# Chapter 1
# The Aralkum, a Man-Made Desert on the Desiccated Floor of the Aral Sea (Central Asia): General Introduction and Aims of the Book

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What is the meaning of "Aral"? The name Aral Sea is not easy to explain. Berg (1908) gave some explanations. He cited several papers where the Aral Sea is called the Sea of the Islands, e.g. by the Russian topographer Rychkov (1762). This interpretation was also taken by von Humboldt (1844) in his book *Zentralasien*, as well as by Berg (1901) in his first publication on the Aral Sea.

The khan of Khiva Abulgazi (1603–1663) in his history book writes, "...1644 I became the khan in the country *Aral*, which is located at the inflow of the Amu to the sea...". The region of the Amu Darya delta was apparently called "Aral". The old Russian geographers called the Uzbeks from the Amu Darya delta the "Aralthsy", meaning the "Aral settlers". Since the delta area is a complex region with many islands and changing water courses, the original word "Aral" was apparently used for this area of islands; later it was used for the whole Aral Sea.

In the sixteenth century the Aral Sea was also named the Blue Sea (*Sinee More*) by Russian cartographers and travellers, as e.g. in the *Kniga Bolshogo Chertezha* (1647). The map by Remesov of 1697 (after Berg 1908) used "Aral Sea" (*Aralsko More*). The Russian czar Peter the Great in an official declaration in 1697 also used the term *Aralsko More* as a synonym for Khiva Sea. In 1716, Peter the Great sent an expedition under the command of Prince Bekovich-Cherkassky to Khiva with a diplomatic mission and to investigate the Uzboi River and the Amu Darya and its relation to the Aral Sea; at that time this term was already in common use. The expedition, however, was destroyed by the khan of Khiva.

In *Kniga Bolshogo Chertezha* (1647) there is a description of the northern coast of the Blue Sea (Berg 1908). Here, the sandy desert in the northeast is called the Kara-kum ("the black sand"; in Uzbek and Turkish *kara* means "black"), which we today call the Priaralski Karakum. In 1664–1665, the Dutchman N. Witsen visited Moscow and translated several texts from the *Kniga Bolshogo Chertezha* (1647). His book (Witsen 1672) used the term "Arakum" (in Dutch *Arakoem*) instead of Karakum for the sandy areas along the northeastern coast. According to the Russians, he used the term "Blue Sea".

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In fact the term “Aralkum”, which we used (Agachanjanz and Breckle 1993), is from 1672. The term “Kyzylkum” is derived from its red sands (in Uzbek and Turkish *kyzyl* means “red”).

The Aral Sea was the fourth largest lake on the globe 50 years ago. Today, the Aral Sea no longer exists.

The Aral Sea basin is located in a vast-stretching tectonic depression. This Aralo-Caspian basin in Central Asia exhibits a dry desert climate. Today, only four more or less saline lakes and some salt swamps exist. The former Aral Sea is (after the dissolution of the Soviet Union) part of Uzbekistan and Kazakhstan (Fig. 1.1). But also Turkmenistan, Kyrgyzstan and Tajikistan and even Afghanistan have territories which are part of the Aralo-Caspian basin.

The Aral Sea no longer exists. Only the Small Aral Sea now has a constant water level. The huge desiccated seafloor (Walter and Breckle 1994; Breckle et al. 1998, 2001) is the source of salt-dust storms and sandstorms. These are affecting large proportions of the villages and agricultural systems in the whole region, as well as the livelihood and health of the people. In the coming years these saline areas will increase even more (Breckle and Wucherer 2006). Within about 50 years a huge


**Fig. 1.1** Geographical Map of Middle Asia, indicating countries and main cities around former Aral Sea

new desert has developed (Fig. 2.7). This desert is caused by human activities and thus is an artificial desert, but all the ongoing processes follow natural laws and are most interesting for science. The area can be called the largest primary succession experiment of mankind (Wucherer and Breckle 2001), or depending on one's viewpoint, one of the biggest ecological catastrophes (Letolle and Mainguet 1996).

