The Aral Sea Encyclopedia

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Springer

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The Aral crisis is the most dramatic example of the environmental problems with serious socioeconomic consequences facing, directly or indirectly, all states of Central Asia. The crisis related to the drying of the Aral Sea emerged as a result of the agrarian orientation of economics based on development of irrigated farming and growing volumes of consumptive water use for irrigation.

Fourth Conference of Ministers
"Environment for Europe"
Central Asian States:
Environmental Assessment,
Denmark, Orkus, June 1998

Once upon a time the sea was here
Near the steep slope.
The Aral fishermen enjoyed themselves
Just on its scope.
They were catching fish by fishing tackle,
Lived in peace and concert,
Spent the nights near campfires,
Sang the songs, and never thought
That the sea would disappear here,
And no place would be for them
In the sea expanse.
The Aral went away,
We'll never meet again,
The only thing which left
It is its name...

Olga Krestovskaya
Pupil of the 6th class
Aralsk, 1998

It takes all our strength and resolution not to leave things that will make our future generations feel shameful.

Saigo Takamori,
last samurai of Japan

Contents

Introduction

The "Aral Sea Encyclopedia" is the first one in the new series of encyclopedias about the seas of the former Soviet Union.

Preparing it we faced certain difficulties. The thing is that this encyclopedia is a *monument to the sea* that is disappearing during our lifetime.

The world community considers the situation with the Aral Sea and all changes that occurred in its whereabouts in the recent decades as one of the most serious, if not disastrous anthropogenic environmental crises of the 20th century.

Before 1960, this was a water-abundant sea-lake that was fourth among world lakes after the Caspian Sea (USSR, Iran), the Great Lakes (USA, Canada) and Victoria Lake (Africa). This was a real "pearl" among the sands of the largest deserts, the Karakums and the Kyzylkums. Navigation between the sea ports Muinak and Aralsk and fisheries famous for the Aral breams, barbells, sturgeons, shemaya, and others were developed here. One could find beautiful recreational zones and beaches here. The deltas of the Amudarya, the major river of Central Asia, and the Syrdarya bringing their waters into the Aral Sea were famous for their biodiversity, fishery, muskrat rearing, reed production. The local population found occupations related to the water infrastructure.

However, the development of wide-scale irrigated farming in an attempt to create cotton independence for the former Soviet Union demanded regulation of the Amudarya and Syrdarya flows and construction of water intake structures there. With the expansion of irrigated lands, the water inflow into the Aral Sea diminished and the process of its drying and salinization was set in motion. This led to a practically complete degradation of the historically established ecosystem and, as a result, to the socioeconomic crisis in the whole Circum-Aral area.

By the mid-1980s, the Aral crisis was acknowledged by the whole world and became one of the most significant environmental protection issues. The Aral problem is not global, but nevertheless it stirs global interest. For many years, it was used by various interested parties to stress how quickly human activities may cause degradation of vast expanses on our planet.

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Fig. 1 The map of Asia (http://www.lib.utexas.edu/maps/asia.html)

Former US Vice President and 2007 Nobel Prizewinner Al Gore, who visited the Aral Sea during the period of its drying, wrote that more often many people define their nationality using ecological rather political terms. Thus, the Aral Sea region was populated by the people from some former Soviet republics affected by the regional environmental disaster of the Aral Sea (Al Gore, Earth in the Balance, Ecology and the Human Spirit, 1992).

Today much of the geographical and hydrographic "infrastructure" of the Aral has been lost, and, unfortunately, we have to write about this in the past time. This loss includes islands, bays, capes, arms, and straits. Of course, their contours are changing, and now they are not found among the waves of a blue sea, but in the "sea" of the stiffened, sandy waves of the world's youngest desert – Aralkums. And today, the Aral really turns into a "glass of water" as A.I. Butakov, who studied this sea, wrote in the mid-19th century (although in Butakov's time this "glass of water" was rather full).

The Aralkum "sea" is a museum in the open air. Its main exhibits include remnants of ships that not long ago sailed over the real sea but have now turned into rusty metal hulks, replaced by the live "ships of the desert" – camels.

As is known, today the Aral Sea is shared by two independent states, the Republic of Uzbekistan and the Republic of Kazakhstan. They share the suffering of all of the consequences of the Aral Sea drying. But the same

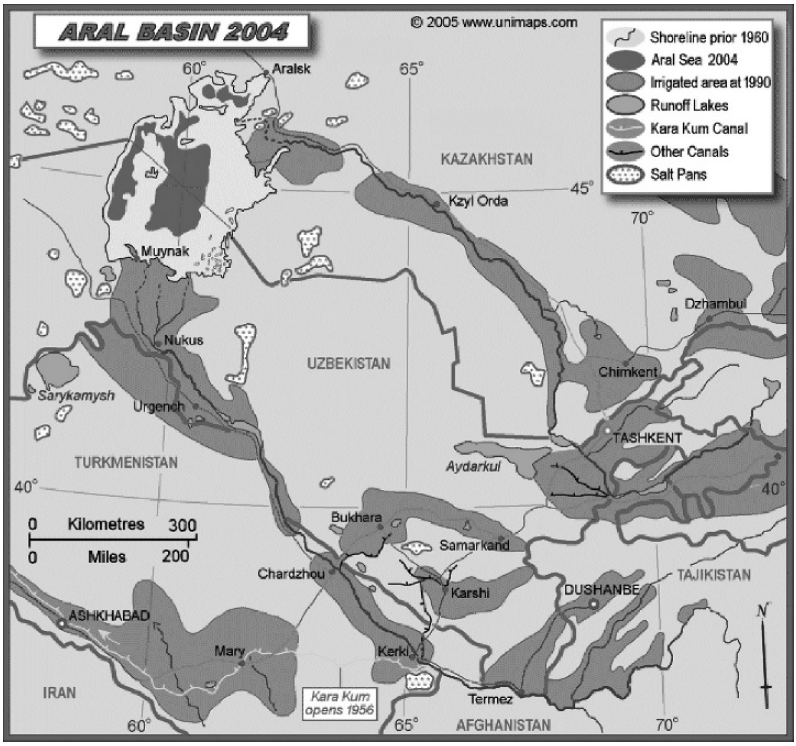

Fig. 2 The map of the Aral Sea Basin (http://unimaps.com/aral-sea/aral-pic.gif)

Fig. 3 The remnants of ships in the Aralkums desert

consequences are faced in the northern territories of Turkmenistan, too, which border the Amudarya delta.

Five independent states located in the Aral Sea basin – Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan – demonstrate their truly Oriental wisdom in understanding the significance of the population salvation in this region and imparting stability to the natural-anthropogenic complex of the Circum-Aral area. They have rallied their efforts to create an interstate authority for water resources management in the basin, which has made it possible to attract many leading governmental and nongovernmental international organizations to address many complicated hydrological, hydrotechnical, and socioeconomic issues. The results are already palpable – the Small Aral Sea is being restored; however, a wealth of unsettled issues remain.

This encyclopedia combines the principal results of the fundamental, so to say "benchmark," investigations of the Aral and also information about the leading international programs and projects. Naturally, this was the authors' choice. During preparation of this encyclopedia, the authors faced certain difficulties related to the lack of or not readily accessible information from the Aral countries.

The encyclopedia includes a chronology of historical events relative to the Aral Sea development and study for the past 300 years – from the time of Peter I to the present.

