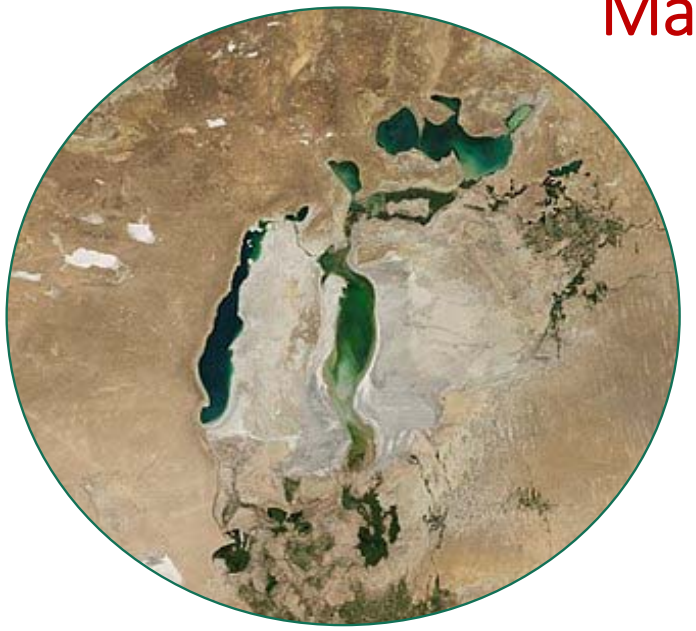
International Symposium on Ecological Restoration and Management of the Aral Sea



The Aral Sea Disaster: Climate Change and Water-Land Ecological Problems in Uzbekistan

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General contents

- About the Aral Sea disaster
- Climate change problems of the ASB
- Water and land resources of Uzbekistan
- Salinization of the irrigated lands – Navoi and Jizzakh provinces (Uzbekistan)
- Return flow- Collector-Drainage Water

