International Conference Aral '09

(13-15 October, Saint Petersburg, Russia)

Aral: Past, Present and Future

Two centuries of the Aral Sea investigations

The Aral Sea: already dead, dying, or alive?

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Parameters of the Aral Sea in the beginning of 20th century

- Area 67499 km^2
  Large Aral 61381 km^2
  Small Aral 6118 km^2
- Volume 1089 km^3
  Large Aral 1007 km^3
  Small Aral 82 km^3
- Level +53.4 m
- Maximal depth 69 m
- Salinity about 10 g/l
- The Aral Sea was inhabited by about 12 species of fishes and about 150 species of free-living invertebrates excluding Protozoa and small-size Metazoa

Following main principles of conception of relativity and plurality of salinity barrier zones (Aladin, 1986, 1988; Aladin, Plotnikov, 2007) the following salinity zones were suggested for Aral Sea waters.

Ecosystems	Salinity range
Basic freshwater	0-3 ‰
Transitional freshwater-brackishwater	3-8 ‰
Basic brackishwater	8-13 ‰
Transitional brackishwater-marine	13-29 ‰
Basic marine	29-42 ‰
Transitional marine-hyperhaline	42-51 ‰
Basic hyperhaline	> 51 ‰

Number of species of animals and plants is different but all ecosystems are definitely alive and it is not wise to say that some of them are more alive and healthier than others.

Between the middle of the 19th century and 1961 shape and salinity of the Aral Sea practically didn't change. We must note, however, that due to intended and accidental introductions, that started in the 1920s, the number of free-living animals grew substantially.

In the Aral Sea appeared:

Fishes – 17

Mysidacea – 5

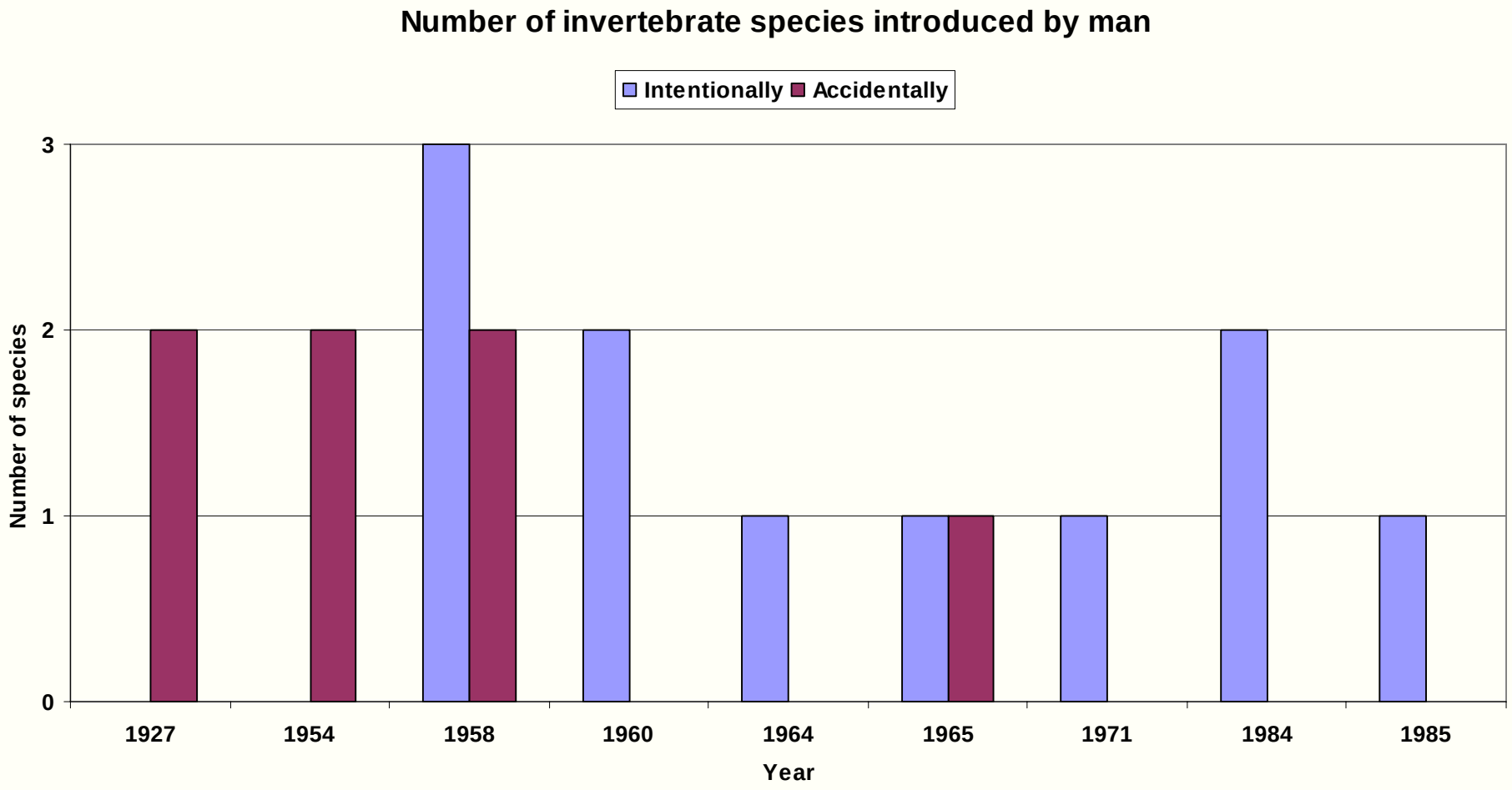
Decapoda – 2

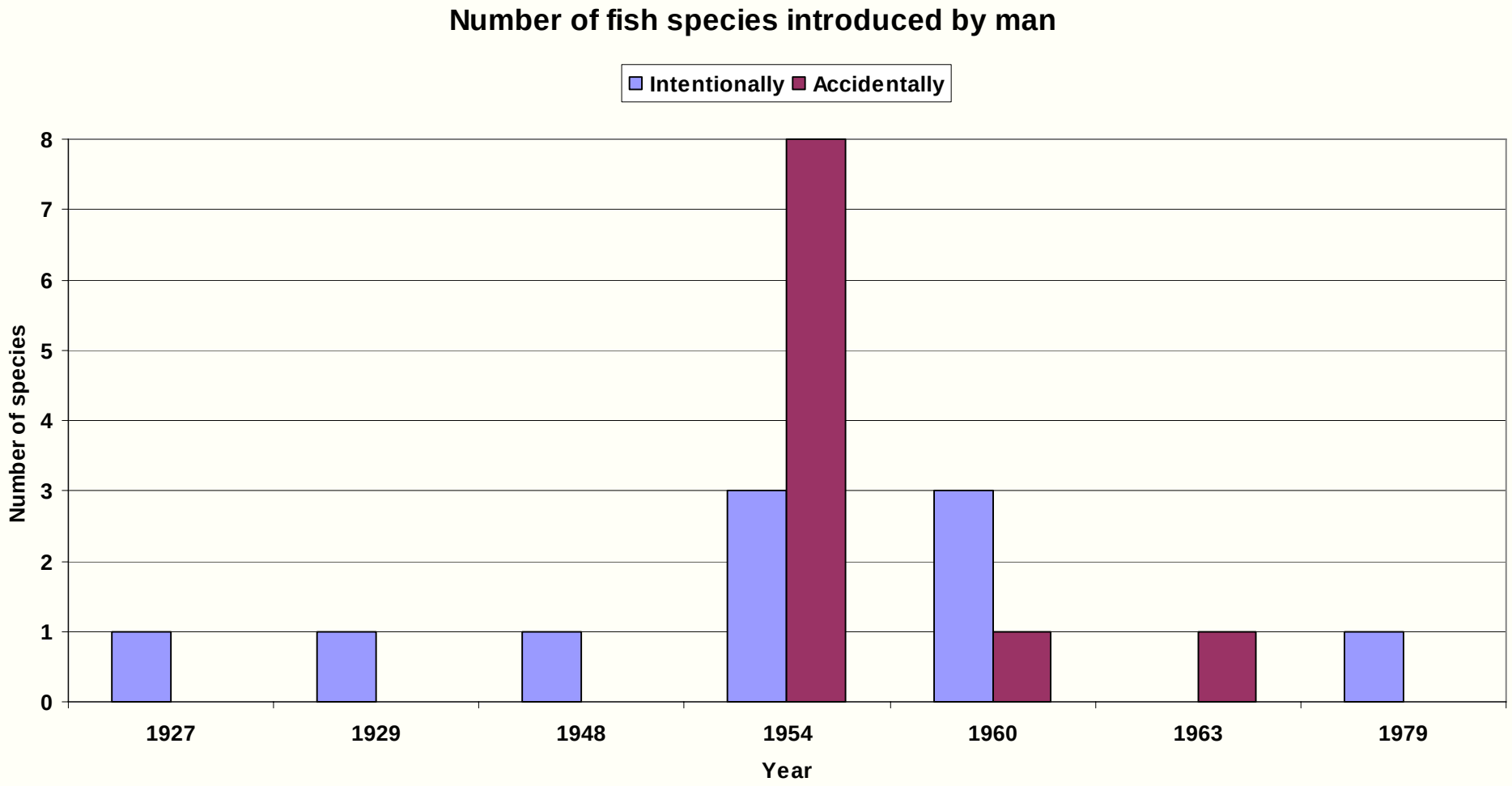
Copepoda – 1

Polychaeta – 1

Bivalvia - 1

TOTAL: 27


Number of invertebrate species introduced by man
Intentionally
Accidentally
Number of species
3
2
1
0
1927
1954
1958
1960
1964
1965
1971
1984
1985
Year


Number of fish species introduced by man
Intentionally
Accidentally
Number of species
0
1
2
3
4
5
6
7
8
1927
1929
1948
1954
1960
1963
1979
Year

Abra **and** ***Nereis*** **introduced by man are of great importance for flounder nutrition.**

Rithropanopeus **was introduced accidentally and disturbs lake sediments.**

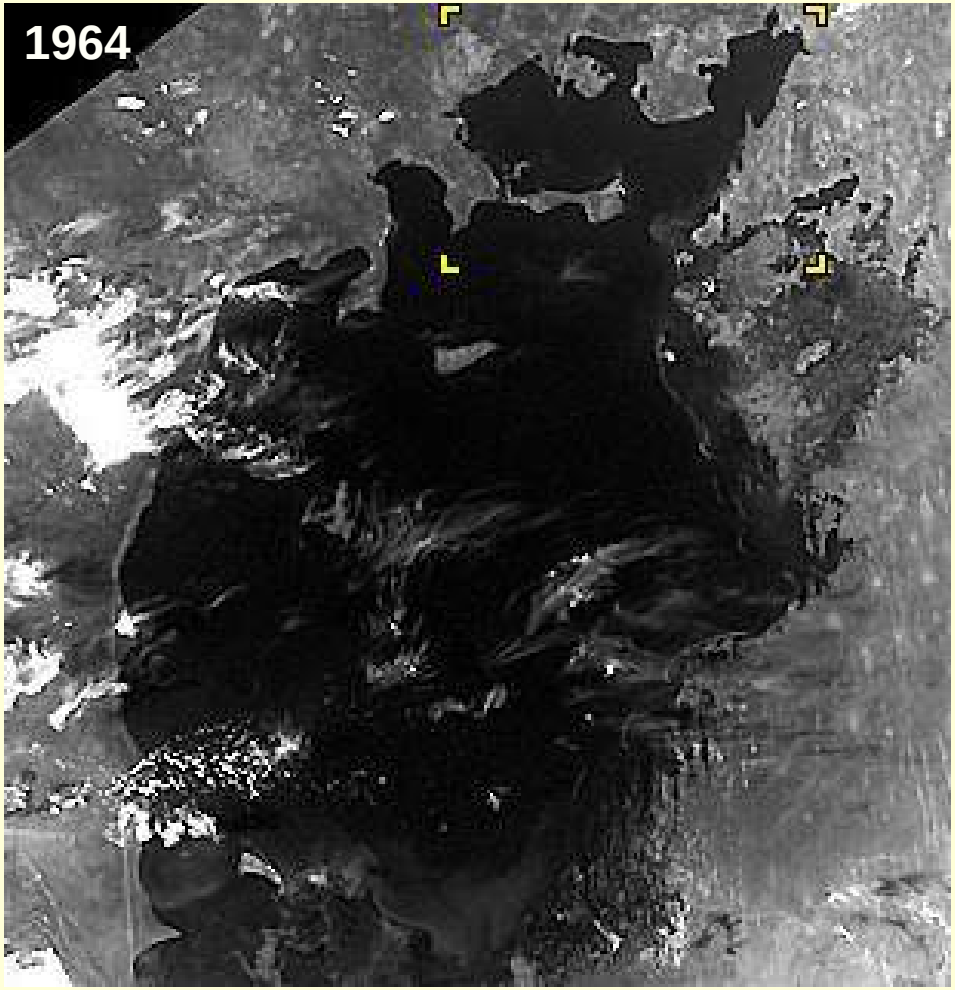
First introductions of alien species into the Aral Sea at the end of 1920's – beginning 1930's and their consequences

- In 1929-1932 there was unsuccessful attempt to introduce (by developing eggs) Caspian shed *Alosa caspia*. This introduction had no influence on the Aral ecosystem.
- The next was also unsuccessful introduction in 1933-1934 of stellate sturgeon *Acipenser stellatus* in order to enrich commercial stocks of sturgeon fishes in the Aral Sea represented only by bastard sturgeon *A. nudiventris*. While transported from the Caspian Sea mature and young fishes didn't survive, the consequences were significant and negative. Introduced sturgeons infected aboriginal ones with gill parasite monogenetic trematode *Nitzschia sturionis* and coelenterate parasite of sturgeon eggs *Polypodium hydriforme* which were not in the Aral Sea before. The first parasite produced epizooty between aboriginal sturgeons and their mass death as a result.
  Commercial stocks of sturgeon fishes *A. nudiventris* instead of enriching were undermined as a result.

Introductions of alien species into the Aral Sea since 1950's and their negative and positive consequences

- **Negative consequences.**
  Together with valuable alien species introduced advisedly into the Aral Sea some undesirable species were brought accidentally. These species could cause serious negative impacts on the ecosystem. So, 3 species of gobies, atherine and needle-fish had naturalized and became rivals for aboriginal young fishes.
  The most serious negative consequences were caused by introduction and naturalization of commercial Baltic herring *Clupea harengus membras*. This plankton-eater exterminated large crustacean species (*Arctodiaptomus salinus, Moina mongolica*, *Alona rectangula*, *Ceriodaphnia reticulata*) predominated in the zooplankton. As a result, average zooplankton biomass decreased by more than 10 times.
  It could be that accidently introduced shrimp *Palaemon elegans* competing with aboriginal amphipod *Dikerogammarus aralensis* step by step caused its extinction.
- **Some positive consequences.**
  Some positive effect gave introduction of commercial freshwater fishes of China complex. Introduced from the Sea of Azov in the beginning 1960's polychaete *Nereis diversicolor* and bivalve *Abra ovata* became valuable food for benthophage fishes. Introduced from the Sea of Azov copepod *Calanipeda aquaedulcis* has replaced former dominant of the Aral Sea zooplankton *Arctodiaptomus salinus* which was exterminated by Baltic herring. Due to their high euryhalinity they survived further Aral Sea salinization and left dominants in zoobenthos and zooplankton.
  When all freshwater aboriginal and introduced fishes disappeared or were to be disappear due to Aral Sea salinization, successful introduction of flat-fish *Platichthys flesus* in the end of 1970's allowed to keep commercial fishing for long time.

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)



September, 2009: Aral area – 8410 km^2 (13%), volume – 85 km^3 (7.5%);
the Large Aral – 4922 km^2 (8%), 58 km^3 (6%), salinity >100 g/l;
the Small Aral – 3487 km^2 (57%), 27 km^3 (33%), salinity 10-14 g/l.

IRRIGATION DEVELOPMENT IN ARAL SEA BASIN

MAJOR IRRIGATION COMPLEXES IN THE ARAL SEA BASIN

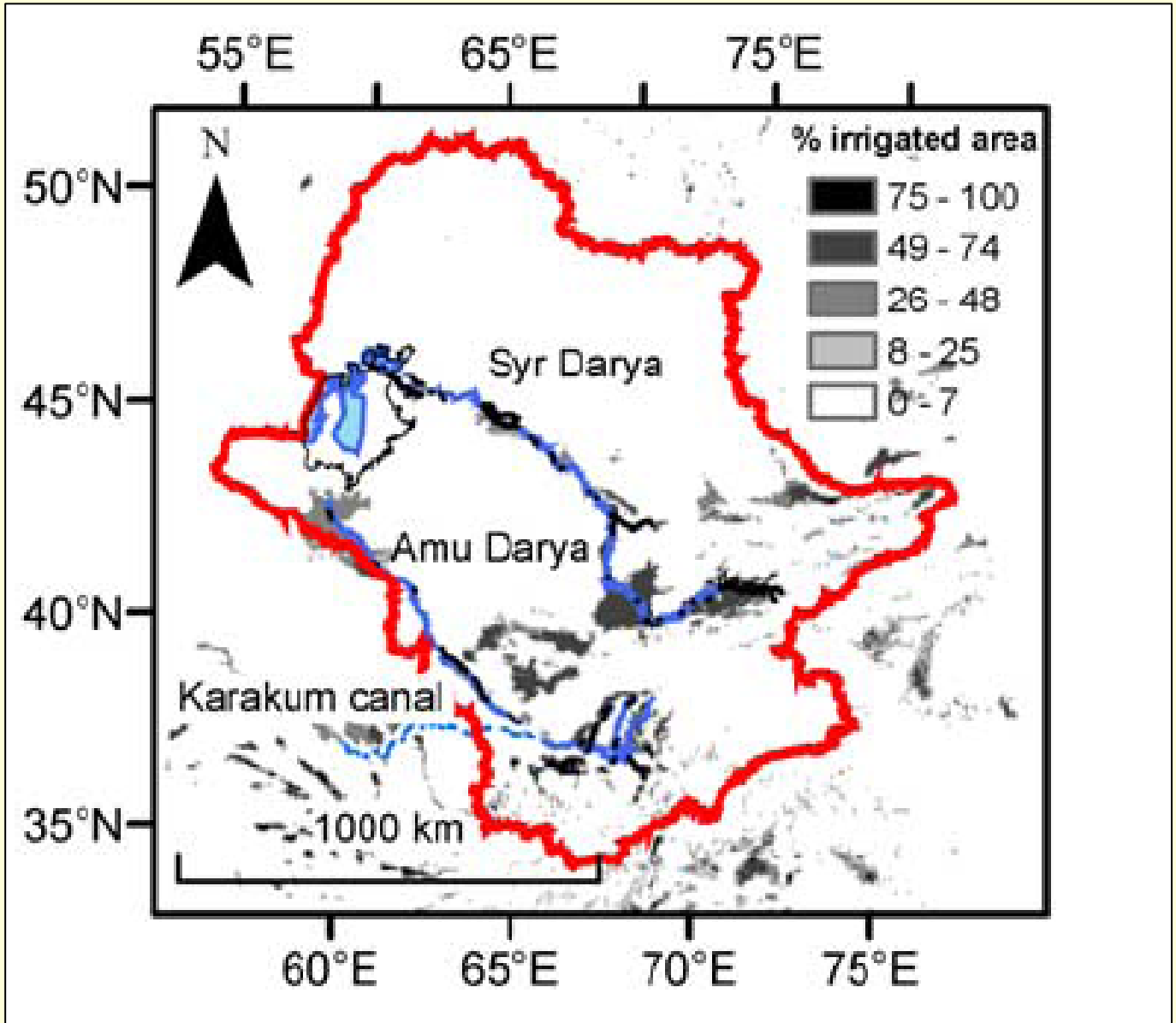
main irrigation zones in the Aral Sea Basin

