From Aral Sea to Aralkum

Problems of and solutions for a lost lake

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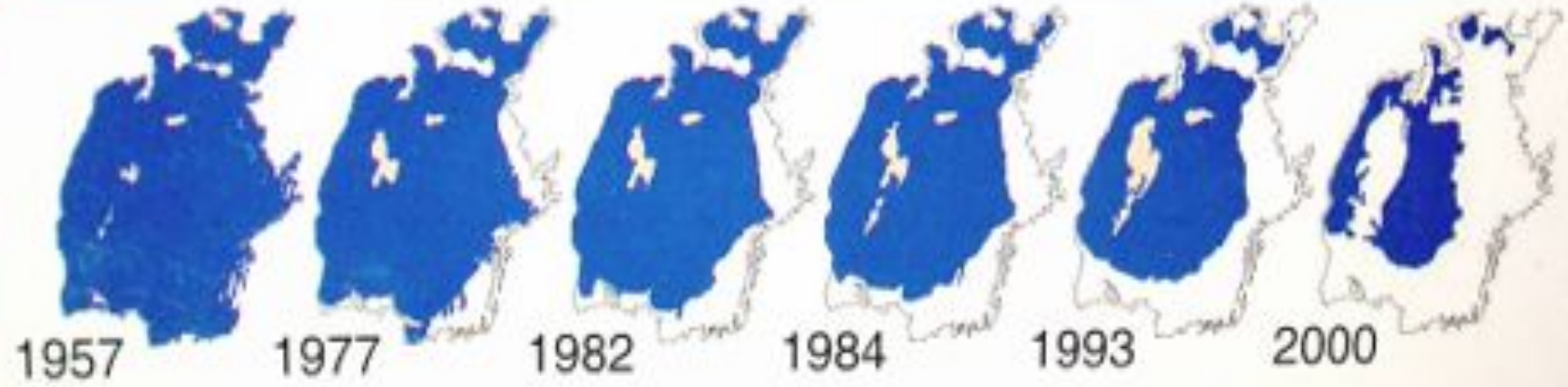
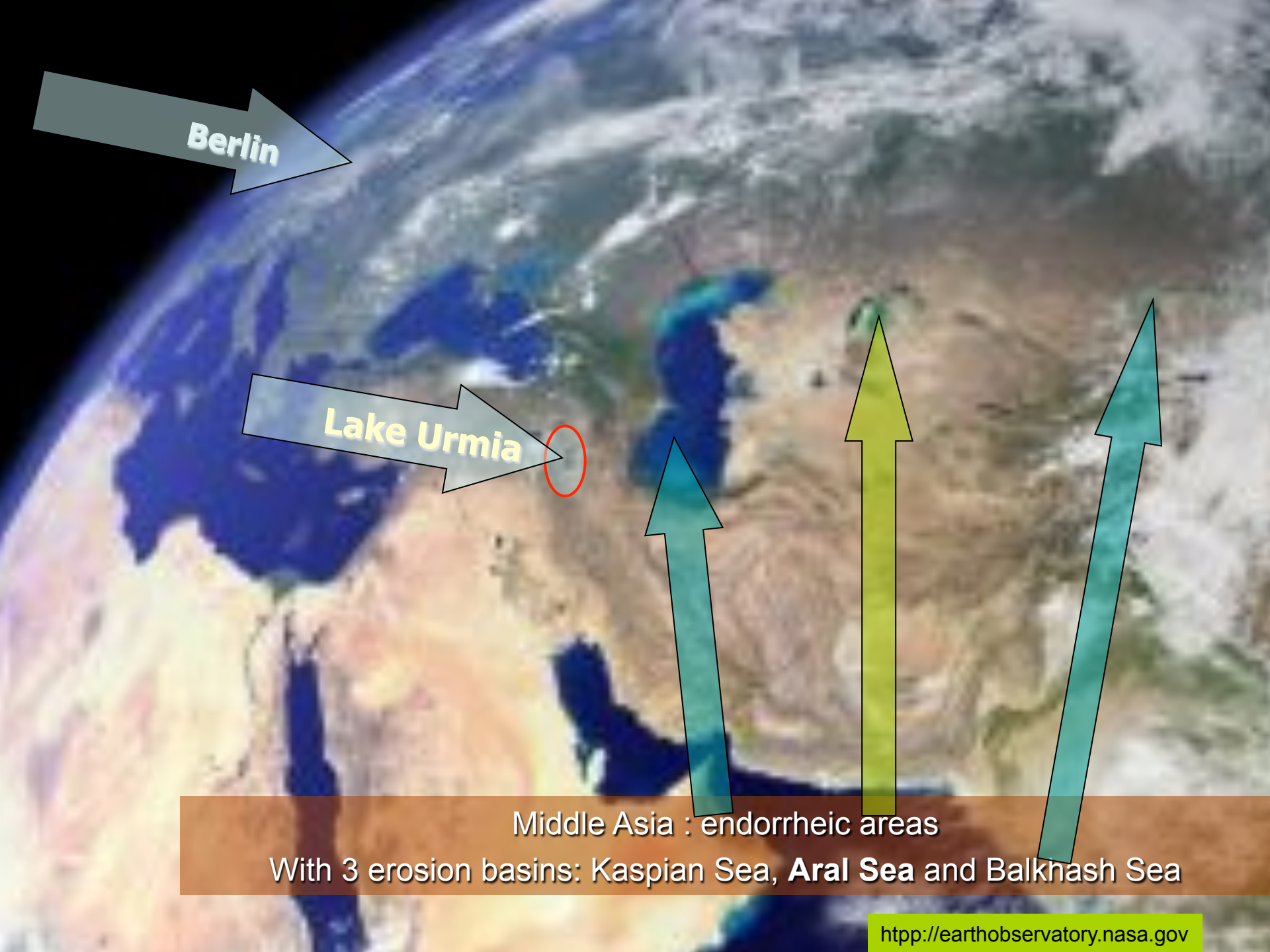
Dept. Ecology / Bielefeld



The disappearance of the Aral Sea within the last half of the former century



Middle Asia : endorrheic areas

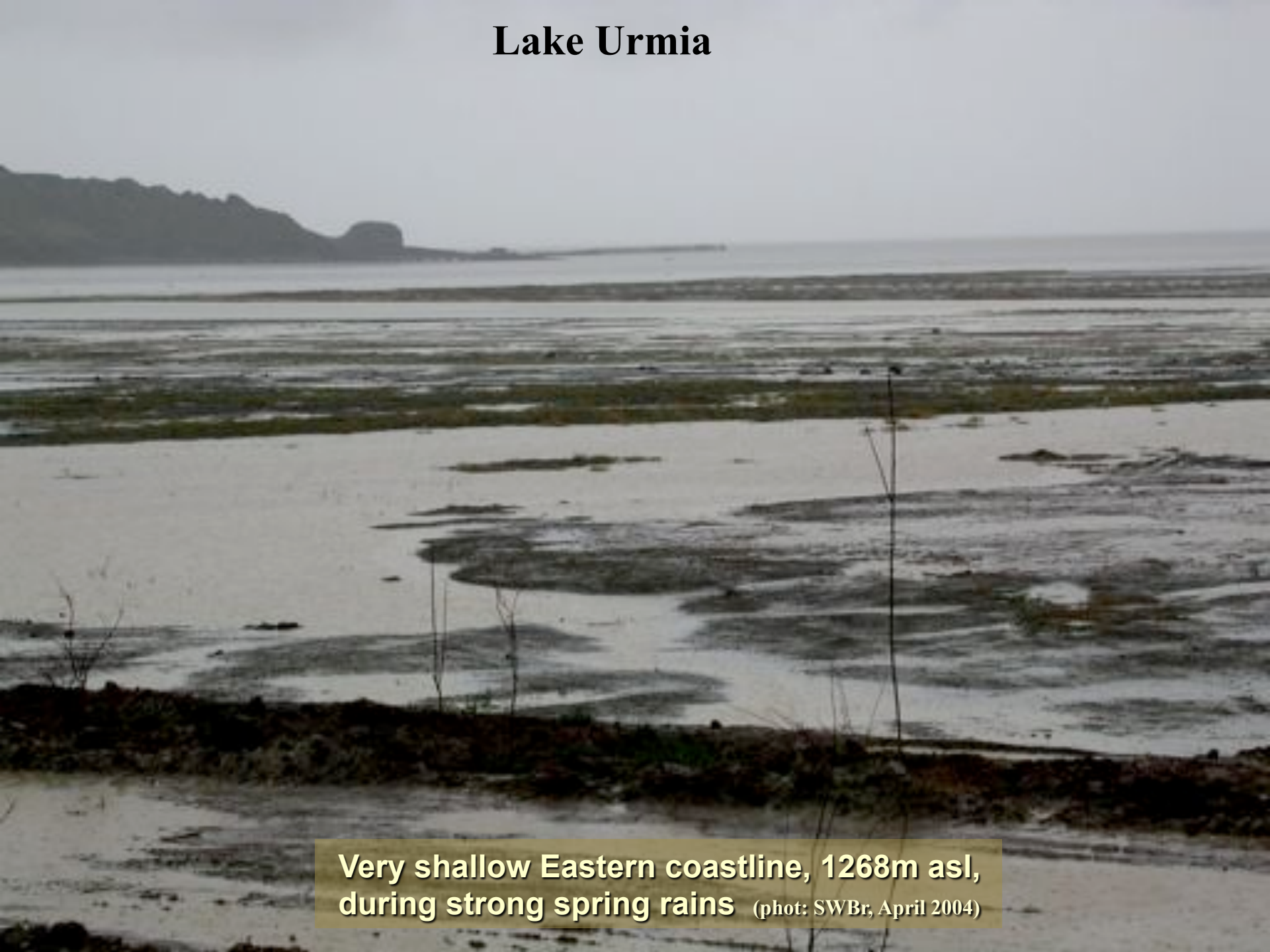
With 3 erosion basins: Kaspian Sea, **Aral Sea** and Balkhash Sea

htpp://earthobservatory.nasa.gov

„The lost Aral Sea“

Very shallow coastline, NW of Barsa Kelmes, 28m asl, background Kulandi peninsula (phot: SWBr, July 2004)

