

Chapter 16

The Siberian Water Transfer Schemes

Philip Micklin

Abstract The twentieth century was the era of mega-engineering thinking. This was a worldwide phenomenon, but perhaps had its clearest expression in the Soviet Union, a nation with a well-developed ideology promoting man subduing nature for purported human betterment. Soviet plans to transfer huge amounts of water long distances from Siberian rivers to Central Asia were initially conceived, during the Stalinist era, as a way to fundamentally transform the physical environment of this region. During the period 1960 to the mid 1980s, these projects were primarily seen as the best means to provide more water for irrigation expansion and, secondarily, as a way to provide more water to the Aral Sea. After several decades of intense scientific study and engineering development, a final design for Siberian water transfers was on the verge of implementation when an abrupt change of national policy in 1985–1986 put it in on hold for the foreseeable future. The plan foundered owing to Russian nationalist opposition, enormous costs, a changing political environment, and the threat of significant environmental damage. The collapse of the USSR has probably doomed the project although it continues to be promoted by Central Asian governments and even some prominent Russians as a means to bring back the Aral Sea.

Keywords Davydov Plan • Siberian water diversion • Siberian water transfer • Ob • Irtysh • NAWAPA

P. Micklin (✉)
Department of Geography, Western Michigan University, 1903 W Michigan Ave., Kalamazoo,
MI 49008-5433, USA
e-mail: Micklin@wmich.edu

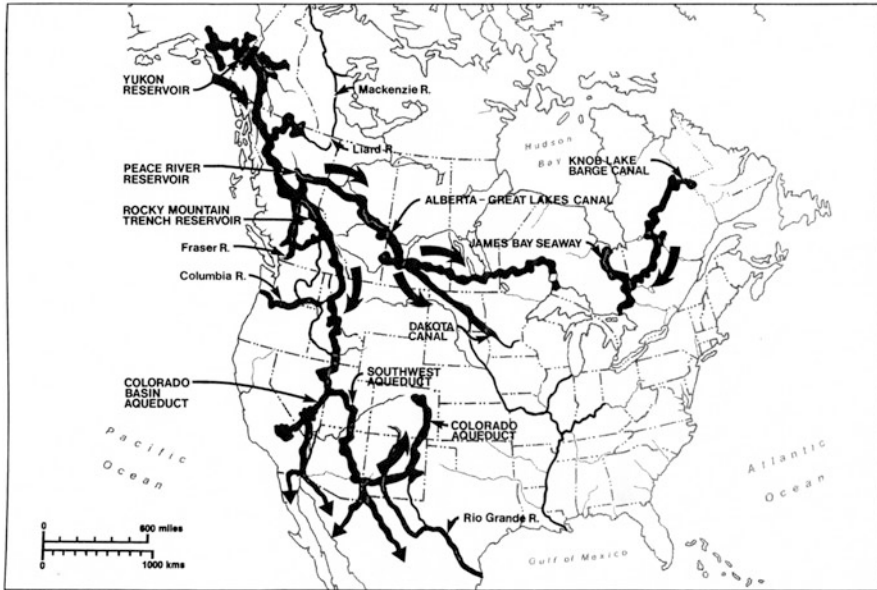


Fig. 16.1 The North American Water and Power Alliance Scheme (NAWAPA) (Source: Sewell, W.R. (1974). "Water Across the American Continent." *Geographical Magazine*, Vol. XLVI, No. 9 (June), Figure 1, p. 472. Used by permission of Wiley, the Publisher.)

16.1 Introduction

The twentieth century was the era of mega-engineering water development projects. We were confident that humans not only had the technology but the need and right to remake and control nature. Beginning in the 1930s, chains of gigantic dams were built on a number of the World's major rivers for hydroelectricity, flood control, irrigation and navigation purposes turning them from free flowing to a series of lakes. In the second half of the century, engineers moved on to designing and even building projects to move large volumes of water from one drainage basin to another for hydroelectricity production (e.g., The James Bay Project in Canada) or from perceived regions of surplus to perceived regions of deficit (e.g., the California State Water Project). The most grandiose scheme of this genre was NAWAPA (North American Water and Power Alliance) (Fig. 16.1). Conceived in the 1950s and 1960s, it would have involved connecting via a vast system of dams, canals, and pumping stations all the major drainage basins of western North America and the Great Lakes (Micklin 1985) in order to transfer up to 300 km^3 of water annually from humid northern to arid southern regions at an estimated cost in 1975 USD of 120 billion. Seen by proponents as a continent-wide scheme to solve all critical North American water supply problems for the next several centuries, it never went beyond the conceptual design stage owing to its huge expense, likely significant negative environmental consequences, and

opposition from Canada and the northwestern U.S. states (Washington, Oregon, Idaho and Montana), which would have been the major “donors” of water. By the 1980s NAWAPA had retreated to the status of an ambitious engineering dream.

However, in the Soviet Union, a smaller, but still of unprecedented scale, inter-basin water transfer project was on the verge of implementation. It contemplated taking flow from the huge northward flowing Siberian rivers Ob and Yenisey and sending it thousands of kilometers southward to the mainly arid Aral Sea Basin. The Siberian Water Diversion Project (better known simply as “SibaraI” the abbreviation for “Siberia to Aral Sea Canal”), promoted and discussed since the latter part of the nineteenth century, underwent sophisticated refining, designing, and environmental evaluation from the late 1960s until the early 1980s. By 1985, the route was chosen, survey work completed, specialized construction equipment built and, it appeared, construction imminent. But in August 1986, the Soviet government announced the “Project of The Century” had been indefinitely postponed.

16.2 Rationale and History

Why was the Government of the USSR so interested in large-scale north to south water transfers? The primary motivation was the sharp geographical non-correspondence between regions with abundant fresh surface water resources, which consists mainly of river flow, and regions, which had high demand for water (Micklin 1987). Rivers carrying 84 % of average annual discharge flowed north and east across sparsely inhabited, economically underdeveloped territory to the Arctic and Pacific oceans (Fig. 16.2). The remaining 16 % of flow crossed the southern and western zones of the country where some 75 % of the population lived, which generated 80 % of economic activity, and which contained over 80 % of cropland, including the most fertile. Furthermore, although southern regions of the former USSR have the best soils and thermal conditions for agriculture, they have a decidedly deficit moisture balance (i.e. potential evapotranspiration significantly exceeds precipitation).

Hence during the Soviet years, irrigation had been increasingly developed to both increase and stabilize agricultural production (Micklin 1983a). In 1980, of 337 km³ withdrawn for all uses in the USSR, 177 km³ or 53 % went for irrigation, nearly all of which was confined to southern semi-arid and arid regions. With a 1985 irrigated area of 19.6 million ha, the USSR tied for third place in the world with the USA and behind China and India. Soviet officials viewed irrigation expansion in the south, particularly in Kazakhstan and the four Central Asian Republics (Uzbekistan, Turkmenistan, Tajikistan, and Kyrgyzstan) as absolutely essential for the economic improvement of those regions and of the entire country. And the logical place to get the needed water was from the giant rivers of the northern zone of “surplus” flow.

The condition of several southern water bodies: the Azov, Caspian and Aral seas (strictly speaking, these are lakes) was a second powerful factor motivating interest in north to south water diversions (Micklin 1986). Since the 1930s, periods of low natural flow, the construction of reservoirs, and irrigation measurably reduced inflow to the Caspian and Azov seas, leading to a 3-m drop in the level of the

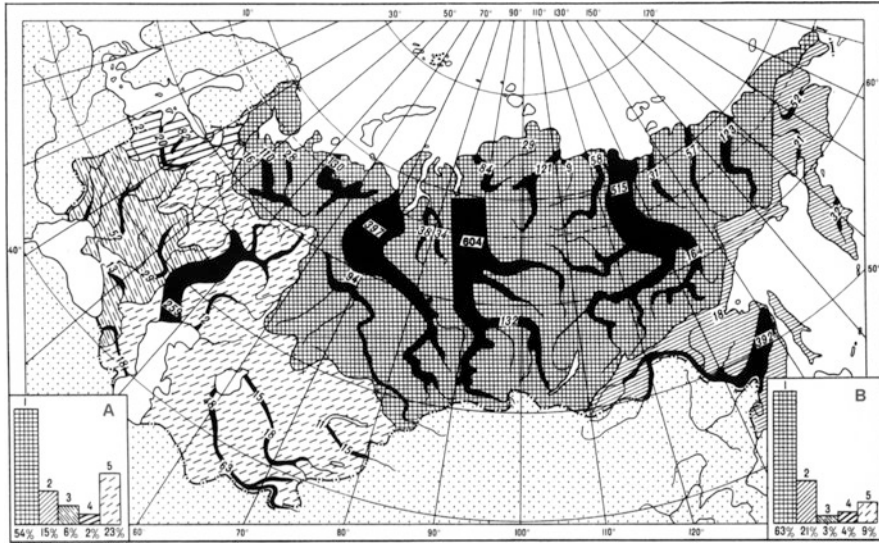


Fig. 16.2 Mean flow of USSR Rivers (km^3/year) (Bar chart A (left) indicates percentage of the USSR's territory with river discharge into specified sea and ocean basins. Bar chart B (right) indicates percentage of USSR's average annual river discharge accounted for by rivers flowing into specified sea and ocean basins. Numbers above the bars indicate drainage basins: 1-Arctic Ocean; 2-Pacific Ocean; 3-Black and Azov seas; 4-Baltic Sea; 5-Caspian and Aral seas) (Source: Adapted from Nikolskiy I.V., V.I. Tonyayev and V.G. Krasheninnikov (1975). *Geography of water transport of the USSR* (Moscow: Transport) (In Russian))