proposed Siberia-Aral Sea Canal

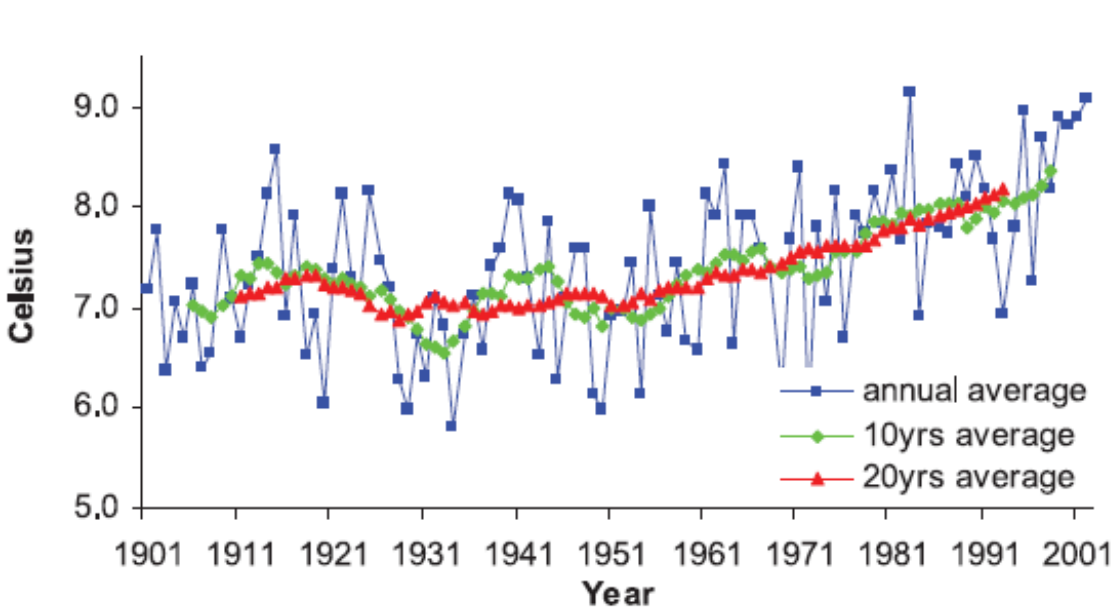
1. Kara-Kum Canal
2. Amu Dar'ya Delta
3. Amu-Bukhara Canal
4. Zeravshan Valley
5. Karshi Steppe
6. Middle Amu Dar'ya
7. Surkhandar'ya Valley
8. Golodnaya Steppe
9. Fergana Valley
10. Middle Syr Dar'ya
11. Kzyl-Orda Canal
12. Syr Dar'ya Delta

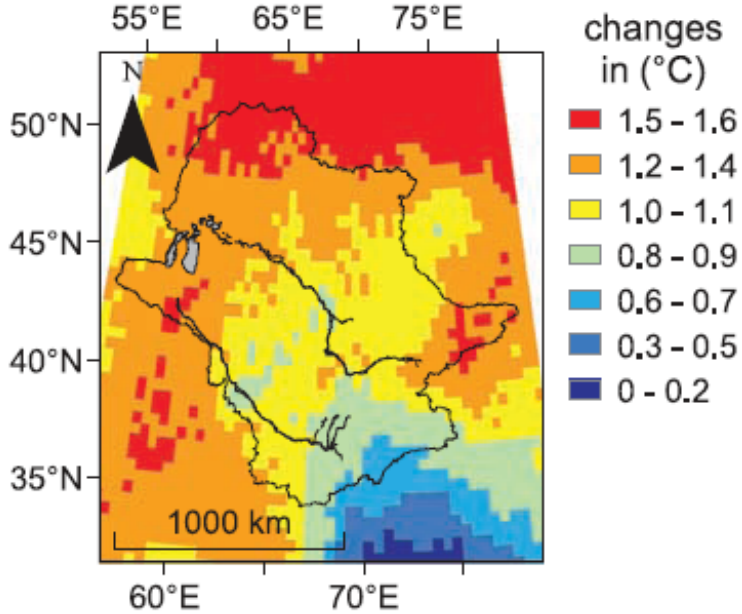
The Aral Sea Drainage Basin (red line)

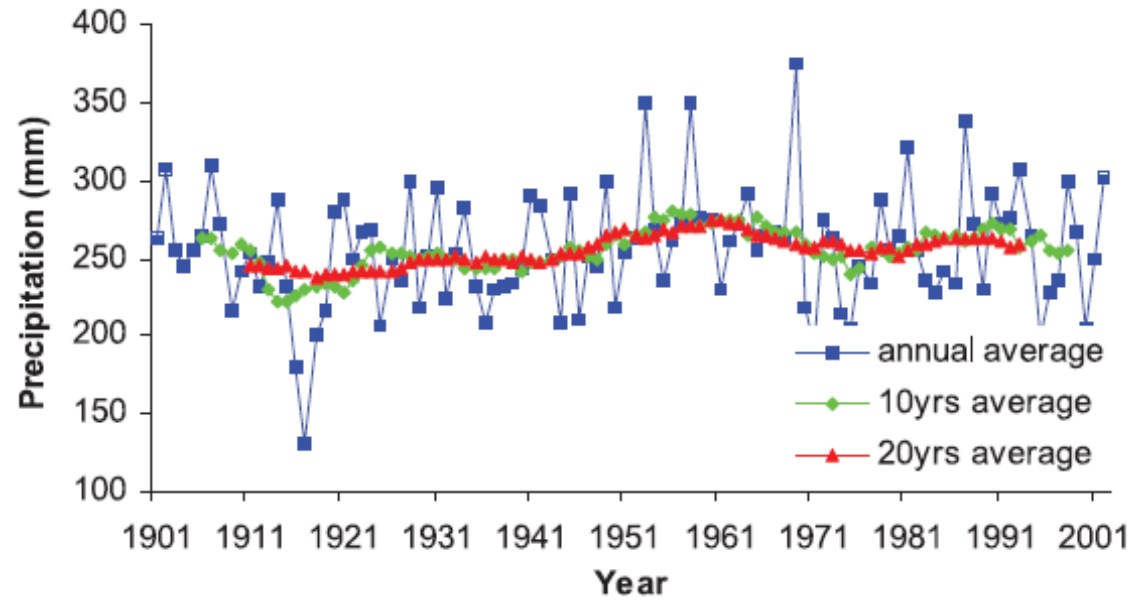
(by: Shibuo, Jarsjo, Destouni, 2007)

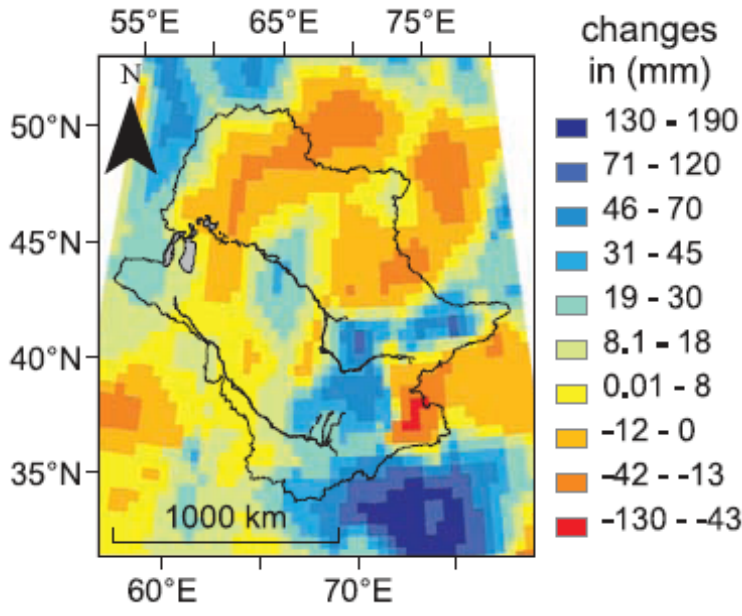


Temperature and precipitation data within the Aral Sea drainage basin (left); temporal trends (right).
(by: Shibuo, Jarsjo, Destouni, 2007)









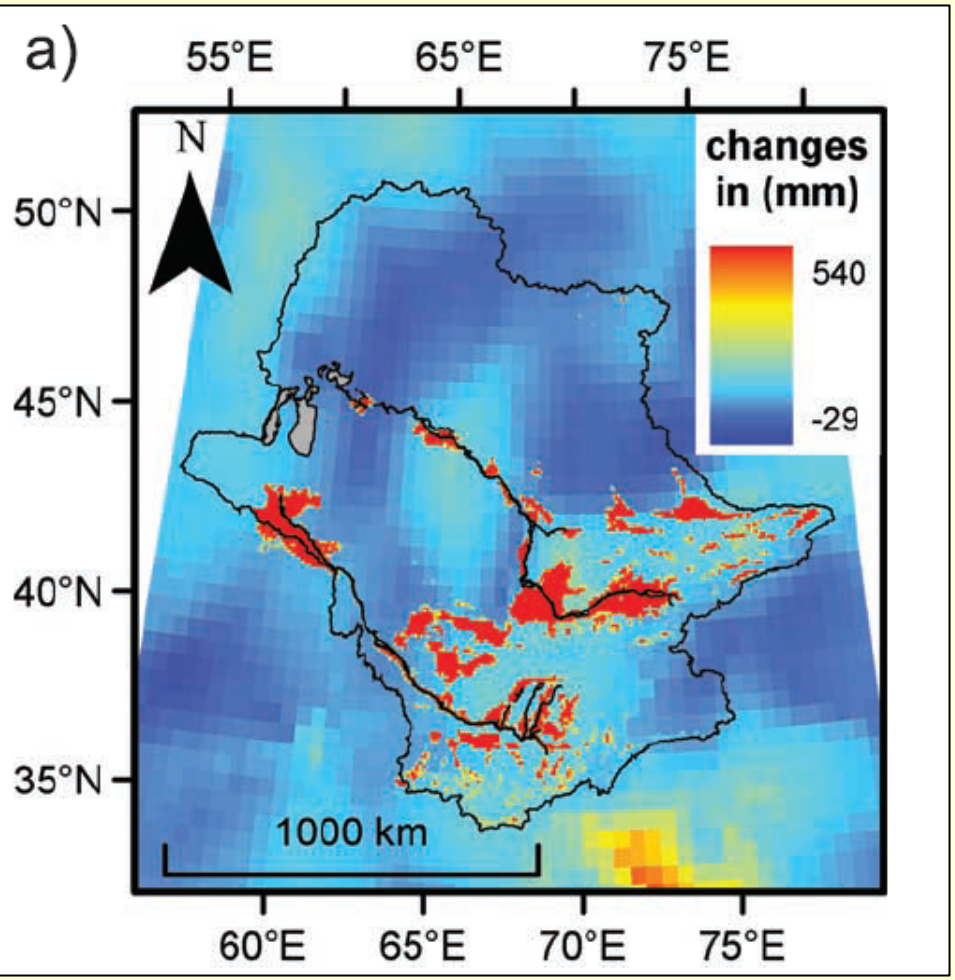
Summary of Water Flows in the Aral Sea drainage basin for the Three Different Investigation Scenarios

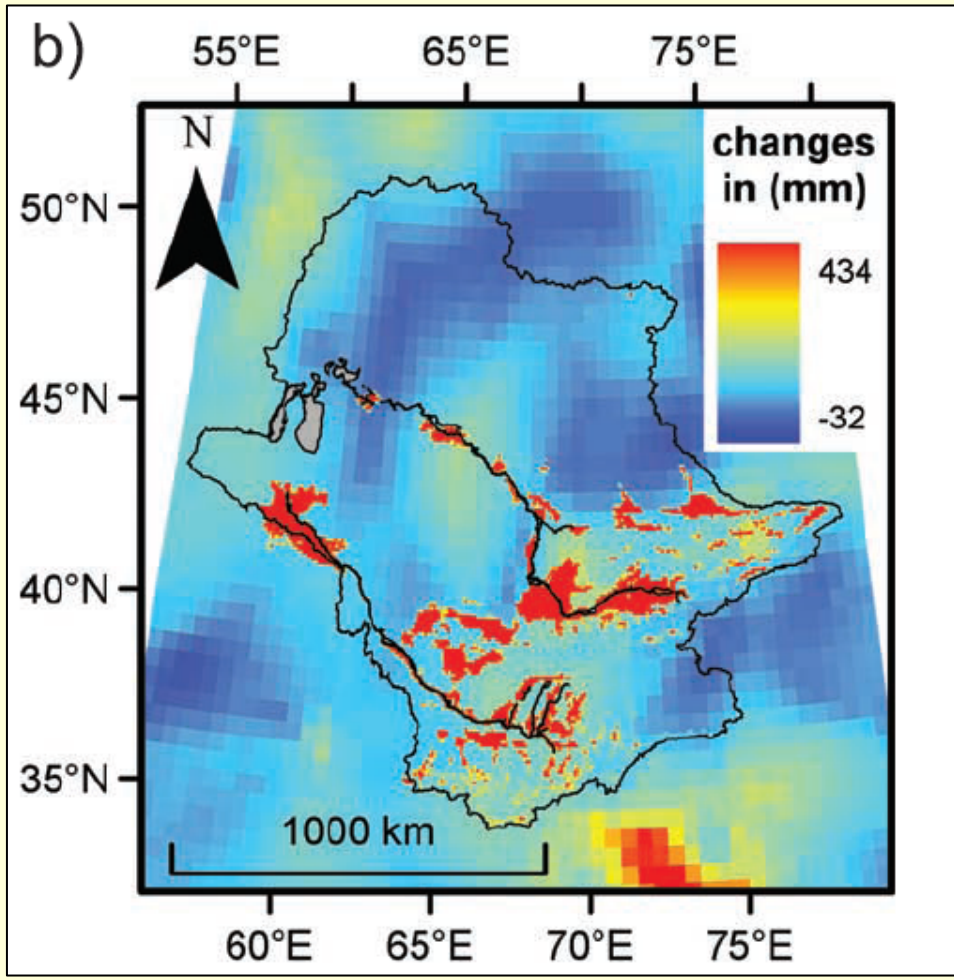
(by: Shibuo, Jarsjo, Destouni, 2007)

	Scenario1: 1901–1950, Natural		Scenario 2: 1983–2002, Climate		Scenario 3: 1983– 2002, Climate-Irrigation	
	ETIa	ETth	ETIa	ETth	ETIa	ETth
Amu Darya	43	37	44	39	8	7
Syr Darya	30	20	31	23	5	4
Unmonitored	4	0	3	0	3	0
Total	77	58	78	62	16	11

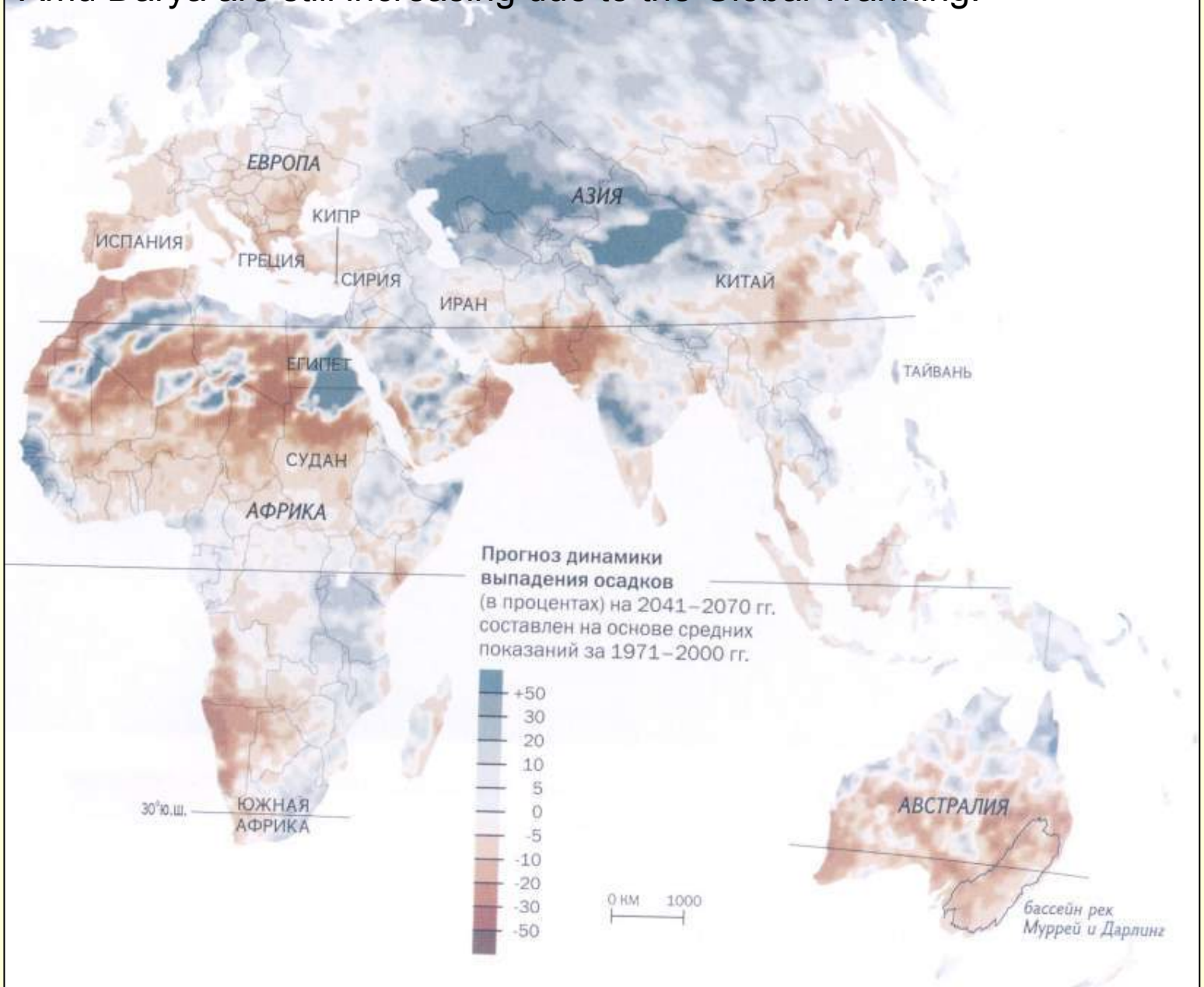
Evapotranspiration change in the scenario 3 relative to the natural scenario 1, based on the two different ET calculation methods (a) ETla and (b) ETth