In our opinion, this work is necessary to preserve and highlight for future generations the history of the major mistakes of an authoritative society of "nature conquerors" and attempts at rectification of those mistakes. This work does not claim to be exhaustive in elucidation of the Aral problem. This publication is intended for a wide public – from decision-makers to school pupils and for all those who are interested in the problems of this region – its geography, history, ethnography, economics, and ecology.

We would like to thank Springer-Verlag for the steady interest to the Aral Sea problem, which was initiated by the book by Letolle R. and Mainguet M. "Aral" published in 1993. In 1996 the Proceedings of the NATO Advanced Research Workshop on the Aral Sea Basin, that was held in 1994 in Tashkent, Uzbekistan, were published and till present are cited very often in the scientific publications. The same year Springer published in German the book by Letolle R. and Mainguet M. Der Aralsee (1996). Another interesting book "Sustainable Land Use in Deserts" edited by S.-W. Breckle, V. Veste, W. Wucherer was published by Springer in 2000. In 2005 Springer in association with Praxis Publishing issues "Physical Oceanography of the Dying Aral Sea" by P.O. Zavialov. The present book "The Aral Sea Encyclopedia" continues this very interesting Aral Sea series and starts the new one – "Encyclopedia of the Seas", that will be continued by the following volumes –"The Caspian Sea Encyclopedia" and "The Black Sea Encyclopedia" in 2009. And finally, in 2009 Springer will publish "The Aral Sea Environment" edited by A.G. Kostianoy and A.N. Kosarev.

We acknowledge with many thanks the assistance of Ubbiniyaz Ashirbek Ashirbekov, Director of the Nukus Branch of the Executive Committee of the

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Prof. Igor S. Zonn
Prof. Michael H. Glantz
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Prof. Aleksey N. Kosarev
Moscow, 24 April 2008

A

Actions on radical improvement of the environmental and sanitary situation in the Aral Sea region, more effective management and protection of water and land resources in its basin – Resolution of the CPSU Central Committee and the USSR Council of Ministers No. 1110 of September 19, 1988. It was elaborated on the basis of the report prepared by the Governmental Commission on Environment Condition in the A.S. Basin under the guidance of Yu.A. Izrael. The Resolution cited serious shortcomings in water and land resources management, including the cultivation of newly irrigated lands without appropriate consideration of environmental and social consequences, and provided a brief description of the condition of the natural environment and economy in the region and proposed a complex of actions to improve the environmental equilibrium in the Circum-Aral Area and growth of production forces. It envisaged a growing river inflow into the deltas of the Amudarya and Syrdarya as well as to A.S. in the following amounts: in 1990 – no less than 8.4 cu. km, in 1995 – 11 cu. km, in 2000 – 15-17 cu. km, and by 2005 – up to 20–21 cu. km (in regard to drainage waters). In 1988–2000 projects rehabilitating the irrigation systems on an area of 3.2–3.3 mln ha, constructing and refurbishing the collecting-drainage network on an area of 1.7–1.8 mln ha, and reducing the specific water consumption for irrigation in the A.S. basin by 15% by late 1995 and by 25% in 2000 were proposed. At the same time, projects were proposed to reduce the scale of new cultivation of irrigated lands and from 1991 to suspend the construction of large irrigation systems in the A.S. basin. The urgent construction of water supply projects and improvement of the medical servicing of the population were envisaged. The Resolution also confirmed the need for carrying out research and feasibility studies, including prevention of salt and dust drift from the dried Aral seabed, regulation of the level and water regime of shallow areas of A.S., verification of integrated programs on development of production forces in the Central Asian republics and Kazakhstan, among others. This Resolution played an important role in addressing the Aral problem.

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Adjibai Bay* (formerly Ken-Kamysh) – found to the west of the *Rybatsky Bay* (see) and sandwiched between *Muinak Island* (see) and the high, steep mainland bank in the southwest of the Aral Sea. The northern border runs along the line connecting the eastern inlet *Cape Tigrovy khvost* (Tiger's tail) (see) with the Kustau Cape in the west. In the west of the bay between Muinak Island and the mainland southward of the island is *Muinak Bay* (see). The depth in the bay's central part was 6 to 8 m and tends to gradually decrease towards the banks. In the south of A.B. the Urginsky path rambles through the reed thickets. In 1985, the bay dried out completely and an artificially regulated water body was created in its place. It is fed by Amudarya waters via the *Mezhdurechensky reservoir* (see) and the *Kazakhdarya flow duct* (see).

Agreement among the Kazakhstan Republic, Kyrgyzstan Republic, Uzbekistan Republic, Tajikistan Republic, and Turkmenistan on cooperation in joint management of utilization and protection of interstate water resources – historic agreement signed by the heads of water management organizations duly authorized for entering into negotiations on behalf of the governments of the 5 new Central Asian states, on February 18, 1992 in Almaty, Kazakhstan. The Agreement comprises a preamble and 15 articles. Among other things the Preamble states:

> . . . guided by the need for coordinated and organized settlement of issues of joint management of interstate water resources and with a view of further pursuance of the coordinated policies in the interests of economic development and improvement of the life standard of the population;
>
> proceeding from the historical unity of the peoples living on the territories of these states, their equal rights and responsibility for ensuring the rational management and protection of water resources;
>
> acknowledging the uninterrupted dependence and interrelation of the interests of all states in addressing the issues of joint management of water resources on the common for the whole region principles and just regulation of their consumption;
>
> showing respect of the established structure and principles of distribution and based on the acting regulatory documents on distribution of water resources of interstate sources the aforementioned Agreement was signed.

Pursuant to Article 7 of this Agreement, the parties decided to create on a parity basis the Interstate Coordination Water Management Commission (ICWC) for regulation and rational management and protection of interstate water resources and include into its membership the heads of water management organizations who envisioned convening quarterly and, if necessary, on the initiative of the parties by turn in each country.

In December 1992 in Tashkent the regulations of the ICWC were signed.

The adopted Agreement was ratified by the Government of Kazakhstan on February 29, of Uzbekistan on March 4, of Tajikistan on March 12, of Kyrgyzstan on April 2, and of Turkmenistan on April 20, 1992.

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* Because many of geographical objects, flora and fauna have changed or disappeared in the Aral Sea, hereinafter asterix means that the description of the term is given for the state in the early 1960s

Agreement on joint actions to settle the Aral and circum-Aral area problems, improve environmental conditions, and ensure the socioeconomic development of the Aral region – Agreement signed on March 26, 1993 in Kyzyl-Orda by the Presidents of five Central Asian states. It confirmed the resolution of five states to further cooperation in management of water resources in the basin. Within the framework of this agreement, several regional organizations responsible for integrated management of water resources were established: the Interstate Council for the Aral Sea Problem (ICAS), the highest ranking body in charge of elaboration of recommendations to the five states on behalf of the basin in general; the Executive Committee and Secretariat of the ICAS; and the International Fund for saving the Aral Sea (IFAS), the highest ranking body in charge of financial support of ICAS activities.

Agurme Peninsula* – located in the middle of the eastern coast of the Aral Sea. It extends from the north to the south for nearly 16.5 km to the left of the entrance into the *Bozkol Bay* (see). The peninsula is low-lying, sandy, and its shallow rugged banks are overgrown with reeds.

