Chapter 88
Aral Sea Partial Refilling Macroproject

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88.1 Introduction

In 1960, the Aral Sea's volume was slightly more than 1000 km^3 with a salinity of ~10 g/L and a surface area of 67,000 km^2. Its level stood at about 53 m above the world-ocean's mean sea level. Since then its size has been reduced continuously, with a concomitant rise in the impounded water's salinity. By 2007 the Aral Sea level had dropped to ~30 m above the world's prevailing ocean level (Zavialov, 2009a).

A comprehensive control strategy to partially recreate the endorheic Aral Sea is proffered in this chapter. It is a brief presentation of results reported in Badescu and Cathcart (2009a, 2009b). It involves regulation of several hydrological factors: (1) overland tensioned textile pipeline conveyance of seawater extracted from the Caspian Sea and deposited in the Aral Sea Basin; (2) overland importation of seawater by tensioned textile pipeline from the Black Sea to the Caspian Sea; (3) stabilization of the endorheic Caspian Sea's water level by a real-time hydrological management of the freshwater inputs of the Volga and Ural rivers as well as regulated evaporation in the Kara-Bogaz-Gol Bay (Kasarev 2009). Subsequently, the imported seawater will be diluted with freshwater inputs conserved in the contributing catchments of Central Asia.

88.2 Background of Proposed Macroproject

Especially since the onset of humankind's Space Age in 1957, the world-public began to become more aware of the Aral Sea's reduced area and fluid volume. As early as the 1960s, Earth-orbiting USA imagining reconnaissance satellites began to fully document the physical state of the Aral Sea in Kazakhstan because the relatively nearby Baikonur Cosmodrome, built in the 1950s, in that region was the rocket launching facility for all USSR manned space missions, starting with

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Yuri Gagarin in 1961. Publicized satellite imagery revealed the ongoing drastic anthropogenic geographical alterations. The former seabed, now exposed to the air by the regressing body of water, became a wind-modified, salt-strewn arid landscape, the Aralkum Desert. Indeed, the draining event-process took place with such rapidity that one might imagine that artist Barry Flanagan's "Hole In The Sea" (1969), a cylindrical hollow plastic tube buried in the beach swash-zone at Scheveningen, The Netherlands, and filmed from above while the tide rose, was operating.

Once fed by two historically famous rivers, the Amu Darya and the Syr Darya, the Aral Sea mingled their runoffs in a contiguous body of water. The extreme post-1950 abstraction of freshwater from these Central Asian Aral Sea-feeding rivers for ultimate application on mismanaged farmland irrigation mega-schemes caused such a pronounced technogenic reduction of the Aral Sea that, since 1989, there are now really three discontinuous lakes remaining. The new geographical reality is described in *World Atlas* (2007) and *Aral Sea Encyclopedia* (2009).

It was during the 1950s that scientists finally recognized that humanity's technological impacts on the Earth-biosphere were almost total. Year 1950 AD is also the reference for carbon fourteen dating. With regard to the modern-day diminished Aral Sea, it if were possible to provide the three lakes with the Central Asian river runoffs extant during the pre-1960 period, at least 200 years would be necessary for the Aral Sea to recover. And, of course, the presence of the Aralkum Desert, as well as the vast regions of inefficient mono-culture irrigation agriculture, has caused remarkable short and long-term meteorological changes in the various climates of Central Asia. Full restoration of the 1960 Aral Sea through freshwater conservation alone is unrealistic since such a restrictive consumptive use program would impose very great economic hardships on the populations of Central Asia's post-1991 independent ecosystem-states (Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan). A reasonable estimate of the normal freshwater inflow to the vicinity of the Aralkum Desert during the 21st century is ~12 km^3/year; to restore the Aral Sea fully to its 1960 presence would require a total annual fluid inflow of more than 56 km^3.