former by 1977. Soviet water management planners wanted to send part of the flow of northern European rivers southward to improve the water balances and salinity of these two water bodies. Contrary to expectations and forecasts, inflow since the late 1970s to both the Azov and Caspian seas rose substantially and the level of the latter has risen over 2 m (Aladin et. al. 2008). The Aral Sea fell 10 m from 1961 to 1985 and its salinity doubled, owing to the great reduction of discharge to the lake from its two influents (the Amu and Syr rivers) owing to very heavy irrigation withdrawals.

Although not the primary goal, which was expansion of irrigation in the Aral Sea Basin, water transfers from Siberian rivers would have aided in ameliorating this problem by increasing return irrigation drainage flows to the two rivers which feed the lake. Opposite to what happened with the Caspian, inflow to the Aral from the Amu and Syr has remained very low and the lake has continued to rapidly shrink and salinize with severe environmental and economic consequences.

A third factor making the transfers appealing was the relatively straightforward, given the projects scale, nature of the requisite construction required for their implementation. The headwaters of north and south flowing rivers in the former European USSR, now Russia, are proximate and separated by low divides. In the Asiatic part of the former Soviet Union, on the other hand, although long, a natural route of transfer across the low Turgay Gate dividing Western Siberia from

Kazakhstan and Central Asia is available. These features simplified the engineering and lowered the estimated costs of the diversions.

Politics and ideology also played a substantial role in the push for huge water transfer projects. They were to be built within one nation having an authoritarian and powerful central government. This negated the need for time consuming and complicated negotiations with other states (as would have been necessary, for example, to implement NAWAPA, requiring the acquiescence not only of the United States but of Canada and Mexico). It also meant that the Central Government could override opposition (that, as we shall see, was quite strong against the Siberian project). Soviet dogma was also favorable to such mega engineering ideas. An ideological commitment to economic determinism and the concept of humans mastering and remaking nature for human betterment through science and technology was a fundamental tenet of Marxism-Leninism (Micklin 1971). Hence, Soviet leaders tended to reject the idea of environmental constraints and looked favorably on gigantic “nature transformation” efforts.

The potential for moving water from Siberian rivers into Central Asia was recognized even in Tsarist times. In 1871, the engineer Demchenko proposed diverting water from the Ob River into the Aral Sea and from there into the Caspian (Micklin 1971). The plan was an engineering dream and well beyond construction technology of the day. During the 1920s and 1930s, both European and Siberian diversion concepts were seriously studied as part of the plans for the general development of the nation’s water resources (Berezner 1985, pp. 13–18, 106).

M.M. Davydov, a Leningrad engineer, proposed the most grandiose Siberian water transfer scheme in the late 1940s as part of the “Stalin Plan for the Transformation of Nature” (Rus: *Stalinskiy plan dlya preobrazovaniya prirody*) (Micklin 1971, pp. 251–253, 1977). The goal was radical improvement of the climate of the entire Aral-Caspian lowland and the conversion of steppe and desert regions into productive pastures and croplands. This grand concept, to be implemented in stages, proposed ultimately taking 315 km³ annually from the Ob and Yenisey rivers of Western Siberia, which flow into the Kara Sea, which is a marginal sea of the Arctic Ocean and sending it gravitationally via a 930 km canal to be dug through the Turgay Gate water divide (maximum elevation 125 m) to Kazakhstan and Central Asia (Fig. 16.3).

The water would have been used to expand irrigation in this region from less than 5 to 25 million ha and to supplement inflow to both the Caspian and Aral seas to make up for river water flowing to the two water bodies that would be withdrawn for irrigation. The length of water transfer from Western Siberia to the Caspian Sea would be 4,000 km.

The plan would have reduced the average annual discharge of the Ob and Yenisey by 32 %, created a gigantic 250,000 km² reservoir on the West Siberian Plain, inundating swamps, forests, farmland, and the largest, but unknown at the time, oil deposits in the USSR. Costs would have been enormous, running in today’s U.S. dollars up to 200 billion. The plan, similar in scale to the NAWAPA scheme, would have taken 30–50 years to implement. Little was heard of it after Stalin’s death in 1953 when the grand plans for “Nature Transformation” were quietly shelved.

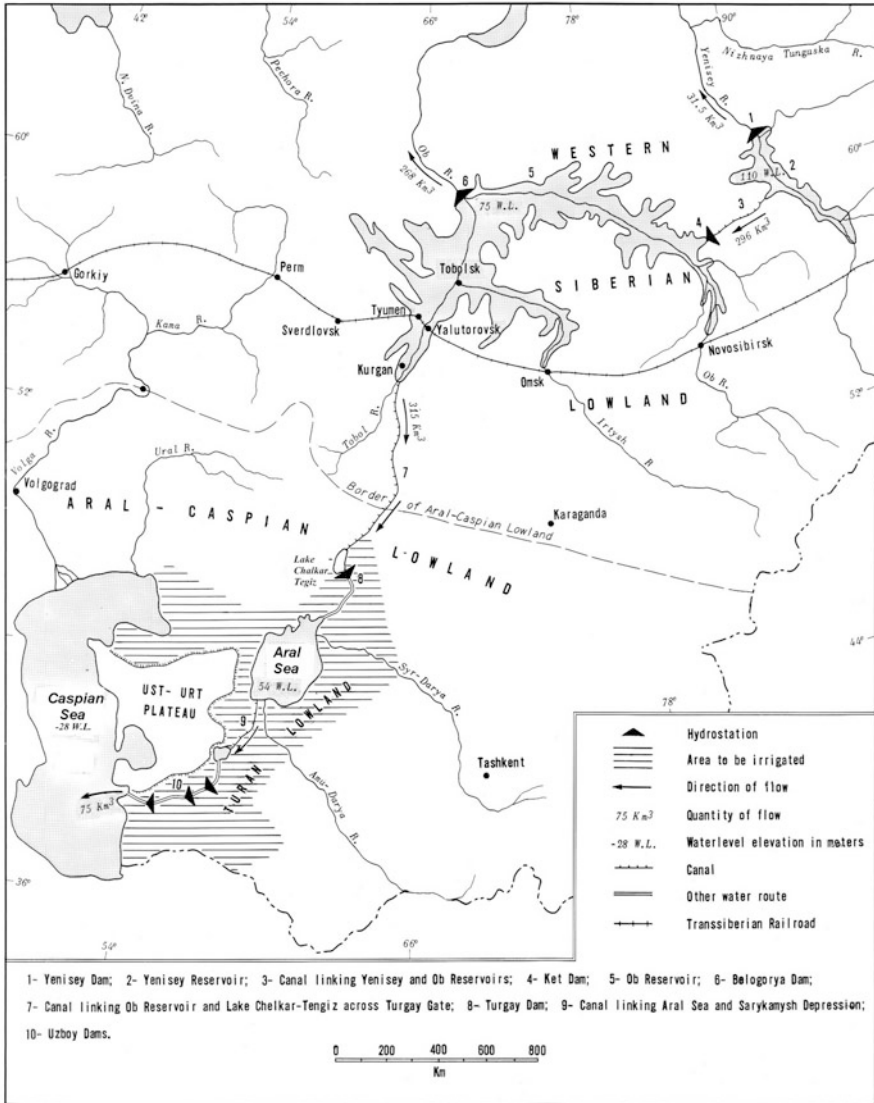


Fig. 16.3 The Davydov Plan (Source: Adapted from Davydov, M. M. (1949), “The Ob-Aral-Caspian Water Connection,” *Gidrotekhnicheskoye stroitel’stvo*, No. 3, p. 10 and Davydov, M. M. (1949), “Transformation of the drainage network in the Soviet Union,” *Geografiya v shkole*, No. 3, p. 15 (both in Russian))

During the 1950s and 1960s, primary attention was focused on water transfer plans in the European part of the USSR where the water management situation was perceived as more critical than in Central Asia (Micklin 1983b). However, in the early 1970s as water use in Central Asia grew rapidly and the Aral Sea continued to

recede, interest renewed in schemes for sending Siberian water southward. Design efforts initially were the responsibility of Soyuzvodproyekt (National Water Management Design Corporation), but in the late 1970s, primary responsibility was assigned to Soyuzgiprovdokhoz (National Water Management Design and Scientific Research Institute). Both of these agencies were subordinate to the Ministry of Reclamation and Water Management (Minvodkhoz).

