4

The Land

The land has been exhausted . . . our cropland urgently needs treatment everywhere.
—R. A. Giniyatullin, chair, Uzbek Ministry of Land Reclamation and Water Resources

For those who want to admire the beauties of Aral, the best thing now is to take an airplane.
—*Kommunist* (February 1990)

One of the most telling indictments of the Soviet economic system was the persistent queues for food at state stores even as the government spent billions of dollars to import massive quantities of grain. This condition stood in stark contrast to the role of the Russian Empire as a major grain exporter before the Bolshevik revolution. The region's food supply problems rested, to a large extent, on the unproductive nature of collective agriculture, unrealistic prices, and an inefficient and wasteful food processing and distribution system. In addition to its tax on the economy, Soviet agricultural development policy emphasized massive investments in mechanization, chemicals, and irrigation that proved catastrophic for the state of land resources and compounded the region's food supply problems. In a special report on agriculture to the Russian parliament, agricultural economist Sergei Bobylev criticized the technocratic approach to farming: "One of the principal reasons for present conditions is the underestimation, and even the complete lack of understanding, of the role of ecological factors in agricultural development."[1]

Moreover, studies indicate that the food available to consumers often is unsafe for human consumption because of inappropriate or negligent practices. In September 1989, 100 students fell ill while helping with the onion harvest outside Yekaterinburg (formerly Sverdlovsk). Many of the

students had to be flown to a nearby hospital for treatment, and some were incapacitated for months. Tests revealed that the students were suffering from "toxic polyneurosis" as a result of coming into contact with soil laced with "a number of pesticides." The farm's director maintained that the students simply suffered from exhaustion, but a government investigation revealed that pesticides were improperly stored and handled on the farm and that soil samples contained concentrations of chemicals exceeding safe limits by as much as 120 times. Use of some preparations present had been banned. The onions were impounded, but the harvest apparently continued later.[2] Responding to a report of the incident, a woman from Murmansk queried: "Who will answer for the poisoning not only of the students from Sverdlovsk but also of all the Russian land?"[3]

Soviet agricultural policies have had a negative impact not only on farmland but on the environment at large. One Kyrgyz parliamentarian related the following story about how local farmers avoided fulfilling the state's plan for fertilizer use:

> When asked to fulfill [the plan], farmers begin looking for ways to avoid doing so. One method is to take the fertilizer outside of city and regional boundaries and bury it there. Recently, several places where fertilizers had been buried were found near our unique lake Issyk-Kul. There are 100 tons of fertilizer there. The neighboring People's Republic of China has been asking for fertilizer, so it would have been very easy to simply sell it. Instead farmers transported it to this region and buried it, thereby polluting [the lake].[4]

Despite the benefits to be reaped from radical economic reforms like privatization and marketization of agriculture, producers, consumers, and nature alike will be burdened for the foreseeable future by the environmental legacy of Soviet agriculture.

A POOR INHERITANCE SQUANDERED

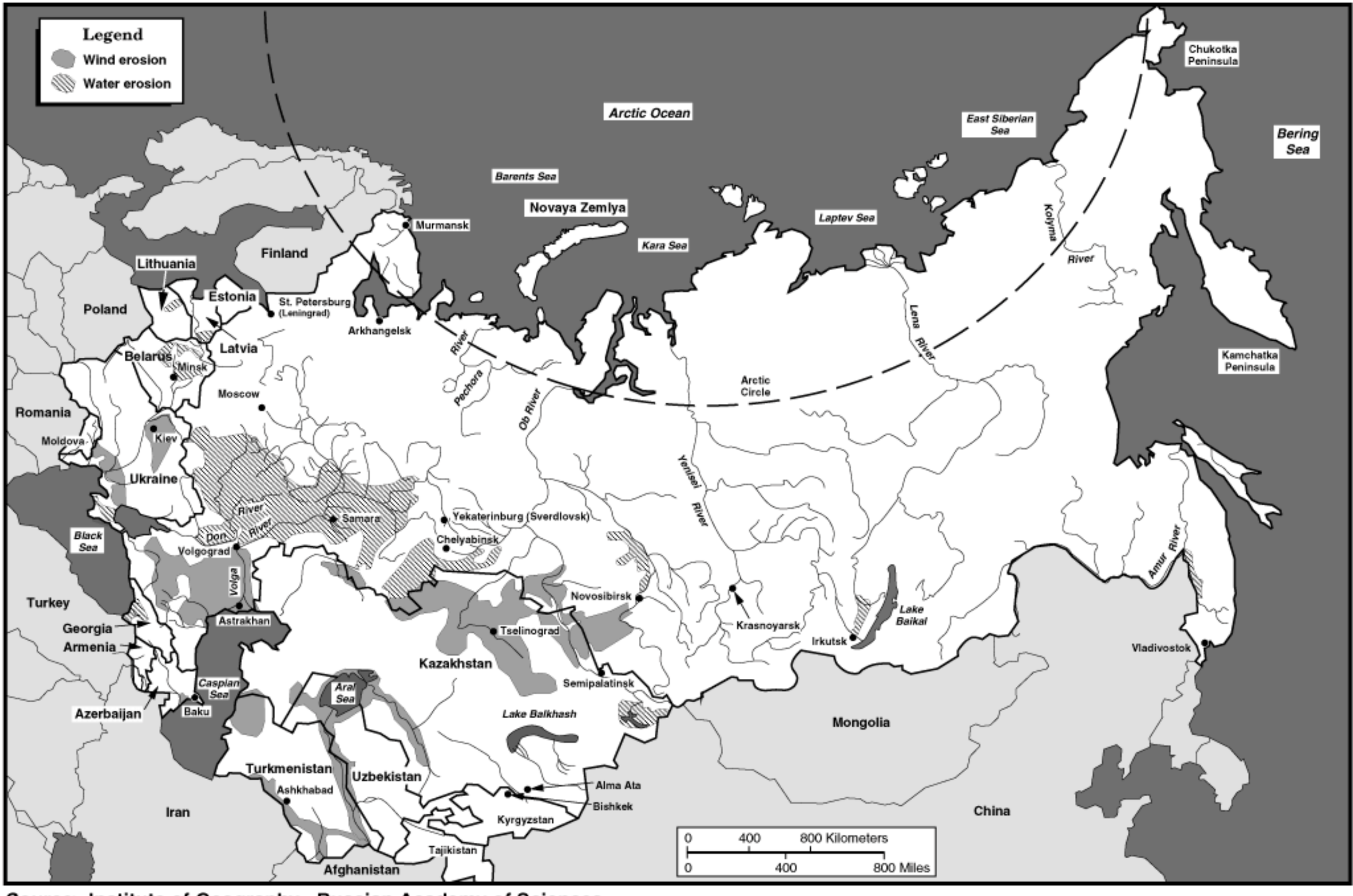
The territory that comprises the former Soviet Union, though vast, is composed to a large extent of tundra, taiga, mountains, semidesert, and desert—terrain that is relatively unsuitable for intense economic activity and is very susceptible to degradation. Similarly, agricultural land (which covers 6 million square kilometers, or about one-quarter of former Soviet territory) tends to be rocky, low in humus and essential nutrients, hilly, exposed to wind erosion, and subject to flood and drought. To make matters worse, productive lands, such as the rich black earth zone

(*chernozem*), were badly abused by Soviet agriculture. Degradation of the *chernozem* is particularly troubling because this region accounted for 60 percent of the cultivated land and produced 80 percent of the USSR's marketable grain.

In the words of Goskompriroda's 1988 report on the state of the environment: "The condition of land resources is a cause of great concern."[5] When the condition of land resources is analyzed by region, Moldova has suffered the worst; the Caucasus, Central Asia, and the central *chernozem* zone are not much better off.[6] The most serious problem has been erosion that has affected half of agricultural land, a fifth of it critically (see Map 4.1). The Soviet environment agency estimated that wind, rain, and melting snow eroded 1.5 billion tons of topsoil from farmland annually.[7] The agroindustrial agency, USSR Gosagroprom, was more pessimistic, putting losses of fine soils (*melkozem*) from Soviet farmland at 2–3 billion tons annually. In addition, the agency pegged the loss of humus and fertilizer at 100 and 43 million tons, respectively.[8] According to a 1988 report to the USSR Academy of Sciences, the region's farmland has been scarred by almost 1 million kilometers of gullies and washouts.[9]

In consequence, the humus content of the soil has been maintained in only a few regions: the Baltic states, Belarus, and several oblasts in Ukraine and Russia. In parts of the *chernozem,* up to one-third of the humus has been lost.[10] In Ukraine, erosion has affected almost a third of all arable land, resulting in the production loss of "millions of tons" in wheat in 1990.[11] Researcher M. N. Zaslavskii estimated that the effect of erosion in grain-growing regions of the Soviet Union reduced potential production by 90 million tons per year.[12] As an indication of the scale of the problem, this equaled about half of total Soviet annual production in the late 1980s, and the Soviet Union imported 35 million tons of grain in 1988.[13] Agricultural analyst A. N. Kashtanov reported in 1988 that agricultural output averaged 15 to 60 percent below its potential because of erosion, resulting in annual losses costing the USSR 7–8 billion rubles. Fertilizers lost to erosion added another 2.5 billion rubles to the toll. The total impact of erosion on land and water resources added up to 11–15 billion rubles per year.[14] Zaslavskii was more pessimistic, putting the loss at 15–20 billion rubles annually;[15] when other costs to the economy were added, the bill rose to 30 billion rubles, over 10 percent of total agricultural production.[16]

In addition, large-scale irrigation of arid and semidesert regions and overirrigation, as outlined in the previous chapter, had caused the soil in many areas to become waterlogged and saturated with salt. Of arable land in the former USSR, 13 percent was reported to be excessively saline.[17]



Source: Institute of Geography. Russian Academy of Sciences

Map 4.1. Agricultural Regions Subject to High Rates of Erosion, Late 1980s.

