The Aral Sea Crisis Region

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Abstract. The term Aral Sea crisis region covers the lower stretches of the rivers Amudarya and Syrdarya, where the effects of the diversion of the river water from the Amudarya and Syrdarya are a blatant case. The drying of the Aral Sea, according to the Scientific Board for Global Environmental Changes of the German Federal Republic (WBGU), was declared the greatest environmental disaster caused by mankind in this century by changing the regional water budget. The disintegration into smaller water bodies is reality. Meanwhile the knowledge and information basis on the status of land degradation and on current activities in the crisis region is still insufficient. Up-to-date information on monitoring of land use and of the situation of the ecosystems in the crisis region is important, since the ecological situation is very dynamic and unstable. Degradation and desertification are threatening the whole population of the area and endangering their basis of living.

Introduction

The huge irrigation projects in Central Asia during Soviet times are the main cause for the catastrophic desiccation of the Aral Sea. The luxury use of the water resources of the Aral Sea basin have led to a severe loss of equilibrium between the natural water sources in ecosystems and the water use in agricultural irrigation. This predominantly unintentional and unreflected water use has led to an agricultural system characterized by extensive use of water and thus to steadily increasing damage to and impact on the ecosystems of the whole Turan Basin.

The Aral Sea can be regarded as the centre, where all the political and other interests of the new Central Asian states are connected to each other. The

northeastern half of the Aral Sea belongs to Kazakhstan, the southwestern half to Uzbekistan. The catchment area of the two large rivers, the Amudarya and the Syrdarya, are part of the mountain republics Tadzhikistan and Kirgizistan, but the main water consumers are Kazakhstan, Turkmenistan and Uzbekistan (Kuznetsov 1986; Agachanjanz 1988; Glazovskii 1990; Letolle and Mainguet 1996; Walter and Breckle 1994; Klötzli 1997; Micklin and Williams 1996; Breckle et al. 1998).

The term Aral Sea crisis region covers the lower stretches of the rivers Amudarya and Syrdarya, the Aral Sea and adjacent surroundings, where the effects of the diversion of the river water from the Amudarya and Syrdarya are a blatant case (Giese 1997). This is mainly the case for the districts of Khorezm and Karakalpakistan in Uzbekistan, the districts Kzyl–Orda in Kazakhstan and Tashauz in Turkmenistan. The area of this region is about 500 000 km^2, the population about 3 800 000. It is likely that especially Karakalpakistan is severely affected, along the lower stretches of the Amudarya. In September 1995 the Nukus Declaration was adopted by the Central Asian States and by international organizations, declaring as an important aim the solution of the problems of the region by a development of a sustainable environment in the Aral Sea Basin. Since then, some activities in the region have started: attempts to supply the towns and cities with clean drinking water; projects to improve land use; construction of dams for better water use in agriculture etc.
Meanwhile the knowledge and information basis on the status of land degradation and on current activities in the crisis region is still unsufficient. Up-to-date information and the monitoring of land use and of the situation of the ecosystems in the crisis region are important, since the ecological situation is very dynamic and unstable. Especially the process of water loss of the Aral Sea has now become crucial. The salt concentration of the Aral Sea water is now higher than sea water; the new dry sea floor is strongly saline. Salt desertification in the Aralkum covers huge areas, thus forming salt deserts which are the main source of salt dust and sand storms. The delta areas are suffering from lack of water, the remaining tugai forests have died and were cut down, the oases are suffering secondary salinization. Degradation and desertification are threatening the whole population of the area and are endangering their basis of living.

The Aral Sea

Formerly (before 1960) the Aral Sea was the fourth largest inland lake on the globe with a surface area of about 68 000 km^2. Since 1960 the surface area has decreased drastically (see Table 1). About 80% of the water body and about 60% of the water surface have been lost (Fig. 1). The area of the dry sea floor, the Aralkum, is about 40 300 km^2 (level 1999).
The drying up of the Aral Sea according to the Scientific Board for Global Environmental Changes of the German Federal Republic (WBGU) was declared the greatest environmental disaster which mankind has caused by changing the regional water budget. The developing new land was called the Aralkum desert (see also Walter and Breckle 1994). It is obvious that the speed of drying up and the increase in the dry sea floor area in the 1980s was especially fast. The water supply by the rivers to the Aral Sea in this time dropped to about 4 $km^3\ a^{-1}$, before 1960 it was on average about 60 $km^3\ a^{-1}$. During the past years, in the 1990s, the average water input to the Aral Sea has increased again to about 14 $km^3\ a^{-1}$. This is

a very positive sign, which in future will slow down the drying out of the Aral Sea.