There are many plans for tackling and combating the disastrous situation caused, e.g., by the dangerous salt-dust storms (Chaps. 5–7). Public awareness of this giant catastrophe has grown considerably in the last few decades, especially in the 1980s and in the 1990s; this is also documented by increasing scientific interest (Zonn et al. 2009). On the other hand, the exploration of the area in general started relatively late; there have been successful expeditions only since <200 years ago, e.g. in 1848–1849 by Butakov (Uhrig 2008).

The present tragic situation may be improved if the recommendations for conservation and restoration of the sea are applied. Those concepts envisage transformation of development strategies in the region, modernization of the irrigation systems, afforestation and phytoreclamation in the area (Levintanus 1992), as is shown in later chapters.

Within the last 20 years many new developmental projects have been performed. However, most of them need basic knowledge which can only be provided by scientific expertise. So it is necessary to bring together not only interdisciplinary and international scientists in the fields of ecology and geography (with remote sensing, using geographical information systems), but also climatologists, soil scientists, social scientists, economists, nature conservation organizations, developmental and health agencies, other main stakeholders in the area, administrations, decision makers and regional and national politicians.

There were few attempts to study the steadily increasing desiccated seafloor until 1995. Then the BMBF (German Federal Ministry of Education, Research and Technology) financed two research projects of the Department of Ecology at the University of Bielefeld. The first was to study "Succession processes on the desiccated seafloor of the Aral Sea and perspectives of land-use" (1998–2001); the second was to study "Combating desertification and rehabilitation of salt deserts in the Aralkum" (2002–2005). Many open questions needed answers. What ecosystems develop on the desiccated seafloor? What plants may invade those new salt deserts and what vegetation may develop? Can the natural succession be accelerated by seedings or plantings?

Both projects revealed not only interesting and new scientific data and results but they were also able to contribute to better socioeconomic conditions in some villages, and to increase the participatory involvement of stakeholders at the grass-roots level by capacity building. The cooperation with scientific institutions in Kazakhstan and Uzbekistan and with the relevant political administration on various administrative levels gave good opportunities for information exchange and increased mutual understanding in future applications of phytomelioration measures and nature conservation topics.

Sandstorms affect settlements and villages, since their close surroundings are overgrazed and all woody vegetation is cut down. Sand dunes started to develop and to move. This is a local problem in many areas. It should be solved by local wind shelter programmes and rational grazing management, involving activities of all inhabitants.

Salt-dust storms originate mostly from the younger seafloor surface covered by puffy-crusty solonchaks, and from abandoned salinized fields with salt crusts. This is a regional problem. It can only be solved by huge plantings of heat- and frost-resistant as well as drought- and salt-resistant woody plant species to minimize the effects of wind-speed and deflation processes on the soil surface of the fields and especially on the dry seafloor. Huge experimental plantings (Chaps. 15–17) with plots up to 250 ha have shown that only very few species are suitable for this purpose: *Haloxylon aphyllum* and *Halocnemum strobilaceum*. Some other species still need to be tested accordingly (*Halostachys caspica* and *Tamarix*, *Ammodendron, Suaeda* and *Salsola* species). Furthermore, recent evaluation of various experimental sets revealed that special techniques to plant saplings have to be applied and have to be adjusted to the relevant soil situation.

A variety of desert types have been described in the literature. On the basis of surface properties, the following main types have been mentioned: rocky and blocks surfaces (hamada); gravely surfaces (serir); stone pavement surfaces (reg); sandy surfaces (erg), clay surfaces (takyr) and saline surfaces (sabkha, playa or salina). In deserts all these types occur often rather mixed or along catenas. However, about only 15% of deserts is covered with sand fields (erg) (Breckle et al. 2008). The main deserts of the globe are listed in Table 1.1, as are the percentages of sand cover areas within them.