Like other natural resources in the Soviet Union, agricultural land suffered heavily from the extensive nature of its exploitation. Many problems can be traced to the Virgin Lands Program instituted in the 1950s by Nikita Khrushchev. Dissatisfied with the low yields on existing farmland, Khrushchev initiated a drive to open up vast new tracts of land to farming as a means of solving the Soviet Union's food supply problems. Most of the virgin lands were grassland of marginal quality, however, and very prone to erosion when planted with row crops and not allowed to lie fallow for long periods. Though the program was abandoned, these marginal lands continued to be cropped continuously as farmers were under constant pressure to boost output. As a result, an average of 30–50 percent of the humus was lost, turning parts of southern Siberia and northern Kazakhstan into a virtual dust bowl.

With erosion, pressure on pastureland by overgrazing and the cutting of too much hay has given rise to desertification, particularly in Central Asia. In Tajikistan, the "long term, unsystematic cutting and overgrazing" of grasslands have led to "a catastrophic worsening" in the state of grasslands there, and the productivity of the land has decreased 10–50 percent.[18] In Kyrgyzstan, 85 percent of the republic's territory consists of grassland: "Unfortunately, we are losing this wealth," noted Apas Dzhumagulov, the republic's prime minister, in a 1989 address devoted to ecological issues.[19] Over the 1950s–1980s, the yield from the republic's grasslands decreased by a third: "If we do not take essential measures, what will we leave to our descendants?" he asked.

To combat the decreases in harvest that resulted from soil degradation, the Soviet government funded major land reclamation projects, but it proved to be a losing battle. In spite of the fact that over a half million hectares of agricultural land were reclaimed in 1989, according to official reports, water erosion continued to grow, claiming 100,000–150,000 hectares.[20] Between 1975 and 1985, the area of saline land nearly doubled. Most of the reclamation work funded by the government did not entail restoration of degraded lands per se but the extension of irrigation and drainage systems. Moreover, many of the land improvements documented existed only in the reports to economic planners; as in other sectors of the Soviet economy, the quality of work was poor. According to a report that appeared in the agricultural newspaper *Sel'skaya zhizn'* (Rural Life), land reported to have been improved and brought into economic use in the Russian Federation between 1981 and 1986 needed "major" repairs by 1990.[21] In 1975, 4.8 million hectares of irrigated land were in need of capital work; by 1985, the area increased to 5.6 million hectares; and by 1988, it reached 7 million hectares—almost one-third of all irrigated land.[22] In the paradoxical words of a USSR Gosplan official:

"The improved state of a significant portion of these lands is constantly worsening."[23]

In sum, between 1968 and 1988, poor land use rendered 6 million hectares of the most productive agricultural land barren—an area the size of West Virginia.[24] According to N. Z. Milashchenko, first vice-president of the Academy of Agricultural Sciences, "These figures underscore the problems in investment policies and also the environmentally dangerous trends in farming."[25] In a review of the environmental impact of Soviet agriculture, Kashtanov, writing in the *Bulletin of the USSR Academy of Sciences*, noted the following as the fundamental causes of the poor state of Soviet land resources:

> a lack of an individual responsibility for the land; the ecological illiteracy of many agricultural specialists and managers; unsatisfactory government control of the regulation and conservation of soil productivity and of [those who cause] erosion; the lack of a specialized government erosion control service . . . the lack of the technical means to conduct soil conservation; and the low level of scientific expertise in the conservation of the soil and the environment.[26]

As mentioned in Chapter 2, land resources have been damaged not only by destructive agricultural development but also by exogenous factors such as airborne pollution. Aleksei Yablokov labels industrial pollution and its threat to the food supply as Russia's number two environmental threat.[27] On this point, USSR Goskompriroda chair Nikolai Vorontsov made the following comment:

> When industrial plants discharge a ton of sulfur onto a square kilometer of farmland, the properties of the soil are substantially degraded, to put it mildly. Let us see where our chief producers of noxious waste are concentrated—on the mightiest *chernozem* soils: Zaporozhye, Dnepropetrovsk, Dneprodzerzhinsk, the entire Donbass. . . . We will try to introduce new and more progressive soil protection measures—contour plowing, using the very gentlest implements, limiting the amounts of chemicals that go into the soil, and so on, but the poison will continue to be showered from above.[28]

The accumulation of industrial pollutants has been greatest near metallurgical centers—such as Ukraine's Donets Basin and Russia's Kola Peninsula and southern Urals region—where zinc, copper, cobalt, cadmium, vanadium, and numerous other elements have been found in the soil in concentrations far above permitted levels.[29] An official at the Georgian State Planning Committee reported contamination of the soil

by these and other metals around the cities of Tbilisi, Rustavi, and Batumi.[30]

In a vain attempt to compensate for the myriad of ills besetting Soviet agriculture—low productivity of the soil, an undeveloped infrastructure, squalid rural living conditions, a lack of effective financial incentives, and poor farm management, to name a few—planners often turned to technological quick fixes. Beginning with the Khrushchev regime, the Soviet government poured hundreds of billions of rubles into agriculture in an attempt to put more food on the table. Along with state ownership of the land and collective agriculture, heavy mechanization and the extensive use of agrochemicals were portrayed as an unquestionable good.

Contrary to officials' intentions, many investment programs were ill-conceived and misdirected and served only to promote further the deterioration of regions they were supposed to help. USSR Goskompriroda estimated that between 1965 and 1988, capital investment in agriculture increased 5-fold, fertilizer and pesticide use went up comparably, and the total area of irrigated and drained agricultural land doubled. Yet gross agricultural output over the same period increased by a mere 20 percent—not enough to keep pace with the growth of the population.[31]

TROUBLE WITH TRACTORS

In 1988, Soviet factories turned out 559,000 tractors, six times the volume produced in the United States.[32] In addition to being ubiquitous, Soviet-designed tractors were uniformly big and heavy—so big and heavy that they were described by USSR Goskompriroda as being one of the principal factors contributing to soil degradation and causing "a massive loss in agricultural production."[33] Juhan Aare, a member of the committee on the environment in the Estonian parliament, complained that "our small fields and plains are being destroyed by gigantic machines designed for the needs of the enormous Russian and Ukrainian steppes. . . . Heavy tractors mean death for our land."[34] *Sel'skaya zhizn'* carried the following commentary on Soviet tractors:

> Modern technology—powerful and heavy—is damaging the land and excessively compacting it. After numerous passes by a Kirovets, Don, or KamAZ [tractor], a tight ear of wheat will not develop, no matter how much the soil is fertilized. According to specialists' calculations, the excessive compaction of the soil prevents the country from producing 15 million tons of wheat yearly.[35]

The problems, according to *Sel'skaya zhizn'*, began in 1959, when Nikita Khrushchev visited the farm of Roswell Garst in the United States

and saw that U.S. tractors were equipped with tires. Back in the USSR, Khrushchev demanded that Soviet tractors also be outfitted with tires instead of the customary Caterpillar tracks. Khrushchev, did not, however, pay attention to all the details, such as the weight of the tractor or the air pressure needed in the tires. In comparison studies, the K-700 model tractor equipped with tires exerted up to twice as much pressure on the soil as lighter models with wheels or vehicles of comparable weight with Caterpillar tracks. The result was a drop in crop yields estimated to be as much as 25 percent.