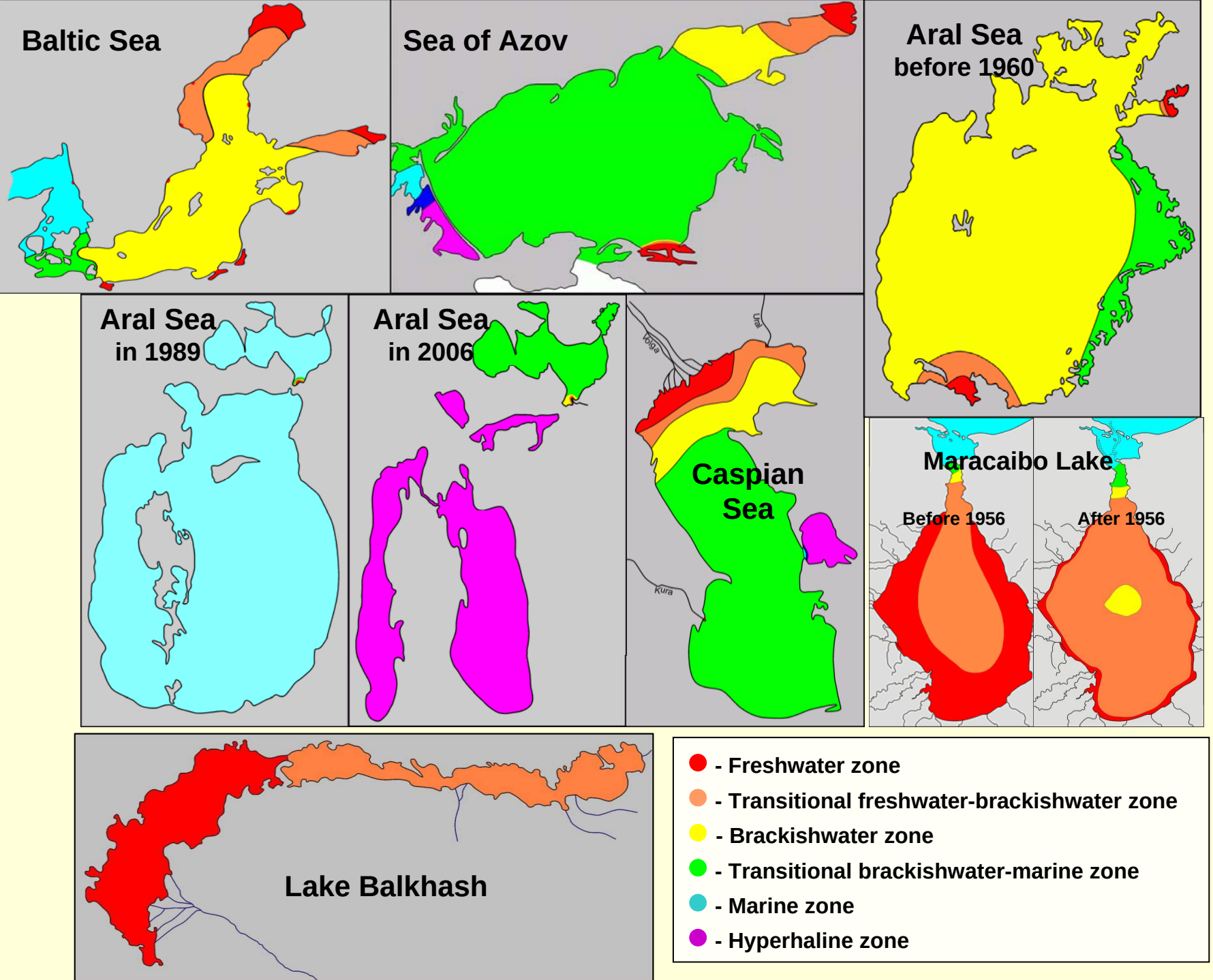
(by: Shibuo, Jarsjo, Destouni, 2007)





Due to the Global Warming precipitations in 2041-2070 will increase up to 50%. Melting of mounting ice caps that is feeding Syr Darya and Amu Darya are still increasing due to the Global Warming.




Baltic Sea
Sea of Azov
Aral Sea
before 1960
Aral Sea
in 1989
Aral Sea
in 2006
Ural
Volga
Caspian
Sea
Kura
Maracaibo Lake
Before 1956
After 1956
Lake Balkhash
- Freshwater zone
- Transitional freshwater-brackishwater zone
- Brackishwater zone
- Transitional brackishwater-marine zone
- Marine zone
- Hyperhaline zone

As salinity of the Aral Sea was increasing its biodiversity became lower:

- In 1971-1976, when salinity exceeded 12-14 g/l, brackish-water species of freshwater origin became extinct.
- In 1986-1989, when salinity exceeded 23-25 g/l, Caspian brackishwater species became extinct.

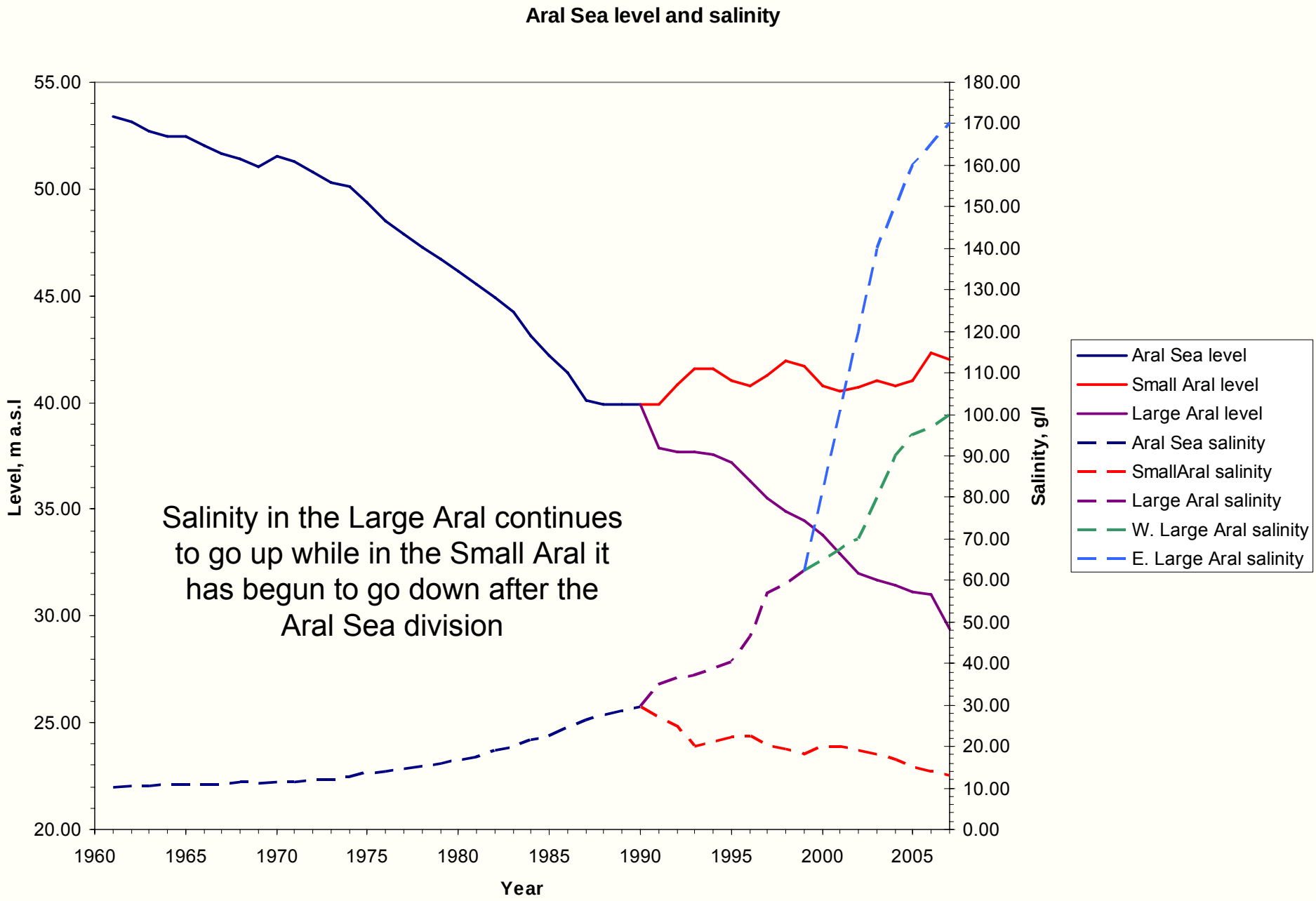
Since the end of 1980's, when the level dropped by about 13 m and reached about +40 m, the Aral Sea divided into the Large and Small Aral

Area 40000 km^2 (60% from 1960)
Volume 333 km^3 (33% from 1960)
Salinity 30 g/l (10 g/l in 1960)

In autumn 1987 – spring 1989 Aral Sea divided into 2 lakes: Small (Northern) Aral and Large (Southern) Aral. In both lakes salinity increased and could survive practically the same number of free-living animals.

Fishes – 10; Rotatoria – 3; Cladocera – 2; Copepoda – 2; Ostracoda – 1; Decapoda – 2; Bivalvia – 2; Gastropoda - >2; Polychaeta – 1.

TOTAL: >25


Aral Sea level and salinity
Level, m a.s.l
Salinity, g/l
Year
55.00
50.00
45.00
40.00
35.00
30.00
25.00
20.00
180.00
170.00
160.00
150.00
140.00
130.00
120.00
110.00
100.00
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
1960
1965
1970
1975
1980
1985
1990
1995
2000
2005
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
Aral Sea level
Small Aral level
Large Aral level
Aral Sea salinity
SmallAral salinity
Large Aral salinity
W. Large Aral salinity
E. Large Aral salinity

Hydrologic and Salinity Characteristics of the Aral Sea

by: P. Micklin

Year	Level (m asl)	Area (km^2)	% of 1960 area	Volume (km^3)	% of 1960 volume	Average salinity (g/l)	% 1960 salinity
1960 (whole sea)[b]	53.4	67499	100	1089	100	10	100
Large Sea	53.4	61381	100	1007	100	10	100
Small Sea	53.4	6118	100	82	100	10	100
1971 (whole sea)[b]	51.1	60200	89	925	85	10	100
1976(whole sea)[b]	48.3	55700	83	763	70	14	140
1989 (whole sea)[c]		39734	59	365	33		
Large Sea	39.32	36307	60	341	34	30	300
Small Sea	40.2	2804	46	23	28	30	300
2009 (whole sea)[c]		8409	12	85	8		
Large Sea	29.4	4922	8	58	6	East >200 West >100	>2000 >1000
Small Sea	42.0	3487	57	27	33	12	120

[a]Annual average.

[b]As of January 1.

[c]The sea will consist of a western and eastern part.

Zooplankton and zoobenthos of the Aral Sea just after its separation (1989)

(only common species)

Average salinity about 30 g/l

ZOOPLANKTON

Rotatoria

Synchaeta vorax

S. cecilia

Copepoda

Calanipeda aquaedulcis

Halicyclops rotundipes aralensis

Bivalvia Larvae

Abra ovata

Cerastoderma isthmicum

ZOOBENTHOS

Bivalvia

Abra ovata

Cerastoderma isthmicum

Gastropoda

***Caspiohydrobia* spp.**

Polychaeta

Nereis diversicolor

Ostracoda

Cyprideis torosa

Decapoda

Palaemon elegans

***Rhithropanopeus harrisii tridentata* (only in Large Aral)**

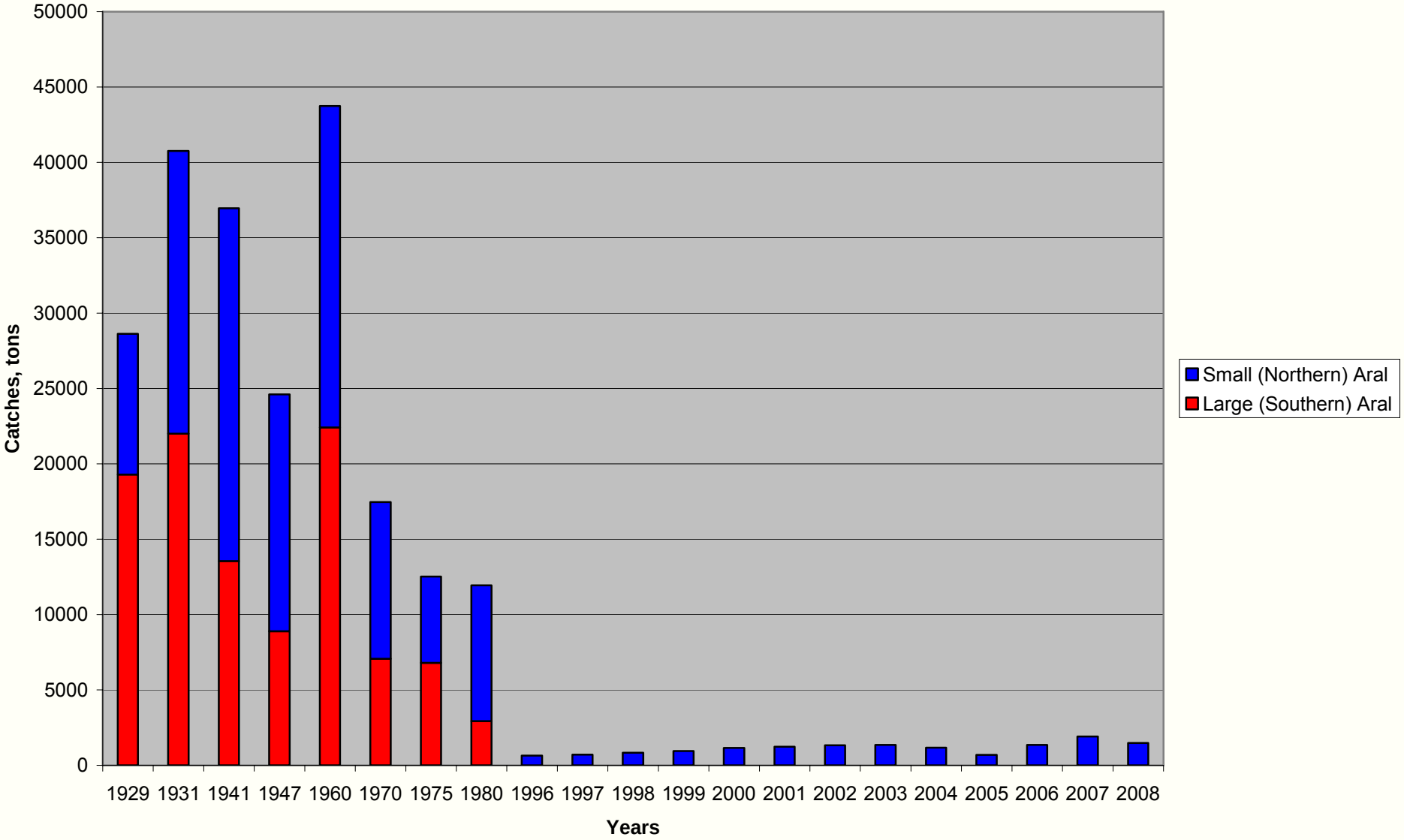
Fishes of the Aral Sea just after its separation (1989)

Average salinity about 30 g/l

1. **Flounder – *Platichthys flesus luscus***
2. Stickleback – *Pungitius platygaster* - ?
3. Baltic herring – *Clupea harengus membras*
4. Silverside – *Atherina boyeri caspia*
5. Bubyr goby – *Knipowitschia caucasicus*
6. Sand goby – *Neogobius fluviatilis*
7. Round goby – *Neogobius melanostomus*

Dynamics of fish catches in the North and South Aral Sea

recent data for Small Aral Sea is received from Z.Ermahanov



Concept to Partially Preserve Small and Large Aral Seas
(proposed by Lvovich and Tsigelnaya, updated and modified by P. Micklin)

Small Aral Sea

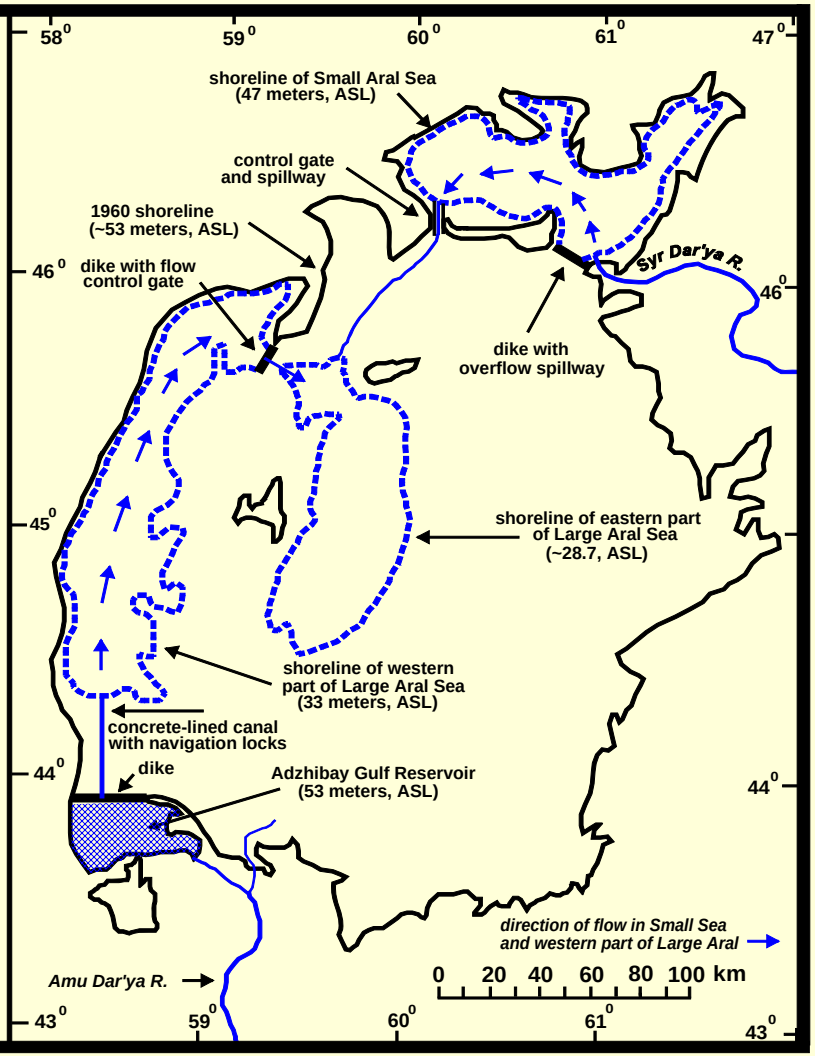
level 47 m, area 4310 km2, vol. 46.5 km3, river inflow 4.5 km3, outflow toward L. Aral 1.4 km3, salinity 7.6 g/l (?), start date for project - 2004

Large Aral Sea

Western Sea: level 33 m, area 6203 km2, vol. 85 km3, river inflow 7.35 km3, outflow to E. Aral 3.05 km3, salinity 45 g/l, (21 g/l by 2050), start date - 2007

Eastern Sea: level 28.7 m, area 5710 km2, vol 21 km3, inflow from W. Aral 2.95 km3, inflow from Small Aral 1.03 km3, salinity 362 g/l (?)

