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Introduction

For a long time, the West knew little about the systematic pollution and general deterioration of the environment in the Soviet Union. Throughout the years of Soviet rule, vast areas of dense forests have disappeared in European Russia and in the Ukraine.[1] Soil, which had been fertile and productive, became depleted.[2] Open-pit mining of ore and coal disfigured the landscapes of central Russia, the Donbass and other regions. In the areas where heavy industry is prominent, such as Kriv Rog, the Donbass, Zaporozh'e, Magnitogorsk, and the Kuzbass, the air has been polluted by acids and soot well above permissible standards.[3] Many small rivers have become ditches carrying multicolored sewage or industrial waste fluids; others have simply dried up or have become saline.[4] The most fertile croplands in river valleys have been flooded by hydropower storage reservoirs or sewage ponds.[5] Other arable acreage has been irretrievably lost to agriculture due to soil salinization.[6] Healthy and highly productive riverine and estuarine habitats of south-flowing rivers have been destroyed by mismanagement and can no longer ensure the reproduction and survival of many commercially important fish.[7] Water pollution has reached an appalling level.[8] Until recently, the inland sea-lake, the Caspian, was shrinking at a catastrophic pace.[9] The heavily saline Lake Aral is continuing to dry up and will be a vestigal lake in about 10 to 12 years.[10] Many of the precious beaches on the Black Sea have been lost through excessive use of beach sands and construction errors, then partially restored by multimillion-ruble projects. In the Black Sea, coastal benthic communities have been substantially destroyed,[11] and the stocks of several deep-sea fish have drastically decreased.[12]

Local and large-scale ecological catastrophes have plagued the Soviet

economy literally at every turn in its development. Whether these catastrophes are the result of a confluence of unpredictable reactions of natural systems and cycles, an unavoidable consequence of technological progress, or a series of tragic miscalculations on the part of Soviet leaders, is unclear. Some of these factors arose inadvertently, and all of them might seem plausible explanations to Western observers, who also face ecological problems at home.

Examples of problems affecting the global environment are plentiful and well documented. Widespread air pollution not only affects populations of various nations; it also kills trees--for example, in West Germany's Black Forest--and it spoils architectural ensembles, as can be seen in France and Italy. Acid rain is especially dangerous. It is a health hazard, and it renders lakes and streams lifeless. Water-quality records for rivers in the United States from 1974 to 1981[13] indicate widespread increases in chemical pollution. However, fecal bacterial concentration and lead contamination decreased following improved municipal treatment and limitations on the use of leaded gasoline. Intensive work is being done by various countries and international organizations to assemble statistical data on air and water pollution in Western Europe[14] and to increase the effectiveness of treatment facilities. Nevertheless, chemical and bacterial contamination in Japan and various West European nations continues to pose a considerable threat to populations and industries.[15] The alarming depletion of vast underground water reservoirs--such as the great Ogallala Aquifer, which stretches from West Texas to northern Nebraska--and the frequent exhaustion of surface water reservoirs severly impact on populations and national economies. For example, New York City was affected by the exhaustion of surface water reservoirs in

1980 and 1985, and several eastern and southern states were affected in 1986. In addition, ominous signs point toward the depletion of the ozone layer. This phenomenon will noticeably increase atmospheric carbon diozide concentration and intensify the planetary "green-house effect," which can cause the melting of polar ice, rising sea levels and disastrous changes in the water budgets of the most populous areas.

Ecological concerns were exacerbated by the alarming nuclear accident at Chernobyl in 1986, as well as by earlier less damaging, recently reassessed accidents, including the 1957 explosion at a radioactive waste dumping site near Cheliabinsk in the western USSR.[16] The safety of all nuclear power technology has become questionable. Stricter enforcement of safety measures is necessary because atomic energy is bound to become one of the major components in the world energy mix.[17]

The occurrence of nuclear accidents buttresses a consensus among scientists[18] that "domestic" ecological problems can no longer be viewed strictly as internal problems of single countries. Local modifications in processes controlling the state of natural resources shared by many nations can potentially have a cumulative environmental impact on large subdivisions of the biosphere. For example, it has been argued that coastal and deep-sea oil and chemical pollution, coupled with overfishing of traditional commercial species has affected plankton communities and fish stocks,[19] and apparently has reduced the ability of oceans to serve as effective sinks for fossil fuel and carbon dioxide.[20] The destruction of rain forests, thermal and radioactive pollution, and increased particle content in the atmoshphere have already caused subtle shifts in climate.[21] It has not been ruled out that the increasingly severe global "El Nino" shifts in atmospheric circulation and

precipitation patterns, especially of 1982 and 1983 that caused torrential rains in some areas and severe drought in others with an estimated $8.65 billion in damages, were partially a man-made problem.[22]

The USSR, which occupies one-sixth of the land mass of the planet and which stretches over several climatic zones, is perhaps the only country in the world where the massive use and reshaping of national resources can engender noticeable modifications in the global environment. This is best exemplified by Soviet water management practices.

The Soviet socioeconomic system is under the tight control of a politically strong, unified government that attempts to solve the majority of its economic problems by large-scale integrated programs.[23] Several programs for river basin development in the European part of the USSR and in Central Asia from the 1930s-70s, and for river transportation, hydroenergy, flood control and agricultural irrigation substantially modified the country's drainage systems and affected the water budget of large areas. These projects led to the depletion of freshwater reserves and have been implicated in alterations in the hydrochemical regime followed by unfavorable changes in the biota of the Azov Sea, the Black Sea and the Caspian Sea.[24] Begun in 1984 and abolished in 1986, the long-distance diversion of the north-flowing rivers to the southern slope of the USSR could have severely affected the hydrologic cycle of the entire Northern Hemisphere.[25] Large-scale public works related to water resource management in any country are always the responsibility of national governments. Only governments can provide the unique technical, planning, and financing resources necessary for the considerable modification of natural landscapes needed to expedite overall economic growth. However, an "audit" of Soviet water management policies indicates that at the time of

their inception, the water resource projects were only marginally linked to the goals of long-range economic planning.[26]

Inexorable ecological degradation in the USSR is inherently connected with the communist state's ideological dominance over environmental policies. By and large, Soviet leaders pursued short-term political and--sometimes exclusively--ideological goals in harnessing their vast water resources. However, in the long run, these policies have proved to be detrimental to the nation's economic development. Until very recently, scientific predictions regarding the possible environmental impact of rapid technological growth were poorly represented in Soviet economic planning. Since Mikhail Gorbachev came to power in 1985, some ecologically questionable projects concerning the extensive use of freshwater have been effectively slowed; others have been stopped altogether, and environmental policies have demonstrated emphasis on better conservation and more prudent use of water and other resources.