Lake Urmia



Very shallow Eastern coastline, 1268m asl, during strong spring rains (phot: SWBr, April 2004)

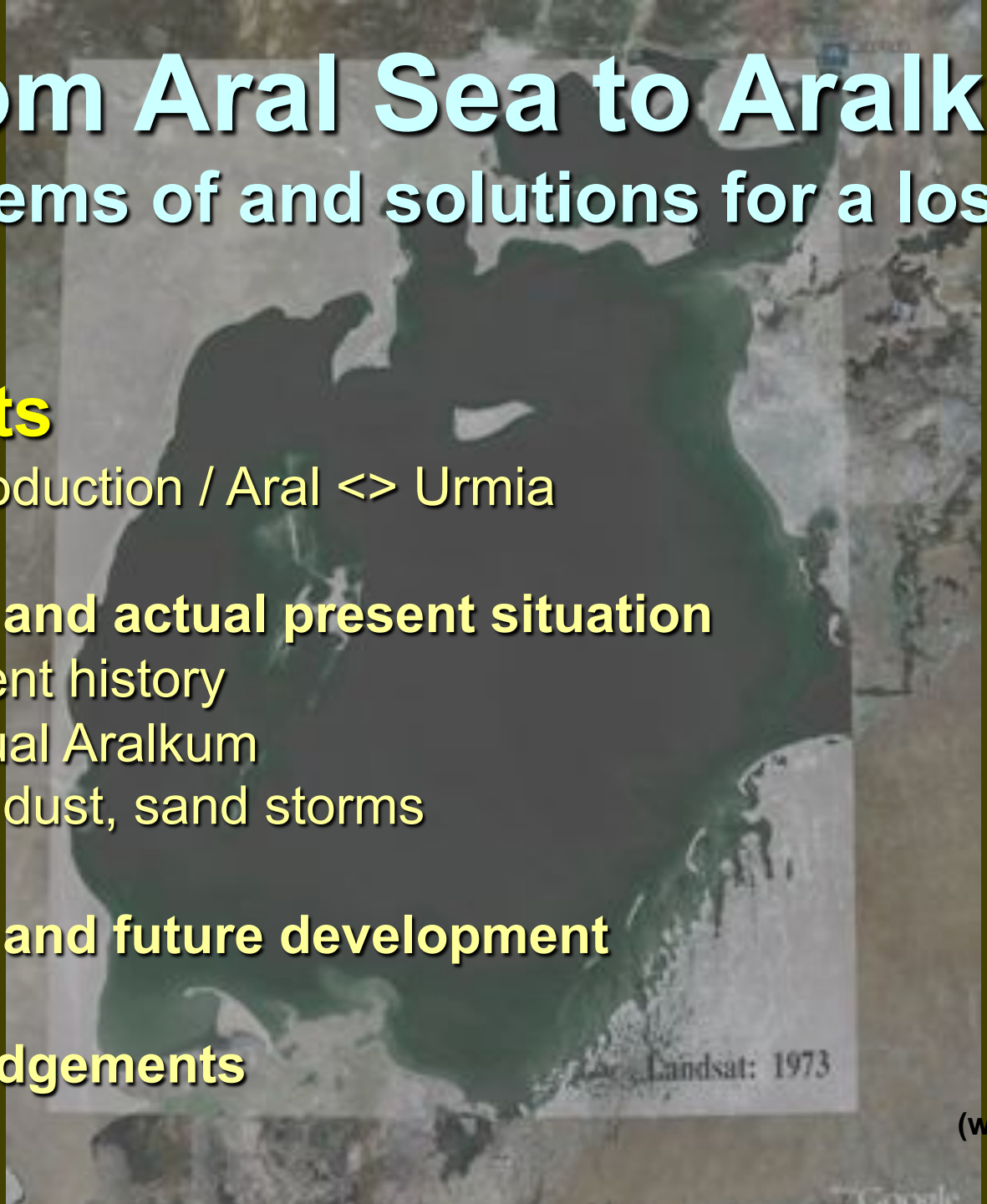
Strong spring rains in Kandovan village (2240m asl) (phot: SWBr, April 2004)

Strong rains and floods in Kandovan village (2230m asl) (phot: SWBr, April 2004)

Strong spring rains in pittoresque Kandovan village (phot: SWBr, April 2004)

From Aral Sea to Aralkum

Problems of and solutions for a lost lake

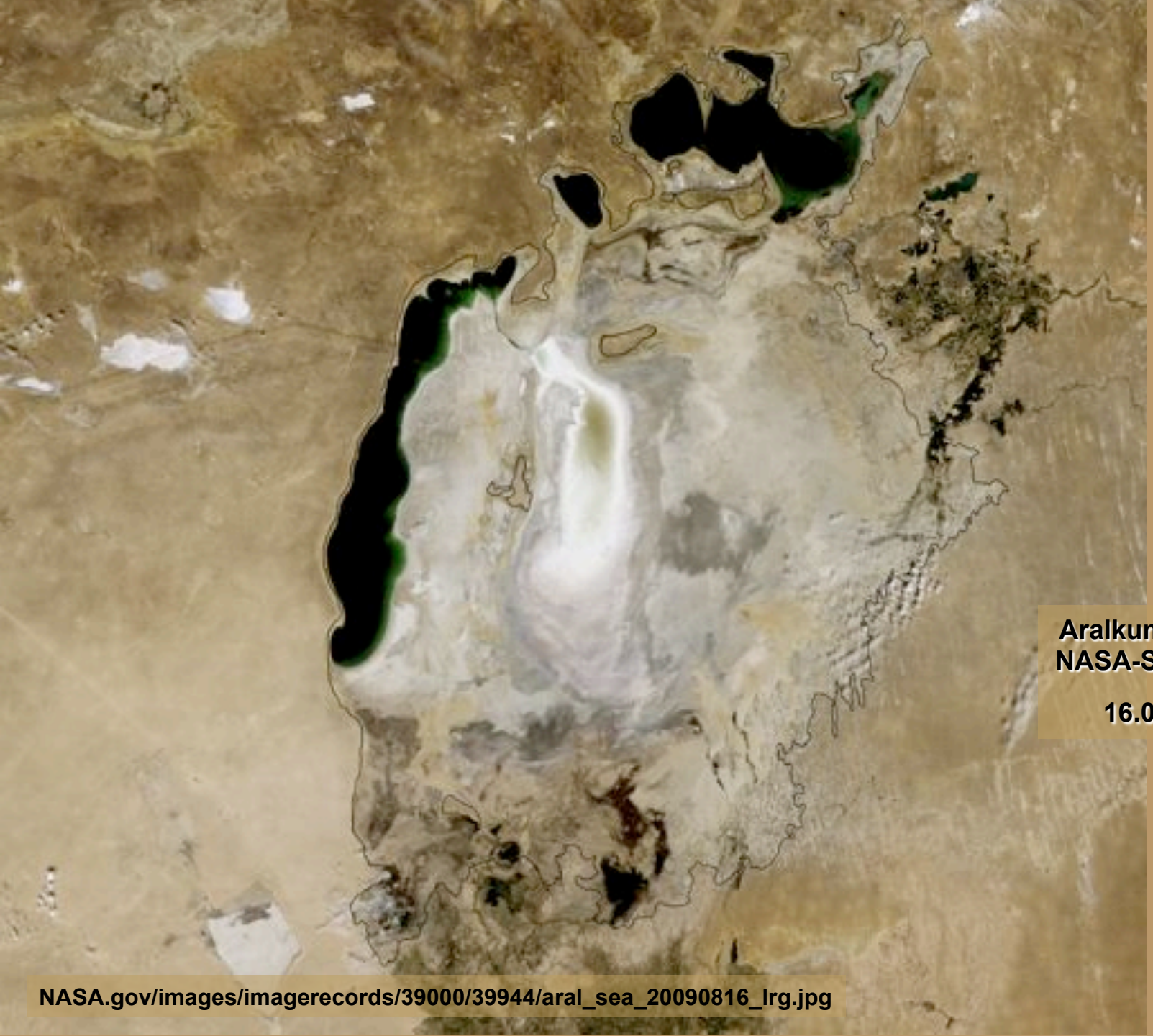


Contents

(www.na.unep.net)

Aral Sea Landsat-Scene 1973

(www.na.unep.net)