Adzhibay Gulf Reservoir: level 53 m, area 1147 km2, vol. 6.23 km3, inflow from Amu Dar'ya 8.26 km3, outflow to W. Aral 7.35 km3, salinity ~2g/l



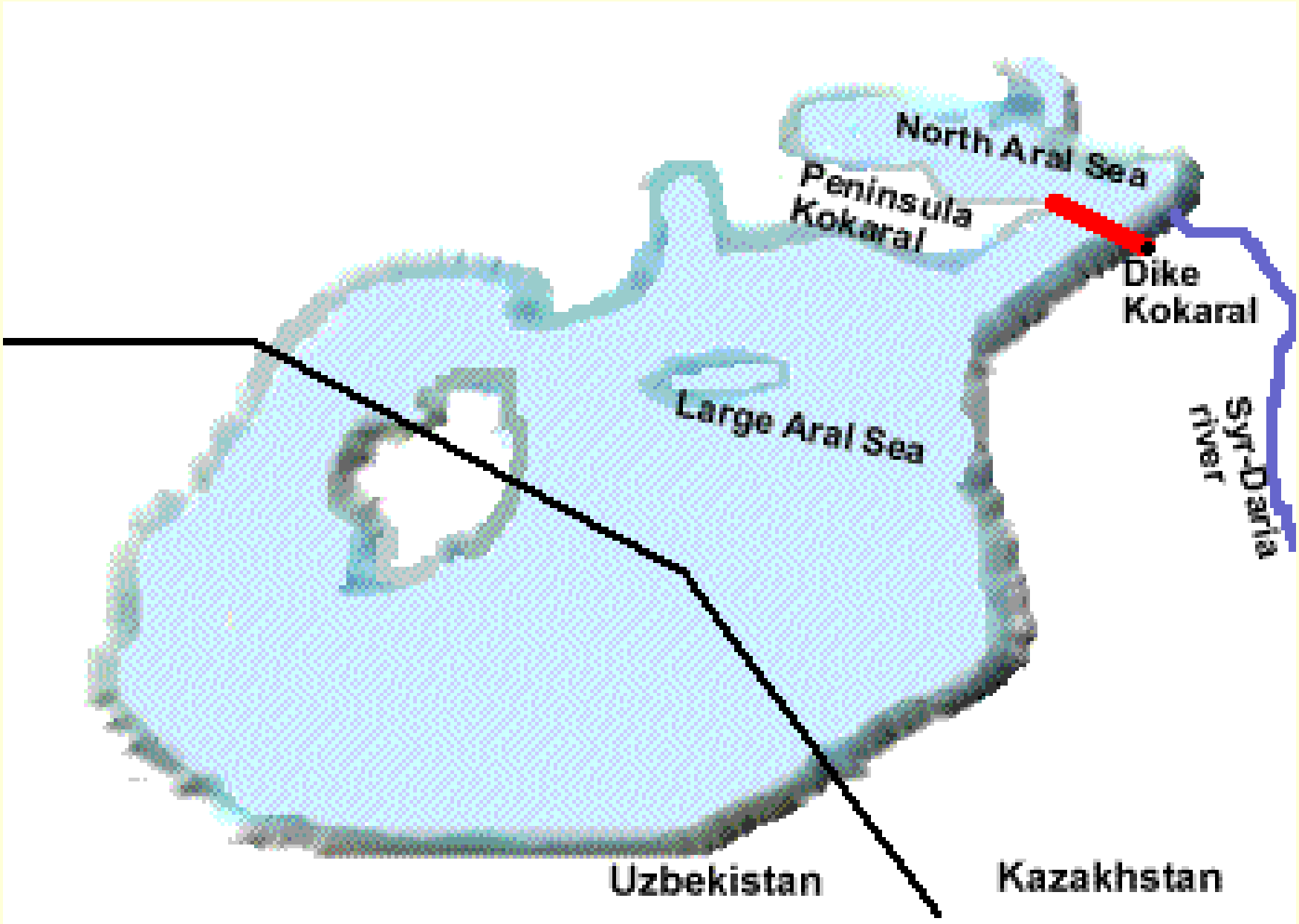
Another option would be to give more water to the Eastern Large Aral from Small Aral via Berg strait and from Amudarya river via Akdarya river bed. Level of Western Large Aral Sea might be maintainable using ground water flow from Amudarya delta and Ustjurt plateau.

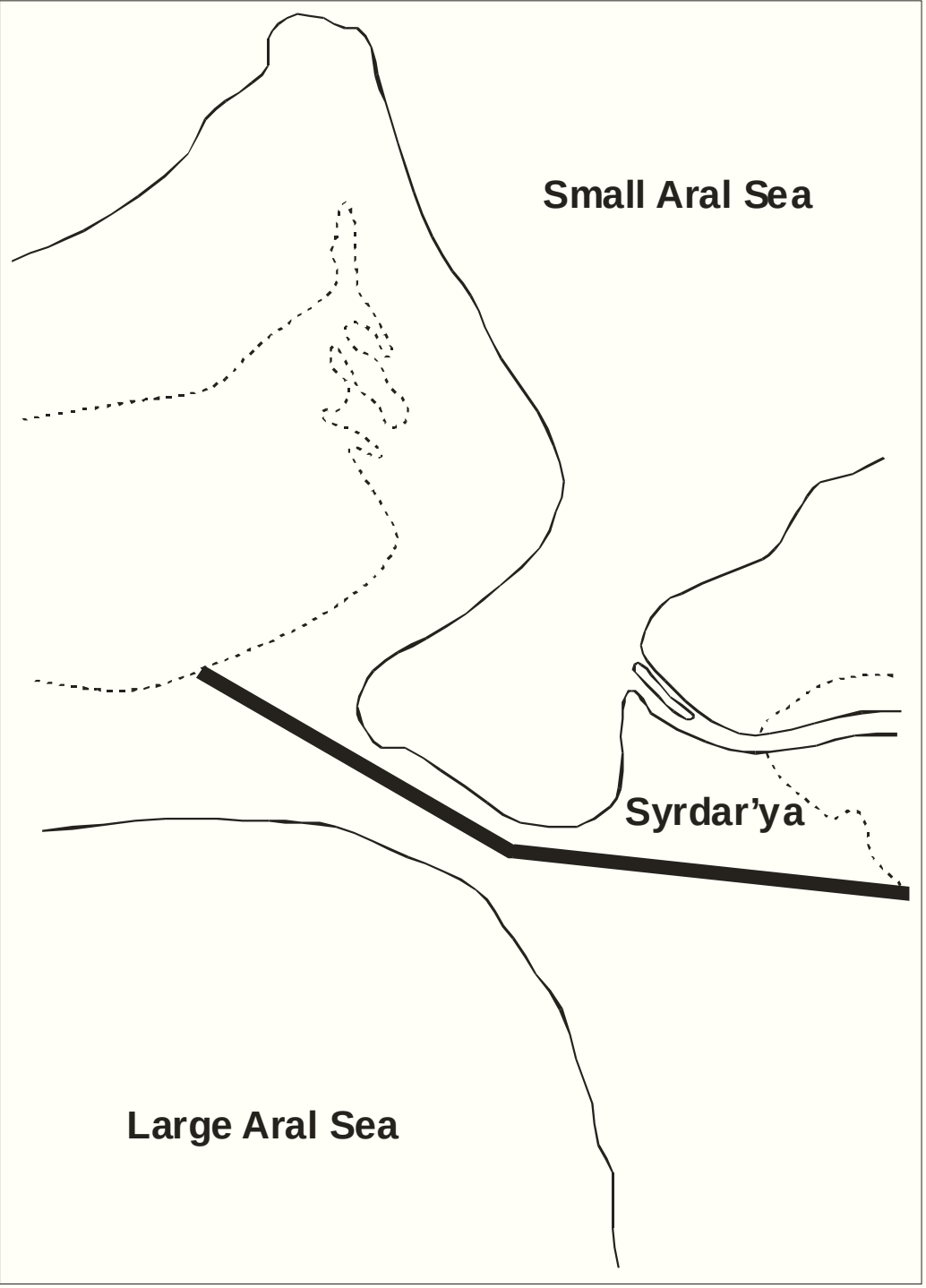
Realization of this project will help biodiversity conservation.

Discharge of water from Small Aral occurs primarily in Spring-early Summer high flow period on Syr Dar'ya. Since August 2005 outflow is controlled by a discharge structure (gates) in the dike.

SMALL ARAL AND NORTH PART OF LARGE ARAL
(Showing effect of Spring/early summer "high flow" and later Summer "low flow" of Syr Dar'ya)

Dike in Berg strait is preserving Small (Northern) Aral and rehabilitating its biodiversity.

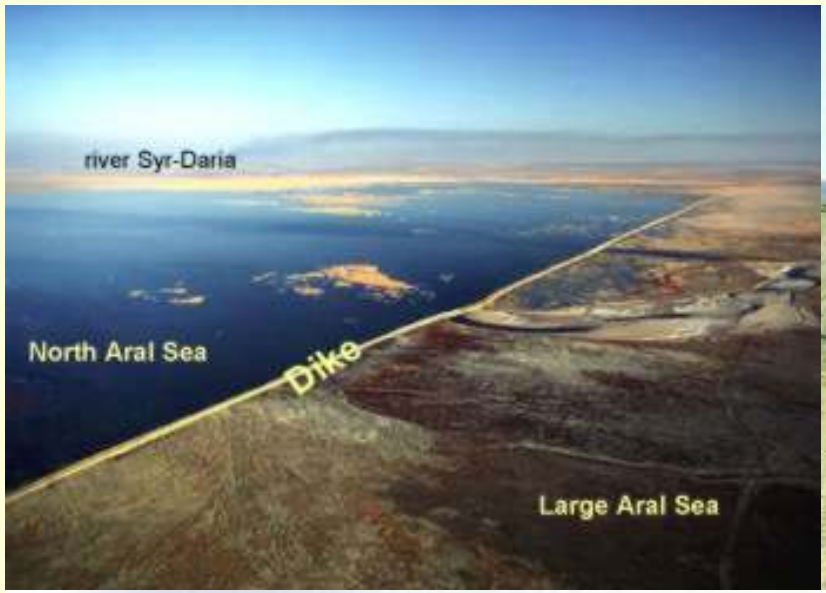




Dike in Berg strait is preserving Small (Northern) Aral and rehabilitating its biodiversity.

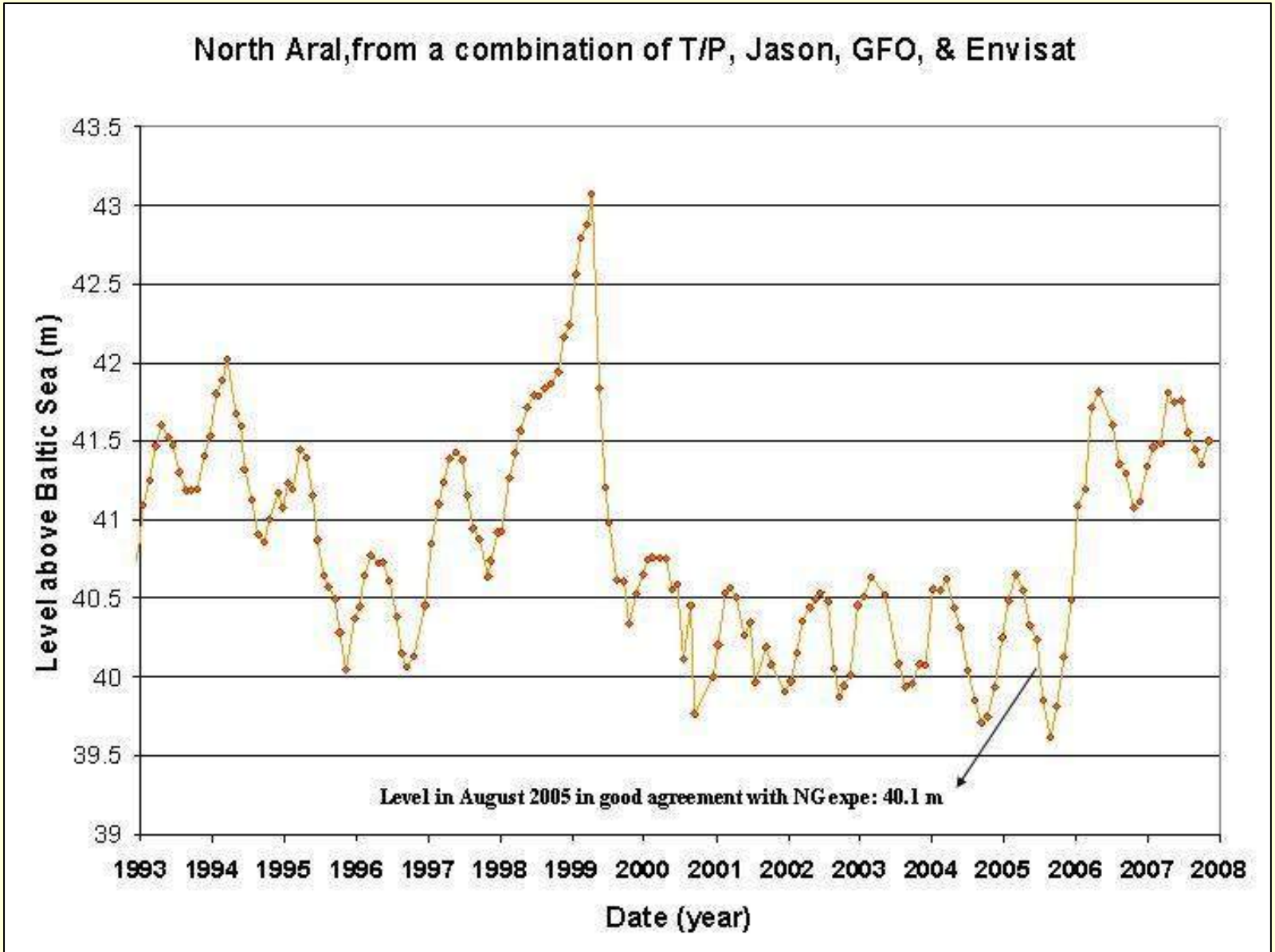
By: Aladin N.V., Plotnikov I.S., Potts W.T.W., 1995. The Aral Sea desiccation and possible ways of rehabilitation and conservation of its North part // Int. J. Environmetrics. Vol. 6: 17-29.

The first dike was built by our proposal in August 1992. Its existence till April 1999 allowed to rehabilitate biodiversity. Number of free-living animals increased.



In April 1999, when the Small Aral Sea level increased more than by 3 m and reached +43.5 m, the dike broke.

(data below are from satellite altimetry courtesy of Jean-Francois Cretaux)



Small Aral sea before dike construction

This boat was far from the sea in September 2005

Small Aral sea after dike construction

Owing to level rise of the Small Aral the boat was mostly under water by September 2007

Kok-Aral dike built by Russian company “ZARUBEZHVODSTROY”

When water gates are open in Kok-Aral dike all remnant water bodies of the Aral Sea are connected

Since beginning of 2003, when the level in the Large Aral Sea dropped by 22 m and reached about +31 m, the Large Aral Sea is practically divided into the Eastern Large and Western Large Aral

Sept. 6, 2009: Area 4922 km^2 (8% from 1960)
Volume 58 km^3 (6% from 1960)
Salinity: Western part and Tschebas Bay – >100 g/l, Eastern part – >200 g/l)

In 2010 Eastern part can be desiccated almost completely.

In both lakes salinity increased so high that all fishes gone and only few free-living invertebrates could survive.

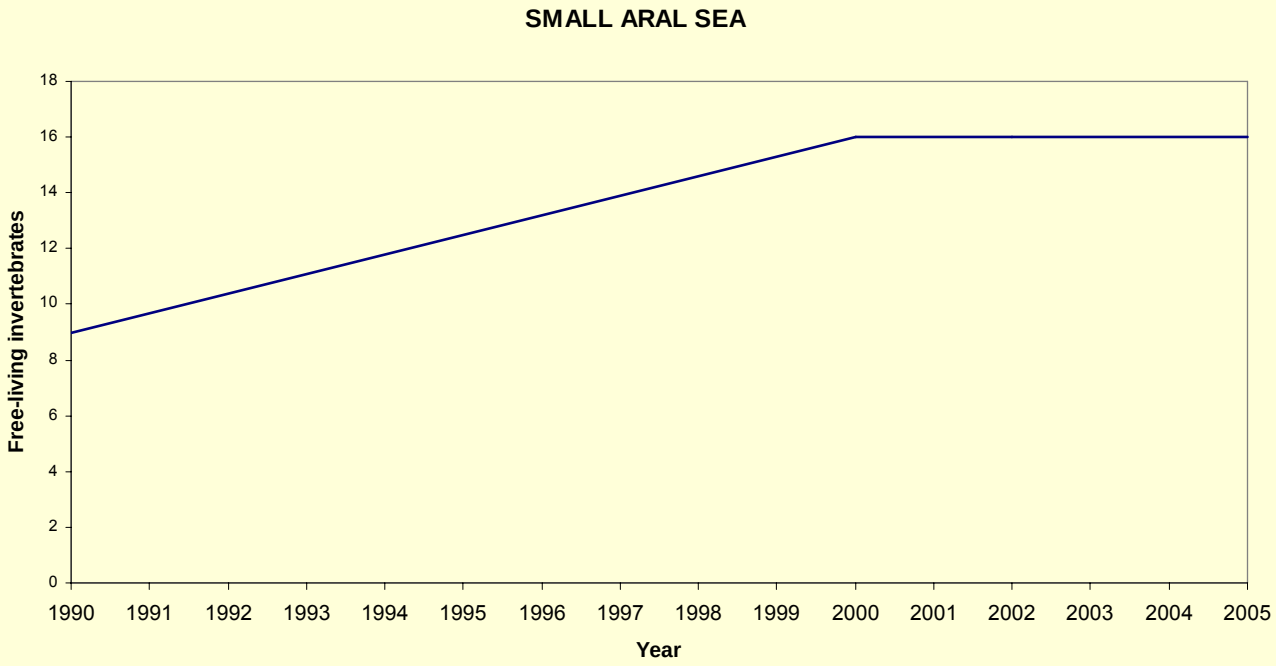
Western part and Tschebas Bay of Large Aral:
Infusoria – 2; Rotatoria – 2; Copepoda – 1; Ostracoda – 2; Branchiopoda – 1; Gastropoda - >2.
TOTAL: >10?

