Aral Sea

Experience and Lessons Learned Brief

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This report gives an overview of major environmental and socio-economic challenges that the Aral Sea region is facing, threats to the sustainable management of the lake basin, major measures supported by the governments and international donor organizations aimed to address these critical environmental problems, and lessons learned from the environmental cooperation to date. Given the great territory of the Aral Sea Basin (Figure 1), and the large number and scale of interconnected political, economic, environmental issues and agendas of multiple players and stakeholders in the region, this background report cannot offer a complete picture of the situation in the region and it cannot formulate global recommendations for future actions to be taken. Instead, the focus of the report is on the overall lessons learned and the priority direction for work to promote the regional cooperation and long term environmental improvements in the Aral Sea Basin.

Figure 1. The Aral Sea Basin.

1. General Description of the Basin

Seven countries share the ethnically-diverse Aral Sea Basin: Afghanistan, Kazakhstan, the Kyrgyz Republic, Tajikistan, Turkmenistan, Uzbekistan and the Islamic Republic of Iran. The basin encompasses a total area of 1,549,000 km^2. Up to 25.1% of the entire flow in the Aral Sea Basin is formed in the Kyrgyz Republic, 43.4% in Tajikistan, 9.6% in Uzbekistan, 2.1% in Kazakhstan, 1.2% in Turkmenistan, and 18.6% in Afghanistan and the Islamic Republic of Iran (SPECA Project 2002). There is a very small part of the basin located on the territory of the Islamic Republic of Iran. Only Kazakhstan and Uzbekistan are riparian states on the Aral Sea, with each possessing an approximately equal length of shoreline.

The Aral Sea is situated in the center of the Central Asian great deserts (Kara-Kum, Kyzyl-Kum, and Betpakdala) and the area as a whole experiences high rates of evaporation. The Aral Sea's size and water balance are fundamentally determined by river inflow and evaporation from its surface.

Amu Darya is the largest river in the region. The river's main catchment area is in Tajikistan, from where it flows along the border between Afghanistan and Uzbekistan, crosses Turkmenistan, flows back into Uzbekistan and finally in the territory of Uzbekistan where the river flows into the Aral Sea. In terms of silt content, the Amu Darya clearly ranks first in Central Asia and one of the highest in the world. The Syr Darya ranks second in terms of water flow, even though it is actually the longest river in Central Asia. Its sources are in the Central Tian Shan Mountains. The river is at its fullest in spring and summer, starting in April and reaching its peak in June. Its main catchment area is in the Kyrgyz Republic, from where the river crosses Uzbekistan and Tajikistan and flows into the Aral Sea in Kazakhstan.

In 1960, the Aral Sea was the world's 4th largest inland water body with a surface area of more than 67,000 km^2. At that time, the lake was brackish, with a salinity averaging near 10 g/L (less than a third of salinity of the ocean) and was inhabited by mostly freshwater species. The sea supported a major fishery and functioned as a key regional transportation route. The extensive deltas of the two major inflowing rivers, Syr Darya and Amu Darya, sustained diverse flora and fauna. They also supported irrigated agriculture, animal husbandry, hunting and trapping, fishing, and harvesting of reeds, which served as fodder for livestock as well as building materials.

Prior to 1960, the annual volume of inflows from the Syr Darya and Amu Darya was 56 km^3; while following the increase in diversions for greatly expanded irrigated agriculture, the annual average inflows in the decades that followed were 43 km^3 (1961–1970), 17 km^3 (1971–1980), and 4 km^3 (1981–1990) (Letolle and Mainguet 1993). This precipitous decline in inflows has led to the rapid desiccation and salinization of lake with the total water area dropping to 17,000 km^2 by 2003 and with a loss of volume of approximately 90%. This dramatic desiccation has led to a suite of environmental, social, economic, health, and cultural impacts (described below).

It is interesting to note that the current desiccation is not historically unique; in the 15th and 16th centuries (and perhaps at other times, too), the lake had recessed, possibly due to similar human-induced causes (Boroffka et al. 2005). Additionally, since the beginning of the 20th century many exotic fishes and invertebrates were artificially introduced into the Aral Sea, but the present desiccation has led to their demise (Aladin et al. 2005).

2. Water Use in the Aral Sea Basin

Water usage, primarily for drinking and irrigation, started more than 6,000 years ago. In the 20th century, and especially since 1960, the intensity of water use increased under the pressures of rapid population growth, industrial development, and most of all, irrigation. Based on information in SIC ICWC (2002), water withdrawals for irrigation almost doubled from 1960 to 2000, with irrigation accounting for around 90% of the region's total water withdrawal. The area of land in the basin under irrigation is presented in Table 1, along with other basic indicators of water and land use.

Different water-related economic priorities of the four countries in the Syr Darya Basin (Kazakhstan, the Kyrgyz Republic, Tajikistan, and Uzbekistan) have led to conflicts of interest over water release schedules from the Toktogul Reservoir located in the Kyrgyz Republic on the Naryn River. Kazakhstan and Uzbekistan have been insisting on giving priority to irrigation,

Table 1. Basic Indicators of Water and Land Use in the Aral Sea Basin.[a]

Indicator	Unit	1960	1970	1980	1990	2000
Population	million	14.1	20.0	26.8	33.6	41.5
Area under irrigation	million ha	4.51	5.15	6.92	7.60	7.99
Irrigated area per capita	ha/person	0.32	0.27	0.26	0.23	0.19
Total draw-off	km^3/yr	60.61	94.56	120.69	116.27	105.0
Draw-off for irrigation	km^3/yr	56.15	86.84	106.79	106.40	94.66
Unit draw-off per ha under irrigation	m^3/ha	12,450	16,860	15,430	14,000	11,850
Unit draw-off per capita	m^3/person	4,270	4,730	4,500	3,460	2,530

Source: Scientific Information Center, Interstate Coordination Water Commission (2002).
Note: a) Excludes part of basin that lies in Afghanistan and Iran.

while the Kyrgyz Republic and partly Tajikistan prefer using water for electric power generation. As a result, since 1993, the Toktogul cascade of reservoirs has been applying schedules that make for a sharp increase in summer storage and water drawdown in winter to suit the needs of the Kyrgyz hydropower industry.