Aralkum from space:
NASA-Satellite image

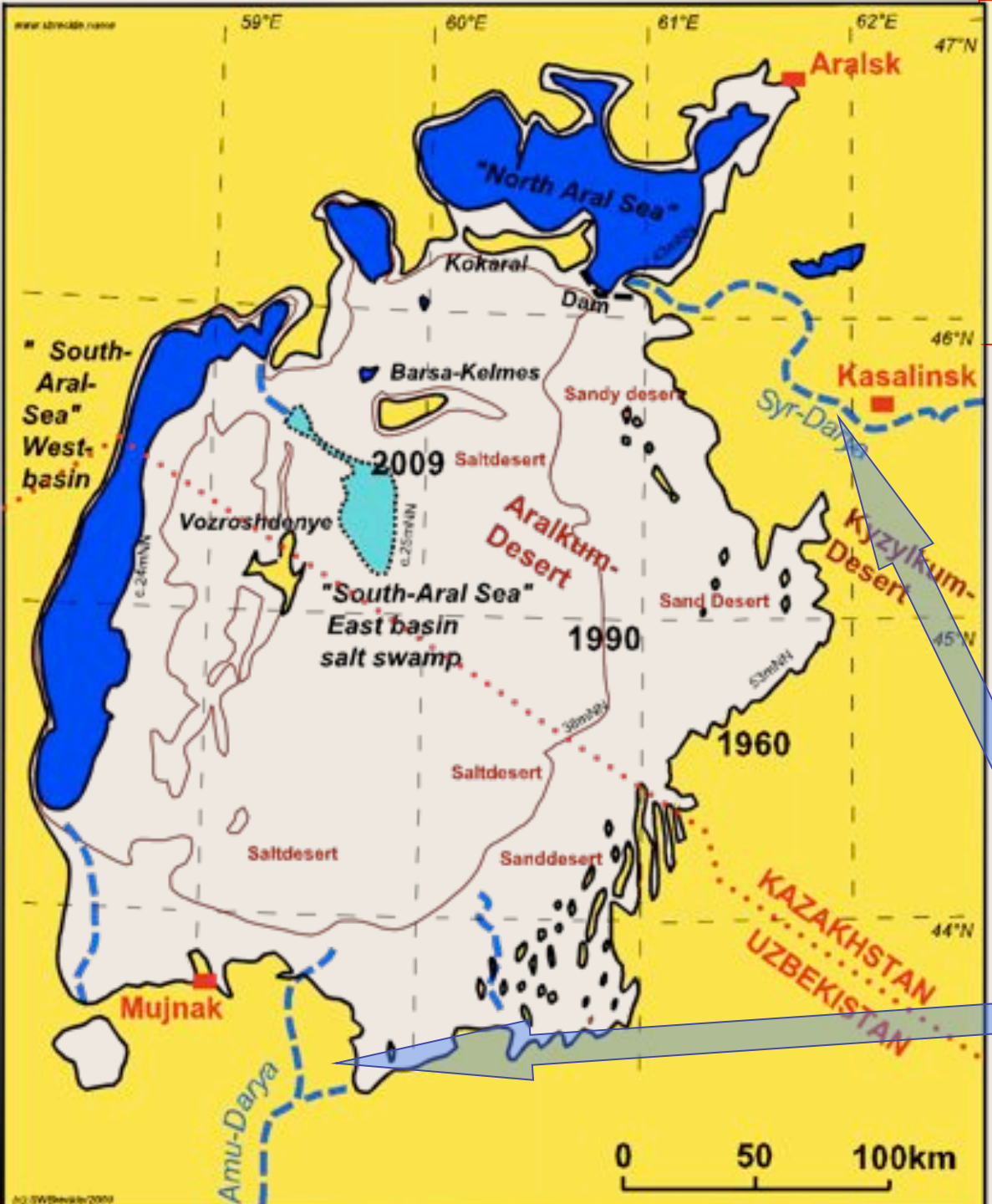
16.08.2009

NASA.gov/images/imagerecords/39000/39944/aral_sea_20090816_lrg.jpg

Aralkum from space:
NASA-Satellite image

26.08.2010

earthobservatory.nasa.gov/Features/WorldOfChange/images/aral/aral_sea_20100826_lrg.jpg



The lost Aral Sea:

year	area	volume	salinity
1960	100%	100%	0,9%
1971	90%	89%	1,0%
1982	76%	59%	1,7%
1993	66%	26%	3,5%
2004	40%	19%	4,3%
2010	12%	6%	7-10% AS(WB)

The new desert:

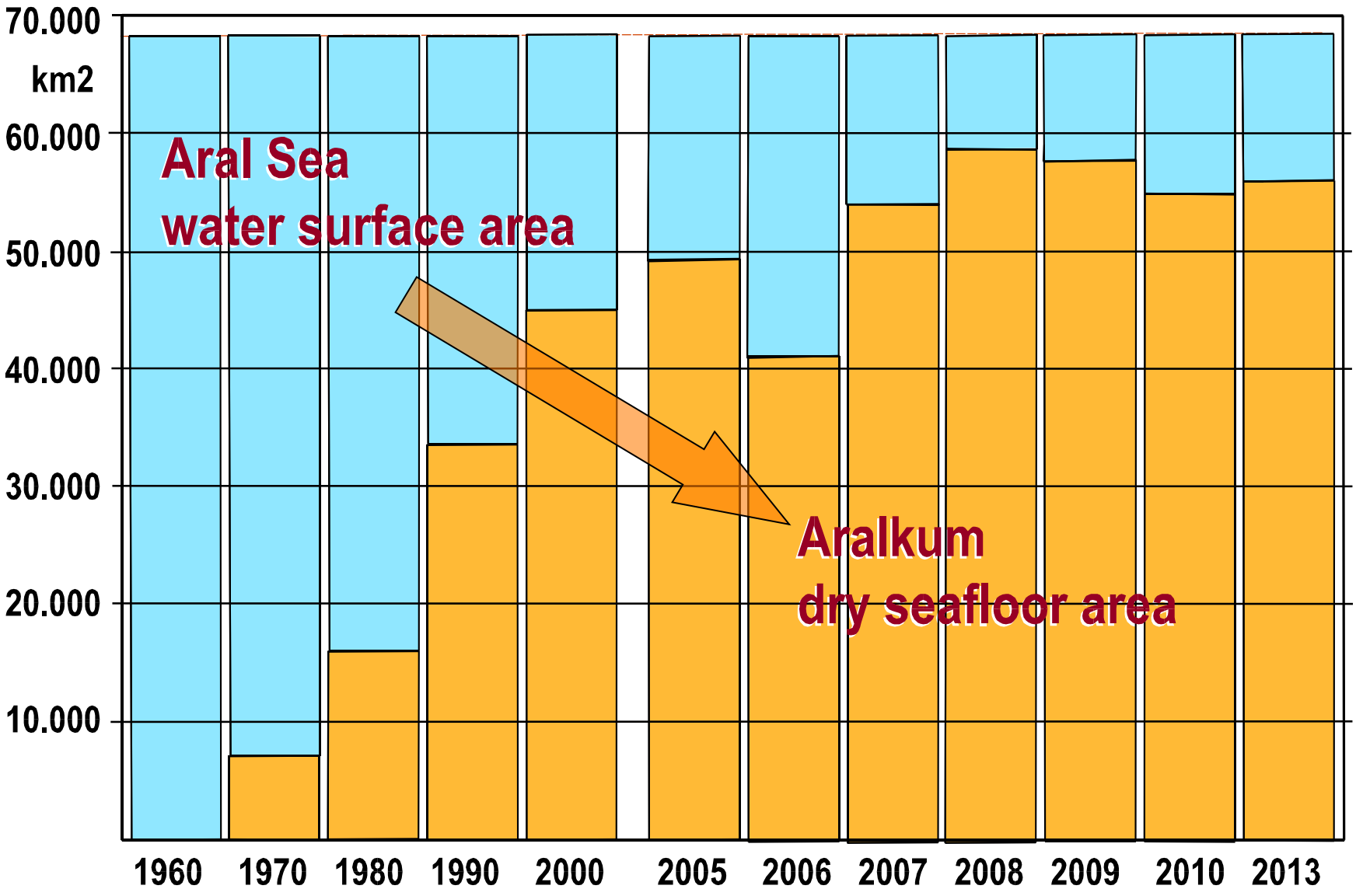
Aralkum

Almost 60.000 km²

Larger than the Netherlands
[41.500km²]

Syrdarya, Amudarya:

Main tributaries to the Aral Sea



From Aral Sea to Aralkum – Loss of c. 55.000 km^2 water surface area

The retreating Aral Sea: sea floor desiccation, North Coast of Barsa Kelmes (phot: SWBr Juli 2004)

Crusty marshy Solonchak, Barsa Kelmes North Coast, (phot: SWBr July 2004)

The lost Aral Sea: Ships without water in the middle of the new sandy desert (phot: M. Wennemann May 2003)

Rusty remnants of steam boats (phot: SWBreckle April 2004)

Lacking infrastructure: loamy salt desert roads are slippery like soap (phot: SWBreckle April 2004)

Loamy salt desert roads are slippery like soap (phot: SWBreckle April 2004)