Ideological Aspects of Soviet Environmental Policy

During the first decade of Soviet power, the economy was a shambles, and no one gave the least thought to the rational use of national resources. Economic success had to be attained at any price, with whatever sacrifices were necessary, and one of the most important political slogans of that time was "*obuzdat' stikhiiu!*" (harness the elements!). From the very onset of the Soviet era, the large-scale disfiguration and distortion of the USSR's natural landscapes were side effects of the country's industrialization programs. At that time, the communist party announced that the "reordering" of natural realms should demonstrate the might of the first socialist nation to confront the forces of "wild nature"--forces that had to be mastered in order to achieve a glorious "bright future."

During this period, there was a seemingly illogical emphasis on the politico-propagandistic aspects of Soviet environmental activities--some of which turned out to be detrimental to the ecology and the economy. Communist leaders, before and after the Russian revolution, persistently declared that Soviet-type socialist systems are the inevitable and scientifically predictable outcome of world-wide socioeconomic evolution, as described by Karl Marx. The speculations and predictions of Marx and Frederick Engels were adopted without reservation by Lenin and his followers,[27] then refined to meet new conditions and termed the laws of the theory of "scientific communism."[28] According to Soviet ideologists, this theory describes the Soviet system and provides guidance for all practical economic actions, including those related to the environment. In the case of environmental management, though, application of the "laws" of scientific communism are complicated by the necessity to account for the laws of nature. Soviet ideologists circumvented nature-related "snags" by formulating several "enviro-ideological doctrines," or concepts that provide a theoretical basis for the assimilation of nature's laws into the production systems of administrative dictates.

Soviet ideologists proudly claim that they have enacted, and in many cases have modified, comprehensive legislation in which resource exploitation and conservation policies are clearly spelled out.[29] The procedures for any new project, from the drawing board to implementation, have been frequently upgraded--currently they are known as Construction Norms and Rules (SNIPy)--and they are adhered to by managers under the supervision of the appropriate agencies and ministries. This general model of environmental management applies primarily to small-scale projects utilizing natural resources, and it has little bearing on long-lasting programs involving renewable natural

resources and the ecological cycles of natural habitats. Contrary to the general view that the authoritarian nature of the Soviet political system and the paternalistic nature of its economic system have discouraged public participation, proponents of the socialist line on environmental questions claim that Soviet public involvement in this area is the greatest in the world.[30]

The discrepancy between theory and practice stems from the authoritarian nature of the Soviet system. The majority of large-scale projects have been run as "campaigns" with incessant propaganda drum-beating and sloganeering. Such endeavors--whether they were the product of Stalin's personal decisionmaking or an outcome of the Politburo's "collective thinking"--immediately acquired the status of a *velikaia stroika kommunizma* (great construction of communism) or an *udarnaia stroika* (urgent construction). The latter was more popular during the Khrushchev and Brezhnev periods. No alternative solution or shadow of doubt was raised to question the legitimacy and necessity of any *stroika*, but these artificial "crises" drained resources and manpower from established users and local industries, causing havoc to the national economy and inflicting losses to natural resources. All *udarnye stroiki*--including inland navigational canals, hydropower plants, virgin land campaigns, and the Baikal-Amur Mainline (BAM)--produced tremendous strains on the entire country. Enviro-ideological concepts were designed in order to justify large-scale water resource projects scientifically.

One such enviro-ideological concept is based on the assumption that certain natural resources--such as solar energy, the internal heat of the Earth, precipitation, the energy of wind and water, and ocean and sea water--are inexhaustible.[31] The hydraulic energy of river flows was considered to

fall in this category, and it was the only resource that could be efficiently exploited to create electric power. In order to maximize the utility of this single practical and seemingly inexhaustible resource, the morphology of the USSR's drainage system was modified to such an extent that some loss of water and other natural resources related to water became unavoidable.[32] However, the initiators of the USSR's hydroelectric power programs during the 1930s and 1940s had no experience in dealing with the formidable transformations they had begun. In a rush to produce hydroelectricity as fast as possible, they did not compute reliable water budgets for transformed river systems. Belief in the inexhaustibility of river water flows held an extraordinary fascination for Stalin's executives, and for a long time it remained undisputed dogma. Only in the 1970s did experts begin to assess the damage this doctrine had done to the environment.[33]

Another enviro-ideological concept regarding the use of natural resources, which is still in force,[34] assumes that any given renewable or nonrenewable resource can be used for many purposes and at the same time can be protected from degradation if the distribution of the resource is handled by a "leading sector" of the economy. For example, the Ministry of Agriculture is the "master" of all lands, wildlife, and vegetation, except forests. The State Committee of Forestry and Timber has jurisdiction over timberlands, and the Ministry of Fisheries has responsibility for catches and the protection and reproduction of fish and shellfish resources. The stewardship of freshwater resources has changed hands. At the dawn of the Soviet regime, river navigation was considered the main use for water.[35] Stalin cherished the dream of making all major rivers navigable in order to transfer battleships from one sea to another. This far-fetched scheme was

doomed to failure from the start because of the limited dimensions of the inland waterways. Canal construction became merely a vehicle for putting political prisoners to work on conspicuously monumental projects.