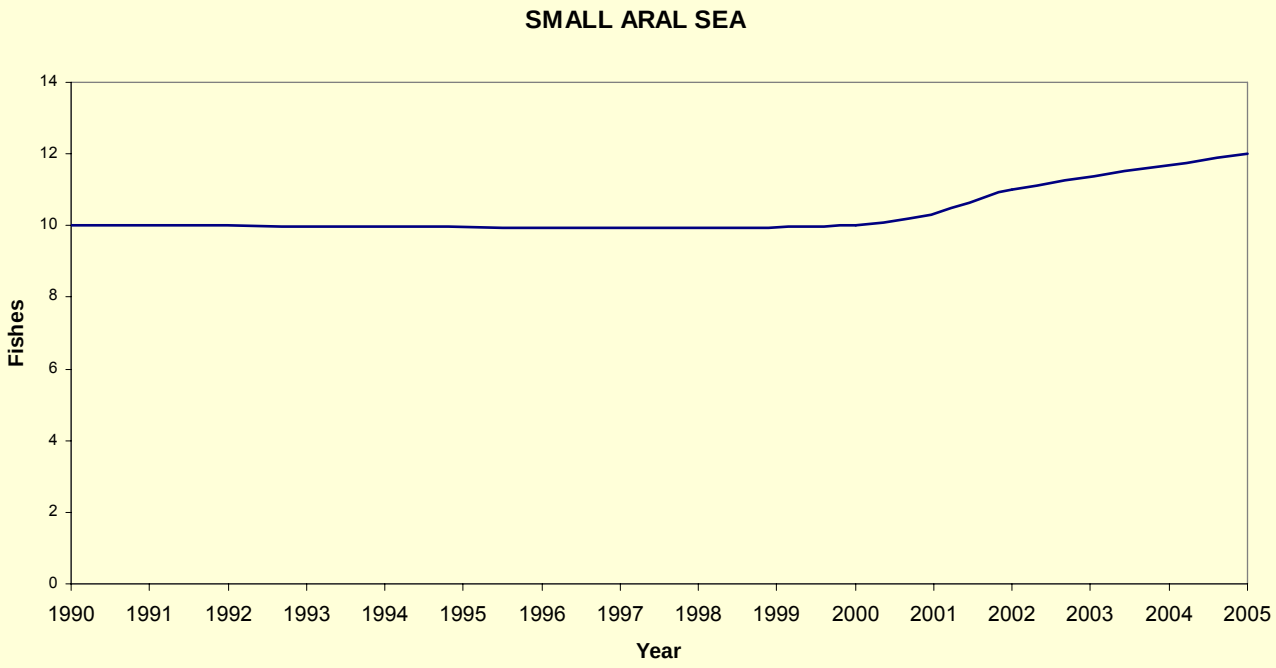
Eastern part of Large Aral :
Branchiopoda – 1.

Since separation of the Small Aral Sea from Large Aral at the end of 1980s number of free-living animals increased because salinity in this lake was cut by 50 % and in 2005 reached about 17 g/l.

Area 2865 km^2 (47% from 1960), Volume 23 km^3 (28% from 1960), Level +40.4 asl

Fishes – 12?;
Rotatoria – 3;
Cladocera – 2;
Copepoda – 2;
Ostracoda – 2;
Decapoda – 2;
Bivalvia – 2;
Gastropoda - >1;
Polychaeta – 1.
TOTAL: >27?





Change of species number in the Small Aral Sea.

Top: free-living invertebrates excluding Protozoa and micro-Metazoa

Bottom: fishes

Zooplankton and zoobenthos of the Small Aral Sea (2009)

(only common species)

Average salinity about 11-14 g/l

ZOOPLANKTON

Rotatoria

- *Synchaeta vorax*
- *S. cecilia*

Cladocera

- *Podonevadne camptonyx*
- *Evadne anonyx*

Copepoda

- *Calanipeda aquaedulcis*
- *Halicyclops rotundipes aralensis*

Bivalvia Larvae

- *Abra ovata*
- *Cerastoderma isthmicum*

ZOOBENTHOS

Bivalvia

- *Abra ovata*
- *Cerastoderma isthmicum*

Gastropoda

- *Caspiohydrobia* spp.
- *Theodoxus pallasi*

Polychaeta

- *Nereis diversicolor*

Ostracoda

- *Cyprideis torosa*
- *Eucypris inflata*

Decapoda

- *Palaemon elegans*

Insecta

- *Chironomidae* larvae

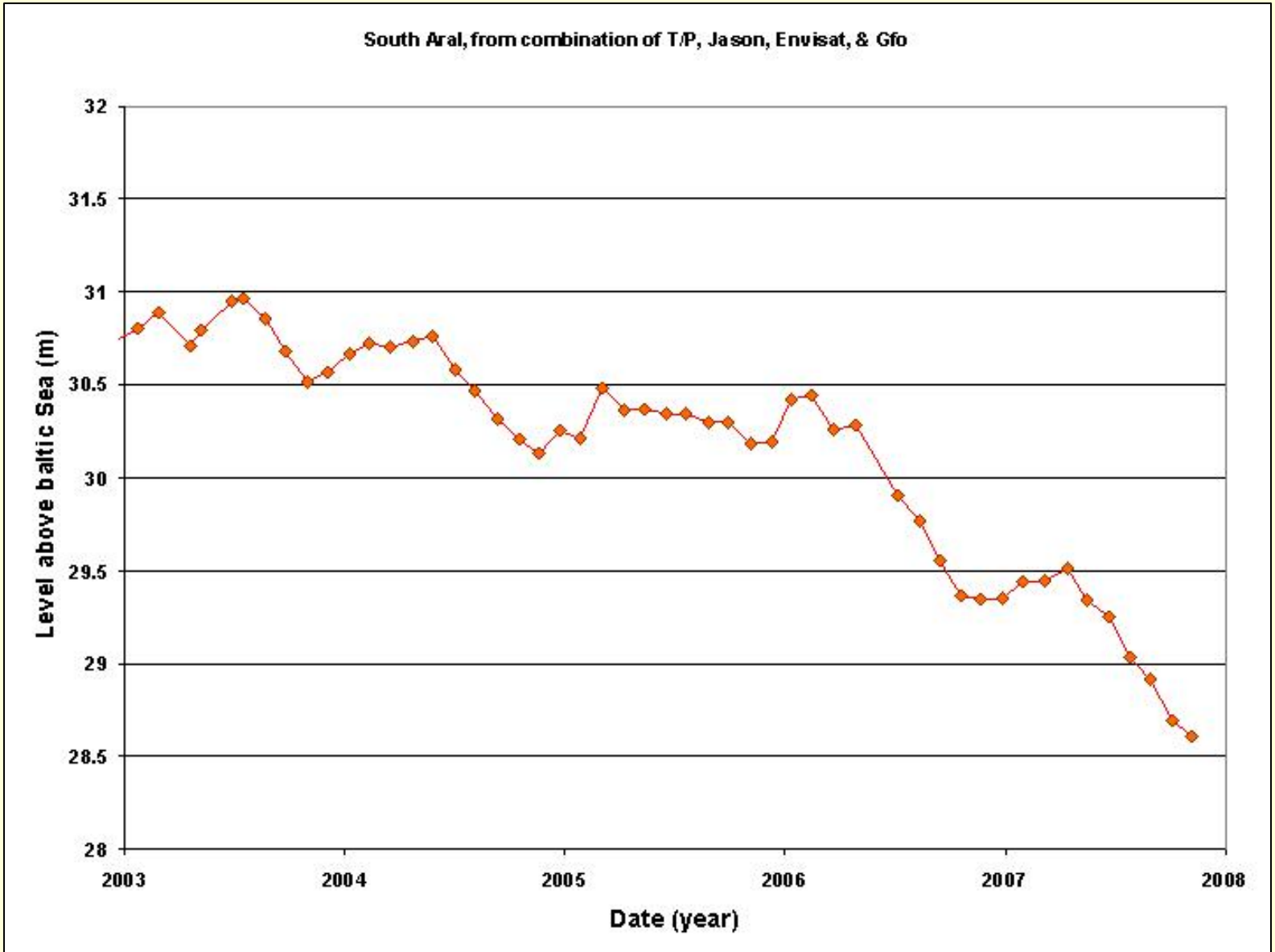
Fishes of the Small Aral Sea (2009)

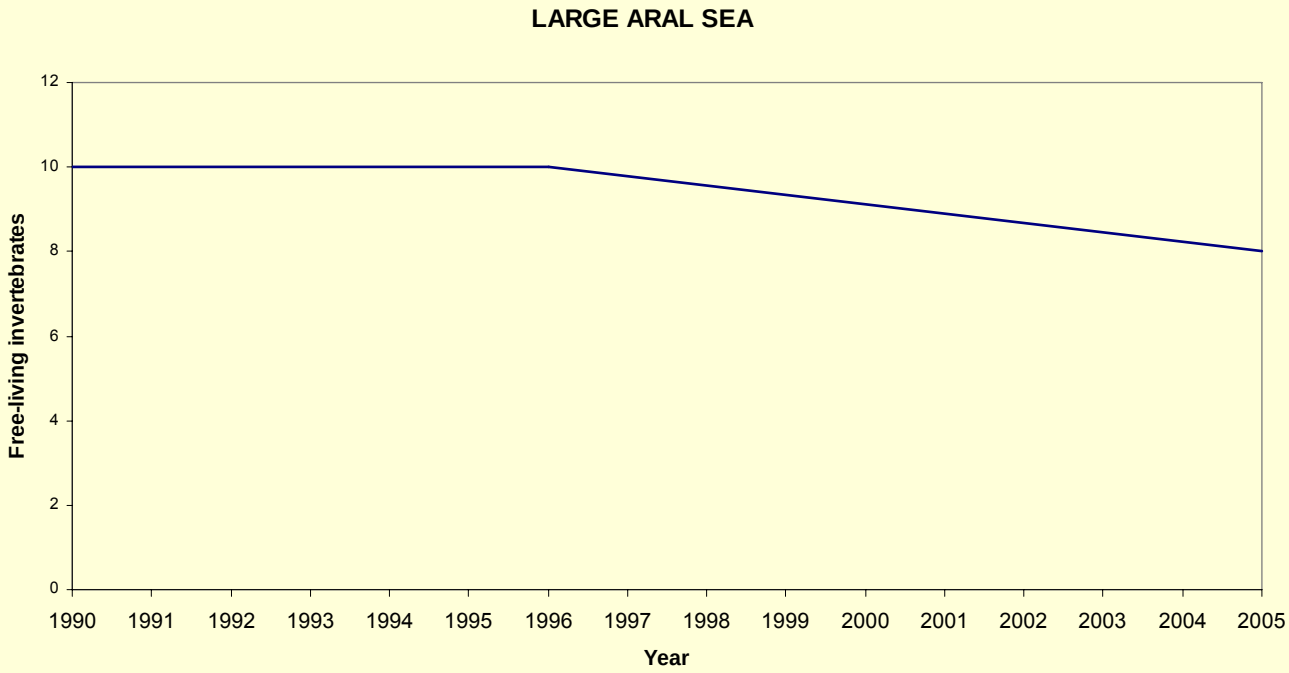
Average salinity about 10-14 g/l

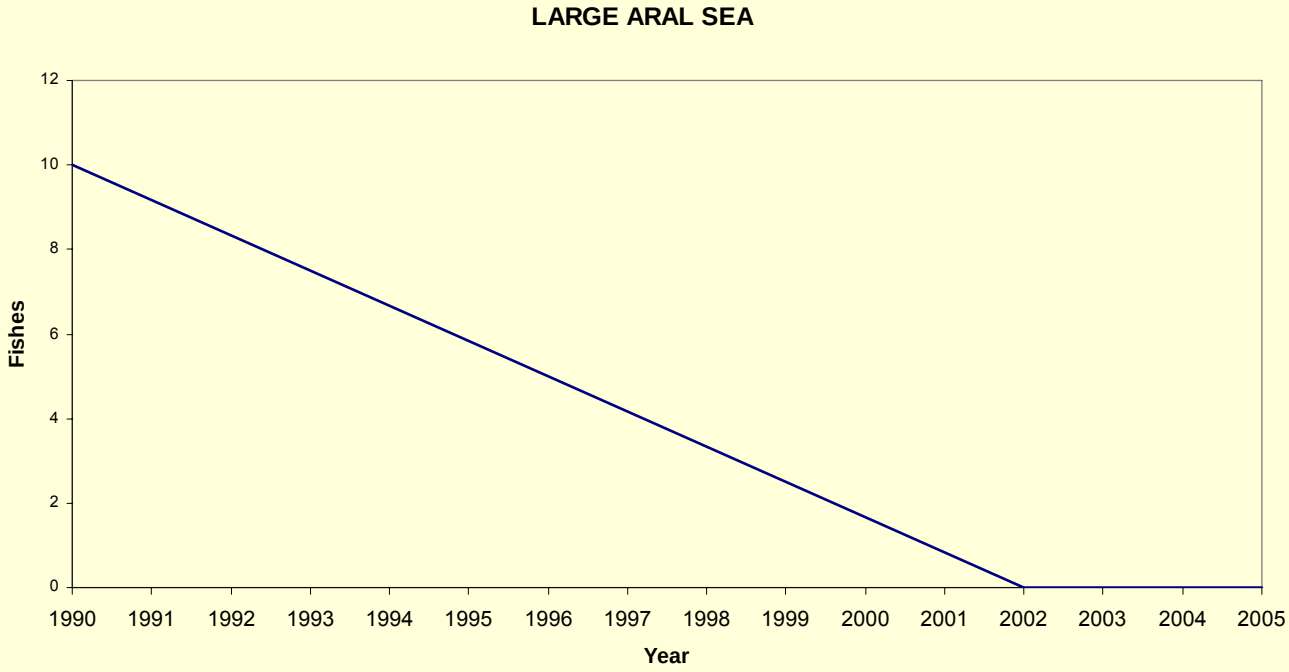
1. **Bream – *Abramis brama***
2. **Carp – *Cyprinus carpio***
3. **Roach – *Rutilus rutilus aralensis***
4. **Asp – *Aspius aspius iblioides***
5. **Sabrefish – *Pelecus cultratus***
6. **Grass carp – *Ctenopharyngodon idella***
7. **Pike perch – *Sander lucioperca***
8. **Flounder – *Platichthys flesus luscus***
9. Stickleback – *Pungitius platygaster* - ?
10. Baltic herring – *Clupea harengus membras*
11. Silverside – *Atherina boyeri caspia*
12. Bubyr goby – *Knipowitschia caucasicus*
13. Sand goby – *Neogobius fluviatilis*
14. Round goby – *Neogobius melanostomus*

Since Aral Sea divided into 2 lakes at the end of 1980s level of Large Aral Sea is constantly declining.

(data from satellite altimetry, courtesy of Jean-Francois Cretaux).







Change of species number in the Large Aral Sea.

Top: free-living invertebrates excluding Protozoa and micro-Metazoa

Bottom: fishes

Zooplankton and zoobenthos of the Western Large Aral Sea (2009)

Average salinity >100 g/l

ZOOPLANKTON

Infusoria

Fabrea salina

Rotatoria

Brachionus plicatilis

Hexarthra fennica

Cladocera

Moina mongolica

Copepoda

Apocyclops dengizicus

Branchiopoda

Artemia parthenogenetica

ZOOBENTHOS

Infusoria

Frontonia marina ?

Turbellaria

Mecynostomum agile ?

Gastropoda

***Caspiohydrobia* spp.**

Ostracoda

Cyprideis torosa

Eucypris inflata

Insecta

Chironomidae larvae

In Tsche-Bas Bay zooplankton and zoobenthos resemble those of the Western Large Aral Sea

Zooplankton and zoobenthos of the Eastern Aral Sea (2009)

Average salinity > 200 g/l

ZOOPLANKTON

Artemia parthenogenetica

ZOOBENTHOS

Alive macro- and mezo-Metazoa are not available

Changes in the invertebrates fauna of the Large Aral Sea due to its transformation into hyperhaline water body

- *Synchaeta* spp.
  – is extinct since1997
- *Calanipeda aquaedulcis*
  – is extinct since1997
- *Nereis diversicolor*
  – is extinct since 2001
- *Cerastoderma isthmicum*
  – is extinct since 2001
- *Abra ovata*
  – is extinct since 2002

- *Artemia parthenogenetica*
  – appeared in 1998
- *Moina mongolica*
  – reappeared in 1996
- *Apocyclops dengizicus*
  – appeared in 2004
- *Hexarthra fennica*
  – became common species
- *Brachionus plicatilis*
  – became common species

At the end of 20th century brine shrimp *Artemia parthenogenetica* appeared in the Large Aral Sea.

Nowadays industrial harvesting under aegis of international company INVE Aquaculture is being considered, but in 2005 the company postponed activities until salinity increase to levels more favorable for brine shrimp.

