols, zinc, chromium, and lead salts), Volga (phenols, synthetic surfactants, and nickel salts), as well as the rivers and oceans of the Kola Peninsula (petroleum products, ammonia nitrogen, copper, zinc, nickel salts).

Minor rivers (up to 100 km in length) whose total length amounts to 3.9 million km or 92% of the total length of all rivers in the country are the most prone to the damaging effects of anthropogenic sources. A substantial fraction of surface water runoff in the USSR derives from minor rivers. The minor river runoff in the RSFSR accounts for more than one-third of the total long-term water runoff, while minor river runoff accounts for 60-80% of total runoff in the Central-Black Earth region and in the Northern Caucasus.

A substantial fraction of the municipal and rural population lives in the watershed areas of minor rivers. The extensive utilization of water resources and adjacent lands has resulted in the depletion, aggradation, and pollution of such rivers. The resolution adopted by the USSR Council of Ministers entitled "Enhancement of Small River Conservation to Eliminate Pollution, Aggradation, and Depletion and Assure Rational Use of River Water Resources" charges the ministries and departments whose enterprises are located in such river basins to develop and implement measures to restore river water content and purity.

The institutes under the USSR Ministry of Reclamation and Water Management have developed small river conservation plans for 225 river basins designed to restore normal hydrologic and health conditions.

The following operations were implemented over the period 1985-1987: 151,000 km of boundary lines on water conservation zones were established (4% of the total length); 122,000 hectares within these regions underwent afforestation; 126,000 hectares in coastal water conservation areas were resodded; 54,000 km of small river beds were dredged and cleared (1.5% of the total); approximately 3000 km of coastline was improved and approximately 1000 facilities were transferred outside the water conservation zones.

Future economic utilization of small rivers will involve limiting water extraction from such rivers as well as wastewater discharge and will include a more rational approach to economic development of the river basin to account for its natural features and will eliminate water-rich rivers and river basins with valuable natural resources from possible consideration for economic utilization.

More than 2% of the USSR includes blind drainage regions: the Aral-Caspian region which contains the largest interior lakes of ancient origin: the Caspian and Aral Seas and Lakes Balkhash and Issyk Kul. These

represent the termination points for major river systems: the Volga, Syr Darya, Amu Darya, and Ili River Basins.

The economic assimilation of these basins is causing substantial changes in lake conditions. Lake Aral has suffered severely (see Section 1.9).

1.3. Seas and Oceans

The seas and oceans regulate vital processes, shape the appearance of our planet and maintain its ecological equilibrium.

The USSR coastline is over 50,000 km in length with inland ocean and territorial waters exceeding 1,000,000 km² in area.

If the seas and oceans have traditionally been used in history for transportation, today they function as a source of oil, gas, and rare metals, manganese concretions, etc. The value of the oceans as a source of protein grows each year.

Human activity has also grown each year in the seas and oceans and this, of course, does not occur without having some effect. The rapid growth of population, industry, and agricultural production, the increase in maritime traffic and oil and gas recovery operations in not only the coastal but also the shelf regions are accompanied by a substantial increase in organic and inorganic manufacturing waste and consumption goods with ocean and sea pollution resulting from the dumping and discharge of such wastes.

A total of 1.12 km³ of polluted wastewater was discharged into the seas by the USSR in 1988. A substantial number of pollutants were from river runoff.

The inland seas and territorial waters in the USSR contain approximately 200 maritime trade and fishing ports and port facilities with an annual cargo turnover of over 500 million tons and there are over 15,000 existing offshore oil and gas wells. Over 15,000 cargo ships and other craft are registered to the sea ports and port facilities. There are over 300,000 port calls at the ports and port facilities of the USSR every year with over 12,000 foreign ship calls at the 47 open ports.

The present section will provide a brief description of the pollution levels of the Caspian and Baltic Seas, the Beloye More [White Sea], the Barents Sea, as well as the Arctic and Far Eastern Seas. Information on the Sea of Azov and the Black Sea is provided in Section 1.9: *Regional Economic Problems*.

Caspian Sea. The Caspian Sea water quality is affected by river runoff, industrial and utilities wastewater discharge, offshore oil drilling and operations, as well as oil shipping.

The average annual concentration of petroleum products and phenols in 1988 in the northern Caspian region and in the Dagestan and far eastern

coastal areas were 2-3 and 4-6 MPC, respectively. The high petroleum and phenol pollution level (4-12 and 5-16 MPC) continues along the Azerbaijan [Azerbaidzhan] coastline.

The "Orgsintez" [organic chemistry facility] and the "Khimprom" [chemical industrial facility] production unions located in Sumgait are among the primary polluting enterprises on the Caspian Sea.

Baltic Sea. In recent years the level of petroleum product contamination of the open regions of the sea has risen to 2 MPC. Hydrogen sulfide exists in the water column below a density gradient (at a depth exceeding 80 m). The extent of chemical pollution to the coastal areas has stabilized sufficiently in recent years. The most severely polluted regions for both chemical agents and oxygen conditions include the Neva Inlet [Nevskaya Guba] (manganese, copper, and organochlorine pesticides), the port aquatories (OCP, phenols, metal particulates, and oxygen deficiency), the estuaries of the Lielupe and Pergol Rivers (phenols, oxygen deficiency) and Kurskiy Zaliv [Kursk Bay] (phenols). The primary sources of pollution in the Baltic Sea include public utilities (Leningrad, Riga, Ventspils, etc.) as well as pulp manufacturing plants.

The waters of the Baltic Sea extend along the coastline of seven European nations and in 1974 these nations signed a Convention to Protect the Marine Environment. A range of water conservation measures aimed at reducing pollutant discharge in the Baltic Basin has been developed in accordance with this Convention. The Soviet Union is presently beginning to implement a program that envisages a 50% reduction in all pollutant discharge by the year 1995.

Belove More [White Sea]. Sea contamination by petroleum products ranged from 1.5 to 2.0 MPC with mean synthetic surfactant levels throughout the sea below the maximum permissible concentration.

The waters of Onega and Dvina Bays [Gulf of Archangel] are the most heavily polluted.

The primary pollution source is river runoff and the majority of pollutants originate from the enterprises of the Ministry of the Lumber and Woodworking Industries, the RSFSR State Agroindustrial Committee, the USSR Ministry of the Medical and Microbiological Industries, as well as other ministries.

Barents Sea. The open sea pollution level in the Pechenga and Teriber Inlets as well as Motov Bay have diminished. The petroleum product concentration has risen to some degree (to 1 MPC) as has the phenol concentration (up to 7 MPC) in Kola Bay and in Pecher Inlet [Pecherskaya Guba].

The highest pollution level attributable to petroleum products is near the "shelf-4" offshore oil platform and the Murmansk port as well as Severomorsk and Polyarny.

The primary pollution sources are the facilities and fleet of the "Sevryba" [Northern Fisheries] production association of the USSR, Ministry of Fisheries, the Fleet of the Murmansk Maritime Shipping Agency as well as enterprises involved in oil and gas recovery.

Arctic Seas. The primary pollutants in the Kara, Laptev, Eastern Siberian, and Chukotsk Seas include oil, petroleum products, phenols, and heavy metal particulates; the sources of such pollutants include oil and gas field operation and exploration/prospecting enterprises, the maritime and inland water fleets, fuel oil and lubricant manufacturing facilities, cities and villages along the Arctic coastline, floating wood, Arctic ice, etc.

Overall the pollution level in these seas, including both the open seas and the coastal regions, is below the maximum permissible concentration.

Far Eastern Seas.

Pacific Coastline (Kamchatka Penninsulas). The average annual concentration of petroleum products in Avachin Bay is 4-6 MPC while the phenol and synthetic surfactant levels are at the MPC levels. However, the lack of sufficient water exchange combined with a stable water pollution level has reduced the oxygen concentration in the bay during the summer months. Approximately the same petroleum product and synthetic surfactant levels have been detected in Kamchatka Bay. The primary petroleum pollution sources include runoff waters from industrial facilities, ships and oil spills while phenols and synthetic surfactants derive from river runoff.

Sea of Okhotsk. The pollution level from petroleum products along coastal regions in the northern section of the sea is 6 MPC with the open sea regions registering 2 MPC. The phenol pollution level averages below the MPC with satisfactory oxygen conditions. The most extensively polluted regions continue to be the coastal regions near Korsakov and Poronaysk and the village of Starodubovskiy. The primary sources of pollution in the southwestern region of the sea are the enterprises of the USSR Ministry of the Lumber and Woodworking Industries, the RSFSR Ministry of Public Housing, sea ports, and oil and gas production facilities and ships, while in the northern Sea of Okhotsk the primary pollution sources include the facilities of the USSR Ministry of Nonferrous Metallurgy, the USSR Ministry of Fisheries, as well as the fleet of this ministry and other departments.

Sea of Japan. The open sea has insignificant pollution levels while the contamination level of coastal regions has remained unchanged for many years for all primary pollutants (petroleum products, phenols, ammonia nitrogen) and lies between 1 and 3 MPC.

The primary pollution sources in Peter the Great Bay include the cities of Vladivostok and Nakhodka as well as the Artemovka, Partizanskaya, and Razdol'naya Rivers; the northern regions of the sea are polluted by municipal runoff as well as industrial discharges and pollutants from agricultural facilities on Sakhalin.

The unfortunate condition of USSR seas and oceans must be redressed to the greatest possible extent with an eventual complete elimination of pollutant discharge into seas and oceans from all sources. Several resolutions have been adopted by the supervisory government organizations for such purposes; these resolutions specify a range of water conservation measures for implementation at many enterprises throughout out country.

1.4. Primary Pollution Sources and Volumes

The effect of economic activity on the environment today is largely determined by the substantial volume of atmospheric emissions, water consumption, and wastewater pollutant discharge. Measures that have been implemented to reduce discharge levels have yielded limited positive results and the specific outlay of raw materials and energy resources per unit of output for most products has been reduced. However, the total volume of pollutant emission remains rather high; see Figure 19. According to data provided by the USSR State Committee on Statistics for 1988 approximately 62 million tons of pollutants were emitted into the atmosphere from stationary sources. The "contribution" of the principal air pollution source-industries in the national economy is distributed as shown in Table 9.

Emissions of solid matter, sulfur dioxide, carbon monoxide, the oxides of nitrogen, and hydrocarbons (the "primary pollutants") account for near 98% of total emissions, see Figure 20. As demonstrated by atmospheric tests emissions of such substances in most industrial cities produce an elevated ambient pollution level against which any specific pollutants can clearly be detected. In 1988 99.2 thousand tons of hydrogen sulfide, 27 thousand tons of carbon disulfide, 25.9 thousand tons of fluorides, 7.9 thousand tons of lead, and 5.2 thousand tons of chlorine were released into the air. The atmosphere is also polluted by ammonia, acetone, phenol, xylene, toluene, benzene, and many saturated and unsaturated hydrocarbons.

The elevated atmospheric pollution level in major cities from such pollutants as carbon monoxide, the oxides of nitrogen and hydrocarbons is largely the result of vehicle and motor transportation which accounts for 36 million tons or 47% of total pollutant emissions, including the following breakdown by component: oxides of nitrogen - approximately 22%; hydrocarbons - approximately 44%; carbon monoxide - approximately 60%. The highest absolute volume of vehicular emissions has been recorded in Moscow (over 840 thousand tons per year), Leningrad (approximately 370 thousand tons per year), Tashkent (310 thousand tons per year), Kharkov, Alma-Ata, Tbilisi, and Baku (between 150 and 300 thousand tons per year).

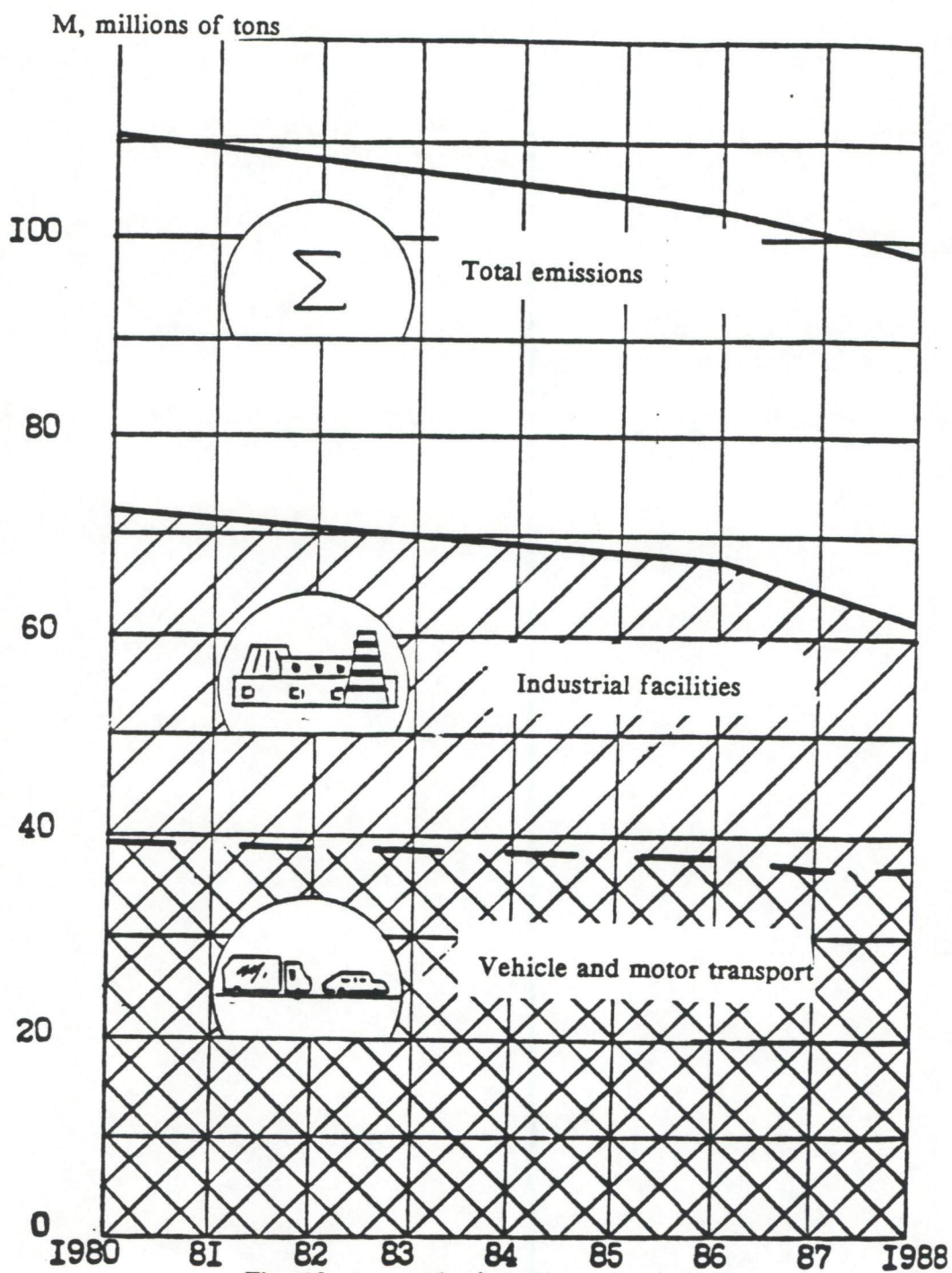


Table 9
Atmospheric pollutant emissions for individual ministries
from stationary sources (in thousands of tons)

USSR Ministries	1985	1987	1988
1	2	3	4
Total	66514	64295	61716
Including:			
Ministry of Power Engineering and Electrification	17389	16534	15354
Ministry of Ferrous Metallurgy	11214	10871	10389
Ministry of Nonferrous Metallurgy	6413	6104	5935
Ministry of the Petroleum Processing and Petrochemical Industries	4259	3968	3704
Ministry of the Building Materials Industry	4080	2249	2036
Ministry of the Coal Industry	1559	1486	1401
Ministry of the Lumber and Woodworking Industries	1521	1471	1361
Ministry of the Chemical Industry	919	917	857
Union-Republic Ministry of Mineral Fertiliser Production	752	714	632
Ministry of the Medical and Microbiological Industries	158	165	156

In excess of 30 million tons of pollutants were discharged into the water bodies and reservoirs of the country in 1988; such pollutants included 15 million tons of chlorides, 11 million tons of sulfates, 1752 thousand tons of organic matter, and 2090 tons of suspended matter, 23.5 thousand tons of synthetic surfactants, 57.5 thousand tons of petroleum products, 82 tons of pesticides, etc. The dynamics of wastewater pollution discharge into surface water bodies is shown in Table 10.

The following data characterize in greater detail the individual areas of the national economy as sources of environmental pollution.

USSR Ministry of Power Engineering and Electrification. Power engineering enterprises represent one of the major sources of air pollution. They account for 25% of all emissions from stationary sources. Sulfur and nitrogen oxides represent more than 65% of such emissions (approximately 43% and 59% of total emissions of these substances throughout the country).

M, millions of tons/yr.

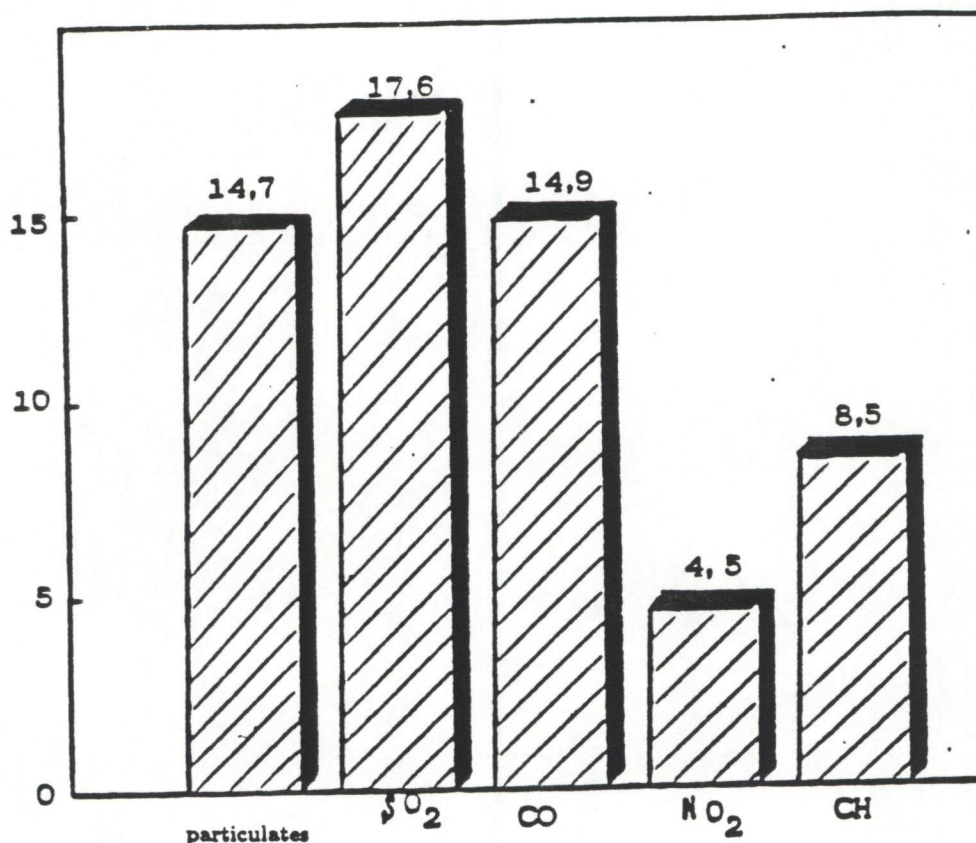


Fig. 20. Industrial airborne pollutant emissions (1988).

The enterprises of the USSR Ministry of Power Engineering and Electrification have not used ash residues to a sufficient extent; the output of such residues from thermoelectric power plants totalled approximately 110 million tons for 1988. Only 13% of this volume obtained primarily from the combustion of Baltic shale was used. Ash tailings from the combustion of Ekibastuz, Kansk-Anchinsk and Kuznetsk coals were virtually unused. The ash tailings were transported to dumps by means of waterways, resulting in secondary soil and water pollution. 32.5 thousand hectares of land have been lost to the tailings dumps of the USSR Ministry of Power Engineering and Electrification and only 15.6 thousand hectares have been re-cultivated.

Table 10
Wastewater pollutant discharge into surface water bodies for
individual USSR Ministries

Ministry	1985			1887			1988		
	Total	Including un- treat	under- treat	Total	Including un- treat	under- treated	Total	Including un- treat	under treat
	2	3	4	5	6	7	8	9	10
Total	15896	68850	9046	20620	6677	13943	28434	8062	20370
Including:									
Ministry of Lumber and Woodworking Industries	2520	481	2039	2694	463	2231	2718	402	2316
Ministry of Ferrous Metallurgy	1044	94	950	1080	203	877	1324	304	
Ministry of Petroleum Process- ing and Petrochemical Ind.	455	37	419	552	35	517	1251	198	
Union-Republic Ministry of Mineral Fertiliser Prod.	671	135	536	961	250	711	1104	333	
Ministry of Power Engineering and Electrification	264*	95*	169*	314*	110*	204*	1097	754	
Ministry of Chemical Ind.	462	227	234	512	223	289	959	261	
Ministry of Nonferrous Metal.	646	275	371	490	220	270	629	238	
Ministry of the Coal Ind.	336	173	163	444	183	261	574	145	
Ministry of Medical and Microbiological Industries	173	30	143	178	26	152	185	38	
Ministry of Building Materials Industry	64	20	44	85	20	65	56	14	
Councils of Ministers:									
RSFSR	5187	3337	1850	6974	1422	5552	12357	3393	
Ukrainian SSR	559	162	397	494	116	378	1301	115	
Lithuanian SSR	293	198	105	257	106	151	312	123	
Azerbaijan SSR	305	251	54	317	264	53	288	238	
Latvian SSR	216	114	102	226	113	113	252	113	
Byelorussian SSR	70	0.3	69.7	55	-	55	48	-	

* Including the individual enterprises of the USSR Ministry for Atomic Energy

Health regulations are not observed during the construction of water reservoirs or hydroelectric power stations, while floodplain areas are not properly reinforced. Approximately 3.6 million m³ of pulp wood has accumulated in the Bratsk, Krasnoyarsk, and Ust'-Ilimsk reservoirs alone, resulting in average phenol concentrations in these waters of 5-10 MPC in recent years.

Extensive eutrophication has occurred in the water reservoir network of the Black Sea basin. The rising groundwaters in flat terrain conditions has flooded woodlands, produced swamps, and damaged occasionally productive meadows.

The majority of the floodplain area contains lowland reservoirs. Reservoir retention of floodwaters and maximum drawdown of such reservoirs without taking into account the natural cycles will disrupt the biological processes in the downstream waters. In the final analysis these processes will result in a loss of soil fertility and will cause desiccation in the river floodplains, while the destination water bodies will dry up and disrupt fish spawning and life support conditions. Fishing is largely supported by artificial breeding and valuable fish species are vanishing from the fishing industry.

The USSR Ministry of the Petroleum Processing and Petrochemical Industries. The increasingly severe ecological situation is further exacerbated in no small measure by emissions and discharges from petroleum processing and petrochemical facilities. Their total contribution to nationwide emission levels is as follows: hydrocarbons and ammonia - near 30%; hydrogen sulfide and phenol - up to 15%.

The enterprises under the control of this Ministry discharged 1,251 million cubic meters of wastewater pollution in 1988. These enterprises have had an especially significant effect on the increasingly severe ecological conditions in the Caspian Sea basin. The Ministry has not implemented the resolution adopted by the CPSU Central Committee and the USSR Council of Ministers entitled *Measures to Eliminate Volga and Ural River Contamination from Untreated Discharge*.

The issue of waste utilization from petroleum processing and petrochemical enterprises has not yet been properly resolved. Acid goudrons represent a serious environmental threat; their volume amounts to 200,000 tons annually with an excess of a million tons accumulated to date. This problem especially applies to the enterprises in Gorkiy and Yaroslavl'.

The problem of eliminating sludge-ponds has not yet been solved and biological treatment plants at the Volgograd petroleum processing plant have not yet been constructed.

The plan to put waste gas recovery and treatment facilities on-line for petroleum processing and petrochemical enterprises in 1988 has been only 55% implemented.

USSR Ministry of the Gas Industry. The industry had an 89% implementation rate on the treatment plant construction plan in 1988. A total treatment plant capacity of 105,000 m³/day was put on line over a three year period (1986-1988).

The enterprises of the USSR Ministry of the Gas Industry have the lowest waste gas recovery level (3%) of all USSR ministries and departments. Elevated atmospheric pollution levels have been recorded in natural gas recovery, storage, and pipeline regions due to gas leakage, well purging, or disruption of gas drive conditions.

The total volume of atmospheric pollutant discharge for 1988 by the enterprises under the USSR Ministry of the Gas Industry was 2.8 million tons, including 1.4 million tons of hydrocarbons or 16% of the total nationwide emission level.

The USSR Ministry of the Gas Industry expended 1.6% of the maximum capital investment budget on conservation and rational use of natural resources. 17% of capital expenditures for conservation measures were directed at air conservation while 28% of capital expenditures were targeted for water resources. Only 78% of the budget was used for environmental protection in 1988.

USSR Ministry of the Coal Industry. In addition to industrial wastewater the enterprises of this Ministry discharge into water reservoirs 162,000 tons of suspended matter, 823,000 tons of sulfates, 472,000 tons of chloride compounds, 34,000 tons of iron compounds, 300 tons of petroleum products, etc.

In the Eleventh Five Year Plan the USSR Ministry of the Coal Industry implemented a total purification plant capacity of 970,000 m³/day or 80% of the level established by the Five Year Plan. An 80% completion rate has also been achieved after three years in the present Five Year Plan (a total treatment plant capacity level of 559,000 m³/day has been established for the Five Year Plan while a capacity of 456,000 m³/day has been implemented to date).

The enterprises of the USSR Ministry of the Coal Industry produce 5.3 million tons of pollutants with a recovery rate of 3.9 million tons or 73.6% (with a national average of 77.2%). 1.4 million tons of pollutants were released into the air in 1988 with 1.0 million tons of such pollutants in gaseous form (sulfur dioxide, carbon monoxide, nitrogen dioxide, hydrogen sulfide, hydrocarbons, etc.).

The USSR Ministry of the Coal Industry has not systematically implemented plans to incorporate waste gas pollutant recovery capacity. A 74% completion rate was achieved on the plan in 1986 while an 85% level was achieved in 1987; no plants were put on-line in 1988, although they were stipulated by the plan.

Overall the USSR Ministry of the Coal Industry budgets 1% of capital investment on natural resource conservation and rational use, although 72% of this capital budget has been utilized. 68% of the capital investment budget was utilized in the previous Five Year Plan.

Mineral losses remain significant in the excavation, processing, and transport processes. In the Ukrainian SSR alone approximately 13.8% of the total volume of excavated bituminous coal is irretrievably lost in underground mining operations. Backfilling mining accounts for less than 1% of the total excavation volume.

Mining wastes remain severely underutilized. Approximately 30 million tons of coal enrichment waste is generated at the enterprises of the USSR Ministry of the Coal Industry in the Ukrainian USSR, and a little in excess of 4.9 million tons or 14% is utilized.

USSR Ministry of Ferrous Metallurgy. Ferrous metallurgical enterprises account for approximately 17% of all atmospheric pollutant emissions and 4.7% of pollutant discharges into water reservoirs.

The enterprises under this Ministry have created severe ecological conditions in the following cities: Krivoy Rog, Magnitogorsk, Mariupol', Lower Tagil, Novokuznetsk, as well as other cities.

Wastewater treatment plants in this industry are highly inefficient and groundwater pollution by phenols, cyanides, and other matter has been observed in the regions containing these enterprises.

93% of the state capital investment budget for natural resource conservation measures was used in 1988 while 90% of planned wastewater treatment capacity and 90% of waste gas treatment capacity were implemented in this same year.

In this industry a substantial percentage of the physical plant equipment is obsolete and in a poor state of repair while the construction of circulation recycling water systems is proceeding at a slow pace: only 30% of the planned volume was put on-line in 1988.

Approximately 3 million tons of toxic industrial waste material is produced annually at these facilities with only 34% recovered and detoxified.

USSR Ministry of Nonferrous Metallurgy. The enterprises under this Ministry are among the major sources of air pollution. Pollutant emissions were reduced in 1988 by 169,000 tons or 3% compared to 1987 for the overall industry. Sulfur dioxide represents the major pollutant at nonferrous metallurgical facilities (>75% of total emissions). The level of waste gas pollutant recovery in the industry is 97.7% for solids and 42.8% for chemical and gaseous agents. In spite of the fact that the sulfur extraction level from waste gases at metallurgical facilities was 44.2% in 1988, approximately 25% of all sulfur dioxide emissions for the entire country derive from the enterprises of the Ministry of Nonferrous Metallurgy.

This industry has neglected air conservation issues: only 62% of stationary pollution sources are equipped with dust and gas treatment plants and up to 30% of such facilities are low-efficiency plants.

The primary direction of gas desulfurization for recycling of sulfur dioxide in this industry involves production of sulfuric acid and elementary sulfur. Due to the poor physical plant facilities at a number of enterprises involved in processing sulfide raw materials, the degree of gas desulfurization copper smelteries is 55% while the same level at zinc smelteries is 94%.

A lack of industrial manufacturing discipline resulted in elevated gas loads in 1988 near the Alaverdi integrated mining and metallurgical works whose emissions rose by 24% compared to 1987. It was decided that the metallurgical conversion facility at the works should be closed effective January 1, 1990 for public health reasons.

This industry utilized 96% of its capital investment budget for environmental protection. The wastewater treatment capacity plan had an 83% implementation rate while the waste gas treatment plan had an 84% implementation rate.

Measures to regulate pollutant emissions in severe weather conditions have not been properly implemented throughout the enterprises of this industry.

USSR Ministry of the Building Materials Industry. The enterprises of this industry released approximately 2 million tons of pollutants into the air in 1988, including 1.3 million tons of solid particulates and .8 million tons of gaseous and liquid agents. The waste pollutant recovery and detoxification level for the entire ministry is 92.6%, including 95.3% for solid particulates and 16.8% for gaseous agents. These figures represent an improvement compared to 1987 when the recovery and detoxification level was 92.8% for solid particulates and 13.7% for gaseous and liquid agents.

The enterprises of the cement industry represent the major contributor to atmospheric pollutants in this field (85%).

Wastewater discharge which includes nitrogen and phosphor compounds as well as lubricants, oils, nitrates, and other matter totalled 56 million m³ in 1988 versus 84.8 million m³ in 1987.

In 1988 71% of the state capital investment budget for environmental protection and rational use of natural resources was utilized, while no more than 50% of the planned wastewater and waste gas treatment capacities were implemented.

USSR Ministry of the Petroleum Industry. The enterprises of the USSR Ministry of the Petroleum Industry account for 9% of all pollutant emissions. Solid particulate account for 4.2% of the total atmospheric pollutant emissions in this field while gaseous and liquid agent pollutants account for 95.8%. The majority of such pollutants are discharged by the Glav-

tyumenneftgas [Main Tumen Oil and Gas Enterprise] (48.8%) and Glavtransneft' [Main Oil Transport Enterprise] (14.4%).

This industry has a very low level of waste gas recovery and detoxification (40.1% for solid particulates and 4.2% for liquid and gaseous agents).

The concentration of petroleum products in the Ufa River reached 260 MPC in March of 1988 as a result of a rupture in the Shaim-Volgograd oil pipeline in the Ufa region.

The area of sea pollution resulting from leakage during recovery is 240 km² in the Neftyanie Kamni [Oil Shale] region of the Caspian.

In spite of the fact that 119% of the Ministry's capital investment budget was expended, only 65% of the planned water treatment capacity was implemented.

USSR Union-Republic Ministry of Mineral Fertilizer Production. Pollutant atmospheric emissions from the enterprises under this Ministry totalled 631.9 thousand tons in 1988 including 144.8 thousand tons of solid particulates and 487.1 thousand tons of gaseous agents. The industry-wide recovery and detoxification level for solids is 97.9% and for gaseous agents is 78.4%.

Extremely high air pollution levels have been recorded annually in the city of Volzhskiy as a result of activities of the enterprises under this Ministry due to the lack of effective treatment plants and irregular operating conditions.

The enterprises of this industry contribute substantial pollution to the Debed (Armenian SSR) and Chapaevka (Kuibyshev oblast') Rivers.

In 1988 86% of the state capital investment budget on wastewater treatment was utilized while 74.3% of planned wastewater treatment capacity and 52% of planned waste gas treatment capacity were implemented.

Domestic Solid Waste (DSW). Between 115 and 117 million m³ of domestic solid waste (DSW) is generated in cities and municipal villages in the RSFSR. Based on the mean annual increase in DSW volume by the year 2005 this volume will grow to 180 million m³/yr.

Domestic solid waste creates epidemic health problems, disrupts the aesthetic appeal of cities and other populated regions as well as adjacent areas, and has a negative effect on the environment.

Moreover, solid waste also contains valuable components that could be used as secondary resources; see table 11.

During DSW collection from residences, all food refuse is separated out into a separate container and used for cattle feeding. Approximately 2 million tons of food refuse was collected in 1988, representing a substantial fraction of its total content in domestic solid waste.

The primary trends in efforts to improve domestic solid waste collection have been determined based on current domestic and foreign experi-

ence. Areas for improvement include increasing the level of labor mechanization by introducing new types of refuse collection vehicles, using large-capacity removable containers, introducing centralized vacuum systems in new housing areas, and establishing a separate domestic solid waste collection facility in individual cities which have secondary raw material processing capability; metal, glass, paper, etc. will be separated out at such a facility.

Table 11
Domestic solid waste composition (for the RFSFR)

Components	Percentage of total waste volume
1	2
Paper, cardboard and paperboard	20-36
Food refuse	20-38
Wood	1-4
Textiles	3-5
Leather, rubber	1.5-2.5
Bones	1-2
Polymer materials	3-5
Ferrous and nonferrous metals	2-3
Glass	5-7
Gems, ceramics	1-3
Coal, slag	0-2.5
Screenings below 16 mm in size	8-28

Note: A higher ferrous metal and glass waste level has been identified in Siberia and the Far East, while a higher volume of food refuse is characteristic of the southern regions, particularly in the fall.

Domestic solid waste is largely handled by KO-413 garbage collection trucks today. A drawback of these vehicles is low capacity (14 m³). Refuse transport becomes an expensive operation when treatment facilities (disposal sites and facilities) are located at a significant distance.

A large-capacity garbage collection truck using a KAMAZ chassis (40 m³) is also used, although its larger size eliminates the maneuverability needed in domestic collection and therefore has limited application.

A two-stage domestic solid waste collection system has been implemented in a number of cities in the RFSFR (Perm, Komsomlsk, Krasnodar, Dzerzhinsk, etc.) whereby refuse is transferred from garbage collection trucks into large-capacity vehicles.

The "Transprogress" production union in Leningrad has designed an experimental industrial pipeline pneumatic container transport system for domestic refuse to handle 500,000 m³ annually, although the system was not feasible due to engineering and technological complexities.

Table 12
Percentage distribution of various domestic
solid waste treatment and processing methods

Country	Domestic solid waste vol. mil.t/yr	% of total DSW accumulation			
		Disposal at refuse sites	Combustion	Composting	Other methods
1	2	3	4	5	6
RSFSR	27.0	97.0	2.3	.7	-
Austria	1.6	58.0	22.0	18.0	2.0
Belgium	2.4	44.0	47.0	9.0	-
Great Britain	16.5	88.5	10.0	1.4	0.1
Hungary	2.1	92.0	8.0	-	-
German Democ. Rep.	4.5	96.5	3.3	0.2	-
Denmark	1.9	17.5	80.0	0.5	2.0
Italy	15.0	67.0	18.0	10.0	5.0
Canada	6.0	80.0	19.0	1.0	-
Netherlands	7.0	44.0	40.0	15.0	1.0
USA	235.0	85.0	14.0	0.1	0.9
France	16.0	46.4	41.0	12.0	0.9
Federal Rep. Germany	28.0	61.0	34.0	5.0	-
Czechoslovakia	2.4	89.5	8.0	2.5	-
Switzerland	1.3	4.0	80.0	10.0	6.0
Sweden	2.5	34.0	56.0	9.9	0.1
Japan	32.0	27.0	70.0	0.3	2.7

Generally domestic solid waste is decontaminated by dumping at refuse sites with multilayered underground burial or burial by other inert materials. Operational and health standards are not satisfied due to the lack of proper equipment (bulldozers, excavators, scrapers, dump trucks, and compactors), which produces environmental pollution.

Ninety seven percent of domestic solid refuse is dumped at refuse sites in the RSFSR today while 2.3% is burned and approximately 0.7% is composted; see Table 12.

On the average approximately 70% of solid waste is decontaminated by employing refuse sites in other countries while this figure exceeds 85% in the US, Canada, Czechoslovakia, and Great Britain.