The 10th Five Year Plan (1976–1980) was a period of intense research and design work on both European and Siberian diversion schemes (Micklin 1986, 1987). Planners recognized that identification and study of the potential environmental impacts of water transfers as well as development of mitigation measures for these lagged design efforts. A major effort to correct this deficiency was launched under the general supervision of the State Committee for Science and Technology and the specific guidance of the Institute of Water Problems of the Academy of Sciences in which more than 120 scientific and planning agencies participated. Research results were presented and discussed at a series of conferences as well as being published in numerous articles and in several summary volumes. Technical-economic feasibility studies (TEOs) were also completed on the initial phases of both European and Siberian diversion projects. These documents were subsequently submitted to Gosplan (the state planning agency) for their evaluation and approval.

Research and design work on diversion projects continued in the 11th Five Year Plan (1980–1985) but the emphasis was on the latter. The 26th Communist Party Congress in 1981 called for initiating construction work on European diversions before 1990 and for continuing scientific evaluation of and design work on Siberian transfers. An expert commission of Gosplan during 1980–1983 evaluated the TEO for the first phase Siberian project. In August of 1983, it approved the scheme with one minor change that increased the proposed annual diversion from 25 to 27.2 km³ (Micklin 1984). In January 1984, the USSR Council of Ministers accepted the positive recommendation of the expert commission and directed the Minvodkhoz to prepare the detailed engineering designs necessary for construction of the main diversion canal known as “Sibara1”.

The director of the Institute of Water Problems, Grigoriy V. Voropayev, who headed the research program on the environmental effects of water transfer projects, indicated to the author of this paper in February 1984 that, dependent on a favorable decision by the Government on the final design, first phase Siberian diversions could be under construction by 1988. Figure 16.4 shows European and Siberian diversion schemes according to the designs worked out by 1984 (Micklin 1986). Figure 16.5 shows the Siberian diversion plan in more detail

Implementation of European transfers would occur in several phases and stages. The first stage of the first phase (5.8 km³/year) was to be started in the 12th Five Year Plan (1986–1990) and completed in the 1990s. First phase transfers (19.1 km³/year) were to be completed in the early twenty-first century. European diversions could possibly be increased to more than 60 km³/year during this century, but would require much more research and design work prior to construction.

Two phases were planned for Siberian diversions (Micklin 1986). The first would draw 27.2 km³ annually from the Ob River and its right-bank tributary the

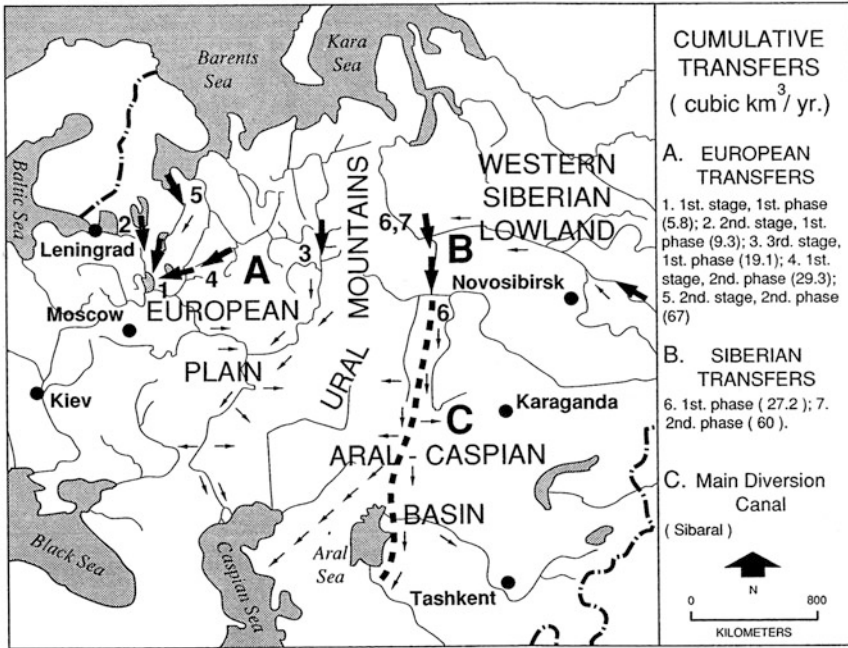


Fig. 16.4 Final diversion plans for European and Siberian Parts of USSR (1984) (Source: Micklin (1991). "The Soviet Experience with Large-Scale, Long Distance Water Transfer Planning," p. 94, Fig. 14. In Marie Sanderson (ed.), *Water Pipelines and Diversions in the Great Lakes Basin*, Department of Geography Publication Series, Occasional Paper No. 13. Waterloo, Canada: University of Waterloo)

Irtysh and send it southward. The route from the Ob to the Amu Darya River in Central Asia would stretch 2,544 km. The first 344 km would follow the Irtysh River from its confluence with the Ob to the city of Tobolsk; the river over this part of its course would have its flow reversed (i.e. become an "anti-river") to deliver water from the Ob from September to April. Water would then be pumped on a year-round schedule from Tobolsk up and across the Turgay divide and from here move mainly by gravity to the Amu Darya via a huge earth lined canal. Another possible variant was a left bank canal that would parallel the Irtysh and avoid the need to reverse its flow. By 1985, however, the anti-Irtysh variant, apparently, had won out. The cost of the project was estimated to be 13 billion rubles. An additional 18 billion rubles was estimated to be necessary for the construction of water distribution and irrigation facilities along the route, for a total project price of 32 billion rubles (a dollar figure is problematic, but the first phase certainly would have run into the equivalent of several tens-of-billions of 1984 U.S. dollars).

Construction of first phase transfers was set to begin by the late 1980s and to be completed around the turn of the century. Table 16.1 shows basic economic and environmental information related to first phase Siberian diversions. A second phase would raise Siberian diversions to 60 km³/year. It would likely require