Fishes of the Large Aral Sea

1998
(salinity about 60 g/l)

Flounder – *Platichthys flesus*

Baltic herring – *Clupea harengus membras*

Silverside– *Atherina boyeri caspia*

Bubyr goby – *Knipowitschia caucasicus*

Sand goby – *Neogobius fluviatilis*

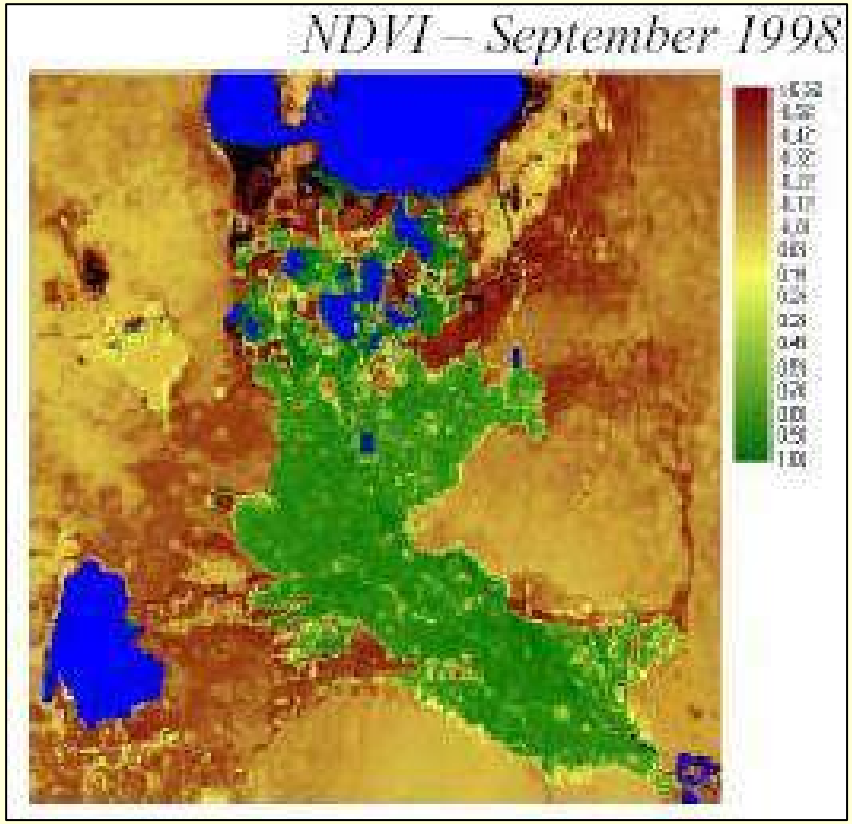
2009

Western Large Aral:
(salinity >100 g/l)

Eastern Large Aral:
(salinity >200 g/l)

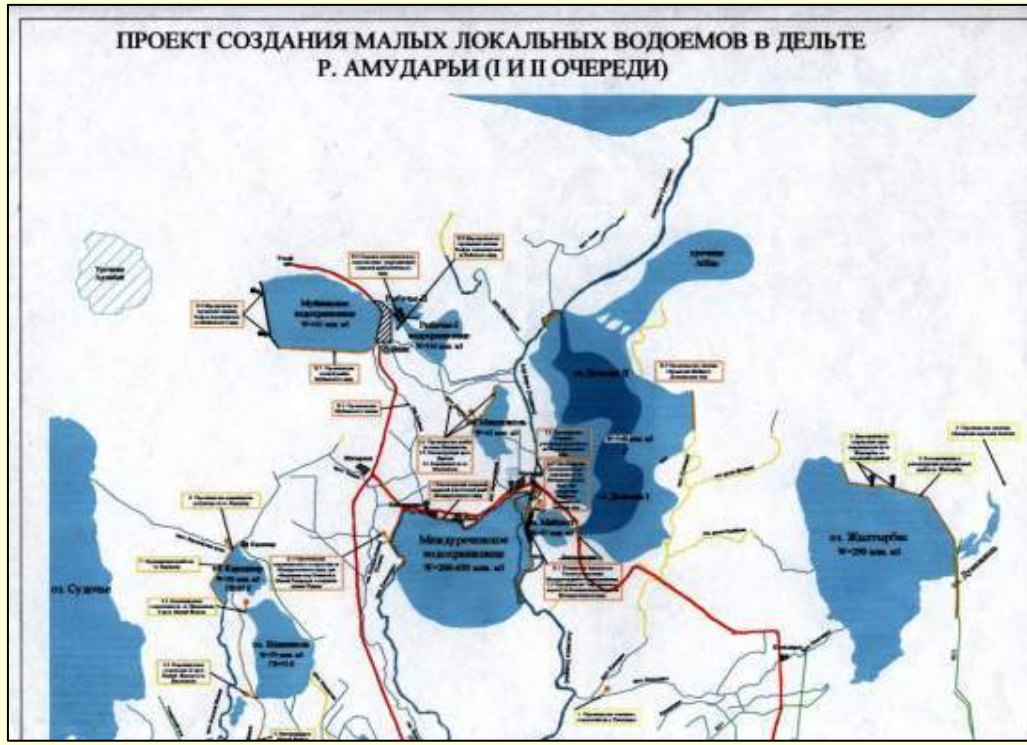
No fishes survived

In lower reaches of Amudarya a lot of freshwater and brackish water reservoirs were built. One of the most successful projects is Sudochie lake.



Besides Sudochie lake it were a number of other successful projects with former Aral Sea bays like: Sarbas, Muynak, Adjibay and Zhiltyrbas. Fisheries and hunting activities came back for the areas mentioned above.

Uzbekistan branch of IFAS in cooperation with other national institutions prepared a plan of Amudarya delta rehabilitation

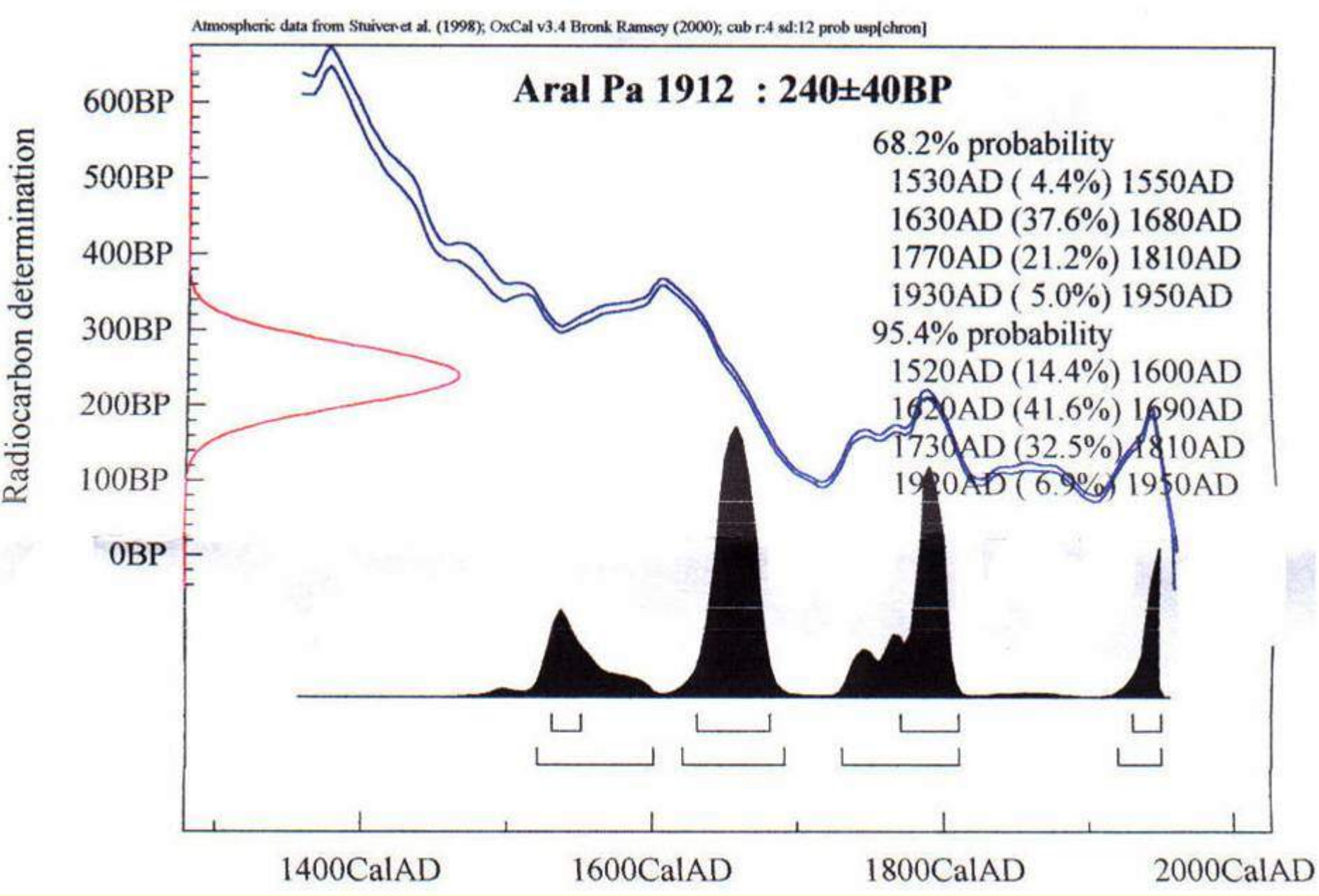


Sudochie lake is completely filled up and via underground flow is giving some water to the Western Large Aral Sea.

Reeds, aquatic birds and hydrobionts are almost recovered in Sudochie lake.

Remnants of medieval saxauls on the dried bottom

Remnants of medieval saxauls under water



Radiocarbon dating of saxaul stumps

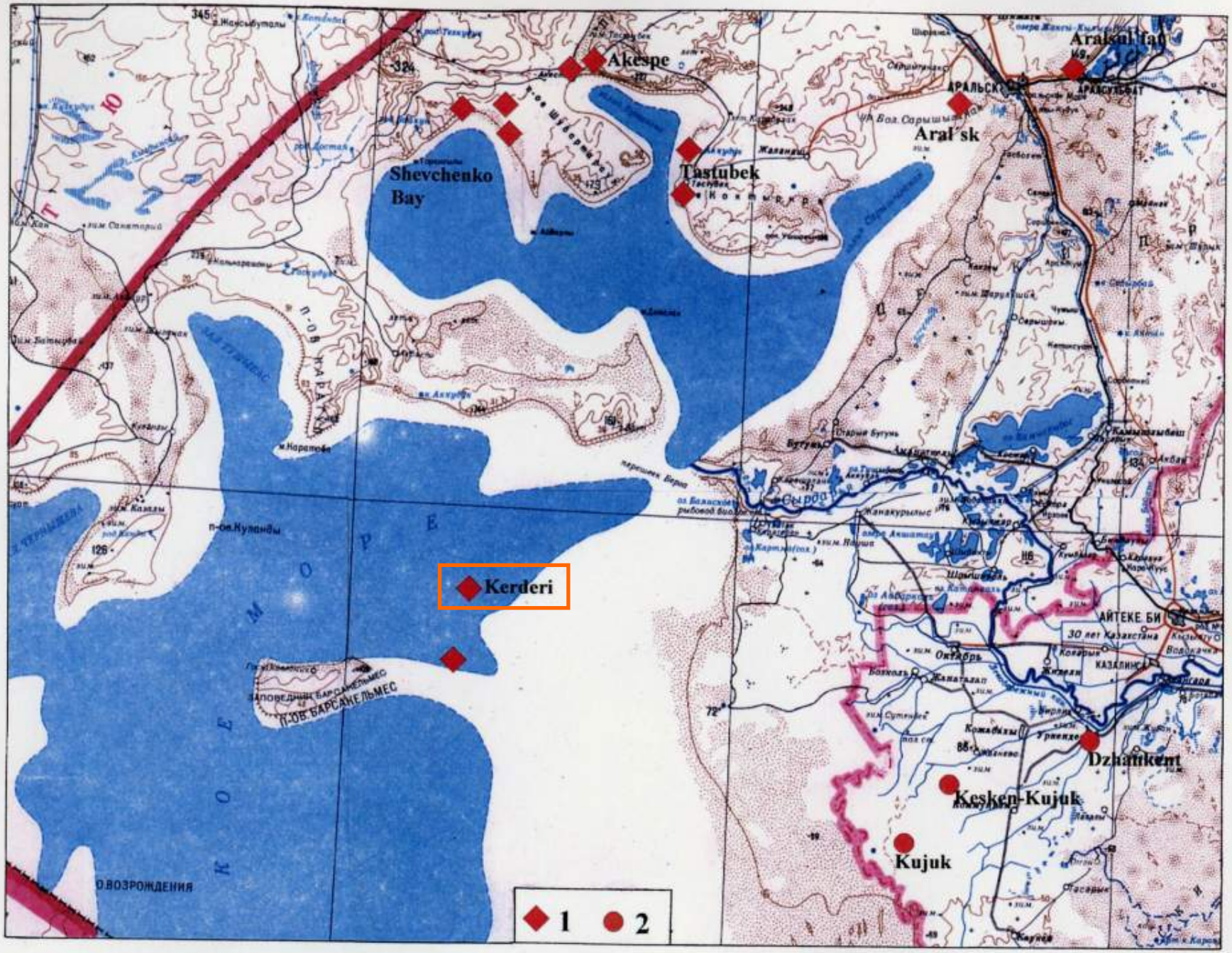
Coring in the Aral Sea. August-September 2002.

Cutting plastic tube containing core of bottom sediments

Cutting the core with metal plate and splitting into two halves

Cut cores. Layers of deposits are neatly visible.

Location of Kerdery Mausoleum



**Ruins of medieval mausoleum (Kerdery) on dried bottom.
In 1960 it was about 20 m below lake level
(photo by N.Boroffka).**

The same mausoleum 4 years later. Terrestrial vegetations covered the ruins. (photo by E.Putnam)

Decorative ceramics from the Mausoleum. (photo by E.Putnam).

Bones of *Homo sapiens* and domestics animals were found near mausoleum (photo by E.Putnam)

Photo by D. Eliseev, member of National Geographic expedition, June 2005

Millstone found on the bottom of the Aral Sea not far from Kerdery mausoleum

Photo by D. Eliseev, member of National Geographic expedition, June 2005

Elements of ceramics and scull of *Homo sapiens* found on the bottom of the Aral Sea not far from Kerdery mausoleum

Photo by I.Plotnikov, member of National Geographic expedition, August 2005

Broken jug found on the bottom of the Aral Sea not far from Kerdery mausoleum

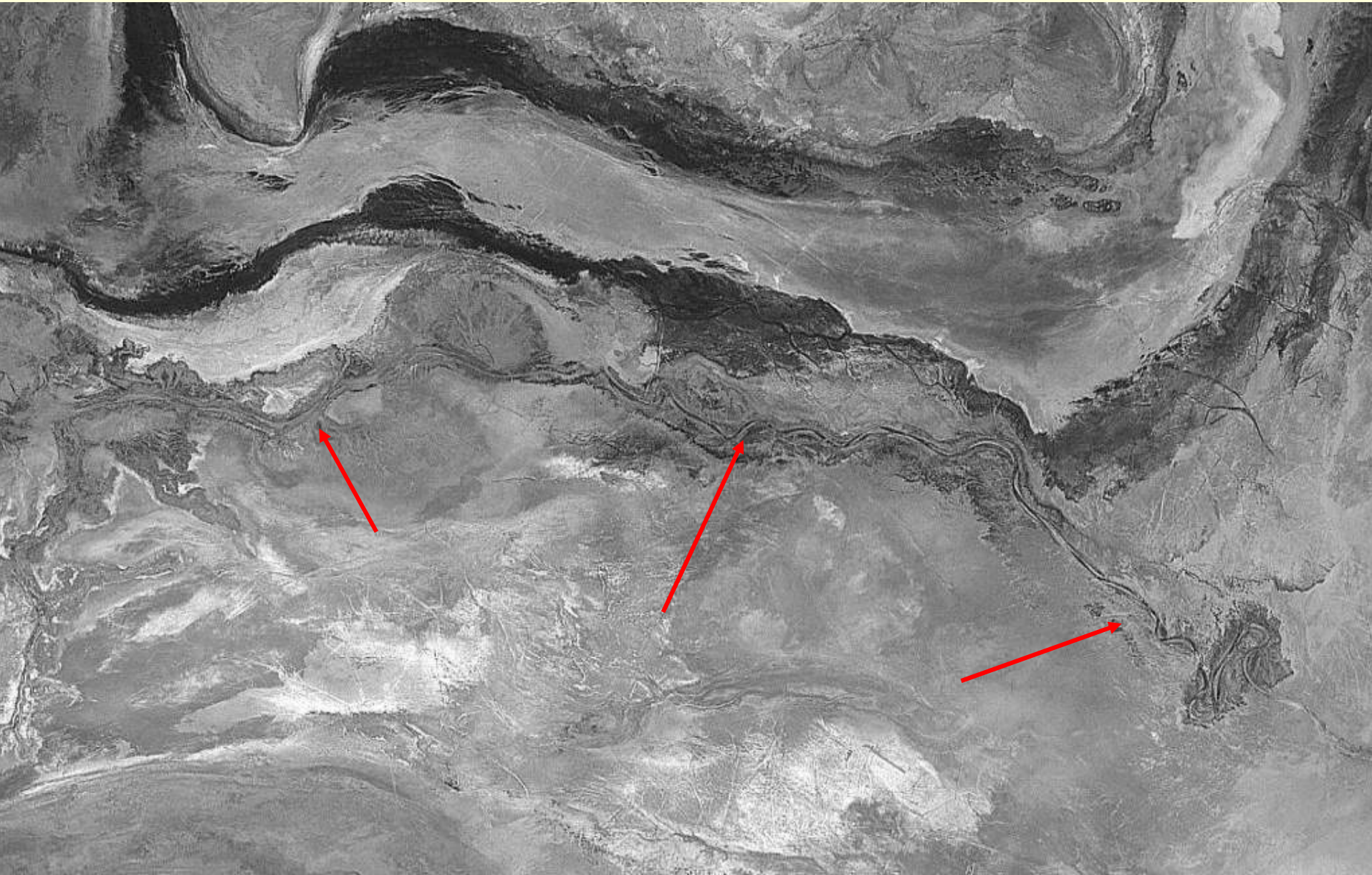
Photo by D. Eliseev, member of National Geographic expedition, June 2005

Some more evidences of human activities found on the bottom of the Aral Sea not far from Kerdery mausoleum

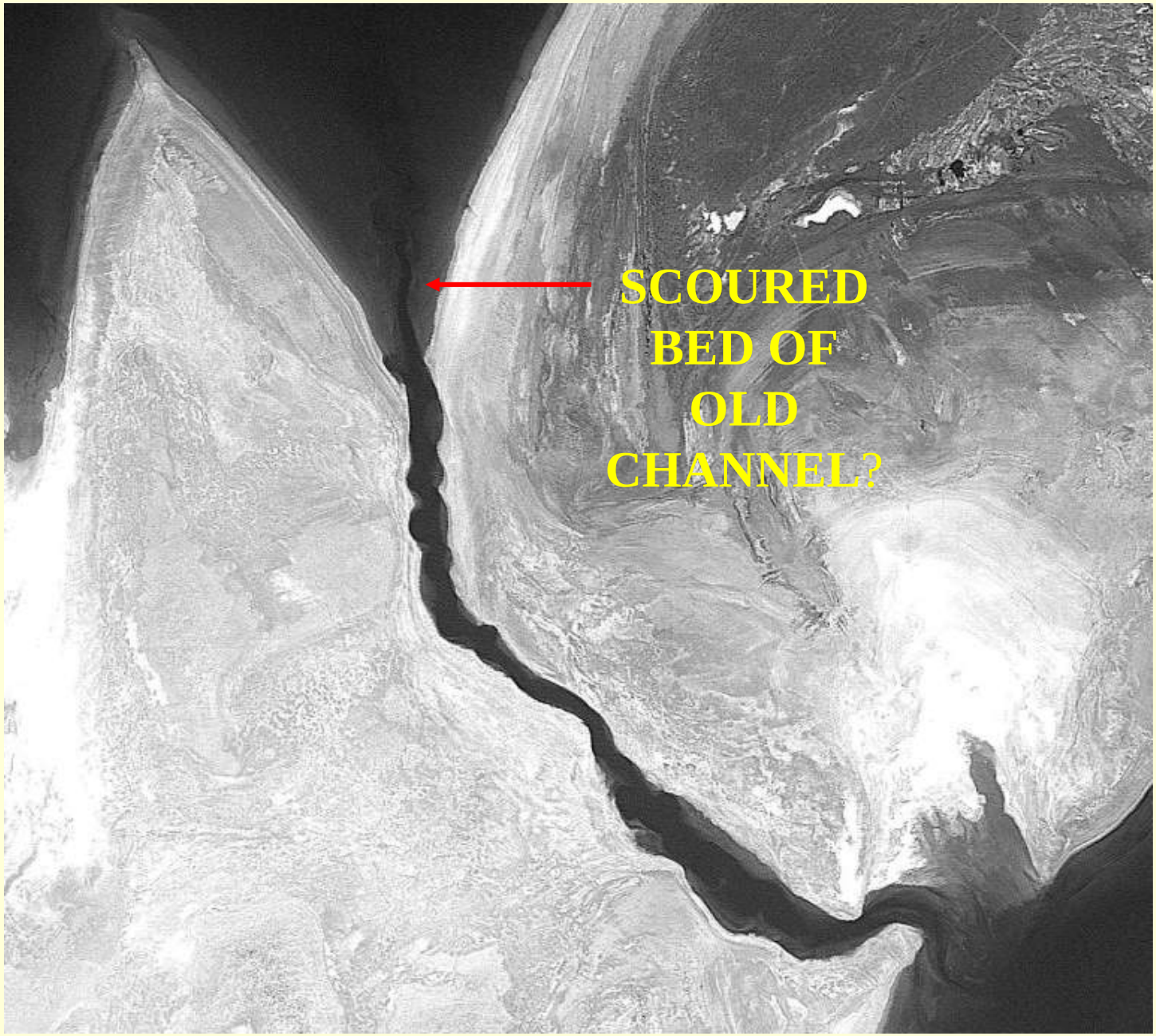
Remnants of Medieval river beds on the former Aral Sea bottom

ANCIENT RIVER BEDS IN THE NORTHEAST FROM BARSAKELNES ISLAND. LANDSAT 5, SEPT. 11, 2007, BAND 1 (BLUE-GREEN), 30 METERS, SHARPENED AND CONTRAST ENHANCED. IN MIDDLE, STRETCHING EAST TO WEST IS OLD RIVER BED (SEE RED ARROWS).