Industrial solid waste decontamination and recycling methods are becoming increasingly popular in the RSFSR. A total of approximately 3% of solid waste is processed by industrial methods in the RSFSR; such waste products are produced by factories in Moscow, Vladivostok, Vladimir, Sochi, Pyatigorsk, Murmansk, Leningrad, and Gorkiy. Similar facilities are under design and construction in a number of other cities (Omsk, Saratov, etc.). Industrial solid waste treatment processes are under improvement; these include composting by incorporating waste-free technology, pyrolysis in an experimental industrial treatment plant at the Leningrad refuse treatment facility; combustion to enhance waste treatment and processes involving the use of slag, ash, and exhaust heat.

1.5. Land Resources

The USSR state land resources total 2231.1 million hectares; a breakdown of land resources by category is shown in Figure 21.

The majority of territory is occupied by tundra, tundra-forest, taiga, mountains, deserts, and semi-arid lands.

The total cultivated land area as of November 1, 1988 was 604.9 million hectares with the following distribution (in millions of hectares): pastures - 333.3; arable lands - 227.7; hay fields - 38.5; permanently cultivated lands - 4.8; idle lands - 0.6; see Figures 22, 23. Moreover, deer and reindeer occupy an additional 308.8 million hectares.

Approximately 91% of cultivated land area is currently under use by state farms, collective farms, and other agricultural enterprises, while the remaining cultivated land area is used for farmsteads, gardens, and private plots of laborers, professional workers and other citizens as well as agricultural produce areas within cities and both forestry and industrial enterprises.

The current state of land resources is a cause for alarm. There has been a uniform reduction in natural soil fertility levels throughout the country as well as erosion-induced soil damage and degradation resulting from

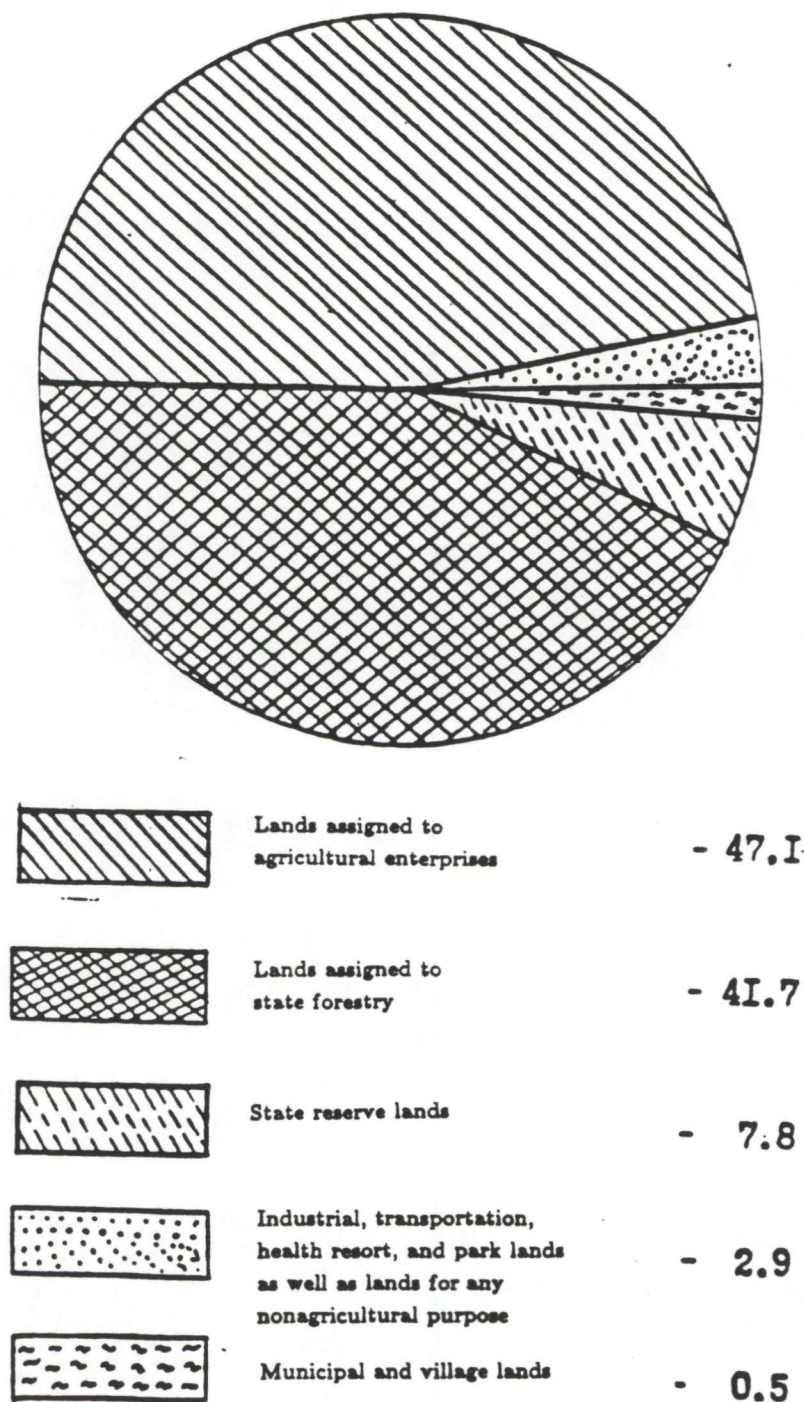
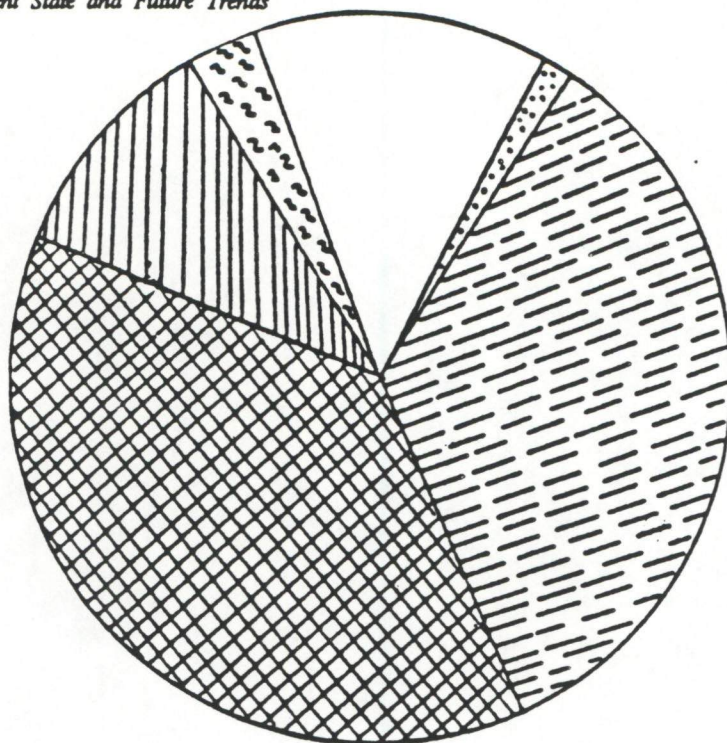


Fig. 21. Distribution of state lands by category, %.



Cultivated lands:
Breakdown as follows:

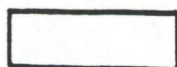
27.1%



Arable lands 10.2



Hay fields 1.7



Pastures 14.9



Other cultivated lands - 0.3



Woodlands -33.1



Other lands 39.8

Fig. 22. Distribution of state lands by type, %.

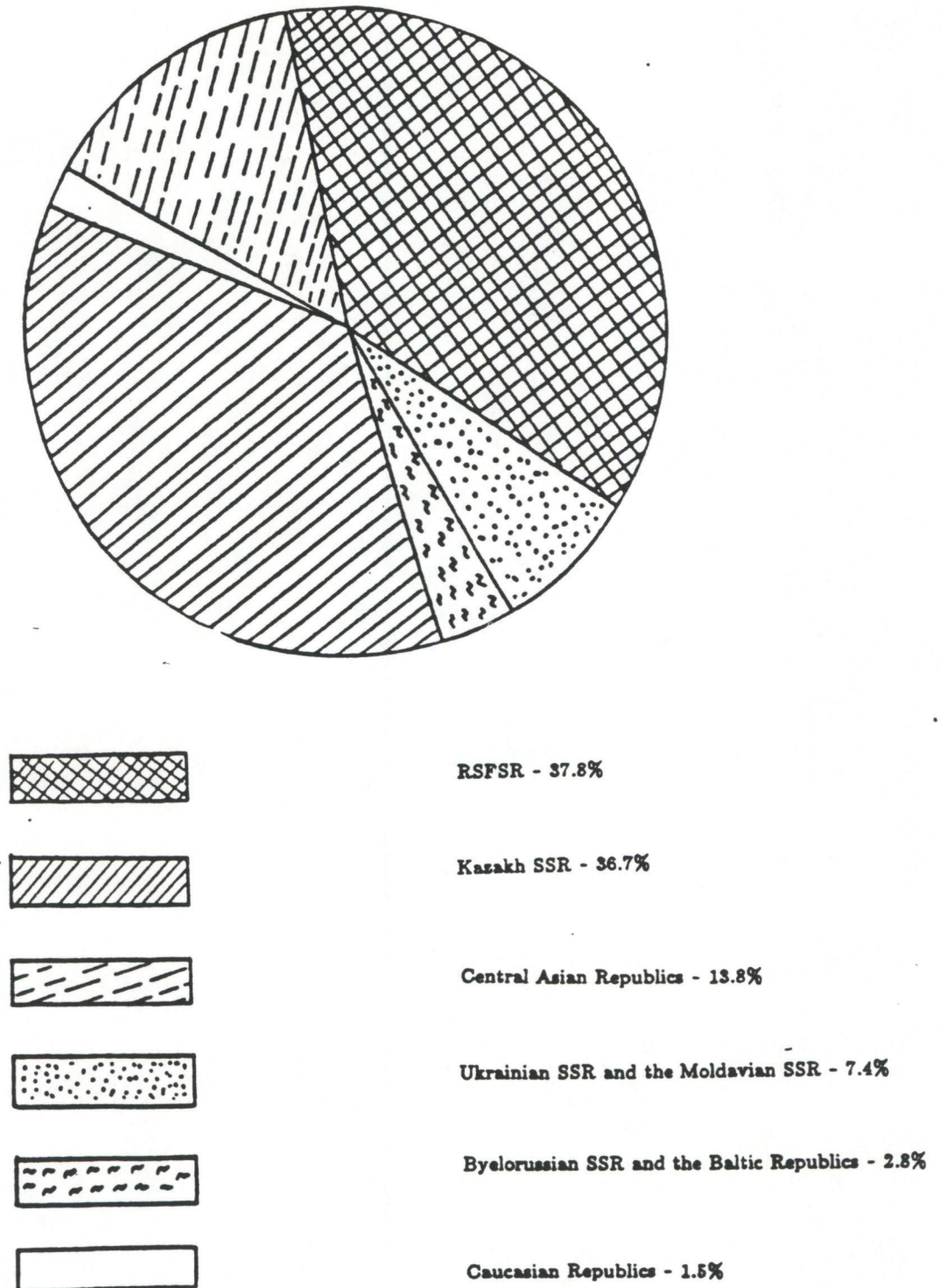


Fig. 23. Distribution of cultivated lands

salinization and the technogenic load. Among cultivated lands 157 million hectares have undergone salinization and contain alkali soil complexes; 113 million hectares have been eroded; 62 million hectares are rocky lands; 25 million hectares contain water-logged and swampy soils. Of the soil-producing lands 12 million hectares are overgrown by bushes and trees and 4.6 million hectares are hilly lands.

Soil fertility is diminishing. Soil humus concentrations have diminished throughout the country over the last 25 years by .4%. A zero-deficiency humus balance is maintained in only a few regions, including the Byelorussian, Lithuanian, Latvian, and Estonian Union Republics and certain regions of the Ukraine and the Russian Federation. The shortage of soil phosphor, calcium, potassium and other elements continues.

The Black Earth region of the European section of the country has already lost up to 25% of the soil humus. Such a loss of fertility is largely due to subjective factors, above all the unique fetish for scientific and technical progress. The belief that technology, fertilizers, and pesticides can produce an infinite increase in crop yields has stalled agrarian culture and has resulted in an endless consumption of soil resources.

Diminishing soil fertility has been the decisive factor in the low return on investment in agriculture. Since 1965 the fixed production assets in agriculture have grown by a factor of nearly five while the use of toxic chemicals (insecticides, fungicides, and herbicides) has increased by a factor of 4.5 while the area of irrigated and reclaimed lands has grown by a factor of 2. However, the gross output from plant cultivation increased by only 20%. The per-ruble agricultural output increased by a factor of 1.8 for the period from 1965 through 1985.

The irrational use of pesticides in agriculture has resulted in an accumulation of residual pesticide quantities in the soil, followed by accumulations in water and food products. More than 10 million hectares of cultivated lands in the country contain residual quantities of DDT (including its metabolite) above the maximum permissible concentration.

The highest DDT soil pollution levels have been identified in the Azerbaijan, Armenian, Moldavian, and Uzbek republics where its average concentration varies from 2 to 8 MPC. Soil contamination has been observed in not only gardens and in cotton-growing areas, but also in grain- and vegetable-growing soils and forage grasses. Aside from DDT soils have also been contaminated by residual quantities of thiodane in isolated regions throughout the Azerbaijan SSR while residual concentrations of delapone, treflan, and phosalone have been identified in the Moldavian SSR and traces of magnesium chlorate have been found in the Uzbek SSR.

In the Osh oblast' of the Kirgiz SSR the average DDT soil concentration is 5 MPC. In the Sergiev region of the Northern Caucasus oblast' the

average soil concentration of DDT is 13 MPC with a maximum level of 19 MPC, indicating its use during the growing period of 1988.

A significant quantity of DDT (ranging from 40 to 200 MPC: an extremely high level) has been detected in the soil of the Novosibirsk oblast'.

Regions with average soil pesticide contamination levels (up to 3 MPC) include the Central Povol'zhe, the Primorskiy krai, the Ukrainian SSR, and the Central-Black Earth regions.

Overall insignificant pesticide contamination of soils (below .5 MPC) has been found in the Byelorussian, Georgian, and Kazakh SSRs, in the Northern Caucasus, the Upper Povolzh'e, in Western Siberia, the Irkutsk, and Moscow oblast's.

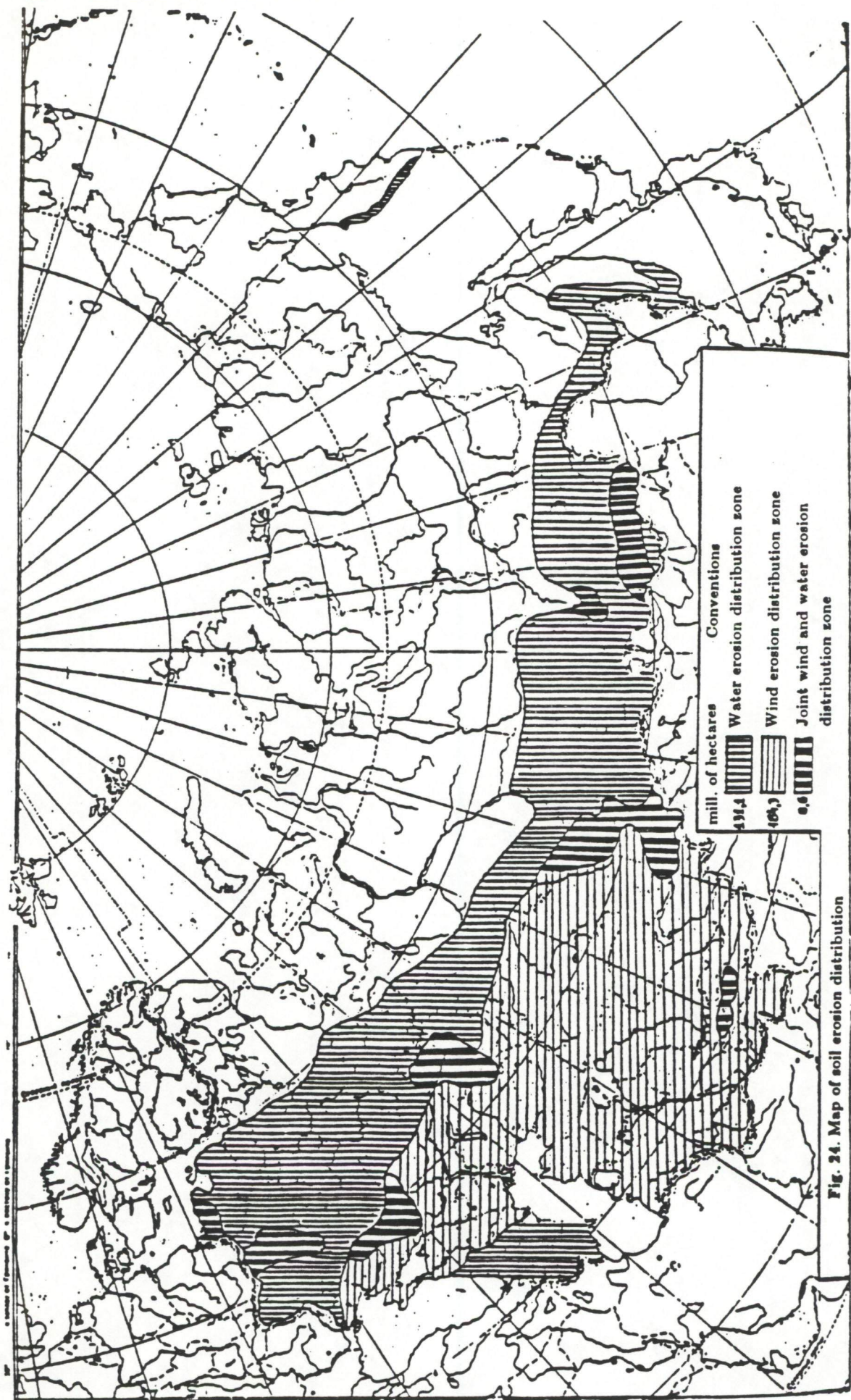
Waterlogging processes as well as overgrowth of shrubbery and scrub forests and desertification have occurred on a dangerous scale. Approximately 6 million hectares of productive cultivated land has been lost over the last 20 years and has primarily occurred in regions with available water supplies. Over 3 million hectares of land has been flooded or submerged.

The problem of soil erosion protection has great socioecological significance; see Figure 24. Approximately 6 million hectares of protective forest stands have been established since 1968 as well as 1.9 million rubles worth of hydrologic antierosion structures. Terracing of steep slopes was used over an area of more than 100,000 hectares while agrarian cultivation methods have been used on an increasing scale. All these measures have eliminated destructive dust storms in many regions and have reduced active water erosion of soils. However, in recent years the accelerated development of agriculture and other fields of the national economy has magnified the problem of soil erosion.

The volume of surface melt and precipitation runoff for the 243 million hectares of cultivated lands at slopes exceeding 1° totals approximately 70-90 billion m³ annually, while near 1.5 billion tons of fertile soil is lost annually in this runoff as well. In this process the loss of nutrients exceeds their replacement by fertilizer by a factor of 1.5-2.

A special set of measures has been developed to implement soil erosion protection plans throughout the country. State plans for economic and social development contain annual budget outlays for constructing antierosion structures as well as protective forest stands, scientific studies, and design work. Techniques are currently being developed for implementing antierosion cultivation methods. The soil chiseling area in 1988 totaled 58.9 million hectares.

Plans are in place to proceed with the broad incorporation of antierosion contour strip cropping and to fully implement soil-protection cultivation technologies on cultivated lands in areas with slopes above 2° in inclination.



Lands destroyed from mineral mining, construction and other operations account for approximately 2 million hectares. The majority of such lands are in favorable cultivation regions and densely populated areas of the country.

1712 thousand hectares of disturbed lands had been reclaimed by early 1989; 464 thousand hectares are classified as arable lands while 555 thousand hectares are now cultivated land. The remaining areas are occupied by forest stands, water reservoirs, and have been assigned for construction.

Efforts to conserve and utilize the fertile soil layer for improving low-yield soils by using displaced soils from mining and earth-moving operations in construction play a prominent role in the overall range of measures aimed at rational use of land resources and its principal component: the soil. In just the last 13 years 1.910.7 billion m³ of fertile soil has been removed of which 1.640 billion m³ has been employed for recultivation of disturbed lands and improvement of low-productivity areas. A total of 180.8 thousand hectares of cultivated lands have been improved.

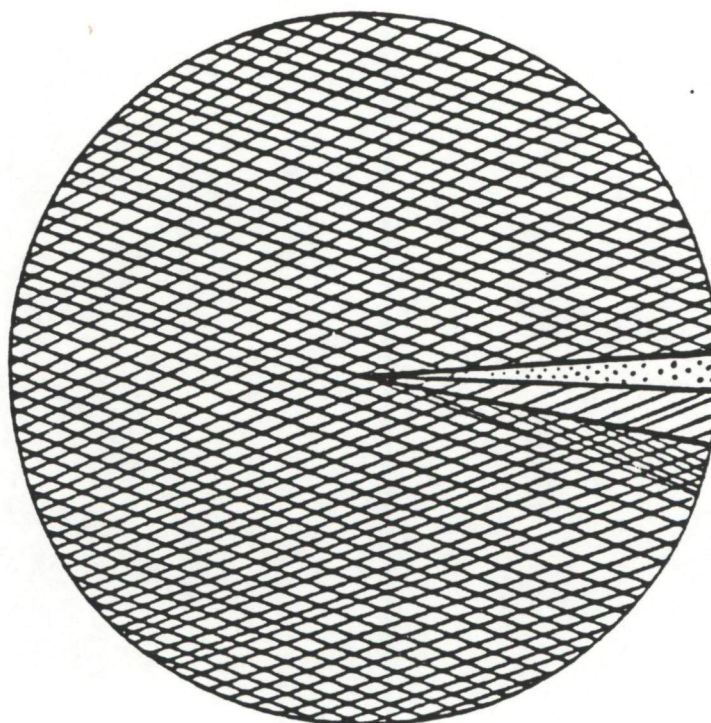
Approximately one-half of arable lands are located in an arid zone with atmospheric precipitation of less than 400 mm/yr while only 1% of the area has precipitation exceeding 700 mm/yr. Land irrigation therefore acquires special importance.

Irrigated and reclaimed land areas grow by 800-900 thousand hectares annually. At present 35.7 million hectares of cultivated lands have been improved; of these 20.5 million hectares have been irrigated and 15.2 million hectares have been reclaimed; see Figure 25. The irrigation network in an area over 700,000 hectares in size is currently under reconfiguration and water supplies are being improved; approximately 450,000 hectares of irrigated land is under capital planning and land improvement while near 200,000 hectares of reclaimed land is being improved.

The current status of irrigated and reclaimed lands remains unsatisfactory over a substantial area as their productivity has not reflected expenditures or capabilities. Approximately 200,000 hectares of irrigated land is left unused each year due to flooding, salinization, failures of the irrigation system, and for other reasons, while two-thirds of improved lands do not have the projected yields.

Over two million hectares of reclaimed lands require modernization of the land improvement installations while 1.1 million hectares of land require cultivation.

Approximately 70 million hectares (including 52 million hectares of arable land) has elevated acid levels and hence government grants assign 8-9 million hectares annually for liming.

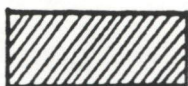


CULTIVATED LANDS: 557.5 MILLION HECTARES

Including:



unimproved lands - 521.8 (93.6%)



irrigated lands - 20.5 (3.7%)



reclaimed lands - 15.2 (2.7%)

Fig. 25. Percentage distribution of improved lands among cultivated lands in agricultural industries.

In recent years there has been a trend towards reducing the volume of chemical agents for vegetation protection. Their volume of use was reduced by 21 million hectares compared to 1986 while areas employing biological methods grew by 2.3 million hectares. In 1988 chemical agents were used on crops covering an area of 165.7 million hectares while biological agents were employed on crops over an area of 26.7 million hectares.

Soils are also polluted by mineral fertilizers applied in extreme doses. Nitrogen fertilizers wash out of soils and pollute water reservoirs.

Substantial land area is also polluted by various substances of industrial origin.

The highest soil contamination level is attributable to pollution by substances discharged by industrial enterprises and such a level is characteristic of terrain near ferrous and nonferrous metallurgical centers. There is also a broader spectrum of metals accumulated in the soil in such areas.

High soil pollutant concentrations have been identified at distances up to 20 km for pollutants discharged by the enterprises of the USSR Ministry of Nonferrous Metallurgy in the village of Glubokoe and the city of Ust'-Kamenogorsk (the Eastern Kazakhstan oblast'), Gorlovka, and Konstantinovka (Donetsk oblast'), Dal'negorsk, and Rudnaya Pristan' (the Primorskiy krai), Monchegorsk (the Murmansk oblast'), Revda (the Sverdlovsk oblast'), Chimkent, etc.

The lead concentration in soils surrounding the village of Glubokoe in 1988 was found to be 22 MPC while the cobalt, zinc, and copper concentrations exceeded the ambient levels by a factor of 10.28 and 100, respectively.

The maximum lead concentrations in these soils were as follows: from 11-29 MPC in Alaverdi, Ust'-Kamenogorsk, Belovo, and Dal'negorsk; 50 MPC in Konstantinovka, 125 MPC in Rudnaya Pristan', and 340 MPC in Chimkent.

An elevated concentration of benz(a)pyrene was also identified in the soils of Rudnaya Pristan' and Dal'negorsk: up to 19 and 98 MPC, respectively.

The highest mercury concentrations in soils were observed in Khaidarkan (Kirgiz SSR): up to 100 MPC.

The copper content of soils around Alaverdi exceeds the ambient concentration (AC) by a factor exceeding 10 (16 AC) as well as in the vicinity of Kazharan (18), Monchegorsk (40), and Revda (79). The maximum copper concentration in this case exceeded the ambient level in Monchegorsk by a factor of 300 and the level in Revda by a factor of 411. The ambient concentration of nickel in the soil was also much higher in Monchegorsk: average concentration of 50 with a maximum concentration of 70 AC.

Fluoride contamination is present in the soils near enterprises located in Bratsk, Volgograd, Yerevan, Krashoturinsk, Krasnoyarsk, Novokuznetsk, Sumgait where the maximum total fluoride concentration exceeds the ambient value by a factor of 6-10.

The soils surrounding the enterprises of the USSR Ministry of Ferrous Metallurgy are heavily contaminated by manganese. The average manganese concentration in soils around Kommunarisk is 6 MPC with a maximum value of 18 MPC; the figures are 3 and 24 MPC in the Kramatorsk region, respectively. The MPC values for manganese are also exceeded in soil readings for the following cities: Dneprodzerzhinsk, Dnepropetrovsk, Donetsk, Yenakiev, Zestafoni, Krivoy Rog, Mariupoli, Temirtau, and Cherepovets.

The soils surrounding ferrous metallurgy enterprises also contain the following elements in concentrations exceeding the MPC or the ambient level (by a factor of greater than 10): benz(a)pyrene, vanadium, cadmium, cobalt, molybdenum, tin, lead, fluorine, and chromium.

Petrochemical and petroleum processing facilities generally produce petrochemical pollution of soils. The concentration of petroleum products in soils within a radius of 1-2 km from oil and gas production regions substantially exceeds the ambient level; the depth of the polluted layer of disturbed lands generally runs to 1 m and in spots to 2 m. The most severe soil contamination from petroleum products is in the Apsheron field where the average petroleum product concentration exceeded the ambient level by a factor of 32 with a peak at 83 times the ambient level.

Additional sources of soil pollution include ash tailings from the enterprises of the USSR Ministry of Power Engineering and Electrification. Improper operation of the Ekibastuz GRES-1 tailings dump has caused severe ash contamination of arable lands and crops in the area between Ekibastuz and Pavlodar.

Lands are also polluted by domestic and agricultural wastes which, in combination with industrial pollution, serve to reduce crop yields and degrade the quality of agricultural produce.

The yield of natural hay fields and pastures is also low, even though 225,000 hectares of pasture land is improved annually and 3 million hectares have developed water supplies. Natural grazing lands are generally not well used and efforts to improve such areas are insufficient, resulting in damage to soils and swards. Feed production from such lands is not growing. The grain yield for many years has totalled only 6-6.5 cm/hectare.

One of the most important issues in land use is to avoid soil degradation from packing caused by heavy agricultural machinery. The enormous agricultural losses from soil packing has made it necessary to explore new approaches to designing machinery with less contact between the treads and the soil. Wide-angle and integrated machinery is planned for use in the

future while field operations in areas with high soil water content will be limited and herbicides will be used in place of mechanical working.

The assimilation of productive lands for nonagricultural uses has been reduced in recent years due to increasingly stringent land use legislation. If 180 to 190 thousand hectares of cultivated lands were assimilated annually for such purposes between 1976 and 1985, including up to 50,000 hectares of pasture, between 1986 and 1988 these figures totaled approximately 100,000 hectares, of which 30,000 hectares are pasture land. However, even this level of assimilation of cultivated lands for nonagricultural purposes remains high and additional measures must be taken to reduce this trend. Even with the absolute increase in arable land area in the nation there is nonetheless a continuing diminishing trend of available cultivated land per capita in the USSR; see Table 13.

Table 13
Change in per capita cultivated and pasture lands for the USSR

Years	Cultivated lands hectares	Pasture lands hectares
1	2	3
1960	2.87	1.03
1965	2.66	.97
1970	2.51	.92
1975	2.38	.89
1980	2.29	.85
1985	2.20	.82
1987	2.13	.89
1988	2.11	.79

In 1988 the USSR State Agroindustrial Committee in conjunction with the USSR State Committee on Science and Technology and the All-Union Academy of Agricultural Sciences developed a Comprehensive Program to Enhance Soil Productivity Through the Year 2005. The program outlines measures for rational land use, soil conservation, methods of improving soil fertility and other conservation measures.

Special budget outlays for land use and other economic leverage for implementation of rational land use are planned for the future. Such plans include a comprehensive program for state monitoring of land use and conservation with assessments based on airborne and space remote sensing

data together with the development of ecological efforts within scientific research programs and other measures.

1.6. Mineral Reserves

The Soviet Union Possesses an enormous mineral reserve. The current state and future prospects for its assimilation will satisfy the demand of the national economy for primary mineral resources. Sufficient capital for successful operation of the mining industry has been developed to date. This includes up to 40% of capital investment in industry and 20% in labor resources.

Substantial reserves of coal stock, ferrous metal ores, potassium salts, chrysotil-asbestos, and cement raw materials have been accumulated making it possible to economically process the materials over an extended time at a high level of economic efficiency.

A number of important measures to assure rational and comprehensive utilization of mineral reserves have been adopted. This has made it possible in recent years for mining enterprises to largely satisfy state plans specifying complete extraction of the most important mineral reserves from raw materials and other components from processing. Mineral losses from mining have been reduced. These reductions include the following figures for 1988 compared to 1990: coal - 16.8 to 12.6%; manganese ores - from 6.1 to 5.7%; apatite-nepheline ores - from 8.1 to 5.6%; muscovite-micas - from 11.9 to 9.5%; and chrysotil-asbestos - from 3.6 to 2.8%, see Figure 26. Iron ore extraction in mining has stabilized in recent years at a 95-96% level with the ferrous metal recovery rate equal to 90-96% from metallurgical conversion. A number of enterprises have also achieved excellent results in the comprehensive utilization of mineral resources. The Balkash Metallurgical Works has incorporated 14 of 15 ore components into their commercial marketable goods; the by-products in this process account for approximately one-third of the total. At the Ust'-Kamenogorsk Metallurgical Works 16 components are extracted from complex lead-zinc ores and 26 types of commercial products are manufactured. Vanadium and apatite concentrates with yield rates of approximately 70 and 64% are obtained as by-products on a commercial manufacturing scale from complex iron ores at the Kachkanar and Kovdor Ore Enrichment Works. Desulfurization of waste gases from zinc and copper smelteries has expanded in scale during the last Five Year Plan. All these measures have had a positive effect on environmental conditions near such facilities and also make it possible to obtain an additional and significant quantity of sulfur, sulfuric acid, phosphorus pentoxide, and other byproducts.

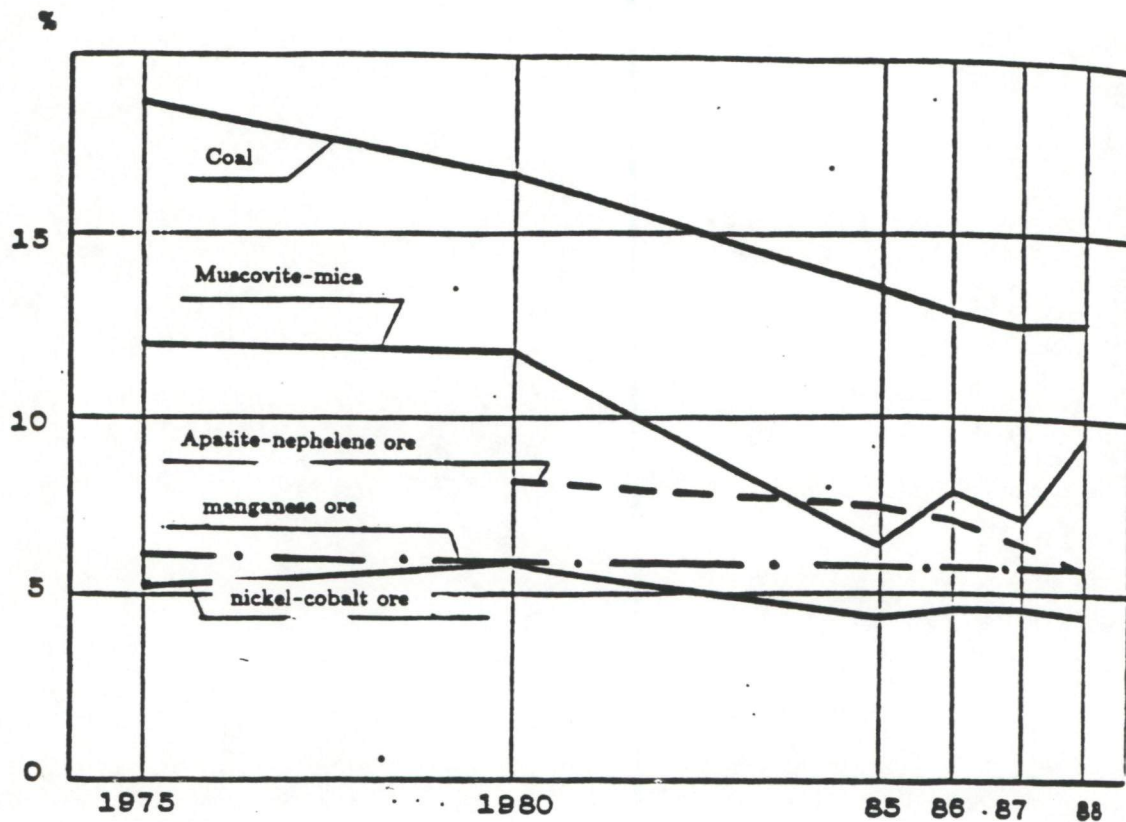


Fig. 26. Reduction in losses of certain minerals in the mining process.

The comprehensive program entitled *The Comprehensive Rational Use of Mineral Resources in the National Economy Through the Year 2000*, amended for the period through 2005, has begun to be implemented; this program was developed by the interested ministries and departments and has been approved by the USSR State Planning Committee. The program reflects the primary directions of scientific and technical progress in the regional and overall exploitation of mineral resources and designs for rational land use based on modernization, expansion, and construction of interdepartmental industrial facilities.

However, the current utilization of mineral resources is not yet in full compliance with resource conservation legislation. The current level of commercial output from the mining industry is largely maintained due to outside factors, the continuous increase in the volume of mineral extraction, the construction of new mining enterprises and the annual 10-15% volume

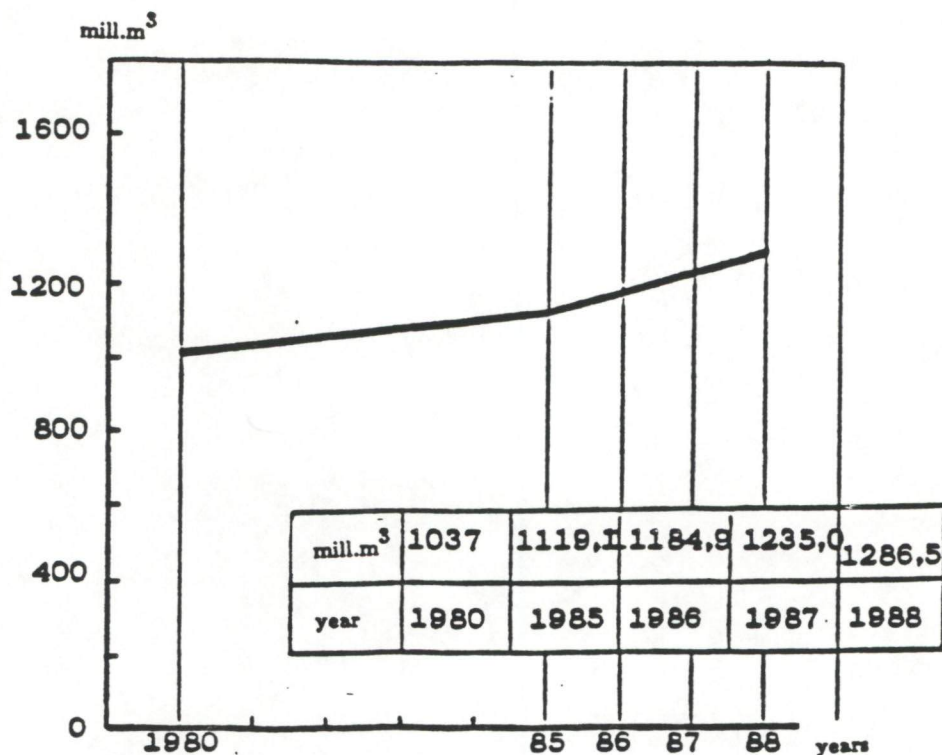


Fig. 27. Increase in use of overburden and enclosing rock for commercial purposes (including enrichment wastes).

increase in raw material mining and processing. The transition to accelerated operations in mineral utilization and conservation is progressing slowly.