Once the soil has been excessively compacted it takes years to recover. Agronomists began in the mid-1970s trying to undo the harm wrought by Khrushchev's scheme, but to little avail. Extensive research indicated that using different tires or reverting to Caterpillars would improve the situation, and new standards were adopted by the government accordingly. The tractor manufacturers, however, balked at the new regulations and managed to get them shelved—an easier task than building lighter tractors or fitting Caterpillar tracks to existing models.[36]

"STUFFED WITH FERTILIZER"

With Khrushchev's crash campaign to "chemicalize" agriculture, begun in the early 1960s, fertilizer became one of the most important weapons in the Soviet struggle to produce more food. Planners measured success in terms of gross output of fertilizer, not food: In 1960, Soviet fertilizer production amounted to less than half that of the United States; by the late 1960s, the Soviet Union had drawn even in fertilizer output. In 1988, the USSR produced more than 37 million tons, nearly twice as much as its rival.[37] In contrast with many of Khrushchev's other challenges to the West, the USSR won the fertilizer battle, but it lost the food production war.

Despite the increase in fertilizer output, agriculture officials often pointed out that overall fertilizer use was relatively low in comparison to that in Western countries. On average, one hectare of arable land in the Soviet Union received about 120 kilograms of fertilizer per year in the 1980s; the rate in Western Europe, according to Soviet comparisons, often was 5 to 6 times as high during the same period. Such comparisons, however, were faulty: Fertilizer use under Soviet central planning, like many other indicators, was very uneven, and the discrepancies were not accurately reflected in government statistics. Belarus, Lithuania, and Latvia, for example, averaged over 300 kilograms per hectare, whereas one-quarter of all Soviet land under cultivation normally received no fertilizer at all. Kazakhstan registered the lowest average fertilizer use

under the Soviet system, only 34 kilograms applied per hectare.[38] Yet great discrepancies existed in the republic also: In 1989, *Sel'skaya zhizn'* reported that in the southern section of Kazakhstan, "the land literally has been stuffed with fertilizers."[39]

While state planners focused on boosting output, other aspects of the fertilizer drive—distribution, storage, and, most important, application—were overlooked. An audit conducted by the state planning agency USSR Gosplan revealed that 11 percent of all fertilizers never reached the field because of transport and storage problems. *Pravda* provocatively recommended that farmers sow their crops along railroad tracks because so much fertilizer was lost from loaded trains on the way from factory to farm.[40] When supplies did reach the farm, they often were left out in the open: Turkmenistan's agricultural agency reported that in one region, only one-quarter of farms had necessary storage facilities.[41] The problem is likely to continue for the new republics because the construction of special facilities for the storage of agrochemicals dropped 30 percent across the USSR in the late 1980s.[42]

While agronomists worked out in detail how to apply fertilizers properly, farmers and rural specialists were often oblivious to these guidelines. An academician interviewed by *Pravda* complained that the government poorly trained farmers in the use of agrochemicals. Boris A. Yagodin, a member of the Academy of Agricultural Sciences, complained that agricultural chemistry was not being taught at technical schools and that several agricultural institutes had been closed down. Moreover, ignorance was compounded by negligence: "Technological discipline is . . . low. It is easier for a manager to report the quantity of fertilizer applied than to bother with a troublesome, scientifically based system of chemical use for each individual field."[43] As a result, farmers often dumped agricultural chemicals on the soil without regard for the specific needs of the crop, the weather, the season, soil conditions, or the type of product being applied.

Gosplan estimated that across the Soviet Union, rain and irrigation washed a third of all fertilizer out of the soil and into groundwater.[44] Accordingly, N. Z. Milashchenko wrote in 1989: "An increase in nitrate contamination of ground and surface waters has been noted in all areas in recent years." Toxicologists estimated that over 16.6 million tons of lead, 3.2 million tons of cadmium, and a half ton of mercury had been added to the soil with phosphorous fertilizers alone—then there was fluorine, strontium, and uranium. "Unfortunately," wrote Milashchenko, "the biological aspects of this problem . . . still have not been worked out."[45]

PROBLEMS WITH PESTICIDES

About 25 percent of all agricultural land was treated with chemical-based pesticides during the Soviet era; improper application of these preparations, however, caused considerable harm to the environment, crops, and farm workers.[46] As with fertilizers, little training was given in the use of pesticides, and technical support was poor. In addition, farmers often lacked the necessary equipment to apply properly the pesticides supplied to them. As a consequence, more than just plants were treated: According to one source, half of all pesticides were used in an "unsatisfactory" manner, and aerial crop dusting proving particularly problematic.[47]

Farmland has been "significantly contaminated" by pesticides (i.e., insecticides, herbicides, and fungicides) in Azerbaijan, Armenia, Kyrgyzstan, Moldova, Tajikistan, Uzbekistan, and elsewhere.[48] Pesticide use was particularly heavy in rice- and cotton-growing regions during the Soviet era. According to a report in the business weekly *Ekonomika i zhizn',* pesticide use averaged 15–25 kilograms per hectare of rice in the 1980s. "This is only in theory," added the authors, "[and] in practice, far more pesticides are used." Damage was compounded when farmers flooded the paddies immediately after treating them, sending the pesticides directly into the water table.

In 1987, almost a third of all fish in the Volga Basin reportedly died from pesticide poisoning.[49] In many regions, such as the cotton belt of Central Asia, reports indicated that pesticides were turning up in the drinking water supply. In the Krasnoarmeiskii region of southern Russia's Krasnodar region, the use of pesticides on rice crops has taken a heavy toll on the health of the population. According to a statement in 1989 by a health official in the region, the incidence of cancer among the general population increased by 50 percent over the previous five years, and children's immune systems weakened. Yevgenii Rybailov complained: "The fields are being attacked with over one hundred preparations. They arrive at the state farms without any accompanying documentation, without instructions—the workers just do not know how to use them. We are wasting money and paying for it with our health."[50] Uzbekistan Goskompriroda reported that more than 250,000 containers holding 6,000 tons of "banned toxic chemicals," including DDT and the highly toxic defoliant butifos, had piled up on the republic's farm.[51]

DDT was banned in the Soviet Union in 1970, but the environment has continued to suffer the effects of this long-lived pesticide. Of soil samples tested in late 1988, one-half showed residual levels and about 15 percent (accounting for 8,300 hectares of land) contained concentrations of DDT that exceeded the maximum level specified in health regulations. The re-

publics most affected—with average concentrations from 2 to 8 times the established norm—are Azerbaijan, Armenia, Uzbekistan, and Moldova. Traces of the pesticide have been found not only in cotton-growing areas, where it was used most heavily, but also in regions where other crops are raised; in Kyrgyzstan, soil under wheat and vegetable crops reached 33–46 and 9–20 times the norm, respectively. Soil samples from Novosibirsk oblast contained concentrations of DDT as high as 56–192 times the permissible norm, suggesting that use of the preparation continued after the ban.[52] The government also ran down its stocks of DDT by exporting the pesticide. Between 1986 and 1989 (the only years for which data are available), Soviet entrepreneurs sold approximately 14,000 tons of the pesticide abroad.[53]

A review of the state of the environment in Ukraine summed up the effect of the Soviet government's chemicalization drive in these words:

> The unshakable belief that intensive chemicalization of agriculture would substantially increase yields turned out to be premature. Unscientific and intensive chemicalization brings with it serious negative social and ecological consequences. It has already been established that it is the fundamental cause of the increase in illness among the population living in regions of intensive application of pesticides. The increase in infant mortality and illness in rural regions causes alarm. The monitoring for the contamination of foods with various chemicals has prompted serious concern.[54]

FROM FIELD TO TABLE

Soviet consumers added a new word to their daily vocabulary and daily concerns in the 1980s—*nitraty*, or nitrates—prompted by a spate of media reports on Soviet agriculture and its impact on the food supply.[55] Yet the region's food supply is threatened not only by nitrate contamination, a function of the improper use of fertilizers, but also by pesticides, heavy metals, and even radioactive elements. In his 1991 report to the Russian parliament, Bobylev wrote: "The quantity of produce which contains radionucleides presently consumed by the public is great."[56] Sadly, chronic food shortages and high prices mean that the public has no choice but to continue eating such tainted produce.

According to official data, over 1.8 million tests were carried out on food products in the Soviet Union in 1988. One-tenth of the produce examined failed to meet various government health standards. Uzbekistan had the worst record; nearly one-fifth of the food tested there did not pass inspection. Other republics with rates of contaminated food above the Soviet average were Kyrgyzstan, Tajikistan, Kazakhstan, and Russia.[57] In terms of nitrates, one-quarter of all crops tested in Estonia

and Moldova were reportedly contaminated in 1989; in Russia, Belarus, Kazakhstan, and Lithuania, the share was one-sixth.[58] In Russia, over 28 percent of potatoes tested registered above-norm levels of nitrates.[59] In Lithuania, over half of the potatoes, a third of the cabbages, and over a quarter of onions tested failed government standards for nitrates in 1987; results of these inspections and others for Lithuania are outlined in Table 4.1.