Aiderly Cape* – the eastern inlet cape in *Shevchenko Bay* (see), it protrudes far into the sea to the south. It consists of flat, elevated terrain that dips steeply into the bay. The eastern coast of the cape is gently sloping, while the western coast is steep.

Aijarym Island* – located in the eastern part of A.S. Together with *Tasty Island* (see) it lies to the south of *Bozkol Bay* (see). The island was low-lying and was surrounded by shallow waters with depths of less than 1 m.

Aitek-Aral Island* – occupies the northern part of the Ushkol Bay in the north of A.S. It divides the entrance into two straits: eastern and western. The eastern strait is shallow, while the western strait has depths from 1.2 to 1.4 m. The island does not have very high cliffs and is practically devoid of vegetation. A sand bar runs from the northeastern tip to the northwest obstructing the entrance into the Ushkol Bay.

Akbasat Bay* – protrudes into the A.S. eastern coast and makes up the eastern shallow part of the *Kashkynsu Bay* (see). It has several low-lying sandy islands; its depths are not more than 1 m. This bay is the easternmost part of A.S.

Akbasty Island* – located in the east of A.S., 18 km to the south-southeast of *Kaskakulan Island* (see). The island is low, covered with thin shrub vegetation; its shallow waters are overgrown in places with reeds.

Akbidaik Bay* – protrudes into the western coast of *Butakova Bay* (see); the bays are linked with a strait about 1.3 km wide. The strait is very shallow – about 2 m. The commercial fishing industry once located in Akespe on the northern cape restricted the entrance into the bay.

Akchadarya delta of the Amudarya river* – located to the east of its modern delta on its right bank. In the 9th to 2nd centuries B.C., this area was covered by vast tugai

wetlands that received 5 to 10 km^3 of water a year. In the 2nd century B.C., artificial irrigation was practiced in the delta. At this time, the delta's marshes were lost, and as a result the Amudarya river rushed to the Aral Sea and drained the valley.

The delta was formed in the Late Pleistocene and Holocene and consists of two parts: the southern, located to the south of Sultanuizdag ridge, and the northern that stretches southward and eastward of Beltau. Its surface gradually merges with the modern Amudarya delta in the west and *Zhanadarya* (see) in the northeast. The southern and northern deltas are linked via the Akchadarya corridor separating the Western and Central Kyzylkum. The southern A.D. is broken up by large and small river channels up to 5–10 m deep. Some of them were used in the past and are used at present as irrigation canals, while their greater part is deflated and filled with sand. These sands cover large areas here. All these river channels join together in the Akchadarya corridor, the width of which is no more than 2–4 km. To the north of this corridor the river channels become fan-like, irrigating a vast territory of the northern delta. Flat takyr surfaces with relic uplands composed of parent rocks and separate sand massifs prevail here. Similar relic highlands are found in the southern delta, too, and are located mostly to the north and east of the delta at a height of 40–80 m. The southern delta was used for irrigated farming, but as the Amudarya waters have stopped flowing it has dried out for the most part.

Akchadarya Lowland – located to the east and northeast of the Sultanuizdag mountain ridge. In ancient times only one of the Amudarya arms, the Akchadarya, flowed into this area. It ran around Sultanuizdag on the southeast, gradually forming a vast delta. Later on the Akchadarya delta deposits were diminished to a great extent and the delta became a sandy desert.

Akdarya – one of the Amudarya branches. In the early 1980s, waters from the Amudarya flowed via it into A.S near the Uoredobay settlement.

Akhmeta Island* – located to the north of the A.S. (Small) in the northeastern part of the *Greater Sarychaganak Bay* (see) directly before *Aralsk City* (see). It covers the *Aralsk Bay* (see) to the southeast.

Akkala, Cape* – located in the south of A.S., separates the Djiltyrbas and *Adjibai* (see) bays.

Akkol, Bay* – located 20 km to the south-southeast of the Syrdarya mouth and encroaches the land eastward for 10 km. The entrance into the Bay is bound on the north by the sandy *Kosaral Peninsula* (see), the northern part of which accommodates the settlement of Karateren where fishermen live. An underwater bar overgrown with reed and rush runs from this peninsula for 2.6 km in the south-southeast direction. To the south, the entrance into the Bay is bound by the flat sandy Karashokat Cape. Nearly the whole water area is overgrown. The depth here is approximately 3 m.

Akpetkinsky (Karabailinsky) Archipelago* – located in the southeastern part of A.S. It comprises about 230 islands, though other sources claim up to 300.

It takes its name from nearby shoal Ak-Petki and Rusengir Island. Its area is over 2,000 sq. km. The Archipelago was formed in the early 20th century when the Aral Sea, after the level rise, intruded into the Kyzylkum sands for 40–50 km near the ancient delta of *Djanadarya* (see). As a result, many low islands and islets with numerous bays, including *kultuks* (see) and *uzyaks* (see), were formed here, while on the continental coast, many shallow lakes were connected with the sea via uzyaks. The Archipelago coastline configuration is variable because it depends on the sea level. The Archipelago and the whole eastern coast as far as the Kuilyus Bay are covered with reed and rush. As the Aral waters dried out, they were gradually replaced with *collection-drainage waters* (see) which formed an intricate system of lakes on the exposed seabed.

Aksaga Bay* – located in the north of the *Akpetkinsky Archipelago* (see) 9 km to the south-east of the *Kendyrli Island* (see) and extending for about 28 km southwards. On the east it is confined by the *Seleuli Island* (see) and a meandering continental coastline. The bay depth is up to 10 m. The western edge of the bay is sheltered by the *Greater Chushka* (see), Little Chushka, and Kamyshovy islands.

Aktumsuk, Ak-Tumsuk Cape* – located on the western coast of A.S. 40.5 km southwards of the Djidelibulak Cape. The coast near the Cape is high and steep. On the south-east the Cape has two escarpments formed by blocks with a complicated configuration. The Cape has a steep underwater slope. At a distance of 350 m from it the depth reaches 10 m, while at a distance of 4 km, the depth is 40 m (1960). From 1948–1964, a sea observation station was located here, while at present there is a meteorological station.

Fig. 4 Aktumsuk meteorological station. Photo by Dmitry Soloviev, June 2008

Aktykendy Cape* – located 22 km to the south-southwest of the *Baigubekmuryn Cape* (see). It is high and steep, and its far end descends smoothly to the sea. The Cape has a steep underwater slope. At 350 m from it reaches a depth of 10 m, while at a distance of 3.5 km to the east of the Cape a bottom trough 69 m deep runs parallel to the coast.