Coal, bituminous shale, iron, and copper ore losses in underground mining remain high. Less than one-half of the balance supply of potassium salts, oil, and condensate are mined. Mineral component losses in the enrichment of raw materials are especially high; significant capital is expended in mining these components. Approximately one-third of the recovered tin and the phosphorus pentoxide from phosphorite ore, more than one quarter of the iron, manganese, zinc, and tungsten, and one-fifth of potassium salts are lost in this mineral processing stage; see Table 14.

Table 14
Extraction of mineral components from raw mineral
resources by beneficiation (as a percentage of
concentration in processed raw material).

USSR Ministry	1985	1986	1987	1988
1	2	3	4	5
<i>Ministry of Ferrous Metallurgy</i>				
iron	73.3	73.7	74.0	74.1
manganese	74.6	74.1	73.8	72.7
chromium oxide	80.7	80.1	81.2	83.0
<i>Ministry of Nonferrous Metallurgy</i>				
copper to copper concentrate	85.2	85.0	85.5	84.6
lead to lead concentrate	77.0	76.3	76.5	75.6
zinc to zinc concentrate	74.3	73.8	74.3	74.6
nickel to nickel concentrate	89.1	89.4	89.7	90.0
tin to tin concentrate	65.9	65.6	64.8	67.4
tungsten trioxide to tungsten concentrate	67.0	69.1	70.1	69.8
molybdenum to molybdenum concentrate	81.0	81.6	81.2	81.5
<i>Union-Republic Ministry of Mineral Fertilizer Production</i>				
potassium hydroxide from potassium salts	76.9	78.9	79.5	80.3
potassium hydroxide from apatite-nepheline ore	90.2	91.1	91.0	91.2
phosphorus pentoxide from phosphorite ore	74.6	73.2	72.0	70.4
sulfur from sulfurous ore	80.1	82.6	80.8	79.7
<i>Ministry of the Building Materials Industry</i>				
muscovite-micas	91.8	92.3	89.7	91.8
chrysotil-asbestos	87.6	87.9	88.2	87.8

Manganese resources are used very poorly in ferrous metallurgy. At present in excess of 60% of the manganese is lost in mining and metallurgical processes (mining, beneficiation, and metallurgical conversion). In spite of the extensive reserves of manganese ore in the country, the more available oxidic ores which have found application in ferroalloy production will be nearly exhausted by the year 2010 or 2015 in view of their extensive mining.

Byproduct petroleum and natural gases remain underused; sulfur, helium, ethane, and other valuable elements can be recovered from such waste gases; see Table 15. In 1988 alone in excess of 15 billion m³ of byproduct petroleum gas was burned off or released into the air.

The quality of mined coal remains a serious problem. Its ash content was 26.6% in 1987.

Interdepartmental issues associated with the comprehensive utilization of mineral reserves have not been satisfactorily resolved, particularly in the Angar, Ekibatuz, and Pridniprovs'k coal fields which contain, in addition to coal, substantial reserves of byproduct components.

The interdepartmental problem of the comprehensive exploitation of the rich and extensive mineral preserves in the Kola Peninsula has remained unsolved for more than a half century. Apatite - a raw material for mineral fertilizer production - has mostly been extracted to date from apatite-nepheline ore together with, to some degree, nepheline which is used to produce aluminous raw materials. All remaining elements including ethane, titanite and other valuable components which account for more than 60% of the actual processed raw material are discarded in the tailings.

Table 15
Recovery of byproduct components from processed gases
(as a percentage of concentration in processed gas)

USSR Ministry	1985	1986	1987	1988
1	2	3	4	5
<i>Ministry of the Petroleum Processing and Petrochemical Industries</i>				
sulfur from petroleum gas	88.3	87.0	87.4	84.3
helium from petroleum gas	76.7	76.8	77.7	77.6
ethane from petroleum gas	44.7	43.4	43.7	44.3
<i>Ministry of the Gas Industry</i>				
sulfur from natural gas	91.1	93.0	86.9	89.9
helium from natural gas	87.9	88.6	88.1	90.7
ethane from natural gas	25.3	25.0	27.5	29.8
propane and butane from natural gas		30.3	28.7	32.4

Over the last several decades six major complex iron ore fields have been developed in the field of ferrous metallurgy; in addition to iron these fields contain commercial supplies of nonferrous metals, sulfur, and other valuable products. However, only iron is currently mined. Moreover, it is

possible to acquire an additional 157 million rubles of output from the beneficiation byproducts from only a single Sokolov-Sarabaisk works. The problem of utilizing the byproduct oxidized ferrous quartzites at the Krivbass and Kursk enterprises is only slowly being resolved.

An analogous situation exists with respect to the comprehensive exploitation of fields in other divisions of the mining industry. The comprehensiveness and thoroughness of field exploitation, measured as the ratio of the potential and currently-mined yields based on mineral prices, remains below 40-50%.

In recent years there has been some increase in the use of overburden rock for recultivation and other applications; see Figure 27. However the use of wastes from mining production for manufacturing construction materials remained essentially flat and accounted for 3-4% of the total output. At the same time the enterprises of the USSR Ministry of the Building Materials Industry continues to assign new resources for mining of construction materials.

In excess of 50 billion tons of tailings have been accumulated to date in dumps, including: approximately 500 million tons of halite tailings (sodium chloride), 150 million tons of phosphogypsum, and 30 million tons of pyrite cinder (byproducts from the manufacture of phosphor fertilizers), 1 billion tons of ash dumpings from thermoelectric power plants, and 1.2 billion tons of slag from ferrous and nonferrous metallurgy.

New technology, progressive low-waste, and waste-free mineral mining and processing technologies are slow to develop and be incorporated.

Therefore, at the present time extensive and valuable byproduct components from mined ores are not recovered and are irretrievably lost in dumps and refuse storage facilities at mining enterprises which now occupy approximately 1 million hectares of land.

For 1988 alone the volume of mining and beneficiation waste from the enterprises of the Ministry of the Coal Industry, the Union-Republic Ministry of Mineral Fertilizer Production, and the Ministry of the Building Materials Industry as well as the metallurgy ministries totaled 3.3011 billion m^3 while only 1.2864 billion m^3 or 39% was utilized.

The narrow bureaucratic approach to solving the problems of rational use of mineral reserves represents an obstacle to interdepartmental cooperation and timely construction of interdepartmental facilities that will implement comprehensive exploitation of mineral fields and mineral raw materials.

No effective economic mechanism has yet been developed to stimulate mining enterprises to use mineral raw materials both efficiently and thoroughly.

At the same time there exist substantial unused reserves in industries involved in mineral prospecting, mining, and processing. Incorporation of

such reserves will make it possible to accelerate production, produce mineral raw materials and the resulting finished products at substantially lower costs, eliminate the existing shortages in many minerals, improve the structure and quality of the mineral raw material base as well as the ecological conditions in industrial mining regions and achieve a qualitative new level in mineral mining and processing.

The rational and comprehensive exploitation of mineral fields based on the introduction of scientific and technical achievements will make it possible to increase the annual volume of finished product output, to reduce costs by 10-20% as well as per-capita capital investment by 30-50% while reducing the volume of ore recovery by 15-20%.

The problem of rational and comprehensive utilization of mineral resources is an interdepartmental problem. Its solution will require assigning priorities to the development of low-waste, low-consumption manufacturing processes that will make it possible, at substantial economic benefit, for the enterprises of so-called "unspecialized" industries to acquire mineral resources short supply as well as the required finished products, for example: titanium and vanadium from oil, alumina, soda, and potash from agrochemical raw materials, sulfur from gas or the waste gases from metallurgical factories, etc.

1.7. Vegetation

The vegetation ecosystem consists of wild flora and fauna of many taxonomic groups comprising the widest variety of communities (woodland, pasture, tundra, steppe, arid land, etc.). This environment provides the habitat as well as the food supply for animals, and satisfies the national demand for timber and produce. The vegetation ecosystem plays a critical role in regulating atmospheric composition as well as the flow conditions of surface streams and groundwaters, maintains fertility and protects soils from erosion; this environment is being used increasingly for therapeutic purposes and for aesthetic and recreational purposes.

The vegetation ecosystem is state property in the USSR and its rational use intended to satisfy the ecological, economic, and social demands of society, is a problem shared throughout the state and by all peoples.

Forest conservation and rational utilization plays a special role in the national economy; all forests in the USSR are included within the total forest stock, consisting of:

- state forests, i.e., forests under management by the state forestry organizations as well as municipal forests assigned to individual ministries and forests located in wildlife reserves;

- collective farm forests, i.e., forests in areas permanently assigned for collective farm use.

As of January 1, 1988, the total land area of the USSR forest stock totaled 1.2542 billion hectares, including state forests: 1.234.5 billion hectares (98.4%) and state farm forests: 19.7 million hectares (1.6%).

The lands occupied by the state forest stock are divided into the following classes (Figure 28):

- forest areas occupying 941.5 million hectares including forested areas of 814.3 million hectares and deforested areas (felling areas, burned clearings, thinned areas, glades, deserts, etc.): 127.2 million hectares;

- nonforest areas (cultivated lands, cleared strips, roadways, etc.), occupying 312.7 million hectares.

All forests are divided by economic use, location, and function into three groups in accordance with the *Fundamental Principles of Forestry Legislation of the USSR and Union Republics*.

The first group includes forests that largely perform water conservation, protection, health and hygiene and therapeutic functions as well as special purpose forests (forests in wildlife preserves, national and natural parks, forest preserves, forests of scientific or historical interest, memorial natural parks, recreational forests, forests in nut harvesting areas, forest stands, tundra, and subalpine forests). These account for 24% of the total forest stock.

The second group includes forests in areas of high population density and extensive transportation routes with either a protective or a limited economic purpose. These include forests with insufficient forest support resources, protection forests whose continuity and long-term survival require stricter forest utilization conditions as well as state farm forests excluded from the first group. The forests in the second group account for 8% of the forest stock.

The third group, which accounts for 68% of the forest stock, includes multiforested regions principally used for lumber production as well as reserve forests, accounting for 36% of all forests in this group.

The grouping of forests is important from the environmental protection viewpoint, since the forestry and forest management procedures will depend on the class of the individual forest.

The total timber stock in the forests is 85.93 billion m^3 , including mature and over-aged timber (48.82 billion m^3).

The USSR accounts for 22.5% of the world's forest reserves (in terms of forested area) and accounts for 23.9% of total reserves in terms of timber-producing capacity.

Felling covers an area in excess of 2.2 million hectares annually throughout the country of which approximately 2.0 million hectares is densely harvested. The scientifically-substantiated standard for principal

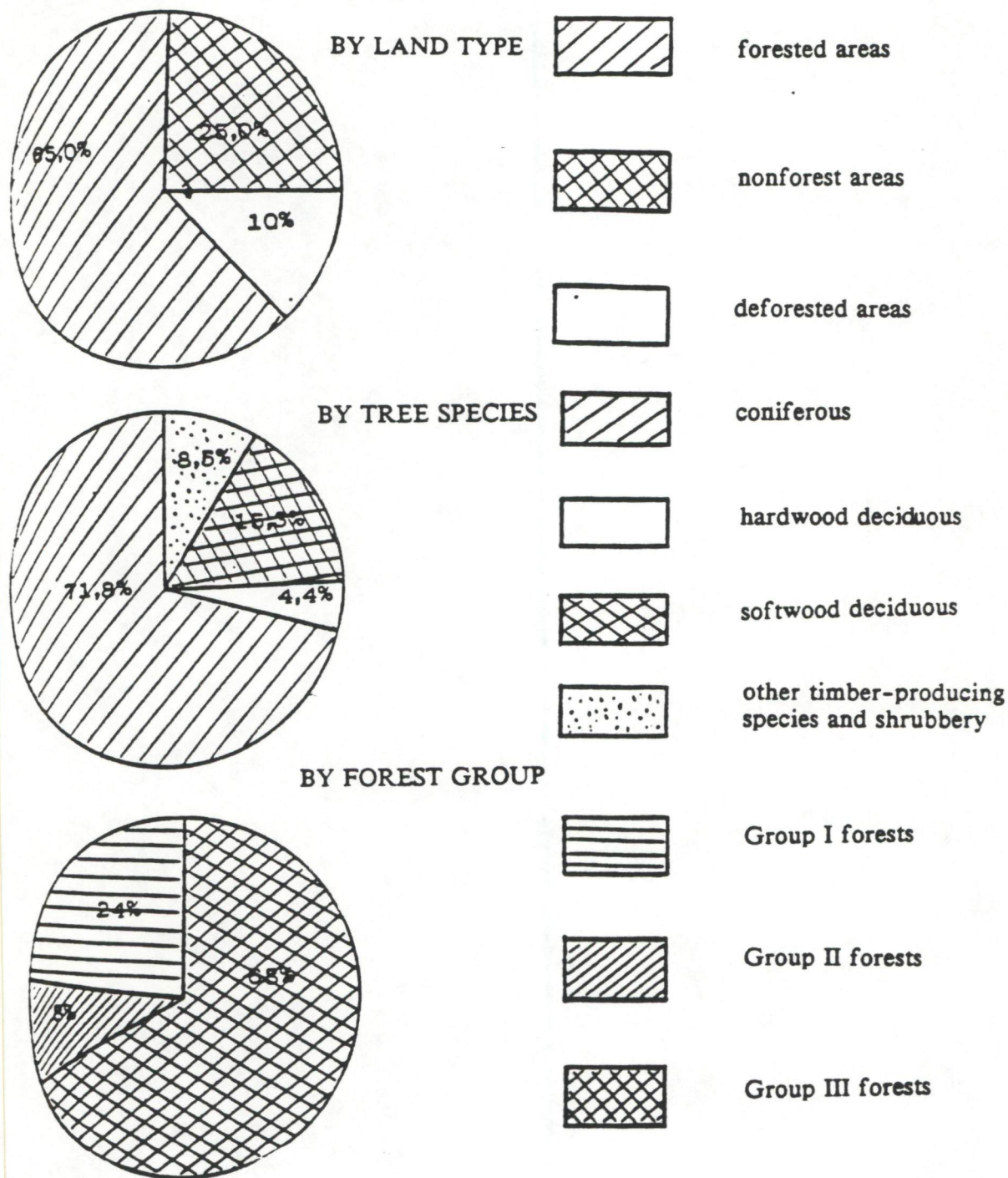


Fig. 28. Primary characteristics of USSR forest stock (as of Jan. 1, 1988).

forest use is designated felling which has assigned 626.8 million m^3 for felling, including 393 million m^3 in coniferous forests, with actual harvesting of 344.9 million m^3 in 1988 or 55% of the designated felling area, including 245.5 million m^3 in coniferous forests, or 62.5%.

The level of forest use will vary due to the nonuniform distribution of timber reserves as well as varying industrial capacities throughout the nation; see Figure 29.

The European-Urals region contains 23.6% of all forested area, although 202.2 million m^3 or 58.6% of total available timber has been taken. The coniferous timber resources have been virtually entirely harvested at the same time that in softwood deciduous forests 33-35 million m^3 of timber is left unharvested annually.

The Asian section of the country contains 76.4% of the forests; 142.7 million m^3 or 41.4% of the total timber procurement volume has been taken here including 120.9 million m^3 of coniferous forest.

Significant timber losses occur during procurement, transport, and processing. The larch (which accounts for one-third of the nationwide timber reserves) is very poorly utilized as are deciduous species. Timber procurement enterprises do not observe standard lumbering practices and often damage valuable underbrush.

A poorly-developed road system, a lack of appropriate timber procurement capabilities in high-yield areas, the relative neglect of deciduous timber and the high rate of timber losses at all production stages have resulted in superfelling of designated harvesting areas in coniferous forests in certain regions of the country. In 1988 such superfelling was permitted in 108 enterprises and totaled 17.1 million m^3 .

Felling of cedar forests is highly inefficient. The preferential harvesting of cedar has resulted in its replacement by deciduous species of less value. The cedar forest areas in the Primorskiy and Khabarovsk regions have diminished by 851,000 hectares or 21.8% over the last 20 years due to intensive harvesting.

State forestry organizations are taking appropriate organizational and land management measures to enhance the water-retention and other useful natural properties of the forests. For example, a coastal protection zone has been established around Lake Baikal where general purpose felling is forbidden; modifications have been introduced in the Felling Regulations within the forests of the lake basin. The new designated felling within the water conservation zone of Lake Baikal in the Buryatsk ASSR has been reduced by 18%, in the Chitinsk oblast' by 25% and in the Irkutsk oblast' by 80%.

The long-term utilization of timber and other raw materials from forests depends on timely and effective reforestation.

The total volume of reforestation at present exceeds 2.2 million hectares annually, which exceeds the volume of continuous felling. Approx-

imately 1 million hectares of this area is seeded and cultivated. In 1988 the USSR Ministry of the Lumber and Woodworking Industries reforested areas totaling 1271.5 thousand hectares including seeding and cultivating 846.2 thousand hectares.

Technologies, machinery, and equipment for tree growing and maintenance that is targeted to the forest growing conditions of the regions as well as the classification of the forestry areas are currently under development and are being introduced into production.

Between 5.5 and 6.0 billion seedlings are grown in forestry nurseries annually.

As of January 1, 1988 the forest stock of the country included 19.5 million hectares of forest plantings. There are also 4.8 million hectares of recent seedlings that have not been transplanted to open forest areas. The fraction of coniferous and other valuable tree species in nurseries is rising.

A number of problems requiring resolution are currently encountered in reforestation. Insufficient resources and lower material and technical support have resulted in disturbances to the cultivation conditions in reforestation operations. This has resulted in poor quality of the forest plantings and widespread die-outs of replanted areas. Forest fires, diseases and pests as well as industrial emissions have a significant effect on the condition and reforestation of forest areas.

Statistical record keeping of forest fires, forest pest and disease zones and active fire fighting and pest management cover 760.1 million hectares of the state forest stock under the management of the USSR State Committee on Forestry. In the remaining 387.7 million hectares which are not commercially exploited, such fire, disease, and pest management operations are implemented only in exceptional cases (when the migration routes of wild animals, or forest areas adjacent to villages, etc. are threatened). Special airborne and ground-based forest fire monitoring and fire-fighting services, the forest conservation services of the USSR State Committee on Forestry, as well as enterprises involved in monitoring forestry and forest utilization are charged with pest and disease management, and forest fire detection and fighting; see Figure 30. If forest fires threaten to go out of control and cannot be managed by these services or enterprises the local governmental organs can enlist additional human and material resources from other fields in the national economy.

Between 10 and 30 thousand fires covering areas of between hundreds of thousands to 1-2 million hectares are recorded annually in the actively-monitored forest reserves; see Table 16. The majority of such fires occur in 3-5 administrative regions (oblasts, krai, and autonomous Soviet Socialist Republics) whose territories contain forests with the highest fire danger due to weather conditions.

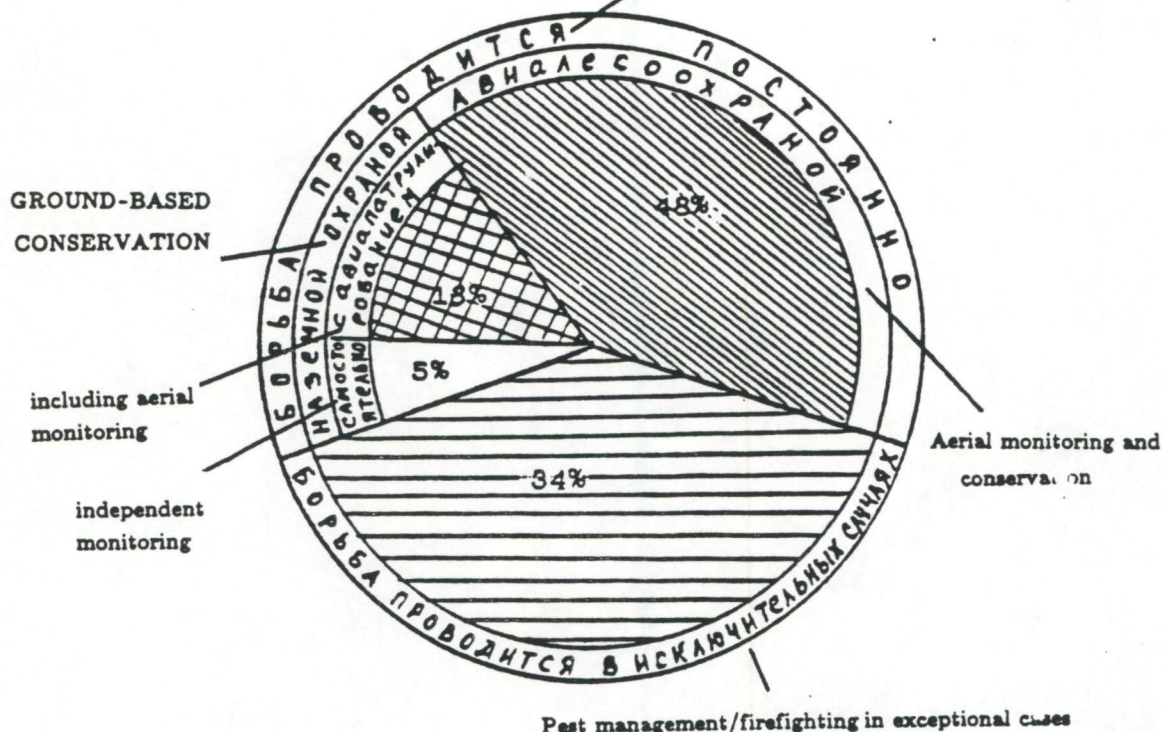
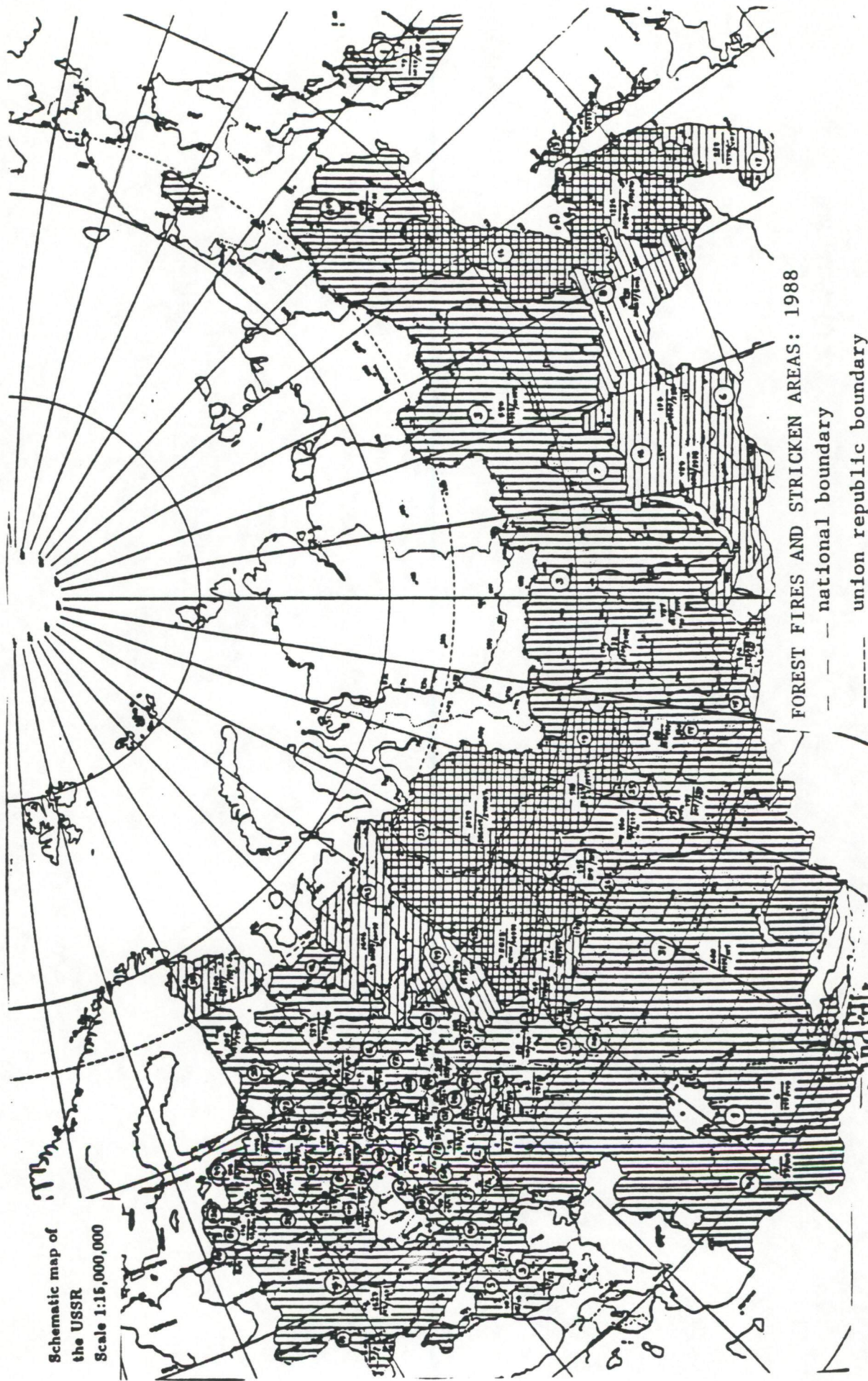


Fig. 30. Territorial distribution of forest stock under management of the USSR State Committee on Forestry classified according to fire, disease, and pest management policy.

The frequency of forest fires (the numbers of incidents per year per 1 million hectares) in the area under active conservation and management varied from 20-23 in the period from 1986-1988, while the burn-out rate (the percentage of total forest stock area burned out by fires annually) varied from .122 to .166%. The variations in these figures for separate regions of areas under conservation and management even within the single year of 1988 were more substantial and varied from 0 to 213 for fire frequency (Byelorussian SSR) and from 0 to .490 burn-out rate (the Kharkov krai (district), RSFSR), Figure 31

A comparison of the forest burn-out rate in the USSR to European and North American nations reveals that the level of forest fire protection in our country is comparable to the levels in most of these countries. However, this level is maintained largely by diverting substantial resources from other



areas of the national economy to fire fighting, at the same time that in foreign countries specialized fire fighting services are used.

Table 16

Forest fires and affected areas in lands under active conservation and management by the USSR State Committee on Forestry: 1986-1988.

Year	Forest Fires, thds	Burned area, thousands of hectare			Fire distribution by cause, %	
		Forest	Nonforest		Human-caused	Natural phe-
		total	Including forested area			
1986	20.8	662.0	652.4	452.9	86	14
1987	15.0	519.4	487.7	740.7	82	18
1988	21.7	704.1	679.2	221.4	83	17

Within the state forest reserves pest and disease damage zones are identified annually over a 3-4 million hectare area; the most damage-prone areas (an area of 1.2-2.0 million hectares) are under active management and monitoring; see Table 17.

Table 17

Areas of pest and disease damage zones
(1986-1988)

Pests and Diseases	Total area of damage zones, thousands of hectares		
	1986	1987	1988
Total number of sites	3309.1	3748.0	3906.2
Including:			
coniferous pests	412.1	533.2	1092.7
deciduous pests	2127.1	1892.0	1416.1
other	348.9	358.0	391.3
diseases	421.0	964.8	1006.1

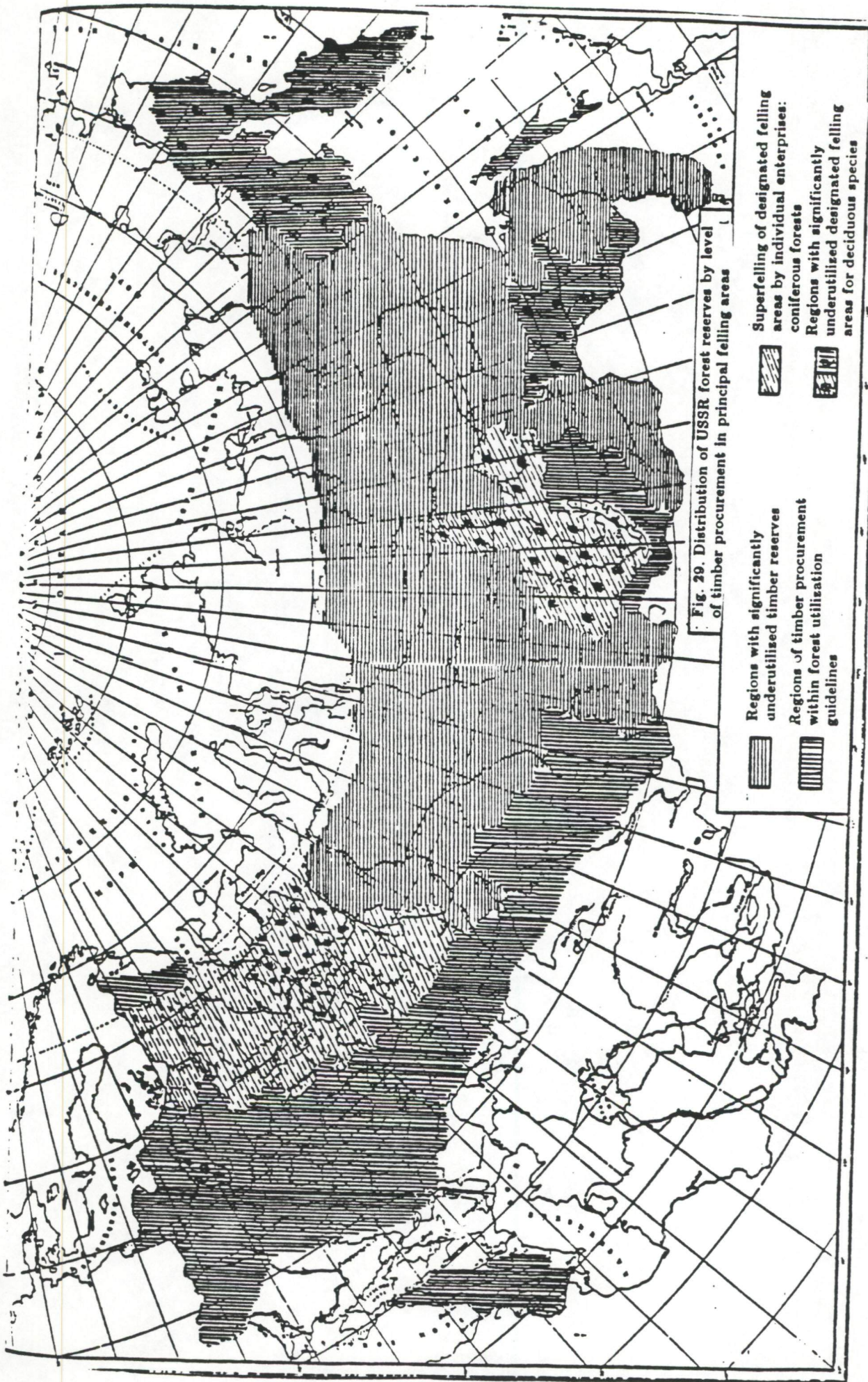


Fig. 29. Distribution of USSR forest reserves by level of timber procurement in principal felling areas

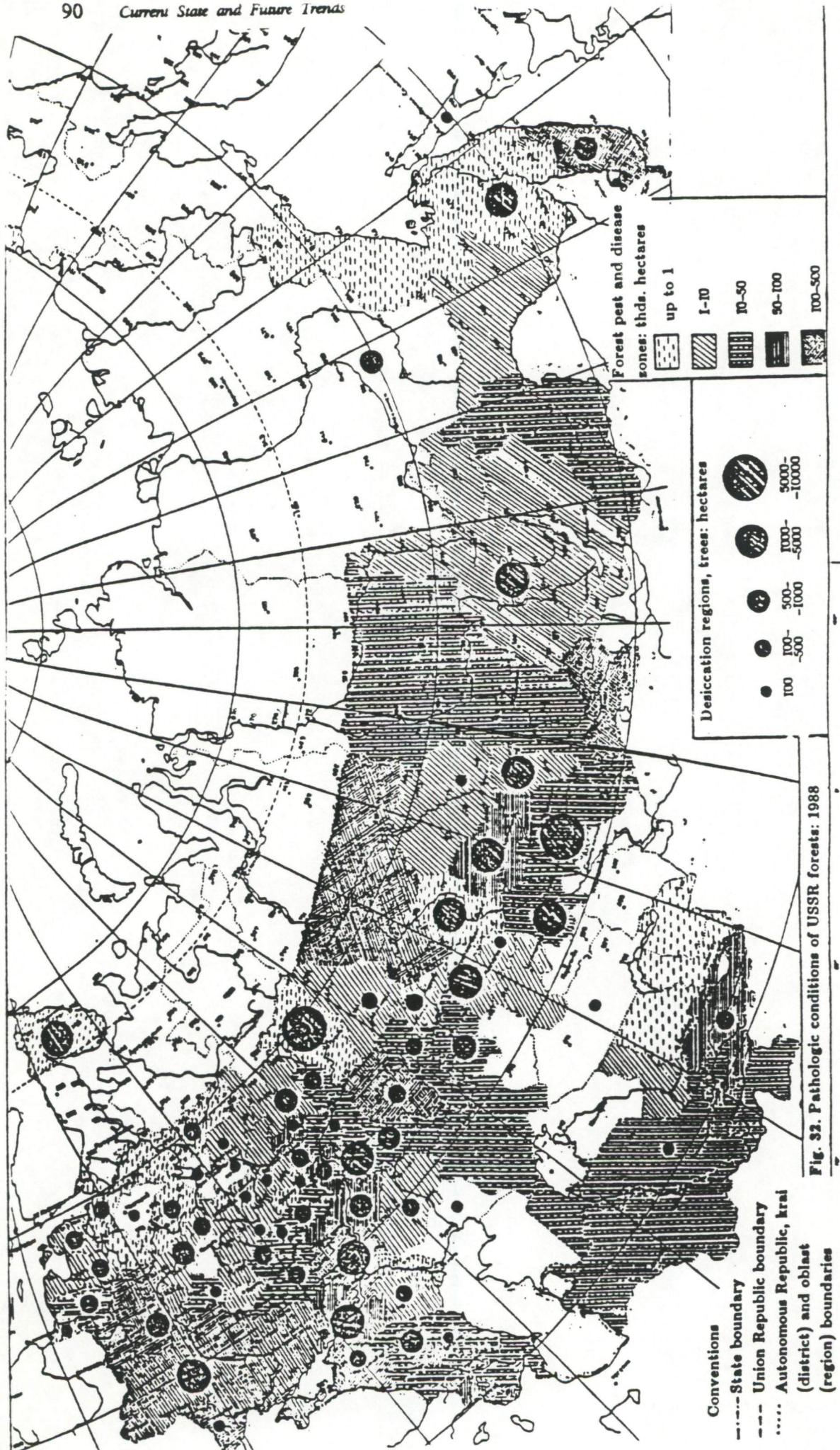


Fig. 32. Pathologic conditions of USSR forests: 1988

The nation also contains approximately 600 species of wild varieties of cultured vegetation with 300 species located in Central Asia. A number of wild (most closely related) varieties of cereal grains, fodder grasses, fruit-bearing, commercial-grade, and other useful vegetation are used for breeding purposes.

A diminishing reserve of a number of wild species of vegetation is being observed today throughout the world, including in the Soviet Union. Several species are on the edge of extinction, while others have already vanished from certain regions. Near 2000 species of vesicular vegetation comprising 10% of the flora of the USSR must be protected.

The reserves of many useful wild vegetation species are also diminishing due to changes in their natural domain (commercial or agricultural assimilation of land, reclamation and improvement) and due to excessive and in many cases unmonitored use.

An inventory of flora and lists of rare and endangered species of vegetation requiring special conservation measures were used to create the *Red Book* of the USSR and the corresponding *Red Books* of the union republics.

As of January 1, 1988 the *Red Book* of the USSR contained 603 species of vesicular vegetation (including 49% that are endemic forms of a specific region of the country, 23% of which are at the periphery of their geographic range and 19% are relics), 32 species of bryophytes, 29 species of lichens, and 20 species of mushrooms.