In the Aralkum, about 20% (about 12,000 km$^2$) of the area is sand and sandy-loamy deserts, mainly the first parts of the seafloor which became dry in the 1960s and 1970s (Fig. 2.7). The majority is salt desert (70%, about 42,000 km$^2$), and this situation is rather different from that in other deserts, where sometimes no salt desert may exist (e.g. in the Negev, the Sonoran Desert or the Chihuahua; Table 1.1). The remaining area (10%) is wetlands and remnants of tugai scrub, as well as transformed landscapes that are under the influence of the Amu Darya and the Syr Darya.

From an ecological point of view, sand deserts offer more favourable conditions than other desert types for plant cover and species diversity. This is due to the special characteristics of the sand, namely low water absorption, rapid infiltration rate and especially low evaporation losses (since capillary threads reach only 10 or 20 cm). Thus, all sandy areas represent, even in dry arid deserts, water-storing bodies. The only limitation for plant establishment and plant cover is a high frequency of extreme wind speeds that limit surface stability. In areas where the frequency of extreme wind speeds is low, the sand surface is relatively stable. Under such conditions the establishment of plants takes place spontaneously, leading to increased surface stability by further reducing wind speed and sand mobility, often favoured by biotic crust formation as the primary process (Breckle et al. 2008). This is an important fact for phytoreclamation programmes.

The changes in the Aral Sea region within the last 50 years can be briefly characterized as follows (data for 2009):

**Table 1.1** Major drylands/deserts of the World

| Name, type of desert | Surface area ($10^6$ km$^2$) | Sand desert area ($10^3$ km$^2$) | Salt desert area ($10^3$ km$^2$) | Location | Desert types, in brackets: (approximate percentage of sand desert), [approximate percentage of salt desert] |
|---|---|---|---|---|---|
| Sahara, subtropical ZBIII (including the Egyptian desert east of the Nile) | 9.25 | 2750 | 220 | Northern Africa | 70% gravel, rock plains. Contrary to popular belief, the desert is only <30% sand (several erg fields) [2%] |
| Arabian, subtropical ZBIII | 2.59 | 620 | 25 | Arabian Peninsula | Gravel plains, rocky highlands; one quarter is the Rub al-Khali ("Empty Quarter"), the world's largest expanse of unbroken sand (25%) [1%] |
| Australian deserts, subtropical ZBIII, ZEII-III (Great Victoria, Great Sandy, Gibson, Simpson Sturt, Stewart) | 1.38 | 400 | 60 | Australia | Sandhills, gravel, rocks, grassland, Simpson parallel sand dunes are the longest in the world: up to 200 km (30%) [4%] |
| Gobi, cold winter ZBVIIa, ZBVII(rIII) | 1.33 | 200 | 30 | China, Mongolia | Stony, sandy soil (15%), steppes and dry grasslands [2%] |
| Patagonian, cold winter ZBVIIa | 0.67 | 0 | 7 | Argentina | Gravel plains, plateaus, basalt sheets (0%) [1%] |
| Kalahari, subtropical ZBIII, ZBII | 0.57 | 400 | 4 | South Africa, Botswana, Namibia | Sand sheets, longitudinal dunes (70%) [1%] |
| Great Basin, cold winter ZBVIIa | 0.49 | 15 | 140 | USA | Mountain ridges, valleys, sand dunes (3%) [30%] |
| Thar, subtropical ZEII-III | 0.45 | 45 | 10 | India, Pakistan | Rocky sand and sand dunes (10%) [2%] |
| Chihuahua, subtropical ZBIII, ZBII(rIII) | 0.44 | 9 | c.0 | Mexico | Grassland, cacti savannah (2%) [0%] |
| Taklamakan, cold winter ZBVII(rIII) | 0.36 | 290 | 4 | China | Sand dunes (80%), up to 300 m high; gravel [1%] |
| Iranian deserts, cold winter ZBVII, ZBIII (Registan) | 0.35 | 35 | 70 | Iran, Afghanistan | Salt, gravel, rock, sand fields (10%) [20%] |
| Colorado Plateau, cold winter ZBVIIa | 0.34 | 0 | 0 | USA | Sedimentary rock, mesas, and plateaus – the Grand Canyon, "Painted Desert" (0%) [0%] |

(continued)

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