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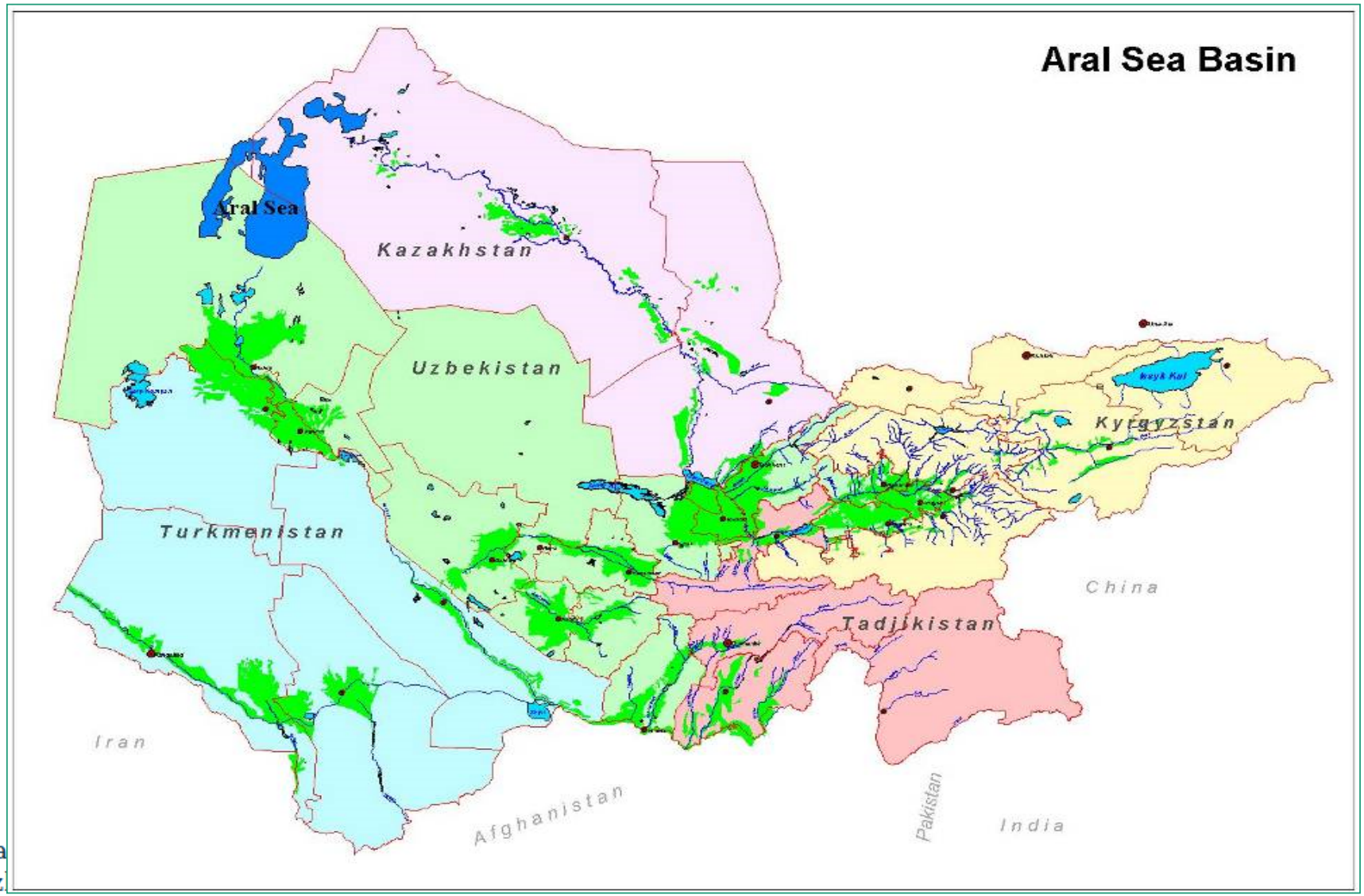
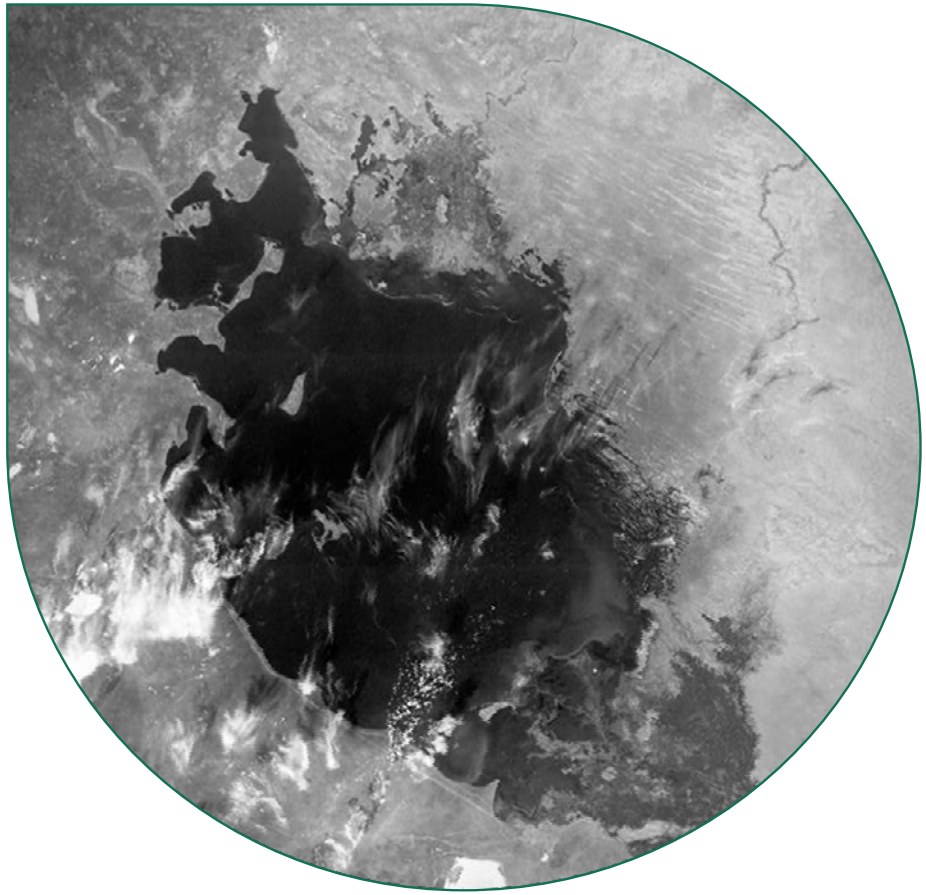