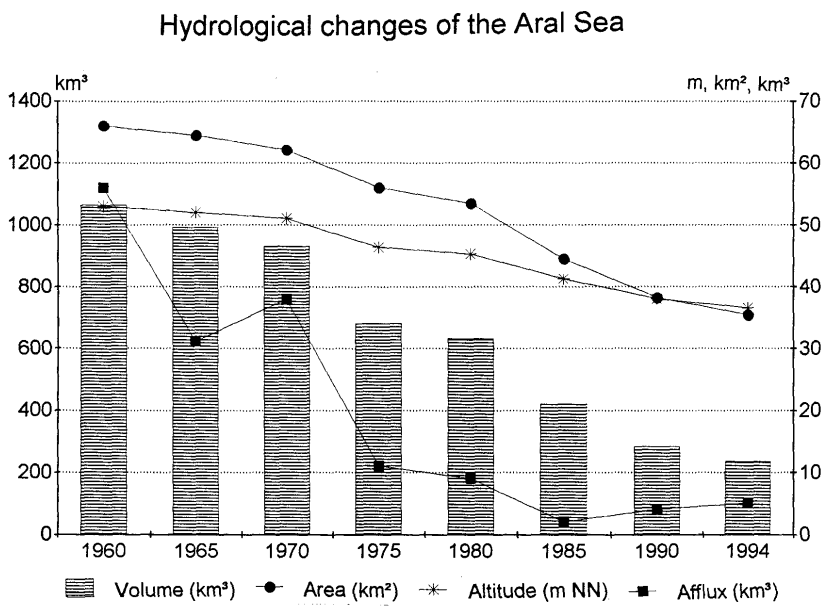

Fig. 1. Dynamics of the water volume and sea level of the Aral Sea

Table 1. Dynamics of the water surface area of the Aral Sea and dry sea floor. Data from 1960, 1970, 1980 according to Aralskoe More (1983), for 1990 from Ressl (Aral Sea Homepage 1999) and for 1999 from B. Geldyev

Year	Water level (m NN)	Water surface (km^2)	Area of dry sea floor (km^2)
1960	53.4	68 000	0
1970	51.5	61 000	7 000
1980	46.0	52 000	16 000
1990	38.5	38 800	29 200
1999	[a]	27 700	40 300

[a] In 1999 the water level in the Small and the Great Aral Seas were different.

However, the situation has reached a status where the dynamics of the northern and the southern sea basin have started to be different and the formation of

separate sea basins started: the northern Small Aral Sea and the southern Great Aral Sea; the Great Aral Sea is almost divided north–south by the island Vozrozhdenie into the deeper Western Aral Sea and the shallower Eastern Aral Sea. This disintegration into smaller water bodies is almost reality, as well as the new terms, Aralkum and Aral Sea Syndrome, as complex phenomena of various desertification processes.

The Ecological Situation of the Great Aral Sea Area

The lowering of the sea level of the Great Aral Sea is still continuing. The water level of the Great Aral Sea in 1999 was about 33.8 m NN and the surface area of the sea was about 24 400 km^2. The drying out of the Great Aral Sea causes four main environmental problems:

- the threat to the existence of the nature reserve Barsa–Kelmes;
- the opening of the former military experimental site by a land bridge;
- the formation of a huge new salt desert between the island Vozrozhdenie and the eastern coast;
- loss of the remnant fish fauna.