Since 1994 the water regime in the Syr Darya Basin has been the main theme in government talks. To meet Kyrgyz demands for increased supplies of heat-producing energy and the needs of Kazakhstan and Uzbekistan in the summer season, a decision was made in 1998 to define mutual obligations of these countries in fuel and energy exchange. This approach, however, does not account for all the environmental problems in the watershed because releases from the Syr Darya will be falling below minimum discharge levels that have been recorded in the last one hundred years of observation. On the other hand, the irrigation and water supply concerns of the downstream countries will only be met if the three upstream states fully comply with the terms of signed agreements on fuel and power supply and the purchases of excess electricity. The slightest non-compliance will undermine sustainable water supply. Actual implementation has revealed that conflicting power and irrigation needs of the four states have hindered the fulfillment of agreed water allocation terms and necessitate further talks.

In the Amu Darya Basin, up until 1992, the allocation of the Amu Darya waters among four countries—the Kyrgyz Republic, Tajikistan, Turkmenistan and Uzbekistan—was based on the water development master plan for the Amu Darya Basin. The allocation plan was approved by Resolution 566 of the Science and Technological Council of the former Soviet Union's Water Management Ministry in 1987. The resolution fixed the following allocation of surface waters (% of projected flow in the main stem of the Amu Darya): the Kyrgyz Republic 0.6%; Tajikistan 15.4%; Turkmenistan 35.8%; and Uzbekistan 48.2%. The quota principle has survived until now, with Turkmenistan and Uzbekistan getting equal shares of the so-called "adjusted run-off" measured at the Kerky hydrographic section, including diversion to the Karakum Canal (the world's longest canal at 1,400 km in length). This provision was reiterated in the bilateral agreement signed by the heads of these two states in Cherdzjev (Turkmenabad) in 1996.

An important issue in discussing the water use in the Aral Sea Basin is inadequate efficiency for uses in all economic sectors, especially irrigation farming. Statistics indicate that the principal water losses occur in the on-farm delivery networks and directly in the field. According to WUFMAS (SIC ICWC/IWMI 2002), water losses in these two cases may account for 37% of the total supply to farm contours. On average, about 21% of irrigation supply is wasted directly in the field. Since most losses occur in the field and in deliveries among farms, water user associations, along with charges, may be an effective way of streamlining the use and conservation of water.

It should be noted that the interests regarding use of water resources in some countries such as the Kyrgyz Republic, Kazakhstan and Turkmenistan is not limited to the Area Sea Basin. For example, of the total amount of irrigated land within Kazakhstan, only 35% is within the Aral Sea Basin. For the Kyrgyz Republic, the figure does not exceed 40%. Additionally, different countries in the Central Asia region have very different populations, economic interests and activities, and exercise different approaches to water management—from a firmly market-oriented approach in Kazakhstan to a full state property of water resources in Turkmenistan.

3. Ecological, Economic, and Health Consequences of Aral Sea Desiccation

The four basic problems in water and environmental management of the basin were discussed by the World Bank/ Global Environmental Facility Aral Sea Basin Program Project Document (World Bank 1998): environmental degradation, with the increase in land and water salinization; the gradual drying up of the Aral Sea, with huge adverse socio-economic and environmental effects; water management in the basin, with its built-in potential threat to peace in the region; and instruments for interstate cooperation, with the commitment of sovereign states the biggest challenge. Despite the fact that this list of regional issues was produced in 1998, the same issues of concern remain very relevant today.

3.1 Environmental Degradation with an Increase in Land and Water Salinization

Salt loads to drainage water from irrigated lands in one country are fully or partially returned to the rivers and passed to downstream countries. Salinization has occurred because of salt mobilization in subsoils triggered by irrigation and drainage practices, salt pick-up in upper watersheds, and inadequate disposal of drainage water. Increasing salinization of the land and rivers threatens entire economies and millions of people throughout the basin and results in the following problems:

- *Erosion and sedimentation that in turn threatens the basin water regulation infrastructure*. As a result of the increasing soil erosion in upper watersheds due to deforestation and overgrazing of mountain pastures, changes in performance of the basin water regulation infrastructure take place that affects the water allocation and distribution in the basin;

- *Soil contamination*. On all irrigated land in Central Asia, pesticides and fertilizers were used to an amount that by far exceeded the norms of the former Soviet Union (UNESCO 2000);

- *Diminishing wetlands and biodiversity*. Desiccation of the deltas has significantly diminished the area of lakes, wetlands, and their associated reed communities; and,

- *Environmental problems in mountain areas* where water flow originates, including preservation of glaciers and glacial feeding of rivers; sustainability of mountain forests; erosion of mountain slopes, especially as conditioned by the development of irrigation in alpine valleys.

3.2 The Gradual Drying Up of the Aral Sea and Its Adverse Socio-economic and Environmental Effects

As a consequence of the drastically reduced water inflow from rivers, the Aral Sea separated into two water bodies, the Northern Aral Sea (also referred to as the Small Aral Sea) and a Large Aral Sea (also referred to as the Big Aral Sea) in the south in 1989 (see Figure 1). The Syr Darya flows into the Northern Aral Sea, and the Amu Darya into the Large Aral Sea. Between 1960 and January 2005, the level of the Northern Aral Sea fell by 13 m and the Large Aral Sea by 23 m (Table 2). A channel (river) has intermittently connected the two lakes, with the flow from the Northern Aral Sea to the Large Aral Sea. The area of both seas taken together diminished by 75% and the volume by 90%. Salinity in the Northern Aral Sea is estimated to have decreased from around 30 g/L around the time of the splitting of the Northern and Large Aral Seas to 12 g/L in 2005, whereas salinity in the western part of the Large Aral Sea has increased by more than 7-fold (Table 2).

The two lakes have evolved in different ways. The Northern Aral Sea receives run-off of the Syr Darya and began to overfill due to positive water balance. The surface area of this lake is small, and evaporation from its surface is less than inflows from the Syr Darya, atmospheric precipitation and ground waters. As for the Large Aral Sea, its water balance is negative, and evaporation from its huge surface is still higher than the small inputs of the Amu Darya, atmospheric precipitation and ground waters (Aladin et al. 1995). These differences in the hydrological regimes of the two new lakes have led to stabilization of the level of the Northern Aral Sea and the continued desiccation and salinization of the Large Aral Sea. (Table 2; also see Section 5.3)

The mainly human-induced desiccation of the Aral Sea has had severe negative impacts. Striking ecological, social and economic problems have arisen in the near-Aral region, including the following:

- *Desertification*. Greatly reduced river flows through the deltas and the virtual elimination of spring floods in them (caused by upstream abstractions and construction of upstream storage reservoirs), as well as declining ground water levels (caused by the falling level of the Aral Sea), have led to spreading and intensifying desertification;

- *Dust and salt winds*. One of the results of the sea drying and the desertification is that strong winds blow sand, salt and dust from the dried bottom of the Aral Sea, now largely a barren, salt-covered desert with an area near 50,000 km^2, onto adjacent lands. Estimates of the total deflated material, which were made in the late 1980s, ranged from 13 million to as high as 231 million metric tons/year (Glazovskiy 1990). The salt and dust also have ill effects on wild and domestic animals by

Table 2. Hydrological and Salinity Characteristics of the Aral Sea, 1960-2011.