There are already proposals to bring water to the relict Aral Sea from outside Central Asia (Micklin & Aladin, 2008). In other words, the replacement of a 20th century desert-like landscape covered by a 21st century-instigated refilled "New Aral Sea". Most macro-engineers have contemplated only 27–30 km^3/year of freshwater inflows – as from the long-discussed Siberian River Diversions (Duke, 2006) and such postulated freshwater transfers will certainly be affected by global climate change during the 21st century.

Even so, some Russian geopoliticians have tried to revive the Siberian River Diversion macro-projects to import freshwater from the Ob River and its tributary, the Irtysh River, to Kazakhstan via a proposed "SibAral Canal Project". The concrete-lined Sib-Aral Canal is planned to be ~2,500 km long and 200 m wide with a maximum prism depth of 16 m that would convey ~27–30 km^3/year of freshwater – about 6–7% of the Ob River's discharge – to Central Asia, overcoming a 110 m-high topographic elevation in the Turgai Depression at a high cost in expensive electricity of ~10.2 billion KW/h. Disconcertingly, the Ob River's annual flow seems to be contaminated with unhealthy nuclear materials and, therefore, its partial transfer might constitute an undesirable Aral Sea pollution since the Aral Sea already has uranium contamination present (Friedrich, 2009). Furthermore, although northern Eurasian rivers discharging into the Arctic Ocean do have rising minimum daily flows (Smith, 2007) possibly due to melting permafrost, the overall situation is that these rivers have not yet shown decisively any indisputable evidence of strong influence by global climate change (MacDonald, 2007). The Irtysh River seems to be a seriously affected ecological river basin that may not offer its abusive users any excess exportable freshwater outflow by *circa* 2030 (Hrkal, 2006). In brief, the feasibility of the "SibAral Canal Project" is questionable.

A possible one-time only 17×10^6 m^3 induced controlled flood of freshwater, departing a headwater tributary to the Amu Darya Basin, could eventually be beneficially channeled into the currently diminished Aral Sea(s) to help reclaim that anthropogenic wasteland (Risley, 2006). On 18 February 1911 a very strong earthquake caused a landslide in the Pamir Mountains of eastern Tajikistan that blocked the Bartang River, one of many tributaries of the Amu Darya. A large-volume lake 60 km-long accumulated upstream of this rock fall, named "Usoi" after a village that was buried by the landslide. The Usoi landslide dam is 600 m-high and is the highest dam, natural or anthropogenic, in the Earth's biosphere. The lake, Lake Sarez, has a maximum depth of ~550 m and a volume of ~17 km^3. During April and May of 2007, a Tajik Government-sponsored conference was held in Dushanbe to consider means of preventing a catastrophic structural failure of the dam. A lake-tapping pipeline, as well as a regulating hydropower plant has been suggested to reduce the volume of freshwater behind the natural dam to some as-yet-undetermined "safe" level (Parshin, 2007). If a controlled release of this impounded freshwater reservoir were technically arranged by macro-engineers, and safely performed, then such a carefully planned freshwater shifting could jump-start the "Aral Sea Partial Refilling Macro-project" seawater importation via tensioned textile pipeline macro-project proposed in Badescu and Cathcart (2009a, 2009b). Drained, or nearly drained, Lake Sarez's freshwater would serve to dilute the imported salty water extracted from the Black Sea and Caspian Sea (Zavialov, 2009b).

Aside from the exciting, but obviously frustrating, geographic projection of the Siberian River Diversion, however, imported seawater diluted with all available locally-derived and legally obtained freshwater would be useful to the region's inhabitants. Seawater, transported from afar, must be filtered to remove all harmful biota. The best source for seawater is the nearly tide-less Caspian Sea, lying presently ~27 m below the world-ocean's level and, approximately, 600 km west of the Aralkum Desert. The route of the pipeline is proposed to connect the Caspian Sea and the northern regions of the Aral Sea, because of the low elevation relief in that region (Route A in Fig. 88.1). Another overland route for a pipeline transporting salty water from the Aral Sea to the Caspian Sea, (i.e., route B in Fig. 88.1) is the abandoned natural Uzboy Channel which, as recently as 1500 B.C., connected the Aral Sea with the Caspian Sea as an Aral Sea peak-flood overflow channel (Letolle, 2007).