Of food supplies tested specifically for pesticide residues in 1989, 3.9 percent on average contained levels higher than the permissible norm (see Table 4.2). Georgia had the most serious problem that year, with 11.7 percent of the food tested exceeding the limit.[60] Reports of these government studies did not mention at which point the tests were conducted—whether in the field, processing plant, or point of sale—or what was done with produce that failed. In April 1989, Goskompriroda's Fedor Morgun admitted that health codes occasionally were ignored, and "products contaminated above established norms are being sold."[61] Other sources reported worse figures. Bobylev claimed that 17 percent of Russian produce was contaminated with "residual quantities" of pesticides.[62] Russian environmentalist Aleksei Yablokov has been one of the most outspoken about the threat to the food supply and, citing 1987 data, alleged that in some areas of the USSR, up to half of foodstuffs tested were contaminated with pesticides and unfit for human consumption.[63] A third of produce tested in St. Petersburg that year contained quantities of pesticides at levels hazardous to health.[64]

Food quality standards, like other public health norms, were established by the USSR Ministry of Health. Like water and air quality standards, those for food were strict. "Regarding our standards matching in-

TABLE 4.1 Nitrate concentration of produce in Lithuania, 1987

	Number of Samples Tested	*Percent Within Norm*	*Percent 1–2 Times Permissible Limit*	*Percent Exceeding Twice Permissible Limit*
Potatoes	2,124	42.1	48.8	9.1
Cabbage	449	61.3	24.7	14.1
Onions	143	73.0	25.3	1.7
Green onions	116	81.4	16.3	2.3
Beets	391	87.2	12.5	0.3
Cucumbers	52	88.5	9.6	1.9
Tomatoes	62	91.9	4.9	3.2
Carrots	505	92.7	6.1	1.2

Source: Kaunas Economics Institute, "Urgent Ecological Problems in Lithuania," briefing submitted to the Lithuanian Council of Ministers, November 1988, p. 36.

TABLE 4.2 Pesticide contamination of soil and produce by republic, 1989 (percentages)

	Samples with Residual Levels		*Samples with Above-Norm Levels*	
	Soil	*Produce*	*Soil*	*Produce*
USSR average	33.4	25.0	4.6	3.9
Azerbaijan	58.4	42.4	29.2	na
Belarus	37.2	10.0	24.8	3.4
Georgia	63.8	55.1	24.4	11.7
Kazakhstan	17.8	9.8	1.4	3.5
Kyrgyzstan	2.8	1.0	4.9	0.6
Lithuania	1.6	16.0	5.6	4.1
Moldova	30.2	8.8	11.7	6.9
Russia	25.8	17.1	1.4	5.1
Tajikistan	66.6	34.8	3.9	0.0
Turkmenistan	33.6	60.9	na	0.0
Ukraine	54.2	29.6	0.7	0.5
Uzbekistan	65.3	53.4	4.7	2.9

Source: USSR Goskompriroda, *Sostoyanie prirodnoi sredy i prirodookhrannaya deyatel'nost' v SSSR v 1989 godu* (Moscow: Institut Molodezhi, 1990), p. 107.

ternational norms," Morgun assured the public, "they are, in general, fully comparable." But, he added: "There are also examples of [levels of] maximum permissible concentrations being revised upwards unjustifiably."[65] In 1988, the health ministry increased the concentrations of nitrates permitted in many vegetables and fruits; standards for potatoes and cabbage, for instance, more than tripled.[66]

In December 1989, *Komsomol'skaya pravda* looked into the issue of contaminated foods in Ukraine. Over a period of four months in 1989, public health specialists conducted 542 tests on food in the republic's capital; a quarter revealed excessive levels of nitrates. The chair of the department of biophysics and radiobiology at the Ukrainian Academy of Science Botany Institute, Dr. D. M. Grodzinskii, related the following story to the newspaper: "In our laboratory, we have 14 colleagues living in 13 districts of Kiev. And so we decided that each of us would bring to the laboratory milk, vegetables, and fruit from our districts. We ran tests. The results were stupefying . . . a very high level of contamination."[67]

With the active participation of scientific institutions, two journalists from *Moskovskaya pravda* investigated produce from three state farms serving the capital. After running tests for the presence of heavy metals, they concluded: "The results of the analysis, unfortunately, exceeded the

most pessimistic fears. . . . It turns out that of the three state farms, only one was 'clean.'" Carrot samples exceeded permissible concentrations for cadmium by a factor of between 3 and 8, and in beets by 10–14. The presence of zinc in beets was 2–3 times above the maximum permissible concentration.

The newspaper revealed that the main wastewater treatment facility serving Moscow had been disposing sludge at dozens of farms on the outskirts of the city. As many industrial enterprises in the capital released their wastes into the city sewage system indiscriminately, the precipitate produced by the city's two wastewater treatment plants contained high levels of heavy metals. Fields fertilized with the precipitate contained concentrations of mercury 10 times higher than those found in untainted soil; concentrations of silver and chromium were 3–10 times higher; and zinc, copper, arsenic, strontium, vanadium, nickel, and cobalt levels were elevated as much as 3 times.[68] The chief engineer of the Kuryanovo plant dismissed the threat as unwarranted. On the grounds of the sewage plant, juicy tomatoes and cucumbers thrived in greenhouses built to supply plant personnel. Tellingly, he conceded that the facility's produce was not grown with sludge.[69]

THE TECHNOCRATIC APPROACH TO AGRICULTURE RECONSIDERED

The reliance on agrochemicals permitted the stagnation of efforts to improve farmland in more constructive ways—for example, by introducing lighter farm equipment, shallow tilling, contour plowing, and crop rotation, not to mention reforming collective agriculture. *Sel'skaya zhizn'* characterized the state of affairs in Kazakhstan thus: "The pursuit of instant success and victorious reports through the introduction of monocropping led to such an impoverishment of the soil that one might as well remove them from production and let them lie fallow for a long time."[70]

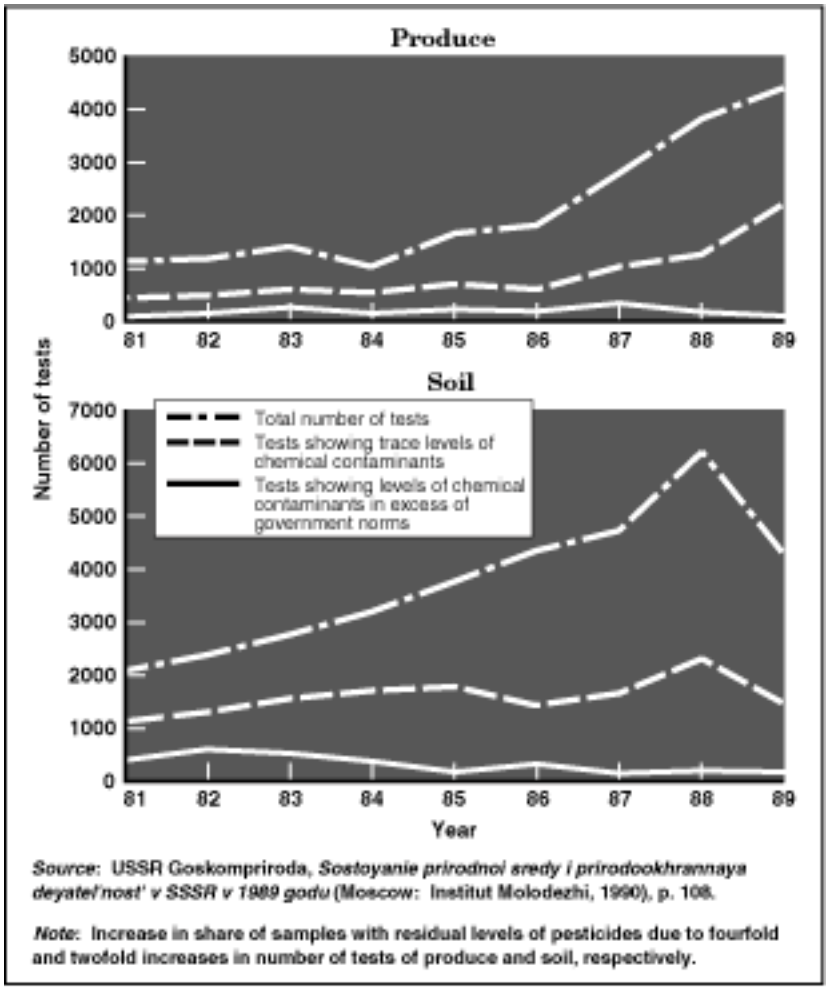
As Soviet society began to question the efficacy of collective farming and public ownership of land, policymakers also started to reconsider the traditional technocratic approach to agriculture. For example, USSR Goskompriroda's Valentin Sokolovskii blamed the state of Soviet agriculture on a modernist "fetishization of scientific and technical progress," adding, "The belief that technology, fertilizers, [and] pesticides can boost productivity infinitely has led to stagnation in the development of agricultural science and the unrestrained spending of the soil's reserves."[71] Petr I. Poletaev, another official at USSR Goskompriroda, related the following telling anecdote: The chairman of a collective farm was asked

once why he was using so much fertilizer. "Our land is like a drug addict," the farmer replied. "It cannot survive without it." Poletaev's wry retort was "Alas, a drug addict does not last long either."[72]