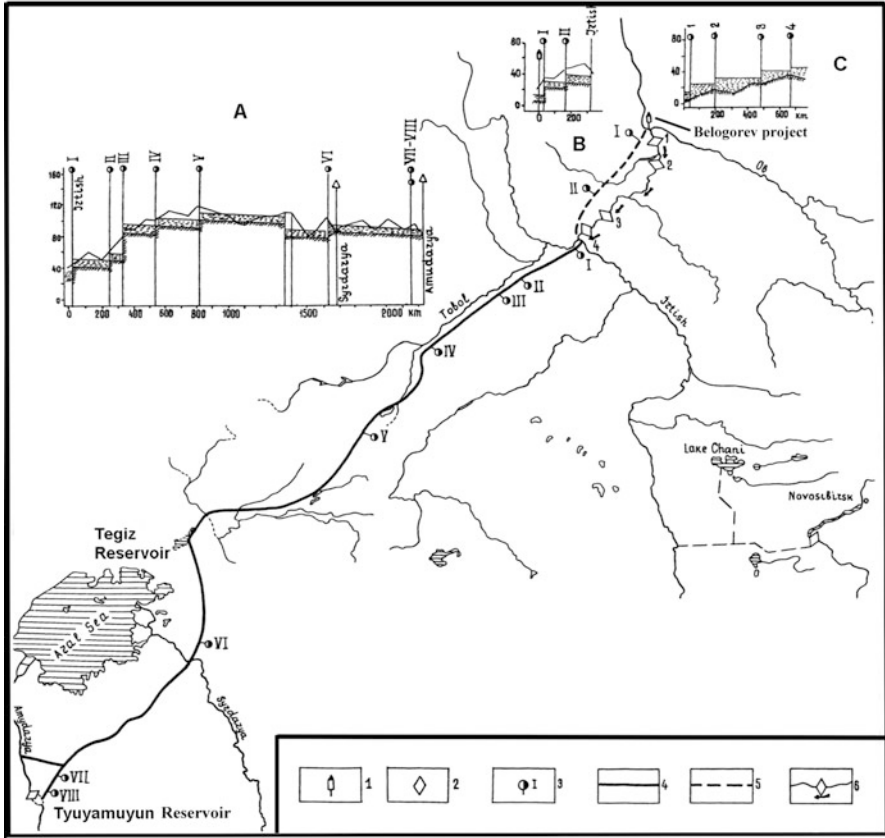


Fig. 16.5 The First Phase Design for the Siberian Water Diversion Project as of the Early 1980s (*Diagram A* (upper left on map) shows the N to S cross section of the main diversion canal with elevations in meters on the Y axis and distance in km on the X axis. Roman numerals I–VIII on this diagram indicate pumping stations. *Diagram B* (top center) shows the cross section of the variant with a left bank Irtysh canal (dashed line) and two pumping stations. *Diagram C* shows the so-called “anti-Irtysh” variant in which the flow of the Irtysh River would be reversed for more than 600 km by four hydrocomplexes (low dams and pumping stations). The anti-Irtysh design was selected in the final project plan. Symbols on the bottom of the map indicate (1) water withdrawal facilities without dams, (2) hydrocomplexes, (3) pumping stations, (4) main diversion canal, (5) left bank Irtysh canal and (6) anti Irtysh) (Source: Adapted from Voropayev, G. V. (1982), “Problems of water ensuring of the country and the territorial redistribution of water resources.”, *Vodnyye resursy*, No. 6, Fig. 3, p. 7 and Voropayev, G.V. and A.L. Velikhanov (1985), “Partial Southward Diversion of Northern and Siberian Rivers,” Fig. 4, p. 76. In Genady N. Golubev and Asit K. Biswas (eds.), *Large Scale water Transfers: Emerging Environmental and Social Experience*, UNEP Water Resources Series 7. Oxford: Tycooly)

supplementing the Ob with water from the Yenisey River, which lies to the east. Implementation of the second phase would require further research and design work and was not viewed as necessary until well into the twenty-first century.

Table 16.1 Selected economic and environmental characteristics of the First Stage Siberian water diversion project

Annual average diversion (cubic kilometers)	27.2
Capital cost of main diversion canal (millions of rubles)	
Total	13,000
Per cubic kilometer	478
Capital cost of water distribution and irrigation facilities (Millions of rubles)	18,000
Amortization (payoff) period (years)	10
Irrigated area (millions of hectares)	
1984 irrigated area in affected zone(1)	87
Area to be irrigated from diversions	45
Percentage increase over 1984 irrigated area	50
Feasible irrigation area in affected zone by 2010	16–17
Benefits of first phase Siberian diversion (claimed)	
Increased food production: grain (17.1 mill. tons), including 13.1 of corn; vegetables, potatoes and melons (6.7 mill. tons); fodder crops (45.1 mill. tons); meat (2.9 mill. tons); milk (10.9 mill. tons); eggs (9.2 bill.); vegetable oil (130,000 t)	
Creation of a navigable waterway from the Amu to the Ob	
Improved industrial and municipal water supplies	
Creation of employment opportunities for the rapidly growing population of Central Asia	
Improved water quality along the Amu and Syr rivers	
Some reduction of flooding and water logging below points of diversion along the Ob and Irtysh rivers in Western Siberia	
Potential harmful consequences of diversion project to northern regions of water export (Western Siberia) (examples)	
Flooding of land including agricultural (amounts unknown)	
Inundation of commercial timber (amount unknown)	
Resettlement of people (numbers unknown)	
Deterioration of fisheries of the Ob and Irtysh as well as Ob Gulf	
Worsened ice (i.e. lengthened cover) and climatic (i.e. cooler spring and summer) conditions in Ob Gulf	
Degradation of water quality downstream from points of diversion deterioration of flood plain meadows with agricultural value downstream from points of withdrawal owing to reduced spring flooding	
Worsened low-flow navigation conditions below points of diversion	
Slower summer melt of Kara Sea ice cover	

Source: Micklin (1987), p. 72

(1) Kazakhstan and the republics of Central Asia; some water would be used for irrigation in the RSFSR (southern Western Siberia)

The October 1984 plenary meeting of the Soviet Communist Party confirmed the start of construction on the initial phase of European diversions (5.8 km³) by 1990 and indicated design work would continue on Siberian diversions but did not provide any timetable for implementation of the latter (*Pravda*, 27 October 1984, pp. 1–2). On the other hand, the Uzbek paper *Pravda Vostoka* reported in January 1985 that construction crews had arrived in Western Siberia from that republic to

start work on infrastructure facilities for the main diversion canal to Central Asia (*Pravda Vostoka*, 9 January 1985, p. 1). On June 5, 1985, Vasilyev, Minister of Land Reclamation and Water Management, announced at a press conference that both the European and Siberian water diversion projects would proceed as planned (*Reuters*, 5 June 1985). In August 1985, a series of articles promoting the rapid implementation of the first phase of Siberian water transfers appeared in *Pravda Vostoka* (7 August, p. 1, 21 August, p. 31, 24 August, p. 1). It was reiterated that a large detachment of personnel from Uzbek water management construction agencies were building housing facilities and a construction base in anticipation of the initiation of work on the main Siberian diversion canal. Design work for this canal was now supposed to be completed in 1987.

16.3 The Fall of Sibaral

However, when the government released the draft guidelines for the 12th Five Year Plan in November 1985, there was no mention of Siberian diversion projects, only the vague statement that the “Scientific justification of the regional redistribution of water resources needed to be raised” (Basic directions. . . 1985, p. 47). Construction of the initial phase of north–south European diversions, however, was included in the plan. From September 1985 to the 27th Party Congress in late February 1986, scathing criticisms and denunciations of diversion plans by well-known Russian writers and prominent scientists appeared in a number of popular national circulation papers as well as Communist party papers and journals (Micklin 1987). The water transfers were barely mentioned at the 27th Congress. The final guidelines for the 12th Five Year Plan stated only that it was necessary, “To deepen the study of problems connected with the regional redistribution of water resources.”

Nevertheless, *Minvodkhoz* continued to proceed with route and facility design work for the Siberian first stage transfer and preliminary construction work on the first stage European diversions. These actions were denounced as a violation of Party intent at the Eighth Congress of the USSR Union of Writers in July 1985. In August 1986, the Central Committee of the Soviet Communist Party and the Council of Ministers, the top governmental body, stopped all construction work on first phase European diversions and design efforts on Siberian transfers (Micklin 1987). However, the decree did allow further research on the scientific problems associated with water diversions, stressing ecological and economic concerns, and the utilization of mathematical models as well as domestic and foreign experience.

The stopping of design work on the Siberian project, postponing of the decision about its implementation into the indefinite future, and the call for further basic research into its economics and ecological consequences represented a surprising and fundamental change in Soviet national water management policy. The official Party and government line since the early 1970s was that this project required implementation by the turn of the century to meet the increasing water needs in Central Asia (Micklin 1986, 1987, 1988; Micklin and Bond 1988). National Party

and governmental leaders as well those from the Republics of Central Asia (including Kazakhstan) who would receive the Siberian water, and national and republican reclamation and water management design and construction organizations strongly supported implementation of diversion projects as would be expected. However, the need and inevitability of Siberian (as well as European) water transfers was also widely accepted by many experts in the Soviet scientific establishment. These scientists' basic concern was that water transfer concepts be carefully investigated and their likely consequences (economic, social, environmental) understood in order to select routes and facility designs that would minimize harm while providing the necessary amount of water to southern regions.

Soviet scientists involved with the research effort on diversions were, in the 1970s, critical of many aspects of the then current proposals (Micklin 1983a, b, 1986, 1987). They believed research on environmental and ecological effects lagged behind design efforts. The massive environmental impact assessment program conducted in the 11th Five Year Plan (1976–1980) was intended to resolve this problem. There is no doubt the findings influenced the selection of the final routes, volumes and designs of transfer facilities as well as being used to develop mitigation measures. By the early 1980s Soviet water management experts and scientists working on the diversion projects (while admitting that not all questions about water transfers had been adequately answered) publicly professed that the main environmental concerns had been addressed, that appropriate modifications had been incorporated into the schemes to minimize environmental harm, that though there would be local environmental and economic damage from the projects, the probability of catastrophic and widespread effects was minimal, and that, on balance, the benefits of diversions to the south would outweigh costs to northern regions of water export. The impression was conveyed that, with some further research and minor design refinements, the initial stage of European and Siberian transfers could safely proceed.

Although the 1970s and early 1980s were years of general optimism about north–south water transfers, there was a consistent thread of concern about and criticism of them. The milder critiques tended to dwell on the need for further research. Thus, the directors of the Institute of Water Problems and Institute of Geography, (both supporters of water transfers) were still in 1982 calling for deeper research into a number of issues related to Siberian diversions including social-economic consequences and better estimates of future water requirements in regions of proposed import (Voropayev 1982; Gerasimov et al. 1982).