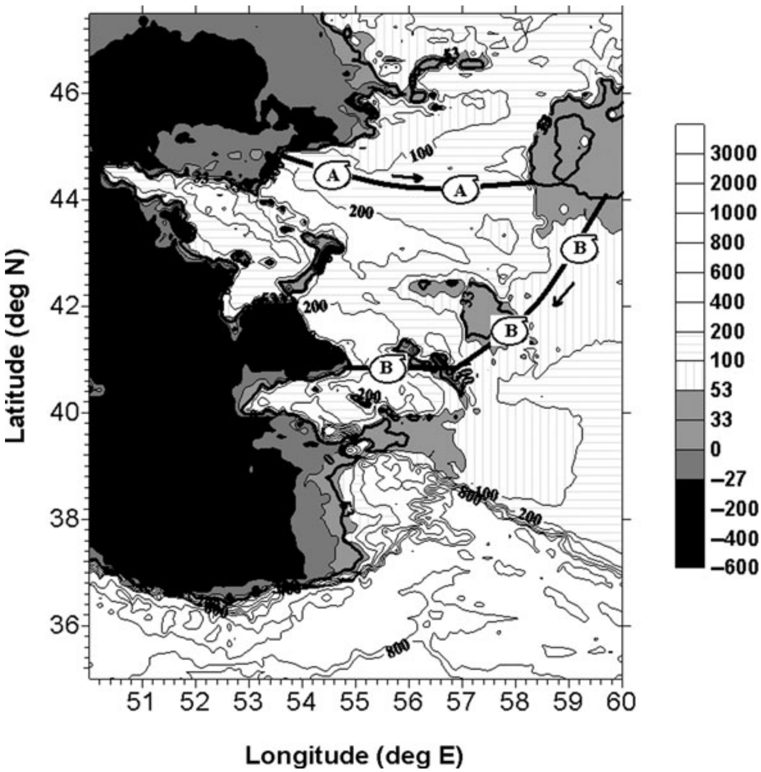

Fig. 88.1 Routes for the pipelines connecting Caspian Sea to Aral Sea, with altimetry shown (m)

Most of the world-public has been made aware of the geographical news fact that the world-ocean rose by ~13 cm during the 20th century but few persons situated outside of Central Asia are aware that the Caspian Sea level rose by ~13 cm just during the period 1977–1995. Coastal erosion, infrastructure damage and other macro-problems stimulated by such fluid volume variances have proven to be chronic drags on the fragile economies of the bordering ecosystem-nations. Recent super-computer general climate modeling hints that the Caspian Sea climate regime is changing, and that there is therefore a possibility that the Caspian Sea may decrease in elevation by several meters during the 21st century. Hence, a replenishment of the Caspian Sea with filtered seawater imported from the Black Sea by a tensioned textile pipeline seems doubly proper and truly cost-effective in terms of professional Macro-engineering. Integrating the 700 km-long Black Sea-Caspian Sea pipeline plus the 600 km-long Caspian Sea-Aralkum Desert pipeline would form a combined effective pipeline system or network that totals ~1,200 km, ~54% of the 2,200 km length of the “SibAral Canal Project”.