During the years 1996 to 1998 a land bridge was formed between the island Barsa–Kelmes, which was originally in the centre of the Aral Sea and then the eastern coast of the Aral Sea. The area between the island Barsa–Kelmes and the peninsula Kokaral is now in a terrestrial developmental phase. The island Barsa –Kelmes is one of the most precious nature reserves within the Central Asian deserts, which was established in 1939. The zonal ecosystems of the island with *Artemisia* and *Anabasis* vegetation complexes are amongst the best-preserved ecosystems of the northern Kazakho–Dsungarian deserts. The flora of the island comprises about 257 species. Some antilopes (*Gazella subgutturosa* and *Saiga tatarica*) as well as the onager were introduced (*Equus hemionus*) on the island years ago. The animal populations of *Gazella subgutturosa* and *Equus hemionus*, which are part of the Red Faunal List, are especially to be mentioned. The natural isolation of this Nature Reserve gave it a perfect protection, thus the status of this area corresponds better with the international rules of IUCN for strict nature reserves than any other protected area in Central Asia. However, in 1999 the island became accessible from the mainland. Geologists from Kazakhstan and from have reached the island, coming from the east coast by four-wheel trucks and have made trial drillings on the island. Native people have started hunting. Without special additional means of protection this former island will rapidly lose its role as one of the most important nature reserves.
It is obvious that by continuous drying out of the Great Aral Sea, it will be soon divided into two separate water bodies. The island Vozrozhdenie will mark the watershed between the Western Aral Sea and the Eastern Aral Sea. The island Vozrozhdenie was formerly the experimental military site of the Soviet army.

Remnants of arms, technique and military supplies are still left on the island, probably also remnants of biological and chemical weapons. It is not known what kind of military experiments were made here. In the very near future the island Vozrozhdenie will be accessible from the mainland as was Barsa–Kelmes. Immigration of animals and people from the mainland might result in unexpected biological effects or toxic damage in the area. Thus, drastic means to prevent uncontrolled access to the area by civilians have to be put into effect, as long as the epidemiological, toxicological and ecological situation of the island is unclear. Caused by the drying out of the eastern part of the Eastern Aral Sea, the formation of another huge open salt desert will occur. The colonization of the dry sea floor on the areas from the 1960s and the 1970s is rather dense, their salinity is low, but the areas from the 1980s and the 1990s are already covered by salt deserts with very isolated single plants only (Fig. 2). In continuation of the increase in salt desert areas, salt and dust storms will become more common and more frequent.

Fig. 2. The salt desert on the dry sea floor at the east coast of the Aral Sea

The increase in salt concentration (to more than 50 g l^{-1}) in the Great Aral Sea has already led to the extinction of almost all native fish species as well as of the plaice (summer flounder), which was introduced several years ago. At the recent southwest coastline of the Kokaral peninsula the authors have seen salt marshes covered by dead plaices.

The Ecological Situation of the Small Aral Sea and the Dam

The water level of the Small Aral Sea in the 1990s exhibited large fluctuations. In 1990 to 1993 the sea level was about 38–39 m NN; the water surface of the Small Aral Sea varied between 2600 and 3100 km^2 and the volume of the water body

was about 17–22 km^3 (Bortnik 1996). In the second half of the 1990s the water level of the Small Aral Sea rose rather rapidly and the water body increased correspondingly (Fig. 3). According to data from the ecological station at Kasalinsk in August 1997, the water level was about 40.3 m NN and in August 1998 at about 41.8 m (according to nivellements at the transect Karabulak by Wucherer). The surface area then had increased to about 3700 km^2. Fishing on a small scale had restarted. The introduced plaice flourished. According to local fishermen, the daily haul reached about 1000–1500 kg. This overall positive development was caused by a drastic decrease in the irrigation area of the paddy fields of the Ksyl–Orda-district, as well as by the construction or reconstruction after damage of a dam between the Kokaral and Kosaral peninsulas, separating the Syrdarya water discharge totally from the Great Aral Sea. Bortnik (1991) has given a pessimistic and an optimistic prognosis for the development of the Small Aral Sea (Fig. 4). It is obvious that the real rise in water level of the Small Aral Sea exceeded even the optimistic variant of the prognosis. The hydrological water budget of the Small Aral Sea and the Syrdarya discharge would enable a recovery of the Small Aral Sea within 5 to 7 years. However, this would need a strong and durable dam construction. The present dam is rather provisionary and primitive (Fig. 5). The material used is solely loose sand and loam; but the local people and the local administration tried to do their best when the situation at the dam became alarming during the spring tides; the whole available technical vehicle fleet was involved. Despite the lack of money and a severe economic situation, the district government of Ksyl–Orda and the Aralsk administration tried to improve the situation of the Small Aral Sea by erecting and repairing the dam. However, in April 1999 the water level rose very rapidly and a storm caused the total breakage of the dam. Figure 6 shows how the water flood wrecked the vehicles. The flood caused huge damage on the northeastern dry sea floor of the Great Aral Sea. The sea level dropped by about 2.5 m. The great efforts of the whole decade (the 1990s) to stabilize the Small Aral Sea were useless.