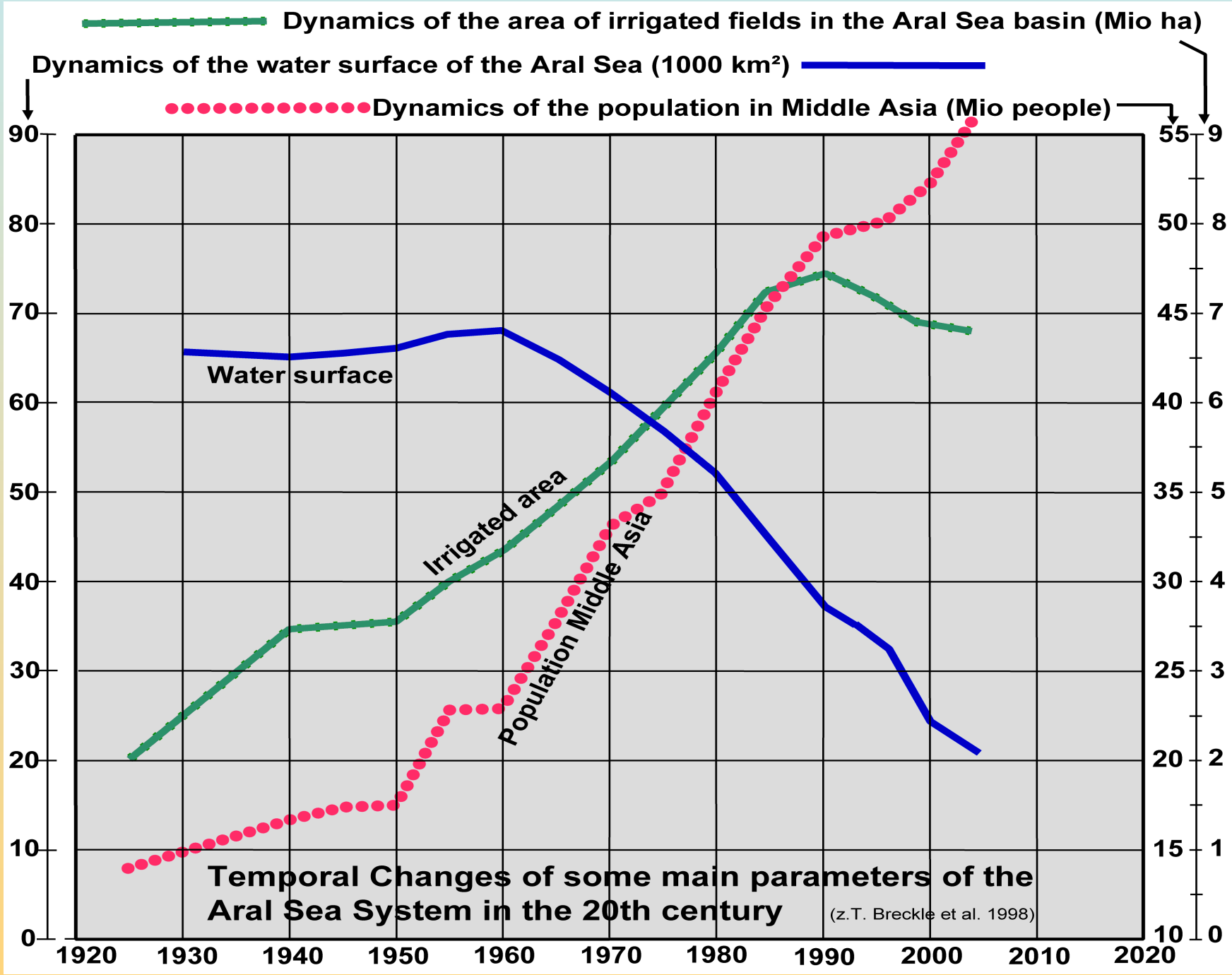
Desiccation: Dry sea floor, salty loam mosaic, N Aral Sea coast (phot: SWBreckle April 2004)

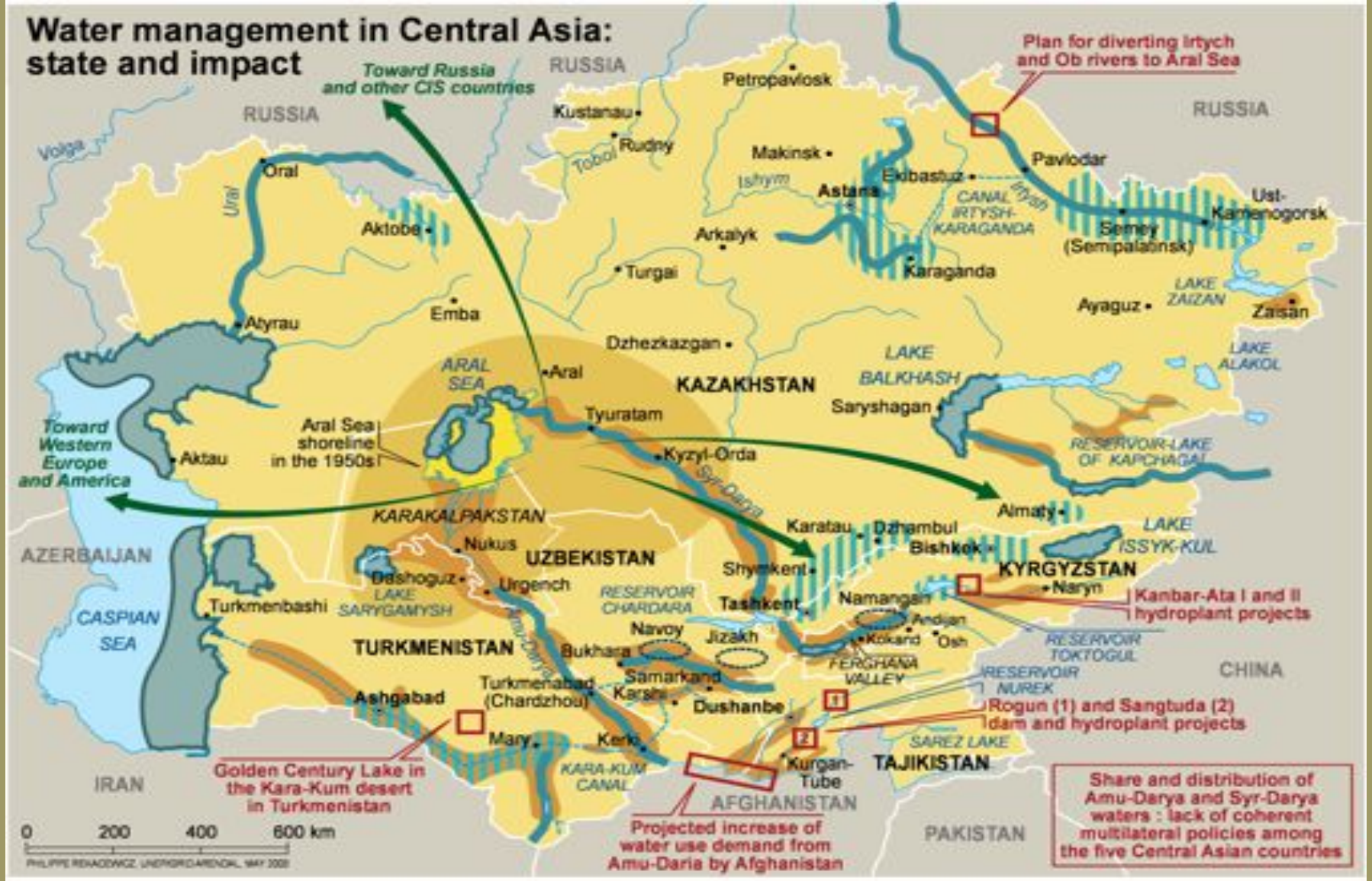
Reasons for the desiccation of the Aral Sea since 1960:

The hydrological water budget became strongly negative (water scarcity) since 1960

Reasons:

1. Huge new irrigation areas (cotton, rice) in Middle Asia
2. Extensive new canal-systems (with great water losses)
3. Newly installed fish ponds and water reservoirs
4. New lakes (eg Sarykamish-basin)
5. New water reservoirs in middle and upper river parts and tributaries of Amudarya und Syrdarya


Dynamics of the area of irrigated fields in the Aral Sea basin (Mio ha)
Dynamics of the water surface of the Aral Sea (1000 km²)
Dynamics of the population in Middle Asia (Mio people)
Water surface
Irrigated area
Population Middle Asia
90
80
70
60
50
40
30
20
10
0
55
50
45
40
35
30
25
20
15
10
9
8
7
6
5
4
3
2
1
0
1920
1930
1940
1950
1960
1970
1980
1990
2000
2010
2020
Temporal Changes of some main parameters of the Aral Sea System in the 20th century
(z.T. Breckle et al. 1998)


Water management in Central Asia: state and impact
Toward Russia and other CIS countries
Plan for diverting Irtych and Ob rivers to Aral Sea
RUSSIA
Petropavlosk
Kustanau
Rudny
Makinsk
Pavlodar
Ekibastuz
Astana
Oral
Volga
Ural
Aktobe
Arkalyk
Turgai
Karaganda
Semey (Sempalatinsk)
Ust-Kamenogorsk
Ayaguz
Zaisan
Atyrau
Emba
Dzhezkazgan
Aral
ARAL SEA
KAZAKHSTAN
Saryshagan
Tyuratam
Aral Sea shoreline in the 1950s
Toward Western Europe and America
Aktau
Kyzyl-Orda
Syr-Darya
KARAKALPAKSTAN
Nukus
Dashoguz
Urgench
UZBEKISTAN
Karatau
Dzhambul
Almaty
Bishkek
KYRGYZSTAN
Naryn
Shymkent
Tashkent
Namangan
Andijan
Kokand
Osh
Kanbar-Ata I and II hydroplant projects
AZERBAIJAN
CASPIAN SEA
Turkmenbashi
LAKE SARYGAMYSH
RESERVOIR CHARDARA
Amu-Darya
Navoy
Jizakh
Bukhara
TURKMENISTAN
Samarkand
Karshi
Turkmenabad (Chardzhou)
Ashgabad
Mary
Kerki
Dushanbe
FERGHANA VALLEY
RESERVOIR TOKTOGUL
RESERVOIR NUREK
CHINA
Rogun (1) and Sangtuda (2) dam and hydroplant projects
SAREZ LAKE
Kurgan-Tube
TAJIKISTAN
KARA-KUM CANAL
IRAN
Golden Century Lake in the Kara-Kum desert in Turkmenistan
AFGHANISTAN
PAKISTAN
Projected increase of water use demand from Amu-Daria by Afghanistan
Share and distribution of Amu-Darya and Syr-Darya waters : lack of coherent multilateral policies among the five Central Asian countries
LAKE BALKHASH
LAKE ZAIZAN
LAKE ALAKOL
LAKE ISSYK-KUL
RESERVOIR-LAKE OF KAPCHAGAI
CANAL IRTYSH-KARAGANDA
Ishym
Tobol
0 200 400 600 km
Polluted water bodies
Rivers and canals
Lakes
Groundwater
Areas under threat of flood and of pollution due to mismanagement of upstream water reservoirs and hazardous waste storage sites
Impact
Former bed of the Aral Sea, uncovered area entirely desertified and saline
Areas directly affected by the consequences of the shrinkage of the Aral Sea (toxic salts), leading to salinization and desertification
Migration from environmentally degraded areas
Concerns for the future and potential areas of tension
Areas of intensive and inefficient irrigated agriculture practices with potential to sterilize soil and threaten human health
Projected water infrastructure or management plans with conflict or international dimension