Year	Level (m asl)	Area (km^2)	% 1960 Area	Volume (km^3)	% 1960 Volume	Avg. Salinity (g/L)	% 1960 Salinity
1960 (Whole Aral Sea)[a]	53.4	67,499	100	1,089	100	10	100
Large Aral Sea	53.4	61,381	100	1,007	100	10	100
Northern Aral Sea	53.4	6,118	100	82	100	10	100
2005 (Whole Aral Sea)[b]		17,382	26	108	10		
Large Aral Sea	30.0	14,325	23	81	8	East Sea 80? West Sea 70-75	800 700-750
Northern Aral Sea[d]	40.5	3,057	50	21	26	12	120
2011 (Whole Aral Sea)		12,014	18	92	8		
Large Aral Sea[c]	28.3	8,550	14	62	6	›100	›1,000
Northern Aral Sea[d]	42.5	3,580	59	28	32	10	100

Sources: 1960 data provided to Philip Micklin by Glavgidromet (The Main Administration for Hydrometeorology) of Uzbekistan; 2005 and 2011 level, area and volume figures from annualized, Excel-based, linked water balance models for the Northern Aral Sea and the Large Aral Sea developed by Philip Micklin using Soviet and post-Soviet data on net evaporation from the Aral Sea, especially those from Shivareva, S., Ye Ponenkova,. and B. Smerdov (1998), "Modelirovaniye urovnya Aral'skogo morya," [Modeling the level of the Aral Sea], pp. 5-10 in Problemy basseyna Aral'skogo Morya, issledovaniya, proyekty, predlozheniya [Problems of the Aral Sea Basin, research, projects, proposals] (Tashkent, "Chinor" ENK), inflow to the sea, corrected for losses below the gauging stations, estimates of net groundwater inflow, sea bathymetry, NASA Modis satellite imagery of the Aral, and sea level data provided by Jean-Francois Cretaux of the French Space Agency (CNE) in Toulouse, France. Salinity figures for 2005 based on data from the GIS Research Center in Nukus, Karakalpakstan and from salinity measurements taken by Philip Micklin during an expedition to the Aral Sea in August and September 2005.

Notes: a) annual average; b) on January 1; c) the sea will have divided into a western and eastern part; d) after implementation of north Aral project in 2005.

directly harming them and by reducing their food supply (Palvaniyazov 1989);

- *Changes in the regional climate*. Owing to the lake's shrinkage, climate has changed in a band up to 100 km wide along the former shoreline in Kazakhstan and Uzbekistan (Micklin 1991; Glazovskiy 1990). Maritime conditions have been replaced by more continental and desertic regimes; and,

- *Health problems of the population*. The population living in the "ecological disaster zone" suffers acute health problems (Micklin 1992; Medicins sans Frontieres 2000). In an interview made by Manchester Guardian Weekly in November 2003 (Brown 2003) an aid worker who was one of the last to visit the southern Aral region said: "The people are in a terrible state, drinking out of muddy ditches, which is all that remains of a once mighty river. We had a plan to relocate the people but Uzbekistan refused to agree and threw us out. No one has any idea what happened to the people we were trying to help."

Local health experts also consider airborne salt and dust as a factor contributing to high levels of respiratory illnesses and impairments, eye problems, and possibly even throat and esophageal cancer in the near-Aral region (Abdirov et al. 1993; Tursunov 1989). More recent field work by a British-led group indicates that salt and dust blowing from the dried bottom (and likely from irrigated farmland in regions adjacent to the Aral Sea) is laced with the heavy use of toxic chemicals (e.g., pesticides and defoliants for cotton) in irrigated agriculture, mainly during the Soviet era.

However, the most serious health issues are directly related to "Third World" medical, health, nutrition and hygienic conditions and practices. Bacterial contamination of drinking water is pervasive and has led to very high rates of typhoid, paratyphoid, viral hepatitis, and dysentery. Tuberculosis is prevalent as is anemia, particularly in pregnant woman. Liver and kidney ailments are widespread; the latter is probably closely related to the excessively high salt content of much of the drinking water. Medical care is very poor, diets lack variety, and adequate sewage systems are rare. Health conditions in the Karakalpak Republic in Uzbekistan, with the possible exception of places in the formerly civil war-torn Tajikistan, are likely the worst in the Aral Sea Basin. Surveys conducted in the mid- to late-1980s showed the average infant mortality rate at more than 70/1000 live births whereas several districts adjacent to the former seashore ranged from 80 to over 100/1000 live births (Micklin 1992). These rates are three to four times the national level in the former Soviet Union and 7-10 times that of the United States. Although efforts have been made in the post-Soviet period to improve health conditions here, it is doubtful these rates have declined in any substantial way.

3.3 Water Management in the Aral Sea Basin with Its Built-in Potential for Conflicts

Degradation of lands due to the soil salinization and contamination results in the loss of lands that can be used for agriculture. The introduction of cotton monoculture has violated traditional sustainable crop rotation practices that used mainly alfalfa and manure, and has exhausted the nutrients of the soil. With yield outputs dropping in the 1970s, the cotton was planted even on private plots where peasants grow their own vegetables and fruits. Traditional agriculture was destroyed. Losses in the commercial fisheries, transport routes in the lake, and in agriculture resulted in poverty in the region.

There are seven countries in the Aral Sea Basin of different sizes, different political orders, and different political and economic interests, including conflicting interests on natural resource use. Tensions exist between the different countries because there are conflicting interests between the states in use of scarce water resources, undeveloped institutions for resolving differences in opinions between the states, and drastic economic and ecological problems in the region. In particular, tensions between Kazakhstan and Uzbekistan (the two riparian countries) have increased (Brown 2003).

The legal basis for the interstate cooperation between the Central Asian states is still in the development process. There is still no interstate agreement for the Aral Sea Basin that addresses the responsibilities and cost sharing of operations, maintenance, rehabilitation and modernization of infrastructure. Nor is there an interstate agreement for the Aral Sea Basin that would address issues of regulation of information exchange. This creates some difficulties in coordination of water governance and planning. Draft of such agreement was prepared under WARMAP project in 1999 (SIC ICWC/IWMI 2002), but countries have still not approved it for operational use.