Fertilizer use began to taper off in 1988. Deliveries of fertilizer decreased by one-fifth by 1990, but gross agricultural output remained relatively steady.[73] The drop in fertilizer use may be attributed to two causes: bottlenecks in the supply system as a result of economic dislocation (particularly transport slowdowns and a drop in petroleum production), and attempts by farms to economize on inputs in the wake of economic reforms—namely, the shift to financial independence and sharply rising input prices. The application of chemical-based pesticides peaked in 1985, and by 1990 had dropped over 50 percent, while the use of herbicides alone fell by over 60 percent.[74] As in the case of fertilizers, this reduction likely reflected farm managers' attempts to cut costs. Another probable cause was a decrease in the availability of pesticides and a tightening of regulations. Production of a number of ineffective preparations was curtailed, and the use of other pesticides, such as butifos, was banned.[75] Finally, many farm managers appear to have been adversely affected by heavy media attention on the misuse of agrochemicals, particularly of herbicides in Central Asia, moving them to avoid their use.

As a result of the decrease in the use of pesticides and a greater awareness of their proper application, the share of food and soil samples registering above-norm levels of pesticides tapered off (see Figure 4.1). Similarly, the share of many common vegetables registering above-norm levels of nitrates decreased from 12.3 percent in 1988 to 6.8 percent in 1989.[76]

Meanwhile, the use of organic methods to protect crops was increasing—organic farming was up by 10 percent between 1986 and 1988 alone. Despite the increase, however, the share of agricultural land being thus treated remained small, only 4 percent.[77] It is interesting to note that the original impetus to pursue organic farming came from high Soviet officials who sought to obtain a safe supply of food for their families. Enterprises like the Ala-Tal state farm outside of Alma-Ata, which raised apples, strawberries, tomatoes, and even trout, were directed to do so with minimal chemical inputs.[78] The motivation to grow organic foods became strong as media reports indicated that produce certified "organic" in urban peasant markets sold briskly, despite higher prices.[79] In response to the deteriorating quality of the republic's food supply, the Kazakh government passed a resolution mandating punitive fines for those found selling tainted produce.[80] In May 1990, the Soviet government announced it would pay a premium for grain grown with-



Source: USSR Goskompriroda, *Sostoyanie prirodnoi sredy i prirodookhrannaya deyatel'nost' v SSSR v 1989 godu* (Moscow: Institut Molodezhi, 1990), p. 108.

Note: Increase in share of samples with residual levels of pesticides due to fourfold and twofold increases in number of tests of produce and soil, respectively.

FIGURE 4.1 Trends in pesticide contamination of soil and produce, 1981–1989.

out chemical pesticides as part of its larger program to promote grain sales to the state.[81] Parliamentarians from Central Asia met in Tashkent in October 1991 to coordinate the republics' environmental policies. The representatives announced an ambitious plan to halt the use of pesticides and herbicides in the region by 1995.[82]

INTERSECTION OF LAND AND WATER USE: THE CASE OF THE ARAL SEA AND CENTRAL ASIAN AGRICULTURE

The Aral Sea was once the world's fourth-largest inland lake, with a surface area greater than the state of West Virginia. A fleet operating out of the port town of Muinak on the Amu Darya delta to the south regularly hauled in over 40,000 tons of fresh-water fish a year from this verdant, self-sustaining ecosystem. Around its shores in Kazakhstan, Uzbekistan, and Turkmenistan, nomadic tribes raised livestock.[83]

In Central Asia, agricultural development under the Soviet regime was epitomized by the dominance of cotton, as the Kremlin aggressively sought self-sufficiency in what planners dubbed "white gold." In the late 1950s, the Central Asian republics, most notably Uzbekistan, began to fulfill their "internationalist duty" by rapidly expanding irrigation in arid zones and plowing up their market gardens and orchards to obtain extra acreage for cotton. Between 1960 and 1988, the production of raw cotton was boosted 80 percent in Uzbekistan and over 350 percent in neighboring Turkmenistan.[84]

In the early 1990s, Soviet Central Asia was the world's third-largest cotton-growing region and accounted for 12 percent of world exports, a share second only to that of the United States. Uzbekistan accounted for over 60 percent of total Soviet cotton production, with cotton plantations occupying up to three-quarters of the republic's agricultural lands. Despite the monetary reward, the price paid by the people of Central Asia for the cotton monoculture has been high.

To help fulfill this duty, engineers built the 1,100-kilometer V. I. Lenin Karakum Canal to bring water from the Amu Darya to new cotton acreage in the Turkmen desert. Water also was drawn off at numerous other points along the Amu Darya and Syr Darya in Turkmenistan, Uzbekistan, and Kazakhstan on their way to the Aral. Whereas these rivers once fed the sea 50–70 cubic kilometers of water annually, the inflow to the Aral had been reduced to a trickle by the 1980s. In the most favorable years, the sea has received no more than 20 cubic kilometers. Meanwhile, water has evaporated from it at a rate of 33–36 cubic kilometers annually. By the 1990s, the water level of Aral had dropped by more than 15 meters, and the sea had shrunk to almost half its former size, causing the sea to split into two: "Little Aral" to the north fed by the Syr Darya, and "Big Aral" in the south fed by the Amu Darya (see Map 4.2). Thus, the Aral Sea is fast becoming the Aral Desert.

The demise of Aral can be ranked as a major land-use disaster. As the water has fallen, its salinity has increased sharply (from 10 percent in

Map 4.2. Aral Sea Region

1960 to 27 percent at the end of the 1980s), wiping out 20 of 24 species of fish. With nothing to catch, abandoned trawlers now lay beached on the sand 70 kilometers from water. In a futile attempt to preserve the 1,100 jobs at the Muinak and Aralsk fish-processing plants (now located far from the coast), the Soviet government resorted to shipping in frozen fish by rail from the Pacific and Atlantic. Windstorms rake the exposed lake, whipping up tens of millions of tons of sand, salt, and accumulated agricultural chemicals into the air. In 1988, USSR Goskomstat reported that an average hectare of agricultural land in the region had received over one-half ton of airborne salt, leading to the destruction of crops and forests.[85] The salt also travels for thousands of kilometers, reaching the Pamir Mountains of Tajikistan along the Afghan and Chinese border and accelerating spring snowmelts there. Meanwhile, the reduced surface area of the lake has modified the weather in the Aral region. The climate is more continental—summer heat has become hotter and drier, winters are more severe, and the growing season has been reduced by up to a fortnight.

All this has ensued while irrigation canals upstream leak profusely—on the order of one-half the volume of water diverted away from theAral Sea.[86] Since the early 1970s, engineers in Ashkhabad, the capital of Turkmenistan, have been struggling to prevent the city from being inundated by seepage from the Karakum Canal by drilling 150 relief wells to pump the water out of the city.[87] The use of leaky and rudimentary water delivery systems in the fields has resulted in uneven and often excessive irrigation, and a lack of adequate drainage systems prevents the return of groundwater to the rivers or its reuse. When runoff is collected, it has not been put to beneficial use. Runoff from cotton and rice irrigation along the lower course of the Amu Darya has not been returned to the river, but has been allowed to flow into a desert depression, 200 kilometers southwest of Aral on the Turkmen-Karakalpak border, creating Lake Sarakamysh.

The result of overirrigation and poor drainage is rising water levels in the fields, a factor that has promoted the salinization of upper soil layers through evapotranspiration. From the mid-1970s to the late 1980s, the area of irrigated land in Uzbekistan suffering saline conditions increased by almost 40 percent to affect almost one-half of all irrigated land in the republic.[88] In the Karakalpak republic of Uzbekistan, which borders on the Aral Sea, only one-quarter of the 485,000 hectares of irrigated land are not excessively saline as farmers are forced to draw irrigation water coming downstream with an elevated salt content.[89] In many regions of Central Asia, the soil has become so saline that it appears to have been dusted with snow. In winter, farmers often apply more water in a des-

perate yet often more destructive effort to purge the soil of salt. The precipitous decline of Aral notwithstanding, existing patterns of irrigation are not sustainable because rising salinity levels in Uzbekistan corresponded with the dropoff in cotton yields in the 1980s.[90]

Unfortunately, the ambitious diversion of water resources tells only half of the story. The region's cotton plantations came to be dependent on fertilizers when the poor desert soils were depleted of nutrients because the government's demanding plan prevented farmers from planting other crops to build up the soil. Persistent cotton cropping also favored an increase in pests, forcing farmers to rely more heavily on pesticides. In Turkmenistan, for example, farmers applied pesticides at 20–25 times the Soviet average in the 1980s.[91] David Smith, a U.S. geographer specializing in Central Asian agriculture, has pegged pesticide use in Uzbekistan at 10 times the level recommended in the United States.[92] Finally, farmers turned to heavy doses of potent defoliants in autumn to facilitate harvesting the cotton crop.