North Coast, Northern Aral Sea (Shevshenko-Bay), stiff cliffs (chinks) and the typical vegetation/ecosystems gradient **Panorama;** phot: SWBr May 2003


1960
Saxaul-Belt
(Haloxylon aphyllum)
Tamarix-Belt
and/or Halocnemum
Atriplex pratovii-Belt
and open saltdesert
Suaeda-Belt
Salicornia-Belt
2004
Saxaul-Belt
(Haloxylon aphyllum)
➔ the spatial gradient
and the temporal replacement (succession)
(phot: SWBreckle May 2003)

Seedlings of *Petrosimonia, Suaeda* and *Salicornia* in car traces of Solonchak

(phot: SWBr July 2004)

Dry sea floor: remnants of *Zostera* and germinating *Salicornia* (phot: SWBr Juli 2004)

***Salicornia europaea*, Aral Sea surface in the first year after desiccation** (phot: WWucherer Oct. 1994)

Salicornia europaea **community on marshy solonchaks (one year after drying out)**

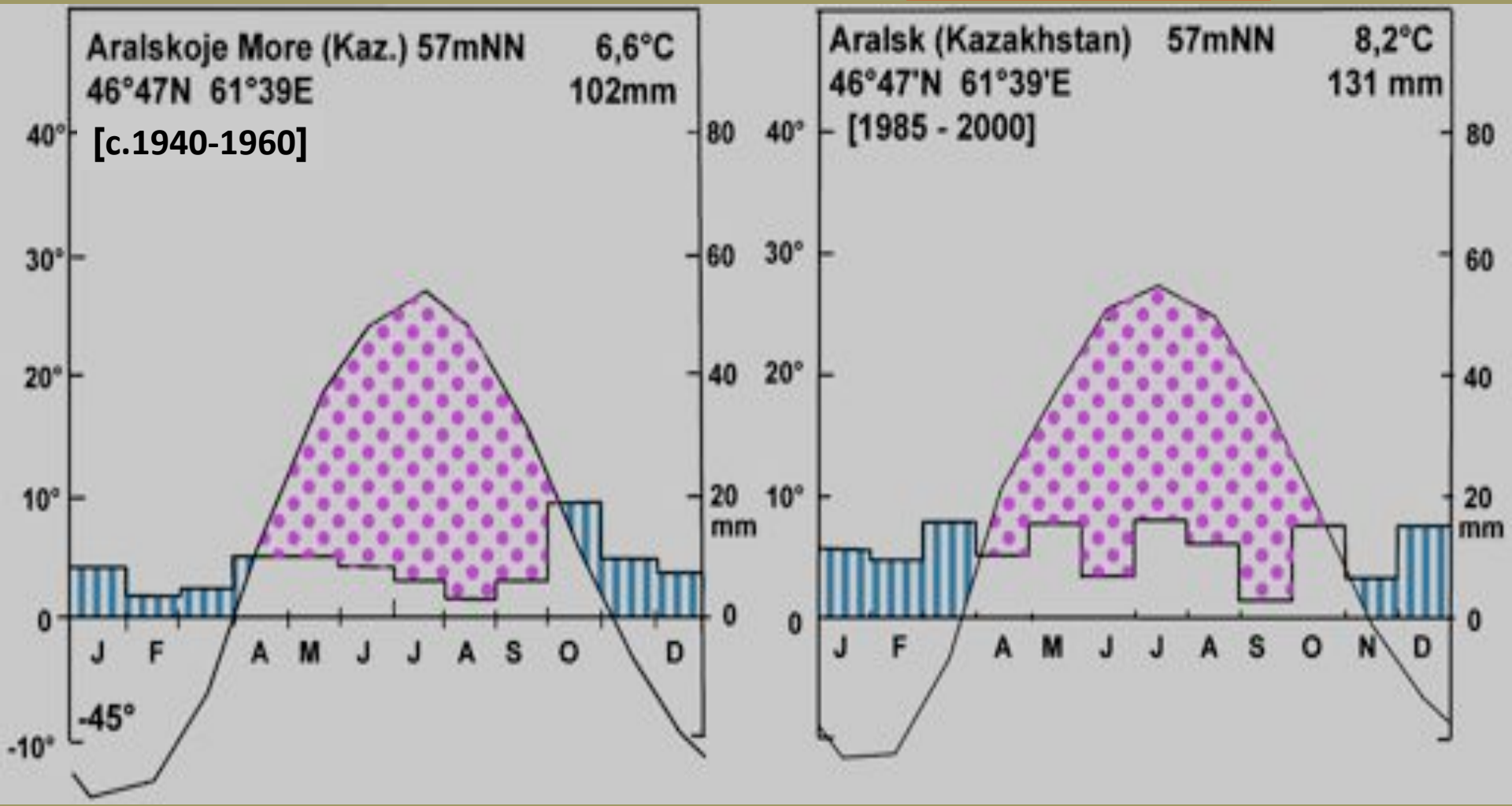
Bassia hyssopifolia **community on coastal solonchaks (9 years after drying out)**

Haloxylon aphyllum-Atriplex pratovii **community on degraded coastal solonchaks (22-24 years after drying out)**

Halocnemum strobilaceum **community on coastal solonchaks (30-32 years after drying out)**

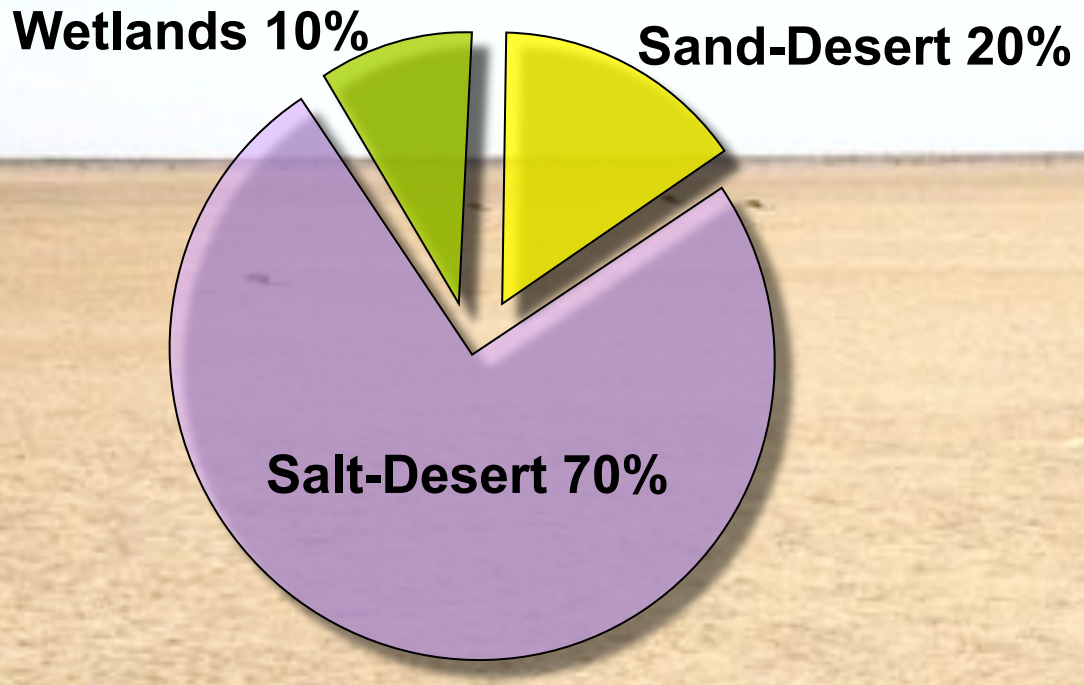
Climate

Very hot summers



Very frosty winters

Main landscape types in the new Aralkum



Huge flats between Barsa Kelmes and Kaskakulan, source of salt dust,
with few single *Halocnemum strobilaceum* bushes (Chenopodiaceae) (phot: WWucherer)

Saltcrust and saltdust desert up to the horizon

Crusty-puffy solonchak plains of the Aralkum east of Barsa Kelmes: the source of salt dust storms (phot: SWBr Juli 2004)

htpp://earthobservatory.nasa.gov (18.04.2003)

The salt dust cloud from Aralkum is blown southwards
=> dust: Long distance => sand: short distance

htpp://earthobservatory.nasa.gov

Leeward accumulating sand at a young *Halocnemum strobilaceum* plant (phot: SWBr June 2004)

Moving sand (phot: SWBr June 2004)

Sand is always moving
(Tenebrionid-beetle)

(phot: SWBr June 2004)

The Ideal-Situation : dense „Saxaul-Bushes“ the „Final Stage“ of Succession (?)

