The past and future of the biological resources of the Caspian and the Aral Seas

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Caspian Sea is the world’s largest lake
(area of the world’s largest lakes is shown in brackets in km$^2$; area of the Aral Sea is given for 1960)
## Main parameters of the Caspian Sea

<table>
<thead>
<tr>
<th>The Caspian Sea</th>
<th>The Middle Caspian Sea</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Max. length</strong></td>
<td>1204 km</td>
</tr>
<tr>
<td><strong>Max. width</strong></td>
<td>566 km</td>
</tr>
<tr>
<td><strong>Mean width</strong></td>
<td>204 km</td>
</tr>
<tr>
<td><strong>Volume</strong></td>
<td>77000 km³</td>
</tr>
<tr>
<td><strong>Max. depth</strong></td>
<td>1025 m</td>
</tr>
<tr>
<td><strong>Mean depth</strong></td>
<td>184 m</td>
</tr>
<tr>
<td><strong>Area</strong></td>
<td>436000 km²</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>The Northern Caspian Sea</th>
<th>The Southern Caspian Sea</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Volume</strong></td>
<td>0.94%</td>
</tr>
<tr>
<td><strong>Area</strong></td>
<td>27.73%</td>
</tr>
<tr>
<td><strong>Max. depth</strong></td>
<td>10 m</td>
</tr>
<tr>
<td><strong>Mean depth</strong></td>
<td>6.2 m</td>
</tr>
<tr>
<td><strong>Volume</strong></td>
<td>63.67%</td>
</tr>
<tr>
<td><strong>Area</strong></td>
<td>35.64%</td>
</tr>
<tr>
<td><strong>Max. depth</strong></td>
<td>1025 m</td>
</tr>
<tr>
<td><strong>Mean depth</strong></td>
<td>325 m</td>
</tr>
</tbody>
</table>
Caspian Sea zones
(by Aladin, Plotnikov, 2000)

1. Middle (1a) and Southern (1b) Caspian Seas = the Caspian Sea proper.

2. Northern Caspian (2) – a giant shallow bay, estuary of 4 rivers: Volga, Ural, Terek, Sulak.


4. Low saline bay and lagoon on the Southern coast: Gorgan Bay (4a), Anzaly Lagoon (4b).

5. Low saline estuaries and deltas of Caspian Sea rivers: Volga (5a), Ural (5b), Emba (5c) (not inflowing now), Atrek (5d), Sefidrud (5e), Kura (5f), Samur (5g), Sulak (5h), Terek (5i).
Catchment area of the Caspian Sea. Dark-green area is below the present Ocean level.
## Number of species in the Caspian Sea

<table>
<thead>
<tr>
<th>Author</th>
<th>Estimate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Derzhavin (1951) &amp; Zenkevich (1963)</td>
<td>476</td>
</tr>
<tr>
<td>Chesunov (1978)</td>
<td>~ 550</td>
</tr>
<tr>
<td>Kasymov (1987)</td>
<td>~ 950</td>
</tr>
<tr>
<td>Dumont (1998)</td>
<td>~ 1800</td>
</tr>
<tr>
<td>Aladin et al. (2001)</td>
<td>&gt; 2000</td>
</tr>
</tbody>
</table>
Caspian Sea endemic animals

The native habitat of the ctenophore *Mnemiopsis leidyi* is in temperate to subtropical estuaries along the Atlantic coast of North and South America, where it is found in an extremely wide range of environmental conditions. 

Winter low and summer high temperatures of 2ºC and 32ºC, respectively, and salinities of < 2 to 39 g/l.
Mnemiopsis spreading over Caspian Sea
Dynamics of sturgeon catches (1) and salmons (2) in the Caspian Sea, thousands of tons
1. At the end of XX century about 25% of Caspian seal population died out due to various diseases.
2. Very warm winter of 2000 and lack of solid ice in the Northern Caspian Sea created big problems for seal reproduction.
3. Some scientist believed that it was walrus in the Caspian Sea, but in Medieval time hunters totally exterminated this giant aquatic mammal.
Artemia and its cysts
Floating cysts of *Artemia*
Studying and testing *Artemia* cysts in laboratory (Akatau, Kazakhstan)
On the demonstrated photo president of Kazakhstan participated in the opening ceremony for Mangistau Bioresource.
In order to have successful navigation in the shallowing Caspian Sea special military boats were built.
Main threats to the Caspian Sea biological resources

1. Pollution due to:
   - oil and gas excavation and transportation,
   - agricultural activities,
   - industrial activities,
   - military activities

2. Exotic species introduction

3. Overfishing and poaching

4. Rivers regulation

5. Sea level fluctuation

6. Climate change
Catchment area of the Aral Sea is about 1.8 million km²
Parameters of the Aral Sea in the beginning of 20th century

- Area 67499 km²
  - Large Aral 61381 km²
  - Small Aral 6118 km²
- Volume 1089 km³
  - Large Aral 1007 km³
  - Small Aral 82 km³
- Level +53.4 m
- Maximal depth 69 m
- Salinity about 10 g/l
- The Aral Sea was inhabited by about 20 species of fishes and about 200 species of free-living invertebrates
Since 1960 the Aral Sea has steadily shrunk and shallowed owing overwhelmingly to irrigation withdrawals from its influent rivers (Amu Dar’ya and Syr Dar’ya).