Interstate cooperation is still emerging; the process of institutionalization of the Aral Sea interstate cooperation is still at its beginning. In the context of the underdeveloped formal system of resolving conflicts of interests, interstate disputes over water allocation between the riparian countries occur every year regarding seasonal water delivery scheduling since the states feel that the existing agreement on annual water allocation (an agreement based on central policy considerations of the former Soviet Union) is not consistent with principles of equitable rights and sustainable development. The reasons for the disputes are that the water releases for hydropower during winter by the upper riparian states reduce the amount of water available to downstream users for irrigation in summer. Additionally, water allocated to one country is only partially returned to a transboundary river or the Aral Sea. Even when there are agreements between the countries on the water distribution, for a number of reasons, they are either improperly implemented or not implemented in the required time. Implementation of the signed agreements

remains to be a challenge along with the development of the legal and institutional base for the interstate cooperation in the Aral Sea Basin.

4. Available Management Options to Address the Consequences of Environmental Degradation

To address the major environmental challenge of the Aral Sea desiccation, the only realistic means for substantially increasing inflow to the Aral is reducing the consumptive use of water for irrigation in the lake's drainage basin. This water intensive activity, conducted on around 7.9 million hectares and the basis of agriculture here, accounts for 92% of withdrawals and an even larger share of consumptive use (Ruziev and Prichodko 2002). The largest irrigated area in the basin is found in Uzbekistan and Turkmenistan; these two nations, respectively, account for 54% and 22% of all irrigation withdrawals (Micklin 2000). It is irrigation that has depleted the flow of the Amu Darya and Syr Darya and led to the great reduction in discharge of these rivers to the Aral as well as the consequent desiccation of the water body with all its attendant negative ramifications.

Irrigation in the Aral Sea Basin is inefficient. Substantial improvements to it, technical, economic, and institutional, could save considerable amounts of water. Attempts are underway to implement improvement measures but the substantial and comprehensive program needed would be extremely costly and faces concerted opposition from forces within governments and from segments of the public. Taking costs as an example: complete renovation of irrigation systems on 6 million hectares could likely save 12 km^3 a year but would cost at least US$16 billion (Micklin 2002). To reach the maximum potential savings of 28 km^3 (based on technically, economically, and institutionally reforming irrigation on the "Israeli" model) would cost multiples more. These figures are far beyond the willingness and ability of the basin states, in combination with international donors, to pay. Furthermore, the technical condition of irrigation systems in the basin, far from improving, is steadily deteriorating owing to inadequate funding for, and lack of management responsibility over, operation and maintenance activities.

Overall, significant improvements in irrigation efficiency in the Aral Sea drainage basin could save considerable water resources that, if delivered to the Aral Sea, would measurably improve its water balance; however, this would require a massive and very expensive reconstruction of irrigation systems as well as radical social and economic changes in the way the water resources are managed in the region; this is very unlikely for many years to come.

Switching to less water intensive crops (e.g., from cotton and rice to grains, soybeans, fruits, and vegetables) and reduction of the irrigated area are other means of significantly reducing water usage in irrigation. The former strategy is being employed. Between 1990 and 1998, the area of cotton as a percent of the total irrigated area dropped from 45% to 25% while the area of winter wheat rose to 28%. This probably was a major factor in the drop in irrigation withdrawals from 109 to 92 km^3 (16% decline) at the same time the irrigated area increased 10%. However, there are limits to such a program as the two primary irrigating nations (Uzbekistan and Turkmenistan) are intent on keeping cotton as a major crop since it plays a key role in earning foreign currency. Reductions in the irrigated area are unlikely in the short- to mid-term future. All the former Soviet republics, except Kazakhstan, intend to expand irrigation, mainly to meet food needs for a growing population (UNESCO 2000).

There are also engineering measures that have been proposed and are already in the implementation stage with the support of the World Bank aimed to revive the Northern Aral Sea through constructing a dam thereby raising its water level (see discussion below).

It is possible to bring water to the Aral Sea from outside Central Asia. During the latter part of the Soviet period, water managers in Moscow and in Central Asia proposed diversion of massive flow, up to 60 km^3, from Siberian rivers to the region as the panacea for perceived water shortage problems. Although real and serious potential ecological threats (of regional, not global magnitude as claimed by some opponents) were given as the chief reason for canceling the project, economic considerations were the fundamental factors in this decision. This grandiose scheme was taken up again in 2003 under the leadership of the Moscow mayor Mr. Luzhkov. It is extremely unlikely that implementation of this project will take place. Costs would be enormous, at least US$30 billion by the latest estimates, and even if the Russian Federation was willing to help finance the project, it is doubtful sufficient funds could be accumulated for construction (Temirov 2003) or that there could be a shared agreement on the project from all the relevant authorities of the Central Asian states and international funding organizations.

The studies in the region showed that the ground water contribution to both the Large and Northern Aral Seas is much greater than previously considered. This factor should be taken more seriously into account in the process of developing recommendations for sustainable management of water resources in this region.

Roadmaps to the improvement of the situation in the Aral Sea Basin were developed by the respective governments in cooperation with different agencies and projects (for example, the Global Environmental Facility/World Bank regional water strategy, UNESCO's Water Related Vision for the Aral Sea Basin, EU TACIS Aral Sea Programme, the UN ECE and ESCAP Special Programme for the Economies of Central Asia (SPECA) Strategy for use of water resources; and others).

The general recommendations developed by different organizations with regard to addressing the regional and

national issues of water use and protection in the Aral Sea Basin can be summed up as follows:

- Improvement of the interstate cooperation on integrated water resources management;
- Orientation to water saving and increasing of water and land productivity;
- Introduction of the basin principle for water governance;
- Development of water allocation principles, including economic instruments;
- Development of national water use policies taking into account agreed national and regional interests;
- Construction and improvement of water delivery infrastructure;
- Creation of a joint system for monitoring the status and quality of water resources;
- Creation of a joint information system and information exchange;
- Strengthening of capacity building activities, including training programs;
- Establishment of agreed environmental requirements relating to the protection of aquatic ecosystems; and,
- Establishment of mechanisms for coordination and further development of foreign aid.

An important resource in addressing environmental challenges in the region is more effective coordination of efforts of governments, stakeholders and donors supporting water projects in the Aral Sea Basin.