Old *Haloxylon aphyllum* – Formation with perfect regeneration (with 4 to 5 younger generations) (c. 30 years after desiccation) (phot: W.Wucherer)

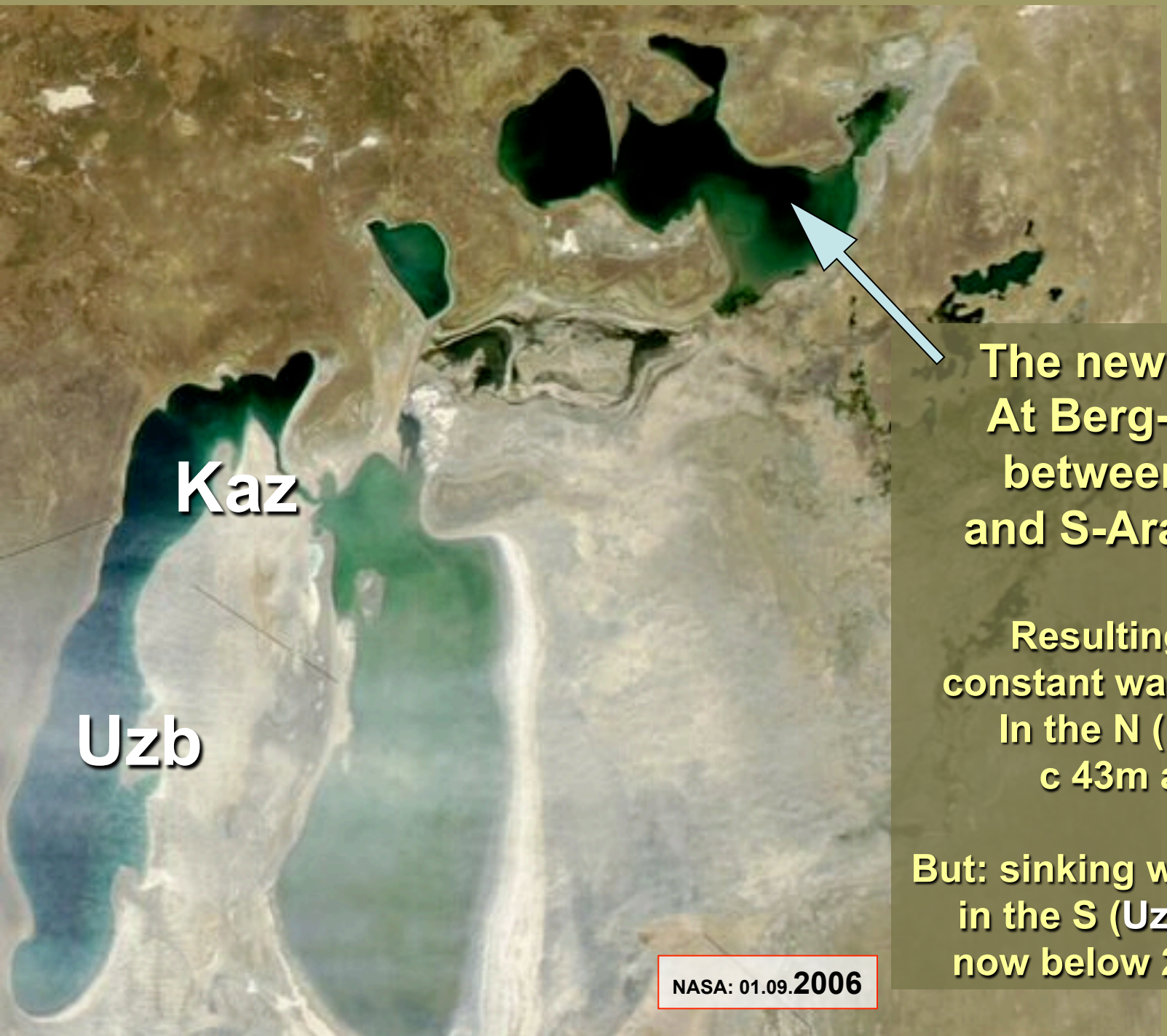
Saxaul saplings on sandy solonchak
(phot: SWBr June 2004)

Plantings of Saxaul (*Haloxylon aphyllum*)–Saplings on shallow sandy soils at dune base after 2 years (phot: WWucherer Juli 2004)

Plantings of *Halocnemum strobilaceum*,
c. 10 years old, Experimetal Plot of Kazakh Ministry of Forestry (phot: Kaverin)

Checker straw technique against moving sand dunes near Bugun school (phot: WWucherer)

Ruins of the former fish factory on the island of Uzunkair (phot: SWBreckle may 2003)



The new dam
At Berg-Bay,
between N-
and S-Aral Sea

Resulting in:
constant water level
In the N (Kaz),
c 43m asl

But: sinking water level
in the S (Uzb+Kaz)
now below 26m asl

NASA: 01.09.2006

Remnants of fisher boats at the Northern Aral Sea, near Bugun (phot: SWBreckle May 2003)

Hot springs at N Aral Sea coast (phot: SWBreckle April 2004)

Hot springs at N Aral Sea coast (phot: SWBreckle April 2004)

Nature Conservation field station at Barsa Kelmes Island (phot: SWBreckle April 2004)

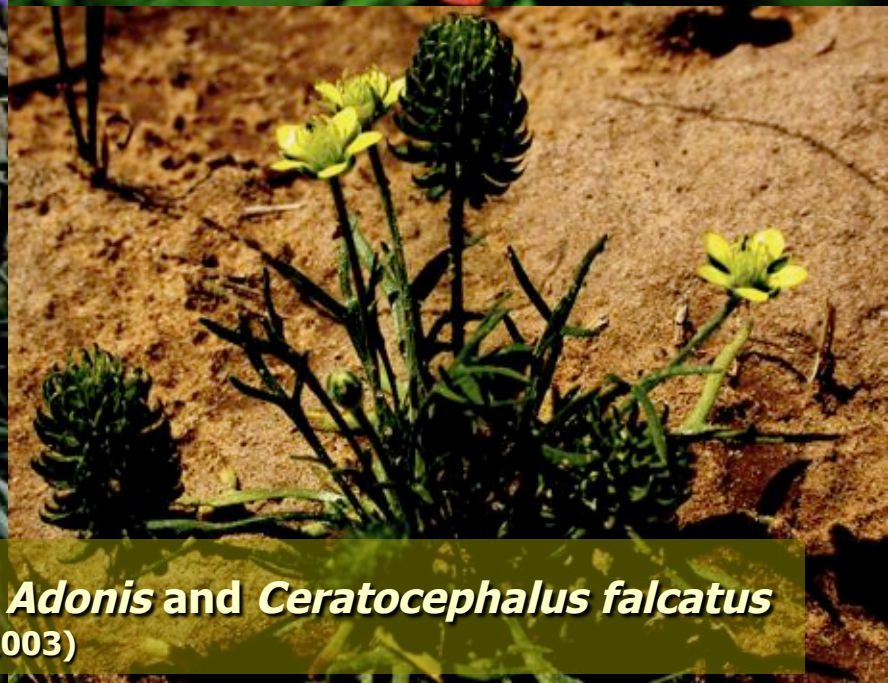
20km E of Barsa-Kelmes:
On the dry dry floor
Observation tower of the
nature conservation agency
(phot: SWBr Juli 2004)

On the former island
Barsa-Kelmes:
The old house of the
nature conservation administration
is gain used

Barsa Kelmes

Schematic map of the former island Barsa Kelmes nature conservation agency in Aralsk (phot: SWBr July 2004)

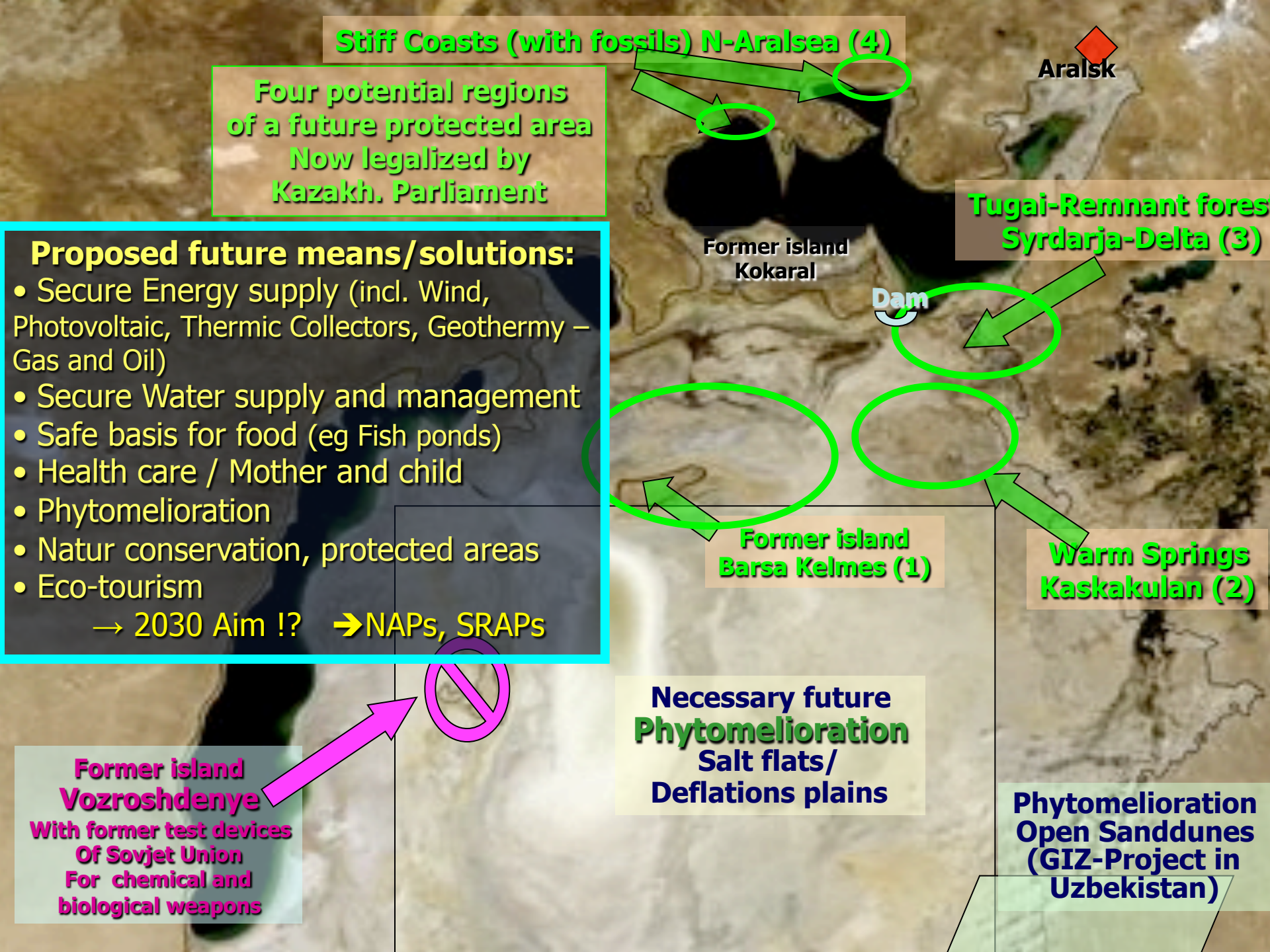
Nature Conservation
Barsa Kelmes



Colourful spring flowers: *Ixiolirium tataricum, Adonis* and *Ceratocephalus falcatus*
(phot: SWBr May 2003)