Aktyubinsk region (Kazakh – *Aktobe oblysy*) – formed on March 10, 1932, it belongs to the Republic of Kazakhstan, located in its western part. Its area is about 300,000 sq. km (about 10% of the Kazakhstan territory). Population: 682,000 (1999). The region includes 12 administrative districts, 7 cities (Alga, Zhem, Kandyagash, Temir, Khromtau, Shalkar, Emba), and 4 urban-type settlements. Center: Aktobe (former Aktyubinsk); population: 278,000. The greater part of A.R. is a flat terrain broken by river valleys. Prevailing altitudes: 100–200 m. The central part of the region is covered with the Mugodjary Mountains (the highest is Greater Baktybai, 656 m). The western part of A.R. is occupied by the Poduralsky Plateau passing in the southwest into the Circum-Caspian Lowland. The Turgai table area is in the northeastern part of A.R. The southern part represents massifs of hummocky sands: *Circum-Aral Karakums* (see), *Greater and Lesser Barsuki* (see) and others. Here the region goes out to the Aral Sea. The following deposits are found here: chromites, iron pyrite, nonferrous metals, phosphate rocks, bauxites, oil, black and brown coal, potassium salts. The climate in A.R. is sharply continental and dry. The average temperature in July in the northwest is $+22.5^{\circ}$C and in the southeast $+25^{\circ}$C; the average temperature in January is -16°C and -15.5°C, respectively. The precipitation in the north in the center of the region is about 300 mm a year, reducing sharply southwards. The vegetation period varies from 175 days in the northwest to 190 in the southeast. All rivers in A.R. run to the drainless basins of the Caspian Sea and other small lakes. The largest river here is Emba. Among other rivers are tributaries of the Ural – Or and Ilek as well as Irgiz, Uil, Turgai and Sagiz. The rivers are mostly shallow and in summer they dry out. More than 150 lakes are found in A.R. The northwestern part of the region is covered with cereal-wormwood steppes composed of dark chestnut soils. The valleys of the rivers are overgrown with thickets of shrubs; the asp, birch and poplar groves are also found here. The middle and northeastern parts are covered with wormwood-cereal vegetation growing on light-chestnut slightly alkaline soils. In the south wormwood-saltwort deserts composed of brown solonetz soils spread. The main industries developed here are mining, chemical, machine-building, and meat production. Power generation is based here on Karaganda coals. The industry is mostly concentrated in Aktobe. The leading branch of agriculture is rainfed grain farming. In late 1950 over 2 mln ha were cultivated here. The northwestern part of A.R., with its well-developed farming and animal husbandry, specializes in rearing large-horned cattle (meat/milk breeds) and pigs, while in the south mutton-fat and mutton-wool sheep are tended. The Orenburg–Tashkent railroad crosses the region from northwest to southeast, while the Atyrau–Orsk rail line crosses from the southwest to the northeast.

Akushpa Lake – located in the southern part of A.S., its area is 308 sq. km. It makes up part of the wetlands of *Sudochie Lake* (see), covering 70% of their area. The maximum lake length is 20 km, width is 6.5 km, and depth is no more than 1.5 m; the coastline runs for 62 km. In 2000–2001 during a disastrous low-water period, the lake nearly lost its flow and dried out

completely. In 2003 after intensive filling the water level in the lake reached 52.5 m abs. elev.

Altai Island (former Uzun-Kair)* – located in the eastern part of the Aral Sea to the north-east of the *Uyaly Island* (see). Viewed somewhat as Uyaly's extension. The island is low and sandy and merges with the mainland line. The banks are covered with dense thickets of reeds.

Altynkol Bay* – lies in the eastern part of the Aral Sea 3.5 km eastwards of the *Karatma Bay* (see). It stretches meridionally for 27 km. The prevailing depths in the bay are 2–4 m, the maximum depths (6–7 m) being found in its central part.

Amudarya, Amu-Darya (*Oxus* (Lat.), *Ox* (ancient Greek name, a changed local name "Vakhshu"), Oke or Okey, Araks (Antique); Djeikhun (Arab) translated as "Wild", "Amudario" (Uzbek) – by watershed and water flow, the largest river in Central Asia. "Amu" – from the city, Amul (Amue, Amu, former Charjou), located on the river; and "Darya" from the Persian, "great full-water river." The Amudarya is mentioned in the "History of Northern Courts" (5th century) and in later publications under the name of "Uhu" and the ancient Persian name, "Veh-rud." Beginning in the 14th–15th centuries, the name Amudarya came into local use. It flows over the territories of Tajikistan, Turkmenistan, and Uzbekistan, though its watershed basin also includes Kyrgyzstan. It originates in Afghanistan at the Vrevsky glacier (altitude: 4900 m) where it is called "Vakhadjir," then it begins flowing as "Vakhandarya." After confluence with the Pamir River, it becomes the "Pyandj." Below the confluence of the Pyandj with the Vakhsh, it is called "Amudarya." The length from the confluence of the Pyandj and Vakhsh Rivers is 1450 km; the total length of the river from the origin of Pyandj is 2574 km. It flows into the Aral Sea from a total watershed area of 465 thou sq. km, of which only the mountainous area (227.8 thou sq. km) generates runoff. The main tributaries are found in the mountainour area of the basin: Gunt, Bartang, Yazgulem, Vanch, Kyzylsu, Kafirnigan, and Surkhandarya. The tributaries join the river in its first 180 km stretch: at the 12th km from the left the Kunduz (Surkhab) River (Afghanistan); at the 38th km from the right, the Kafirnigan River; at the 137th km, the Surkhandarya; and at the 180th km, the Sherabad River. Downstream from the Surkhandarya mouth, the Amudarya runs out to the *Turansky Lowland* (see) and receives water from no other tributaries before reaching the sea (1200 km). In the plains, the Amudarya. flows over the Karakum and Kyzylkum Deserts. In the lower reaches, it forms *the delta* (see) with an area of approximately 9,000 sq. km. Its average many-year flow is evaluated at about 70 cu. km, a number subject to significant variations depending on water abundance in a year. Out of the total flow, 19 cu. km or 24% comes from the territory of Afghanistan. Currently, the flow is almost completely regulated and is withdrawn mostly for irrigation purposes, the main cause of the drying up of the Aral Sea (the water level in the sea dropped from 53 m abs. elev. in 1960 to 29.6 m in 2006).

In its lower reaches, the river enters from the *Tuyamuyun narrow* (see) and then runs for about 260 km over the valley as far as the *Takhiatash settlement*

(see). The total length of the river from Tuyamuyun to the Aral Sea is 452 km. The width of the valley reaches several dozen kilometers. Its slopes smoothly merge with the surrounding terrain. The river floodplain widens to 6–10 km and abounds through lakes and meandering arms. During high-water periods this area floods. The riverbed is highly furcated, though in areas of parent rock outcrops (Djumurtau, Kipchak, Takhiatash) it narrows to 0.3–0.4 km. The lower reaches are heavily affected by bank erosion (*deigish*, see).

The basin is sharply broken into a mountainous area, where runoff forms, and a flat area, where runoff spreads. In the past, about 2600 lakes were found in the lower reaches, though at present nearly all of them are dried out due to insufficient flow coming to the delta and a dropping of its base level of erosion. The Amudarya has glacier-rainfall recharge and its water regime is characterized by a high flow in summer and a low flow in winter. The greatest water flows are observed in July–August and the lowest are in January–February. It freezes only in its lower reaches, mostly within the delta area (near Nukus for approximately 4 months).

Water flow begins increasing in March-April, with the March-May period characterized by non-stop rainfall augmenting the general rise of water level, causing sharply pronounced peaks of small duration. In June, July, and August, the water flow is the highest due to glacier and snowfield melting.

Before regulation, the spring flood coincided with the beginning of snow melting and rainfall, while the summer flood was fed with thawing waters from glaciers and permanent snow. The water in A.R. is very turbid, taking first place in Central Asia and among the top rivers in the world by this parameter (its sediment flow is twice as large as that of the Nile). In the peak of the summer flood (June), the river resembles a mud flow running at a speed of 15 km/hour (4.17 m/s).