Courtesy by P.Micklin



Fossil (probably Medieval) canal between Western and Eastern Large Aral discovered by Prof. Dr. Rene Letolle and predicted by Dr. David Piriulin

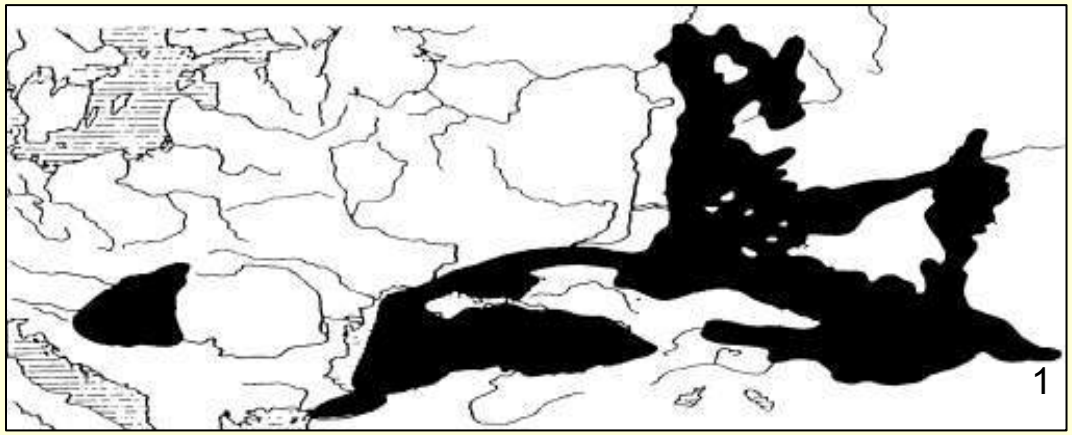


KULANDY CHANNEL, 9-11-07, LANDSAT 5, 30 METER RESOLUTION, BAND 1 (BLUE-GREEN) THAT DIFFERENTIATES SHALLOW FROM DEEPER WATER. SHARPENED AND ENHANCED

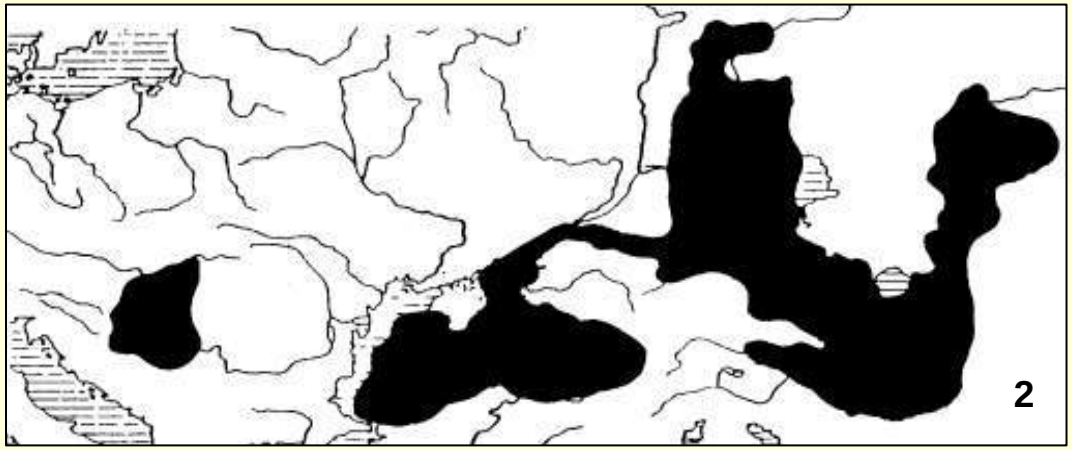
Courtesy by P.Micklin

Separation of Kulandy Channel from the Western Large Aral

Caspian Sea transgressions



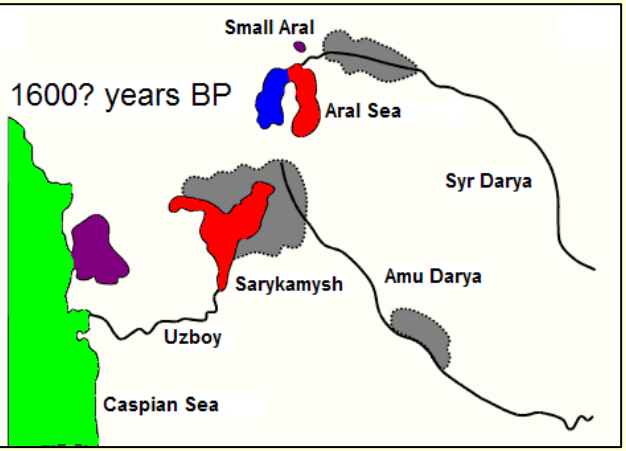
Akchagylian and Kuyalnik lake-seas (3 mil BP)

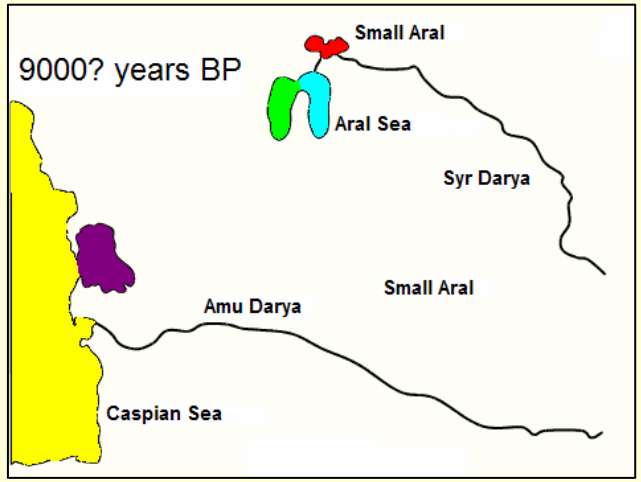


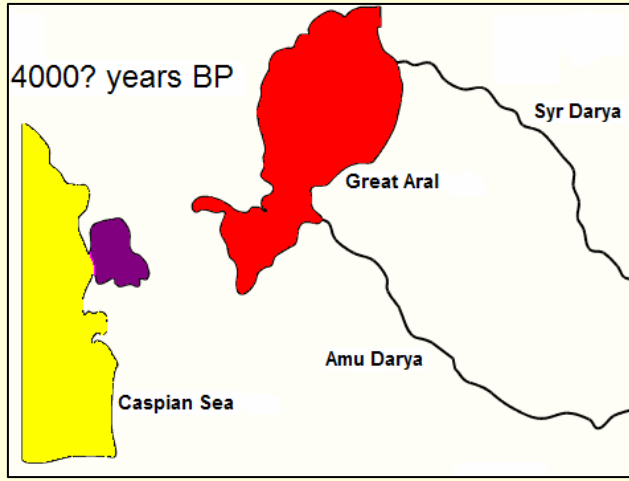
Apsheronian and Gurian lake-seas (2 mil BP)

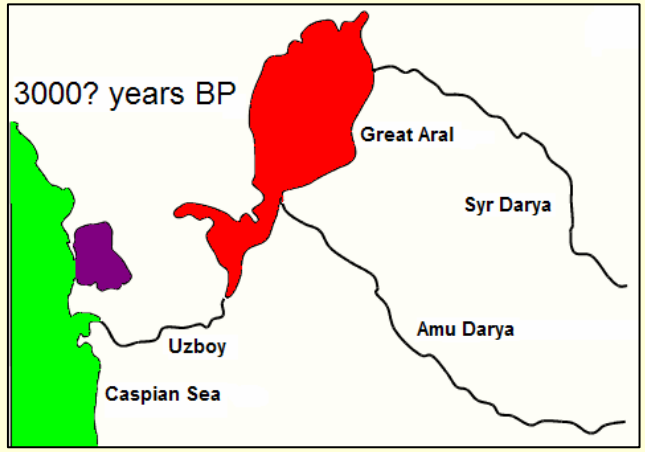
Ancient Euxinian and Khazarian lake-seas (0.4 mil BP)

Aral Sea: from 9000 to 1600 years BP



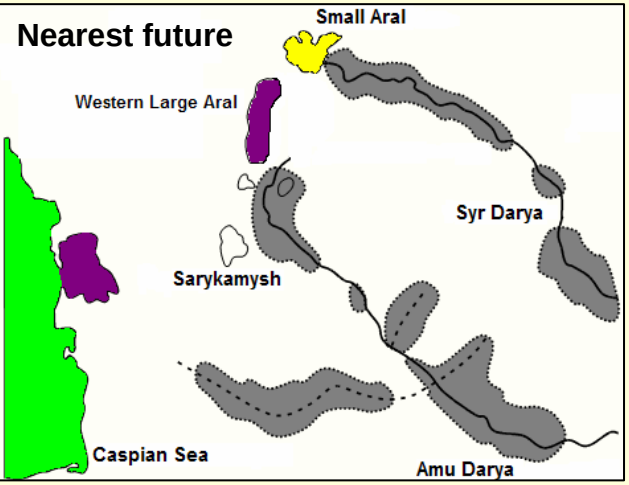


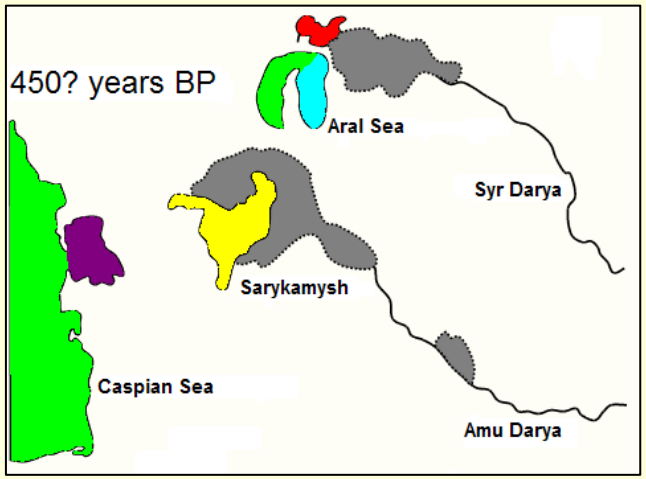


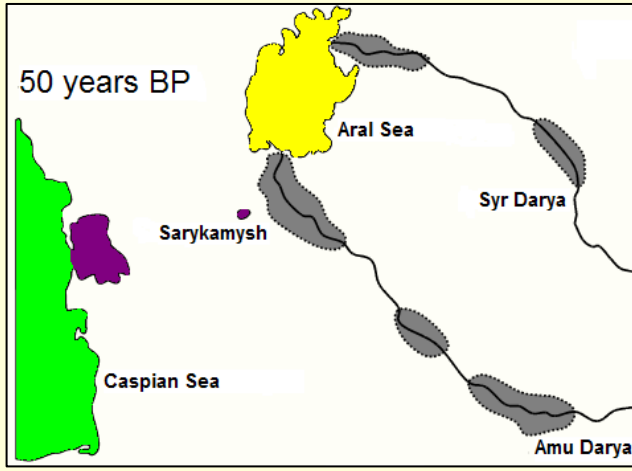


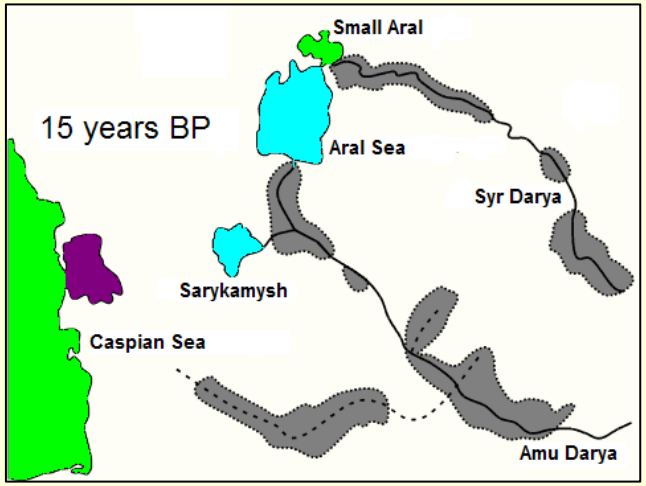
Salinity: ● – 0-3‰; ● – 8-13‰; ● – 13-29‰; ● – 29-42‰; ● – 42-51‰; ● – >51‰