The species listed in the *Red Book* or species that are classified as threatened under the Convention of International Trading of Wild Flora and Fauna Species can only be acquired or exported from the USSR in extraordinary cases and by special permission by the USSR State Committee for the Protection of Nature.

The broad variety of natural conditions and the extensive land area of the USSR from both north to south and east to west have produced a substantial range of wildlife in the country. Moreover, due to the extreme northern latitudes of the majority of land area and the surrounding oceans and seas within a single, albeit a very large Holarctic faunal geography zone the fauna of the USSR is comparatively limited. The number of species within the USSR exceeds 180,000. If the total number of animal species throughout the world is numbered at 1.5 million, the USSR (which occupies 15% of the land mass and, including the seas and oceans, 8% of the Earth's surface) contains approximately 12% of the worldwide fauna. The number of vertebrates inhabiting the USSR represent 7% of the total number of worldwide fauna species (2900 species), including:

mammals (354 species)	9%
fish (1700 species)	6%
birds (803 species)	9%

The relative paucity of USSR fauna in no way suggests a paucity of wildlife overall. The practical significance of wildlife and its role in biogeocenosis is determined above all by the abundance of species and their biomass and only to some degree by the faunal (species) variety. The quantity of many species of commercially important wildlife in the USSR is large. Moreover, their density per unit of area is responsible for the high vegetative productivity of the terrain and water bodies. Hence the USSR is one of the richest nations in the world in commercial wildlife and fish reserves.

The conservation and rational use of wildlife is dictated by both the important role of this component of the biosphere and, at the same time, by the fact that it represents a biological resource which is a renewable source of valuable products. Wildlife in fact represents a source for commercial and medicinal raw materials, food, and other material goods needed to satisfy the demands of the populace; wildlife is also used for recreational, scientific, instructional, educational, and aesthetic purposes.

The conservation of rare and endangered wildlife species is considered to be a problem of national importance. A USSR "Wildlife Use and Conservation Act" was adopted in 1980; the USSR Council of Ministers adopted a resolution entitled *On the Red Book of the USSR* in 1983: this resolution outlines special legislative guarantees to protect wildlife.

The *Red Book* of the USSR is a state legal document establishing a system of conservation measures for rare and endangered species of wildlife and vegetation. It contains information on not only the number, distribution, and other biological features of wildlife, but also a list of recommended conservation measures. As of January 1, 1989 the *Red Book* of the USSR listed 463 wildlife species.

Republic *Red Books* have been established in addition to the *Red Book* of the USSR.

The creation of protected areas — wildlife reserves and sanctuaries — in areas of different terrain are among the most effective form of conservation.

Wildlife reserves for conservation and breeding purposes in the USSR contain 39% of the amphibian mammal species, 55% of the bird species, 56% of the fish species, 68% of the reptile species, and 90% of the amphibians listed in the *Red Book* of the USSR. Protected territories play an important role in the conservation of rare species of mammals. Protected wildlife reserves have been virtually the only means of protecting the following wildlife in the Soviet Union: Amur tiger, 'kulan', goral, Bukhara deer, spotted deer, etc.

Certain protected territories are not permanent habitats although they do support the life cycles of rare wildlife. For example, the wildlife reserve on Wrangel Island is the primary "maternity barn" of the polar bear in the USSR. The role of wildlife reserves in rare bird conservation is some-

what more limited. Nonetheless, when wintering grounds of rare bird species outside the Soviet Union are reliably protected the role of wildlife reserves at nesting sites becomes critical in maintaining these species.

The Soviet Union is a signatory to the following agreements: Convention on International Trade of Endangered Fauna and Flora Species; the Agreement on Polar Bear Cooperation; the Convention on Swamplands of International Importance as Waterfowl Habitats; and the Convention on Migratory Bird Conservation signed by the government of the Soviet Union and the governments of the USA, Japan, India, The People's Republic of China; these governments will make efforts to enhance conservation measures for such birds at their nesting sites and on their flyways.

The development of rare wildlife groups that will breed in captivity is becoming increasingly important. In spite of the fact that captive breeding is an extreme measure it still represents the only absolutely reliable method of maintaining the genotype stock.

At present breeding nurseries are operated in the USSR for the following animals: European bison, goral, *Gasella subgutturosa*, mountain goat, Armenian mouflon, and rare falcon and eagle species. Animal parks contribute to breeding of rare species in captivity.

The most recent scientific techniques for reintroducing into the wild animals raised in captivity are beginning to be used. New populations of European bison, spotted deer, 'kulan', and Bukhara deer have been raised.

Rare wildlife preservation has begun with an inventory and creation of special annotated cadaster-lists. This establishes the basis of the state wildlife cadaster system. The legal basis for this process is the resolution adopted in 1984 by the USSR Council of Ministers entitled *Procedure for State Inventory of Wildlife and Use and for Drafting of the State Wildlife Cadaster* which will in the coming years provide an objective representation of wildlife conditions throughout the country.

Wildlife listed in the *Red Book* or protected by international agreements can be acquired and exported in the USSR only upon appropriate authorization from the USSR State Committee for the Protection of Nature.

Wildlife conservation also involves rational use which in our country includes hunting and fishing.

The USSR has the largest total area of hunting grounds in the world; these territories have an extensive number of species and wildlife stock. The total hunting ground area amounts to approximately 2 billion hectares of which 1.55 billion is assigned to hunting organizations and enterprises.

As of January 1, 1989 the following figures were used for existing wildlife stock (in thousands of head): deer - 1271.3; saiga - 1034.5; sable - 946.2; roe deer - 745.8; moose/elk - 790.9; wild pigs - 406.3; sea otters - 256.2; brown bears - 84.5; and for wild fowl (wood grouse, geese, partridges, black grouse, and ducks) - upwards of 40,000 head.

At present there are in excess of 7000 hunting organizations in the country, including 6.7 thousand recreational/sporting operations and 486 commercial operations. The total annual harvest from these organizations for gross output at market prices is up to 220 million rubles while marketable output totals 112.1 million rubles.

In 1988 hunting organizations harvested and delivered to the state wild game (hoofed) totaling 46.7 million rubles, and commercial-grade fur (12.1 million pelts) totaling 74.3 million rubles in value. Total hunting expenditures were 227.2 million rubles, including 48.0 million rubles on conservation and breeding.

A system of measures to improve conservation and assure rational use of hunting game and to improve the hunting management system is planned for the future.

One of the causes of the diminishing wildlife population in the USSR is habitat disturbances resulting from anthropogenic influences. This process has translated into a reduction in habitats suitable for various species, disrupted breeding conditions, and game flyways. For example, the kalmytsk saiga population was restored in the 1960s and 70s after great effort. By the early 1980s the total saiga population exceeded 700,000 head, although today only 160,000 head of saiga remain in the Kalmytsk Steppes. This resulted from the establishment of an irrigation system that was not well thought out in advance and was not approved by the environmental protection organizations of the state. Overgrazing of livestock also contributed. The extensive use of barbed wire fencing also had a negative effect. The saiga is a typical steppe animal and water barriers are virtually impenetrable; saiga drowned by the thousands in channels criss-crossing its migration routes. The development of the Volga-Chogray Canal which has the properties of a full-size river and multiple branches may finish off the Kalmytsk population of this antelope.

Although the law specifies the possibility for limiting the rights of land users as well as other users and imposes specific responsibilities on such users to protect and avoid damage to wildlife there is at present no legal procedure for enforcing this law.

The national fish stock (which includes marine mammals, aquatic vegetation, and wildlife, including invertebrates) represents the wildlife area whose conservation and use is regulated by the "Wildlife Conservation and Use Act" as well as other USSR and union republic legislation based on this Act.

The majority of inland water bodies in the USSR are important fishing areas. The fishing industry which provides in excess of 20% of animal protein, plays an important role in providing food products to the population, including live, refrigerated, frozen, dried, cured, and smoked

fish as well as fish filets and more than 100 types of fish species and near 700 brands of canned fish.

Over the last 40 years 1.0 to 1.2 million tons of fish are harvested annually in the inland waterways of the country. However, through the mid-1950s the majority of the catch (80%) consisted of valuable fish species: sturgeon, salmon, whitefish, bream, pike perch, carp, etc., and then the composition of species in the catch changed dramatically. Today the majority (80%) consists of sprat, anchovy, sardelle and other small fish that, as a rule, have poor marketability as food products.

The sharp reduction in the stock and catch of valuable fish species in the inland waterways of the country resulted from regulation of river runoff, the increase in nonreturnable water use for industrial purposes and irrigation, pollution of water reservoirs by industrial, agricultural, and utility wastewaters as well as chemical agents and pesticides. The negative effect of anthropogenic factors on fishing waters has damaged existing natural ecological systems, degraded breeding conditions, reduced the water regions containing valuable commercial fish and has diminished the fish yield of the Caspian Sea, Sea of Azov, Aral Sea, and Lake Balkhash basins.

The diversion of fresh water has had an especially negative effect in the Aral Sea. This formerly highly-productive water reservoir that contained upwards of 40,000 tons of valuable fish species has lost virtually all its value from a fishing standpoint and no fish management or restoration measures will be successful in returning the sea to its former condition.

The Caspian basin is an extraordinarily important fishing area; the primary commercial fish catch in this area includes the following species: sturgeon (sturgeon, white sturgeon (beluga) , starred sturgeon), bream, pike perch, carp, vobla, catfish (sheatfish), herring, etc.

However, the condition of the stock of the majority of commercial fish was severely damaged after diversion of the Volga runoff and fish harvests diminished significantly. In 1956 the total fish catch in the Volga-Caspian region was 280.5 thousand tons, while the total catch for 1976 was 81.3 thousand tons and for 1988 was 76.5 thousand tons. The bream catch dropped by a factor of 4.5 over a 13 year period while the vobla take dropped by a factor of 8, the sturgeon catch dropped by a factor of 16, and the pike perch catch dropped by a factor of 24. Hydrologic works reduced the area of sturgeon spawning grounds along the Volga from 3,600 hectares to 450 hectares. The spawning beds of the white salmon and herring were completely destroyed.

The widespread pollution of water sources by industrial and agricultural discharge is driving the fishing industry of the Volga-Caspian region to the edge of disaster. The accumulation of heavy metal salts and pesticides in the water, soil, and in the fish directly resulted in a massive annual die-

off of sturgeon hatchlings at the Volgograd Fishing Factory between 1976 and 1980.

These same causes are responsible for a massive outbreak of myopathy in the sturgeon in the Lower Volga; this disease is characterized by muscle fatigue and weakening of roe membranes. In 1988 8,496 sturgeon perished from this disease in the downstream waters from the Volgograd Thermoelectric Power Plant. Myopathy was also identified in 1988 in pike, catfish, and carp, i.e., the phenomenon has become progressive.

The Sea of Azov is the second most important inland water body for the fishing industry. During optimum conditions the harvest of valuable fish species from the Sea of Azov totaled 160,000 tons. Regulation of the Don and Kuban River flows by power plant and irrigation facilities and the increase in nonreturnable water consumption (primarily for irrigation) have severely disrupted the natural breeding conditions of the primary commercial fishing stock in the Azov basin. The commercial fishing harvest has diminished from 35,000 tons in the 1951-1955 period to 8000 tons today.

The nonreturnable water use in the Don basin accounts for more than 30% of the average annual runoff today. This has drained the floodplain and has therefore eliminated spawning beds at the mouth of the river.

Only 4.2 km³ of the annual 12.5 km³ of flow on the Kuban is used to support fishing.

The extensive use of chemical agents to protect crops from diseases, pests, and weeds has resulted in widespread seepage of such chemical agents into fishing reservoirs, killing fish and the fish food supply.

A dangerous situation has evolved in the water reservoirs in the Krasnodar krai (district) where chronic pesticide toxicosis between 1983 and 1987 has produced an annual massive die-off of fish in firths, water reservoirs, and the commercial fishing areas throughout the district. Upwards of 170,000 carp alone totaling over 400 tons perished in this period.

An analogous situation has developed in the Balkhash-Ili basin. Pollution of the water body from industrial discharge and drainage waters from rice paddies beginning in the 1970s has produced cases of dermatofibrosarcoma in pike perch. As a result health officials banned the use of pike perch in any form as a food product effective from 1987 on.

Industrial dumping accidents seriously damage fishing stock (over 200 cases annually). For example, in January of 1987 fish losses in the Rybinsk water reservoir were attributed to accidental wastewater spillage from the Cherepovetsk Metallurgical Works. Losses to fishing stock exceeded 19 million rubles.

The USSR Ministry of Fisheries has introduced a range of measures for implementing a rational fishing policy in order to maintain valuable fish stock levels for commercial fishing purposes in principal fishing areas with substantially damaged ecosystems. These measures specify improvements in

fishing regulation, maintenance of natural reproduction (construction of artificial spawning beds as well as restoration of fishing areas), expanding the volume of artificial breeding, incorporation of acclimation programs, etc.

Recommendations of scientific-research fishing organizations were used to develop the Fishing Regulations, Marine Mammal Hunting and Conservation Regulations, Marine Vegetation and Aquatic Invertebrate Harvesting Regulations. These regulations specify the permissible catch levels of the various commercial fishing areas as well as the age and size composition of the catch, a seasonal haul graph, geographical distribution, permitted and forbidden fishing gear, fishing methods and procedures and other commercial stock conservation, regulation, and monitoring measures.

Special regulations that were also based on the recommendations issued by scientific fishing research organizations are used to regulate recreational and sport fishing.

The management of conservation, rational use, and reproduction of fishing stock and other commercial fishing facilities is handled by the USSR Ministry of Fisheries by the Main Administration for the Conservation and Reproduction of Fishing Stock and Fishing Regulation (Glavrybvod), which includes basin management, the extensive network of fish conservation inspection stations, fishing enterprises, commercial acclimation stations, ichthyological monitoring stations and other subdivisions.

Today the national fishing system contains 13 acclimation stations and 177 fishing enterprises. In 1988 artificial breeding facilities stocked natural water reservoirs with more than 7 billion commercial fish hatchlings, including: 123.1 million sturgeon, 788.7 million salmon, 91.5 million herbivorous fish, 84.1 million whitefish, and 6.1088 billion small (carp, bream, pike perch, etc.) fish; see Table 19.

Table 19
Stocking levels of natural water bodies and reservoirs:
Commercial fish hatchlings (millions)

Fish species	1985	1986	1987	1988
USSR total	8784.5	8637.0	8689.1	7196.2
including:				
sturgeon	143.1	131.2	123.4	123.1
salmon	694.1	834.5	657.2	788.7
herbivorous fish	94.2	86.5	99.0	91.5
whitefish	94.6	62.1	57.8	84.1
small fish	7758.5	7522.7	7751.6	6108.8

Special attention is given to artificial breeding of fish stock in the basins of the following seas: The Caspian Sea (sturgeon, salmon, carp), the Black Sea and the Sea of Azov (sturgeon, carp), the Baltic Sea (salmon) and seas in the Far East (Okhotsk, Sea of Japan, Bering Sea) (salmon). The fishing enterprises in the Northern European section of the country and in Siberia are involved in breeding salmon, whitefish, and sturgeon, while various species of carp are the primary target of breeding efforts in Central Asia and Kazakhstan.

The fishery supply organizations and the fishery conservation departments annually implement a wide range of reclamation measures at the commercial fishing areas around the country; such measures enhance the state of natural spawning grounds and migration routes for fish hatchlings and producers and improve natural reproduction efficiency. Near 2.0 million artificial spawning beds for carp species are annually introduced to water reservoirs, lakes, and other inland waterways.

Acclimation programs are implemented on a broad scale. The subdivisions of Glavrybvod [Main Administration for the Conservation and Reproduction of Fishing Stock and Fishing Regulation] sponsor 150-250 stockings of 35-40 fish species and more than 10 types of fish food stock for commercial fishing areas around the country.

The state inspection organizations involve a wide range of social organizations in the fish stock conservation effort: the Institute of Public Inspectors has been established within the system of fish conservation state organizations; this institute includes more than 70,000 volunteer assistants.

However, the fishing reclamation and improvement measures adopted by the USSR Ministry of Fisheries as well as organizational efforts aimed at improving fish stock conservation and establishing scientifically-validated measures for regulating fishing are not capable of countering the increasing effect of various fields in the national economy on commercial fishing stock of surface water bodies and inland waterways of the country.

According to data from fishing scientific research organizations under the USSR Ministry of Fisheries given the current ecological condition of the surface fishing water reservoirs throughout the nation the total fish take in 1995 will not exceed 1.0 million tons with the principal catch remaining the minor fish species: sprat, anchovy, sardelle, and small fish.

The restoration or even a rise in commercial fishing stock in the surface waters and inland waterways of the country will require timely solutions to the problems of rational use of water resources with a priority assigned to fishing, maintenance of effective fish protection at water intake facilities, a reduction in water pollution by wastewaters from industrial, municipal utility, and agricultural facilities as well as toxic chemical pollutants.

A wide variety of *Pinnipedia* inhabit the waters of the Soviet Union and the adjacent regions of the SEa of Okhotsk, the Bering Sea, the Chukchee Sea, the Beloye More [White Sea], and the Barentz Sea: Greenland and Caspian seals, the Baikal seal, bristly seal, bearded seal, banded seal, larga seal, and walrus. These *Pinnipedia* species are actively hunted at sea and along the coastline in the northern and far eastern basins as well as the Caspian and Baikal basins.

The stocks of Greenland and Caspian seals as well as the Baikal seal and the Pacific Ocean Walrus were severely depleted from extensive hunting 15-20 years ago, while stocks of the bristly, banded, and bearded seals have begun to diminish in the Sea of Okhotsk and the Bering Sea.

The USSR Ministry of Fisheries has taken a broad range of conservation measures. Such measures include limiting the harvest of individual age/sex groups, banning hunting in certain regions or for certain time periods, forbidding the hunting of threatened species listed in the *Red Book* of the USSR and establishing biologically-based harvest limits. Marine mammal hunting is permitted only in accordance with the conservation and hunting regulations. These measures have made it possible to stabilize the population of *Pinnipedia* at a sufficiently high commercial level in virtually all regions.

The seal take in virtually all hunting regions amounts to 150-160 thousand head annually.

Approximately 7000 head of ocean fur seal is taken annually in the Sea of Okhotsk and in the Eastern Kamchatka region.

Up to 5000 head of seal and 167 gray whales are taken annually to support the indigenous population in the Chukchee Sea and the Bering Sea, while approximately 300 beluga (white whale) are taken in the Beloye More [White Sea], the Barentz and the Kara Seas.

1.8. Specially Protected Natural Environments

The changes that have occurred over the last century in nature and the environment have been accompanied by a transformation of the Earth's surface on scales and at rates that far exceed those of natural evolutionary changes. This has resulted in the extensive formation of technogenic terrains and have substantially altered the evolutionary conditions of organisms.

Under such conditions wild natural environments that have been untouched (or altered to a lesser degree than technogenic terrains) with all the richness and variety of form, species, and communities can be conserved only in isolated, island areas. Many regions contain no virgin environments at all or such environments are restricted to small areas.

The conservation of natural territories and ecosystems accounting for biotic and abiotic environmental factors therefore occupies an important place in the overall system of environmental protection measures.

The primary principles and ideas behind the current formulation of wildlife reserve policy in the nation were established as early as the initial documents adopted in the creation of the Soviet state. The system that has been established and is currently in effect in the USSR integrates a wide variety of organizational forms targeted for conservation of natural territories and facilities. This system includes territories that perform largely resource conservation functions as well as those that comprise the wildlife reserves of the state.

Specially-protected natural environments in our country are areas of severely-limited or special use. Such areas are set aside to maintain ecological equilibrium, conserve the genetic variety of vegetation and species, obtain information and scientific data on the progression of natural processes and the effect of anthropogenic factors as well as information used for ecology education and propaganda. They may also have differing specific purposes within the framework of these primary tasks.

The category of specially-protected natural environments that essentially perform resource conservation functions includes specially-protected forests, protected (green) regions within cities and health resorts (including parks and gardens); sanctuaries and reservations, and breeding grounds in managed territories. Such areas attempt to conserve and restore the supply of certain natural resources (forests, wildlife, fish, rare vegetation, etc.) by strictly limited and regulated use of other resources.

Certain specially-controlled lakes, historical and cultural parks, and territories designated for recreational purposes and for restoration of the natural environment play an important role among such protected areas.

This category of specially-protected environments includes approximately 1900 sanctuaries today; these sanctuaries protect the environment and its components in many areas including conservation of specific species or groups, protection of wildlife on migration routes or during nesting, bird shedding and wintering and restrictions on resource utilization during certain seasons, etc.

The green areas within cities and health resorts as well as parks and gardens with a total area near 200 million hectares have a special place in the system of specially-protected natural environments. Ordinarily located within or near populated regions these areas perform environmental stabilizing functions as they support worker health, rest, and relaxation, satisfy the natural human need for interaction with nature and facilitate a communal attitude to nature.

The country has maintained a large number of well-known parks and gardens established 100 or more years ago; many of these parks are protected by the state and have been restored. These include: Letny Sad [Summer Palace] and Petrodvoretz near Leningrad; Ekaterina and Alexander Gardens in the city of Pushkin; Kuskovo Park in Moscow, and the Archangel Park-Palace near Moscow. Landscape parks and gardens with special architectural designs emphasizing the beauty of landscapes and their individual areas have become world famous; these include Pavlov Park near Leningrad, Tsaritsino, Kuz'minki, Gorenki, Bykovo, Marfino, Grebnego, Voronovo, Abramtsevo, and Sukhanovo in Moscow, the Aleksandrievka and Sofievka Parks in the Ukraine, and the health resorts along the Black Sea coastline in the Caucasus.

Given the environmentally stabilizing value of municipal vegetation and plants, a differentiated municipal landscaping and park system will be based on an optimum relationship between open vegetation, and built areas, proper selection of bushes and trees throughout the city, and trees in the surrounding areas.

In modern municipal planning concepts gardens and parks are considered to be individual design and building elements within the structure of the overall municipal and developmental plans. Landscape, terrain, and architectural features are accounted for in their design. Performing the important function of providing oxygen to the atmosphere within cities and enhancing the climatic heat and humidity exchanges processes within municipal regions, green zones, parks, and gardens require protection from the damaging effect of anthropogenic factors, above all, industrial emissions.

The second principal category of specially-protected natural environments includes state wildlife reserves which protect representative natural ecosystems, landscapes, and unique natural formations, as well as the genetic variety of biological resources. These resources include state wildlife reserves (including biosphere reserves), natural memorial parks, national parks, botanical and zoological gardens and certain other specially-protected natural environments.

As of January 1, 1989 the USSR had a total of 164 state wildlife reserves (including 22 biospheric and hunting reserves), 19 natural national parks, and more than 5000 memorial parks. The data shown in Table 20 show the development of the network of specially-protected natural environments in recent years.

The wildlife reserve system in the Soviet Union today differs from the foreign system; the concept of biospheric wildlife reserves currently used by UNESCO largely reflects our principles used in the development and operation of wildlife reserves.

Wildlife reserves represent a more severe and therefore more effective form of conserving representative elements of nature, and conserving

the genetic variety of vegetation and wildlife. Wildlife reserves can be divided into two groups based on the degree of conservation of natural ecosystem environment.

Table 20
Development of network of specially-protected
natural environments

Year*	Wildlife reserves and protected hunting grounds		National parks	
	Number	Area, thd hectare	Number	Area, thd hectare
1975	108	7856	3	178
1980	135	11060	7	411
1985	150	17549	13	788
1988	164	21597	19	1779

* At the end of indicated year

The first group includes large wildlife reserves in which the existing natural ecosystems maintain their capacity of self regulation and management. These include the Kavkazskiy, Kronotskiy, Barguzinskiy, Altayskiy, Sikhote-Alinskiy, etc. wildlife reserves.

The second group of wildlife reserves protect natural reproducing systems that are not capable of self-reproduction or self-regulation due to a limited ecosystem composition, insufficient territorial availability, and a high level of anthropogenic influences from the surrounding areas (the Astrakhan, Central-Black Earth and Voronezh reserves):

The third group includes wildlife reserves that protect technogenic terrain ecosystems (the Berezinskiy wildlife reserve).

The scientific research conducted on wildlife reserves has a number of special features. Its principal unique feature is the use of long-term, year-round stationary biogeocenotic studies which include:

- inventorying of natural components within the wildlife reserves;
- monitoring of natural processes, maintenance of a "natural environment log" which is the primary document containing records of natural phenomena and changes in nature;

- investigation of the structure and mechanisms behind ecosystem operation as well as the function of individual organisms and species and the environmental effect on these factors;

- development of scientific recommendations for conservation and restoration of ecosystems and the genetic stock.

Biospheric wildlife reserves also include a research program devoted to ambient monitoring of environmental pollution on a global scale and analysis of trends resulting from anthropomorphic factors.

Scientific research and practical field studies on wildlife reserves devoted to analysis and conservation of the genetic stock of wildlife and vegetation has made it possible to protect and restore many valuable and rare wildlife and vegetation species whose existence was until recently threatened by extinction due to predators or habitat destruction. Such studies and research have been used to protect the sobol, tiger, aurochs, kulan, goral, spotted and Bukharsk deer, Caucasian mountain goat, leopard, white panther, European river otter, Russian Desman, flamingo, turach, ular, and the following vegetation species: lotus, yew, box tree, and many other types.

Wildlife reserves, national parks and other specially-protected environments in the USSR play an important role in ecological education and distribution of information relating to the mission of wildlife reserves and sanctuaries, in teaching environmental awareness and activism to the population and in training both domestic and foreign scientific ecologists and staff.

Rapid industrial development has caused certain wildlife sanctuaries and other specially-protected environments to be exposed to pollution sources located in nearby areas: industrial facilities (the Astrakhan, Lapland, and Prioksko-Terrasnyj wildlife reserves); power plants (Pripyat' and Voronezh) and water works (Zeyskiy), etc.

In addition to further expanding the network of specially-protected natural environments and improving the ecological situation at the wildlife reserve sites, these projects also require increased material, technical and financial support as well as modern scientific instrumentation.

The legal status, operation, and maintenance of wildlife reserves, sanctuaries, national parks and other specially-protected natural environments are defined and regulated by legislation and standards documents. Special attention is currently devoted to modernizing the legal status of specially-protected natural environments. Specifically a special section in the current draft version of the USSR Environmental Protection Act will be devoted to legal protection.

The departmental split in management of wildlife reserves which existed until recently represented a serious hindrance in the development of the theory and practice of wildlife reserve management. Since 1988 wildlife

reserve management in the country has been under the control of the USSR State Committee for the Protection of Nature whose system already unifies approximately 120 wildlife reserves (of a total of 164). Twenty-seven major wildlife reserves in the USSR are under the direct control and management of the Committee for which the Committee has a special section.

1.9. Regional Ecological Problems

An overall assessment of the state of the environment in various regions resulting from human economic activity makes it possible to identify the ranges of severe ecological conditions throughout the country.

A substantial volume of cartographic, statistical and reference materials on the environment, the national economy, and the population of each region was used in producing this assessment. This made it possible to employ a comprehensive geographical approach for each of the ecological ranges identified in analyzing the various forms of land use (anthropogenic effects), in assessing the potential and stability of landscapes and terrain as well as the natural conditions of life of the local population.

A joint analysis of current land use, mineral prospecting and mining, and soil restoration was carried out for each region of the country under analysis for a collection of anthropogenic loads of different types and levels. Violation of the anthropogenic loads was identified by variations in the environment- and resource-producing properties of the terrain or the natural conditions of human life, i.e., by the occurrence of an environmental problem.

The criteria for defining environmental problems consist of the following elements: air and water pollution: by levels over the MPC; erosion: by the area of heavily-eroded soil (exceeding 20-40% of the total territory) or ravine density; pasture digression: by grass cover and diminishing phytomass; forest superfelling: by violation of designated felling, etc. The value of the criterion of each specific environmental problem may differ substantially depending on region.

All environmental problems are classified in six groups:

1. atmospheric problems (atmospheric pollution);
2. aquatic problems (water depletion and pollution);
3. vegetation/forestry (forest degradation due to external factors, forest superfelling, pasture digression, and depletion of fish stock);
4. soil-geomorphological problems (erosion, deflation, ravine formation, salinization, pollution, disturbance of permafrost state of soils);
5. land-use (damage to lands and depletion of mineral resources, land alienation);

6. landscape-terrain (degradation or losses of natural recreational qualities and violation of protected status of unique natural environments).

Ranges indicating severe ecological conditions were assigned where an environmental problem or ecological situation has become most severe defined by these levels exceeding various economic, scientific, or standard assessments. As a rule, significant, intractable and occasionally irreversible changes in the environment and the terrain will occur within such ranges. The range boundaries were defined in accordance with the variation in severity or the trend of the ecological state, zones of influence of any of a variety of anthropogenic effects and the physical geographical features of the territory.

In certain cases it is difficult to establish precise boundaries on the environmental problem ranges due to the lack of specific research or standards for maximum permissible variations in terrain under the influence of anthropogenic effects. In most areas, however, they coincide with the land use contours, for example, arable land, or are determined by intensive land use zones (for example, in the Central-Black Earth regions and in the Northern Caucasus). It is most difficult to establish the boundaries of influence of reclamation systems since groundwater rising, soil and ground salinization, vegetation degradation and destruction, and effective destruction of cultivated lands will often result at substantial distances from reclamation systems.

Certain difficulties also arise in determining the ranges of environmental problems associated with industrial and transportation activities. These ranges include urbanized territories: suburban zones and infrastructure lands as well as the high industrial influence zone whose area will depend on the size of the industrial facility as well as the quality and composition of wastewater (emissions).

Ranking natural resource problems by ranges makes it possible to establish their significance as ecological situations occur. In a substantial number of ranges the primary issue is air and water pollution which has a direct effect on human health, as well as land disturbances from mining, which serves to degrade and occasionally destroy the terrain.

For example, in the Urals, the main influential factor is the ore and mineral processing industry followed by urbanization of the territory and the mining industry. The primary consequences include air pollution, water depletion and pollution, and land disturbance. The mining industry on the Kola Peninsula has resulted in land disturbance and has caused terrain disturbances and air pollution.

The environmental problems are divided into three groups based on their consequences:

1. anthropoecological (changes in the health of the population);

2. economic-resource (resource depletion or loss, lower quality or productivity);

3. natural-terrain (changes in terrain, reduction in the genetic stock or uniqueness of the terrain, etc.).

The country contains a total of 290 ranges of severe ecological conditions covering an area of approximately 3.7 million square km² or 16% of the land area. The individual range area varies from .6 to 420 thousand km². The largest number of ranges occur in Western Siberia (33), Eastern Siberia (28) and in the Northern European Section (22) due primarily to the development of the mining industry and forestry. The most significant area covered by ranges of severe ecological conditions is in the Kazakh SSR (637,000 km²), in Central Asia (400,000 km²), in Eastern Siberia (523,000 km²), and in the Urals (326,000 km²). The ranges in the Moldavian SSR and the southern and Urals economic ranges occupy the greatest area of the corresponding region, while the smallest area is occupied by ranges in the Baltic region.

The area of the ranges of severe ecological conditions exceeds that of the specially-protected environments (wildlife reserves, sanctuaries). In some cases such specially-protected territories lie within the zone of influence of these ranges.

The ranges are divided into complex, transitional, and simple ranges based on the number and type of conservation problem. Figure 33 shows sample ranges for the entire country and for two specific economic regions.

Complex ranges can be attributed primarily to the polluting effect of industrial centers, the extensive utilization of natural resources (mining, agricultural activity) and a very high population density. These include, for example, the Donbass, Kuibyshev industrial region, the Kuzbass, the industrial zone in the Northern Urals (from the Southern Tura through Chelyabinsk), the Fergan lowlands, and Transcaucasus.

The problem of air and water pollution exacerbated by a high population density is the primary problem in these ranges. The secondary problem is degradation and damage to the natural terrain (primarily the forests) which plays an important role in both recreation and in establishing the overall regional environment.

There are a total of 45 complex ranges with a total area of 676,000 km² or 3.3% of the entire country.

The transitional ranges whose natural resource (water, forests, vegetation, land use, etc.) depletion or waste levels are identical in severity to the complex ranges in certain cases will also present a threat to human health (for example, in the Aral Sea region). The transitional group includes mining ranges (for example, on the Kola Peninsula and in Northeastern Siberia); water and air pollution ranges (Noril'sk); pasture degradation, wind erosion, and soil salinization and forest degradation ranges (the Baltic region) as well

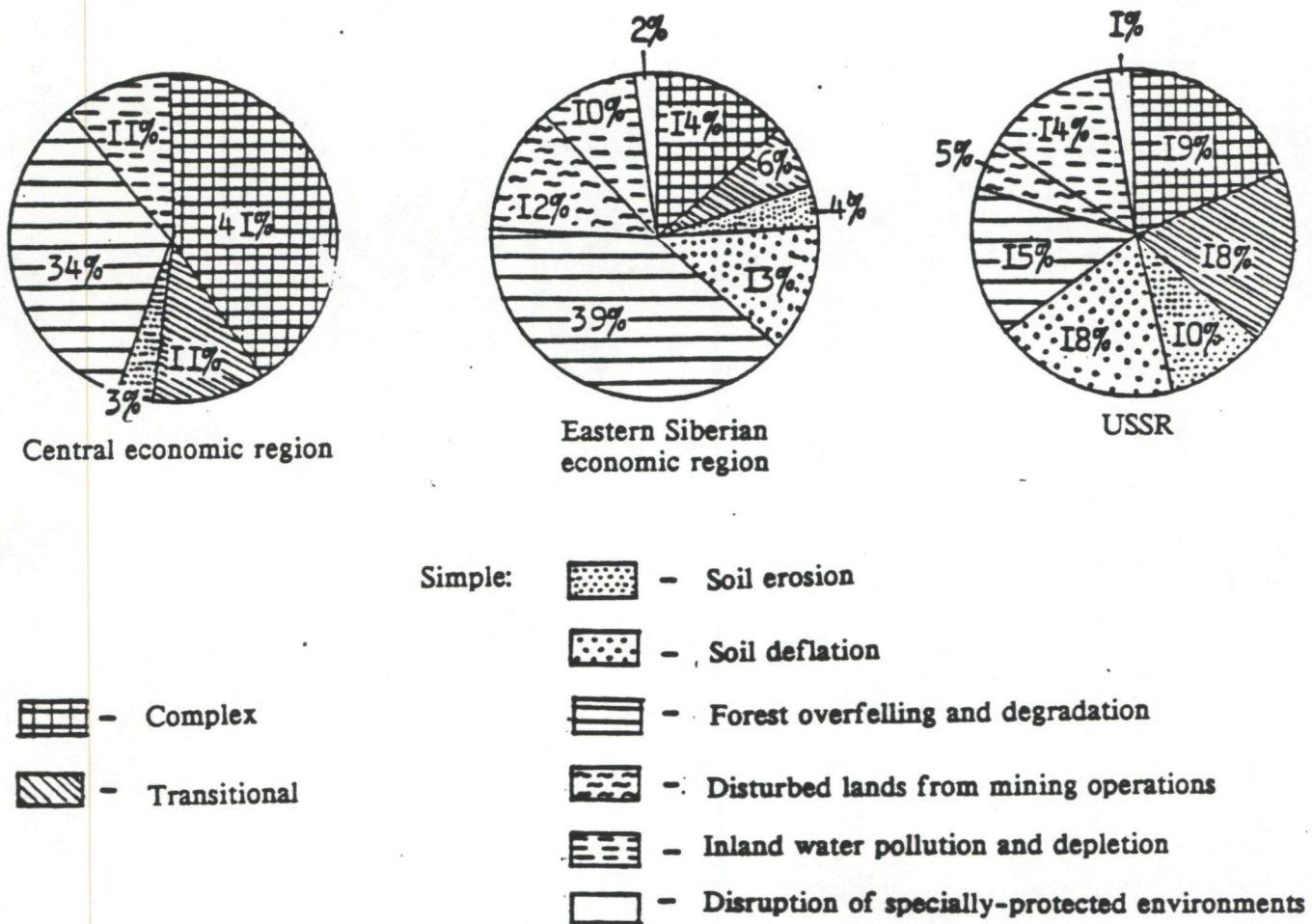


Fig. 33. Distribution of various natural resource problem ranges by ecological region and the entire USSR

as ranges where elevated pollution of the environment has been observed (an industrial center with a relatively high pollution level). The total area of the 154 ranges in the transition group is 646,000 km² or 3% of the land area of the country.