In the past, the lower reaches of the river were navigable; however, large flow velocities (over 1 m/s) and a great number of shallows, a breakdown of the riverbed into arms up to 1 m deep, and a great quantity of suspended sediments cause difficulties for shipping. To maintain normal conditions, extensive channel-improving and bottom dredging efforts are needed along with releases of about 250 cu.m/s of water to the river mouth (downstream of the last water intakes). In recent years, the water intake from A. in springtime (March–April) for irrigation purposes has grown, so the lower reaches do not receive the water flows necessary for normal shipping.

In the A. basin there were 88 hydraulic structures, of which 36 are water intakes, 341 km of which are canals of interstate significance, and more than 100 of which are hydrological stations, among others.

The Karakum Canal is intensively used for irrigation water supply (at present called the Karakum River or Turkmendarya). Via the Amu-Bukhara and Karshi canals, A. is linked with the piedmont drainless areas of the Zarafshan (378 km long) and Kashkadarya (877 km long). One of the spawning rivers for *bastard sturgeons* (see) is found 1800–2600 km from the *fattening area in the Aral Sea* (see). Such cities as *Urgench, Nukus* (see), and Termez are also found on A.

According to Moslem myths from the late Middle Ages, four of the world's largest rivers have their origin in Edem, flowing from under a crystal dome into the world. These rivers are the Nile, the Tigris, the Euphrates and the Djeikhun (Amudarya).

The Amudarya, in the basin of which such ancient Central Asian states as Khorezm (in the river mouth), Sogdiana, and Bactria (in the middle and upper reaches) were found, has been known from Ancient Times. In the Neogene a powerful predecessor of A. – Pra-Amudarya – flowed through the central part of the Karakum Desert and further westwards to the Caspian Sea. About 70 thousand years ago it turned to the north and, having cut a deep narrow near Tyuya-Muyun, reached the Khorezm trough where a large lake was formed. The enormous quantity of sediments brought here with water gradually deposited in the lake turned it into a flat plain. About 10 thousand years ago, A. flowed westwards and reached the *Sarykamysh Depression* (see) having turned it into a lake. Fresh waters that filled the Sarykamysh partially flowed from it along the *Uzboy* (see) to the Caspian Sea. Deposits were gradually built-up in the river delta and soon its flow to the Sarykamysh became obstructed. About 4 thousand years ago or, according to other sources, about 10 thousand years ago, A. turned to the north and flowed into the huge *Aral Depression* (see) that later on became a lake-sea.

Arab geographers Ibn-Khordabek (about 847), Ibn-Rust (between 903 and 913), Masudi (died in 956), Istakhry (about 951), Ibn-Khaukal (976) evidenced that A. (Djeilhun) flowed into the Aral Sea.

Fig. 5 Amudarya River near Khiva (http://cache.eb.com/eb/image? id = 69539&rendType Id = 4)

Amudarya basin museum – opened in 1993. It is located in a specially constructed building near the Takhiatash dam on the right bank of the Amudarya River. The exposition included materials showing the history of irrigation and hydraulic construction development in the Amudarya basin.

Amudarya navy fleet – a unit of the military department of tsarist Russia. It was created in mid-1888 on the Amudarya River with a view to support transportation during construction of the Trans-Caspian railroad and to safeguard waterways. The base in Chardjui (Charjou, presently Turkmenabad) was under command of the Turkestan military area. In 1897, the flat-bottomed ship "Great Duke" built in Abo (presently Turku) in Finland was brought to Charjou. In 1901, the fleet comprised 6 paddle steamers, 2 steam cutters, and 13 barges. In 1917, it took the side of the Soviet power.

Analogs of the Aral Sea problems – on the globe level, there are some lakes that face problems similar to those of the Aral Sea, in particular drying out due to excessive withdrawal of flow of the rivers feeding them. Among such analogs are lakes Mono, Pyramid, and Salton in the USA, Lobnor Lake in China, Lake Victoria in Africa, Murray-Darling River basins in Australia (analog of the Amudarya-Syrdarya river basins). These analogs are presented in a small booklet, "Brothers in Misery: Analog Problems of the Aral Sea Basin" published in 1997 by *NIC MKVK* (see). It should be noted that in 2003 in Liege (Belgium) at a special *NATO Meeting "Dying and Dead Seas"* (see) it was stressed that the situation observed in the Aral Sea is similar to the problems of the Dead Sea, Balkhash Lake, Kingai-Hu and Ebi-Nur lakes (China), Eyre and Korangamite lakes (Australia), Chad, Quota, Rudolf, Tanganyika, Nyasa lakes (Africa). Of course, the causes, both natural and man-made, of water level fluctuations in these lakes differ, but the consequences are similar to a great extent.

"Anthropogenic degradation of lands in the Aral Sea basin" map – a map at scale 1:2500000 prepared in 1993 by the Institute of Desert Studies of the Turkmen Academy of Sciences. Applying a system of symbols, this map provides characteristics of the following processes: vegetation degradation, deflation, water erosion, irrigated land salinization, land salinization due to a water level drop of the Aral Sea, man-made desertification, pasture waterlogging in the zone of irrigation canals, air pollution in urban areas. All criteria are grouped into three classes: (1) by degree of geosystem degradation – from undisturbed to slightly disturbed; fairly disturbed; from heavily disturbed to complete loss of biological productivity; and (2) by class of geosystem degradation – slight, moderate, and strong; and (3) lands that are practically not used in the economy, such as natural drifting sands, solonchaks, outcrops of parent rocks and territories close by their utilization regime to nature preserves (a strip along the frontier of the former USSR). As there are no data about the "background level"' of geosystems, the first class includes geosystems undisturbed or slightly disturbed. Here the authors proceeded from the fact that practically the whole territory of the Aral Sea basin was affected by anthropogenic activities. These lands are not anthropogenically affected and that is why their degradation was not assessed.

Antipolder – a system of small water bodies created in the dried part of the Amudarya delta. The development of such system was elaborated by *SANIIRI* (see).

Arabian-Aral water transportation route (AAWTR) – a project developed by the Water Problems Institute of the Uzbek Academy of Sciences about joint

interstate utilization of a part of the flood flow of the Indus and Ganges rivers for the purposes of the socioeconomic development and environmental improvement of the habitat in arid territories of a group of states of Southern, Western, and Central Asia. Some specific features of AAWTR are as follows: an interstate regulation of the flood flow by large reservoirs, pump water lifts, and high power consumption. AAWTR construction may ensure lower damage from floods of donor-rivers; navigation links among states of the region with access of the Central Asian republics to the sea routes; irrigation and development of arid zones in Beludjistan, Systan, Gerat, Khorasan; employment possibilities for the growing population; harnessing of hydropower resources; environmental enhancement in the Circum-Aral region; and better water quality in the Amudarya River basin. Water sharing between the states of the Iranian Plateau and Central Asia is nearly equal. According to preliminary estimates, the cost of AAWTR construction will be 20–30 bill US Dollars depending on the headwater intake volume. Annual costs (conventionally 10 states) may be as high as 120 mln US dollars. Feasibility studies and feasibility report preparation are to be carried out jointly by all interested states.