But the most rigorous and persistent critics of the Siberian project were natural and social scientists from Western Siberia, the region where negative effects of the transfer would be concentrated. The scientists at professional meetings and in publications expressed grave concern about the negative impacts of the proposed water transfers (Micklin 1986; Voronitsyn 1986). Yu. P. Mikhaylov, a Siberian resource geographer, for example, stated the designers had exaggerated the benefits, minimized the harm, and greatly underestimated the cost of the scheme. He called for much more research on the project and alternative means of meeting water needs in Central Asia and cautioned against any rapid move toward project

implementation. However, since the conference proceedings and other publications were released in small numbers, the serious substantive issues raised about Siberian diversions did not reach even a broad scientific audience, let alone the general public.

However, early in 1982 the Siberian project was subjected to a major public challenge. The widely read and influential newspaper *Literaturnaya gazeta* (10 March 1982, p. 11) carried a full-page debate on the proposed diversion under the title "Project of the century from different points of view." Defending the scheme was chief project engineer Igor Gerardi; attacking it was economist Victor Perevedentsev who was affiliated with the Institute of International Workers Movement in Moscow who had worked at the Institute of Economics of the Siberian Branch of the Academy of Sciences in the 1960s. Gerardi asserted the first phase Siberian transfer had been thoroughly vetted by the experts and that it would have major economic benefits (chiefly for irrigated agriculture in Central Asia). He contended the project would quickly pay for itself with an amortization period of 10 years, that its environmental hazards were not severe, and that it must be implemented in the near future owing to the deteriorating water situation in Central Asia.

Perevedentsev categorically rejected these arguments, questioning the adequacy of the environmental research and the need for, and economic justification of, the project. He provided calculations indicating the payoff period would be at least 20 years and noted that it would be many years after construction started before water would be delivered and expenditures began to be recouped. Perevedentsev argued that more effective alternatives exist to increase food production and deal with water problems in Central Asia, including the irrigation of grains in Western Siberia and northern Kazakhstan and the reconstruction of old, inefficient irrigation systems. Perevedentsev and his views were bitterly denounced in April of 1982 in the Uzbek paper *Pravda Vostoka* (3 April, p. 3) by a member of the Uzbek Academy of Sciences and two individuals identified as "honored irrigators" of the Uzbek Republic. They stated that Perevedentsev was uninformed and his arguments absurd. They challenged his figures on the water savings from reconstruction of irrigation systems and said this program was already underway, as well as reiterating that the payoff period for the project would be 10 years (but no supportive calculations for this were provided).

This exchange occurred during the expert commission of Gosplan's evaluation of the technical document (TEO) on the Siberian project. The opposition may have been making a last attempt to derail the scheme and have it subjected to a thorough reappraisal, knowing how hard it was being pushed by Central Asian and reclamation interests. Perevedentsev worked at the Economics Institute in Novosibirsk during the 1960s. Academician Abel Aganbegyan, reportedly a long-time critic of Siberian diversions, was there at the same time. He and Perevedentsev no doubt knew each other well. It is likely Perevedentsev was presenting, as well as his own, the views of prominent scientists such as Aganbegyan, who opposed the project but felt they could not speak out publicly against it.

A number of Russian writers with a nationalist/populist/environmentalist orientation also played an important role opposing the river diversion projects, both European and

Siberian (Darst 1988). Sergey Zalygin, a former reclamationist and supporter of large-scale water management projects, who had a change of heart and became an adamant opponent of the proposed diversions, was the most well known member of this group. These writers saw the water transfer projects as a threat not only to the character and integrity of the environment of northern European Russia and Western Siberia, but to traditional culture and village life in these regions. They saw no reason to send precious Siberian water to Central Asia where, in their view, it would only be wasted. Their writings often had racist overtones toward the non-Russian Central Asian population.

The “official” approval of the Siberian scheme by the expert commission of Gosplan in August 1983 and the subsequent confirmation of this by the Council of Ministers in January 1984 had a chilling effect on the opposition. The clear message was that the decision had been made that the project will go forward and debates about it were over. The media were no longer open for any fundamental criticism of either European or Siberian diversions. Those who felt these projects were a mistake were relegated to sending private letters to high officials expressing their concerns and circulating underground manuscripts (samizdat – literally “self-published” documents).

A manuscript bitterly attacking European diversion plans, particularly for the damage they would do to historical, cultural, and archaeological treasures in the northern zone of water export, was smuggled to the west and published in 1984 (“One more time...” 1984). It contained copies of letters to the Politburo and Soviet Leader Andropov from prominent humanists, scientists (including many academicians, among them A. L. Yanshin, vice-president of the Academy of Sciences) and the group of nationalist/populist/environmental writers mentioned above. The manuscript pointed out the disastrous consequences of the European projects and called for a delay in implementation until much more thorough research has been conducted. One of the letters stated that the press was closed to critics of the project. Although the document did not deal with the Siberian project per se, one can reasonably assume its opponents were receiving the same treatment.

Hence, the evidence is unambiguous that by 1984 the proponents of moving rapidly toward final designs for and near-term implementation of the Siberian projects, in spite of opposition, had won the day. But their victory was short-lived; by the fall of 1985 they were on the defensive and 1986 saw the entire thrust of the early 1980s toward realization of the plan reversed with the cancellation of design work and a return to a phase of basic research and re-evaluation.

The ascension of Gorbachev to General Secretary of the Communist Party and leadership of the Soviet Union in March 1985 was the key factor in this sudden reversal. His background as the top party official for agriculture (1978–1983) and his emphasis on economic efficiency and the need for careful scientific founding and clear justification for large construction projects very likely had made him an opponent of the diversion projects long before he became the top Soviet leader. He had a close friendship with Academician Aganbegyan, with whom he attended Moscow State University in the mid-1950s and the latter had also served him as an unofficial economic advisor for some time.

After assuming leadership and placing his supporters on the Politburo and in the Government, Gorbachev moved to reverse the decisions that had been made about both European and Siberian diversions. That this would happen was no doubt clear to supporters of these projects. Thus, the flurry of optimistic articles in the Central Asian and some national papers from January until September 1985 on the Siberian project and the press conference of the Reclamation Minister Vasilyev in June 1985 promoting both European and Siberian transfers (which interestingly was reported in the Western media but not within the Soviet Union), with hindsight, appear to have been desperate attempts to keep the projects moving toward construction rather than a continuation of the steady progression of these projects to fruition which was assumed by Western observers (including this writer) at the time. Their efforts were to no avail. The fall of 1985 saw a resumption of the public debate over diversions (without doubt not only tolerated but encouraged by Gorbachev and his supporters) that had been silenced since 1982. This time around, however, the opponents of the water transfers commanded by far the most media attention

Project opponents' initial goal was the elimination of the go-ahead for construction on the first stage of European diversion (which had been included in the draft guidelines of the 12th Five Year Plan) as construction work had already commenced on it (Berezner 1985, pp. 13–18, 106). Consequently, most of the specific criticism was aimed at this project rather than the Siberian plan. It was charged that the scheme was unnecessary to meet water needs in the south and would be damaging to the environment of the north. A major issue was made of potential harm to cultural, historic, and archaeological sites, as it had been earlier in the 1982 *samizdat* manuscript. As noted above, permission for construction of the first stage European project was deleted from the final guidelines for the 12th Five Year Plan.

Discussion of the Siberian diversion disappeared from not only the national papers but also the Central Asian press in August 1985 (Brown 1985, 1986). Central Asian Party and governmental leaders also stopped talking about it and it was not mentioned at the 27th Party Congress held in February 1986. Favorable public discussion of the project, it appears, was declared off-limits. Nevertheless, *Minvodkhoz* (the National Ministry of Water Management) continued to push ahead with design work on the Siberian project and construction efforts on the European plan until the August 1986 decree finally halted these efforts and limited further work to basic research.

The reasons cited for suspending both the European and Siberian projects were economic, institutional–political, and environmental (Micklin 1987). A main economic argument was that not only would the projects be very costly and require a lengthy period of implementation, but that there are cheaper means of improving water supplies and agricultural production in the arid south. Reducing the great waste of water in irrigated agriculture in Central Asia was viewed as essential (see Chap. 8 for a more detailed discussion of this). Lining of earthen canals, accurate measurement of water use, more appropriate applications of water to crops, substitution of less for more water intensive crops such as cotton, among others, were put forward as means to “free up” ample water and obviate the need for Siberian water.