In the mid-1930s, hydroelectric power programs gradually became the leading use for the Soviet Union's water reserves. Since that time, Soviet freshwater management has been guided by the principle of retaining the maximum possible amount of freshwater in upland areas. Storage lakes became the principal instrument of this policy. It was believed that they would provide cheap power from nonpolluting hydroelectric stations. They were also intended to improve river navigation by guaranteeing stable and safe river depths. In addition, they were to provide reserve water for irrigation and for municipal and industrial water supplies. Moreover, certain storage reservoirs were expected to absorb some of the pollutants coming from nearby towns and enterprises. Finally, some of these artificial lakes were to be used for controlled fishing and recreation.

Soviet freshwater management policies provide a clear example of the concept that subsequently became known as *kompleksnoe ispol'zovanie* (multipurpose use [of natural resources]).[36] Multipurpose river basin development is actually a very sound approach to water management and has been successfully applied in many countries.[37] However, Soviet-style water management converted "multipurpose" into "all-purpose" water resource development, which is better understood when compared with the American experience. In the United States, attempts are made to protect many environmental intangibles, such as recreational sites and the integrity of fish migration and breeding grounds. Attempts have also been made to mitigate the effects of flooding by making use of institutional arrangements,[38]

specifically through costsharing policies, bargaining between the states and the federal government, and insurance programs and flood-warning systems.

In the USSR, such institutional structures are virtually absent. Therefore, Soviet water planners attempt to force all water users, even those who suffer from river basin development, to share the costs involving dams and hydropower plants (HPPs). For example, the fishing industry must pay for fish conveyance facilities (*rybokhody*), which presumably help anadromous fish to migrate upstream, over HPP dams. Unfortunately, these facilities have never worked. Losses of popular sporting, boating, and fishing sites were to be replaced with other recreational amenities in deep storage reservoirs. However, the slow movement of water in these reservoirs resulted in entrophication and bad smelling stagnant water. There are other such failures of Soviet water planning.

In short, Soviet water management policy resorts to high-cost integrated projects--such as river impoundments, large irrigation systems, and interbasin water transfers--as a means of solving major economic problems related to river basin development. These policies have led to the irreversible modification of large areas and have inflicted ecological damage on river basins. From a political point of view, hydrotechnical facilities, such as HPP plants, dams, and canals were ideally suited to meet the goals of the Stalinist leaders. These facilities allowed a large number of prisoners working for clearly specified goals to be concentrated in one place and to be easily controlled. Forced labor was used for "magnificant accomplishments"--which were supposed to symbolize the might of the Soviet system, transforming the energy of "uselessly" flowing water into electricity.

Since the 1960s more experienced water management personnel and improved

technology have facilitated river basin development. Soviet leaders after Stalin have no longer resorted to massive arrests as a method of obtaining cheap labor. There are new methods of recruiting large numbers of laborers to work under unhospitable conditions. These laborers include both "voluntary" and involuntary dispatches of the Komsomol, the main communist youth organization; servicemen who have completed their compulsory military service; and specialized *brigady* (teams) that must migrate to the provinces in order to maintain their relatively high salaries.

The above-mentioned three concepts of Soviet environmental decisionmaking--the inexhaustibility of natural resources, reliance on the "leading sector" of the economy, and the multipurpose use of natural resources--seem to suggest a uniform, integrated approach to environmental programs. In water management, for example, a single leading water user--the state--controls the "inexhaustible" natural resource, surface water, for complex use by the national economy and society.

Soviet environmental legislation does not question the basis of large-scale environmental programs as a possible cause of environmental damage. Constantly ungraded environmental laws deal primarily with small-scale, readily observable violations. Disruption of large-scale natural cycles is not considered a crime. As several authors have stated, such processes have not been studied to the degree that the violator can be isolated.[39]

Existing Soviet water legislation[40] lists harmful, punishable actions pertaining to the management of water resources. These violations include improper control and negligence in the operation of hydrotechnical facilities leading to unfavorable changes in hydrologic regimes, pollution above

permissible norms, mismanagement, and contamination of inland and coastal waters. Harsh measures are taken against individuals for such crimes as poaching, arson, and unauthorized tree-cutting and hunting in *zapovedniki* (natural reserves). In short, Soviet environmental legislation deals with single enterprises and with individuals, but it has practically nothing to say regarding the legitimacy of large-scale environmental planning. Nor does it say much about the judgment or responsibility of those who have purposely or inadvertently abused the environment by modifying renewable natural resources and cycles. If problems concerning the use of natural resources in the USSR had been addressed together with other economic issues, the massive degradation of water resources could have been prevented.

Ecological and Economic Aspects of Soviet Water Management

The modern science of ecology--to which Soviet researchers have made valuable contributions--demonstrates that various processes occurring in the atmosphere, hydrosphere and biosphere are intimately linked. All three dynamic envelopes of the Earth compose a single multicomponent system. Attempts to interfere with this system, to isolate a natural resource and regulate it by technical means, will invariably cause disruption in all of the links and natural cycles of the environment. A combined economic-ecological system operates as a self-sustaining mechanism in which an initial disturbance is amplified as it passes through the system until, during some later cycle, either the economic or environmental component collapses. In the USSR, at each stage of its economic development, this problem has been compounded by a political machine driven by the far-fetched dogmas of "scientific communism," which, in turn, contradict the socioeconomic dynamics of the modern world. Nonetheless, attempts are being made to control the interaction of the economy

and environment by using the hydrologic cycle over a huge area.

The exploitation of millions of political prisoners for slave labor during the Stalin era resulted in, among other things, grandiose hydrotechnical constructions and the physical annihilation of the prisoners. This was the first disturbance that inflicted incurable trauma on the natural provinces of the USSR, and later it led to many economic failures. Hydrotechnical programs of the post-Stalin era were doomed to fail for both ecological and economic reasons.