Aral Sea: from 450 years BP, till now and in the future

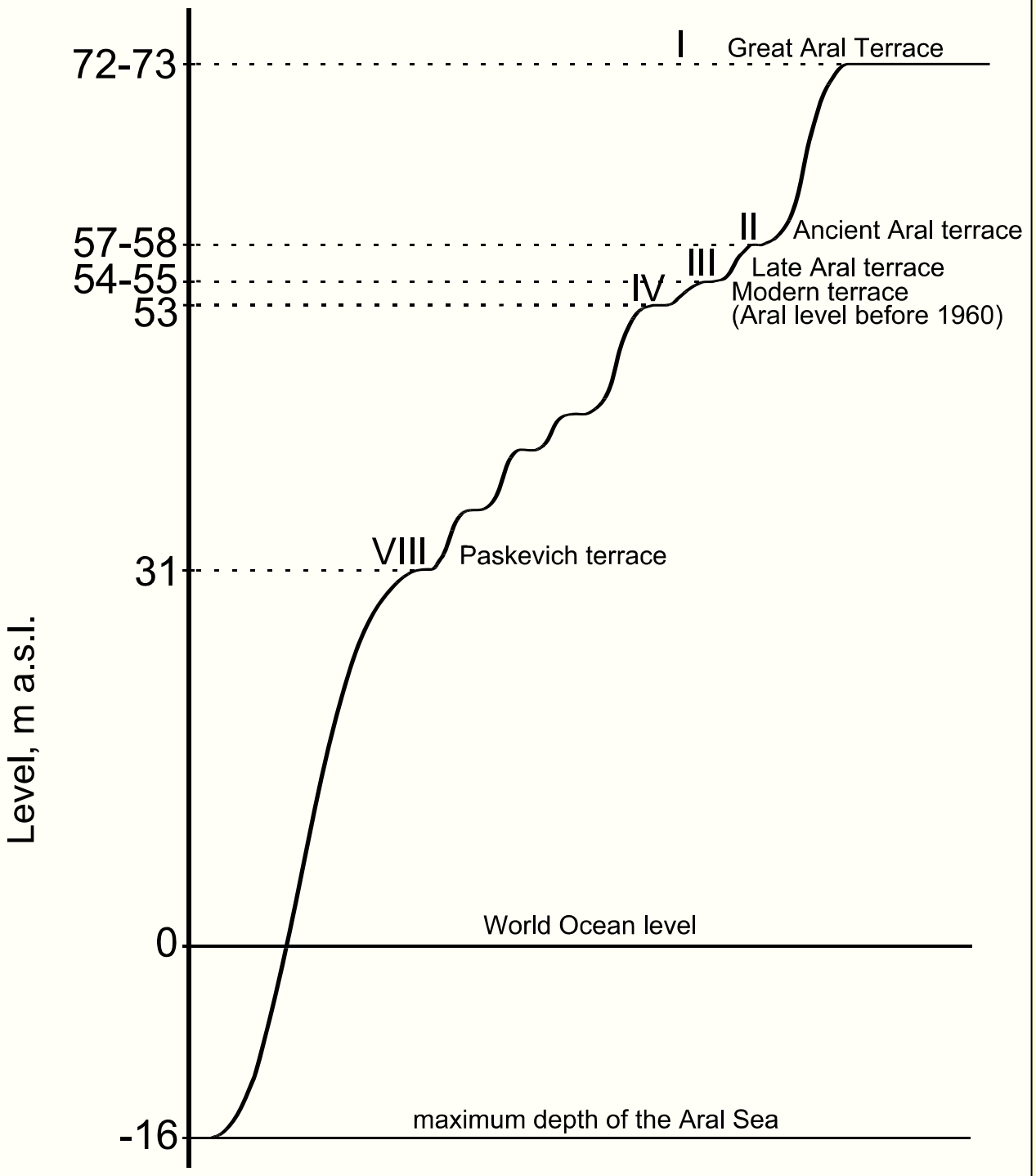








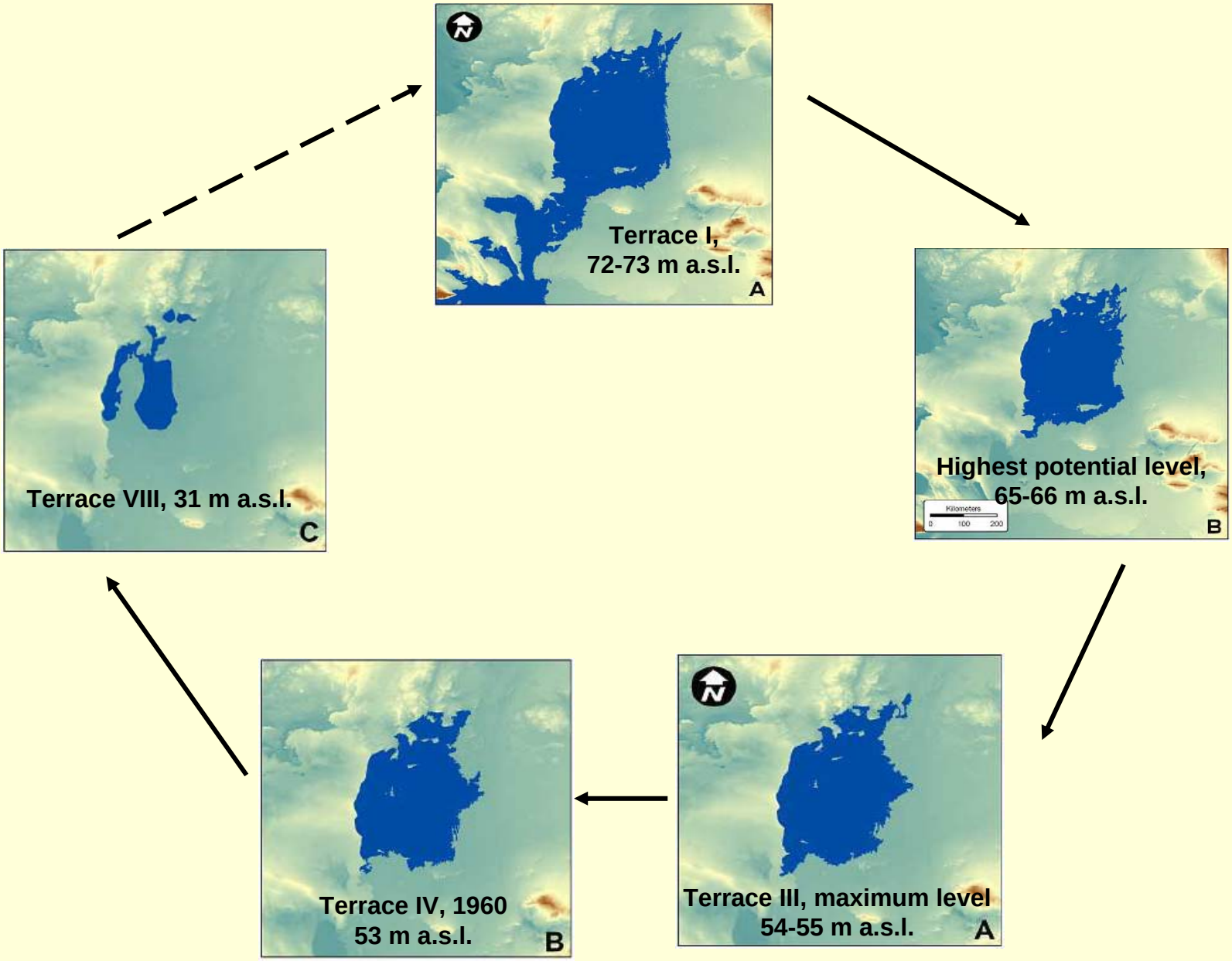
Salinity: ● – 0-3‰; ● – 8-13‰; ● – 13-29‰; ● – 29-42‰; ● – 42-51‰; ● – >51‰



Main Aral Sea terraces

Surface areas of the Aral Sea at different levels

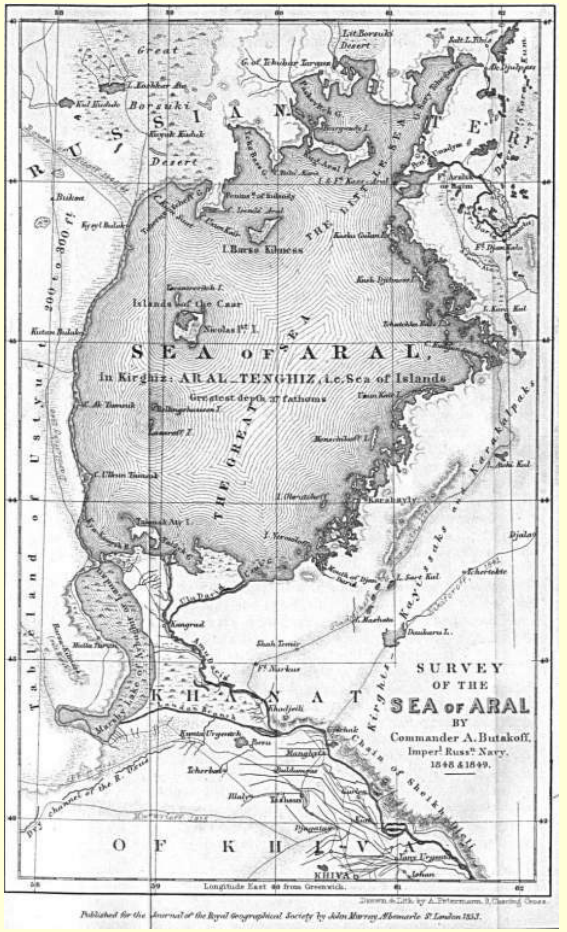
By: Ch. Reinhardt, 2006, 2007



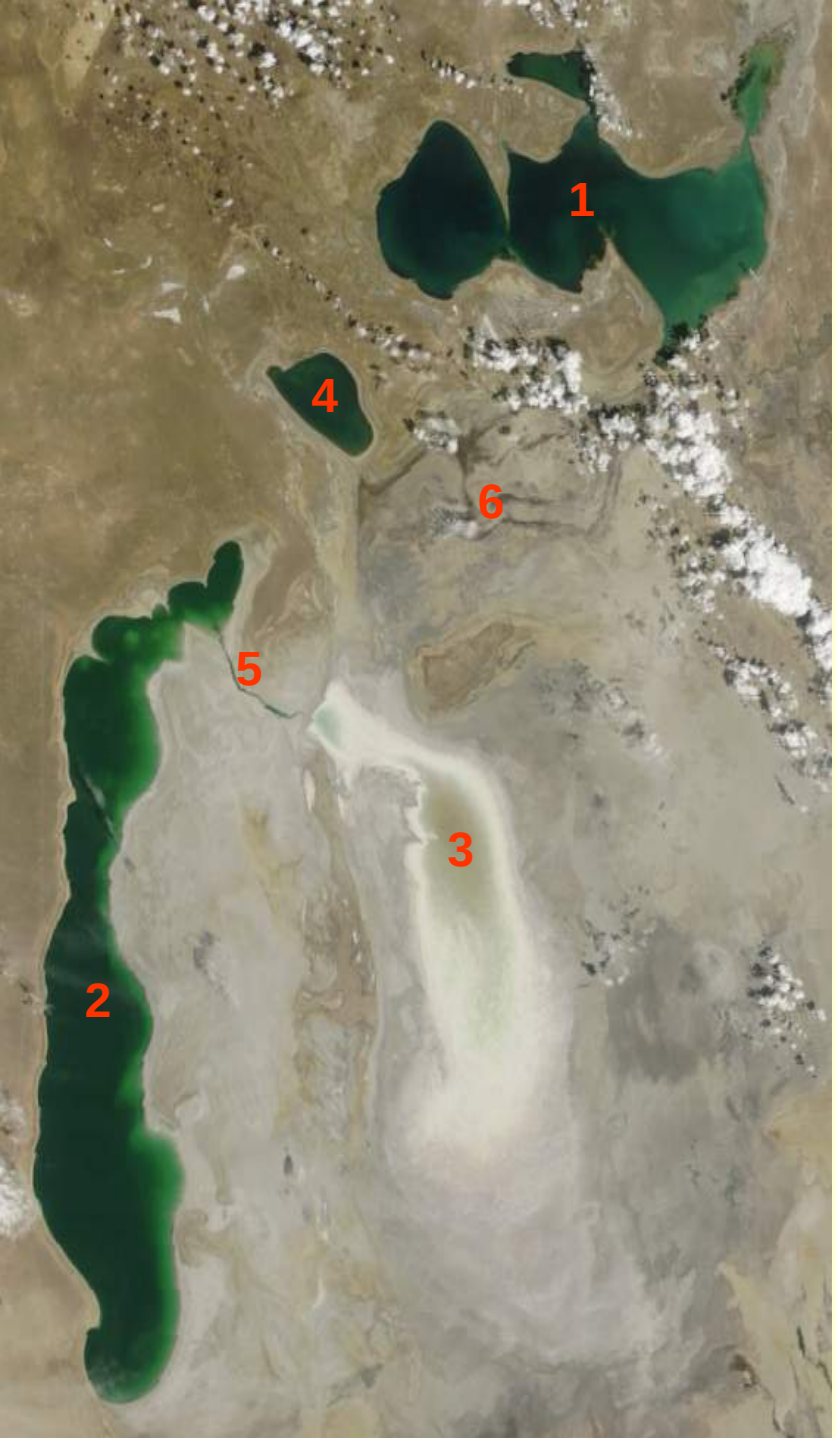
Evolution of the Aral Sea

Middle Ages

Middle of the XIX century



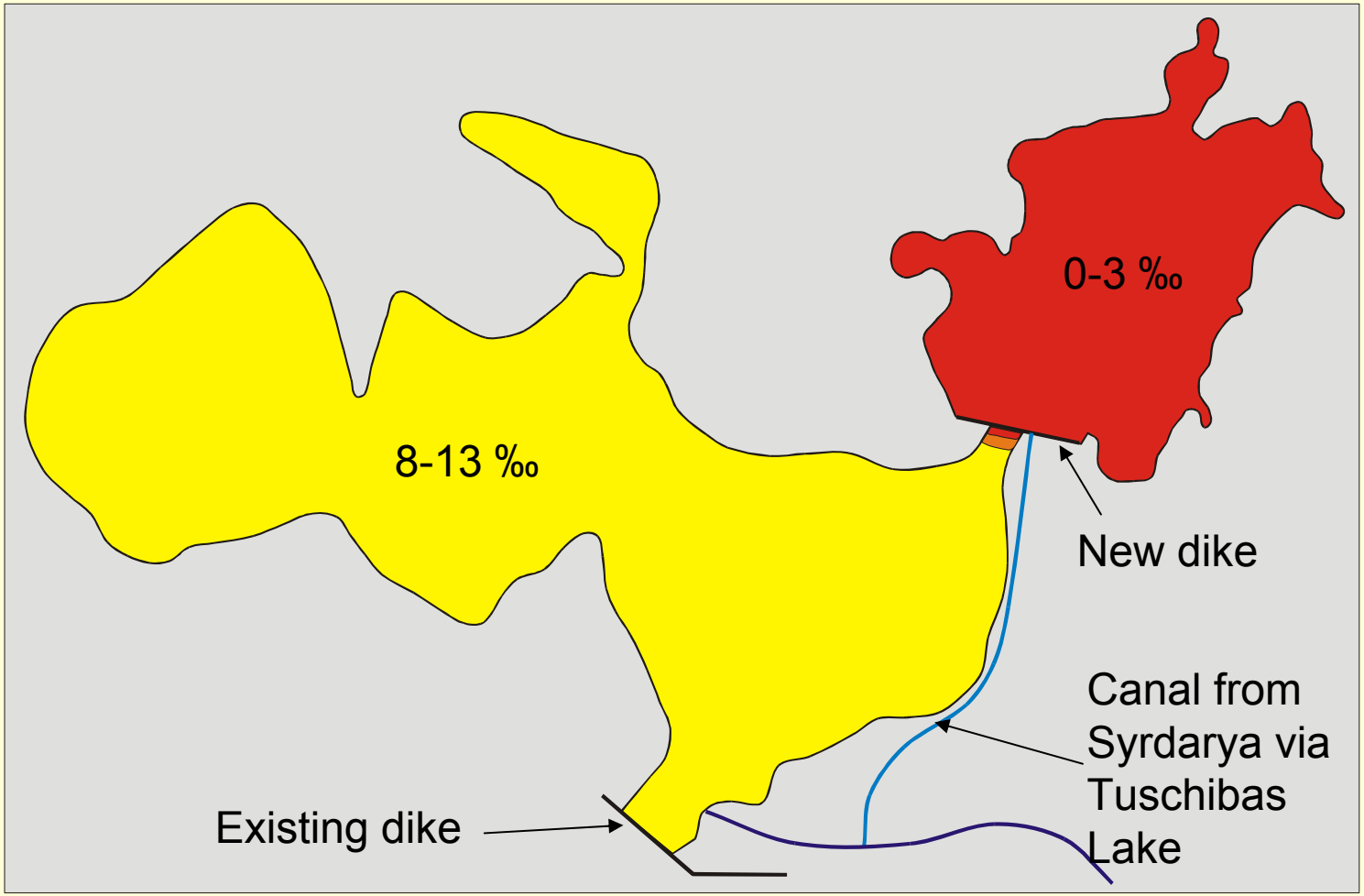
Beginning of the XXI century



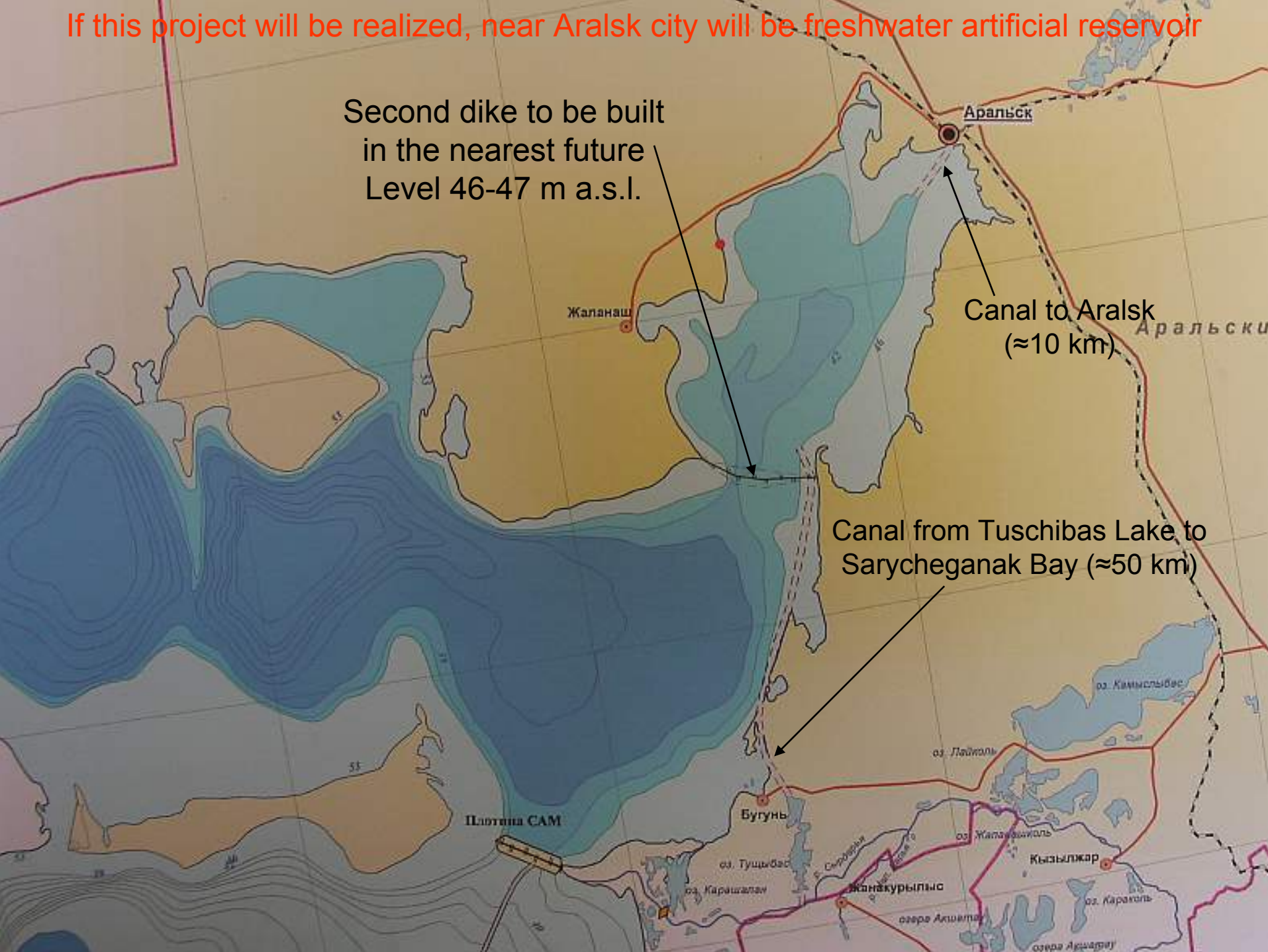
MODIS image of the Aral Sea from August 21, 2009

1. Small (Northern) Aral Sea. Common name – “Kazaral Sea”. Correct scientific name – Northern Aral Sea derived brackish-water regulated reservoir.
2. Western Large (Southern) Aral Sea. Common name – “Western Uzaral”. Correct scientific name – Aral Sea derived Southwest hyperhaline non-regulated lake.
3. Eastern Large (Southern) Aral Sea. Common name – “Eastern Uzaral”. Correct scientific name – Aral Sea derived Southeast hyperhaline non-regulated lake.
4. Former Tschebas Bay. Common name – “Tschebas-Kul”. Correct scientific name – Aral Sea derived Tschebas hyperhaline non-regulated lake.
5. Strait between Eastern and Western Large Aral (common name – “Uzun-Aral”). Correct scientific name – natural Kulandy Channel.
6. Remnants of strait from Small Aral to Large Aral.

Alternative 2nd phase of the Small Aral rehabilitation project



- **Alternative 2nd phase of the project would raise level only of Saryshaganak Gulf.**
- **Second phase would allow further improvement of the health of the local people, to decrease unemployment and increase living standards as well as income to the local families.**
- **The local economy also will be improved (fishery, shipping, etc.).**
- **Local microclimate around Small (Northern) Aral Sea will be much better than now.**


If this project will be realized, near Aralsk city will be freshwater artificial reservoir
Second dike to be built
in the nearest future
Level 46-47 m a.s.l.
Аральск
Жаланаш
Canal to Aralsk
(≈10 km)
Canal from Tuschibas Lake to
Sarycheganak Bay (≈50 km)
Плотина САМ
Бугунь
Кызылжар
Жанакурылыс
озера Акшатау


Aral Sea has the future!
Aral Sea derived natural and man-regulated water bodies are still alive.
Aral Sea ecosystem is not dying, just transforming.


Thank you for your attention