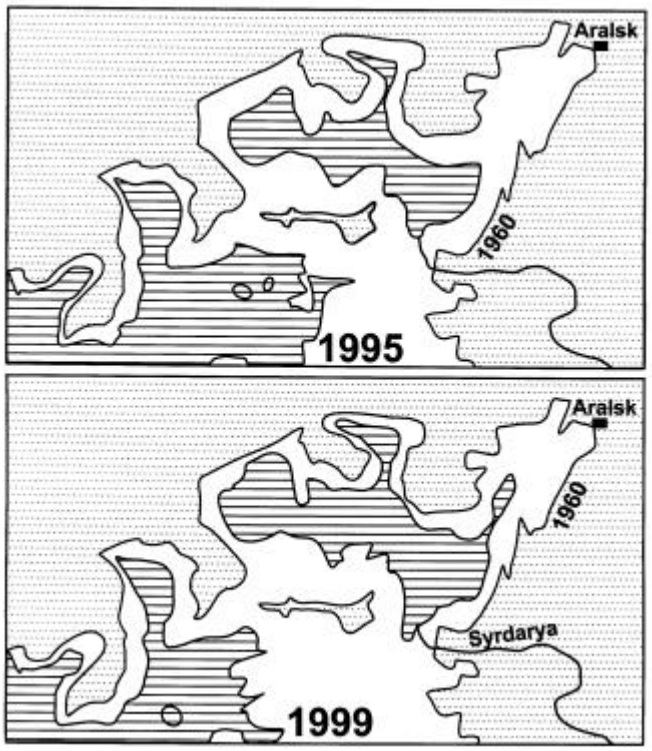

Fig. 3. Increase in the water body of the Small Aral Sea in the past 5 years (1995–1999)

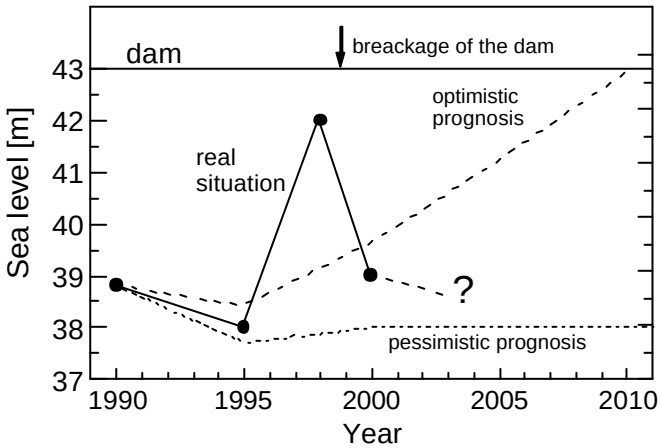

Fig. 4. Dynamics of the sea water level of the Small Aral Sea

Fig. 5. The dam between the Small and Great Aral Sea

Fig. 6. Damaged and abandoned technology on the breakage of the dam

A solid dam cannot be realized without sufficient international help. A sound technical solution to control the sea level of the Small Aral Sea by solving the construction of a solid dam with electric generators etc. will most probably have a whole set of positive ecological and social effects. Maintenance and support of various small villages around the Small Aral Sea, reviving the fishery and support of the city of Aralsk, development of salt marshes, enhancement of a more sustainable economy based on camel grazing, less salt and sand storms etc.