It was too late when Soviet planners recognized that the morphological modifications of water basins and the subsequent storage of huge masses of "dead water" also affected water quality through the retardation of river flow, eutrophication, evaporation, seepage, and pollution--especially in reservoirs in the middle and lower parts of the plains rivers, such as the Dnieper, the Don, the Volga, including its tributaries, and the Kuban'. On the other hand, storage lakes at the upper reaches of the rivers--prior to the point of confluence with their tributaries--and in mountain gorges and canyons, do not affect large territories and exert minuscule influence on the drainage capacity of the watershed. But specific land losses per megawatt power increase manifold for HPPs in the lower reaches of the rivers. For example, the powerful 2,700 megawatt Nurek HPP on the Vakhsh River in Tadzhikistan floods only 0.05 square kilometers per kilowatt, whereas this factor increases to 7.0 square kilometers for the 312 megawatt Kakhovskaia HPP and to 16.4 square kilometers for the 165 megawatt Tsimliansk HPP on the Don. It was the inundation of vast areas of cropland and the unavoidable alteration of physical, chemical, and biological conditions that eventually led to the depletion and degradation of Soviet water resources.[41] In comparison, the

major high dams in the United States are constructed either in mountainous areas at the upper reaches of big rivers, or in tributaries of rivers draining south and east.[42] Therefore, with a few notable exceptions, agricultural and ecological damage resulting from water flow is relatively small.

In the overall energy mix of the USSR, the share fromm river hydropower is small and will continue to drop in the foreseeable future. Other energy sources, such as nuclear power, oil, and coal, are developing at much faster rates. If the initiators of Soviet hydroenergy programs had attempted a reasonable forecast of the future development of energetics, they would have realized the senselessness and fallacy of their undertaking.

At the present stage of the USSR's socioeconomic development, it has become clear that utilization of freshwater is necessary to support the chronically ailing agricultural sector. Soviet economic planners have taken several steps to improve water quality and prevent useless water losses. Some of the measures introduced were programs to improve nationwide water quality control to be carried out by a network of water and sanitary inspectorates; the construction of recycling systems in technological industries that were marked by extremely dangerous pollution levels; improved waste water treatment; and the construction of fish breeding and nursery farms in estuaries. However, the concept, or dogma, of the inexhaustibility of water flow, in force until recently, allowed for the unrestricted use of water for irrigation and municipal needs. On the debit side, this water was already hopelessly polluted by wash-outs from fields and by fertilizers and agricultural chemicals. Surface water now bears a "double" load in the Soviet Union: hydraulic energy production and waste-loading from pollution. Natural self-purification processes are hampered by reduced flow rates and inadequate

drainage from catchment areas. The quality of rapidly dwindling water resources has sharply worsened. This has serious implications for the ecology of rivers and estuarine regions, and leads to conflicts over the use of resources.

The concept of the inexhaustibility of water flows is an utter fallacy. In industrialized societies, freshwaters swiftly move from the category of an environmental component to that of a complex raw material or even a mineral that requires expenditures of energy and labor for restoration and production. Modern technological processes demand water of a certain quality. This means that water needed for technological purposes can be used only after undergoing special purification processes similar to those for other raw materials, such as ore, coal, and oil. Fortunately, some water resources, even without undergoing such purification processes, are still of the quality required for the majority of humankind's biological, productive, and social functions. It is difficult to identify a natural resource whose use is more diverse, more multi-purpose, or more general than freshwater. The indispensability of this raw material necessitates minimum water losses in processes where water can be substituted for another resource.

Technological Advances in Water Utilization

During the 1960s, major advances in modern technology allowed precise assessments of the water volume required for a given crop to be utilized. Various techniques, such as those emphasizing fertilization methods; the protection of vegetation by plastic covers; the computerized monitoring of air temperature, humidity and wind speed; and genetic engineering came to be commonly used in developed countries. Soviet planners would be wise to borrow from the experiences of such countries, and to achieve water self-sufficiency

in the sunny southern regions of the USSR without expensive interbasin water transfers. Several steps have been made in this direction.

As numerous experimental stations emerged in key agricultural provinces of the USSR, the communist party encourged new and advanced methods of fertilizer and water use. Aided by the lessening of East-West tensions during détente, Soviet agronomists and planners rapidly assimilated Western ideas regarding the use of modern agricultural machinery, chemical fertilizers, and water, as well as crop selection methods for the country's complex mosaic of soil structures and various temperature and moisture conditions. The selective use of river basins was proposed as a solution to stop water depletion and pollution.[43] This meant that the middle courses of northern and Siberian rivers would be primarily for navigation and local water supplies, while hydroenergy generation would be limited to the mountainous upper reaches. The rivers of the vast southern plains were to be used for recreation and fisheries and to maintain water supplies.

These programs were not enacted. It should be noted that a totalitarian power always strives for better consolidation of its might. Taking advantage of a respite in the arms race during the relatively benign political climate in the late 1960s, the Soviet political leadership began intensive programs aimed at improving offensive weapons. Neither the means nor time remained for the modernization of agriculture based on new scientific methods and Western experience. Instead, the Soviet leadership hastily veered from one extensive program to another.[44] After rather moderate success with the Virgin Land campaign in Siberia and Kazakhstan, and with the program emphasizing the extensive use of agricultural chemicals in other regions during the early 1960s, a vast program was initiated in 1964 and 1965 aimed at increasing

irrigation in the southern USSR. After 1974, this program was curtailed when principal funds, manpower, and machinery were switched over to a program aimed at ameliorating agricultural conditions in the Non-Black-Earth zone in central Russia. Neither of the latter programs ensured sustained growth in crop yields because of serious limiting factors, such as water deficits and poor pollution control in the south, and a brief warming period and poor agricultural results in central Russia.