Aral – a fundamental monograph prepared by French scientists René Létolle and Monique Mainguet published in 1993 by the French "Springer-Verlag-France" Publishers. The preface to this book was written by Professor N.F. *Glazovsky (see)*. The book includes 357 pages, 120 black–white, and 47 color photographs. Both French scientists visited the Aral more than once as international experts participating in investigations and addressing Aral problems. The book has 8 chapters: Chapter 1 "Introduction", Chap. 2 "Between Europe and Asia: Geography and Geology of the Aral Sea Basin", Chap. 3 "History of the Aral Region: Crossroads of Civilizations", Chap. 4 "Live Nature, Soils, and Vegetation of Turan: Agriculture, Animal Husbandry and Fishery Development", Chap. 5 "Aral Region Management: Giantism and Fragility", Chap. 6 "Aral Tragedy: Complex of Problems", Chap. 7 "Que faire?", Chap. 8 "Conclusion".

Aral-88 – the first All-Union Integrated Scientific-Publishing Expedition organized on the initiative of editorial boards of "Pamir" and "New World" journals. The expedition was led by writer and journalist G.I. Reznichenko. The expedition conducted investigations in the Amudarya, Syrdarya, and Aral basins. One of the results of this expedition was the book *"Aral Disaster"* (see) by G.I. Reznichenko published in 1992.

Aral and its problems – a special heading that appeared in 1999 in the Journal, *"Problems of Desert Development"* (see) (Ashgabat, Turkmenistan), that publishes articles devoted to investigations of the Aral Sea.

Aral Asp (***Aspius aspius ibboides***)* – anadromous fish of the carp family (*Cyprinidae*). The body length is up to 80 cm and weight up to 5 kg. Most often found in the Aral Sea basin. In spring (February–March) and autumn (October–December) the fish migrates into rivers. It reaches maturity in its 4th–5th year. Spawning: early spring. A predatory fish, it feeds on sand smelt, roach, sichel, and white-eye. Commercial fishing tools used are nets and shore seines.

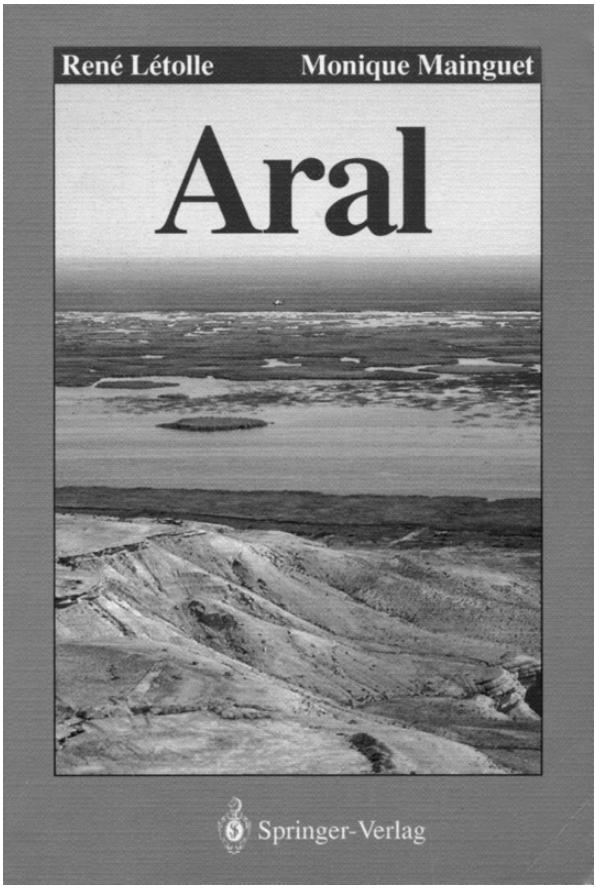

Fig. 6 Letolle R., Mainguet M., 1993. Aral. France: Springer-Verlag

Aral Barbell (***Barbus brachycephalus***)* – the migratory fish of the carp family (*Cyprinidae*). Its length is up to 1 m and weight up to 20 kg. It is fattening in the open sea. The maturity is reached in the 5th–6th year of age. It migrates to the Amydarya and Syrdarya 10–12 months before spawning. It usually selects the grounds for spawning behind sand bars with solid ground where the water current is not high and a depth is 1 to 2 m (the spawning peaks during the highest water level in a river). The eggs are pelagic, reaching 4.6–6.8 mm in diameter, and fecundity is high (193–540 thousand eggs). After laying eggs, the fish return back into the sea and feed mostly on mollusks there. The greater part stay in the river for no more than one year where they eat profusely and then migrate to the sea. Most often found in the Aral Sea basin and in the Chu River. Valuable commercial fish. Prior to 1960, up to 20 thou tons were produced here. In the sea it is caught with shore seines and in the river it is caught with drift nets. The monograph "Aral Barbell," written by L.P. Pavlovskaya, was published in 1975.

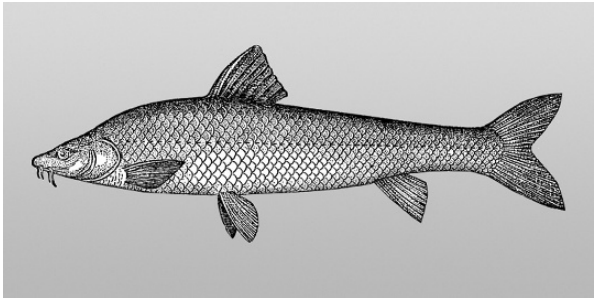

Fig. 7 Aral barbell (*Barbus brachycephalus*)

Aral bastard sturgeon (***Acipenser nudiventris***)* – the only representative of the sturgeon family (*Acipenseridae*) in the Aral Sea. Apart from the Aral it is found also in the Black, Azov, and Caspian seas as well as in the Balkhash Lake where it resettled from the Aral in 1933. Young bastard sturgeons that were hatched in the Balkhash basin are already found in the Ily River. The A.B.S. are mostly 12 to 21 years in age. They lay eggs in rivers with stony beds in April at water temperature 10–15°C. The sturgeon may hibernate in a river till next spawning. They are referred to as early-run fish. Most of the eggs are eaten by the barbells and other fish. From 1936, a high death rate was recorded among the sturgeons due to suffocation caused by attacks of parasite *Nitschia sturionis* that, most probably, was brought here from the Aral together with the starred sturgeon. The catches of the bastard sturgeon dropped sharply from 3497 quintals in 1933 and 6209 quintals in 1936 to 417 quintals in 1937.

Aral beautiful fish – fishing of sturgeon in the A.S. was started by the Urals Cossacks who in 1875 were expelled from the Ural Cossack Troops and deported to the Turkestan Territory for opposing the new code that stopped the election of chieftains. Most of 2500 Cossacks with their families were included into the Kazalinsky military workers battalion. At first, fishing was strictly local and fish was caught for eating. Later, fishing of the Aral *ship* (bastard sturgeon) (see) reached commercial scales and here the fishing of Asian *shovel-nosed sturgeons* (see) was widespread locally. Because of their "long" tails, the aboriginal population called them mouse- and snake-tailed fish, wizard fish, devil, witch and mirage. It was not only a bad omen to eat such fish, but also to catch or even cast a glance at it. In their regulations, the Shi'ah Moslems prohibit eating sturgeon after its descaling, while other theological schools refer to this fish as unclean food. That is how food restrictions of the Islam played a key role in protection of the sturgeons in the Aral basin before Central Asia was included into the sphere of the Russian interests. According to incomplete data, in 1885 the catch of bastard sturgeons was 38500 specimens. The fish was delivered via caravan routes to Orenburg, Tashkent, and Merv, while fishery producers – the brothers Vanyushins – brought it to the Caspian Gulf Mertvyi Kultuk. After establishment in 1892 of the Turkestan Farming and State Property Department at the Ministry of Farming and State Property,

fishing regulations were enforced, prohibiting fishing locations and periods. A strong impulse for the development of the Aral fishery industry was given by the opening of the Orenburg-Tashkent railroad. In 1905, it connected Turkestan with the metropolis.