August, 2015: Aral area – 8031 km$^2$ (12%), volume – 48 km$^3$ (4.5%); the Large Aral – 3900 km$^2$ (6%), 58 km$^3$ (5.5%), salinity >100 g/l; the Small Aral – 3300 km$^2$ (57%), 27 km$^3$ (33%), salinity 6-7 g/l.
IRRIGATION DEVELOPMENT IN ARAL SEA BASIN

MAJOR IRRIGATION COMPLEXES IN THE ARAL SEA BASIN

- main irrigation zones in the Aral Sea Basin
- proposed Siberia-Aral Sea Canal

1. Kara-Kum Canal
2. Amu Dar'ya Delta
3. Amu-Bukhara Canal
4. Zeravshan Valley
5. Karshi Steppe
6. Middle Amu Dar'ya
7. Surkhandar'ya Valley
8. Golodnaya Steppe
9. Fergana Valley
10. Middle Syr Dar'ya
11. Kzyl-Orda Canal
12. Syr Dar'ya Delta
At the end of 1980’s, when the level dropped by about 13 m and reached about +40 m, the Aral Sea divided into the Large and Small Aral

Area 40000 km² (60% from 1960)
Volume 333 km³ (33% from 1960)
Salinity 30 g/l (10 g/l in 1960)

Between autumn 1987 – spring 1989 Aral Sea divided into 2 lakes: Small (Northern) Aral and Large (Southern) Aral. In both lakes salinity increased and in each lake practically the same number of free-living animals were able to survive.
Salinity in the Large Aral continues to go up while in the Small Aral it has begun to go down after the Aral Sea division.
• The resulting rapid increase in salinity has caused a dramatic decrease in the lake biodiversity and biological resources and loss of a once thriving fishery.
• Only a small part of the indigenous biota has survived.
Dynamics of fish catches in the North and South Aral Sea
Dike in Berg strait is preserving Small (Northern) Aral and **rehabilitating its biodiversity**.
Dike in Berg strait is preserving Small (Northern) Aral and rehabilitating its biodiversity.

New Kok-Aral dike built by Russian company “ZARUBEZHVOVDSTROY”
• The water level in the Small Aral has increased several meters and its salinity has returned to levels that can sustain the pre-1960 ecosystem.

• The biodiversity and biological resources also has been somewhat rehabilitated, and the commercial fisheries have revived.
Canal to Aralsk (≈10 km)

Second dike to be built in the nearest future
Level 46-47 m a.s.l.

Canal from Tuschibas Lake to Sarycheganak Bay (≈50 km)
1. Small Aral: level ~42 m, area 3300 km², salinity 6-7 g/l

2. Western Basin of Large Aral: level ~25 m, area 3120 km², salinity >150 g/l

3. Tsche-Bas Bay: level ~28 m, area 385 km², salinity 85 g/l

4. Central Aral: level 27-28 m, area 405 km², salinity variable

5. Eastern Basin of Large Aral: level 26-27 m, area 974 km², salinity >150 g/l?

TOTAL ARAL AREA = 8031 km²

A – Kokaral dam (Central dam)
B – Proposed Northern dam
C – Proposed Southern dam
Discharge of Syrdarya water to the Eastern Large Aral
05.02.2015

Proposed Southern dam
• The remnants of the hyperhaline Southern (Large) Aral continue their retreat and salinization.
• The Large Aral contains no fish species, and almost all the invertebrate species have been lost.
• The only biological resource here in hyperhaline environment is brine shrimp (Artemia), and its eggs are harvested now.
Small Aral Sea: Level 48 m ASL, area 4830 km², vol. 53.5 km³, river inflow 5.0 km³, outflow toward L. Aral 1.0 km³, salinity 6.0 g/l.

Large Aral Sea

Western Sea: level 33 m ASL, area 6200 km², vol. 85 km³, river inflow 6.4 km³, net groundwater inflow 2.0 km³, outflow to E. Aral 3.6 km³, salinity drops to 42 g/l by 2060 and to 15 g/l by 2120.

Eastern Sea: level ~28.0 m ASL, Area ~3800 km², vol. 7.6 km³, inflow from W. Aral 3.6 km³, inflow from Central Aral highly variable, salinity >200 g/l

Adzhibay Gulf Reservoir: level 53 m ASL, area 1147 km², vol. 6.43 km³, inflow from Amu Dar’ya 8.0 km³, outflow to Western Aral basin 6.6 km³, salinity ~ 2 g/l

Concept to Partially Preserve Small and Large Aral Seas
(Lvovich and Tsigelnaya, updated and modified by P. Micklin)
• In conclusion, the authors of this report argue that by setting complex and hard-to-reach scientific and practical goals, such as, for example, preserving the biological diversity and biological resources of the Caspian and Aral Seas, researchers need to rely not only on modern scientific equipment and computer programs, but they also must have heartware.

• The authors are sure that only men can try to restore what they themself have put at risk or destroyed. Unfortunately, robots will never be able to do this.

• Concluding our report, we demonstrate a symbolic drawing of infographics by Mikhail Olegovich Janson. The previously shown logo, dedicated to the study of the Aral Sea, Balkhash and the Caspian, was also made by him.
heartware

hardware

software
Thank you for your attention

Biological resources of Caspian and Aral have future