The Politics of Soviet Economic Decisionmaking

It seems to be quite a challenge for Western analysts to explain adequately the unfathomable inefficiency of the Soviet goverment in its attempts to institute key environmental programs, all of which have been nonabusive to nature and the national economy. Sometimes a parallel is drawn between Western and Soviet experiences interferring with nature.[45] Ineffectiveness and inertia on the part of any state bureaucracy--capitalist or socialist--poor information systems, greed, and wastefulness can lead to local disturbances in the environment of any country. In the United States, however, no proposals involving the substantial reshaping of the environment can be discussed in Congress without prior thorough scientific, social, and economic justification, and detailed open discussion by all parties.

In the USSR, private parties with vested interests in particular environmental programs do not play a role in the decisionmaking process, nor do complex legal issues pose obstacles for Soviet planners. The Soviet Union has developed state-of-the-art methods of geological exploration and sophisticated ecological models, and it has accumulated vast experience with interbasin water transfers. It would seem natural that in such an atmosphere, decisions affecting the environment would be much more effectively made in the

Soviet Union than in the West. Because such decisions presumably do not undermine Soviet ideology, political leaders are able to trust scientists who are faithful to the system, and depend on their prognoses and their work.

Obvious contradictions between such logic and Soviet practice have led Western Sovietologists to seek explanations for the inefficiency of administrative directives to specific industries, which detail production outputs and target dates of execution, in a variety of factors. These include the institutional deficiency of the Soviet industrial bureaucracy; the rivalry between various groups in the Central Committee and Politburo, for example, between the "agricultural coalition" and the "energy lobby"; the hasty abandonment of economic methods and programs that do not immediately succeed in increasing industrial output; the severe competition for scarce resources and labor; the preference for quantitative growth to the detriment of output quality; and the launching of a large number of fixed large capital projects with long gestation periods, which inhibits modernization.[46] P. R. Pryde attributes the causes of environmental mishaps in the USSR to a Soviet "predilection" for large-scale alterations of the environment that grew out of the traditions of the tsarist era.[47]

Western analysts have shown that it is sometimes the case that key individuals wield inordinate influence over the production process of the Soviet economy.[48] For example, in order to meet the strongest production targets and deadlines given limited available resources and labor, local managers deliberately evade centrally determined priorities and rules. They passively obstruct changes in investment and resource utilization that may entail a great deal of uncertainty regarding end results. They redirect efforts away from smooth performance, regular maintenance, and fine tuning of

machinery, toward the construction of new units and the development of large-scale uniform techniques.

The Soviet system is seemingly successful at creating large, integrated industrial systems--such as those for hydropower plants, strategic rockets, the Baikal-Amur Mainline, and automobile industries--and a large number of smaller, relatively uniform systems--such as those for mass housing, fighter aircraft, and consumer durables. However, the Soviet system is largely helpless when it comes to creating custom-made systems, such as those for technologies that draw on several industries or individually tailored designs, including computer software systems, small- and medium-sized research instruments, and novel architectural designs.[49] In Western decentralized societies, such tasks might be carried out by, for example, small companies and freelance experts.[50] In short, the Soviet economy lacks an "organized mesoscale structure," which can rapidly adjust large-scale technology to new requirements. All the above flaws of Soviet centralized decisionmaking and management are inherent in the Soviet productive system and place a large burden on natural resources and cycles.

Another factor that has been largely underestimated in assessing the roots of Soviet inefficiency and environmental degradation is that mesoscale economic mechanisms in the USSR exist in a very disorganized, perhaps even archaic, form. They function through ministerial research institutes, experimental plants and laboratories, and repair shops affiliated with various enterprises, as well as numerous research groups in universities and institutes of the all-union and union republican-level Academies of Sciences, which are financed by industrial enterprises. As strange as it may seem, individual enterprises can cooperate and even compete with each other in

fulfilling planned targets by using rather peculiar "currencies," or barter of goods, in trading scarce and centrally allocated materials (*fondovye materialy*), bonuses for good performance, living quarters, subsidized passes to resorts, and even business assignments abroad. This invisible "market" is controlled by special brokers, or "pushers" (*tolkachi*), who have developed their own information networks and methods for assessing services and materials.

Soviet managers can also manipulate certain levers of the party hierarchy in order to redistribute manpower and funds horizontally. A. Katsenelinboigen calls these activities "coloured markets."[51] But this system is very awkward and inefficient. It wastes resources and labor, frequently makes illegal or semi-legal use of procedures, which in turn produce unparalleled corruption and theft, and drain funds and resources into the much more efficient underground, or "second," economy.[52]

However, these procedures provide the means for economic decentralization along horizontal lines, and they give some freedom and leverage to local authorities for the rapid modification of technological processes in response to varying conditions. Leaders do not simply watch in resignation as this clumsy mesoscale "circuitry" operates. They actively participate in it, controlling aggregated indices, such as those for overall funds and material allotments, while gaining substantial benefits for themselves and for their localities. Well-defined microscale economic systems operating on the individual level can also be identified.

Obstacles to the Development of Sound Environmental Policy

The following obstacles to environmentally sound environmental policy show how these meso- and microscale mechanism are related to efficient

resource use. First, in a country that claims to have achieved "developed" socialism, one of the most amazing economic paradoxes is expressed in the familiar slogan "All reserves into action." *Pravda* carries this rhetoric from issue to issue. It permeates various areas of production, as well as trade newsletters and other publications dealing with the economy. Even a superficial review of these publications provides convincing evidence that the Soviet Union has no uncommitted human, land, food, energy, or currency resources. They are consumed ferociously by the USSR's ineffective industrial and military machines. The untapped natural wealth of the largest country on earth is its only underused resource, and, under the above slogan, it is now being thrown into action.

Second, the precarious mesoscale mechanisms described above traditionally operate in relatively uniform production structures, but this is not the case in water diversion or amelioration programs. These programs are site-specific and short-lived projects that affect immense and diverse natural areas. It is difficult to imagine that labor- and capital-intensive auxiliary systems used for testing, verification, and adjustment of environmental methods could arise in this framework. The anticipated results of unprecedented, large-scale efforts to reshape nature are therefore based solely on theoretical ideas and "expert" assessments that are impossible to verify. Thus the lack of auxiliary, meso-scale systems in the USSR largely explains past--and most likely will account for future--failures of Soviet environmental practices.