5. Regional Cooperation in the Aral Sea Basin as a Factor Contributing to Solution of Regional Environmental Issues

5.1 Intergovernmental Cooperation

Development of the mechanisms and procedures for interstate cooperation in the Aral Sea Basin is one of the main challenges of today. The procedures for regional cooperation should be developed using the Integrated Water Resources Management principles. This includes involvement, along with the governments of the concerned states, of all stakeholders, such as businesses, farmers, scientists, environmentalists in the process of the discussion of the issues, developing policies and making decisions on the use of natural resources in this region. However, until now, there has been little involvement of stakeholders in the political process of the transboundary water cooperation in the Aral Sea Basin as involvement of the stakeholders is not something which is encouraged by the Central Asian governments. Also, regional cooperation in the strict sense (i.e. involving all the five countries of Central Asia) has in the past proven difficult to realize at the political level. The larger states, Uzbekistan and Kazakhstan, have vied for the position of regional leader to the exclusion of pursuing political cooperation with their more immediate neighbors. In contrast, the poor and resource-deprived economies of the Kyrgyz Republic and Tajikistan have recognized that they are very much dependent on regional integration for their future growth prospects (European Commission 2002).

Historically, during the Soviet era, the water management was centralized on the federal level and each republic of the former Soviet Union in the Aral Sea Basin received its share of water in accordance with quotas approved by the former Soviet Union's State Planning Committee. Annual plans essentially determined reserves for the main long-period storage reservoirs (Toktogul, Andizhan, Charvak, Nurek) and were approved on the federal level.

When the republics in the region gained their independence as new nations, it became necessary to set up a mechanism for regional cooperation in the organization of water resource management. On 12 October 1991, Water Ministers of the new independent states jointly declared they would continue using the existing Soviet principles of water allocation (UNESCO 2000). An interstate agreement was signed on 18 February 1992 to reflect this commitment and also laid a foundation for the regional cooperation by establishing a technical Interstate Commission for Water Coordination (ICWC), responsible for determining and approving annual water allocations for each state and approving schedules for the operation of reservoirs.

On 26 March 1993, the five states of Central Asia signed a new agreement that affirmed the commitment of these states to cooperate in the management of the basin's water resources. The agreement established regional institutions charged with comprehensive water management, including: the Interstate Council on the Aral Sea Problems (ICAS), a high level body charged with recommending actions to the five governments in the name of the basin as a whole; the Executive Committee of ICAS (EC-ICAS), a secretariat for ICAS; and the International Fund for the Aral Sea (IFAS), a high level body charged with financing the activities of ICAS.

The ICWC was placed under ICAS by a later decision; but because ICWC decisions had legal force and ICAS's did not, the precise relationship between them remained unresolved. Another agreement of 19 July 1994 resulted in establishment of an Interstate Commission for Socio-Economic Development and Scientific, Technical and Ecological Cooperation, the name of which was later changed to Sustainable Development Commission (SDC); this body also operated under ICAS. Following a Heads of State meeting in February 1997, ICAS and IFAS were merged into a newly structured IFAS—International Fund for Saving the Aral Sea. As a result, the political level of

decision making related to water and environmental sectors in the region belongs only to the Board of IFAS, which consists of the deputy prime ministers of the five states Kazakhstan, the Kyrgyz Republic, Tajikistan, Turkmenistan and Uzbekistan. This is the highest political level of decision making before approval by the heads of state (if appropriate). The most important issues can be decided only at the meetings of the Heads of State followed by their recommendations/approval for IFAS. The IFAS Executive Committee was established as a permanent body that included two representatives from each state and implements the IFAS Board decisions through the IFAS National Branches.

In 1994, the Heads of State adopted the Aral Sea Basin Program which was designed to be administered by the new regional institutions. Establishment of the program was aimed to prepare a general strategy for water distribution, rational water use, and protection of water resources in the Aral Sea Basin. Following the establishment of the Program, the Heads of State met at least once a year during the next six years to further develop, approve and express support to the program. In 1999, the Heads of State adopted the Ashgabat Declaration where they stressed their support for joint actions to address shared environmental problems in the basin and promote better quality of life for people living in the Aral Sea Basin. At the summit of the Heads of State in 2002 in Dushanbe, "Main Directions" of a program of specific measures aimed to improve socio-economic and ecological situation in the region for the period until 2010 were adopted. At both high level meetings it was stressed that the measures that are being taken are not enough and there should be more international efforts to improve the environmental and social situation in the Aral Sea area. The adopted joint statement of the 5-6 July 2003 meeting of Heads of State stressed the importance of the regional and international (with international organizations and donors) cooperation in the water, energy and transport sectors (in Kazakhstanskaya Pravda, 5 July 2003).

During the past decade there has been progress in the development of the interstate regional cooperation in the Aral Sea Basin as multiple agreements and conventions were signed and institutions established. However, with regard to the organization of the cooperation, it is important to stress that the institutional arrangements in the Aral Sea Basin are a mix of the institutions for the interstate cooperation and of procedures and rules that are still used since the time of the existence of the Soviet Union, and therefore, the regional cooperation cannot be yet considered as truly intergovernmental. One example is that the 1991 agreement establishing ICWC embodies a degree of interstate cooperation. However, first, the decree establishing the Commission did not provide a basis on which the states could address water issues in a comprehensive and integrated manner, and second, the implementation bodies of the Commission are in fact managed within one country only, Uzbekistan, and therefore recommendations produced by these bodies were not quite trusted by states other than Uzbekistan. This created tensions with Kazakhstan and has impeded the cooperation between the two countries to address shared environmental challenges in the Aral Sea Basin.

There is still a long way towards achieving genuine interstate cooperation in the Aral Sea Basin. This will require development of awareness and understanding at the state level of the differences between the nature and character of the cooperation between the states both during and after Soviet times. This will also require elaboration of a comprehensive and multilevel legal and institutional framework for interstate cooperation, starting from the international level of management to the local in cooperating countries. This will also require development of the political process in support of cooperation based on a shared vision of the Aral Sea Basin development where high-level representatives of the cooperating countries would be willing to put the common regional cooperation interests above the national interests. At present, the Central Asian Cooperation Organization is the only political forum for regional cooperation on an exclusively Central Asian level (without participation of Turkmenistan) (European Commission 2002). Development of an agenda for the political cooperation on water management issues in the Aral Sea Basin and involvement into the discussion of the highest political representatives as well as diverse stakeholders are necessary.

5.2 Stakeholder Cooperation

Involvement of stakeholders in the regional water cooperation is very important. However, very few larger organizations of economic interests and NGOs are active on the regional level today; most are involved in water management on the local and national levels only. One example is the NGO Aral Tenizi which is located in Kazakhstan (see www.aralsea.net).