The simple ranges are associated with depletion or loss of specific natural resources. These include territories with extensive forestry activities, extensively polluted water bodies that have partially lost their value from the natural resource standpoint (the Sea of Azov, the Black Sea, the Beloye More (White Sea), and to some degree the Caspian Sea, Lake Onega, and Lake Ladoga), and heavily eroded arable and pasture land (the Central Black-Earth region and Northern Kazakhstan), and the degraded pastures of the Kalmyk ASSR. The severity of conditions in this case is due to the significant loss of biological productivity and fertility of the soils. Such ranges include territories where there are threats to the genetic stock and losses to unique natural terrain, which are difficult to restore. The total area of the 91 ranges in the third group is 2,284,000 km² or approximately 10% of the land area of the country. These include water-induced soil erosion ranges of 373,000 km², forest overfelling and degradation of 534,000 km², wind erosion ranges of 670,000 km²; mining-disturbed land ranges of 162,000 km², and surface water pollution and depletion ranges of 496,000 km².

The majority of ranges reveal a rather strong propensity for natural zones. Thus, the major ranges associated with forest overfelling encompass the regions containing the most valuable pine forests in the taiga zone with the best yield (Kareliya and Priangar'e) as well as the more varied and valuable (oak, cedar) forests in the southern regions of the Far East. The largest wind erosion range (the Northern Kazakhstan range) covers the unstable land-use belt at the boundary of dry steppe and semi-arid zones.

Overall approximately 20% of the population of the country live in unfavorable ecological conditions (excluding the radiation conditions from the Chernobyl Nuclear Power Plant accident).

The natural zone distribution of the ranges of severe (unfavorable) ecological conditions manifests the following irregularities.

The environmental and conservation problems in the tundra and tundra forest are largely related to overgrazing of reindeer pastures and mining. The group of ranges with the most clearly-expressed expansion are clustered along the northern region of Western Siberia in the oil and gas prospecting and mining regions. Above all these areas are characterized by petrochemical pollution of the environment which is particularly dangerous due to the low air, water, and soil temperatures as well as the slow self-purification processes. The pollution also damages breeding of fish stock. Pipelines and other piping, roads, and wires create obstacles to wildlife

migration and severely reduce the biological productivity of reindeer pastures.

The primary cause of conservation and environmental problems in the taiga zone is forest felling which far exceeds the designated felling level. This is accompanied by a reduction in biomass reserves, waterlogging of land, river pollution, etc. (the northern region of the European sector of the country, the Angarsk region, and the Urals). Mineral mining severely damages the environment. Conservation problems associated with land use (soil erosion) urbanization and forest felling are common in the broad-leaved forest region.

The steppe and forest-steppe landscapes are highly plowed (to levels of 30-70%) and have high soil fertility losses (humus losses to 30-50%) as a result of soil denudation and gulying. The pastures are overgrazed by cattle, which further degrades or causes digression of the pastures. Substantial useful land area is then lost for nonagricultural uses.

The conservation and environmental problems in the semi-arid and arid zones largely concern soil irrigation (salinization, water depletion and pollution) and excessive cattle grazing (pasture degradation).

Therefore environmental and conservation problems arise in different regions due to a zealous approach to natural resource utilization, neglect of landscape features, its potential and resistance to anthropogenic effects. All these factors may expand existing ranges of environmental and conservation problems and produce new ranges if extreme measures are not implemented immediately.

Certain regions of the country where severe (unfavorable) ecological conditions have developed are examined in detail below.

The Aral Sea region. The Aral Sea and its adjacent regions are located in the northern sector of the central Asiatic economic region. The total area is 473,000 km² with a population exceeding 3 million.

During the years of Soviet power the Aral Sea region, which previously supported only extensive nomadic cattle farming and primitive irrigated farming was transformed into a multifaceted agricultural production region based on extensive irrigation.

Large-scale restoration projects and the development of industry converted these economically-backward regions into major agro-industrial complexes. The regional output of agricultural products increased by a factor of four compared to the 1950 level.

Serious errors were also committed in efforts to organize water and land use from the Aral Sea. Primary attention was long focused solely on exploiting new water areas.

Nonreturnable water use for cotton plantation irrigation has resulted in severe reductions in Amu Darya and Syr Darya flows into the Aral Sea in recent years. The water level in this case has dropped by more than 12 m

while the area of the water body itself has dropped by a third compared to the early 1960s with the water volume diminished by 60%. The river water in the downstream waters of the Amu Darya and Syr Darya has degraded to a catastrophic level and these waters are not potable. Severe desiccation and salinization of lands in the deltas of these rivers have resulted together with severe degradation of the ecological systems, and the wildlife and vegetation of the Aral Sea and adjacent regions.

Hundreds of thousands of hectares of irrigated lands in the region have been submerged and salinated. Significant land areas designated for cotton growing have been infected by pathogens and pests. Soil fertility has diminished in many irrigated land areas and the yield of major agricultural crops has dropped.

A severe socioeconomic, ecological and health situation that represents a danger to human health has thus evolved in the Aral region, particularly in the Karakalpak Autonomous SSR, the Kzyl-Ordinsk and the Tashauzsk oblasts (regions). According to data from the USSR Ministry of Public Health there has been a rise in the morbidity rate, particularly for women and children, while the death rate has risen as well. The worsening health conditions of the population in the Aral area, in addition to ecological factors, can also be attributed to serious deficiencies in medical facilities, and the lack of a central water supply system in a number of populated regions. For example, in the Karakalpak region a centralized water delivery system is available in only 11% of municipal areas and is completely lacking in the villages.

The increasing severity of ecological conditions in this region can also be attributed to the depletion and pollution of the Amu Darya and Syr Darya waters as well as the anthropogenic desertification of the Aral region. River and water reservoir pollution is produced primarily from industrial discharge and agricultural wastewaters. The agricultural facilities contribute an enormous quantity of phosphor and nitrogen compounds as well as other substances, including toxic substances contained in defoliants and insecticides. The discharge of highly-mineralized drainage waters in the rivers is responsible for the elevated mineral content of the river flow. The total bacteria level exceeds the maximum permissible concentration by a factor of 5-10.

The new land made available from the retreat of the Aral Sea has become a site of wind transport of topsoil and salts. Here dust will travel upwards of 200 km in distance. Preliminary estimates suggest that between 15 and 75 million tons of dust rises into the atmosphere annually. All salts deposited on the terrestrial surface in the Aral region averages 520 kg/ha, which is one of the causes of soil degradation.

The central organs of the state have adopted a special resolution in order to improve the ecological conditions and health of the populace as well

as to further develop the productive capacity in the Ural region. This resolution outlines a set of conservation measures to be implemented between 1988 and the year 2000; the primary measures include: increasing the water supply level and health support services; establishing normal human health and sanitary conditions in the Aral region; step-by-step reduction in the use of chemical agents in agriculture; water rationing; water conservation technologies in all economic areas; establishment of guaranteed discharge from the Amu Darya and Syr Darya into the Aral Sea beginning in 1990. The current plan is for the volume to increase to 11 km³ by 1995, to 12-17 km³ by the year 2000 and to 20-21 km³ by the year 2005.

Caspian Sea Region. The overall ecological situation in the Caspian Sea basin, which is accompanied by diminishing sanitary/health and fishing conditions, is presently classified as a pre-crisis situation. The self-purification system of the basin and the water bodies and reservoirs has completely destabilized. A rapid degradation of the ecosystems of the Volga River estuaries continues.

A range of radical measures to restore the environment has been planned to avoid further damage; these measures include:

- a stage-by-stage reduction in polluted wastewater discharge and the attainment of maximum permissible pollutant concentration standards for wastewaters and atmospheric emissions for the 290 major unions, organizations, and 60 cities;
- construction of wastewater treatment plants for extensive purification to eliminate biogenic elements and adoption of other measures to deal with eutrophication of the water reservoirs;
- a ban, beginning in 1989 on the use or storage of pesticides of mineral fertilizers in water reservoir zones and elimination of rice cultivation;
- completion of conservation facilities prior to the start-up of the second series of the Astrakhan gas condensate plant, the Tengiz petroleum field, or the Karachagansk gas condensate field;
- construction of facilities for recycling, detoxification and burial of toxic industrial, domestic, and other municipal wastes;
- assignment of water conservation plant design and construction supervisory functions to the organizations under the USSR Ministry of Public Health;
- initiation, beginning in 1990, of fundamental research on the development and incorporation of new, progressive, wastewater treatment and purification technologies and equipment for various industrial fields and other natural resource conservation measures.

Sea of Azov. The Sea of Azov is an extremely valuable inland natural salt water reservoir characterized by shallow water (average depth: 8 m), a low inertia and rapid variability of abiotic properties.

The hydrobiological conditions in the Sea of Azov are determined by the river discharge water into the sea as well as its water exchange with the Black Sea.

Initially the yearly fresh water discharge into the Sea of Azov amounted 42 km^3 , including 28 from the Don, 13 from the Kuban, and 2 from small rivers. With this discharge rate the mean annual salinity of the sea was 10.5‰ while the mean annual salinity of the Gulf of Taganrog was 6-7‰; four-fifths of the sea area was occupied by water with salinity below 10‰ and the salinity reached 12‰ in the Kerch region only.

A significant reduction in fresh water discharge into the sea began in 1948 when the first stage of the Nevinnomyssk multi-use hydrologic works on the Kuban was put on-line.

The Shimlyansk multi-use hydrologic works on the Don, built in 1952, regulated the spring flow of the Don, cutting off all spawning grounds of the white sturgeon, 75% of the sturgeon spawning grounds, 50% of the starred sturgeon, herring, etc. spawning grounds.

Analogous disruptions on the Kuban resulted from the construction of the Federov (1967) and Krasnodar (1974) multi-use hydrologic works. The construction of the Tikhov multi-use hydrologic works (below the Federov site) is currently under completion on the Kuban and the Temizhbeks multi-use hydrologic works are under design.

According to data from the Azov Scientific Research Institute of the Fishing Industry, the biomass of zooplankton during the regulation period is clearly manifesting a substantially diminishing trend; in recent years the biomass of zooplankton in the sea ($160\text{--}250 \text{ mg/m}^3$) is below the level for effective anchovy feeding (400 mg/m^3) while in the Don River delta the level is 10 times lower than during the regulation period.

At present the total annual river flow into the Sea of Azov is approximately 31 km^3 which is at the lower functional limit of the sea ecosystem with a trend towards a transition from an average-productivity level to a low-productivity level.

The Black-Sea jellyfish is common in the sea during low water periods. During the wintertime a fresh resupply of water occurs while in the summertime extensive fish destruction and hydrogen sulfide zones arise.

A further sharp reduction in the water exchange front will result in the formation of stagnation zones, water "bloomings", a precipitous decline in water quality, eutrofication of the Gulf of Taganrog, increasing flow rates into the Taganrog Strait, floor erosion, coastline erosion, worsening shipping conditions, etc.

In 1988 over $1.240 \text{ billion m}^3$ of wastewater was dumped into various areas of the sea from industrial facilities along the coastline; this total includes $.158 \text{ million m}^3$ of untreated wastewater and more than 82 million m^3 of undertreated wastewater.

In 1988 approximately 75 million m³ of treated wastewater or wastewater conforming to treatment standards was dumped into Kerch Bay from industrial operations. However, accidents also occurred, resulting in the discharge of .15 million m³ of untreated wastewater into the bay waters, primarily in the Kamysh-Burunsk Bay. The primary wastewater source is the iron ore treatment plant whose wastewaters contain iron, arsenic, and manganese compounds. The source of the nitrogen- and phosphor-containing compounds in the bay includes the wastewaters from meat- and fish-processing enterprises, while the petroleum products derive from shipping and the discharge of bilge waters from ship repair factories.

The shipping lane regions most polluted by petroleum products (1-3 MPC) include the Kerch Strait, the Gulf of Taganrog, the northwestern region of the sea, the drilling areas in the shelf zone, and the commercial fishing regions of Arabat [Arabatskiy Zaliv], Temryuk [Temruskiy Zaliv], and Yasensk Bays.

The open waters of the Sea of Azov are classified as moderately-polluted in terms of the water pollution index (WPI).

The water pollution index classifications of the coastal areas of the sea include: contaminated: Berdyansk Bay; polluted: the northern section of Kerch Bay, Kerch Inlet, the outer harbor of the port of Maiupol (Zhdanov); moderately-polluted: Kamysh-Burunsk Bay, the Gulf of Taganrog, the sea range of the Don River delta; clean: Kuban beach and the branch of the Protok, the Temryuk Peninsula, and the liman straits.

The Black Sea. The area of the USSR economic zone is approximately 200,000 km² in the Black Sea. The mean annual continental discharge into the sea is approximately 266 km³. The most substantial contribution derives from the following rivers (in km³/yr): the Danube - 132; the Dnepr - 54; the Dnestr - 10.

The primary problems in the Black Sea include salinization of the Dneprovsk-Bugsk and Dneprovsk limans and the pollutants in these limans as well as the northwestern region of the sea.

The most serious danger derives from the hydrogen sulfide present in the waters of the Black Sea. According to specialists the rate of rise in the upper boundary of the hydrogen sulfide zone increased by a factor of 67 between 1935 and 1985: from 3 cm annually to 2 m annually. Hydrogen sulfide now affects 90% of the Black Sea and the lifeless zone begins at an average depth of approximately 80m.

In 1988 848.1 million m³ of wastewater was dumped into the Black Sea from the industrial and commercial enterprises of the major cities and resorts. The wastewater composition was as follows: 262.3 million m³ (92% of which was untreated) was dumped into the estuarine region of the Danube; 202.5 million m³ (4%) was discharged into the Dnepr-Bugsk estuarine region; 166.1 million m³ (11%) was discharged into the northwestern region

of the sea; 156.3 million m³ (3%) was dumped along the coastline of the Krasnodar krai (district); 34.5 million m³ was discharged in the vicinity of the Southern Bank of the Crimea; 25.6 million m³ (18%) was dumped along the Georgian coastline; 0.8 million m³ of wastewater was dumped into Sevastopol Bay. The wastewaters also included the following elements: 2.8 thousand tons of total nitrogen; 1.5 thousand tons of ammonia nitrogen; .9 thousand tons of petroleum products; .7 thousand tons of total phosphorus; 7.6 thousand tons of copper; .2 thousand tons of synthetic surfactants, and 0.9 thousand tons of iron.

Oil slick pollution has been observed most often along the coastline of the Crimean Peninsula and along the Caucasian coastline from Anapa to Batumi. In the Batumi region petroleum product spills from overflowing tanks at the oil and gas processing factory produced an average annual oil slick level on the sea surface of approximately 115 km². The total oil slick areas on the sea surface for individual months in 1988 were: January - 2653 km²; April - 4794 km²; June - 367 km²; August 156 km²; and December - 361 km².

High synthetic surfactant concentrations (10-32 MPC) as well as phenol concentrations (30-52 MPC) have been repeatedly logged in wastewater discharge regions and the drain areas for Odessa and Ochakov municipal storm water drains. An accident at a sewage pumping facility in Ilichevsk produced a spill of untreated wastewater into the sea.

The beaches of Odessa have been closed periodically due to poor ecological conditions resulting from violation of health standards for both bacteriological and hydrochemical factors.

The average synthetic surfactant concentration in 1988 doubled compared to 1987 and totaled 2 MPC in the resort area of Yalta.

The overall coastal pollution level in the Black Sea substantially exceeds the ambient level. Severe hydrochemical conditions are particularly characteristic of port waters as well as severe water exchange regions (the Dnepr-Bugsk estuary, and Sevastopol Bay), and the river drainage zone. The Northwestern Black Sea remains the most severely polluted; here the concentrations of petroleum products, phenols, and synthetic surfactants exceed the maximum permissible concentrations.

Ferrous metallurgy and chemical plants represent the primary pollution sources for the Black Sea.

The Black Sea is an international resource and hence the Soviet Union attaches great significance to approving and adopting a convention to eliminate pollution of the Black Sea. At present a draft convention is under development by the governments of the states bordering the Black Sea: Bulgaria, Romania, the USSR, and Turkey.

The Lake Ladoga and Onega regions. The economic activities of the enterprises under the USSR Ministry of the Lumber and Woodworking

Industries, the USSR Ministry of Nonferrous Metallurgy, the USSR Ministry of the Medical and Microbiological Industries, the RSFSR State Agricultural Committee and municipal economic activities have a substantial effect on ecological conditions in these regions.

Overall the Lake Ladoga waters are moderately polluted (class III). The concentration of such pollutants as copper and manganese salt, phenols, and organic matter substantially exceed the permitted standards. The lake waters are thoroughly polluted with organochlorine pesticides.

The lake Onega waters are largely polluted by organic matter and petroleum products.

These lakes are commercial lakes.

The fate of these lakes is a cause of great concern to both the residents of this region and the government. The USSR Council of Ministers has adopted a resolution entitled *Supplementary Measures for Conservation and Rational Use of the Water and Other Natural Resources of the Basin of Lakes Ladoga, Onega, and Ilmen*.

This resolution has not been satisfactorily implemented. Both domestic and commercial construction proceed in nearly all cities in the region without advanced development of water supply, treatment plant or power capacities. The specialized organizations do not plan the construction of conservation facilities within the standard time periods. Their construction and start-up plans are not systematically implemented.

Moreover, a number of other measures are not practiced including measures to avoid soil erosion, strict observation of conservation requirements, storage and transport of pesticides and mineral fertilizers, and the general procedure for economic activity in water conservation zones. The drainage of soil erosion products into the water bodies has the most damaging effect on the small rivers feeding the lakes.

In order to reduce the damage to the hydrochemical state of the water bodies in the Lake Ladoga basin from wastewaters produced by the enterprises of the USSR Ministry of the Lumber and Woodworking Industries it was decided to shut down two paper machines at the Kamnegorsk paper mill and to limit the production capacity at the Svetogorsk and Syas' works. The toxic wastes produced by the Priozersk pulp and paper mill were treated to achieve ecological purity. These are strictly reactive, tactical measures. The strategic measures will be directly taken by the State Ecological Inspection Team of the USSR State Committee for the Protection of Nature. The Committee is considering a conservation facility construction program as well as other measures through 1995. Implementation of these measures will involve a complete elimination of wastewater discharge into the lakes and rivers of the region and a reduction to conform with standards of pollutant air emissions by pulp and paper plants.

Kola Peninsula. The primary environmental pollution sources on the Kola Peninsula include the enterprises of the USSR Ministry of Nonferrous Metallurgy, the USSR Ministry of Power Engineering and Electrification, the Union-Republic Ministry of Mineral Fertilizer Production, and the USSR Ministry of Ferrous Metallurgy.

The ecological conditions of the Kola Peninsula largely depend on the emissions and discharge from enterprises under the control of the USSR Ministry of Nonferrous Metallurgy. Substantial sulfur gas emissions have resulted in elevated concentrations of sulfur gas in the populated regions of the Murmansk oblast' (region).

The condition of the air basin near the "Pechenganikel" works has become especially critical. The use of imported coal (which has a higher sulfur concentration compared to local raw materials) without preliminary modification of the metallurgical production process has resulted in higher emissions and a severe decline in the ecological conditions in the Pechenga region: near the Nikel urban-type settlement the lichen died off and the grass cover was destroyed.

The sulfur gas emissions resulted in desiccation of the forests on the peninsula and new plantings did not take well in the acidic soils.

Air pollution from sulfur gas, copper and nickel compound emissions near the "Severonikel" works also had a negative effect on the ecological conditions on the peninsula, primarily human health. Damage was also caused to forestry, and the Lapland biospheric wildlife reserve due to the long-term action of sulfur gas and heavy metal compounds.

The existing situation has resulted from industrial development without advanced introduction of environmental conservation techniques and facilities, neglect of metallurgical gas desulfurization standards, and poor operation of dust and gas traps and scrubbers.

Given the ecological conditions in the vicinity of these works and their effect on long-range pollutant transport, a program was adopted to reduce sulfur dioxide emissions by 47% at the "Pechenganikel" works and by 56.3% at the "Severonikel" works by 1993 (levels compared to 1980).

The USSR Ministry of Nonferrous Metallurgy has also developed measures to achieve the standards established for these enterprises by 1995. The primary direction for reducing sulfur dioxide emissions is to convert metallurgical conversion processes to an autogenic technology with recovery of sulfuric acid from the metallurgical gases.

Noril'sk. The polar regions are more sensitive to industrial emissions by virtue of their natural climatic conditions. Therefore special attention is devoted to the state of conservation activities as Noril'sk mining and metallurgical works: the primary environmental pollution source for both Noril'sk and the entire Taimir Peninsula. The total forest degradation range in the Noril'sk area had reached 545,000 hectares by 1989.

The Noril'sk air is most heavily polluted by sulfur dioxide, the oxides of nitrogen, carbon monoxide, phenol, hydrogen sulfide, and chlorine. In 1988 the maximum concentrations totaled: chlorine - 5 MPC; nitrogen dioxide - 15 MPC; sulfur dioxide - 20 MPC; and nitric oxide - 36 MPC. The sulfur dioxide emissions accounted for the majority of the total emission output from the works.

A fundamental solution to the problem of atmospheric pollution by sulfur gas at the Noril'sk works will involve recovery of elementary sulfur from the metallurgical gases and delivery of the sulfur to the customer. An experimental industrial system to recovery elementary sulfur was put on line at the copper smeltery of the works in 1987, although its capacity has not yet reached the design level. A portion of the equipment at the works is operated without the necessary environmental protection measures and equipment.

A comprehensive environmental program has been developed for the works for the years 1988-2005. According to this program the sulfur gas recycling capacity at the copper smeltery and the Nadezhda metallurgical works will be put on line in 1995. However, the issue of sulfur recovery at the works has not yet been resolved. The solution to the problem has been carried over to the Fourteenth Five Year Plan.

Lake Baikal Basin. Lake Baikal is a unique freshwater lake that is both the deepest in the world (1620 m) and has the largest water volume (23,600 km³). The lake contains approximately 20% of the worldwide and over 80% of the USSR freshwater reserves. The Lake Baikal ecosystem is surprisingly rich and varied: over 2400 species and varieties of wildlife and vegetation inhabit the lake. More than two-thirds of the species of Lake Baikal are native species that do not exist in other regions. Lake Baikal is the only water reservoir in the world with a unique deepwater, freshwater fauna. The unique feature of Lake Baikal is its precise biological water self-purification mechanism. The primary role in this mechanism is played by the zooplankton which functions as a filter of the lake's water. Lake Baikal represents an invaluable reservoir of the world's genetic stock.

The uniqueness of the Lake Baikal ecosystem and its natural properties, processes, and phenomena, necessitate an extraordinarily careful and scientifically-validated approach to regional economic development. The watershed basin is an integral part of the lake and any anthropogenic changes in the natural systems of the basin will alter the hydrochemical and hydrobiological conditions of the lake.

The development of economic production forces and the irrational use of regional natural resources has degraded the hydrochemical state of the lake and its tributaries, resulted in air pollution, accelerated erosion processes, damaged life in Lake Baikal, and harmed the forests. Economic activity in the Lake Baikal basin has been responsible for dumping of a

large quantity of organic matter, phenols, petroleum products, synthetic surfactants, and other pollutants into the lake. In regions of permanent human influence (the Baikal pulp-and-paper plant (BPPP), the Selenga pulp-and-paper plant (SPPP), and the Baikal-Amur railway (BAM)) there is an elevated concentration of suspended and material matter, petroleum products and sulfurous organic matter compared to the ambient level. Bottom sediment pollution over an area in excess of 20 km² has been detected near the Baikal pulp and paper plant.

In supporting the active public outcry to conserve this unique natural system the government has adopted a resolution proposing a radical solution to the Lake Baikal problem; one of the fundamental elements of this resolution was to modify the Baikal pulp and paper plant.

Efforts have begun at the Baikal pulp and paper plant to improve the condition of its wastewaters. In 1988 plant capacity dropped by 2.7% and wastewater volume diminished by 2.3% (by 1.804 m³). The discharge of wastewaters meeting pollution standards without purification ceased. The total influx of pollutants to the lake from the plant was reduced by 17%. These measures had some effect: the nonsulfate water pollution area near the Baikal pulp and paper plant was reduced while hydrobiological (phytoplankton and zooplankton) water quality was improved to some degree.

However sulfate, chloride, and suspended matter concentrations remain above the maximum permissible concentrations near the plant while the bottom sediment contamination range at the wastewater discharge site has not diminished.

Elevated concentrations of petroleum products have been observed in other regions of the lake subject to anthropogenic influences; these include Bargazin Bay while high water "blooming", suspended matter, and ammonia nitrogen levels have been observed in the Selenga shallows. Hydrobiological research has demonstrated the negative effect of lake water quality of distributed pollution sources near the town of Baikalsk and the village of Kultuk-Slyudyank.

The government resolution outlines 162 major resource conservation measures for implementation in the region by the year 1995.

A draft version of a general concept for economic development in the Lake Baikal basin has been proposed. A comprehensive environmental design for Lake Baikal is under development together with related water conservation and natural resource regulations. Standards for permissible influences on the ecological system of the lake have been developed and approved.

Regulation of shipping in Lake Baikal and its tributaries is currently being implemented: ship volume has been reduced by 30%.

Necessary modifications have been made to the "Forest Felling Regulations" while designated felling in the water conservation zone of Lake

Baikal has been reduced in order to achieve comprehensive utilization of timber resources and to conserve the soil-retentive and water-conserving properties of the forests.

A promising plan for tourism and resort development has been developed taking into account the general concept of economic development in the Baikal basin.

The problem of lake conservation remains a timely issue and requires an increasing expenditure of efforts and resources for a successful resolution, since the danger of irreversible processes in the Baikal ecosystem remains.

1.10. Public Health

Overall the USSR provides the requisite conditions for maintenance of a healthy lifestyle and environment for the populace, although, as is the case throughout the world, negative factors exist as well. These include unfavorable environmental conditions.

Society is increasingly aware of the fact that solutions to the problems of maintaining and improving public health (improving the environment, establishing and maintaining optimum recreation, domestic, and work conditions, as well as an efficient food supply, etc.) depend on the joint efforts of the ministries, departments, Party and State organizations, and public organizations.

According to census data reported on January 12, 1989, the population of the USSR at the beginning of 1988 was 286.7 million (versus the 1970 population of 241.7 million). The birthrate has increased over the last 15 years: in 1988 the birthrate was 18.8/thousand versus 17.1/thousand in 1970. Regions with high birthrates include the Central Asian republics where more than 11% of the national population resides.

The total death rate in 1988 was 10.1/thousand residents. Infant mortality dropped from 30.6 in 1975 to 24.7 in 1988 (per thousand residents). The average life expectancy was 69.5 years (64.8 for men and 73 for women).

The primary causes of death include cardiovascular disease, accidents, tumors, poisoning and trauma, and respiratory disease (89% of deaths from all causes in 1988); see Table 21.

The incidence of first-time disability in the USSR was 43.1 cases per 10,000 workers and professional staff [blue and white-collar workers] in 1987. The number of illnesses with lost work time increased by 12.5% throughout the nation in 1988.

The morbidity from various respiratory illnesses grew over a 15 year period. The mean annual relative morbidity of the urban adult population in

the USSR has increased from 1982 to 1987: for hypertonic illness: from 12.7 to 20.3 per thousand residents; from ischemic heart disease: from 12.9 to 15.6; from upper respiratory tract illnesses: from 126.2 to 154.2 (from 761.9 to 838.8 with children included); for digestive tract diseases: from 19.5 to 24.3.

Table 21
Dynamics of the death rate in the USSR by cause of death
(per thousand)

Cause of death	1970	1980	1985	1987	1988
Cardiovascular disease	570	692	705	647	647
Malignant tumors	170	169	*176	183	185
Accidents, poisoning, trauma	112	141	120	92	105
Respiratory illnesses	135	124	104	84	85
Digestive tract diseases	31	37	36	32	32
Infections and parasitic illness	31	25	23	21	20

* Standardized figures eliminating the age structure of the populace as a factor.

The number of patients with a first-time tumor diagnosis increased. At the beginning of 1988 there were 2.8 million oncology patients in hospitals and health institutions. Respiratory, stomach, and skin cancers predominate the figures throughout the country.

Clinical figures for the beginning of 1988 show 611.4 thousand patients with active TB.

The morbidity rate for influenza is increasing together with that of acute noninfluenza respiratory illnesses.

The morbidity from acute liver infection totaled 602 cases per 100,000 residents in 1989 while the figures for typhoid fever and types A, B, and C paratyphoid were 4.5; there were a total of 305 cases of viral hepatitis per 100,000 residents.

Approximately 4 million workers lost work time to illness in 1987.

These statistical data reveal the effect of a wide range of social, economic, ecological, and other factors on the human body; such factors influence the overall health and morbidity of the entire population. A significant role among these causal factors is played by environmental quality, lifestyle, nutrition, recreation and work conditions. For example, among the

risk factors for cardiovascular disease are stress at home and on the job, diminished physical activity, an unbalanced diet, excess weight, smoking and alcohol abuse, and, finally, environmental pollution.

In addition to a generally negative effect on human health conditions, environmental pollution also has a direct effect on human health. This has been confirmed by extensive research. The nature of such relationships has been analyzed by the mathematical programs in the AGIS-Health Automated State Data System. By ranking the cities in the system by the morbidity levels of their population a clear relation was established between air pollution levels and population morbidity; see Table 22 (see also Figure 7).

Table 22
Average monthly morbidity factors for the adult
population per 100 residents
(based on data from the "AGIS-Health" Automated State Data System, 1987)

Patient group	USSR Average	Average for individual cities		
		Lipetsk*	Berezniki*	Vilnius**
1	2	3	4	5
Malignant tumor	0.25	0.48	0.32	0.11
Endocrine diseases	0.26	1.09	0.030	0.15
Blood diseases	0.05	0.18	0.28	0.02
Digestive tract diseases	9.90	12.11	6.64	1.78
Respiratory diseases	14.17	32.29	24.96	13.84
Cardiovascular diseases	3.06	18.85	11.70	2.22
Muscular diseases	0.44	1.94	0.56	0.17
Skin diseases	0.76	2.40	1.30.	0.74
Nervous system diseases/ disorders	1.18	4.10	3.02	0.34

* Exceeds the maximum permissible airborne concentration of monitored substances by a factor of 2-6 (Lipetsk) and by a factor of 2-4 (Berezniki).

** Exceeds the maximum permissible airborne concentration of monitored substances to only an insignificant degree (up to 2 MPC for individual pollutants).

To some degree the structure of morbidity depends on the quality level of emissions and the type of industry. For example, a higher morbidity level for the cardiovascular system diseases is evident for emissions from nonferrous metallurgy plants. The emissions from ferrous metallurgy and power generating plants most severely affect the respiratory organs. Allergies (dermatitis, asthmatic bronchitis and bronchial asthma) are more widespread in areas containing chemical and petrochemical enterprises.

In the more heavily polluted regions near Chimkent and Dzhabul the bronchial asthma morbidity is up to three times higher and the chronic upper respiratory morbidity is up to ten times higher than in the control zone. An increasing transition of acute illnesses to chronic illnesses is currently observed. The incidence of pneumonia in children near the Chelyabinsk metallurgical factory is 33% (per 1000 children) higher than in the control zone. Diminishing nonspecific immunity has also been noted.

A significant increase in specific allergies associated with chemical and biotechnological air pollution has been identified. This includes, for example, the increase in illness in the city of Kirish (Leningrad oblast' (region)) and the city of Svetliy Yar (Volgograd oblast' (region)) associated with the effect of emissions from biotechnical enterprises under the USSR Ministry of the Medical and Microbiological Industries. It has been established that these emissions have a specific aggressive action in conjunction with existing chemical air pollution.

Special research conducted over the last decade on changes in the health of children residing in cities and regions with elevated air pollution levels (Voskresensk, Kazan, Monchegorsk, Novokuznetsk, Perm, Podol'sk, Salavat, Svertlitamak, Yaroslavl', etc.) have demonstrated a diminishing nonspecific resistance of the human body. This makes children especially vulnerable to infectious and other diseases. Thus the duration of respiratory infections in children from polluted regions is 2-2.5 times higher than in the control regions (relatively ecologically clean areas).

An irrational use of pesticides in agriculture has a no less significant effect on human health and results in the accumulation of residual concentrations in the soil, water, and food supply. The total annual pesticide load in the Krasnodar krai (district) in the Tadzhik SSR exceeds the average nationwide level by a factor of 3-5, while the total level in the Moldavian SSR exceeds the national average by a factor of 9-10 and the total load in the Armenian and Turkmen SSR exceeds the national average by a factor of 20-25 or more. In high pesticide use areas the total infant morbidity through age 6 is 4.6 times higher than in regions with lower chemical pesticide use (with a predominance of skin, digestive tract, respiratory, and metabolic diseases and retardation in physical development).

The high incidence of acute liver infection is largely due to unsatisfactory health conditions in the central drinking water supply system or the

lack of a centralized water supply system, particularly in villages in Central Asia and Kazakhstan. More than 70% of the cases of typhoid fever occur in these areas. The high level of viral hepatitis is also due to the lack of availability of good quality drinking water to the population. Overall, at the beginning of 1989 no centralized water supply system was available in 18 cities throughout the country with populations exceeding 170,000 or in 597 municipal type villages (15% of their total number), while no centralized sewage system was available in 285 cities with populations exceeding 4 million or in 1894 villages (47% of the total).

The current health condition of the maturing generation is of special concern. A chronic pathology develops as early as the preschool years. According to data from the Scientific Research Institute for Health and Prevention of Diseases Among Children and Adolescents, approximately 14% of preschool children have chronic illnesses to the otorhinolaryngological organs, the musculoskeletal system, and urogenital organs. Only 23% of children up to 7 years of age are effectively healthy.

Absolutely healthy school children account for no more than 20% and no more than 14% in the higher classes. Otorhinolaryngological diseases, digestive tract diseases, nervous system diseases, and allergies predominate in the chronic pathology of school age children; these have more than doubled (they exist in 20% of school children versus 8% in the 1970s), which is due in some measure to worsening ecological conditions.

In the last 2-3 years the public health organs, in addition to their traditional social functions, have begun to focus increasing attention on the practical medical treatment of emergency cases associated with not only the precipitous decline in ecological conditions but also with the relatively common cases of large-scale industrial accidents, catastrophes and natural disasters. An example of such a critical situation is the accident at the Chernobyl Nuclear Power Plant from which public health organs learned useful, albeit painful, lessons.

In addition to the specialized radiological departments of the USSR Ministry of Public Health a substantial range of medical assistance and equipment from the Ukraine and other union republics were brought in to provide a wide range of public health and safety services to protect the population from radiation exposure over the extensive areas contaminated by radionuclides from the accident site.

Nearly 1 million individuals were provided with all forms of medical analysis and testing; of these 700,000 (including 216,000 children) were tested using fundamental radiation-monitoring and hematological analysis techniques. A total physical review and analysis was conducted on 5.4 million residents (including 1.7 million children). A focused mass evacuation of children followed by adults was implemented.

Specialists of the USSR Ministry of Public Health have estimated the effective equivalent doses of internal and external radiation over the first and subsequent years in hundreds of populated areas. A thorough analysis of the isotope composition and gamma-fields made it possible to obtain such data with a sufficient degree of accuracy.

The individual radiation doses (internal and external) accumulated through the fall of 1988 by the majority of residents in monitored regions (based on data from the USSR Ministry of Public Health) averaged 5.3 rem and in only isolated cases did it exceed 10 rem. No radiation sickness of any kind was detected among the populace.

In November of 1988 the USSR Ministry of Public Health established a radiation dose exposure limit for the populace in the monitored regions of 35 rem.

This standard for both internal and external doses is virtually uniformly met at a cesium-137 contamination density of up to 15 Ci/km³ without any shielding measures.

The All-Union Scientific Center of Radiation Medicine of the USSR Academy of Medical Sciences was founded in Kiev to investigate anticipated long-term medical-biological as well as oncologic and genetic consequences of the accident and to support regular specialized radiologic assistance in this region.

The Resolutions of the 27th Congress of the CPSU and subsequent Plenums of the CPSU Central Committee entitled *Primary Developmental Directions in the Protection of the Health of the Populace and the Reconstruction of Public Health in the USSR in the 12th Five Year Plan and Through the Year 2000* and the Resolution of the CPSU Communist Party and the USSR Council of Ministers dated June 20, 1988 entitled *Measures to Further Improve Protection of Public Health and Enhancement of the Material and Technical Base of Public Health Services* establish fundamentally new conditions for the implementation of a single unified policy of the Party and the government in supporting public health.

A Comprehensive Program of Efforts to Improve the Treatment of Disease and Enhance Public Health, 1985-1990 is currently being implemented throughout the country. Moreover, a draft of an analogous program to extend through the year 2000 is also under development. This program envisages such measures as:

- effective environmental protection and enhancement;
- establishment of safe and nonthreatening living and working conditions;
- improvement of recreation and domestic life;
- introduction of a safe, rational, nutritious, and balanced diet;
- involvement of many layers of society in physical exercise and sports, etc.

The actual implementation of this program will help to improve the health of the Soviet peoples and will facilitate the development of both a physically and morally healthy populace and a healthy lifestyle for the entire nation.

SECTION II
STATE POLICY
IN
ENVIRONMENTAL PROTECTION AND RATIONAL USE
OF NATURAL RESOURCES

2.1. The Socioeconomic Development of the Nation and Ecological Problems

Development of the System of State Management of Environmental Protection and Use of Natural Resources

The issue of the causes of the present unfavorable ecological conditions throughout the world and in our country was briefly discussed in the introduction. The following should be added to this presentation.