The inordinate use of fertilizers, pesticides, and defoliants on cotton crops has contaminated groundwater supplies as excessive irrigation has flushed much of the agrochemicals off the field and into the water table. Downstream cities like Chardzhou, Urgench, Tashauz, and Nukus, the capital of Karakalpakistan, not to mention the small towns and villages that line the two rivers and their tributaries, have minimal sewerage treatment capability; municipal and industrial wastes therefore are released directly into the rivers. The toxic brew of agrochemicals, minerals, and waste that continues down the river has made it unfit for consumption by humans and even livestock, yet settlements along the lower reaches of the Amu Darya in Karakalpakistan must draw up to two-thirds of their drinking water from the river; this water is untreated for lack of any alternative.[93]

Assaulted by agrochemicals from above and tainted water from below, the land in the vicinity of Aral is being threatened by what one scholar described as this "slow Chernobyl"—a strain the region's health-care system is woefully ill-equipped to handle. Kakimbek Salykov, chair of the USSR Supreme Soviet Committee on Ecology, noted in 1990 that three-quarters of the population of his native Karakalpakistan suffer from various diseases.[94] *Argumenty i fakty* reported that official infant mortality statistics for the region had risen from 44.7 deaths per 1,000 live births in 1965 to as high as 90 by 1986. Four-fifths of the women and children in the region suffer from anemia. In Kazakhstan's Kzyl-Orda oblast to the northeast of Aral, the incidence of typhoid fever increased 30 times between 1974 and 1989, with viral hepatitis up 7 times. Incidences of tuberculosis and cancer also have been on the rise.[95] Recent

outbreaks of bubonic plague epitomize the region's regression to premodern conditions.[96] In sum, Goskompriroda's Vorontsov labeled the Aral crisis "the greatest ecological catastrophe of our planet."[97]

These consequences were foreseen several decades ago, but planners failed to implement plans to conserve irrigation water or to allow the farms to switch to less water-intensive crops. Consequently, many scientists now believe that Aral is beyond recovery and the best that can be hoped for in the immediate future is that conditions will not deteriorate as fast as they have been. In a September 1988 joint resolution, the Soviet government and CPSU Central Committee called for "a complex of radical measures" to rescue the sea from "the serious deficiencies" of the past. The first section of the tripartite plan contained measures to address environmental degradation, such as reducing the amount of water diverted to agriculture, renovating and upgrading existing irrigation systems, and restricting work on new large-scale projects after 1991. The plan also called for the planting of vegetation in coastal areas and on the exposed lake bed to prevent further wind erosion. The second aspect of the program addressed public health concerns, mandating the rapid construction of municipal water supply systems, strict observation of water quality standards, and improved healthcare services. Finally, the third section called for a multifaceted plan of economic development to combat accumulated social ills in the region.[98]

By the summer of 1990, 50 different projects were reported to be under way to address the region's problems, but evidence suggested any improvement would be a long way off, if not totally elusive.[99] In late 1991, *Pravda* reported that drinking water quality in the region had not improved: Only half of the money allocated for construction and capital repairs of irrigation and municipal water systems had been spent.[100] A principal fault with the government/Communist Party plan was that its conservation measures were not enough to halt the catastrophic decline in the level of Aral. The plan called for a minimum of 8.7 cubic kilometers of water for the sea in 1990 to increase gradually to 20–21 cubic kilometers by 2005. Obviously, even these levels fall far short of the volume of water required just to keep pace with natural evaporation from the lake (33–36 cubic kilometers). Second, efforts to improve drinking water quality for downstream populations along the Amu Darya and Syr Darya focused on diverting agricultural runoff directly into Aral via thousands of kilometers of special drainage canals paralleling the rivers. The approach does not address the fact that vast quantities of agrochemicals will continue to leach into return water that eventually will reach Aral. The benefit to the sea from the plan, therefore, is dubious.[101]

The key to saving Aral and obtaining sustainable economic growth lies with reforming agriculture in Central Asia. One option would be to cut the demand for water by substantially reducing the size of cotton plantations and converting farms to growing less water-consumptive crops. Some suggest growing high-value produce; Uzbekistan, for instance, once had a great reputation for its bounty of fruits, vegetables, and nuts.[102] Local political leaders have expressed an interest in reducing their cotton acreage, but the cost in the short term would be great because cotton exports are the region's principal source of hard currency, netting the region $700 million annually in the early 1990s.[103]

A second option would be to improve the efficiency of water use through the repair and maintenance of existing networks—much of which are in very poor condition—and employment of new water-saving technologies and techniques, such as laser leveling of fields. The largest water savings (up to 30–40 cubic kilometers) could be achieved through the reduction of evaporation and seepage from irrigation projects by lining canals and replacing furrowed irrigation with drip systems.[104] This task would be monumental and expensive because there are over 180,000 kilometers of irrigation canals in Central Asia, less than 10 percent of which have antifiltration linings.[105]

Other costly aspects of dealing with the Aral Sea disaster remain, and all of them—such as controlling water pollution, providing clean drinking water, and addressing the health crisis—entail competing for scarce funds. As Lester Brown of the WorldWatch Institute has pointed out, the region's population has been growing about 3 percent annually, a rate matched only in Africa. This puts a double burden on the environment while exerting downward pressure on living standards: A rapidly growing population increases demand on the local water supply even more, yet scarce government money must be stretched to meet social needs as well as to restore the environment.[106] More people will require more jobs in the future, increasing pressures to maintain the status quo in agriculture.

Although the Soviet government intended to scrap the Sibaral project in its planning stage in 1986, many in Central Asia continue to see the diversion of Siberian water to the south as the only way out of the Aral Sea crisis and the greater water shortage plaguing Central Asia. Alleging that Aral represented a "second Chernobyl," Ulmas Umarbekov, deputy prime minister of Uzbekistan, argued in the republican daily *Pravda vostoka* that the Aral region needed help from wealthier neighbors: medicines, health personnel, clean food, construction materials, and water. Invoking classical communist slogans of the past, he concluded that the river diversion represented "the greatest gesture in history of broth-

erly cooperation [and] friendship of the peoples of the our country."[107] "The Central Asian region must live and develop. Clearly its own water resources are obviously inadequate for this," wrote two officials of the Sredazgidrovodkhlopok water resource development agency in the same newspaper. Taking a conventional prodevelopment position held by many in the West, they argued that Aral was essentially a hopeless case. Rather than spend scarce resources to revive the sea, planners should focus on saving the inhabitants, and the best way was to improve their standard of living. The expensive water conservation projects and plans to reduce allocations for agriculture, therefore, should be scrapped for projects that would provide safe drinking water, improve health care and housing, and boost agricultural output while causing less environmental degradation.[108]

The likelihood of diverting Siberian waters to the south vanished with the rise of Russian national consciousness and independence. With the collapse of Soviet power, the likelihood of significant inflows of investment funds to restructure the Central Asian economy on the scale described here also disappeared. Despite the disintegration of the Soviet Union, Central Asian parliamentarians again raised the issue of water diversions at a regional environmental meeting as late as October 1991.[109]

In their efforts to find a solution to the problem, analysts routinely ignore one of the most glaring causes for poor land and water use in the region: the fact that irrigation water has been supplied to farmers virtually free of charge over the decades. Raising the price of water to agricultural users would prompt more efficient use of inputs and investment in water-saving measures, not to mention create a source of revenue to fund a revival of Aral. Officials have not attempted such a move, however, because of political pressure by the region's powerful farm managers and fears that rising costs would render farms uncompetitive and hurt exports. Taking advantage of its warm climate, Central Asia may replace thirsty cotton with exports of fresh produce to the north—a traditional emphasis of the region's farmers before Moscow's cotton drive. Central Asian farmers may opt for another high-profit crop: opium.[110] Ultimately, nature may preclude any option. According to the Academy of Sciences Institute of Geography, the portion of irrigated land already salinized from excessive irrigation ranges from 35 percent in Tajikistan to 80 percent in Turkmenistan.[111] The land soon could be rendered barren, obviating any alternative to the dismal legacy of the Soviet cotton culture. Said Sabyr Komalov, a local scientist: "We have no more than ten years left to prevent total disaster."[112]

Notes

1. Sergei N. Bobylev, professor of economics, Moscow State University, "APK: Ekologizatsia ili krizis?" briefing prepared for the Russian Federation Supreme Soviet, 1991,unpublished manuscript, 1991, p. 1.