Critics charged that the water management agencies behind the design and environmental evaluation of the water transfers (*Soyuzgiprovodkhoz* and the Institute of Water Problems) had exaggerated the benefits while minimizing the economic and environmental costs of these undertakings to make them look more favorable (i.e., to give them a strong positive benefit/cost ratio) (Micklin 1991, pp. 60–68). One critic of the Siberian project estimated the first phase would cost at least 45 and possibly as much as 100 billion rubles rather than the “official” figure of 32 billion rubles. The agricultural benefits of this project, its main justification, also were challenged. For example, deducting for losses in transport (2.6 km³) and industrial and municipal uses (around 5 km³), leaves 19.6 km³ for irrigation. To irrigate 4.5 million ha from this, as claimed possible, implies an average consumptive withdrawal rate of 4,355 m³/ha, which was far below actual irrigation usage in the Aral Sea Basin.

It was also alleged that most of the studies on project consequences were carried out by organizations whose leadership was committed to their implementation and/or whose studies *Minvodkhoz* financed, most notably the Institute of Water Problems. Concerns were also raised about the objectivity of this research (*Pravda Vostoka*, 9 January, 1985, p. 1). The project designers were also charged with excessive secrecy and trying to keep the projects from public debate (*Literaturnaya gazeta*, 3 September 1986, p. 10). Although this was standard operating procedure in the Soviet Union, Gorbachev’s campaign for openness (*glasnost*) stressed denouncing such narrow, bureaucratic approaches and calling for wide public involvement in the planning of projects with far-reaching consequences.

Concern that the environmental consequences of the projects had not been adequately studied also was cited as a primary reason for not proceeding with them. The August 1986 decree stopping work on them alluded to the necessity of further study of their ecological and economic aspects. On the other hand, one must note that an enormous amount of effort was expended between 1976 and 1980 to forecast potential environmental changes (Micklin 1986). Studies revealed that there would be significant and complicated negative environmental impacts, mainly in areas of water export, but that these would be of a local or in some cases regional nature (Fig. 16.6). The “official” position of the Soviet government until 1985 was that environmental consequences were not sufficient to forego implementation of the projects. Indeed, Soviet experts rejected as absurd specters invoked by some Western writers of initial phase Siberian diversions (27 km³/year) causing global climate changes as a consequence of their impact on the Arctic ice cover (Gerasimov et al. 1982). Independent research by Western scientists supported the Soviet view on this issue (Micklin 1981, 1986). After the water transfers were halted in 1986, the Soviet popular media promoted global climate change as a serious threat from the planned Siberian diversion (*Sovetskaya Rossiya*, 1 Jan. 1986, p. 3).

Certainly the potential adverse consequences from the proposed first phase Siberian diversion would have been consequential and deserved careful attention. A case can be made that the seriousness of environmental concerns was downplayed and some key economic and socio-cultural problems were largely ignored. However, it appears that following the policy reversal in 1986, these were exaggerated, probably to lend further credence to the fundamentally

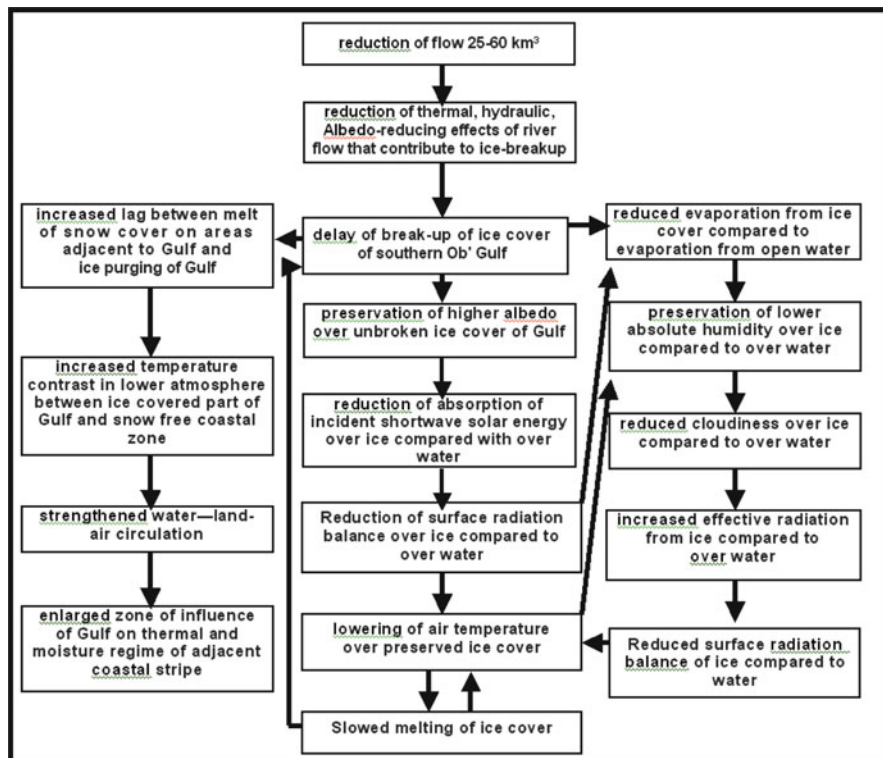


Fig. 16.6 Likely effects of diversion of 25–60 km³ from the Ob River on the climate of the Southern part of Ob Gulf and adjacent regions in June and July (Source: Micklin (1986), p. 317)

investment-based decision to halt the projects. Indeed, a case may be made that environmental concerns probably did not play the dominant role in the Soviet government’s decision to cancel the project. The decision to stop further work on diversions was economics based. The leadership became convinced their costs would be too great, their benefits too small, and that better means existed to obtain their nominal goals. Environmental arguments against them were primarily made to reinforce a decision made fundamentally on economic grounds.

The campaign against river diversion schemes did not cease with their official suspension in August 1986 (Micklin 1991, pp. 60–68; Darst 1988; Micklin and Bond 1988). Savage criticism of the Ministry of Water Management and Reclamation (*Minvodkhoz*), its subagency which designed the diversions, *Soyuzgiprovodkhoz*, and the Institute of Water Problems, which was the main organization evaluating the environmental consequences of these projects, continued unabated in both the popular and scientific media. As a result basic research on water transfers, even though not only permitted but required by the August 1986 decree, virtually stopped. The much (and often-unfairly) maligned Voropayev was forced to resign as director of the Institute of Water Problems in September 1988.

A.S. Berezner, Deputy Director of *Soyuzgiprovodkhoz*, who had headed design efforts on the diversions was sent to Mozambique to supervise Soviet-aided water management construction projects there. The full name of *Soyuzgiprovodkhoz* was changed from the “All-Union Design and Scientific Research Institute for the Diversion and Redistribution of the Waters of Northern and Siberian Rivers” to the “All-Union Design and Scientific Research Institute for the Design of Water Management and Reclamation Projects”. Clearly, opponents of the schemes feared that they could be revived and were intent on ousting diversion supporters from positions of authority and stopping any further research.

For the remaining years of the USSR (1986–1991), there was little interest in north to south European water transfers. The level of the Caspian Sea was steadily rising, removing the key rationale for them (to supplement that lake’s water balance). The Siberian project, on the other hand, was another story (Micklin 1991, pp. 60–68). In January 1988 a joint decree of the Central Committee of the Communist Party and the Council of Ministers devoted to the improvement of water use, directed that scientific study of north–south water transfers continue. After a 2-year silence following the August 1986 decree, Central Asian water management officials, scientists and party and government officials began, again, to push publicly for water transfers as the only means to save the region from a water shortage catastrophe. Having counted on imported water from Siberia, the halting of the project was a great shock and disappointment for them (Micklin 1986, 1987; Micklin and Bond 1988).

In March 1988, a joint article in the Uzbek party and government paper, *Pravda Vostoka*, signed by the president of the Uzbek Academy of Sciences, R. Khabibullayev, and Victor Dukhovnyy (at that time director of the Central Asian Irrigation Research Institute) stated that the ecological and social-economic difficulties of the Aral region could not be solved without diversion of water from Siberian rivers (*Pravda Vostoka*, 3 March 1988, p. 3). In October 1988, a water management expert from *Soyuzgiprovodkhoz* stated that water resources in the Aral Sea Basin would be exhausted no later than 2005, in spite of comprehensive and successful efforts to improve water usage (*Pravda Vostoka*, 10 October 1988, p. 3). He contended diversions would be needed by that date and, considering that 15 years are required for their implementation, stated that it was criminal that even research work on their ecological and economic aspects had come to a standstill.

By 1989, Central Asian political leaders, most importantly Islam A. Karimov, President of the Uzbek Republic and First Secretary of the Uzbek Communist Party, were stressing the dire nature of the water management situation in Central Asia, raising the question if the region could survive without water from outside, and calling on Moscow for help (*Pravda Vostoka*, 23 September 1989, pp. 1–2 and 1 December 1989, p. 2). With the weakening of central (Moscow) authority and the declarations of sovereignty by the Union Republics, Central Asian politicians became more adamant. On June 23, 1990, the presidents of the four Central Asian republics and Kazakhstan signed a joint declaration on mutual problems and approaches to their solution, contending the ecological catastrophe of the Aral Sea and adjacent areas was so acute that it could not be solved by regional efforts (*Pravda Vostoka*, 24 June 1990, p. 1). The leaders called on the national

government to declare the Aral region one of national calamity and to provide real help. They also stated that it was necessary to return to the idea of water diversions from Siberia as one of the principal routes of saving the Aral and ensuring an adequate food supply for the region. In their view, diversions were to decide the region's future.