Third, river diversion projects and other programs concerning the environment lack organizational frameworks that fit traditional economic structures. This is particularly evident in the system of incentives used for those participating in such programs. These incentives are extremely poor,

even by Soviet standards. In addition, the exploitation of freshwater resources, water treatment facilities, and large irrigation systems produces no tangible commodities, and therefore managers have no goods or services with which to barter in the USSR's mesoscale exchange circuitry. The problem is compounded because local authorities and the local population generally resent and passively resist programs that disfigure the environment. Only continuous prodding by the party heirarchy keeps such projects going.

Finally, a lack of open discussion has been another obstacle to the adoption of an environmentally sound economic policy in the Soviet Union. No major program of socioeconomic development seems feasible without open discussions and exchanges of opinions on an international scale, but until recently, Soviet leaders would not tolerate such discussions, fearing that past decisions would be exposed to devasting criticism. They preferred that problems regarding environmental issues be resolved with apparent ease by a small circle of obedient scientists. According to the same logic, no universities or institutes in the Soviet Union teach the environmental sciences, which are taught in most Western universities and colleges.[53] Because the Soviet leadership never diluted its power, there are no administrative bodies in the Soviet Union similar to the U. S. Environmental Protection Agency, which has the ability to interfere with industrial production in cases of environmental abuse and to enforce laws protecting natural resources.[54]

The nearly complete absence of uncommitted resources in the USSR, including the full employment of a work force engaged in ineffective and often useless labor, as well as the stifling of any open criticism are the major obstacles to the use of practical scientific methods in economic planning and

natural resources management.

A retrospective look at the USSR's water resource policies can provide a clue to understanding their role in the Soviet economy. In a relatively short period of time, the Soviet Union developed into the second largest industrial empire, successfully competing with Western societies in the production of major commercial goods and weaponry. This was accomplished at the cost of incredible human sacrifices and the unrestrained destruction of natural wealth. The role played by water resources in achieving this "progress" is unclear. Raw materials, skilled labor, and advanced science are the crucial elements of such large-scale industrial growth. Water resources perform an important but auxiliary function in manufacturing and services, as transportation routes, cooling bodies, solvent media, and waste recipients. Agriculture was the only sector of the economy where water was, until recently, considered the key to success. As it turned out, however, irrigation programs were not enough to deliver food production industries from their abysmal state.[55]

The productivity potential of Soviet *kolkhozniki* (collective farmers) and other agricultural laborers clearly demonstrates that the real causes of Soviet food production failures are only slightly related to deficiencies in water management, agricultural science, technology and policy, and weather--the Soviet leadership's preferred culprit, which is invariably blamed for food shortages. Privately tilled crop-lands constitute only 3 percent of the total arable acreage of the USSR, but they account for 30 percent of the nation's dairy producton, 30 to 40 percent of its meat and poultry, more than 50 percent of its fruits, 32 percent of its vegetables, 31 percent of its eggs, and up to 63 percent of its potatoes. Profits from privately owned plots

constitute 25 to 30 percent of the total. Out of a total of about 32 million people engaged in agriculture, about 4 million people are actively involved in private productivity.[56] Private farming is now considered one of the important assets of Soviet food production.[57] In many regions where centralized food supply is extremely poor, the populations would have faced the danger of famine years ago were it not for these tiny private plots. The success of private farming has been achieved with primitive technology and limited support from the state and collective farms, but without massive irrigation.[58] The new Soviet leadership intends to boost private farming by providing financing, fodder, and transportation to family farms, thus building up incentives for those in the countryside to produce more food for the entire nation.

Changes in Environmental Policies under Gorbachev

With Gorbachev's accession to power in 1985, the leadership's general attitude toward the large-scale reshaping of the environment underwent substantial changes. The Soviet economic system seems to be at a pivotal point in its development, and a shift toward the efficient use of natural wealth may now be under way. In accordance with *glasnost*, or "openness," the new Soviet leadership has opened the flood-gates for freer discussion of environmental policies. Even before the development of *glasnost*, harsh criticisms of extensive water use and environmental degradation had been expressed by the cultural and scientific communities. However, prior to 1985, these voices of protest were hardly heard; in 1971, the Soviet censorship agency issued a classified circular under the symptomatic, ironic title *Sokhranenie okruzhaiushchei sredy* (Environmental protection), which barred information about adverse autropogenic effects on the environment of the USSR.

As a result, since the early 1970s, the Soviet people and the general public in the West, have been ignorant concerning the ongoing nationwide environmental degradation of the USSR.

However, the Soviet leadership could not conceal the USSR's environmental woes. Russian nationalist concerns increased, and distinguished representatives of the cultural and scientific communities began to bombard the Politburo with letters of protest against water projects detrimental to the environment. These protests reached a fever pitch when river flow diversion projects in the Siberian and European parts of the USSR were nearing implementation in 1984. First in *samizdat* (underground "self-published" literature), then in the West,[59] a number of documents appeared revealing the anticipated ecological dangers that would result from expensive river flow diversions.[60]

It is not yet clear what reforms will be implemented by the Gorbachev leadership in the wake of the announced "democratization" of society and the partial decentralization of the Soviet economic system. However, the conceptual base of the Soviet system will be modified, as shown by ongoing trends in environmental activities.