2. *Sovetskaya Rossiya*, September 5, 1989, p. 4, and October 24, 1989, p. 4.

3. *Sovetskaya Rossiya*, October 24, 1990, p. 4.

4. Anatolii Grebenyuk, deputy chair, Committee on Ecology, Supreme Soviet of Kyrgyzstan, presentation at conference on Democratic Federalism and Environmental Crisis in the Republics of the Former Soviet Union, Moscow, August 1991.

5. USSR Goskompriroda, *Sostoyanie prirodnoi sredy v SSSR v 1988 g.* (Moscow: VINITI, 1989), p. 68.

6. USSR Goskomstat, *Okhrana okruzhayushchei sredy i ratsional'noe ispol'zovanie prirodnykh resursov v SSSR* (Moscow: Finansy i statistika, 1989), p. 8. For more on the state of the *chernozem* region, see I. V. Priputina, "Lowering of the Humus Content of the Chernozem Soils of the Russian Plain as a Result of Human Action," *Vestnik Moskovskogo gosudarstvennogo universiteta, geografiya*, No. 5, 1989, translated in *Soviet Geography*, No. 12, 1989, pp. 759–762.

7. USSR Goskompriroda, *Sostoyanie . . . v 1988 g.*, p. 70. Agricultural specialist Sergei Bobylev also pegs soil loss at about 1.5 billion tons annually, including 75 million tons of humus and more than 30 million tons of nitrogen, phosphorus, and potassium. Sergei N. Bobylev, "Puti povysheniya effektivnosti ispol'zovaniya zemel'nykh resursov," in T. S. Khachaturov and K. V. Papenov, eds., *Effektivnost' prirodookhrannykh meropriyatii* (Moscow: Izdatel'stvo Moskovskogo Universiteta, 1990), p. 65.

8. USSR Gosagroprom cited in A. N. Kashtanov, "Ekologizatsiya sel'skogo khozyaistva," *Vestnik Akademii Nauk SSSR*, No. 11, 1988, p. 57. Valentin G. Sokolovskii, the first deputy chairman of USSR Goskompriroda, also cited a figure of 3 billion tons for annual soil loss. A. K. Kuchushev and N. M. Matveev, "Sokhvanit' zdorov'e zemli," *Vestnik Akademii Nauk SSSR*, No. 3, 1990, p. 37.

9. Kashtanov, "Ekologizatsiya," p. 57.

10. USSR Goskompriroda, *Sostoyanie . . . v 1988 g.*, p. 69; Aleksei Yablokov, "The Current State of the Soviet Environment," *Environmental Policy Review*, January 1990, p. 5; V. Ivashchenko, "Intensifikatsiya zemledeliya–osnovnoi put' realizatsii prodovol'stvennoi programmy," *Planovoe khozyaistvo*, No. 8, 1988, p. 106; V. P. Kukhar', "Nekotorye aktual'nye ekologicheskie problemy Ukrainskoi SSR," *Vestnik Akademii Nauk SSSR*, No. 11, 1988, p. 109.

11. Kukhar', "Nekotorye," p. 109; V. Tregobchuk, "Economics and the Environment," *Pod znamenem Leninizma*, No. 4, 1990, translated in JPRS-UPA-90-019, p. 79.

12. M. N. Zaslavskii cited in Bobylev, "Puti povysheniya effektivnosti," p. 66.

13. USSR Ministry of Foreign Economic Relations, *Vneshnie ekonomicheskie svyazi SSSR v 1988 g.* (Moscow: Finansy i statistika, 1989), p. 42. In 1988, the grain

harvest totaled 195 million tons. In 1990, the harvest exceeded 240 million tons, a record crop.

14. Kashtanov, "Ekologizatsiya," pp. 57–58.

15. Nikolai Vorontsov pegged losses resulting from erosion at 15–16 billion rubles. USSR Goskompriroda, *Sostoyanie prirodnoi sredy i prirodookhrannaya deyatel'nost' v SSSR v 1989 godu* (Moscow: Institut Molodezhi, 1990), p. 8.

16. In 1989, agricultural output was valued at 225 billion rubles (in 1983 prices). USSR Goskomstat, *Narodnoe khozyaistvo SSSR v 1989 g.* (Moscow: Finansy i statistika), p. 7. Ruble measures of degradation are provided as an illustration of Soviet analysis of the situation. Such analysis is highly problematic given that prices under the Soviet regime were severely distorted.

17. USSR Goskompriroda, *Sostoyanie . . . v 1988 g.*, p. 115.

18. A. N. Maksumov, "Ob ekologicheskoi obstanovke v Tadzhikistane," *Vestnik Akademii Nauk SSSR*, No. 11, 1988, p. 142.

19. *Sovetskaya Kirgiziya*, July 30, 1989, p. 2.

20. Kashtanov, "Ekologizatsiya," p. 57.

21. *Izvestiya*, February 7, 1990, p. 3.

22. USSR Goskompriroda, *Sostoyanie . . . v 1988 g.*, p. 102.

23. Ivashchenko, "Intensifikatsiya," p. 107.

24. USSR Goskompriroda, *Sostoyanie . . . v 1988 g.*, p. 115.

25. N. Z. Milashchenko, "Solving Ecological Problems in Farming," *Zemledelie*, No. 5, 1989, translated in JPRS-UES-89-025, p. 59.

26. Kashtanov, "Ekologizatsiya," p. 58.

27. *Kul'tura*, No. 12, 1991, p. 3, translated in JPRS–TEN–92–003, p. 54.

28. Nikolai Vorontsov, "The Sofia Ecoforum: Much Work Ahead," *International Affairs*, No. 2, 1990, p. 34.

29. USSR Goskompriroda, *Sostoyanie . . . v 1988 g.*, pp. 73–74.

30. *Zarya vostoka*, January 9, 1990, p. 2.

31. USSR Goskompriroda, *Sostoyanie . . . v 1988 g.*, p. 69; USSR Goskomstat, *Narodnoe khozyaistvo SSSR v 1988 g.* (Moscow: Finansy i statistika, 1989), p. 444; USSR Central Statistical Agency, *Narodnoe khozyaistvo SSSR v 1970 g.* (Moscow: Statistika, 1971), p. 339.

32. USSR Goskomstat, *Narodnoe khozyaistvo SSSR v 1988 g.*, pp. 676–677.

33. USSR Goskompriroda, *Sostoyanie . . . v 1988 g.*, p. 74.

34. *Svenska Dagbladet*, July 29, 1990, translated in FBIS-SOV-89-161, p. 53.

35. *Sel'skaya zhizn'*, November 10, 1988, p. 2.

36. Ibid.; also *Sel'skaya zhizn'*, February 17, 1989, p. 2.

37. Central Intelligence Agency, *Handbook of Economic Statistics, 1985* (Washington, DC: Government Printing Office, 1985), p. 165; USSR Goskomstat, *Narodnoe khozyaistvo SSSR v 1988 g.*, pp. 674–675.

38. USSR Goskomstat, *Okhrana okruzhayushchei sredy*, p. 99; USSR Goskomstat, *Sel'skoe khozyaistvo SSSR* (Moscow: Finansy i statistika, 1988), p. 114.

39. *Sel'skaya zhizn'*, March 28, 1989, p. 2.

40. *Pravda*, January 29, 1990, p. 3.

41. *Turkmenskaya iskra*, April 27, 1990, p. 2.

42. Storage space for 2,284,400 tons of agrochemicals built with government and kolkhoz funding was inaugurated in 1986. The figure fell to 1,988,600 and 1,589,300 in 1987 and 1988, respectively. USSR Goskomstat, *Press-vypusk,* No. 168, April 22, 1989.

43. *Pravda,* May 25, 1989, p. 2.

44. *Pravda,* January 29, 1990, p. 3.

45. Milashchenko, "Solving Ecological Problems," p. 59.

46. USSR Goskomstat, *Okhrana okruzhayushchei sredy,* p. 99.

47. A. F. Kosenko, "Integrated Protection: Conditions and Prospects," *Zashchita rastenii,* No. 10, 1989, translated in JPRS-UEA-90-004, p. 52.

48. USSR Goskomstat, *Okhrana okruzhayushchei sredy,* p. 99.

49. *Ekonomika i zhizn',* No. 13, 1990, p. 6.

50. *Literaturnaya gazeta,* No. 34, 1989, p. 12.

51. *Pravda vostoka,* November 21, 1989, p. 3.