From the earliest days of Soviet Power environmental protection was viewed as not only a critically important state problem but also a task for all people. Lenin's decree *On Land* adopted by the Second Congress of Soviets on November 8, 1917 was the first document in history to revoke private ownership of land, minerals, water, and forests and to assign such resources to government conscription. All natural resources could then be utilized and conserved as the common property of the workers. This decree was responsible for establishing the extensive possibilities for planned and rational use and conservation of natural resources. The significance that the young Soviet government attached to conservation and protection of nature in this difficult time is clearly evident from the decrees adopted during this period, for example, 1918 - *On Forests*, 1919 - *On Hunting*, 1921 - *On the Conservation of Fish and Wildlife in the Arctic Ocean and the Beloye More [White Sea]*, and *On the Protection of Natural Memorials, Gardens, and Parks*. These and subsequent legislative acts provided the basis of state rational land use measures. During this period the conservation section in the USSR State Planning Committee formulated the concept of conservation management: "this issue, as one that affects not only all aspects of human life and the interests of many departments, but international relations as well, should be concentrated in a supreme, federal governmental organ on the republic level outside of departmental control, and have both local authority and sufficient means of support."

However, on the eve of the Second World War the industrial defense output was undergoing rapid expansion and it is not necessary to explain that such industrial development was not consistent with modern health, sanitary, and environmental requirements. During the Great Patriotic War approximately 1700 major enterprises were evacuated in the western region of the European section of the country. These enterprises were rapidly constructed in the new industrial areas of the Urals, Siberia, and Kazakhstan in extraordinary conditions and ecological requirements could not be observed in this case. The period of rebuilding the destroyed economy during the cold war and in isolation then followed.

Only beginning in the 1960s was the country able to formulate the problem of environmental protection as a timely issue and to proceed with a

solution, the more so as the environmental quality problem had clearly worsened by this point.

The USSR Supreme Soviet adopted a number of laws to regulate use of natural resources throughout the country. The conservation and rational use of natural resources were constitutionally-guaranteed. Resolutions of the Party and government were adopted on individual issues. The system of conservation and environmental protection measures in the country was reflected in the resolutions of the Central Committee of the CPSU and the USSR Council of Ministers of 1972 and 1978. These resolutions assigned responsibility for conservation and rational use of natural resources to the ministries and departments. The National Environmental Pollution Monitoring Program which was organizationally based on the operational and scientific organs of the USSR State Committee on Hydrometeorology, the USSR State Committee of Public Health and the USSR Ministry of Land Reclamation and Water Management made it possible to acquire information on the dynamics of environmental pollution and atmospheric pollutant emissions. The information obtained by this service was forwarded to government organs and interested ministries and departments. The USSR State Planning Committee developed the groundwork for the State Economic Development Plan under the division "Conservation and Rational Use of Natural Resources." However, this planning turned out to be ineffective since it did not stimulate efforts to improve environmental protection or conservation by modification of outdated enterprises and conversion of the facilities to low- or waste-free technologies.

The introduction of limits on maximum possible emissions (MPE) and discharge (MPD) established the groundwork for scientifically and technically validated environmental management although such measures were not supported by appropriate capital investment levels or contract budgets; no interest in implementing these measures had been generated in design or construction organizations.

Domestic science also neglected to provide the necessary scientific concepts or ecological land use and conservation standards and this hindered the design and analysis of projects aimed at producing a validated assessment of possible negative ecological consequences.

The negative economic and social processes (the extended range of economic development, the wasteful management process, etc.) could not but have a negative effect on the ecological condition throughout the country, which had become quite severe overall. The bureaucratic treatment of natural resource utilization issues gave rise to a system that permitted flagrant depletion and wasting of natural resources, significant contamination as well as degradation of the environment in many regions. In most cases the damage caused to human health or the environment by the eco-

nomic enterprises had no effect on the assessment of their economic performance.

In treating the state of the environment as one of the principal indicators well-being of the Soviet people the central committee of the CPSU and the USSR Council of Ministers adopted a resolution in January of 1988 entitled "Radical *Perestroika* [reconstruction] of Conservation Practices in the Country" in which the ecological problem solving strategy was defined as a constituent element of *perestroika* in the political, economic, and social spheres.

A central state management organ was established in order to modernize the conservation management and regulation of natural resource use: the Union-Republic state committee of the USSR for the Protection of Nature. This organization was founded against a backdrop of increasing activity on the part of the Soviet peoples due to the development of democratization and *glasnost* in our society.

The USSR State Committee for the Protection of Nature includes a public council whose primary task is to support a comprehensive and thorough discussion of the critical problems of natural resource use, conservation, and environmental protection, as well as to develop recommendations for the State Committee for the Protection of Nature regarding their resolution. The Council consists of seven Peoples' Deputies of the USSR, as well as activists in scientist and culture, representatives of society, the local Councils of Peoples' Deputies, managers of enterprises and organizations, and leaders of conservation and environmental movements.

Modern Ecological Problem of Economic Development

The maintenance of stable rates of economic and social development throughout the country is largely related to the condition of the environment as well as the utilization of natural resources. Environmental and rational resource use issues are therefore treated as priority issues by the government of the USSR.

Between 1976 and 1988 total expenditures in such areas exceeded 100 billion rubles, including 30 billion rubles of capital investment. The volume of recycled and detoxified matter from waste gases and atmospheric pollutant emissions from fixed sources were reduced during this period by approximately 50 million tons due to the construction of treatment facilities and plants. The physical plant capacity for wastewater treatment and purification increased substantially. The volume of circulation recycling of water increased and as a result the annual savings of freshwater intake from natural sources exceeds 274 km³ today which is greater than the mean annual flow of the Volga.

However, an analysis of the results of conservation activities and the state of the environment for 1988 reveals that no substantial improvements in such efforts nor any significant positive changes in the ecological conditions in the country have occurred. In 1988 the state capital investment budget for conservation measures rose by 636 million rubles compared to 1985 or by 26% and exceeded 3 billion rubles. This budget accounted for 1.7% of the total state capital investment (for 1985 this value was 1.6%). However, even given the overall increase in capital spending the actual expenditure of these funds in the present Five Year Plan improved only insignificantly; see Table 23.

Table 23
Capital investment on resource conservation
(millions of rubles)

Resource conservation measures	1981-85 (average annual)		1986-88 (average annual)		Including 1988	
	Actual investment	% budget	Actual investment	% budget	Actual investment	% budget
Total	2224	87	2800	89	3182	80
including:						
Conservation and rational use of water resources	1617	87	1930	87	2091	87
Air conservation	180	80	284	85	317	82
Conservation and rational use of lands	235	90	305	103	393	113
Conservation and rational use of minerals	106	91	192	99.5	217	102

Over the last three years of the present Five Year Plan over one billion rubles of capital investment for the entire USSR has been left unused.

Table 24 shows the use of the state capital investment budget for environmental protection and rational use of natural resources by individual ministries and Councils of Ministers of the union republics.

Table 24
Use of capital investment budget for conservation measures

USSR Ministries	Actual % use budget use		Actual % use budget use		Actual % use budget use		Actual % use budget use	
1	2	3	4	5	6	7	8	9
Measures for environmental protection and rational use of natural resources								
Total	2485.9	88	2614.8	91	2663.5	86	3122.4	90
Ministries:								
Power Engineering and								
Electrification	157.7	106	92.2	116	126.1	96	121.3	97
Atomic Energy	-	-	66.6	92	86.5	89	106.7	122
Coal Industry	52.9	75	56.2	70	48.0	70	49.2	76
Ferrous Metallurgy Ind.	205.8	98	183.0	88	183.5	89	205.0	93
Nonferrous Metallurgy Industry	225.4	87	247.7	97	217.2	83	154.6	96
Union-Republic Min. of								
Mineral Fertilizer Prod.	117.9	79	119.7	82	175.3	84	200.8	86
Chemical Industry	120.2	77	93.8	91	90.5	72	105.5	78
Lumber and Woodworking Industries	51.5	87	65.8	88	88.0	90	115.3	92
Medical and Microbiological Industries	31.4	76	33.7	73	31.2	75	40.9	77
Council of Ministers of the RSFSR	370.6	81	394.1	90	411.0	84	516.0	87
Council of Ministers of the Ukrainian SSR	146.6	93	176.3	92	184.9	92	202.7	94
Council of Ministers of the Kazakh SSR	18.8	55	27.3	66	22.6	54	49.7	95
Council of Ministers of the Byelorussian SSR	21.8	91	25.6	95	23.9	80	28.1	97

In 1988 low capital investment outlays were made for environmental protection and conservation in the following ministries: the USSR Union Republic Ministry of Mineral Fertilizer Production - 86% (1987 - 84%); the USSR Ministry of the Chemical Industry - 78% (1987 - 72%); the Ministry of the Medical and Microbiological Industry - 77% (1987 - 75%); the USSR

Ministry of the Gas Industry - 78% (1987 - 99.8%); Ministry of Automotive and Agricultural Machine Building - 78% (1987 - 85%); and the following Councils of Ministers: the RSFSR - 87% (1987 - 84%); the Estonian SSR - 86% (1987 - 100%); the Tadzhik SSR - 78% (1987 - 98%); and the Kirgiz SSR - 60% (1987 - 79%).

In the present Five Year Plan a number of planned projects for natural resource facilities were not implemented; see Table 25.

Table 25
Implementation of environmental protection plants and installations

USSR Ministry	including 1988		
	1986-1988 (average Actual annual) outlay		% of plan
Wastewater treatment plants thds. m ³ /day, total	5956.4	5196.3	59
Including:			
Ministry of Power Engineering and Electrification	69.5	48.0	41
Ministry of Atomic Energy	29.4	26.4	27
Ministry of the Petroleum Processing and Petrochemical Industries	477.9	742.2	105
Ministry of the Coal Industry	151.9	102.4	45
Ministry of Ferrous Metallurgy	383.0	1017.2	90
Ministry of NonFerrous Metallurgy	139.5	97.7	83
Union Republic Ministry of Mineral Fertilizer Production	158.9	207.4	74
Ministry of the Chemical Industry	138.9	25.0	13
Ministry of the Lumber and Woodworking Industry	298.3	185.2	79
Ministry of the Medical and Microbiological Industries	58.4	57.3	49
RSFSR Council of Ministers	1624.2	1009.3	51
Ukrainian SSR Council of Ministers	365.3	302.3	60
Kazakh SSR Council of Ministers	10.3	2.6	1
Byelorussian SSR Council of Ministers	91.3	6.4	32
Lithuanian SSR Council of Ministers	144.3	5.1	100
Latvian SSR Council of Ministers	6.2	3.7	38
Georgian SSR Council of Ministers	77.6	4.9	12
Estonian SSR Council of Ministers	6.6	1.1	19
Azerbaijan SSR Council of Ministers	138.2	7.6	2

Circular-recyclable water supply system: thds. m ³ /day: Total	23353.0	15520.9	53
Including:			
Ministry of Power Engineering and Electrification	9214.1	8131.3	88
Ministry of Atomic Energy	8485.3	3198.0	26
Ministry of the Petroleum Processing and Petrochemical Ind.	551.3	162.5	33
Ministry of the Coal Industry	16.4	1.8	18
Ministry of Ferrous Metallurgy	1243.4	1389.9	76
Ministry of NonFerrous Metallurgy	744.7	277.4	34
Union Republic Ministry of Mineral Fertilizer Production	786.8	1095.6	52
Ministry of the Chemical Industry	506.2	271.8	83
Ministry of the Lumber and Woodworking Industry	16	35.2	16
Ministry of the Medical and Microbiological Industries	564.0	122.7	23
RSFSR Council of Ministers	87.8	87.2	69
Ukrainian SSR Council of Ministers	125.6	116.6	100
Kazakh SSR Council of Ministers	9.9	-	-
Byelorussian SSR Council of Ministers	8.8	0.9	100
Exhaust gas detoxification and recycling systems: thds. m ³ gas/hr			
Total	37617	25820	66
Including:			
Ministry of Power Engineering and Electrification	11244.3	8740	54
Ministry of the Coal Industry	144.7	-	0
Ministry of Ferrous Metallurgy	8436.3	4254	90
Ministry of NonFerrous Metallurgy	7093.3	4440	84
Union Republic Ministry of Mineral Fertilizer Production	505.3	562	52
Ministry of the Chemical Industry	493	504	88
Ministry of the Lumber and Woodworking Industry	200.7	0.1	0.5
Ministry of the Medical and Microbiological Industries	1597.3	2457	120
RSFSR Council of Ministers	412	382	367

The plans for putting wastewater treatment and purification plants on-line in 1988 were also implemented on a substandard level: the enterprises of the USSR Ministry of the Chemical Industry had a 13% completion rate (versus 91% in 1987), while the USSR Ministry of Power Engineering and Electrification had a 41% completion rate (versus 76% in 1987), the USSR Ministry of the Coal Industry had a 45% completion rate (versus 66% in 1987), the Ministry of the Medical and Microbiological Industries had a completion rate of 49% (versus 60% in 1987), while the values for the Councils of Ministers are as follows: the Kazakh SSR - 1% (42% in 1987); the Azerbaizhan SSR - 2% (49% in 1987); the Georgian SSR - 12% (4% in 1987); while the figures for circulation recycling systems are as follows: enterprises of the USSR Ministry of the Medical and Microbiological Industry - 23% (76% in 1987); the USSR Ministry of Atomic Energy - 26% (100% for 1987); and the USSR Ministry of the Petroleum Processing and Petrochemical Industries - 33% (41% for 1987).

The plan for putting exhaust gas pollutant recovery and detoxification plants on-line at several enterprises were also implemented on a poor performance level. The figures for each ministry are as follows: Union-Republic Ministry of Mineral Fertilizer Production - 52% (90% in 1987); the Ministry of the Building Materials Industry - 52% (70% in 1987); the Ministry of Automotive and Agricultural Machine Building - 47% (45% in 1987); and the USSR Ministry of Heavy, Power, and Transport Machine Building - 27% (100% in 1987).

While water intake from water sources rose by 2% in 1988 (which totaled 365 billion m^3 in 1988) water losses during transport grew by 6%. In 1987 these losses totaled 47.8 billion m^3 , while in 1988 the losses totaled 50.6 billion m^3 . The majority of water is lost in the irrigation systems of the USSR Ministry of Reclamation and Water Management (in 1988 approximately 33 billion m^3 or 19% of the water intake was lost). The level of water losses in irrigation networks throughout the RSFSR, the Azerbaizhan, and Georgian SSRs totaled 23, 29, and 33%, respectively.

The continuing irrational utilization of water for irrigation was also revealed by data from a simultaneous selective inspection to determine the presence and observation of irrigation standards conducted by the USSR State Committee for Statistics in 1988. Of the 656 inspected operations around the country 541 agricultural enterprises (82%) had irrigation standards. In this case 238 of the 541 operations (44%) permitted overirrigation in violation of established norms totaling a volume of 100 million m^3 .

In the Azerbaizhan SSR of the 17 facilities with corresponding standards 14 permitted a violation of the standards for a total of 18 million m^3 ; in the Armenian SSR of the 25 facilities with standards 14 permitted violations totaling 16 million m^3 while in the Georgian SSR of the 22 facilities with standards 14 violated the standards for a total of 15 million m^3 .

One of the principal causes of water overconsumption in violation of established standards is a shortage of water metering equipment. As demonstrated by the selective inspection at the 656 operations inspected the total supplementary demand for water meter instruments was 4.2 thousand instruments or 3.5 times greater than the available supply.

Irregular observance of orders issued by senior state organs to shut down pollutant wastewater discharge into the basins of certain seas, rivers, and other water bodies continues in the present Five Year Plan. Specifically, the plan to put the municipal water works in Baku on-line has been only 50% implemented (the initially established start-up date was 1981).

The construction of municipal treatment plants in Palanga (Lithuanian SSR) only began in 1988 although the order from senior government organs to cease municipal wastewater discharge took effect as early as 1980.

The extensive capability for improving the operation and performance of existing dust and gas purification and scrubbing equipment is not being fully used. As indicated by the results from the selective inspection, approximately 7 million tons of pollutants or more than 10% of the total emission volume from stationary sources are released into the atmosphere each year throughout the country due to failures or improper operation of this equipment.

Calculations also suggest that of the order of 9 million tons of pollutants are released into the atmosphere annually due to the limited technical (design) capabilities of existing air purification plants and currently-manufactured gas dust cleaning and scrubbing equipment. This indicates a need to develop and manufacturer more effective pollution-control equipment for air pollution applications.

Overall it should be noted that the extensive use of natural resources and the natural resource management system that existed for many years in the economic operation of the country substantially reduced the quality and quantity of natural resources and has impaired the natural resource management system. The excess specific consumption of materials and energy in the manufacturing process has given rise to large-scale mineral mining, processing, and combustion which has in turn produced substantial volumes of tailings, rock, and ash as well as atmospheric emissions and wastewater discharge.

One of the fundamental features of the modern stage of conservation and environmental protection in the USSR is the orientation towards restructuring of the economy. Here the discussion concerns reducing the fraction of polluting natural resource- and energy-consuming industries and increasing the fraction of efficient and waste-free technologies in the total production volume.

Over the last three years of the present Five Year Plan 21% of the increase in fuel and energy demand and 60% of the increase in ferrous metal

demand has been satisfied by savings in these resources. Approximately 55 million tons of fuel and energy-producing resources (calculated for an arbitrary fuel) were saved in 1988 (compared to 1985) by reducing consumption standards and introducing structural changes in the manufactured product and operations. Efforts in resource conservation have reduced the specific consumption of metals and energy in the national income figures in 1988 compared to 1985 by 4.6 and 1.7%, respectively.

Ecological Reformation of the Economy in the Restructuring [perestroika] of the Socioeconomic System and the Economy

The establishment of favorable conditions that will permit solutions to ecological problems is closely linked with the restructuring [perestroika] of our society. The most important component of this process is fundamental economic reform.

The fundamental outline of the new economic management system in the USSR was established by resolutions adopted by the June Plenum (1987) of the Central Committee of the CPSU. The following most important directions of *perestroika* that will facilitate an ecological reformation of the economy can be highlighted:

- expansion of the range of preplanning documents based on modern scientific research and designs in environmental protection;

- orientation towards economic planning methods for planning economic development; introduction of payments for natural resource management, alteration of the techniques and methods used in developing natural resource management plans to account for the Law "On the State Enterprise (Union)";

- strengthening of the territorial principle in environmental and rational natural resource use planning;

- decentralization of planning functions, enhancement of the role of the local Soviets of Peoples' Deputies in preparing natural resource management plans.

The introduction of financial incentives for natural resource conservation and on levels of pollutant emissions (discharges) plays an important role in the development of a new economic management system that accounts for conservation and environmental protection.

Payments by state and cooperative enterprises and organizations for mineral reserves, land, water, and forest areas will be established in three principal forms:

- as compensation for reproduction of the corresponding types of natural resources included in the production cost of the user-enterprises;

- as rent payments for using relatively superior natural sources paid out from profits (cost accounting income) of the enterprises;

- as fines and sanctions for excess utilization of natural resources and violations of conservation and environmental protection legislation which are also to be paid out of the profits (cost accounting income) of the enterprises.

All three types of compensation for natural resource utilization are calculated per unit of utilized (consumed) natural resource (per ton of minerals used, hectare of land, etc.) and are differentiated to account for the quality (productivity) and location of the corresponding resources.

Pollution fees are to be introduced beginning in 1991 for enterprises and organizations in accordance with the USSR Law "On the State Enterprise (Union)" and the USSR Law "On Cooperation in the USSR" in order to provide an economic incentive for conservation measures and to regulate their sources of financing.

There are two forms of pollution fees:

- fees for permitted (within the established limits) pollutant emissions (discharge);

- fees for violation of the established limits on pollutant emissions (discharge).

The scale of environmental pollution fees is determined on the basis of economic standards for fees and compensation for pollutant emissions (discharge) and are provided to the facilities as raw data for planning and incorporation in the Five Year Plan.

The profit (cost accounting income) of enterprises are the source of pollution fees.

The standard fees for violation of emission (discharge) limits are established relative to the corresponding fee level for permissible pollution.

Therefore the establishment of standard fees for natural resource use and environmental pollution has served to combine the interests of economic development and ecology in the operations of enterprises and unions. Such a course involving the incorporation of economic interests in conservation and environmental protection will alter the aspects of environmental protection and rational use of natural resources developed in the state plans for national economic and social development.

Currently there is a transition from planning of conservation and rational use measures within the framework of the Principal Directions of Economic and Social Development in the USSR and the State Five Year Plan towards planning and establishment of acceptable degrees of influence of material production and manufacturing on the environment using a system of generalized characteristics: limits on natural resource consumption, limits on pollutant emissions and discharge and waste storage, and natural resource and industrial raw material utilization factors. A system of fees for natural resource use under conditions of increasing independent operation of the

enterprises and unions in planning their own activities will serve as an incentive for their development and incorporation of measures that will facilitate the achievement of such production levels in the Five Year Plans.

An important aspect in the restructuring of natural resource management is the transition from industrial division planning to primarily territorial planning. It has been determined that the environmental and conservation plans will be formulated in the State Plan for the Economic and Social Development of the USSR based on comprehensive economic and social development of the union republics. All territorial management levels (republic, oblast', municipal, and regional) are to participate in formulation of the complex republic plans.

Therefore the territorial conservation plans will orient enterprises towards planning and implementation of the necessary conservation measures. Here the fundamental efforts to prepare conservation and environmental protection plans will be implemented on the "local Soviet of Peoples' Deputies-enterprise" level.

The local governmental organs must have real economic leverage in managing conservation and environmental activities in the territory under their control. One such level takes the form of target regional conservation and rational land use funds which are designated for use in financing mostly interdivisional and regional conservation measures. The primary source of assets for such funds are the fees paid by enterprises for standardized air (water) pollutant emissions (discharges) and for waste storage as well as the fines levied for exceeding the established standards. The regional conservation funds represent a tool for mobilizing the financial resources of enterprises for accumulating these resources and effecting their redistribution in order to implement conservation and resource savings measures with the most optimum socioeconomic and ecological outcomes.

The USSR State Committee for the Protection of Nature in conjunction with the USSR State Planning Committee carried out an economic experiment in order to implement a practical test of the methodological principles and introduction of natural resource use fees and the formation of conservation funds between 1989 and 1990; this experiment encompassed dozens of cities and industrial centers in various regions around the country. An analogous experiment to develop a new economic natural resource utilization mechanism was carried out by the republic governmental management organs in the Estonian SSR within the framework of the transition of the Republic to the principles of territorial cost accounting and self-financing.

One of the central areas in the fundamental restructuring conservation and environmental protection in the country is maintenance of public health of present and future generations, conservation of the biosphere, and restoration of the natural resource potential in the interests of effective and stable socioeconomic development of the country.

The following are required to achieve this goal:

- restructuring of the economy based on resource savings and incorporation of ecological factors in all aspects of social production and consumption;
- rapid conversion of industry and agriculture to low-waste technologies and comprehensive low-waste production;
- establishment of an effective comprehensive natural resource management system in the country based on a rational and efficient combination of political, economic, legal, educational, and instructional techniques;
- in foreign policy: a line that supports international ecological safety as a component part of universal international protection, conservation, and augmentation of the Earth's natural resources.

The primary result from the implementation of these measures will be a stage-by-stage achievement of standard environmental quality between 1991 and 2005 as well as scientifically-validated natural resource utilization factors.

Improvements in legal-standards regulation will require development of a comprehensive system of environmental standards as well as standards on acceptable environmental effects, an effective ecological expert analysis of construction projects, the expansion and modification of economic facilities, and the development of legal and legislative acts for defining the legal and administrative responsibility of natural resource users.

The sociopolitical mechanism must be capable of solving the most severe ecological problems based on democratic principles. The focus will be on increasing the level of ecological education and training, and extensive dissemination of information on the state of the environment to the populace, increasing the role of society and the mass media in environmental issues and the active support of the Soviets of Peoples' Deputies. The problems of rational natural resource use must be solved with specific application to the primary types of natural resources available.

One such task is the maintenance and enhancement of natural soil fertility by achieving a zero-deficiency humus balance and by improving both the physical and chemical properties of the soil. This will require anti-erosion measures on 113 million hectares of cultivated lands.

It is also necessary to recultivate disturbed lands, carry out a fundamental reconstruction and modification of irrigation systems, construct and modernize municipal water drainage systems, eliminate waterlogged lands resulting from reclamation and hydrologic plant construction. Upwards of 10 million rubles of capital investment is required for these goals.

Pesticide use in agriculture should be reduced and the use of biological techniques for protecting vegetation from illness and pests should be expanded by an area of at least 55 million hectares.

A program of rational water use will require the complete elimination of pollutant wastewater discharge into natural water reservoirs. Providing the populace with potable drinking water should receive special attention. The construction of centralized rural water supply systems has therefore been expanded significantly, while the use of drinking water for technical applications has been reduced.

Substantial water resource savings are to be realized in the regulation and reduction of water consumption in agriculture. The specific water consumption per hectare of irrigated land must be reduced by at least 25%.

In order to attain health standards on air quality in cities and industrial centers emissions from fixed pollutant sources must be halved: to 32 million tons while emissions from vehicles and motor transport must be reduced by 40-45%. In order to conserve forest assets, achieve normal reforestation, and introduce timber-saving technologies it is necessary to introduce a redistribution of the forest stock by groups and conservation category: it is necessary to increase the area of group I and particularly group II forests, while the percentage of group III forests must be reduced by a factor of 1.7-2. Timber resources can be increased by retreat felling and by nonclear felling. A rise in timber and wood utility to a 90-95% level in the national economy has been targeted.

At present insect pests and forest diseases cover an area of 2-3 million hectares, of which 65% requires active preservation methods. The most effective techniques are biological methods of combatting pests and diseases. These techniques account for 80% of the total range of forest conservation measures used in the USSR.

The development of a scientifically-validated system of wildlife reserves and sanctuaries in our country should be completed with these areas accounting for 3% of the total area of the country in accordance with ecological standards and 6% when sanctuaries are included. Eighty-five sanctuaries and 51 national parks are slated for development between 1991 and 2005. The area of specially-protected natural environments should be increased by at least a factor of five in republics where there are at present an insufficient number of such reserves: the Tadzhik Republic (from .6 to 3.2%), the Kirgiz Republic (from 1 to 4.7%), and the Uzbek Republic (from .5 to 5%).

One of the most important areas in rational natural resource utilization is maximum utilization of secondary raw materials, and commercial manufacturing and consumer wastes in agricultural production; the utilization level of certain forms of wastes are to be increased to 90-95%.

Large-volume industrial waste represents a reserve capacity for increasing the raw materials base of the economy and reducing the mining level of primary raw materials. It is also necessary to expand the use of

presently unused industrial wastes and byproducts for terrain reclamation, soil recultivation, and filling of mining excavations and cuts.

The implementation of these plans for leading development of secondary raw material collection and recycling capability as well as the introduction of progressive processing methods for such material and expanded utilization of waste materials accumulating in dumps will make it possible to achieve nearly 30 million rubles in savings of primary resources throughout the national economy.

Calculations have demonstrated that the entire range of conservation measures outlined here will require approximately 130 billion rubles of capital investment, i.e., it will be necessary to nearly quadruple the present volume of this capital investment.

Plans are also in place for substantially altering the distribution of capital investment in conservation and environmental protection. Thus the capital investment on rational use and conservation of water resources will be reduced to 40% (from 70% in the Twelfth Five Year Plan); the fraction of capital investment on air quality conservation will be increased by a factor of 1.5, while capital investment on mineral resource conservation will be increased by a factor 11.5, while the capital investment on the conservation and rational use of lands will be increased by a factor of 2.5.

These outlays will be targeted primarily for enterprises and cooperative organizations in accordance with the USSR Law "On the State Enterprise (Union)" and the USSR Law "On Cooperation in the USSR."

State centralized capital investment can be used to finance major interdivisional and regional conservation measures. Moreover, conservation measures are to receive financial support from the Councils of Ministers of the Union and Autonomous Republics as well as the Executive Committees of the local Soviets of Peoples' Deputies deriving from fees charged to unions, enterprises, and organizations for environmental pollution, nonrational use of natural resources and other violations of conservation and environmental protection legislation. The conservation reserve fund of the USSR State Committee for the Protection of Nature can be used for unforeseen operations.

2.2. Science and Technology in Ecological Problem Solving

The problems of social development today cannot be solved without increasing efforts devoted to scientific research in optimization of natural resource utilization, environmental protection, and conservation.

Fundamental and applied research in ecology, however, has been the subject of insufficient attention to date. The USSR Academy of Sciences and institutions of higher education have devoted only irregular attention to

ecological studies and such research has been isolated from practical applications while few resources have been assigned to this area. A poor material and technical base continues to hinder the development of research in this field.

There is an urgent need to develop a scientifically-validated and balanced strategy for natural resource conservation and environmental protection. The formation of such a strategy requires the development of corresponding theoretical concepts. It is extraordinarily important to focus attention away from consequences and on causes of ecological problems and their elimination. Advanced notice of ecological crises and accidents and coordination of economic activities with the functional features of biological systems both require thorough knowledge of both their normal and critical states and the possibilities for restoring the disturbed equilibrium of ecosystems.

The integrated nature of natural ecosystems not only contradicts practical human endeavors which generally are divided into many narrow specialties, but also runs counter to the traditional specialization of scientific knowledge in the sciences associated with studies of the various components of the biosphere. Comprehensive interdisciplinary and retrospective research which has not yet been properly developed is very important in analyzing biospheric processes and in developing scientific conservation and environmental recommendations.

The increasing severity of ecological problems also necessitates a qualitative transition from an expansion of the capacity of waste treatment systems to the development of low-waste technological processes and waste-free manufacturing techniques.

Many ministries are not using natural resources efficiently, and high-waste manufacturing methods are widespread. For each ruble of national income in the USSR more than 35 kg of waste is released into the environment, including 1.2 kg of gas waste (based on the mass of pollutants in waste gases), 24 kg of liquid agents (polluted wastewaters) and 11 kg of solid matter.

Many ecological studies produced by industry are intended to "whitewash" their own manufacturing processes and demonstrate the safety of industrial waste, and both the lack of cost effectiveness or technical merit of conservation technologies. Such industry designs often suffer from a narrow approach to ecological problem solving and are generally intended to make specific improvements or modernization proposals for existing industries.

The interdepartmental comprehensive conservation and environmental protection designs are progressing with great difficulty. The collection of environmental protection and conservation rules and standards in the USSR today is incomplete. The many designers involved in the establishment of

standards do not employ a consistent methodological basis and such efforts are not coordinated. Conservation and environmental protection standards and rules are spread out among more than 800 documents of which more than 80% are recommendations only. Many of these have been based on health and hygiene research from the 1960s and require refinement.

In 1988 the Interim Scientific-Technical Commission to Develop Ecological Standardization of Permitted Economic Loads on Natural Territorial Systems and Natural Components presented a report which proposed several methods for resolving this difficult problem. The report identifies the following four groups of standards:

- divisional natural resource utilization standards by resource;
- regional natural resource utilization standards by resource;
- divisional conservation standards for environmental effects;
- regional ecological standards for environmental effects.

In spite of well-developed scientific and technical developments in natural resource use and conservation these standards were implemented quite slowly. Since the economic mechanism of national natural resource management had not yet been developed, the enterprises remained uninterested in introducing progressive, low-waste manufacturing processes.

The delay in developing a set of standards for technological design and construction of new economic facilities based on scientific and technical achievements acted as a powerful brake on the introduction of existing designs. While the overall utilization of inventions from inventors' certificates in the USSR is near 30%, the percentage figure is even lower for conservation or environmental inventions.

Certain areas of conservation research and development are proceeding quite rapidly. Production and manufacturing accidents and the introduction of complex technologies have given rise to a new research field devoted to studies on industrial safety. Industrial risk assessment was one area of special focus following the Chernobyl accident. The results from risk analysis are important in proper decision making and in determining the sites of industrial facilities as well as operations associated with the transport and storage of ecologically-dangerous materials and substances.

The following are among the individual achievements in fundamental and applied science.

The comprehensive utilization of raw mineral products has become particularly important in the last 50 years. This process has required the development of new techniques for processing beneficiation-resistant ores. The most promising methods included combined chemical-metallurgical techniques. For example, autoclave (pressure), sorption, diaphragm (membrane), and extraction technologies were developed in hydrometallurgy, while in pyrometallurgy, fluid-bed smelting, oxygas smelting and key-set smelting were developed. Magnetizing annealing of sulfate ores, magnetic

separation of iron and cobalt sulfides, magnetic beneficiation of siderite-containing ores and other progressive ore processing methods were investigated.

A sample such resource-saving technology introduced in 1988 is ferrous quartzite beneficiation. Fifty megatons of oxidized ferrous concrete with weak magnetic properties is mined as a byproduct in the Krivbass and the Kursk Magnetic Anomaly. Due to the lack of an appropriate beneficiation technology more than 600 megatons of quartzite has piled up in dumps in the Krivbass alone. 2.5 hectares of earth is lost for each megaton of quartzite waste. The "Gipromashugleobogashehenie" coal beneficiation equipment manufacturing union in conjunction with other institutes developed an electromagnetic separator for beneficiation of the ferrous quartzites. The first 110 such separators were installed at the Krivorog mining and concentration plant. They can be used effectively in the beneficiation and concentration on manganese, chromium and other weakly-magnetic ores.

Low-waste technologies have been developed and incorporated in other industrial fields as well. In 1988 a baromembrane and electro dialysis technology for processing serum for protein food concentrates was introduced at the "Uglich" scientific and industrial association (with the traditional technology only 30% of the serum was reused).

Coal mining conditions become increasingly complex throughout the country each year (deeper mines, etc.) and hence it has been necessary to develop new technologies that will eliminate the endless increasing cost of coal (hydraulic mining and underground gasification in the drilling method, vibration breaking in the mine method, etc.). This in turn made it necessary to avoid the harmful ecological consequences of such new inventions.

A fundamentally new unit designed to recover heat from the underground combustion of formation coal was developed by the scientists of the Moscow Mining Institute. The hot process gases are used as the heat medium. The unit was tested in the Donbass and demonstrated the effectiveness of the technology, particularly for operating mines with thin and ultrathin coal formations.

New waste gas and wastewater purification techniques are also under development and the promise of membrane technology has been confirmed. The area of most practical interest involves the use of membranes fabricated as hollow fibers. Processes utilizing an auxiliary magnetic material are among the most promising new purification and treatment technologies. Wastewater purification technologies in algobacteriological systems have become well developed; these include hydrobotanical grounds, filtering ponds, biological plateaus, and artificial ponds with macrophyte biocenoses.

The Kurnakov Institute of General and Inorganic Chemistry of the USSR Academy of Sciences has studied carbon sorbents as media for biotechnology. Granulated, activated coals are most suitable for immobilization

(adhesion) of enzymes and protein molecules, while felt and fibrous materials are most suitable for microorganisms. Up to 12 g of microorganisms can be immobilized per single gram of carbon adhesion agent (medium). The immobilized microorganisms are biologically active for a period ten times shorter than in suspension. This creates new possibilities for biotechnology, including biological wastewater treatment.

The Institute of Zoology and Parasitology of the Lithuanian SSR Academy of Sciences has carried out experiments on algae purification of wastewaters as well as zooplankton and pond fish hatchling raising at the "Shirvinta" swine processing plant.

Integrated toxicity assessment techniques have been introduced in water pollution monitoring; these are based on biological testing using bacteria, Actinomycetes, algae, protozoa, invertebrates, and fish as test specimens. Approximately 40 biological testing and modification methods have been developed in the USSR. Applied research in the incorporation of ecological requirements in agricultural practice has been developed. For example, the use of a biological method for protecting agricultural crops from pests and disease was further developed in 1988; this made it possible to reduce the use of pesticides which are harmful to human health as well as flora and fauna.

The most popular biological method used in vegetation protection in the USSR involves the use of entomophagous Trichogramma which is employed on 70-80% of the areas protected by biological methods. Trichogramma is used against Lepidoptera on grains and vegetable crops, perennial grasses and in gardens and vineyards against the codling moth and leaf roller moths. The country has a total of 750 production plants for culturing several species of Trichogramma on grain moth eggs. Other natural substrates have been investigated as well. A timely application of Trichogramma can improve harvest yields by (centner/hectare): winter wheat - 1.7-2; corn - 1.8-2.3; cabbage - 20-30; sugar beets - 20-35.

The All-Union Scientific Research Institute for the Protection of Vegetation has investigated the use of pheromones for protecting prune and plum gardens from the codling moth. Using a synthetic pheromone based on acenol (180 g/ha) and denacyl (24 g/ha) twice during the season prior to the butterfly stage reduces crop damage by 80% and, depending on the infestation, can yield savings of up to 100 rubels/ha.