A new concept, *ravnovesnoe prirodopol'zovanie* (balanced natural resource use), or BNRS, has been emerging during the past 13 to 15 years.[61] This approach takes into consideration the explosive growth of technology and radically overhauls the conceptual base regarding the interaction between the economy and environment. Unlike the previous concepts, which have not yet been discarded, BNRS is based on a systems analysis of economic activity in an isolated environmental setting, be it a river basin with a clearly identified watershed, a sea or an estuary, or any land-based, well-defined ecological

system where many enterprises draw on one or several renewable natural resources. Each isolated geographical setting--together with its population, economy, and natural resources--is considered to be a subdivision of the global environment, called the *biosotsial'naia sistema* (biosocial system), or BSS. Each renewable resource in a BSS is considered to be a *proizvoditel'naia sila* (productive force); therefore, each can be introduced into economic mechanisms along with other resources, such as human, energy, natural commodities in fixed supplies, and transportation systems. A set of goals for an identified BSS is formulated within the broader designs of the overall development of the national economy. In order to keep the "operation" of natural resources and cycles economically effective, a lower ranking set, or subset, of goals for environmental protection is also specified for a BSS. The major method for predicting the behavior of a BSS is ecological-economic modelling. The ecological-economic model takes into account the various scenarios of overall economic development on both the national and international levels, and provides a set of measures guiding the operation of a BSS.[62]

The major concepts underlying Soviet views on environmental issues have not provided economic planners with guidelines regarding routine practical procedures. BNRS, on the contrary, constitutes a more down-to-earth approach that can be successfuly used for effective regional planning. But because this concept is rather complex, it is unlikely that the party elite will be able to express its preferences *a priori* for one scheme or another. Therefore, in the future, a much larger group of experts with varying opinions will probably participate in the decisionmaking process, and the atmosphere of economic planning will be ameliorated.

It is not yet clear whether environmental laws will be modified to include new approaches regarding the interaction between ecology and environment in Soviet enforcement procedures. However, a leading expert on environmental laws, O. Kolbasov, suggested during the 1985 *Nash sovremennik* roundtable discussion[63] that long-term programs affecting large subdivisions of the biosphere should be the subject of nationwide discussions in conformity with Article Five of the Soviet constitution. This is the only way, he added, that the USSR can prevent the inception of unpopular and ecologically harmful projects.

By cancelling the north-south Siberian river diversion project, the Soviet leadership demonstrated its determination to stop using large integrated programs as the major method of large-scale water management. Another step in this direction was to curtail the use of nationwide irrigation programs as the major means of increasing farm production. Today, the party favors the use of "intensive" technologies in agriculture, which, by themselves, can liberate water for other needs and decrease pollution. Though a new program has not yet been enacted, several methods of soil and water conservation that would simultaneously increase crop yield have been proposed.[64] These include anti-erosion measures, the cultivation of abandoned lands, the use of drip irrigation, expanded crop rotation, and the increased use of chemical fertilizers. It is persistently emphasized that such measures do not supplant but rather supplement those used thus far in a piecemeal, site-specific manner.

It is not yet clear if economic planners under Gorbachev can implement these measures in order to achieve a smooth and balanced interaction between the economy and the environment. In the past, mismanagement of water

resources has resulted in low water availability and degradation of water supplies in the most populous regions of the USSR.[65] In the last several years, this problem was partially ameliorated by a relatively high rate of precipitation. Abnormally dry periods, such as those that occurred in the early 1970s, recur every four to seven years. Previously, Soviet water-management planners sought to alleviate such conditions though water diversion projects that kept their water-wasteful technology intact. Soviet leaders killed this emergency supply system because it appeared to be extremely expensive and ecologically dangerous. The question arises as to whether Soviet planners will have enough time to utilize new technologies efficiently.

Even though the north-south river diversion project has been officially cancelled, the "project of the century" continues to be openly debated in the Soviet press.[66] Moreover, it now appears that in some cases river diversion projects were partially implemented. Water drainage systems were significantly modified; irrigation systems were built in anticipation of increased water flow; and the production of crops that require such water flow--for example, rice and cotton--was restructured so that in the absence of increased water reserves, regional economies cannot function properly.

The shortage of freshwater reserves has become so widespread and profound that large-scale transfers of water from the north now seem unavoidable. For example, Lake Aral, which was deprived of freshwater run-off, substantially dwindled in size and has partially dried up. Resulting "salt storms" have had a harmful effect on irrigated farm land. Likewise, the dried up Kara Bogaz Gol bay was rejoined with Caspian Sea in order to prevent soil salinization. The huge, canyon-shaped Volga-Don canal was designed to transfer sizeable quantities of water to the Azov Sea basin.

Given the rather ambiguous language of the party decree terminating the river diversion project, managers involved in the project decided not to dismantle the newly constructed facilities. Facilities designed to reroute northern water to southern regions have remained intact in anticipation of dry periods, when the water shortage will become urgent. Opponents of river diversions have called the recent "wet period," which has lasted from 1979 to the present, a "gift of nature." However, proponents of the project have initiated a well organized campaign, in the spirit of *glasnost*, to reverse the decision.

The battle to reach a viable and comprehensive solution to the Soviet Union's water problems seems to have reached an impasse. Implementation of the river diversion project is harmful to the environment and may not be possible, given the deficiency of resources necessary to transport water to various regions of the USSR, particularly Siberia. Water reserves continue to shrink, and an alternative solution regarding water conservation and alleviation of water pollution levels does not seem forthcoming. Opponents of the project--mostly writers, economists, and environmentalists--lack technical expertise. Moreover, there is still no official Soviet agency responsible for overseeing programs designed to ameliorate dry agricultural conditions. It has not been ruled out that farms in the southern USSR may experience a crisis situation in the near future. In this context, a comment by the editor of *Novyi mir*, Sergei Zalygin, that Soviet public opinion has succeeded in forcing the leadership to cancel the water diversion project, appears to be somewhat optimistic.[67]

New economic and environmental policies require simultaneous and coherent modifications of many branches of the economy. Their implementation will

require the retraining and reemployment of large groups of people, the rapid improvement of information technologies, the assimilation of Western experience in economic and environmental planning, the decentralization of power, and the creation of a new system of incentives. During the 27th Party Congress in February and March 1986, Soviet leaders vowed to reach self-sufficiency in the supply of food and consumer goods by 1990.[68] How these targets can be reached during the current period when changes are occurring in water management policies--policies that are currently in complete disarray--remains to be seen.