A possibility to supply Aral fish to the enormous state market immediately attracted the investments of Astrakhan fish producers (for the most part) and spurred very rapid industry development. While in 1905 a total of approximately 3000 tons of fish were supplied, in 1910 this figure increased 11-fold to 33,400 tons. At the same time, the Aral Sea became a water body of state significance. Its southern part was especially important (the mouth of the *Amydarya* (see) because it provided up to 65% of the whole fish output.

The Aral bastard sturgeon migrated to the Syrdarya from mid-April to late August. The greatest catches were in summer, from June through mid-September. The Aral fishermen used such fishing tools as drag seines; stationary, drift and racing nets; akhans; fuke hoops; trotlines; baiting lines; karmak; and trandada. The aboriginal population used such tools as "*kazy*", "*syuzeke*" (landing net) and "*chanishke*" (fish spear). The specific feature of the Aral catches that distinguishes them from the Caspian catches was the dominance of bone fish. At the record high catch in 1908 (1275 tons), the share of bastard sturgeon in the total fish supply was approximately 8%, but in the 1920s–1930s was steadily about 1% of the total catch. The fish producers applied twice for permission to introduce here the starred sturgeon and twice received negative responses from the fishery industry department of the Russian Empire. In 1925, the Soviet Government decided to introduce the commercial fish. In 1934, 300 tons of bastard sturgeon caught here were transported for the first time from Astrakhan. In 1936, a mass death among bastard sturgeons started in the Aral affected by the Caspian *Nitzschia sturionis*, a sturgeon-specific parasite. After 1940, the catches of bastard sturgeon became much less and did not exceed 10 t/year. In 1971, Aral sturgeon fishing ceased to exist completely.

Aral canal* – an artificially deepened waterway connecting the *Aralsk Bay* (see) with the *Greater Sarychaganak Bay* (see). The depths of 3.5–4 m are maintained by periodic dredging. The canal length is 1.6 km, and its width ranges from 60 to 100 m.

Aral-Caspian region, Aral-Caspian basin, Aral-Caspian closed area of internal flow – by its size (4900 thou sq. km), one of the most significant regions in Eurasia. Termed a drainless area because its runoff does not reach the World Ocean but lingers in inland bodies of water, it is second only to the eastern region of Northern Africa in this regard. It is usually divided into two large parts – the Caspian Sea and *the Aral Sea* (see). Natural scientist A. Humboldt, taking into account the common physico-geographical features of the Aral and Caspian seas, linked together both sea-lakes and gave them one common name, the "Aral-Caspian basin." Apart from its drainless nature, the other important feature is the obvious aridity of the region because it is located in desert and semidesert zones. The region covers the following physiographical areas:

circum-Caspian lowland, plains and plateaus of Western and Interior Kazakhstan, Betpak-Dala and Mainykum plateaus, Turan lowland, the Ustyurt and Mangyshlak plateaus, offspurs of the North-Afghanistan Paropamiz (Karabil and Badkhyz low mountains), Messerian plain, Gorgan and South-Caspian lowlands, Lenkoran lowland, Kura-Araks lowland, Terek-Kuma lowland, and Kuma-Manych depression.

Administratively, the Aral-Caspian region completely covers the territories of the Uzbekistan and Turkmenistan Republics and includes parts of the territories of the Russian Federation, Kazakhstan, Kyrgyzstan, Tajikistan, Azerbaijan as well as small parts of the territories of both the Islamic Republic of Iran and the Republic of Afghanistan.

"Aral" consortium – a Union-Republican consortium formed in December 1990. Its founders are the governments of Uzbekistan, Kazakhstan, Kyrgyzstan,Turkmenistan and Karakalpak Republics, State Concern "Vodstroy," Khorezm, Kyzyl-Orda, and Tashauz Regional Executive Committees. The consortium received financial support from the USSR, republican, and local budgets. Its activity was coordinated and controlled by the State Commission of the USSR Council of Ministers on Emergency Situations. The Statute of the consortium, pursuing a single scientific-technical and investment policy, identified as its key targets the elaboration and implementation of the program on the improvement of the situation and living conditions for the population in the circum-Aral region and also the revival of the Aral Sea.

Aral crisis – a monograph by *N.F. Glazovsky* (see), Doctor of Geography and Corresponding Member of the Russian Academy of Sciences. It was published in 1990. The monograph reviews the history of the Aral problem, provides an overview of the natural environmental state and the economic condition in this region, identifies the causes of such crises, defines likely ways for addressing them, and discusses basic tasks of scientific research.

Aral crisis (historical and geographic prospects) – a collection of articles prepared by the *Research Coordination Center "Aral"* (see) and the N.N. Miklukho-Maklai Institute of Ethnology and Anthropology of the Russian Academy of Sciences. It was published in Moscow in 1991. The materials of this collection mostly deal with the history of water and land resources development in the Aral Sea basin.

Aral depression* – the center of the Circum-Aral area located north of the Turan plain on elevations below 60 m (abs.). It has a complicated morphological structure. In the east and south it joins the Aral Karakum lowland (90–100 m abs.) and Aral Kyzylkum lowland (130–160 m abs.). On the west, it is rimmed by the relatively elevated structural-denudation, the *Ustyurt Plateau* (see), that was formed as a result of recent uplifts of the bottom of the sea that existed here in the Miocene. There is an opinion that the A.D. originated mostly due to exogenous processes such as erosion, salt carryover, and deflation (wind destruction of mountain rocks). About 2 million years ago these factors contributed to shaping its basic relief forms and those of the surrounding

Aral-Sarykamysh depression. Originally, A.D. was much larger than today and represented a system of deep (150–200 m) deflation basins having appeared in the Upper Pliocene. Wind erosion was the main factor in the A.D. formation. The volume of wind drift was 15 thou cu. km. The north of this depression borders on the plains of denudation composed of marine sediments that in some places were partially blown from the surface. In such places Aeolian sand areas were formed. To the northeast, east, and south of the A.D., the differently aged alluvial-delta lowlands of Syrdarya and Amudarya, including the Near-Sarykamysh (50–100 m), Akchadarya (60–100 m), Circum-Aral (60–80 m) lowlands as well as the Sarykamysh (minus 20–55 m) and Assake-Audan (30–100 m) depressions, extend. They have formed from the Late Pliocene until the present. They slope toward the A.D. and gradually disappear under the sea forming its most shallow areas. In the meridional direction, between the Muinak and Kulandy Islands, A.D. is crossed by a tectonic rampart. The Vozrozhdeniya, Lazareva, Komsomolsky, and other islands form its highest parts. Such locations of the basic genetic types of the relief on the terrain around the Aral may be attributed to the strictly asymmetric structure of the depression. The eastern part of the depression is characterized largely by a flat topography with prevailing slightly inclined, slightly terraced shelf plains with dominating slopes making fractions of a degree. Such smoothly sloping plains surround the flat bottoms of the basins. The largest of them covers the central part of the Large Sea, while little ones are found in the north within the Small Sea. The structure of the western part of the Aral Depression is somewhat different. Here, the long and narrow Pre-Ustyurt trough runs between the Muinak-Kulunda tectonic rampart and the eastern chinks of Ustyurt. It is associated with the greatest sea depths. The elevations of the trough bottom in its deepest parts reach 19 to 13 m below sea level. The trough has rather steep sides (over 3–5 degrees) with the steepest slopes becoming cliffs in some places and coming together under the Ustyurt chinks, around the Barsakelmes Island, and nearby some abrasion coasts of the Small Sea made up of the parent rocks.