Rhubarb, medicinal plants,
Rheum tataricum, fruiting (phot: SWBr May 2003)

Wildlife in the Aralkum, Agama (phot: SWBreckle April 2004)


Stiff Coasts (with fossils) N-Aralsea (4)
Four potential regions of a future protected area Now legalized by Kazakh. Parliament
Aralsk
Tugai-Remnant fores Syrdarja-Delta (3)
Former island Kokaral
Dam
Proposed future means/solutions:
• Secure Energy supply (incl. Wind, Photovoltaic, Thermic Collectors, Geothermy – Gas and Oil)
• Secure Water supply and management
• Safe basis for food (eg Fish ponds)
• Health care / Mother and child
• Phytomelioration
• Natur conservation, protected areas
• Eco-tourism
→ 2030 Aim !? ➔NAPs, SRAPs
Former island Barsa Kelmes (1)
Warm Springs Kaskakulan (2)
Necessary future Phytomelioration Salt flats/ Deflations plains
Former island Vozroshdenye With former test devices Of Sovjet Union For chemical and biological weapons
Phytomelioration Open Sanddunes (GIZ-Project in Uzbekistan)

Proposed future means and solutions:

- Secure energy supply (incl. wind, photovoltaic, thermic collectors, geothermy – gas and oil)
- Secure water supply and land management
- Safe basis for food (e.g. incl. fish ponds)
- Small scale handicrafts
- Health care / mother and child
- Phytomelioration
- Natur conservation, protected areas
- Eco-tourism

→ 2030 - Goals

➔NAPs (National Action Plans), SRAPs (Subregional Action Plans)

UNCCD

United Nations Convention on Combatting Desertification

The UNCCD entered into force on 26 December 1996, 90 days after the fiftieth Ratification. At the end of 2006 there were 195 signatures.

Desertification is the degradation of land in arid, semi-arid, and dry sub-humid areas. It is caused primarily by human activities and climatic variations.

Desertification does not refer to the expansion of existing deserts. It occurs because dryland ecosystems (more than one third of the world's land area) are very vulnerable to over-exploitation and inappropriate land use. Poverty, political instability, deforestation, overgrazing, and bad irrigation practices are all undermining the land's productivity

Over 250 million people are directly affected by desertification. One billion people in over 100 countries are at risk. These people include many of the world's poorest, most marginalized, and politically weak citizens.

Combating desertification is essential to ensuring the long-term productivity of inhabited drylands. It needs innovative solutions. Past efforts have too often failed, and around the world the problem of land degradation continues to worsen.

Decisive Topics for the Aral Sea Region:

Irrigation-Management, Drainage, Salinity control, Erosion control; Wood as basic fuel, Fire protection; Grazing management, Tugai-forests and afforestation; Hunting management; Nature protection;

=> Decentralized Responsibilities and Administration; Water-/Energy-Supply / Poverty Reduction / Health Control

Conclusions and Summary

The Aral Sea is lost - but almost 60.000 km² of new land!
=> The Aral Sea is lost - there are now 4 remnant basins.

The reason for the desiccation is the centralized agriculture of Sovjet Union which since 1960 has massively increased the irrigated areas in Central Asia as e.g. for cotton monoculture. Today those irrigation systems are partly modernized, they are now the basis for food production for the fast growing population.

➔ The dry sea floor covers almost 60.000 km² : the new Aralkum-Desert.

It is a very dnamic mosaic of sand- and salt-desert ecosystems.

The spontaneous flora of the desiccated sea floor is now about 380 species of vascular plants. Dominant are: Chenopodiaceae, Polygonaceae, Brassicaceae und Asteraceae, few Poaceae (grasses) and Fabaceae.

The coastal parts are regional diversity centers for Chenopodiaceae and Polygonaceae as well as for a rich pattern of halophytes (salt tolerant plants).

Parallel the fauna is now also rather diverse.

The vegetation of the Aralkum exhibits a mosaic of unique vegetation units with rapid changing composition and rapid succession.

The Aralkum can be regarded as a modell ecosystem for studying vegetation dynamics and ecosystems development for all central Asiatic deserts.

Artificial plantings enable the acceleration of a vegetation cover (Phytomelioration) – this is the best precondition to combat the local sand- and to combat the regional dust storms. It enhances small scale soil protection with favouring microbiotic surface layer soil crusts.

Future developmental projects have to focus on safe water-, energy supplies, poverty reduction and health care.

The Nature Protection Area of the former island of Barsa Kelmes has been greatly enlarged according to the new situation, protective procedures have to be modernized.

Four core regions are defined: They are part of a future National Park and Biosphere-Reserve Aralkum:

- **The former island Barsa-Kelmes**
- **Former East coast with the hot springs of Kaskakulan**
- **Tugai forest region of the new developping Syrdarya-Delta after dam construction at Kokaral**
- **Early Quaternary fossil sites at the Northern Chinks**

Acknowledgements
DAAD
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UNCCD
Dept Ecology Bielefeld
Univ Bielefeld
Dept Forestry Kokchetau
Kazak Nat Acad Almaty
Dept Botany Almaty
Nat Parc Office Aralsk

The Aralkum (the desiccated sea floor of the Aral Sea) **is the biggest successional experiment of mankind**

„Sand is the gold of the desert ! “

Many thanks for your attention !

Sand sites have the best water storing capacity and exhibit diverse ecosystems development

Agama **in the evening sun on new Aralkum sand dunes** (phot: SWBr Juli 2004)

Ecological Studies 218

Siegmar-W. Breckle
Walter Wucherer
Liliya A. Dimeyeva
Nathalia V. Ogar
Editors

Aralkum - a Man-Made Desert

The Desiccated Floor of the Aral Sea (Central Asia)

Springer

Springer
the language of science

springer.com

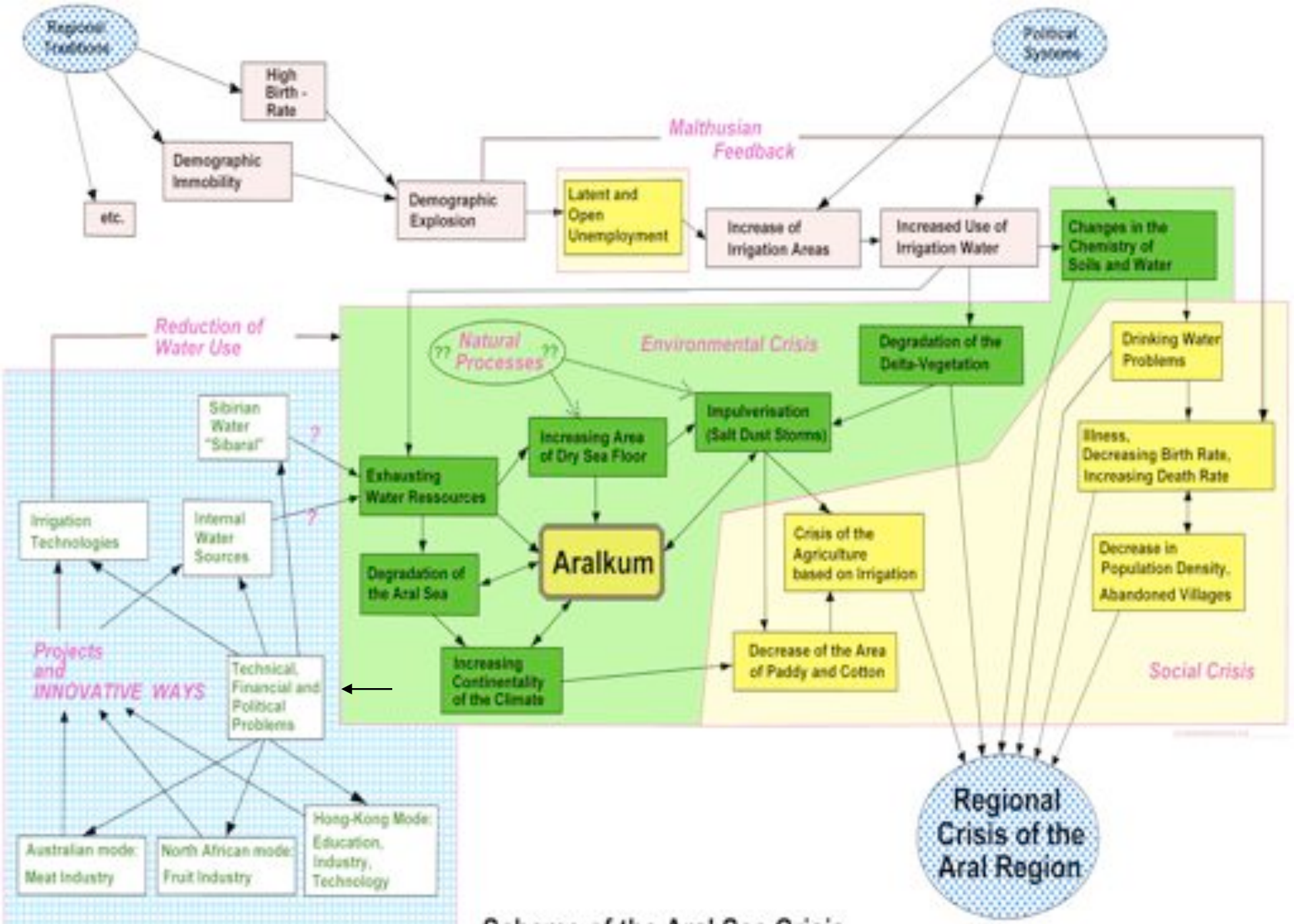
S.-W. Breckle, University of Bielefeld, Germany; M. Veste, University of Bielefeld, Germany; W. Wucherer, University of Bielefeld, Germany (Eds.)