Notes

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3. B. Komarov, *The Destruction of Nature in the Soviet Union* (White Plains, New York: M. E. Sharpe, 1980).

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16. Z. Medvedev, *Nuclear Disaster in the Urals* (New York: Norton, 1979).

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28. A. Bezanson, *Russkoe proshloe i sovetskoe nastoiashchee* [Russian past and soviet present] (London: Overseas Publications, 1984), p. 387.

29. P. R. Pryde, *Conservation in the Soviet Union* (Cambridge: Cambridge University Press, 1972), p. 272; D. C. Kolbasov and N. I. Krasnov (eds.), *Efektivnost' iuridicheskoi otvetstvennosti v okhrane okruzhaiushchei sredy* [Effectivness of jurisdictional responsibility in environmental protection] (Moscow: Nauka, 1985), p. 224.

30. The Soviet communist party enthusiastically encourages wide public participation in numerous environmental preservation societies, such as Obshchestvo Okhrany Prirody (Society for the Conservation of Nature), Zelenii Patrul' (Green Patrol), and Iunye Naturalisty (Young Naturalists). Although these organizations have absolutely no standing in the country's environmental planning, and pursue, at best, educational objectives, millions of people are considered dues-paying members.

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32. S. L. Vendrov, *Problemy preobrazovaniia rechnykh sistem*, p. 236.

33. S. L. Vendrov, *Problemy preobrazovaniia rechnykh sistem*, and *Problemy preobrazovaniia rechnykh sistem SSSR*.

34. S. L. Vendrov, *Problemy preobrazovaniia rechnykh sistem SSSR*.

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36. P. R. Pryde, *Conservation in the Soviet Union*, p. 272; T. S. Khachaturov, *Ekonomika prirodopol'zovaniia*, p. 256.

37. H. P. Caulfield, "U.S. Water Resources Development Policy," pp. 215-231.

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43. S. L. Vendrov, *Problemy preobrazovaniia rechnykh sistem SSSR.*

44. Thane Gustafson, *Reform in Soviet Politics: Lessons of Recent Policies on Land and Water* (Cambridge, Massachusetts: Cambridge University Press, 1981).

45. P. R. Pryde, "The 'Decade of the Environment' in the USSR," *Science*, (1983), pp. 220, 274-79.

46. Thane Gustafson, *Reform in Soviet Politics*; Ed A. Hewett and H. S. Levin, "Panel 1986 on the Soviet Economic Outlook: A Round Table Discussion," *Soviet Economy* 2, no. 1 (1986), pp. 3-18; Ed A. Hewett, "Gorbachev's Economic Strategy: A Preliminary Assessment," *Soviet Economy* 1, no. 4 (1985), pp. 285-305.

47. P. R. Pryde, *Conservation in the Soviet Union*, p. 272.

48. Thane Gustafson, *Reform in Soviet Politics*, pp. 135-139.

49. Thane Gustafson, *Reform in Soviet Politics.*

50. A. Toffler, *The Third Wave* (New York: Bantam Books, 1980), pp. 244-63.

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52. A. Katsenelinboigen, "Corruption in the USSR: Some Methodological Notes," in M. Clarke (ed.), *Corruption: Causes, Consequences and Control* (London: Frances Pinter, Ltd., 1983), pp. 220-38.

53. T. S. Khachaturov, *Ekonomika prirodopol'zovaniia*, p. 256.

54. A recently created special Commission on Environmental Protection and Rational Use of Natural Resources, which is affiliated with the Council of Ministers, does not have the leverage effectively to obstruct economic decisions that are harmful to the environment. This new governmental agency operates under the guidance of the party and can counsel party leaders on environmental issues only to the extent of coordinating efforts to carry out previously made decisions. See, for example, P. G. Oldak, *Ravnovesnoe*

prirodopol'zovanie (Balanced natural resources economics) (Novosibirsk: Nauka, 1983), p. 128.

55. *Pravda*, February 26, 1986.

56. T. Kuznetsova, "Resursnoe obespechenie lichnogo podsobnogo khoziaistva" [Resource base of private farming], *Voprosy ekonomiki*, 1984, no. 11, pp. 19-104.

57. P. G. Oldak, *Ravnovesnoe prirodopol'zovanie*, p. 128.

58. T. Kuznetsova, "*Resursnoe obespechenie lichnogo podsobnogo khoziaistva*," pp. 19-104.

59. V. G. Briusova, V. A. Vinogradov, S. G. Zhukov, M. P. Kudriavtvev, A. J. Nekrasov, S. N. Chernyshow, and F. Ia. Shipunov, *Analiz problemy perebroski chasti stoka rek s severa na iug* [Analysis of the problem of partial north-south river flow diversion] (Grani, 1984), pp. 133, 192-234.

60. David Tolmazin, "Recent Changes in Soviet Water Management."

61. P. G. Oldak, *Sovremennoe proizvodstvo*, p. 190, and *Ravnovesnoe prirodopol'zovanie*, p. 128.

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63. *Nash Sovremennik*, no. 7, 1985.

64. *Pravda*, February 12, 1986; M. Ia. Lemeshev, "Intensifikatsiia proizvodstva i ratsional'noe prirodopol'zovaniie" [Intensification of production and rational natural resource use], *Kommunist*, November 17, 1985.

65. David Tolmazin, "Economic Impact on the Riverine-Estuarine Environment," pp. 137-152; M. Ia. Lemeshev, "Intensifikatsiia proizvodstva."

66. *Novyi mir*, 1987, no. 7, pp. 181-235; *Ogonek*, 1988, no. 1, pp. 23-26.

67. *Novyi mir*, 1987, no. 1, pp. 2-11.

68. *Osnovnye napravelniia ekonomicheskogo i sotsial'nogo razvitiia SSSR na 1986-1990 gody i po period do 2000 goda* [Major directions of economic and social development in the USSR in 1986-1990 and for the period to the year 2000] (Moscow: Politizdat, 1986), p. 96.