All circumstances of the A.D.'s appearance – its filling with water and formation of the modern water basin – have been studied, but insufficiently, although the basic stages of their geological history are known. The Aral evolution is connected with geomorphological (formation of the sea basin) and hydrological (its filling with the river flow) processes. Their interactions are complicated. An important role in Aral paleohistory was played by numerous migrations of the Amudarya riverbed and related periodical flooding and drying of the Sarykamysh Depression and the ancient riverbed of Uzboy.

Aral disaster – the problem of the Aral Sea drying out with all its consequences; often mentioned in scientific and popular publications.

Aral disaster – a diary of the expedition "Aral-88" written by well-known journalist G.I. Reznichenko that was published in 1992 in Moscow. The book discusses the issues related to the death of the Aral Sea and deterioration of the environmental situation in the Aral region. The author was the chief of the

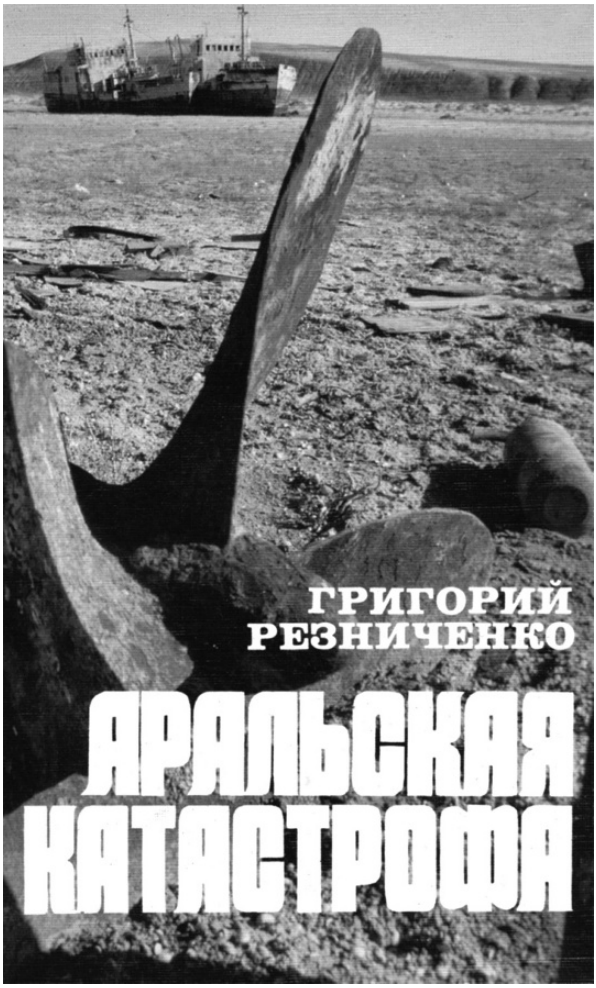

Fig. 8 Reznichenko G.I. Aral Disaster (1992)

scientific and journalistic expedition that was carried out in 1988. He tells the readers about the critical situation in this region and calls to take urgent actions to remedy it.

Aral environmental crisis, Aral crisis, Aral disaster, degradation of the circum-Aral natural complex – a serious environmental problem that arose in the 1960s and that is connected with the Aral Sea's drying out. The sea water level in 2007 became 23.7 m lower than 1960 at an elevation of 29.9 m (January 2007). Sea water salinity reached 90–150 g/l (2006). As a result, about 4.5 mln ha of the sea bed became exposed and turned into a vast solonchak desert – *Aralkum* (see). The area of solonchaks has increased from 85 thou ha to 273 thou ha. The groundwater level now drops to 8 m depending on the distance from the sea shore. The ingress into the river beds is up to 10 m. The *desertification processes*

(see) are going on; there is a real danger of a merging of the *Ustyurt* (see), *Karakums* (see) and *Kyzylkums* (see). In the Circum-Aral area within a strip 150–200 km wide, climate change and a growing amplitude of annual temperature variations have been recorded. The summers have became hotter and the winter colder. The soil cover has also changed: the area of hydromorphic soils has shrunk from 630 to 80 thou ha. In the lower reaches of the Amudarya and Syrdarya a hundred thousand hectares of pasturelands that once might have boasted great species diversity have dried out. The area of *riparian forests* (see) has been reduced from 1300 to 50 thou ha, along with a 20-fold reduction in reed thickets, from 600 to 30 thou ha. Many valuable plant and animal species (in particular birds and fish) have disappeared. Many bays and lakes around the sea have dried out quickly. The surface area of lakes in the Amudarya delta was reduced from 400 thou ha in the 1960s to 26 thou ha in 2001. Progressing intensively are the deflation of bottom sediments – sand, dust, salt, and their drifts – during strong windstorms at a rate of 0.1 to 2.0 t/ha. The annual volume of their drift is 500 km or so and is as high as 75 mln tons. The width of the area affected by dust-salt storms is 40 km and the length is 400 km. The dust and salt spread with winds and atmospheric precipitation deposition in the *Circum-Aral area* (see) where 3.5 million people now live.

Aral Karakums (Aralmany Karakums) – ancient lowland with absolute elevations 90–100 m and channel-like depressions up to 70–80 m. It extends over the north–east of the Circum-Aral Area to the north of the Syrdarya lower reaches. Its relief was formed on the alluvial-deltaic, mostly sandy deposits of the Late Pliocene with a thickness up to 14–20 m. It was strongly affected by eolian processes. At present, a sandy desert topography is developed here: the sands are characterized by the hillocky and cellular and, to a less degree, the ridge-barkhan relief (the Terentikum, Yesentkum, Buyalykum, Kesekum sands, and others). The depth of its dissection varied from 1.5–3.0 m to 5–10 m. In the low-lying desert there were found some isolated structural-denudation plateaus (Yakhshiklych with elevations up to 150 m and others). A gradual transition of the lowland into the Aral Depression was observed, with altitudes dropping to 68–72 m abs. in the north-east.

Aral Kyzylkums – confined by the Zhanadarya deltaic plain on the north-east, east and south. Its western part located mostly within the Akkyr-Kumkialinsky tectonic saddle separating the East-Aral Depression from the Syrdarya Depression. The plain was formed in the Late Pleistocene-Holocene by the Syrdarya waters. This flat, mostly clay (takyr) plain dropped from elevations 130–135 m in the east nearby the Syrdarya to the level of terraces of the Aral Depression. It was composed of sands and loams up to 20 m thick. The plain was dissected by recent channels of Syrdarya arms, such as Inkardarya, Zhanadarya, Kuvandarya and others traced from the Syrdarya as far as the Aral. Not long ago (in the 1970s) some of them (Zhanadarya and Kuvandarya) were used for periodic releases of waters from the Syrdarya. The massifs of eolian sands and remnants composed of clays with wind-formed sandy ridges were met in some places on the plain. The sandy massifs on the plain were represented either by the remnants separated by deltaic arms from