By the early 1990s, it appeared a Siberian diversion "compromise," involving a downsizing of the early 1980s design, might be possible. Ten to fifteen cubic kilometer annually (rather than 27 km³) could be sent directly into the northern part of the Aral Sea or into the Syr Darya Delta by a concrete lined canal and huge pipelines, somewhat shortening the route and considerably reducing filtration and evaporation losses. This would reduce impacts downstream from points of diversion on the Ob and Irtysh rivers in Western Siberia. In conjunction with institution of widespread irrigation efficiency measures in the Aral Sea Basin to free water, a portion of which would go for the Aral, it might have been possible to raise the level of the sea and lower salinity to levels that would allow significant ecological improvement and partial restoration of the fishery, without any significant cutback in irrigation. It could have been argued that saving the Aral outweighed the harm to Western Siberia (although inhabitants of the latter region, no doubt, would have taken grave exception). The Soviet government and Russian Republic could also have insisted that no Siberian water be used for irrigation, encouraging Central Asian water interests to be more efficient, since expansion of irrigation and other water uses would be possible only from water freed by this means.

The Central Asian republics might also have been able to use their exports of food and cotton to the Russian Republic as bargaining chips (i.e., a "food and cotton for water trade"). On the other hand, the Government of the Russian Republic (and popular opinion) at the time remained strongly opposed to Siberian water transfers to Central Asia. Given the balance of power between Moscow and the Republics at the end of the Soviet era, diversions without the approval of Russia, even with the okay of the national government would have been difficult. Nevertheless, two prominent Central Asian water management experts and officials told this writer in 1991, not long before the collapse of the USSR, that Siberian water transfers would go ahead as a means to hold the Soviet Union together.

16.4 Sibaral in the Post-Soviet Era

The short-lived coup against Gorbachev and the imminent signing of the "Union Treaty" in August 1991 effectively ended the Soviet Union, which formally dissolved at the end of that year. The USSR became 15 Independent nations, pursuing their own national interests. All of the former republics except the three Baltic States joined a new organization known as the Commonwealth of Independent States (CIS). However, it had no real power or influence over its members and any decisions reached would require approval of all.

The leaders of the five Central Asian Republics strongly supported the continuance of the Soviet Union and the Union Treaty, but were forced by circumstances to adapt to independence. They believed the economic power and common markets of the USSR were their best hope to prosper (Wikipedia Contributors 2008). No doubt the belief that the Siberian water diversion project stood a far better chance to be implemented by the central government of one nation as opposed to the central governments of six countries also contributed to this support.

Objectively, the dissolution of the USSR was a severe blow to Sibaral. Rather than being a project within one country it now would involve taking water from the Ob and Irtysh rivers flowing to the Arctic through the Western Siberian part of Russia and routing it southward to Central Asia. This would entail formal, complicated international agreements among the six nations on such key issues as construction details and cost sharing, payments for water, allocation of water among the receiving countries, compensation for resulting environmental damage in the water donor regions, etc. Russia clearly had little interest in or incentive to send Siberian water southward.

Nevertheless, proponents in Central Asia did not abandon Sibaral. This grandiose scheme continued to be discussed and promoted in Central Asian water management and governmental circles during the 1990s and into the new millennium. While promoting the need for improved irrigation water use efficiency in Central Asia, they made the argument that even a very costly and intensive program to implement such measures, would not free enough water to expand irrigation to meet the food needs of a growing population and to increase flow to the Aral Sea to stabilize, let alone, raise its level and improve its ecology and restore its fishery.

In the early years of the new century, Sibaral again found a sympathetic ear among some water management professionals and bureaucrats in Russia, including Yuri Luzhkov, mayor of Moscow and N.N. Mikheyev, the First Deputy Minister of Natural Resources (Mikheyev 2002; Polad-Zade 2002; Temirov and Rustam 2003; Timashev 2003). Luzhkov even approached Russian President Putin in 2002 about supporting the Siberian Diversion Project, but Putin was, evidently, not impressed with his arguments (Savelyeva 2010). Not giving up, Luzhkov published a book titled *Water and Peace* in 2008 that promoted the project as beneficial to both Russia and the nations of Central Asia. Victor Dukhovnyy, now head of the Scientific Information Center (SIC) of the Intergovernmental Coordinating Water Management Commission (ICWC) and a long-time supporter of the Siberian Project enthusiastically commented on the book (Dukhovnyy 2009). In his positive review, he reiterated his long held view that the water transfers are absolutely necessary for the future of Central Asia.

An article in the British popular science magazine *New Scientist* (2004) talked of the revival of interest in the plan among Russian Scientists as a means to reduce the flow of Siberia's rivers that have increased (purportedly owing to Global Warming) and could upset the salt balance and circulation of the Arctic Ocean, leading to shutdown of the Gulf Stream that would trigger colder winters across Europe. Igor Zonn, at the time director of *Soyuzvodproject*, told *New Scientist*, "We are beginning to revise the old project plans for the diversion of Siberian rivers. The old material has to be gathered from more than 300 institutes."

The proposed diversion would be the same as under the Soviet plan – 27 km³/year. It would require a 2,500 km canal 200 m wide and 16 m deep. Costs were estimated at 40 billion USD. Proponents of the project again made the arguments that Siberian water is needed to expand irrigation in Central Asia and improve the condition of the Aral Sea, but added several new reasons: increased usage from the Amu Darya (up to 10 km³) by Afghanistan, a predicated (by climate models) major decrease in Central Asian rainfall as a result of Global Climate Change, and the need to protect Central Asian economies from collapse to prevent a flood of refugees to Russia. Proponents also portrayed the scheme as a way for Russia to rebuild its political and economic power in the region.

But, the scheme continues to be hugely controversial in Russia. According to the *New Scientist*, the chairman of the Siberian branch of the Russian Academy of Sciences, Nikolay Dobretsov, believes the diversion would threaten the Ob basin with eco-catastrophe and socio-economic disaster, including destroying fisheries and upsetting the local climate. Dr. Nikita Glazovskiy, a corresponding member of the Russian Academy of Sciences and former deputy director of the Institute of Geography, now deceased, who was very knowledgeable about the Siberian diversion project as well as being an expert on Central Asia, offered a scathing criticism of the “revived” project (Glazovskiy 2003). He viewed the project as an ecological disaster and financial boondoggle that would neither benefit Russia nor Central Asia. Along with others, he contended that there is enough water available in Central Asia to meet all legitimate needs, if used efficiently. Even some Central Asian experts agree that it would be wiser to spend precious capital and effort on improving regional water management rather than importing water from Siberia (Kamalov and Yusup 2003; Savitski 2003).

Even if the Russian Government were willing to permit the southward transfer of Siberian water, obtaining financing for the project would be extremely difficult. The five Central Asian State do not have the likely \$50–\$60 billion needed to build the project. Russia, flush with oil and gas revenue, might be willing to provide a loan for part of the cost but certainly nowhere near the amount needed (Temirov and Rustam 2003). Earlier, Central Asian governments had hopes that international donors, chiefly the World Bank, might be willing to help finance the plan, but that organization has given a firm no, probably owing to its newfound sensitivity to environmental issues surrounding huge water infrastructure projects, such as the Three Gorges Dam in China for which the Bank refused to provide a loan owing to social and environmental impact concerns (The Three Gorges. . . 2012).

In 2009 two “mega engineering” proponents proposed a variant of the Siberian project mainly focused on restoring the Aral Sea (Badescu and Schuiling 2009). It would take water only from Lake Zaysan in Kazakhstan and deliver it into the Syr Darya from where it would flow into the Small Aral Sea raising its level and allowing considerable outflow to the Large Aral Sea on the south). Lake Zaysan is the source of the Irtysh, which is the main tributary of the Siberian River Ob. Diverting the water from Lake Zaysan would make the political negotiations for implementing the project much simpler as it would be implemented in only one country. The authors also see a much lower cost for this project, as the route would

be considerably shorter than other Siberian water transfers schemes. Also, water would flow gravitationally to the Syr River rather than requiring huge electrical inputs for pumping over the topographic divide between Western Siberia and the Aral Sea Basin. However, it would require constructing a large diameter, 100 km tunnel through a mountain range for which the costs are very speculative.