Since the dissolution of the Soviet Union, most environmental NGOs in the region were funded through Western NGOs such as ISAR (Initiative for Social Action and Renewal in Eurasia); however, the Central Asian governments have over time become less receptive to international democracy building efforts (see http://www.fpif.org/briefs/vol5/v5no6aral_body.html) and therefore the international funding has shifted away from civil society enhancement to the promotion of economic reform. As a result, Central Asian NGOs rarely focus on political activity and policy reform but rather on education, economic development, health, and awareness building. Among the larger organizations involved in international water projects in the Aral Sea area is the Regional Environmental Center for Central Asia that is supported by various international funding agencies. The Center implements NGO development, environmental management and education projects.

To develop multi-stakeholder cooperation in region, the Central Asian Global Water Partnership (GWP) was created that is developing a network in the region for sharing information and knowledge and for involving stakeholders in the water cooperation. The GWP network includes NGOs, representatives of the economic sectors, researchers and other stakeholders.

Among major regional networks of stakeholders dealing with community development, including environmental protection issues, is Zhalgas-Counterpart, a network of NGOs registered in different states of Central Asia. Local grassroots organizations in the Central Asia region are weak.

Today there is significant attention in the region from the donors to the water user associations, which are to play an important role in the management of the Aral Sea Basin. However, they are becoming more active on sub-regional and national scales; on the regional scale their input to the water management is still low.

The role of researchers in developing a common vision of the sustainable development of the basin is important. Research projects in the Aral Sea Basin were supported by the North Atlantic Treaty Organization (NATO) and the International Association for the promotion of co-operation with scientists from the New Independent States of the former Soviet Union (INTAS). However, there is a need for support of more policy-oriented research, which would help scientists in the region to get more active in the actual management of transboundary waters.

5.3 Experiences of International Projects and Activities

After the collapse of the Soviet Union in 1991 and following expression of the political commitment by the Central Asian states for the cooperation in the Aral Sea Basin, international aid donors played a major role in promoting cooperation in the management of the transboundary water resources in the Aral Sea Basin. The World Bank was the first major agency to become involved. In the early 1990s, the Bank formulated an Aral Sea Basin Assistance Program (ASBP) to be carried out over 15 to 20 years at around US$250 million, later upped to US$470 million. The main goals of the program were (a) rehabilitation and development of the Aral Sea disaster zone, (b) strategic planning and comprehensive management of the water resources of the Amu Darya and Syr Darya, and (c) building institutions for planning and implementing the above programs. The World Bank encouraged the basin states to create ICAS and IFAS and has worked with and through these organizations to realize the ASBP. The overall international donor contribution to the above-mentioned program during 1993-2000 was about US$45 million (SIC ICWC/IWMI 2002).

Another World Bank effort, supported through the Global Environment Facility (GEF), is the Water and Environmental Management Project (World Bank 1998). It was implemented during 1998-2003 at a cost of US$21.5 million. In line with a new emphasis on regional responsibility for the ASBP, the Executive Committee of IFAS managed the program, with the World Bank playing a cooperative/advisory role. Key tasks were (a) improvement of the management of water and soil salinity related to irrigation practices, (b) development of low-cost, local, on-farm water conservation measures, (c) reduction of the amount of irrigation drainage water flowing back into rivers, (d) strengthening the existing interstate water sharing agreements, (e) improving public awareness of critical water problems, (f) enhancing dam and reservoir management and safety, (g) monitoring of water quality and quantity at transboundary river crossings, and (h) implementing a program to restore wetlands in the lower Amu Darya delta, particularly Lake Sudoche, which is a Ramsar (wetland of international importance) site.

According to the GEF assessment (see Project Supervision Report details at http://www.gefonline.org/projectList.cfm), the project implementation status was rated unsatisfactory primarily due to: delays in start-up and other issues related to the centerpiece sub-component A1 for national and regional salt and water management studies; and problems in component B for public awareness. The Implementation Review by the World Bank of the World Bank/GEF Aral Sea Basin Program (February 2003) confirmed that the technical and technological project's components within the ongoing projects were eventually implemented without major problems. Implementation of the proposed and ongoing technical and infrastructure projects or projects' infrastructure components did not present any big challenge since funding for the investments as well as international and local know-how and expertise is available in the region. However, the same review concluded that the "soft" components aimed at facilitating the interstate dialogue and developing interstate agreements as well as public participation and capacity building were not completed successfully nor on time.

In 2003, the World Bank started a project that supported efforts to revive the Northern Aral Sea. The project funding is US$85 million. Work on the project, a 12 km dike started in July 2003, was expected to be completed in 2004. With the help of this project, Syr Darya water will be prevented from flowing into the Large Aral Sea, where it has been losing a battle with evaporation. Instead it will remain in the Northern Aral Sea, which engineers expect in four years or so to rise 2.5 m and recover about 600 km^2 of exposed former seabed. Then a sluice will be opened, and the excess water will be allowed to flow south again into the Large Aral Sea. The World Bank project includes rebuilding waterworks along the Syr Darya to increase the flow of the waterway substantially.

As a result of the two components, the salt content of the Northern Aral Sea should drop, to somewhere between 4 ppt to 17 ppt (according to Micklin it is now 20 ppt). Many of the 24 fish species that once supplied a 50,000-ton-a-year fishery are expected to return (Pala 2003). Although the resulting size of ~3,300 km^2 is small relative to the pre-1960 Aral Sea, it would still be the 15th largest salt lake and 50th largest lake by area in the world. A previously built dike (1992-1999) raised the lake by 3 m but was breached by large floods (Aladin et al. 1995).

In 1960, the fish fauna of the Aral Sea consisted of a couple dozen native and introduced fishes while the invertebrate community included more than 200 species. When parted into the Northern and Large Aral Seas, only 7 species of fish,

10 common zooplankton species, and 11 common benthic species were present. Increased salinity of the Large Aral Sea has resulted in complete elimination of the fishes and of eleven invertebrate zooplankton species (Plotnikov et al. 1991). Re-colonization of a less saline restored Northern Aral Sea with fauna from the Syr Darya delta is likely and flounder and sturgeon fisheries are listed as economic benefits in an appraisal of the project (World Bank 2001).

To the Kazakhs near the Northern Aral Sea, the benefits will be considerable. Revival of the Northern Aral Sea most importantly will help to reduce poverty by bringing back the commercial fisheries into the region. It should also increase rainfall in the area which should result in better quality of ground waters and is likely to reduce dust storms that cause respiratory diseases among the population in the region.

A number of other international donors, directly or indirectly, have been contributing to Aral Sea region improvement. The United States Agency for International Development (USAID) funded the Environmental Policy and Technology (EPT) project in 1993-1998 and initiated a new, major effort in 2001 known as the Natural Resource Management Project (NRMP). This is a 5-year effort focusing on providing assistance to Kazakhstan, the Kyrgyz Republic, Turkmenistan, Uzbekistan and, to a lesser extent Tajikistan, to improve management of water, energy, and land.