The Aralkum Desert

The Aralkum desert with the remnant water bodies and the recent and older terraces is part of the centre of the Aral Sea crisis region. The dry sea floor is a complicated mosaic of solonchak and sandy ecosystems. The psammophytic

ecosystems were formed mainly during the first phase of drying out until the middle of the 1970s, around the islands of Barsa–Kelmes and Vozrozhdenie until the end of the 1980s. This means that the landscapes dominated by sandy substrates are the typical areas along the former coastline. On the sandy substrates, perennial psammophytic plant communities have developed, mainly *Stipagrostis pennata*, *Eremosparton aphyllum*, *Calligonum* and *Astragalus* species (Fig. 7). On the new dry surface new sand dunes developed rapidly, mainly barchan-shaped. One can distinguish two types of dune systems on the dry sea floor: open dune systems with single dunes, covering much less than 50% of the area; and those with a dense pattern of dunes, covering more than 50%.

Fig. 7. The psammophytic plant community on the southeast coast of the Aral Sea

Since the 1980s on the dry sea floor almost exclusively solonchak deserts have formed. The open dry sea floor of the Aral Sea today is a huge salt flat and a source of salt dust in the larger vicinity. The direct influence of aerosols (salt particles, dust) on the adjacent agricultural areas and their salinization as well as on the natural ecosystems and on the health of the people is still under dispute. The huge salt deserts which have developed since the 1980s are characterized by a rather strong deflation and denudation by wind at a speed of 2 mm a^{-1} (Semenov 1990). This means that the upper 4-cm layer has been blown off during the past 20 years. This investigation takes into account the saline dry sea floor deserts which date from the 1980s. An increasing drying of the sea floor will create even more and greater saline flats, and thus a more enhanced salt dust regime by storms in the near future. This is a threat to the agricultural areas adjacent and beyond the southern and eastern former coast line. It is to be suspected that the salt desertification is spreading in the whole Aralkum and the surrounding areas. Several questions have to be solved: will there be a limit to natural plant colonization? If so, where it will be? How long will the primary and secondary salt deserts prevail? Are there other species which will colonize the dry sea floor?

Is it possible to use phytomelioration (Meirman et al., this Vol.) as a means to effectively combat sand movement, salt dust storms and thus salt desertification?

Deltas and Oases

The drastic cut in discharge of the river waters in the delta areas has caused severe degradation and desertification of soils and dense shrub and river meadow vegetation of the river deltas. In the 1990s the BMBF-UNESCO project studied the delta regions. The main problem of the delta regions again is the unintentional wastage of water. A realistic and sound, sensible and reasonable planning of water use for both nature conservation and overall use in the areas for a sustainable grazing regime is totally lacking. The agriculture of the oases depends totally on irrigation water and again is wasting water. Irrigation certainly has to be kept as the basis for the main agricultural systems in Central Asia. Since the water needs and the consumption will increase in future, the possibilities of water-saving irrigation techniques have to be applied as well as possible, since the extensive increase of irrigated areas is limited. The only solution for the Central Asian states can be to increase the efficiency of water use, to use recycling techniques for water use in order to avoid severe water shortages.

Conclusions

The Aral Sea no longer exists. The separation into smaller water bodies has taken place and will continue. The Great Aral Sea will split into the Western and the Eastern Aral Sea by the continuation of drying out. The Western Aral Sea is rather deep and will remain for a longer time, the shallow Eastern Aral Sea will remain only in small fractions (west of the island Vozrozhdenie). The Small Aral Sea will remain despite the breakdown of the dam. Technical solutions for an improved construction of a new dam for the control of the water level of the Small Aral Sea are necessary.

The nature reserve Barsa–Kelmes is under severe threat. The former island Vozrozhdenie with its military remnants is a great potential danger unless the conditions and the hazardous situation are clarified. For the oases regions and the river deltas, a realistic planning strategy for a sustainable development and nature protection is lacking, but urgently needed. Since the 1980s the development of open salt deserts has increased tremendously, but the natural colonization by plants remains slow in comparison with increased desertification. The increasing by severe effects of salt dust and sand storms from the open dry sea floor and the secondary salinization in vast areas of the whole region, in oases and deltas, is an excellent example of the salt desertification syndrome, which, with all its various threatening aspects for the local economy, is very characteristic for this Central Asian region.

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