Sustainable Land Use in Deserts

Changing desert areas for land use implies a lot of ecological problems. These and related ones are dealt with in this book covering various interdisciplinary and international aspects. Large areas in arid and semi-arid regions are already polluted in various ways. One of the biggest problems is the anthropogenic salinization by inadequate means of agriculture and irrigation. Additionally, most arid areas in the world are dramatically overgrazed. Methods and practices of a sustainable land use in deserts are urgently needed in many arid regions. This book gives a broad survey on some of the affected regions of the world as well as some case studies from elsewhere (Aral Sea, Negev desert, Namib desert etc.). Thus, basic and applied sciences are brought together. Water management in deserts, grazing systems or reclamation of desertified areas are among the topics of this book, as well as social and economic aspects.

2001. XXIV, 465 p. 122 illus., 16 in color. Hardcover

169,95 €, $209.00, SFr. 296.00, £130.50
ISBN 978-3-540-67762-8



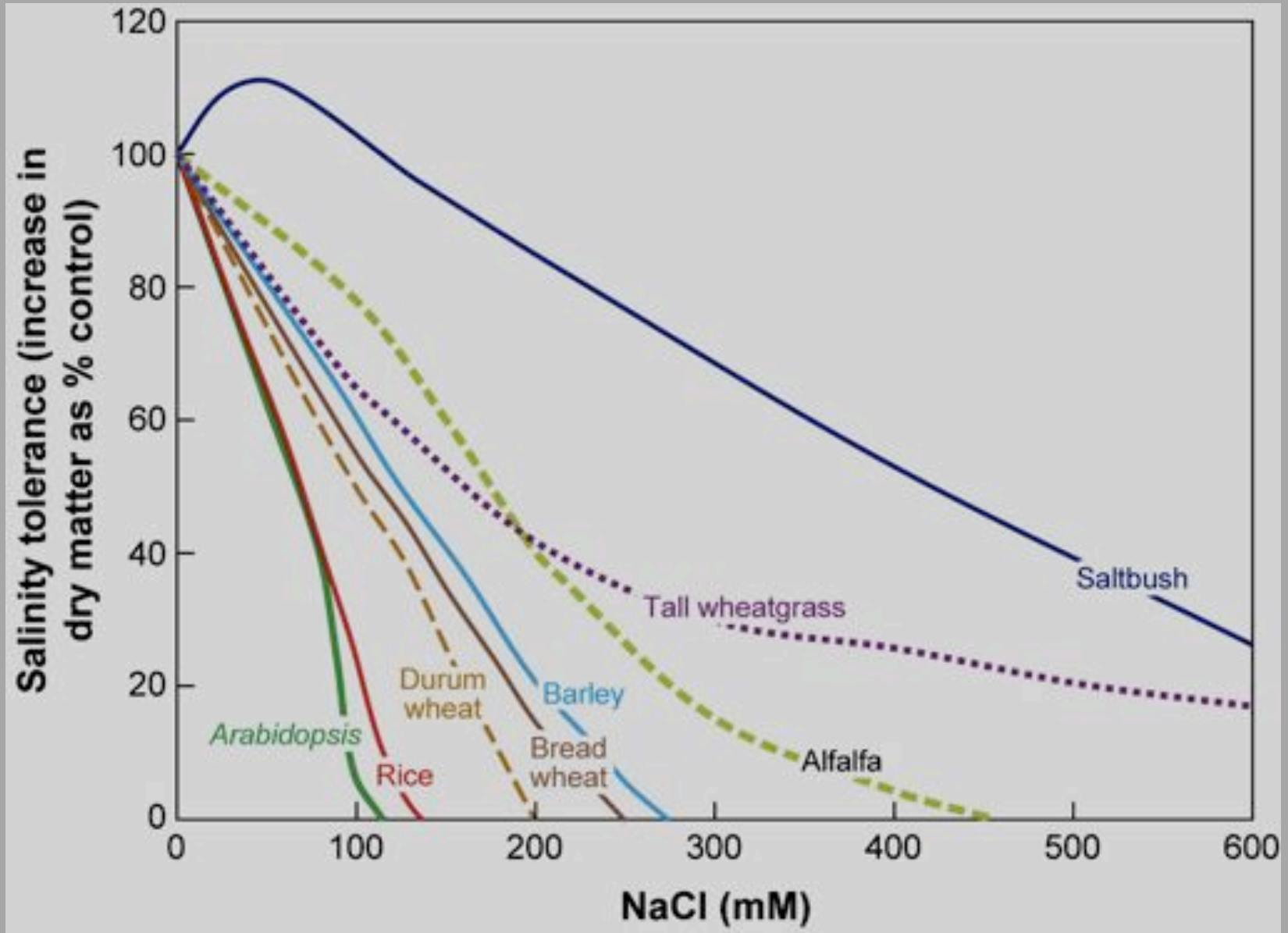
Scheme of the Aral Sea Crisis

(nach BRECKLE et al. 1998)

Salinized fields near Kzylorda (phot: SWBr April 2001)

Salinized plains within Aralsk (phot: SWBr April 2001)

Cotton damaged by salinity (phot: SWBr Juni 1990)



Munns R, Tester M. 2008.
Annu. Rev. Plant Biol. 59:651–81.

The wide stretching root system of a *Calligonum*-shrub (phot: SWBr Juni 2004)

Karabulak, high „Chinks“ at Northcoast, North Basin of Aral Sea (phot: W. Wucherer 2003)

Dense old Saxaul-Forest (*Haloxylon aphyllum*) on Barsa Kelmes, damaged by drought
(phot: SWBr Juli 2004)

Very old Saxaul-Tree (*Haloxylon aphyllum*) on Barsa Kelmes
(phot: SWBr Juli 2004)

Heavily eroded loessicriver banks of; *Ponton-Bridge near Karateren* *(phot: SWBr May 2003)*

ARALSEE => Aralkum

Aus Wasser wird Wüste

Leben mit der Umweltkatastrophe

Kurz-Übersicht mit einzelnen Thesen (keine 95, nur 10)

Wichtig zuerst: Situation und Entstehungsgeschichte der Katastrophe verstehen - aus der Sicht der Naturwissenschaft und Ökologie – dann: Welche Möglichkeiten hat man etwas zu ändern? Wie geht man damit um?

These 1: Den Aralsee gibt es nicht mehr (nur noch Restbecken)

These 2: Der Aralsee ist in absehbarer Zeit nicht wiederherstellbar

These 3: Aus naturwissenschaftlicher Sicht hat am Aralsee das größte menschgemachte Experiment zur „Eroberung von Neuland durch die Natur“ stattgefunden und findet noch statt

These 4: Am Aralsee sind fast 60.000 km^2 Neuland entstanden, weit mehr als die Gesamtfläche der Niederlande.

Allerdings: dieses Neuland ist, aufgrund des Klimas, offene Sand- und Salzwüste

Warum ist der Aralsee ausgetrocknet?

Der Aralsee ist ein Binnenmeer.

Zufluß und Abfluß sind seit 1960 durch den Menschen aus dem Gleichgewicht geraten.

Zufluß gesamt => zum Aralsee (1990-2004): Amudarya: 50-60 => 5-15km^3 /

Syrdarya: 30-35 => 3-7km^3 / Grundwasser c 40 => 2-5km^3

Ursache: neue Kanäle, Bewässerungssysteme, Fischteiche, Staudämme, neue Seen

Die Wassermenge im gesamten Aralbecken ist etwa gleich geblieben, aber es kommt kaum mehr etwas im Aralsee an.

These 5: Die Umweltschäden sind nur durch große Anstrengungen einzugrenzen; insbesondere die Salzstaubstürme (Bisqunaq) haben verheerende Folgen (Mensch, Tier, Landwirtschaft); aber

These 6: Die Umweltkatastrophe am Aralsee muß auch als Chance für einen Neuanfang gesehen werden, so ist die Einrichtung eines großen Naturreservats bereits erfolgt und muß weiter ausgebaut werden mit zusätzlichen Kernzonen

These 7: Die offenen Sand- und Salzwüsten müssen schnellstens bepflanzt werden: Phytomelioration – Aufforstungen - gegen das Ausblasen von Salzstaub (ca 10-50 Mio t / a)

These 8: Die Bevölkerung muß durch neue moderne Technologien dezentral ihre Energie- und Wasserversorgung selbst decken können, dies dient der Armutsbekämpfung und Gesundheitsvorsorge

These 9: Die großräumige Hydrologie muß zu einem neuen Gleichgewicht gebracht werden, einerseits ist dies durch den Dammbau im Norden geschehen: Stabilisierung des nördl. Kleinen Aralsees und dessen Aussüßung. Dies steht andererseits noch aus für das Aralseewestbecken im Süden, eine noch viel größere internationale Aufgabe – Überlaufkanal im Norden zum Ostbecken als Salzsumpf

These 10: Die Resource Wasser ist begrenzt. Nur eine gemeinsame ständige Wasserkonferenz, gemeinsame Strategien und neue sparsame Wassertechnologien aller 6 Anrainerstaaten der beiden Flußsysteme Syrdarya und Amudarya sind auf längere Sicht erfolgversprechend und damit nachhaltig und den Frieden sichernd