Governments of the Netherlands, Japan, Finland, and Sweden, have committed funds to support construction of the water management infrastructure and necessary studies. The European Union (TACIS) initiated a major aid program for the Aral Sea Basin states in 1995 known as the Water Resources Management and Agricultural Production in the Central Asian Republics Project (WARMAP) (Aquater 1997).

The United Nations Educational, Scientific and Cultural Organization (UNESCO) funded a research and monitoring program for the near Aral region from 1992-1996 focusing on ecological research and monitoring in the Syr Darya and Amu Darya deltas (UNESCO 1998). The United Nations Childrens' Fund (UNICEF) launched the Aral Sea Project for Environmental and Regional Assistance (ASPERA) in 1995. It provides assistance to the disaster zone around the lake and focuses on health, nutrition, health education, water and environmental sanitation, and support to NGOs. The United Nations Development Program (UNDP) assistance in the region had two primary foci: strengthening regional organizations that have been established to deal with the Aral Crisis (earlier ICAS and IFAS, now the reconstituted IFAS) and promoting sustainable development to improve conditions for the several million people in the parts of Kazakhstan, Uzbekistan, and Turkmenistan which are closest to the Aral Sea.

A Swiss Government aid program for improving the water sector in Central Asian region emphasizes support for institutional development, capacity building and human resources development linked with infrastructure investments, the promotion of regional partnerships and donor coordination. Geographical focus of the Swiss assistance is concentrated on three priority countries—the Kyrgyz Republic, Tajikistan and Uzbekistan—with limited inputs to Turkmenistan and Kazakhstan in connection with regional programs.

However, as it is expressed in the World Bank "Water and Environmental Management Project" Implementation Completion Report (World Bank 2004), one of the lessons learned in working in the Aral Sea Basin is that "multi-donor projects are extremely difficult to implement". Different donors with different political agendas and interests should coordinate their efforts in the region and the riparian states in a more effective manner. Also, meetings of donors should be taking place on regular basis in the Aral Sea Basin. Perhaps, the global organizations such as the World Bank or various UN agencies should take a lead role in organizing coordinated efforts of different donors on a regular basis.

6. Lessons Learned and Recommendations

The continuing drying of the Aral Sea has brought multiple social, environmental and ecological disastrous consequences to the region and potential solutions to these problems demand great attention, political will, and human and financial resources. Although many projects have been implemented or are being implemented in the Aral Sea Basin, there is still a long way towards achieving the situation where quality of life of the population, including quality of the environment and of the social and economic conditions in the region, will be satisfactory. Among the lessons learned from the cooperation in the Aral Sea Basin are the following.

- Political commitment from the governments of Central Asian countries to the regional cooperation in the Aral Sea Basin is a foundation and a necessary condition of the successful implementation in the region of environmental protection measures. The authors agree with the conclusion of the World Bank that development of the "strong client commitment, including client leadership in project preparation and implementation, even at high costs; enhanced interest of States through equal treatment and systematic consensus building" (World Bank 1998) should be the main focus of attention of funding agencies and international organizations. In similar settings as the one existing in the Aral Sea Basin, where the history of interstate cooperation is very short, institutions and the legal basis for the cooperation are still under development, and the actors lack experience of an interstate cooperation, key international players should use their status and resources to promote the political commitment of the states and the development of trust and consensus over the ways to address shared regional water management challenges. It is not only money that those international institutions should provide but they should also get involved in the role of a mediator and a facilitator of the cooperation.

- To promote the political commitment from the states to the regional cooperation, national ownership of the regional initiatives should be ensured by supporting a larger share of projects and activities on the national level. Support to nationally-implemented projects is important as different countries have different legal and institutional frameworks and there are considerable gaps between the countries' levels of social and economic development. Activities implemented on the national level in different countries are to be complimented by a regional umbrella water management program focused on water management priorities important for whole transboundary basin. This kind of a transboundary umbrella program should mostly contain communication and coordination, as well as public outreach activities. Regular communication should be organized between teams developing transboundary water management strategies and national water management projects.

- In most of the projects in the past, the water management challenges have been addressed in a narrow sectoral way. The water management issues should be connected to other economic and political issues; the water cooperation should be an important part of the discussions of economic development and integration processes in the region; and these discussions should involve both governments and stakeholders. This approach is likely to contribute to a higher political commitment from the states involved in regional cooperation. Also there should be more discussions and activities on the basin level bringing together water quality and quantity.

- Experiences of implementation of international projects in the Aral Sea region showed that technical and technological projects were usually implemented successfully while the "soft" components of the projects aimed at developing institutional frameworks for regional cooperation and public awareness were often unsuccessful. The reason for that is a sufficient know-how and knowledge for implementation of the technical projects; low awareness and a lack of relevant experiences in organizing "soft" water management activities reflecting Integrated Water Resource Management principles to water management. As experience of transboundary water management projects in Europe has shown, for example, in implementation of the Danube River and Lake Peipsi/Chudskoe GEF-funded transboundary water projects, at least 60% of the funding has to go to the "soft" measures aimed to develop regular communication and information exchange between the riparian governments to raise their awareness about the need of the transboundary cooperation. It is also important that allocation of resources for the "soft components" is done in a focused way. Comprehensive communication strategies and tools for communication and information exchange to ensure involvement of not only the governments but also stakeholders on different levels of governance in management of waters should be developed tailored to the needs of different stakeholders in the region.

- Starting regional cooperation initiatives in the geographical areas with little experience of an interstate cooperation requires a discussion of possible institutional models of the future interstate regional cooperation to be developed. In the Aral Sea Basin many regional cooperation organizations operate with rules and procedures that are a mix of the approaches from the old Soviet centralized system and are partly based on the principles of the cooperation between the independent states. Therefore, measures promoting development of real interstate cooperation should be supported. If the states do not cooperate on the fully independent international grounds, they will not be motivated to put their resources to promote regional cooperation. The legal and institutional framework to be developed in the Aral Sea Basin should help the countries to bring together and negotiate diverse state and regional interests.

Institutional models of the interstate cooperation in basins of other regional seas that have proven to be successful could be proposed for study as a possible basis for the development of the interstate cooperation in the Aral Sea Basin. For instance, the intergovernmental cooperation model developed around the Baltic Sea (SIWI 2000) could be used as a model for Aral Sea cooperation. The 25 years of experience of the cooperation around the Baltic Sea where a multilevel governance system bringing together environmental and economic priorities can be very valuable for the Central Asian states and could help them in solving their shared water management challenges in the Aral Sea Basin. The existing platform of the EU Global Water Initiative aimed at disseminating knowledge of organization of implementation of the EU Water Framework Directive by states of the European Union could be effectively used to transfer the knowledge from Europe and the Baltic Sea region to the Aral Sea Basin.