Research has also been conducted to analyze the content, the dynamics, and the genesis of atmospheric ozone. The effect of chlorine and fluorine compounds, freons, oxides of nitrogen, water vapor, and other substances on the ozone has been investigated. Such substances are either catalysts themselves, thereby accelerating the breakdown of the ozone layer at altitudes of 20-40 km, or produce such catalysts in the stratosphere. Some

contributions have also been made to the study of the formational mechanism of the "ozone hole" over Antarctica.

The development of the theoretical principles and practical development of biospheric wildlife reserves has great scientific significance since such reserves can be used to investigate the ambient state of the environment, and to protect the genetic stock of vegetation and wildlife. The Forestry Institute of the Ukrainian Branch of the USSR Academy of Sciences has developed a system of genetic forestry reserves that includes 45 forests in the Orenburg oblast' (region).

The General Biology Division of the USSR Academy of Sciences has generalized the experience gained from assessing the consequences of radioactive contamination of soil and forestry ecosystems and has issued an ecological assessment of the transformation of the Yamal tundra ecosystems near gas field sites and has developed a precise forest fire location system using scanner surveillance. Because of the crisis condition of biological resources, a model of the food chain in the Barents Sea and a general map of algae communities in the Barents Sea have been developed.

In preparing the third edition of the *Red Book* of the USSR the All-Union Scientific Research Institute for Research on Conservation and Environmental Protection developed proposals to modify the list of seminal and sporophyte vegetation, mushrooms, mammals, birds, reptiles, amphibians, fish, and invertebrates.

Guides to freshwater algae in the Ukrainian SSR, the lichen of the USSR, and a number of other regional botanical guides have been published. A *Red Book* of the Armenian SSR has been published (vertebrates).

The modernization of scientific and methodologic principles and appropriate instrumentation for comprehensive ambient monitoring of environmental conditions based on data from ground-based, airborne flash space and cartography observations is considered a critical issue in the USSR. A digital space imaging processing system has been developed and is actively operated at the "Priroda" [nature] State Center within the framework of implementation of this program; this process is intended to obtain topical information necessary for a systematic study of the Earth, for solving ecological problems, and for long-term environmental monitoring.

The further development and modernization of a space-based ecological and natural resource monitoring system is also the subject of substantial attention in the USSR.

The Global Space-Based Ecological Monitoring System recently developed in the USSR will perform the following functions:

- early warning and notification of accidents at ecologically-critical facilities;
- data collection from ground-based automated monitoring stations;

- data collection on environmental pollution sources as well as scales and paths of pollutant transport;
- monitoring of natural resource use and effectiveness of conservation measures.

The information obtained by the Global Space-Based Ecological Monitoring System will be stored and processed in conjunction with other ecological data bases at the information centers of the State Ecological Data System.

The primary purpose of joint data processing is to provide data to customers in the form necessary for decision making in the conservation field. Customers will include the legal and executive organs of the Soviet government on various levels as well as individual industries and enterprises.

The most promising directions of scientific research in optimization of natural resource and environmental protection management are currently being identified while the primary priorities in fundamental and applied research are being determined.

The research prospects are reflected in the problem sections identified in the Comprehensive Program of Scientific and Technical Progress for 1991-2010: *Natural Resources, Environmental Protection, Secondary Resources*. State scientific and technical programs are under development; the implementation of these programs will play an important role in optimization of natural resource management:

- high-speed, ecologically clean transportation;
- ecologically clean power engineering;
- resource-saving, efficient, and ecologically clean metallurgical and chemical processes;
- promising materials, etc.

A State Scientific and Technical Program on Ecological Problems is currently under development. It includes four subprograms:

- the economic and legal principles of rational natural resource utilization;
- ecological standardization;
- modernization of monitoring systems and techniques used to monitor conservation and natural resource utilization;
- scientific and technical support in conservation and rational use of natural resources.

The Program of Biospheric and Ecological Research of the USSR Academy of Sciences Through the Year 2015 has been developed. This program is designed for development of fundamental interdisciplinary problems by joint efforts from the natural, technical, and social sciences. The following high priority problems (program blocks) have been identified:

- development of a theory of evolution of the biosphere and its components;

- investigation of biological systems;
- investigation of energy and mass exchange in the biosphere;
- the principles of environmental monitoring;
- the development of philosophical, general-science, and social problems of human interaction with nature;
- development of the theory and methodology of human ecology;
- development of the scientific principles for identification and solution of regional and global ecological problems;
- development of the ecological principles of industrial manufacturing and transportation;
- development of the ecological principles of agricultural production;
- development of the principles and methods for establishing economic mechanisms and the organizational and legal foundation for natural resource management;
- development of a research methodology and mathematical modeling of human (society)-nature interaction;
- development of the scientific principles, methods, and techniques of geocological information science.

2.3. Legal and Administrative Conservation Measures

The legal basis for conservation and environmental protection is the Constitution of the USSR, and the constitutions of the union and autonomous republics whose legal standards define the sociopolitical significance and tasks of environmental protection and conservation and regulate the conservation activities of the Soviet government.

In addition to the constitutions the laws whose differentiating feature is the comprehensive regulation of conservation and environmental protection also play an important role in the legal regulation of environmental protection and conservation. The following fundamental legislation was adopted in the 1960s through 1980s on the USSR level: On Land (1968), On Water (1970), On Mineral Reserves (1975), and On the Forests (1977); the Wildlife Conservation and Utilization Act and the Air Conservation Act (1980). Legislation on conservation, and codes (land use, water, mineral reserves, and forests) and corresponding environmental protection and wildlife utilization laws as well as air conservation laws were adopted on the union republic level.

An important role in the legal regulation of environmental protection is also played by the sublegal acts; the norms and rules, and standards used to regulate all operations of state organs, enterprises, unions, organizations, departments, and citizens in the interests of achieving rational use of natural

resources and implementing environmental protection procedures play a prominent role here.

The legal ecological demands and the mechanism of legal liability remain underdeveloped in the legal support structure of environmental protection and conservation. In spite of legislative progress the efficiency of legal regulation of environmental protection and natural resource utilization remains rather poor. An enormous gulf exists between the system of ecological demands expressed in legislation and the applied legal practice of conservation legislation, particularly in the sphere of economic activity: in industry, construction, power generation, and agriculture.

The present state of standardization is characterized by great decentralization and an abundance of standardization documents as well as the fact that such regulations are oriented for specific departments. Many standards documents are vague or declarative in nature and are not supported by sufficient methodological or scientific bases.

The list of health standards approved by the USSR Ministry of Public Health is constantly growing: at present it includes the maximum possible pollutant concentrations (levels) for individual components in the environment (including the air, water, soil, etc.). The MPC were then used to develop standards for the maximum permissible emissions and discharge (MPE and MPD). However, the health standards are incomplete, and the maximum permissible concentrations are not easily correlated for different substances and have not been established for many elements. Moreover, the maximum permissible concentration standards do not function as maximum standards since environmental quality has long been assessed on the frequency their violation. Today pollutant concentration standards at various sites in the environment are generally based on human health considerations, i.e., the need above all to protect humans. These standards are not always suitable for protecting other natural life: organisms, populations, and entire ecosystems.

The environmental legislative and standards system therefore requires refinement. The Fundamental Land Use Legislation of the USSR and the union republics are currently under review and efforts are underway to develop draft legislation "On the Conservation and Use of Vegetation", "On Rents", and other legislative acts as well as refinement of the standardization process.

Natural conservation legislation was previously codified by developing legislative acts for individual industries (based on individual resources): the Fundamental Principles of Land-Use, Water, and Forest Legislation, the Fundamental Principles of Legislation on Mineral Reserves, Legislation on Wildlife and Air.

The idea for legislation by economic division developed during the period when the approach to conservation was based on conservation of

individual resources. The legislation was implemented in precisely such a form in the subsequent 1970s and 1980s when the entire world had already recognized the need for a comprehensive approach.

In these conditions it became obvious that once the conservation legislation had been codified based on each economic division, a comprehensive act was needed. The draft legislation of the USSR law "On Conservation" is presently under development; the adoption of this law will represent the logical conclusion to the formation of a conservation legislation system in the USSR.

The need to satisfy the requirements for environmental protection legislation in practice highlights the need to modernize the system of legal guarantees, improve organizational activities and enforcement, and improve the effectiveness of legal liability for ecological violation.

Natural Resource Conservation Management System

A fundamental restructuring of the natural resource conservation management system will be required for harmonious socioeconomic development of the country.

Until recently a number of ministries and departments including the USSR State Agroindustrial Committee, the USSR State Forestry Committee (referred to below as the USSR State Committee for Forestry), the USSR Ministry of Reclamation and Water Management, the USSR Ministry of the Fishing Industry, the USSR State Committee for Hydrometeorology, the USSR Ministry of Public Health, the USSR Ministry of Geology, the USSR State Mining Safety Inspectorate, and the USSR Ministry of Foreign Affairs performed different management functions in natural resource conservation and environmental protection, primarily monitoring functions.

Therefore the economic activities of the natural resource user-facilities under a specific department were monitored by these departments. For example, the enterprises of the USSR State Agroindustrial Committee were the primary users of cultivated lands, while the USSR State Agroindustrial Committee performed the function of state monitoring of activities of all land users. A similar situation also existed in the water management organizations of the USSR Ministry of Reclamation and Water Management which was charged with the responsibility of state management of the use and conservation of all water resources throughout the country. An analogous situation existed in other natural resource consuming industries as well. This was responsible for the serious ecological mistakes made by these ministries.

In order to increase responsibility at all environmental management levels, establish rational use, restoration, and conservation of natural resources, implement a single scientific and technical policy, and coordinate

the activities of the ministries and departments in this field the Central Committee of the CPSU and the USSR Council of Ministers recognized the need to form a Union-Republic State Committee of the USSR for the Protection of Nature. Analogous committees were established in the union and autonomous republics, the krais (districts) and oblasts (regions).

The USSR State Committee for the Protection of Nature is the central governmental organ in environmental protection and natural resource utilization and in conjunction with the Councils of Ministers of the union republics bears complete responsibility for environmental conditions and natural resource utilization throughout the country. Its functions include government monitoring of land utilization and conservation, the utilization of surface and ground waters, air, vegetation and wildlife, the seas and oceans, and the natural resources of the territorial waters of the USSR, the continental shelf, and the economic zone of the USSR as well as common minerals.

The Committee prepares and presents to the USSR State Planning Committee proposals on issues relating to conservation, environmental protection and rational use of natural resources for inclusion in the draft versions of the Concepts and Fundamental Directions of Economic and Social Development of the USSR, develops proposals for improving the economics of natural resource utilization, approves ecological standards, rules and legislation for regulating natural resource utilization and protection of the environment from pollution and other harmful effects.

An extraordinarily important function of the USSR State Committee for the Protection of Nature lies in its role as state ecological approval board for general development and distribution of the nation's productive forces and divisions of the national economy, its monitoring of adherence to ecological standards in the development of new techniques, technology, materials, and substances, as well as construction (reconstruction) designs for enterprises and other facilities which have an effect on the environment and natural resources.

The need for state ecological approval and analysis of products manufactured abroad and designs of joint enterprises as well as products manufactured in the USSR by foreign companies in joint ventures was recognized; this was necessary in order to avoid delivery of products or construction of enterprises that would violate the environmental standards or legislation in light of the requirements of Soviet environmental legislation. At present this problem has become especially critical since effective April 1, 1989 all enterprises, unions, industrial cooperatives and other organizations in the country were granted the right to run import-export operations. The ecological review process must precede contract signing in this case.

A fundamentally important element is the committee's participation in granting natural resource utilization in the USSR. The USSR State Com-

mittee for the Protection of Nature has the responsibility for issuing permission for burial (disposal) of industrial, residential, or other wastes, for pollutant emissions, for special water use, wildlife use, or consumption of air for industrial manufacturing and mineral resource availability for geological prospecting. The Committee is also responsible for monitoring land assignments for all forms of economic activity.

The Committee is charged with government monitoring of hunting throughout the country and also compiles the State Register of Wildlife and the *Red Book* of the USSR.

The USSR State Committee for the Protection of Nature also implements various educational programs for instructing all levels of society in the spirit of a harmonious relationship with nature.

The functions of the USSR State Committee for the Protection of Nature also include planning and implementation of cooperation on environmental issues with foreign governments and international organizations, coordination of the efforts of ministries and departments in implementing the obligations of the Soviet side deriving from international agreements on conservation and rational use of natural resources as well as the analysis, collection, and distribution of international experience in this field.

Certain difficulties are encountered in reorganizing the environmental management system. The ministries and departments previously responsible for state monitoring of the environment and conservation impede the transfer of the corresponding services to the new conservation committee. They prefer to remain responsible for monitoring and review of their own area which makes it possible to monitor and control all natural resource users who then operate without virtually any supervisory control. It was therefore decided to transfer the entire range of management functions over fish stock conservation from the USSR Ministry of Fisheries and the inspector staffs of the USSR State Committee for the Protection of Nature. However, the USSR Ministry of Fisheries retained the right to divide the sphere of government control and monitoring over the use of fish stock as follows: the conservation organs monitor the habitat of aquatic life and vegetation while the organs of the USSR Ministry of Fisheries are responsible for conserving the fish stock, monitoring their status and use.

In order to avoid a transfer of staff and monitoring functions certain departments alter the legal status of their subdivisions. For example, the Main Administration for Fisheries of the RSFSR converted the state departmental hunting inspectorates into commercial fishing administrations, i.e., a monitoring organ was converted into an economic organ which was not subject to control by the USSR State Committee for the Protection of Nature.

A clear differentiation between supervisory departmental management functions and the economic utilization of natural resources is a widely

recognized organizational principle underlying state management in conservation and environmental protection. At present this principle has not been fully implemented. For example, the USSR State Committee for Forestry retains the right to monitor conformity with forest utilization and reforestation rules by the enterprises of the lumber and woodworking industries. The problem of monitoring timber operations has remained unresolved. Designated felling — the basis of rational forest utilization — is defined by the USSR State Committee on Forestry in conjunction with the USSR State Committee for the Protection of Nature, the USSR Ministry of the Lumber and Woodworking Industries, and the Councils of Ministers of the Union Republics and is approved in coordination with the USSR State Planning Committee. This procedure makes it possible to approve the size of designated felling areas which primarily satisfies the interests of timber procurers.

The decision to establish the USSR State Committee for the Protection of Nature was made on the highest government level. However, many elements throughout society are seriously concerned with the slow pace and inconsistency of this process. The same notorious resistance mechanism is beginning to appear in connection with the development of a strong state organ that could counter the bureaucratic policy of natural resource utilization.

Legal Liability in Conservation

A critical component element in the legal system of environmental protection in the USSR is liability for violation of conservation legislation. Legal liability is divided into administrative liability, civil liability, punitive liability, and criminal liability depending on the sanctions imposed.

One of the most widespread forms of legal liability in conservation is administrative responsibility for violations in the field of conservation and environmental protection. In the most recent period over 60,000 people were fined for violation of hunting rules alone with more than 5,000 hunting permits rejected; over 300,000 violations of fishing regulations and approximately 65,000 violations of hunting regulations were identified.

Many administrative legal violations border on criminal violations; for example, pollution of water reservoirs and air pollution, violation of fire safety regulations in forests and illegal hunting; often these become ecological crimes.

Legal regulation of administrative liability for violation of environmental laws is provided by a substantial number of laws and sublegal acts by state organs and state management organs of the USSR and union republics.

Fundamental laws have been adopted in the field of environmental protection over the last 10-15 years that have both expanded and refined the composition of violations with administrative liability. Further steps towards increasing the effectiveness of administrative liability for violations in environmental protection and conservation were established by the Fundamental Legislation of the USSR and union republics on administrative violations and administrative violation codes adopted in a number of union republics.

These legislative acts reinforced the penalties imposed for administrative violations yet they were far from uniformly used for conservation and environmental protection purposes. In the majority of cases the party guilty of an administrative violation in environmental protection and conservation is fined. Occasionally a penalty such as punitive revocation or confiscation of an object which was the violation element occurs. Very rarely is the moral and educational form of administrative liability utilized: punishment. Moreover, the existing legislation that establishes the forms of administrative sanctions for violation of conservation legislation do not provide for corrective labor or administrative arrest.

The wide variety of these violations as well as the cases and types of application of the corresponding administrative legal measures makes a systematic accounting and summary necessary. The state statistical report on administrative violations is presently available; these statistics include violations of conservation and environmental protection legislation as adopted by the USSR State Committee for Statistics in November of 1988. At the same time research conducted by the Institute of Government and Law of the USSR Academy of Sciences in conjunction with other scientific departments around the country has clearly shown that the environmental conservation organs can effectively implement their administrative management responsibilities only by maintaining close contact with the corresponding departments, local Soviets of Peoples' Deputies and workers collectives.

The effectiveness of administrative liability for violation of conservation and environmental protection legislation is further effected by the following facts: poor responsiveness of government organs responsible for administrative legal violations; little educational effect from legal process or imposition of administrative penalties; selective use of legislation; penalties that do not match the offense; the lack of stable and consistent administrative practice; poor knowledge on the part of the subjects of legislation relating to administrative violations, low authority level of executive organs and their departmental affiliation.

Civil liability represents a component part in combatting ecological violations and compensating harm or damages. The levels of such liability include compensatory penalties and punitive sanctions (for violating

responsibilities for rational land use in, for example, forest destruction or damage, and for economic harm which has negative ecological consequences).

The direct purposes of civil liability include general and specific determination of civil damages and indemnification.

An analysis of the statistical data for civil courts of first infraction* in environmental protection for the period 1986-1988 indicates that over 31,000 statements of claim were made throughout the country during this period of which more than 21,000 were satisfied, 5.7 thousand were rejected, and over 700 were passed without review. The majority of cases were settled by payment of compensatory damages by the respondents, by a plaintiff dropping the case or by a corresponding compensatory payment by respondents prior to trial. There has been a stable diminishing trend of civil suits in the field of environmental protection. If in 1986 the courts heard more than 11,000 statements of claim of which more than 8000 were satisfied, approximately 2000 were dismissed and more than 200 passed without review, in 1988 there were a total of approximately 9000 cases of which approximately 6000 were settled, 1.7 thousand were dismissed and 270 were passed without review.

The USSR State Committee on Arbitration has reviewed more than 7000 disputes associated with violations of environmental law; approximately 466 claims were issued and in excess of 214,000 rubles paid out in such disputes. An investigation of arbitrage practice reveals that the primary disputes in this category concern water reservoir pollution by municipal wastewater, damage to fish stock, land-use violations, damage to timber stock, and killing of wildlife.

The percentage of conservation and environmental protection disputes in the total volume of arbitrage cases remains small (in certain regions it accounts for .27-.30%). In recent years, however, there has been an increasing trend in the number of suits involving compensation of ecological damage. The increase in the attention of the arbitrage organs in this issue is especially timely at present, since many enterprises do not yet consider satisfaction of ecological requirements to be a critical factor in their activities. For example, according to the materials of the USSR State Committee on Arbitrage a Western-Siberian metallurgical factory did not implement the measures prescribed by the Comprehensive Environmental Protection Plan of Novokuznetsk. There were repeated discharges of untreated wastewater, the wash oil from cake and by-product processing and from the blacksmith shop into the Tom River, which killed off many fish and resulted in sub-

* Court records include only civil cases for damage to timber stock (individual statute) and cases of property liability for illegal hunting or violation of fishing conservation regulations (jointly).

stantial damage.

An analysis of the arbitrage practice indicates that there are widespread cases where three individuals share guilt in addition to the defendant-enterprise: designers, suppliers, and builders.

There has been an increase in conservation and environmental protection issues in recent years from the procurator departments: the number of findings by public prosecutors on various levels devoted to issues concerning individual liability of violators has increased as have the number of findings relating to measures for preventing or suppressing harmful activities.

The public prosecutor staffs have noted, however, that such a specific reaction to illegal infliction of economic damage as a public prosecutor suit is used rarely.

Punitive liability also can prove to be effective in dealing with ecological legal violations. When all the procedural elements in applying such liability are observed it can prove to be a powerful tool of legal action in the interests of environmental protection.

An analysis of the state of affairs in practice demonstrates that punitive liability in dealing with ecological violations is clearly insufficient today. In the overwhelming majority of cases minor industrial ecological violations are not condemned nor are subject to an official administrative review.

A wide variety of economic and legal incentives have been introduced in production and industrial management in recent years; such methods are based on both ethical and material incentives for workers to observe the rules and implement measures associated with environmental protection and conservation.

Criminal liability for violations of conservation laws is implemented by means of criminal legal standards existing in the All-Union laws as well as the laws and criminal codes of the union republics, although the number of articles in the criminal codes with such standards varies from 8 (the criminal code of the Moldavian SSR) to 13 (the criminal code of the RSFSR).

The articles in the legal codes dictate the following punishments for environmental infringements: imprisonment, reformatory labor, fines, confiscation, restitution, etc.

An analysis of statistical data for 1986-1988 suggests that the number of defendants and the number of individuals convicted on various criminal code violations in the USSR is decreasing stably. This number exceeded 7000 in 1986, totaled approximately 5000 in 1987 and was over 3000 in 1988. An analogous trend is also observed in all different compositions of ecological crimes.

Actual imprisonment is used extremely rarely; in most cases the

punishment is less severe than the lowest class (reformatory labor): supplementary punitive actions are not used in practice and the maximum terms are not imposed even when there are significant damages. This reveals a stable trend towards increasing inconsistency between punishment in law and in practice. This can be attributed to an underestimation of the danger of environmental crimes and violations.

Technical Standards for Conservation and Environmental Protection

Natural resource utilization, conservation and environmental protection activities in the USSR are regulated by administrative and legal mechanisms through a system of technical standards including:

- ecological norms, rules, and standards;
- ecological indices in standard documentation that define the manufacturing quality and technology of products;
- ecological requirements on design and development documentation for constructing new facilities or for reconstructing or modernizing existing facilities.

All forms of technical standards in conservation and environmental protection expand upon and specify the concepts of conservation laws and other national (republic) conservation acts.

The following technical standards, health standards, and other regulations are classified as ecological norms, rules, and standards.

The Maximum Permissible Concentrations (MPC) of environmental pollutants (in water, air, oil, vegetation, and living organisms).

Safety Level Guidelines (SLG) have been established for pollutants and toxins, without maximum permissible concentrations, for air and water.

The Maximum Permissible Discharge (MPD) is established for water bodies; the structure, concentration, and methods for calculating this discharge level are included in the draft of the USSR State Standard.

The Maximum Permissible Emissions (MPE) for atmospheric emissions is regulated by the USSR State Standard (GOST 17.02.3.02.78 "Conservation. The Atmosphere. Regulations for Establishing Permissible Pollutant Emissions from Industrial Enterprises") which has been in effect in perpetuity since January 1, 1980.

Provisionally-Approved Emissions (PAE) of toxins can be established for an enterprise; these levels correspond to the emission level of an enterprise of analogous capacity and manufacturing profile with optimum ecological performance.

A state "System of Standards in the Field of Conservation and Enhancement of Natural Resource Utilization" has been in effect in the country since 1978. This set of standards includes 75 state, 70 divisional, and 4

republic (regional) as well as several hundred enterprise and company standards. There are also more than 600 state standards defining natural resource quality.

Strengthening existing ecological standards and developing new such standards on economic activity and their incorporation in state and republic (territorial) standards have become the predominant areas today in resource conservation regulation.

Ecological economic standards for fee payments for utilization of natural resources and charges for environmental damage are currently under extensive development with regional features taken into account. The primary principles and methods of determining these norms are proposed for incorporation in these standards.

The development of an "Enterprise Ecological Certification" is currently being completed; this certification characterizes and enterprise accounting for demands on natural resources, pollutant emissions and discharge and conservation measures.

More than 150 ecological requirements are also included in design documentation standards.

2.4. The Ecological Social Movement

The ecological social movement, in addition to previously-founded social organizations (republic conservation societies, societies of hunters and fishermen, conservation clubs, etc.), could be characterized in 1988 as a widespread emergence of the broadest range of conservation organizations throughout the country with both different organizational principles (unions, clubs, cooperatives, societies, unions, associations, funds, and committees), and different areas of activity: ecology, socioeconomic, ecological-cultural, etc.

The emergence of new ecological social unions represents the natural result of positive changes occurring in the life of the country, the rapidly increasing availability of information and the sociopolitical activity of the Soviet people. The public is increasingly aware of their personal responsibility for the environment throughout the country today and there is a clear trend towards direct participation in conservation measures.

Small unions on the oblast, regional, and municipal level predominate in this area. Such organizations, as a rule, are formed for specific local problems; for example, the Baikal Conservation Fund (Buryat ASSR); the Public Committee to Save the Volga of Sovetskaya Rossiya [Soviet Russia]; the Ecological Center (Rostov-on-Don); the "Sluzhba okhrany prirody" ["Conservation service"] (Kazan); the ecological group "Rodnik" ["Spring"] (Zelenograd); the "Ekologiya" ["Ecology"] Club (Volgograd); the "Ekolog"

["Ecologist"] cooperative (Yurmala); the "Okhranasredy" ["Conservation"] club (Riga); an ecological union (Novopolotsk); the "Svitanok" union (Minsk); the "Ekologiya" ["Ecology"] union (Vil'nius); the ecological association in Voznesensk; the "Aluston" union (Alushta); the "Tovarishchestvo L'va" ["L'vov Comradship"] club (L'vov), etc.

There has been a trend towards combining individual groups into All-Union organizations in order to coordinate social efforts on a higher level (the Socioecological Union of the USSR, the Ecological Union of the USSR, and the All-Union Society for the Protection of Wildlife, etc.).

There are presently upwards of 100 ecological-cultural associations of varying size that focus on conservation issues and support efforts to maintain cultural heritage. The establishment of an All-Union Ecological-Cultural Association has been proposed.

At the present stage many major (All-Union) ecological organizations have not yet acquired their characteristic, differentiating traits, and have not applied themselves in any specific, unique area. Their primary areas of activity as declared in their charters are largely identical or quite similar.

Republic Conservation Societies. The largest volunteer social organizations have been formed in all 15 union republics of the USSR. The oldest and largest society in this group is the All-Russian Conservation Society, founded in 1924.

The total number of members in the republic conservation societies exceeding 51 million in 1976 while their number grew by a factor of more than 1.5 by 1988. These societies have been founded in order to provide assistance to the Soviet, Party, state, and social organizations to improve environmental conditions, to support rational use and reproduction of natural resources, and to facilitate respect for nature on the part of the population and youth in particular.

The sponsorship of certain "Days" has become traditional in the republics. These include: "Conservation Day", "World Environment Day", "Flower Day", "Forest Day", etc. as well as the "Muravei" ["Ant"], "Zhivoe Serebro" ["Living Silver"], "El" ["Fir"], etc. conservation operations.

The members of the conservation societies implement a wide variety of practical measures aimed at protecting and conserving nature: development of nurseries to grow planting material, conservation monitoring of minerals, forests, water reservoirs, air conditions, etc.

The activities of the republic conservation societies have been justifiably criticized in the mass media for their formality, excess organization, and ineffectiveness. These societies have found their authority diminished among the populace which is one reason for the establishment of alternative social ecological associations.

The Conservation Club Movement. This conservation youth movement has been in existence for approximately 30 years. Student Clubs — independent volunteer social organizations — provide the basis for this movement. Tartu and Moscow State Universities were the founders of this movement.

There are over 100 such clubs throughout the country today with a total membership in excess of 5000.

The primary goal of the Movement is wildlife conservation: the establishment of wildlife reserves, sanctuaries, memorial parks, as well as publicizing natural conservation, dealing with poaching and other violations of wildlife conservation laws. These clubs are becoming increasingly active in efforts to combat industrial and agricultural pollution of the environment.

One characteristic feature of the Conservation Club Movement is the practical focus of all its programs and plans, its struggle against the bureaucratic mentality and formality and attempts to achieve specific results in conservation efforts.

The research activities of student groups are also important. These include a review of territories that require special protection (habitats of rare and endangered species of vegetation and wildlife), analysis of the effect of pesticides, herbicides and other toxins on ecological systems, development of the socioeconomic aspects of natural resource utilization and management, etc.

The Ecological Union. This is a self-managed independent nongovernmental social organization. It was founded in December of 1988 and is a confederation of collective members and divisions operating independently. Any social, governmental or cooperative organizations, labor collectives, nonformal associations, etc. can join the Ecological Union. Individual membership is forbidden by the Union's Charter.

The primary purpose of the Ecological Union is to develop positive solutions to the ecological development of the country and the world and to achieve their ecological safety.

In implementing these programs the Union supports: the USSR Initiative to provide ecological safety and well-being on the local, regional, All-Union, and global levels as well as international actions in this area; the most promising hypotheses, ideas, and projects that facilitate ecological safety and well-being; research aimed at testing of any designs that may prove to cause ecological harm.

The Union plans to provide consultation assistance to regions throughout the country and world that have suffered ecological disasters (natural or anthropogenic).

The Socioecological Union. This is a social organization that was founded in December of 1988, and includes more than 140 different ecolog-

ical clubs, cooperatives, and other social groups from 89 cities and 11 of the nation's union republics.

The primary goals of the Socioecological Union include fostering an ecological world view among the populace, organizing public monitoring of environmental conditions and public supervision of observance of conservation laws and assistance in forming new ecological social associations.

The first practical step of the Union was to organize an All-Union Social Protest Day against the construction of the Volga-Don and the Volga-Chograi Canals.

Mass meetings and other measures occurred within the framework of this protest day in Moscow, Elista, Vologda, Miassa, Tuaps, Astrakhan, and other cities throughout the country.

All-Union Society for the Protection of Wildlife. This is a mass public organization founded in December of 1988 to educate the populace, particularly children, in the spirit of love for wildlife and maintenance of their well-being.

The Society provides assistance to citizens of the USSR, enterprises, departments and organizations in proper maintenance of domestic animals as well as wildlife properly recovered from natural environments; the organization also provides assistance in fulfilling legal obligations and the principles of socialist ethics aimed at protecting animals from mistreatment.

The Ecological Society. This is a social organization founded in January of 1988 with members commonly united by their interest in improving ecological conditions in the USSR and using their creative potential in solving ecological problems. The primary target is coordination and development of socially useful activities on the part of scientific, artistic, and production collectives as well as individual citizens working in the interest of an ecologically optimum development of Soviet society.

The Society attempts to facilitate the development of initiative in analyzing, assessing and predicting ecological conditions throughout the country and in the development of proposals by the Soviets of Peoples' Deputies and other organizations in order to improve ecological conditions.

The "Ecology and the World" ["Ekologiya i Mir"] Association under the Soviet Committee for the Protection of the World. This is a social organization founded in 1987 to develop the fundamental principles of global and regional ecological safety, for determining methods of rational economic development on the global, regional, and local levels, to develop ecological plans, projects, and ideas. The association implements broad-scale all-union and international conservation and nature protection measures, develops cooperation and provides assistance to conservation movements, distributes

information on the idea of environmental protection of the world and also acquires information on the current state of the environment in the USSR and the world. The Association is planning to organize All-Union ecological expert reviews of major economic plans of interrepublic and, particularly, international significance.

Association to Promote Ecological Initiatives of the Social Invention Fund of the USSR. This is a self-managed social organization founded in November of 1988 to provide material assistance and support to initiatives designed to solve global, regional, and local ecological problems, to facilitate contacts between social ecological movements and groups and to provide individual contacts at various levels.

The Social Invention Fund. This is volunteer social organization founded in January of 1989 to provide moral and financial support to various initiatives of social organizations and individual citizens, including ecological projects and programs.

The Public Committee to Save the Volga. This organ was founded in 1989 by the newspaper "Sovetskaya Rossiya" ["Soviet Russia"], the Writers' Union of the RSFSR, the Division of Geology, Geophysics, Geochemistry, and Mining Sciences and the Laboratory of Biospheric Research of the USSR Academy of Sciences and the oblast' newspapers in the Volga region.

The primary purpose of the Committee is to provide universal public assistance in efforts to save the Volga River and its tributaries as a natural, cultural-historical, and economic object of national and international significance, and to protect the region from negative economic consequences. The Committee publicizes the notion of public responsibility for saving the Volga River and attempts to develop a material base for the conservation and rational use of natural resources and the ecological systems of the Volga-Caspian region. The Committee is planning to form a Fund to Save the Volga in the near future.

The Ecological Project Center. This is a social self-financing organization whose collective members include the Soviet Committee in the UNESCO Program "Man and the Biosphere", the Scientific Council on Biospheric Problems of the Presidium of the USSR Academy of Sciences, the Permanent Commission of the Moscow Municipal Soviet of Peoples' Deputies on Environmental Protection, and the Ecological Center of Soviet Young Scientists and Specialists of the Moscow Municipal Committee of the Komsomol.

The Center supports ecological projects in the following areas by contract with state and social organizations and enterprises:

- environmental conservation and enhancement, protection of human health, conservation on natural monuments, history, and culture;
- rational use of natural resources;
- ecological education and training of the populace;
- expansion and development of the material and technical base of the ecology movement and scientific and technical creativity in human interaction with the environment.

The Technical Labor Inspectorate of the All-Union Central Council of Professional Unions for Environmental Monitoring and Development of Ecologically Safe Technology. This organization was founded in December of 1988 by the All-Union Central Council of Professional Unions for supervising the implementation of conservation and environmental protection measures, as well as supervising compliance with established pollutant emission and discharge levels, and toxic waste recycling rules and for supervision in the construction of safe facilities, equipment, and structures. The Council also assures that developed and manufactured equipment and technology corresponds to requirements established by the standards and technical operating conditions.

The Union organizes selective review of projects to assure that such technology is in accordance with ecological requirements, coordinates the conservation activities of the professional union organizations and provides them with requisite assistance in this area.

In 1988 interregional inspectorates have been established at 31 oblast professional union councils.

The "Greens" Movement. The "Greens" Movement, which was most vocal in the Estonian SSR, represents a different direction in the public ecological movement of the country.

Immediately following the founding of the Estonian "Greens" Movement in the spring of 1988 its regional and local organizations began to appear in various cities and regions throughout the republic.

One of the largest and most characteristic Movements is the Tallin Movement which includes 10 territorial (Muug, Kadriorg, Maardu, etc.) and 15 functional (health and safety, research, the "Green" lifestyle, record-keeping, etc.) groups. The entire "Green" Movement in Tallin includes approximately 1500 members including 400 activists.

The specific activities of the Estonian "Greens" Movement can be characterized by the program of the Tallin Movement whose primary and most important areas include: a fragmentary assessment of the environment of the city and its environs, the development and presentation of promising environmental protection measures, distribution of information on conservation and environmental protection, physical labor, and organization of protests against irrational natural resource utilization.

Based on this program the Tallin "Greens" also have activities planned to varying degrees that are not entirely unsuccessful. Their defense of the "Park" square near Syuda and Totori Streets prompted the interdepartmental commission to declare the initial project a threat to human culture and the environment. The "Greens" also proposed an alternative "Maardu Green" project, sponsored successive protests against an environmentally-threatening pulp and paper plant, and the "Estonfosforit" Association, while a wide range of society participated in the administrative setup and support of the Kadriorg Park. The "Greens" also proposed actions supporting the closing of the shop at a radio and television center, proposed health measures for veterans of Chernobyl, supported implementation of the "Pyrand" program, etc.

A number of authoritative representatives of the Estonian "Greens" Movement believe that the primary factors behind its founding and successful operations include the present democratization of public life, the revival of public consciousness and activism on the part of the public, and the deep public concern for the continuing decline in the quality of the environment due to the bidding of the bureaucratic monopoly in the "society and nature" system.

Republic Societies of Hunters and Fishermen. These are public organizations providing a common forum for fishermen and hunters and have been established in each union republic. Among the primary goals of these organizations are distribution of information on conservation and state-of-the-art fishing and hunting, encouraging a respect for nature on the part of the public, active participation in the conservation and rational use of hunting, fishing, and forest resources, wildlife reproduction and combatting poaching.

The Republic Societies of Hunters and Fishermen have a total membership of approximately 3.5 million. The largest such organization is the Union of Societies of Hunters and Fishermen of the RSFSR.

The increased role and attention of public opinion are closely related to the process of democratization and *glasnost* as well as the higher level of social involvement on all layers of society.

Research conducted by the All-Union Center for the Study of Public Opinion on Socioeconomic Issues in eight major regions of the USSR (the Baltic, Northwest, Ukraine, Central Asia, Northern Caucasus, Western and Eastern Siberia, and Moscow) identified a well-formed attitude on the part of the majority of municipal residents towards ecological conditions in the country. The predominant opinion among those polled is that the environment has deteriorated in recent years. A strong concern for the environment and current ecological conditions has therefore developed among the populace with this level of concern slightly lower in children than in other age

groups.

The relative uniformity of public opinion (independent of social-demographic characteristics of those polled) and the level of social concern for the deteriorating environment can be attributed to the fact that in this area the economic and political problems of society are closest and most accessible to understanding by each member of society, since here the fundamental value of human life clearly shows through from behind the notion of social interests and forces.