52. USSR Goskompriroda, *Sostoyanie . . . v 1989 godu,* pp. 59, 69–70, 107.

53. USSR Ministry of Foreign Economic Relations, *Vneshnie ekonomicheskie svyazy SSSR v 1989 g.* (Moscow: Finansy i statistika, 1990), p. 30; USSR Ministry of Foreign Economic Relations, *Vneshnie ekonomicheskie svyazy SSSR v 1988 g.* (Moscow: Finansy i statistika, 1989), p. 27; USSR Ministry of Foreign Economic Relations, *Vneshnyaya torgovlya SSSR v 1987 g.* (Moscow: Finansy i statistika, 1988), p. 27.

54. Kukhar', "Nekotorye," p. 109.

55. Zeev Wolfson, "'Nitrates'—A New Problem for the Soviet Consumer," *Report on the USSR,* No. 20, 1989.

56. Bobylev, "APK," p. 17.

57. USSR Goskomstat, *Okhrana okruzhayushchei sredy,* p. 101.

58. USSR Goskompriroda, *Sostoyanie . . . v 1989 godu,* p. 109.

59. Bobylev, "APK," p. 20.

60. USSR Goskompriroda, *Sostoyanie . . . v 1989 godu,* p. 107.

61. *Argumenty i fakty,* No. 13, 1989, p. 2.

62. Bobylev, "APK," p. 16.

63. Yablokov, "The Current State," p. 5.

64. *Literaturnaya gazeta,* No. 21, 1989, p. 12.

65. *Argumenty i fakty,* No. 13, 1989, p. 2.

66. In accordance with USSR State Sanitary Code No. 42-123-4616-88, permissible nitrate (NO_3) concentrations for potatoes were increased from 80 to 250 milligrams per kilogram; for cabbage from 150 to 500 milligrams per kilogram; and for tomatoes from 60 to 150 milligrams per kilogram. The permitted concentration in onions was increased from 60 to 80 milligrams per kilogram; that for beets was unchanged. Kaunas Economics Institute, "Urgent Ecological Problems in Lithuania," briefing submitted to the Lithuanian Council of Ministers, unpublished manuscript, November 1988, pp. 36–39; Bobylev, "APK," p. 17.

67. *Komsomol'skaya pravda,* December 22, 1989, p. 2.

68. *Moskovskaya pravda,* January 16, 1990, p. 2. The findings in the article were then corroborated by USSR Goskompriroda chair Nikolai Vorontsov. *Moskovskaya pravda,* January 18, 1990, p. 1.

69. Fedor Dainenko, chief engineer, Kuryanovo Wastewater Treatment Plant, personal communication, Moscow, June 1991.

70. *Sel'skaya zhizn',* March 28, 1989, p. 2.

71. Kuchushev and Matveev, "Sokhranit' zdorov'e zemli," p. 36.

72. Petr I. Poletaev, "Vosstanovit' garmoniyu prirody i cheloveka," *Zdorov'e,* No. 6, 1989, p. 1.

73. USSR Goskomstat, *Narodnoe khozyaistvo SSSR v 1990 g.* (Moscow: Finaury i statistika, 1991), p. 447.

74. USSR Goskomstat, *Narodnoe khozyaistvo SSSR v 1990 g.,* p. 448.

75. Kosenko, "Integrated Protection," p. 49.

76. USSR Goskompriroda, *Sostoyanie . . . v 1989 godu,* p. 110.

77. USSR Goskomstat, *Okhrana okruzhayushchei sredy,* p. 99.

78. Hamida and Rafael Yernazarov, staff members, Kazakh Ecological Fund, personal communication, Los Angeles, April 1992.

79. For more reporting on the market for organic food, see, for example, *Pravda,* August 8, 1989, p. 2; and *Izvestiya,* September 11, 1988, p. 2.

80. TASS, December 21, 1989.

81. S*el'skaya zhizn',* November 10, 1988, p. 2.

82. *Pravda vostoka,* October 21, 1991, p. 2.

83. The Aral region (in Russian, Priaralye) is generally considered by commentators to include Kazakhstan's Kzyl-Orda oblast, the Karakalpak republic (Karakalpakistan) and Khorezm oblast in Uzbekistan, and Turkmenistan's Tashauz oblast.

84. Known padding of production figures aside, the output of raw cotton in Uzbekistan grew from 2.9 million tons in 1960 to 5.4 million tons in 1988. The corresponding figures for Turkmenistan are 363,000 tons and 1.3 million tons. USSR Central Statistical Agency, p. 319; USSR Goskomstat, *Narodnoe khozyaistvo SSSR v 1988 g.,* p. 455. Overall agricultural production grew four times (in value terms) between 1950 and 1988. *Sobranie postanovlenii pravitel'stva Soyuza Sovetskikh Sotsialisticheskikh Respublik,* No. 33, 1988, p. 563.

85. USSR Goskompriroda, *Sostoyanie . . . v 1988 g.,* p. 117.

86. USSR Goskompriroda, *Sostoyanie . . . v 1989 godu,* p. 95.

87. K. S. Losev, "Sotsial'no-ekonomicheskie i ekologicheskie posledstvia ispol'zovaniya vody: vozmozhnye puti razvitiya," *Izvestiya Akademii Nauk SSSR, seriya geograficheskaya,* No. 6, 1988, p. 49; Michael A. Rozengurt, "Water Policy Mismanagement in the Southern USSR: The Ecological and Economical Impact," National Council for Soviet and East European Studies, November 1989, pp. 48–49.

88. *Pravda vostoka,* November 21, 1989, p. 3.

89. *Komsomolets Uzbekistana,* July 26, 1989; David R. Smith, "Salinization in Uzbekistan," *Post-Soviet Geography,* January 1992, p. 30.

90. Smith, "Salinization in Uzbekistan," p. 22.

91. USSR Goskompriroda, *Sostoyanie . . . v 1988 g.,* p. 131.

92. David R. Smith, "Growing Pollution and Health Concerns in the Lower Amu Darya Basin, Uzbekistan," *Soviet Geography,* October 1991, p. 560.

93. Ibid., p. 556.

94. TASS, June 14, 1990; Grigorii Reznichenko, "I stakana chistoi vody ne pribavilols'," *Novy mir,* No. 1, 1990, p. 202.

95. *Argumenty i fakty,* No. 51, 1989, p. 4; Radio Moscow, November 23, 1990. For more on the region's health problems, see Annette Bohr, "Health Catastrophe in Karakalpakistan," *Report on the USSR,* No. 29, 1989; *Meditsinskaya gazeta,* May 23, 1990; and *Sem'ya,* No. 19, 1990.

96. Philip Micklin, "Touring the Aral: Visit to an Ecologic Disaster Zone," *Soviet Geography,* February 1991, p. 94; TASS, July 18, 1991.

97. USSR Goskompriroda, *Sostoyanie . . . v 1989 godu,* p. 6.

98. For the text of the resolution, consult "O merakh po korennomu uluchsheniyu ekologicheskoi i sanitarnoi obstanovki . . . ." Incidentally, the committee that drafted the plan was headed by the chair of the USSR State Committee for Hydrometeorology, Yurii Izreal'.

99. TASS, June 14, 1990.

100. *Pravda,* October 15, 1991.

101. In 1989, the Uzbek government began construction of a 400-kilometer diversion canal to run parallel to the Amu Darya. TASS, December 16, 1989. Plans have been in the works for a 1,500-kilometer canal extending all the way up to Termez on the Afghan border. N. T. Kuznetsov, "Otkrytoe pis'mo uchenym, pisatelyam, vodokhozyaistvennikam, vsem, kogo volnuet ekologicheskaya situatsiya v Priaral'ye," *Izvestiya Akademii Nauk SSSR, seriya geograficheskaya,* No. 6, 1988, p. 130.

102. By the 1980s, however, Uzbekistan ranked lowest in the Soviet Union in consumption of vegetables, fruit, meat, and milk. Gregory Gleason, "'Birlik' and the Cotton Question," *Report on the USSR,* No. 24, 1990, p. 22.

103. John Stead, Dunavant Enterprises, Inc., presentation at conference on Central Asian Development in the Future, Scottsdale, Arizona, June 1992.

104. *Pravda,* April 20, 1990, p. 1.

105. Reznichenko, "I stakana," p. 204.

106. Lester R. Brown, "The Aral Sea: Going, Going . . . ," *WorldWatch,* January–February 1991, p. 27.

107. *Pravda vostoka,* June 6, 1990, p. 4.

108. *Pravda vostoka,* January 4, 1990, p. 3. For a rebuttal by the leaders of the Committee to Save the Aral, see *Pravda vostoka,* January 19, 1990, p. 3.

109. *Pravda vostoka,* October 21, 1991, p. 2.

110. *Economist,* September 21, 1991, p. 59.

111. Brown, "The Aral Sea," p. 23.

112. *Guardian,* November 9, 1990.