Although an interesting concept, it has serious deficiencies beyond the tunnel issue (Micklin 2010). The most serious problem is that the idea of taking water from Lake Zaysan to refill the Aral won't work. At Ust-Kamenogorsk, immediately downstream from the Bukhtarma dam, which controls out flow from the lake (now a reservoir), the average annual discharge is around 18 km³/year (Davydov 1955, p. 354). Thus, even if you took all the flow collected in Lake Zaysan and sent it toward the Aral through the proposed tunnel, the average maximum diversion would be 18 km³/year. There would also be inevitable losses to evaporation (and unless the canal was lined to filtration) along the part of the route requiring a canal and in the Syr Darya Delta to both of these plus transpiration from hydrophytes. Farmers along the route would also surely take some of the extra water for irrigation.

It is doubtful more than about 12 km³ or 13 km³ would reach the Small Aral, not the 30 km³ or 40 km³ the authors talk about. So it is in no way a "solution" to the Aral problem. Furthermore, taking all the water balance surplus of the Lake would mean no outflow and hydropower from the Bukhtarma Dam (which with an installed generating capacity of 750 MW is a major power producer). Also, the bed of the Irtysh would be dry for many kilometers downstream, which would be very ecologically harmful and cause water supply problems for people, industry and agriculture along the river as well as losses of power production at other dams farther downstream. Realistically, it is doubtful the Kazakhstan government would ever allow diverting more than 1/2 of the surplus (9 km³). If this were all that could be sent toward the Aral, the project would just not be worth the cost.

Will "Sibaryl" the "Project of the Century" for the twentieth century be realized in the twenty-first? Given the hurdles it faces one must conclude it is unlikely. Yet, water shortage problems grow worse in Central Asia and regional leaders continue to call for its implementation (*Central Asian Environment, Science, Technology and Health News*, June 16–20, 2008, pp. 28–31). In 2007, Nursultan Nazyrbayev, President of Kazakhstan called for the building of Sibaryl at the International Economic Forum in St. Petersburg and Moscow Mayor Luzkhov repeated the call at this event in June 2008. But the Siberian Project has lost its most powerful Russian supporter since Luzkov was stripped of his duties as Moscow Mayor in 2010, partly because of proposing what were considered a series of zany ideas (including the Siberian Diversion scheme) (Savelyeva 2010). And opposition to Sibaryl from prominent Russian scientists as well as cultural and political figures continues unabated. Nevertheless, the project has risen from the dead before and may again.

References

- Aladin N, Plotnikov I, Ballatore T, Micklin P (2008) Review of technical interventions to restore the Northern Aral Sea. In: Japan international cooperation agency: study reports: country and regional study reports: Central Asia and Caucasus, vol 4, pp 1–12. http://wldb.ilec.or.jp/LBMTrainingMaterials/resources/Northern_Aral_Sea.pdf
- Badescu V, Schuiling R (2009) Aral sea; irretrievable loss or Irtysh imports? *Water Resour Manag* 24(3):597–616. <http://www.springerlink.com/content/0920-4741/?k=Badescu>
- Basic directions of the economic and social development of the USSR for 1986–1990 and for the period to 2000 (plan) (1985) Moscow, Pravda (in Russian)
- Berezner AS (1985) Territorial redistribution of river flow for the European part of the RSFSR. *Gidrometeoizdat, Leningrad* (in Russian)
- Brown B (1985) Whatever happened to ‘Sibara’? *Radio Lib Res*, RL 420/85, 1 Dec 1985
- Brown B (1986) What will cancellation of the Siberian River Diversion Project mean to Central Asia? *Radio Lib Res*, RL 334/86, 26 Aug 1986
- Darst RG (1988) Environmentalism in the USSR: the opposition to the river diversion projects. *Sov Econ* 4(3):223–253
- Davydov LK (1955) *Hydrography of the USSR, part II: regional hydrography*. Leningrad University, Leningrad (in Russian)
- Dukhovnyy V (2009) Again about re-distribution of Siberian river flow to the South. Position paper located in electronic library of Cawaterinfo Website. http://www.cawater-info.net/library/index_e.htm. Accessed 4 Aug 2011
- Glazovskiy NF (2003) Considering the revival of an old project: diversion of water from Siberian rivers to Central Asia. *Ecoston News* 10/4(August): 8–10
- Gerasimov IP et al (1982) Problems of redistributing water resources in the Central Region. *Izvestiya Akademii Nauk, seriya geograficheskaya* 6:24–32 (in Russian)
- Kamalov, Yusup (2003) The Aral sea: the legends, the problems, the solutions, *Ecoston News*, 10/1 (January-February), pp. 9–10
- Micklin PP (1971) An inquiry into the Caspian Sea problem and proposals for its alleviation. Unpublished Ph.D. dissertation, University of Washington, Seattle
- Micklin PP (1977) Nawapa and two Siberian diversion proposals: a geographical comparison and appraisal. *Sov Geogr Rev Transl XXVIII(2)*:81–99
- Micklin PP (1981) A preliminary systems analysis of impacts of proposed Soviet river diversions on Arctic Sea ice. *Eos Trans AGU* 62(19):489–493
- Micklin PP (1983a) Soviet water diversion plans: implications for Kazakhstan and Central Asia. *Cent Asian Surv* 1(4):9–43
- Micklin PP (1983b) Water diversion proposals for the European USSR: status and trends. *Sov Geogr Rev Transl XXIV(7)*:479–502
- Micklin PP (1984) Recent developments in large-scale water transfers in the USSR. *Sov Geogr XXV(4)*:261–263
- Micklin PP (1985) Inter-basin water transfers in the United States. In: Golubev GN, Biswas AK (eds) *Large scale water transfers: emerging environmental and social experience*, vol 7, *Water resources series*. UNEP, Tycooly, Oxford, pp 37–66
- Micklin PP (1986) The status of the Soviet Union’s North–South water transfer projects before their abandonment in 1985–86. *Sov Geogr XXVII(5)*:287–329
- Micklin PP (1987) The fate of “Sibara”: Soviet water politics in the Gorbachev Era. *Cent Asian Surv* 6(2):67–88
- Micklin PP (1991) The water management crisis in Soviet Central Asia, vol 905, *The Carl Beck papers in Russian and East European studies*. The Center for Russian and East European Studies, Pittsburgh
- Micklin P (1988) Dessication of the Aral sea: a water management disaster in the Soviet Union. *Science* 241:1170–1176

- Micklin P (2010) The past, present, and future Aral Sea. *Lakes Reserv Res Manag* 15(3):193–213. Abstract available at <http://onlinelibrary.wiley.com/doi/10.1111/j.1440-1770.2010.00437.x/abstract>
- Micklin PP, Bond AR (1988) Reflections on environmentalism and the river diversion projects. *Sov Econ* 4(3):253–274
- Mikheyev NN (2002) Water without limits, *Melioratsiya i vodnoye khozyaystvo*, No. 1, pp. 32–34. (In Russian)
- One more time about the ‘project of the century’ (1984) *Grani* 33:190–268 (in Russian)
- Polad-Zade PA (2002) Thoughts about the management of water resources in Central Asia: past experience and modern realities. *Melioratsiya i vodnoye khozyaystvo* 1:34–37 (In Russian)
- Savelyeva D (2010) Luzhkov’s abnormal projects. *Russia Beyond the Headlines*, 30 Sept. http://rbth.ru/articles/2010/09/30/luzhkov_abnormal_projects04995.html. Accessed 9 Feb 2012
- Savitski AG (2003) Yet again about Siberian Water and Central Asia. *Ecotan News* 10/4 (August): 11–12
- Temirov, Rustam (2003) Lobbying grows in Moscow for Siberia-Uzbekistan water scheme, *Eurasianet*, February 19, (www.eurasianet.org/departments/environment)
- The Three Gorges Dam Project Funding (2012) <http://www.mtholyoke.edu/~lpohara/Pol%20116/funding.html>. Accessed 9 Feb 2012
- Timashev IE (2003) The Caspian, Aral and Russian rivers: nature, society and the 21st century. *Vestnik Kaspiya* 3(41):64–86
- Voronitsyn S (1986) The river diversion scheme: is the public debate only obscuring the real problems? *Radio Lib Res*, RI 310/86, 28 July 1986
- Voropayev GV (1982) Problems of water ensuring of the country and the territorial redistribution of water resources. *Vodnyye resursy* 6:3–28
- Wikipedia Contributors (2008) History of the Soviet Union (1982–1991). *Wikipedia, The Free Encyclopedia*. [http://en.wikipedia.org/wiki/History_of_the_Soviet_Union_\(1982–1991\)](http://en.wikipedia.org/wiki/History_of_the_Soviet_Union_(1982–1991)). Accessed 9 Feb 2012