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8. References

Abdirov, C.A. et al. 1993. "Stress reaktsiya zdorovykh detey Nukusa na vozdeystviya otritsatel'nykh ekologicheskikh faktorov v Priaral'ye" (Stress reaction of healthy children of Nukus from the effects of ecological factors in Priaral'ye). *Vestnik Karakalpakskogo otdeliniya Akademii Nauk Respubliki Uzbekistana* 2: 15-20. (In Russian).

Aladin, N.V., I.S. Plotnikov and W.T.W. Potts. 1995. "The Aral Sea desiccation and possible ways of rehabilitating and conserving its Northern part." *Int. J. Environmetrics* 6: 17-29.

Aladin, N.V., P. Micklin, J.-F. Cretaux, D. Keyser, M. Schlueter, N. Boroffka, I. Plotnikov, D.Piriulin, A. Smurov, L. Zhakova, and V. Gontar. 2005. "Past, Present and Future of the Aral Sea." Paper presented at International Aral Sea Basin Water and Food Security Conference (ABWF 2005), 1-4 September 2005, Almaty, Kazakhstan.

Aquater. 1997. *Water Resources Management and Agricultural Production in the Central Asian Republics: Aral Sea*. DG IA NIS/TACIS Services.

Boroffka, N.G.O., H. Obernhansli, G.A. Achatov, N.V. Aladin, K.M. Baipakov, A. Erzhanova, A. Hornig, S. Krivonogov, D.A. Lobas, T.V. Savel'eva and B. Wunnemann. 2005. "Human Settlement on the Northern Shores of Lake Aral and Water Level Changes." *Mitigation and Adaptation Strategies for Global Change* 10: 71-85.

Brown, P. 2003. "Dam Condemns Aral Sea to Oblivion." *Manchester Guardian Weekly*, 26 November 2003.

European Commission. 2002. *Strategy Paper 2002-2006 and Indicative Programme 2002-2004 for Central Asia*. The European Commission: Brussels, Belgium.

Glazovskiy, N.F. 1990. *Aral'skiy krizis: prichiny vozniknoveniya i put' vykhoda* (The Aral crisis: causative factors and means of solution). Nauka: Moscow. (In Russian).

Letolle, R. and M. Mainguet. 1993. *L'Aral*. Paris, France: Springer-Verlag.

Medecins sans Frontieres. 2000. MSF in Uzbekistan and Turkmenistan: Activity Report 1999-2000.

McKinney, D. 1995. Sustainable Water Management in the Aral Sea Basin.

Micklin, P. 1991. "The Water Management Crisis in Soviet Central Asia." *The Carl Beck Papers in Russian and East European Studies*, No. 905. The Center for Russian and East European Studies: Pittsburgh, PA, USA.

Micklin, P. 1992. "The Aral Crisis: Introduction to the Special Issue." *Post-Soviet Geography* 23(5): 269-283.

Micklin, P. 2000. *Managing Water in Central Asia*. Central Asian and Caucasian Prospects, The Royal Institute of International Affairs: London.

Micklin, P. 2002. "Water in the Aral Sea Basin of Central Asia: Cause of Conflict or Cooperation?" *Eurasian Geography and Economics* 43(7): 505-528.

Pala, Christopher. 2003. "The Aral Sea Gets a New Lease on Life." *International Herald Tribune*, 7 August 2003, p. 9.

Palvaniyazov, M. 1989. "Vlyaniye pyl'nykh bur' na mestoobitaniya nekotorykh mlekopitayushchikh primorskoy zony Aral'skogo moray." (The influence of dust storms on the habitats of certain mammals of the coastal zone of the Aral Sea) *Problemy osvoyeniya pustyn*, No. 1: 55-59. (In Russian).

Plotnikov, I.S., N.V. Aladin and A.A. Philippov. 1991. "The Past and Present of the Aral Sea Fauna." *Zoologichesky Zhurna* 70(4): 5-15. (In Russian).

Ruziev, M.T. and V.G. Prichodko. 2002. "Estimation of prospects of sustainable development of the states of the Aral Sea Basin with the help of modeling calculations." *Melioration and a water economy* 1: 54-56. (In Russian).

SIC ICWC/IWMI (Scientific Information Center of the Interstate Coordination Water Commission/International Water Management Institute). 2002. "Ways of Water Conservation." Result of WUFMAS Sub-project of WARMAP-2 Project (TACIS) and Sub-component A-2 of GEF Project on the Aral Sea basin water resources and environment management. SIC ICWC/IWMI: Tashkent.

SIWI (Swedish International Water Institute). 2000. "Water Security—Opportunity for Development and Cooperation in the Aral Sea Area." SIWI/RSAS/UNIFEM Seminar, 12 August 2000. SIWI: Stockholm, Sweden.

SPECA Project. 2002. *Diagnostic report on water resources in Central Asia*. SPECA Project, pp. 73.

Temirov, R. 2003. "Lobbying Grows in Moscow for Siberia-Uzbekistan Water Scheme." Eurasianet, 19 February 2003. (Available at www.eurasianet.org/departments/environment).

Tursunov, A.A. 1989. "Aral'skoye more i ekologicheskaya obstanovka v Sredney Azii i Kazakhstane." (The Aral Sea and the ecological situation in Central Asia and Kazakhstan) *Gidrotekhnicheskoya stroitel'stvo* 6: 15-22. (In Russian).

UNESCO (United Nations Educational, Scientific and Cultural Organization). 1998. "Ecological Research and Monitoring of the Aral Sea Deltas." *Final Scientific Reports of the Aral Sea Project 1992-1996*. UNESCO: Paris.

UNESCO. 2000. Water related vision for the Aral Sea Basin. UNESCO: Paris.

World Bank. 1998. *Aral Sea Basin Program: Water and Environmental Management Project Document*. May 1998. World Bank: Washington, D.C.

World Bank. 2001. *Project appraisal document on a proposed loan in the amount of US$64.5 million to the Republic of Kazakhstan for the Syr Darya Control and Northern Aral Sea*

Phase-I Project. Rep. No. 22190-KZ. 11 May 2001. World Bank: Washington, D.C.

World Bank. 2004. *Implementation completion report on a grant to the Executive Committee of the International Fund for Saving the Aral Sea for a Water and Environmental Management Project*. 25 February 2004. World Bank: Washington, D.C.

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