88.3 Aral Sea Refilling Pipeline Specifications

To achieve a restoring liquid water flow to the moonscape that is today's Aralkum Desert of 56 km^3/year – or, expressed differently, ~1,776 m^3/s – over a distance of, say, ~650 km within a normal, horizontal steel pipe having a constant 30 m-diameter necessitates a seawater velocity of ~2.5 m/s. Obviously, a substantial volume of freshwater must be set aside and allowed to pass downstream into the rejuvenating Amu Darya and Syr Darya to dilute the saltwater emptied from the importation pipeline into the Aralkum Desert. In other words, the "Aral Sea Partial Refilling Macro-project" will help to induce good long-term rural and urban water conservation practices in Central Asia. In our report, we opt for tensioned textile pipelines, made with strong materials, because they are cheaper, can be moved on the landscape when operations demand, and can be camouflaged.

88.4 Results

A comprehensive control strategy to partially recreate the endorheic Aral Sea is offered in Badescu and Cathcart (2009a, 2009b) which involves several actions: (1) management of the freshwater inputs from the Syr Darya and Amu Darya rivers; (2) regulated evaporation in the existing Western Basin of the Aral Sea; (3) water imported from the Caspian Sea and (4) salty water extracted from the Aral Sea and transported into the Caspian Sea and/or elsewhere. A simple technical and economical model is proposed.

Taking into account that covering the whole Western Basin surface to reduce evaporation is very expensive and yields a gain of about 1 m in free water surface level (see Table 6 of Badescu and Cathcart (2009a)), one may conclude that action (2) is not recommended. A combination of the remaining three actions may, however, yield a steady-state Aral Sea larger than its 2005 status, depending on the funding involved (see Tables 5 and 7 in Badescu and Cathcart (2009a)).

The Aral Sea evolution process has been described in Badescu and Cathcart (2009b) by using two balance equations, for the time variation of water volume and salinity, respectively. These equations were solved under appropriate assumptions, by using common finite-difference techniques. Both the natural stabilization process and the Macro-engineering restoration process have been studied. The main results are as follows.

Three scenarios were used to analyze the natural stabilization process. The Aral Sea water level stabilizes to 28.9, 27.2, and 25.7 m for these three scenarios. The water surface area reduces to a few thousand square kilometers while the salinity increases about two times for first scenario and up to three times in the final scenario.

The influence of various control factors was analyzed when the Macro-engineering solution has been considered. Increasing the freshwater inflow rate by rivers yields an increase of the free water surface level (by 1.4–3.5 m) but the North

Basin still does not merge with the Western and Eastern basins. The fluid water surface stabilizes to about 60–80% of the 2005 A.D. – Aral Sea surface, depending on the case considered. The water salinity decreases by an improved freshwater management, but it is always higher than its 2005 value. The influence of importing seawater from the Caspian Sea at flow rates larger than > 14 km^3/year is associated to a stabilized mean free water surface level in the Aral Sea of the order of ~32 m, which is about 1 m below the level prevailing during 2005.

A few considerations about the ecological, cultural and social consequences of the macro-project (both positive and negative) were presented in Badescu and Cathcart (2009b). Unwanted biotic invasion of the Caspian Sea and renewed Aral Sea can be prevented by thorough filtration of the pumped fluid. Before the restoration is undertaken, it is recommended to (1) remove all rusting shipwrecks from the exposed seabed; (2) fully map the restoration work-site for future hydrographic and navigational charts and (3) fully assess bathymetrically the new saline lake's bottom, just as if it were a commercial "real-estate" development lake.

88.5 Conclusions

A water-filled Aral Sea may change the climate, making it more favorable for human resettlement and salty water from a regenerated Aral Sea may be used for seawater agriculture. Simulation results show that the fluid water surface stabilizes to about 60–80% of the 2005 Aral Sea surface, depending on the case considered. The water salinity decreases by an improved freshwater management, but it is always higher than its 2005 value.

The Caspian Sea water imports can be achieved, at less economic and environmental cost, than strictly freshwater Aral Sea Basin imports from Siberia's diverted rivers. A successful outcome of the proposed Aral Sea control strategy, "Aral Sea Partial Refilling Macroproject," will require a United Nations Organization-observed international treaty-codified unity of the affected region's participating geopolitical and Macro-engineering decision-makers.

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