Unlike the positions of the majority of respondents which could be classified as anthropocentric, some of those questioned a naturalocentric or a sociocentric approach to ecological problems. In the first case nature is valued in and of itself as the harmonious progression of natural processes and the importance of conserving natural equilibrium. The second approach envisages social development accounting for its ecological aspect: the well-being of nature is considered from the viewpoint of its importance for the successful development of society. The adherents of this second approach consider the squandering of natural resources to be especially dangerous. However, there are relatively few who hold the latter two viewpoints.

The most severe ecological problem in cities, according to the respondents, is air pollution. This is then followed by environmental problems in lakes and streams, municipal areas, recreational sites, the quality of food, higher noise levels, and ambient radiation levels. However, a number of indicators of the deteriorating environmental condition which have widely been recognized and are a source of concern to ecological specialists do not cause any concern on the part of the majority of the population. This confirms the general belief that public ecological concern is most directly related to everyday assessments of poor or unfavorable environmental factors that are clearly evident rather than systematic ecological knowledge.

Characteristically only one-quarter of the respondents could provide an answer of any kind regarding the measures taken in society on environmental issues. This indicates that the scale of activities in environmental protection and conservation clearly does not correspond to the severity of the situation. The majority of respondents named the mass media, individual activists, local Party organs, and public health services as the primary initiators of conservation measures. What appears at first glance to be a widely held perception that nonformal associations are effective in this area is not reflected in the survey results.

Ecological public opinion is playing an increasing role as one of the most significant factors in the politicalization of public opinion and in stimulating a broad natural conservation movement.

Involving public conservation organizations in the critical analysis of environmental conditions, in summarizing the world-wide experience in ecological problem solving for problems generated by various industries, in

developing monitoring and test equipment and techniques, and in the ecological education of the populace is becoming an important condition for solving ecological problems of every region and the country as a whole. Hence the maximum utilization of the efforts and intellectual potential of citizens groups and the development of an effective mechanism for interacting with state control and management organs are becoming priority areas in the current level of development of Soviet society.

The elements of such a system were initially put in place in 1988. At this stage the State Committee for the Protection of Nature formed a consultative organ: a public council consisting of 150 members including well-known public figures, representatives from scientific, cultural, union, youth, women's and regional organizations, as well as peoples' deputies and enterprise managers. The primary task of the Social Union is to represent the interests and views of broad social opinion and support a comprehensive and thorough discussion of the major environmental and conservation problems and develop recommendations for their solution. Analogous public organs have also been created under the committees of the Union Republics and their local organs.

2.5. Ecological Education and Training

At present the need for universal ecological education makes this a priority field among all forms of education. The restructuring of the political and economic systems and the problems in the socioeconomic development of the country have highlighted the dependence of society on the condition of the environment, the principles of resource utilization, the role of nature in human consciousness and national culture. The lack until recently of a single uniform government strategy in the field of education devoted to human intervention with the environment coupled with the fact that the appropriate material had not been developed led to differing approaches to such education and anticipated results. Today ecological education refers to general dissemination of information on ecological problems as well as training in specific decision making techniques and methods as well as education. The lack of appreciation of the fact that man is an integral historical and biological part of the biosphere has been responsible for the absence of any clear delineation of his rights and responsibilities on earth as well as the view of nature as a resource which appears in textbooks, lectures, and in practical life, and the limited scope and ineffectiveness of education in this area. This has been responsible for many errors in natural resource utilization policy.

The psychology behind squandering of natural resources began to develop in the late 1920s and early 1930s under the influence of the state

economic policy of maximum utilization of natural resources. The need to allocate material and labor resources to reproduce "inexhaustible" natural resources was not recognized in these conditions.

Such achievements in world-wide scientific thought as the ideas of the Russian "Kosmisty", the scientist V. I. Vernadskiy on the biosphere, and V. N. Sukachev on biogeocenoses as well as genetic laws and concepts relating to the irregularities between economic and social development of society remained outside the scope of the national education system.

Today the urgent need for education in ecology is related to the critical importance of providing each individual with the capacity to develop his own world view based on the knowledge accumulated by mankind and on the basis of international culture. In today's rapidly changing world education must continue throughout life, i.e., it must be a continuous process. History provides examples of stable national and cultural traditions that hand down respect for nature and a concern for the environment from generation to generation. A reliance on historical and cultural traditions is an important technique for successful education.

Theoretical development of the fundamentals of a natural science understanding of the environment outside of present requirements is still not available today. Using the teachings of V. I. Vernadskiy on the biosphere as such a scientific basis we must recognize that it has not yet been translated into the language of specific management solutions nor into the language of popular understanding. The field of social sciences does not yet have such a developed concept. The bureaucratic and resource-centered approaches underlying the modern natural resource conservation education system make it impossible to impart interdisciplinary thought and hence the perception of ecological problems remains fragmentary and disconnected.

Only within the framework of such a narrow consciousness are such "clearly-necessary and easily-executed" plans as the internationally famous projects to divert a portion of the Siberian Rivers, etc. possible. These projects represent a natural manifestation of the subject-specific education system that predominates in our country and the lack of professional problem-oriented educated reflection. The lack of interdisciplinary research programs in our country can also be attributed to this.

Priorities in terminology usage have also changed. If previously we used the concept "conservation" alone the term "environmental protection" is used increasingly often. This term is more precise as it includes the social aspects that accompany the problem. The concepts social ecology, human ecology, cultural ecology, etc. appeared somewhat later. The wide variety of such terms reflects the integration of the separate disciplines and a return to a more integrated and complete view of such categories as the biosphere, evolution, humanity, and time.

Changes in society itself are reflected in changes in the methodologi-

cal approach. Today 68% of Soviet people live in cities. The municipal environment and lifestyle as well as the character of the economy of the nation represent a powerful factor influencing, in addition to our plans, the consciousness of people, and their receptiveness to new ideas, including those relating to nature.

The need for new thinking, with its scientific basis not yet completely developed, has revealed a number of new problems. For example, there is a simplified notion in the social consciousness regarding the rates and methods at which ecological thoughts and concepts are formed during the education process. Given the fact that a world view cannot be simply "borrowed" personal participation by each individual in addressing the problems of the environment and working in this area becomes essential. Domestic psychology offers the principle of A. N. Leont'ev as the basis for an ecological education system; according to this principle the conscience of an individual is nurtured by activity. One practical manifestation of this concept in our country is the use of simulation games and other interactive training methods in the national education system.

The current state of scientific and public thought in the country also represents an important characteristic of ecological education and conservation training. Above all it is necessary to define the subject of ecology training: the "nucleus" of ecological knowledge and human intellectual skills used in interacting with nature.

In 1988 the State Committee on Public Education, the USSR State Committee for the Protection of Nature, the USSR State Committee for Science and Technology, the USSR Academy of Sciences, the Bureau of the Commission of the USSR Academy of Sciences on Biospheric and Ecological Research, the USSR Academy of Pedagogical Sciences, and the All-Union "Znanie" ["Knowledge"] Society reviewed the conceptual basis and program for the development of training and education of professional staff in the field of environmental protection and rational use of natural resources for the Thirteenth Five Year Plan and through the year 2005.

The following were adopted as the primary principles of the program:

- formation of a public world view, development of new thinking and fostering of personal activism;
- knowledge of the fundamental laws of ecological systems;
- interdisciplinary material and training methods;
- the capacity to identify and solve ecological problems accounting for specific natural resource conditions as well as the social, economic and cultural features of the corresponding city, region, or area;
- a continuous educational process that extends throughout a person's life.

The following were proposed in developing the professional staff

training and education system:

- use of a regional (bioregional) approach to problem analysis, establishment of regional ecological training centers;
- provision of timely, reliable and complete environmental information;
- review of the response from both the natural and social spheres on a long-term time scale accounting for the cyclic processes interacting in these systems;
- consideration of the processes occurring throughout the entire chain of cause and effect links.

This program focuses special attention on public education and shaping of public opinions. The primary purpose of these efforts is to facilitate the development of an ecological consciousness on the part of various segments of society accounting for the variable economic conditions and ecological situations on the local, regional, and global levels in the interest of human survival and well being as well as to facilitate active social positions based on a thorough understanding of the personal responsibility of the individual for the fate of the homeland and the entire planet.

This goal will be achieved by:

- developing a public and state system for dissemination of ecological information using public organizations and mass media based on a differential approach to the different population groups;
- maintaining continuity and consistency between formal and informal ecological education;
- seeking out new effective techniques for dissemination of ecological knowledge;
- maintaining the public's accessibility to ecological knowledge;
- developing a wide range of environmental protection teaching programs for distribution by the mass media;
- improving the ecological education and training of journalists, directors, and radio, television and film professionals.

In order to implement these measures the Central Committee of the CPSU and the USSR Council of Ministers have instructed their corresponding ministries and departments, creative unions, mass media facilities, and public organizations to radically increase efforts to distribute information on conservation, to facilitate in the Soviet people an ethical view and respect for vegetation and wildlife as well as other natural resources. Instructions were also issued to improve the quality and distribution of popular science and teaching literature, films, radio and television broadcasts, to increase the level of lectures devoted to these issues, and to use the pavilions reservand topic exhibits at the All-Union and Republic Exhibitions of Achievements in the National Economy as well as cultural, technical, and natural museums to distribute information and knowledge on ecological issues.

SECTION III

**PARTICIPATION IN INTERNATIONAL
COOPERATION IN THE FIELD OF CONSERVATION
AND ENVIRONMENTAL PROTECTION**

The global scale of deterioration of the environment has made it necessary to integrate the efforts of all nations to avoid ecological disaster, protect the Earth's biosphere and facilitate the development of mankind.

The Soviet Union considers the additional factor of maintenance of a stable peace on the planet by international cooperation in support of these goals. The concept of ecological safety as fostered by the socialist nations as an element in a comprehensive approach to international security integrates all component parts and corresponds in full measure to the ideas of the new political thinking which gives priority to common human values in international relations.

3.1. Soviet Initiatives on International Cooperation in the Field of Environmental Protection

The Soviet Union has initiated many proposals to integrate the efforts of various nations in support of environmental protection on both a global scale and on regional and bilateral levels.

M. S. Gorbachev, Chairman of the USSR Supreme Soviet has offered a number of proposals for joint solution of ecological problems in articles published by *Pravda* (September 1987), in Murmansk (October 1987), in Krasnoyarsk (September 1988), at a session of the USSR Supreme Soviet (November 1988), and at the Forty-Third Session of the UN General Assembly (December 1988).

In a *Pravda* article entitled "The Reality and Guarantee of a Safe World" M. S. Gorbachev identified the need to develop a global strategy for environmental protection and rational use of natural resources and proposed an annual report to governments on natural resource activities as well as ecological incidents that have both occurred and have been averted in the respective nations;

- in Murmansk M. S. Gorbachev proposed cooperation between the northern nations whereby the experience of the joint measures to protect the maritime environment in the Baltic could be used to develop the concept of ecological safety of the northern lands and could be implemented in an integrated comprehensive regional environmental protection plan which would include a radioactive contamination monitoring system and the preparation of a unified power generating program for Northern Europe;

- in Krasnoyarsk M. S. Gorbachev proposed establishing a special conference of experts on conservation cooperation in the Asiatic-Pacific Ocean region;

- at the Session of the USSR Supreme Soviet M. S. Gorbachev emphasized that in our time ecological problems require comprehensive solutions not only within individual nations but also continents and even the

entire world; only by entering into specific international cooperation agreements, by becoming signatories to different conservation and natural resource conventions, and by closely cooperating with international organizations that develop regional natural resource use and conservation measures will we be able to rapidly and effectively solve the environmental and resource problems in our country;

- at the Session of the UN General Assembly M. S. Gorbachev highlighted the danger of a world-wide ecological threat and proposed the establishment of an emergency ecological assistance center under the sponsorship of the United Nations and announced that the USSR was prepared to cooperate in the establishment of an international space laboratory or a manned orbital space station that would function as an important integral part in a global environmental monitoring system.

Proposals aimed at the further development and enhancement of international cooperation on environmental protection were also included in a speech by E. A. Shevardnadze, USSR Minister of Foreign Affairs, at the Forty-Third Session of the UN General Assembly. An international mechanism was proposed for developing urgent solutions relating to timely global issues, primarily economic and ecological issues, in order to fulfill the UN role in providing organizational collective support for ecological safety. It was also proposed that the UN sponsor a successive cycle of extraordinary meetings to coordinate efforts in ecological safety: in 1989 a consultative conference of experts on the "health" of the Earth; in 1990: a meeting of senior representatives from 15-20 countries representing all continents and the nonaligned Movement; in 1992: an international UN Conference on Environmental Protection. As expected this conference would define the primary directions of international ecological cooperation through the end of the 20th century and the early 21st century.

The conceptual approach of the USSR and the nations of socialist cooperation to environmental problems underlies the report of the conference of the Political Consultative Committee of the Member-States of the Warsaw Pact (1988) entitled "Consequences of the Arms Race for Environmental Protection and Other Aspects of Ecological Safety."

This document focuses on the need to integrate the efforts of the world community in the interest of a joint and effective solution to environmental problems. It is proposed that compulsory principles be introduced and that the primary directions for international cooperation in ecology be defined with a corresponding international legal document produced in 1992 to mark the 20th anniversary of the UN Conference on the Environment.

Given that all European nations are especially sensitive to the consequences of activities that damage the environment, the participants in the Warsaw pact believe it is advisable to establish an All-European Conference of Ministers on the Environment and to develop a program of joint actions

in order to adopt timely measures to restore the environment of our planet.

The Soviet government has defined the following primary directions for conservation activities in cooperation with foreign governments:

- development of a global strategy for environmental protection and utilization of natural resources that accounts for the entire range of existing and predicted ecological problems;
- development of bilateral and multilateral cooperation;
- refinement of the principles of international natural resource utilization as well as the scientific and legal principles behind efforts to solve international ecological problems;
- development and introduction of resource- and energy-saving, waste-free and ecologically safe technologies as well as proposals for early warning and clean-up of major industrial or transportation accidents or natural catastrophes;
- further development of cooperation in conservation and rational use of the natural resources of the seas and oceans and the continental shelf;
- development of an international environmental monitoring system using space technology;
- development of a system of measures to avoid the ecological and economic consequences caused by global climate changes.

3.2. Cooperation in International Organizations

International organizations play a significant role in conservation and environmental protection.

The multilateral cooperation of the member-nations of the Warsaw Pact is implemented within the framework of the Permanent Commission of the Warsaw Pact on Cooperation in Environmental Protection, founded by a resolution of the Warsaw Pact session held in 1988 (the 43rd, extraordinary session). In this Commission the nations function as managers of divisions that are responsible for environmental protection. The Commission also implements a comprehensive review of the most important conservation problems of the Warsaw Pact member-nations, including water use issues.

The Strategy of Warsaw Pact Member-Nations in Environmental Protection Through the Year 2010 has been developed. This document defines the principles, goals, tasks, and priority areas for cooperation between member nations of the Warsaw Pact and the means for implementing these goals. This strategy is designed not only to eliminate the consequences of human damage to the environment, but more important, to eliminate the causes of the negative anthropogenic effects on the environment and to develop a modern theory and mechanism for rational natural resource utilization.

UNEP (the UN Program on Environmental Protection) implements the key functions within the UN in coordinating activities in environmental protection and rational use of natural resources.

Cooperation of the USSR within the UNEP program encompasses many fields of industry and transportation and all aspects of environmental pollution. Primary attention is devoted to the operation of the global environmental monitoring system, and efforts to implement a global plan to deal with desertification. Our participation in the International Register of Potentially Toxic Chemical Material and the International Reference System of Sources of Environmental Information (INFOTERRA) are also significant.

Many Soviet ministries and departments participate in the UNEP program. The USSR, the Ukrainian SSR, and the Byelorussian SSR make a total of 8 million rubles in contributions every three years to the UNEP volunteer fund, including 2 million rubles in convertible currency. Some of these funds are expended in our country to support operations by Soviet organizations and individual specialists as well as for international organizations operating within the USSR.

In 1988 more than 50 international programs were carried out and 450 specialists, largely from the developing nations, were trained within the framework of this area and sponsored by the Center of International Projects of the USSR State Committee for the Protection of Nature. More than fifty projects in public health, land, water and genetic resources, waste-free technologies, efforts to fight desertification and other problems were examined.

The Soviet Union is in favor of increasing the role of UNEP and supports its primary areas of activity: air quality conservation (including global warming, the ozone layer, and acid rain); maintenance of fresh water resources; conservation of maritime and coastal resources; conservation of land resources; conservation of biological diversity; ecologically safe utilization of biotechnology; and protection of human health and quality of life.

The important issues of international cooperation on conservation and environmental protection are handled under the aegis of the European Economic Commission (EEC) of the United Nations. The senior representatives of the member-nations of the UN EEC on environmental protection and water resources represent the leading and coordinating organs in this area. The most important conservation and environmental protection areas of the Commission include: cooperation within the framework of the Convention on Long-Range Cross-Border Air Pollution Transport and the Declaration on Low-Waste and Waste-Free Technologies and Waste Utilization.

The UN EEC volume entitled *Compendium on Waste-Free Technology* which contains specific and detailed descriptions of industrial processes in various areas has been recognized as valuable among the interested Soviet ministries and departments where it is used by specialists.

Materials designed to assess the anthropogenic effects on the environment (particularly data used to assess the effect of dams, automobile transportation, thermoelectric power plants, etc.) are of great interest.

Practical efforts to develop an agreement to assess environmental effects in a cross-border context are continuing. This area of activity is a timely area of interest to all member-nations of the EEC. Cooperation in the field of flora and fauna conservation in Europe is useful for our country. The Declaration on the Conservation of Flora, Fauna, and their Habitat was adopted in 1988 on the initiative of the USSR. Since many species of wildlife and birds are migratory, i.e., they travel across different European states, joint efforts to protect these species will also yield useful results on a national level.

In addition to participation in UNEP and the EEC the Soviet Union is a member of the International Union for the Protection of Nature and Natural Resources, the International Waterfowl Research Bureau and the International Hunting and Conservation Council.

Comprehensive fundamental scientific research of human effects on natural biospheric processes and analysis of the effect of changes in these processes on mankind are currently carried out within the framework of the UNESCO program "Man and the Biosphere." Such research is aimed at solving specific problems in natural resource management in the nations directly participating in the Program. Operations within the framework of this program are coordinated in the USSR by the USSR Academy of Sciences through its Council on Biospheric Problems.

In October of 1988 E. A. Shevarnadze, in a speech at UNESCO headquarters expressed support for the idea of a "Council of Wise Men" and proposed that UNESCO establish an international committee of scientists entitled "Ethics and the World Community" which would focus on ecological safety issues.

The most important environmental conservation problems are also addressed within the framework of many other international organizations such as the International Atomic Energy Commission, the World Meteorological Organization, the World Health Organization, the International Maritime Organization and regional UN commissions.

An active and successful policy in environmental protection and rational use of natural resources depends on development of a comprehensive information source of environmental measures implemented as well as the ability to compare and integrate the statistics and environmental monitoring data used in individual nations. Practical experience suggests that the problems of cross-border river pollution including pollution of the seas and oceans, pollutant emissions and long-range cross-border transport of such emissions, wildlife conservation, particularly conservation of migratory birds and other migratory species can be solved only by joint efforts using a

common information base. The significance of timely development and introduction of a system of statistical and other data collection and analysis systems including analysis methodologies that permit international comparisons derives from this.

The Soviet Union occupies an active and consistent position on this issue. This position is that in addition to analyzing the statistical methodology of other nations and the comparative environmental assessments produced on this basis, efforts should also be made to develop integrated systems of indices. USSR state organs participated directly in the development of such a system within the framework of the Warsaw Pact between 1980 and 1986. The corresponding information obtained from the incorporation of this system in subsequent years has provided an acceptable basis for comparing measures implemented as well as their effectiveness. Improvements to both this system and the organization of data acquisition and analysis are planned for the future.

The state statistical organs in conjunction with interested organizations have actively participated in the establishment of standard classifications on the primary aspect of conservation activity (primarily in the accounting, utilization and conservation of water resources as well as solid waste formation and recycling (detoxification) under the UN EEC).

The integration of index systems and calculation methodologies made it possible to publish in 1988 the first experimental volume (compendium) on environmental statistics by the UN EEC. The data on the USSR were presented not only in the form of many tables which permitted international comparison, but also was presented in the form of special material characterizing the current state and the environmental conservation measures carried out in the Lake Baikal region.

3.3. Cooperation via International Conventions and Agreements

The Soviet Union has actively developed and strengthened conservation cooperation based on international agreements.

Our nation participates in 55 international conventions and agreements in the field of environmental protection.

Participation in international conventions and agreements helps to achieve practical results in reducing the negative effects of anthropogenic activities on the environment.

In implementing the obligations within the framework of the Convention on Long-Range Cross-Border Air Pollution Propagation the USSR reduced its sulfur compound emissions in the European section of the country by 2 million tons between 1980 and 1988. A program of measures to

limit emissions of the oxides of nitrogen has been developed. Substantial attention is devoted to participation in the joint European long-range pollutant transfer monitoring program. The "Vostok" International Meteorological Center is currently operating in Moscow; this center calculates cross-border pollutant transfer on a country-to-country basis.

The USSR actively participates in the Convention to Eliminate Water Pollution by Waste and Other Material Discharges. The Soviet Union is observing a temporary moratorium on the discharge of radioactive matter into the maritime environment which was signed by the participating nations of the Convention in order to implement a comprehensive study of the effect of radioactive matter on the components of the maritime environment and human health.

The Soviet Union participates in a number of conferences and agreements aimed at conservation of fauna and flora: the Convention on International Trade of Endangered and Threatened Species of Wild Fauna and Flora, 1973; the Convention on Wetlands of International Significance as Waterfowl Habitats, 1971; the Agreement on Conservation of Polar Bears, 1973; and the International Convention on Whaling Regulations, 1946.

The USSR's participation in the following conventions are currently under study: Convention to Conserve Migratory Wildlife, 1979; Modification of the Financial Obligations of the Participating Nations in the Convention of International Trade of Endangered and Threatened Species of Wild Fauna and Flora; the Protocol of 1982 altering the Convention on Wetlands of International Significance, 1971; and the Convention to Monitor Cross-Border Transport of Dangerous Wastes and Their Elimination, 1988.

Today Soviet specialists participate in the development of new international conservation conventions: the Convention on Biological Diversity and the Convention on the Protection and Conservation of the Black Sea.

Satisfaction of the requirements specified by the International Convention to Eliminate Maritime Ship Pollution (MARPOL 73/78) has been simplified by the fact that operational discharge from ships in the USSR Ministry of the Maritime Fleet has been diminished by a factor of several times.

An important event in preventing pollution to regional seas was the signing in February of 1988 of the Declaration to Protect the Maritime Environment of the Baltic Sea which envisages a 50% reduction by 1995 in biogenic waste (nitrogen, phosphorus) as well as petroleum products, certain heavy metals, and organic compounds. In satisfying the requirements of the Declaration measures were developed for the Baltic region of the USSR covering 500 water customer-enterprises and requiring capital investment of approximately 1200 million rubles on conservation measures. Substantial reductions in pollution levels through the estuaries of the primary rivers in the Baltic basin (Neman, Neva, Daugava) for the ingredients outlined in the

Declaration are planned.

The USSR is cooperating with states bordering the Danube on monitoring water quality in the Danube River and establishing a national and total water use balance within the framework of the Declaration on Cooperation on Water Utilization from the Danube River in order to eliminate pollution of the Danube waters.

Implementing the measures specified by this declaration will help to double the total treatment plant and recyclable water use system capacity in the area. As a result the pollutant volume from the Ukraine has diminished by a factor of more than 7.

Today Soviet specialists are involved in drafting new conservation conventions: these conventions concern biological diversity and the protection and conservation of the Black Sea.

While attaching great significance to increasing international cooperation by legal treaties the Soviet Union has begun to consider the issue of the possibility or advisability of becoming a signatory to new international conventions and agreements.

3.4. Bilateral Cooperation

An important direction in international cooperation in the field of environmental protection is bilateral cooperation within the framework of intergovernmental agreements. At present there are 10 such agreements in effect between the USSR and the following countries: Great Britain, Belgium, German Democratic Republic, Norway, USA, Finland, France, Federal Republic of Germany, Czechoslovakian SSR, and Sweden.

Agreements with the Peoples' Republic of Bulgaria, the Hungarian Peoples' Republic and the Polish Peoples' Republic are currently under preparation. Analogous agreements with Austria, the Mongolian Peoples' Republic, Switzerland and other nations are in the development stage. There has been interest in bilateral cooperation between the USSR in the field of ecology with Argentina, Brazil, Iran, the Peoples' Republic of China, the Netherlands, Japan, and a number of other nations.

The cooperation with the USA occupies a special position both with regard to the volume of joint enterprises and efforts, the broad variety of topics, and results achieved to date. There have been more than 30 projects and 11 issues encompassing a broad range of scientific and technical problems in environmental protection, rational use of natural resources, and the interrelationship of society and nature within the framework of Soviet-American cooperation.

As a result of such cooperation both sides have achieved useful scientific and practical results in such spheres as reduction in industrial

pollutant emissions and wastewater discharge, conservation of vegetation and wildlife, overall stabilization of the biosphere, conservation and pollution elimination in the seas and oceans, etc. The program of cooperation also includes new areas of joint research of mutual interest; for example, the development and advancement of low-waste and waste-free technological processes in various industrial fields and the development and recycling of toxic waste materials, etc.

The joint working group "The Joint Franco-Soviet Working Group on Environmental Protection" is charged with developing promising programs for Franco-Soviet cooperation. The Soviet side includes approximately 15 ministries (departments) on the union republic level as well as scientific research departments. Primary efforts today focus on the following projects "Air Odor Treatments on Livestock Farms and Poultry Farms", "Improving Management of Municipal Water/Sewage/Drainage Systems", "Interaction of Man and the Environment", "Development of General Methods for Biological Assessment of Water Quality", "Conservation of Migratory Birds", etc.

The most important directions of Franco-Soviet cooperation include: conservation of the waters in the Gulf of Finland Bay and protection from pollution, establishment of protected natural territories, rare species of fauna and flora, conservation of the air basin, and conservation of surface waters.

Preparations are underway today to establish the "Druzhba" Soviet-Finnish wildlife reserve;

- a joint plan for measures to further reduce pollutant emissions and cross-border pollutant transport. Joint research into the causes of the elevated acid levels of Lapland Rivers is ongoing.

The extensive use of scientific research results on eliminating air pollution, exchanging waste gas and wastewater purification and treatment technologies, developing surface water monitoring techniques, and protecting the maritime environment from pollution due to oil spills along with conservation of the northern fauna are all areas of cooperation with Norway.

To date cooperation with Sweden has been implemented within the framework of a Joint Working Group on Environmental Protection under the aegis of the Soviet-Swedish Intergovernmental Commission on Economic and Scientific and Technical Cooperation. The primary areas of cooperation include the ecological aspects of eliminating contamination and pollution of the Baltic sea, investigations of the population dynamics of wildlife under anthropogenic influences, development of the scientific principles and techniques for natural resource conservation, conservation of ecological systems and individual flora and fauna species. Further cooperation will take place within the framework of the Intergovernmental Agreement signed in 1989.

In June of 1988 an agreement between the government of the USSR and the Federal Republic of Germany was signed in Moscow; this program

provides for the development of operations within the framework of the "Program of Cooperation in Environmental Protection." The first session of the Joint Commission has been held; this session planned joint research on programs to eliminate air pollution as well as fresh water and sea water pollution, conservation of land resources including environmental monitoring, and applied research on the treatment and recycling of domestic and industrial wastes.

Cooperation with the German Democratic Republic in the field of environmental protection has been ongoing for several years. The first stage involved interdepartmental cooperation and has been in effect since 1982 between the USSR State Committee on Hydrometeorology and the Ministry on Environmental Protection and Water Reclamation and Management of the German Democratic Republic based on a corresponding Agreement in which cooperation was based on 10 topic areas. Methodologies were developed for constructing automated surface water pollution monitoring systems, automated monitoring systems for analyzing atmospheric carbon dioxide gas using laser technology and recommendations were developed for improving national environmental pollution monitoring systems; other studies were also implemented.

In early 1989 an Agreement between the government of the USSR and the government of the German Democratic Republic on cooperation in environmental protection was signed in Moscow; this Agreement outlines joint activities by both nations in fundamental and applied research, development and testing of new techniques and technologies, specialization and cooperation in the manufacture of equipment, instruments, and materials, as well as construction of conservation facilities. The primary areas of cooperation will include the development of low-waste and waste-free technologies, methods and technologies for treatment of industrial and domestic refuse, atmospheric air pollution elimination, rational use of natural resources, monitoring of environmental quality, etc.

Implementation of these programs will involve an exchange of scientists and specialists, conferences, symposia, provision of materials, equipment, and personnel for assistance in clean-up of accidents that produce environmental contamination and pollution.

An intergovernmental agreement on cooperation in environmental protection was signed in early 1989 between the USSR and the Czechoslovakian SSR. Among the many areas of cooperation special attention will be devoted to economic incentives for rational utilization and conservation of natural resources and ecological investment. Legal regulation and management in the conservation field as well as ecological training and education are also important.

The possibility of joint anglo-Soviet and Soviet-Belgian agreements which have not been implemented in practice is currently under consider-

ation. Working plans and cooperation programs within the framework of the Agreements with the German Democratic Republic and the Czechoslovakian SSR are currently under development and implementation.

Effective joint efforts on the part of different nations in environmental conservation and the protection of life on earth are a difficult task although they facilitate solutions to national problems, including those in the Soviet Union.

REPORT AUTHORSINTERDEPARTMENTAL COMMISSION

Chairman of Interdepartmental Commission on Report Preparation,
First Deputy Director of the USSR State Committee for the Protection
of Nature: Sokolovskiy, V.G.

Deputy Directors of the Commission: Biryukov, G.Ye., Samotesov, Ye. D.
(USSR State Committee for the Protection of Nature)

Commission Members: Akovetskiy, V.I., Ziberov, V.Ye., Kutukov, S.Yu.,
Luk'yanchikov, N.N., L'vov, A.P., Maksimenko, Yu.L., Osipov, G.I.,
Sakharov, V.B., Trusov, A.G., Tyurenkov, A.I., Yazan, Yu.P. (USSR State
Committee for the Protection of Nature): Arskiy, Yu.M., Kukushkin, G.Ya.
(USSR State Planning Commission); Vinogradov, V.G. (USSR State Committee
on Science and Technology); Gofman, K.G., Yevteev, S.A., Kolbasov, O.S.,
Tuzachenko, Yu.G., Romashov, V.A., Yablokov, A.V. (USSR Academy of Sciences);
Berezhnoy, V.G. (USSR State Committee on Forestry); Gaydamaka, Ye.I.
(USSR State Agroindustrial Committee); Kavtaradze, D.N. (USSR State
Committee on Public Education); Vavilov, A.M. (USSR Ministry of Foreign
Affairs); Ronin, V.L. (USSR Ministry of Land Reclamation and Water Management);
Yefimov, V.F. (USSR Ministry of Geology); Levashova, Z.V. (USSR Ministry of
Public Health); Khalimonov, O.N. (USSR Ministry of the Maritime Fleet);
Stepanenko, B.S. (USSR Ministry of the Fishing Industry); Bukreev, Ye. M.
(RSFSR Ministry of Public Housing); Kuchushev, A.K. (newspaper "Priroda
i Chelovek" ("Nature and Man")); Khozin, G.S. (Moscow State University).

Senior Organizations/Organizations Responsible for the Drafting of Report
Sections and Subsections/Individual Authors

Foreword: USSR State Committee for the Protection of Nature: Sokolovskiy, V.G.

Section I: Current State and Future Trends in the Environment and Natural
Resources: USSR State Committee for the Protection of Nature:
Ziberov, V.Ye.

- 1.1 : Atmospheric Air: USSR State Committee for the Protection of Nature:
Izrael', Yu.A., Bezuglaya, E.Yu., Budyko, M.N., Vasilenko, V.N.,
Rovinskiy, F.Ya., Fridman, Sh.D., Khattatov, V.U., Chernikov, A.A.
- 1.2 : Surface Waters: USSR State Committee for the Protection of Nature:
Lebedeva, G.V., L'vov, A.P., Shlikhunov, V.M.; USSR State Committee
for Statistics: Dumnov, A.D., Krakovskiy, A.I.; USSR State Committee
on Hydrometeorology: Andryukov, V.P., Kovaleva, T.N., Ovanesyants,
A.M., Shekhovtsov, A.A.; USSR Ministry of Land Reclamation and Water
Management: Ronin, V.L., Sumin, L.M.; USSR Ministry of Geology:
Sychev, K.I.; Institute of Geography of the USSR Academy of Sciences:
Krenke, A.N., Medvedeva, G.P.

1. Chlorophyll is the green pigment in plants that captures light energy for photosynthesis.

to use land for one or more of the following purposes:

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- 1.3 : Seas and Oceans: USSR State Committee for the Protection of Nature: Zimin, D.A., Izvol'skiy, I.S., Rumyantsev, V.M.; USSR State Committee on Hydrometeorology: Andryukov, V.P., Kovaleva, T.N., Ovanesyants, A.M., Shekhovtsova, A.A.
- 1.4 : Primary Pollution Sources and Volumes: USSR State Committee on Statistics: Dumnov, A.D., Krakovskiy, A.I.; USSR State Committee for the Protection of Nature: Maksimova, A.A., Perevozchikov, V.B.; RSFSR Ministry of Public Housing: Kuznetsov, N.I., Sirotkina, G.T.
- 1.5 : Land Resources: USSR State Committee for the Protection of Nature: Kuznetsov, V.P., Timofeev, B.A.; USSR State Agroindustrial Committee: Gaydamaka, Ye.I.
- 1.6 : Mineral Reserves: USSR State Committee for the Protection of Nature: Kuznetsov, V.P., Larichev, V.A., Timofeev, B.A.; USSR State Mining Safety Inspectorate: Zimig, V.S.
- 1.7 : Vegetation: USSR State Committee for the Protection of Nature: Bel'golovskiy, V.G., Bodunova, V.V., Dykhov, V.N., Konev, V.G., Kopchenov, N.V.; USSR State Committee on Forestry: Alekseytsev, G.P.; Berezhnoy, V.G., Val'kov, Yu.V., Titov, S.P.; USSR Ministry of Fisheries: Stepanenko, B.S.
- 1.8 : Specially-Protected Natural Environments: USSR State Committee for the Protection of Nature: Bol'shova, L.I., Gorin, D.A.
- 1.9 : Regional Ecological Problems: USSR State Committee for the Protection of Nature: Atamanenko, A.N., Grishin, Yu.I., Lebedeva, G.V., Mulyukina, A.M., Trusov, A.G., Shlikhunov, V.M.; Institute of Geography of the USSR Academy of Sciences: Antipova, A.V., Denisova, T.V., Kochurov, B.I.
- 1.10 : Public Health: USSR Ministry of Public Health: Glazkova, M.F., Levashova, Z.V.; USSR State Committee for the Protection of Nature: Akatov, G.G., Morozov, V.N.
- Section II : State Policy in Environmental Protection and Rational Use of Natural Resources: USSR State Committee for the Protection of Nature: Maksimenko, Yu. L., Kamenskaya, Yu. Yu.
- 2.1 : The Socioeconomic Development of the Nation and Ecological Problems: The USSR State Committee for the Protection of Nature: Luk'yanchikov, N.N., Averchenkov, A.A., Groshev, V.L., Potravnyj, I.M.; USSR State Committee for Statistics: Dumnov, A.D., Krakovskiy, A.I.
- 2.2 : Science and Technology in Ecological Problem-Solving: USSR State Committee for the Protection of Nature: Akovetskiy, V.I., Gogolev, I.Ya. Morozov, N.P., Morozov, V.N.
- 2.3 : Legal and Administrative Conservation Measures: USSR State Committee for the Protection of Nature: Osipov, G.I., Besyatskiy, A.V.,

... Institute of Government and
of Education: Krasov, O.S., Krasov, O.S.

... The USSR State Committee for the
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Mikhaylov, N.A., Proskurin, M.Ye.; Institute of Government and Law of the USSR Academy of Sciences: Kolbasov, O.S., Krassov, O.I.,

2.4

: The Ecological Social Movement: The USSR State Committee for the Protection of Nature: Kutukov, S.Yu., Viktorov, M.Yu.

2.5

: Ecological Education and Training: USSR State Committee for the Protection of Nature: Trusov, A.G.; USSR State Committee on Public Education: Kavtaradze, D.N.

Section III

: Participation in International Cooperation in the Field of Conservation and Environmental Protection: USSR State Committee for the Protection of Nature: Biryukov, G.Ye., Tyurenkov, A.I.; USSR Ministry of Foreign Affairs: Vavilov, A.M.

Report Editing and Layout: USSR State Committee for the Protection of Nature: Samotesov, Ye.D., Boldyreva, L.G., Ignatovich, M.V., Il'ina, T.S., Michurin, Yu.A., Rogozhkin, A.G., Trusov, A.G., Vasil'eva, Zh.Yu., Chernysheva, L.V., Kleymentov, V.D., Belinskaya, Ye.V.

English Translation: Kevin Hendzel