Aral Sea Basin
Aral Sea
Kazakhstan
Uzbekistan
Kyrgyzstan
Issyk Kul
Turkmenistan
China
Tadjikistan
Iran
Afghanistan
Pakistan
India

Back to the past

In 1964:

Formerly one of the four largest inland lakes in the world

- The Sea area **68,900 km^2**
- Water volume – **1083 km^3**
- The Sea length – **426 km**
- The Sea width – **284 km**
- The deepest part – **68 m**
- Annual water supply – **50-55 km^3**



Source: NASA

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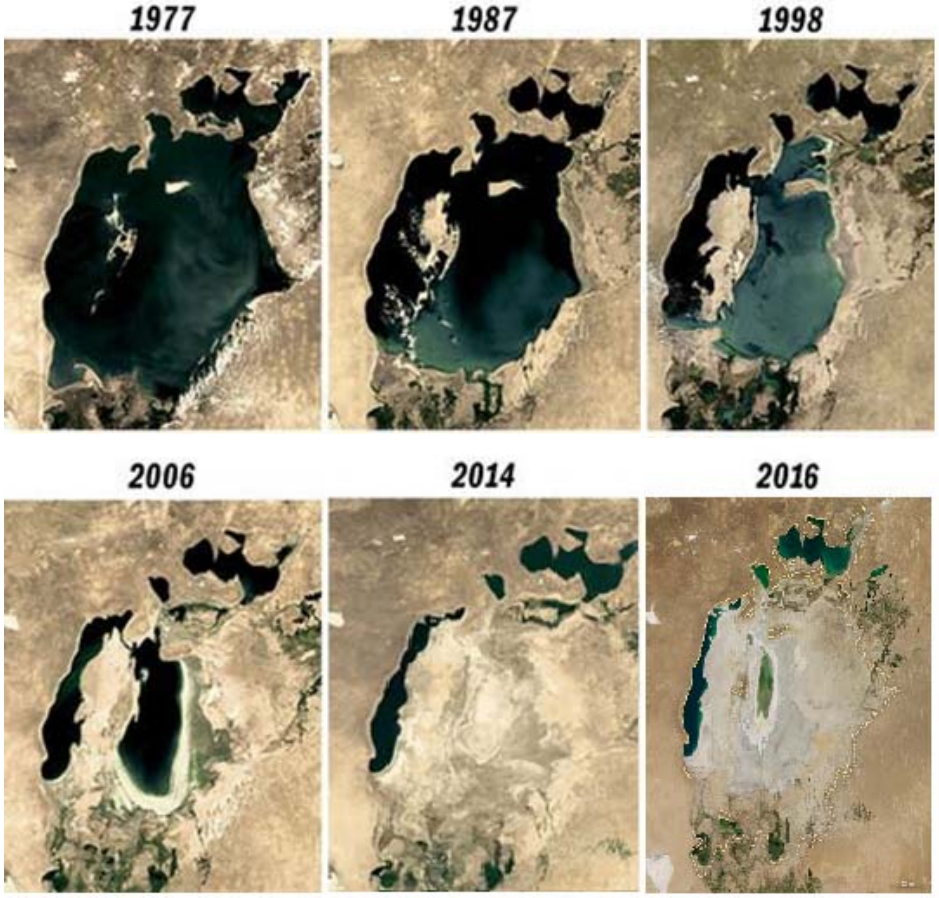
The Aral Sea RAPIDLY shrinking since the 1960s

Last 50-55 years:

- Water volume reduced more than 15 times
- The Sea area reduced more than 8 times
- The Sea level reduced more than 29 meters
- Coastline retreated hundreds of kilometers



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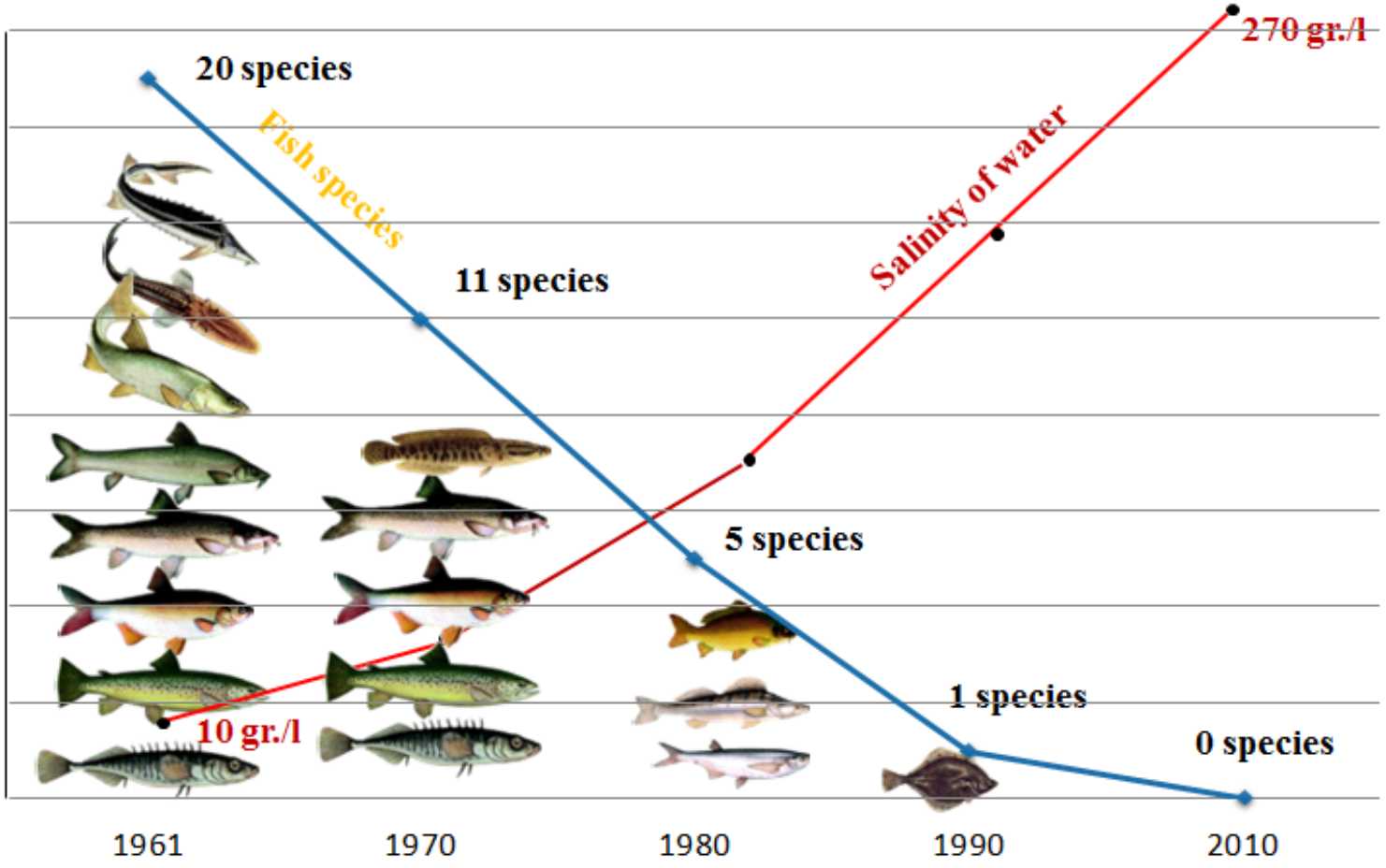
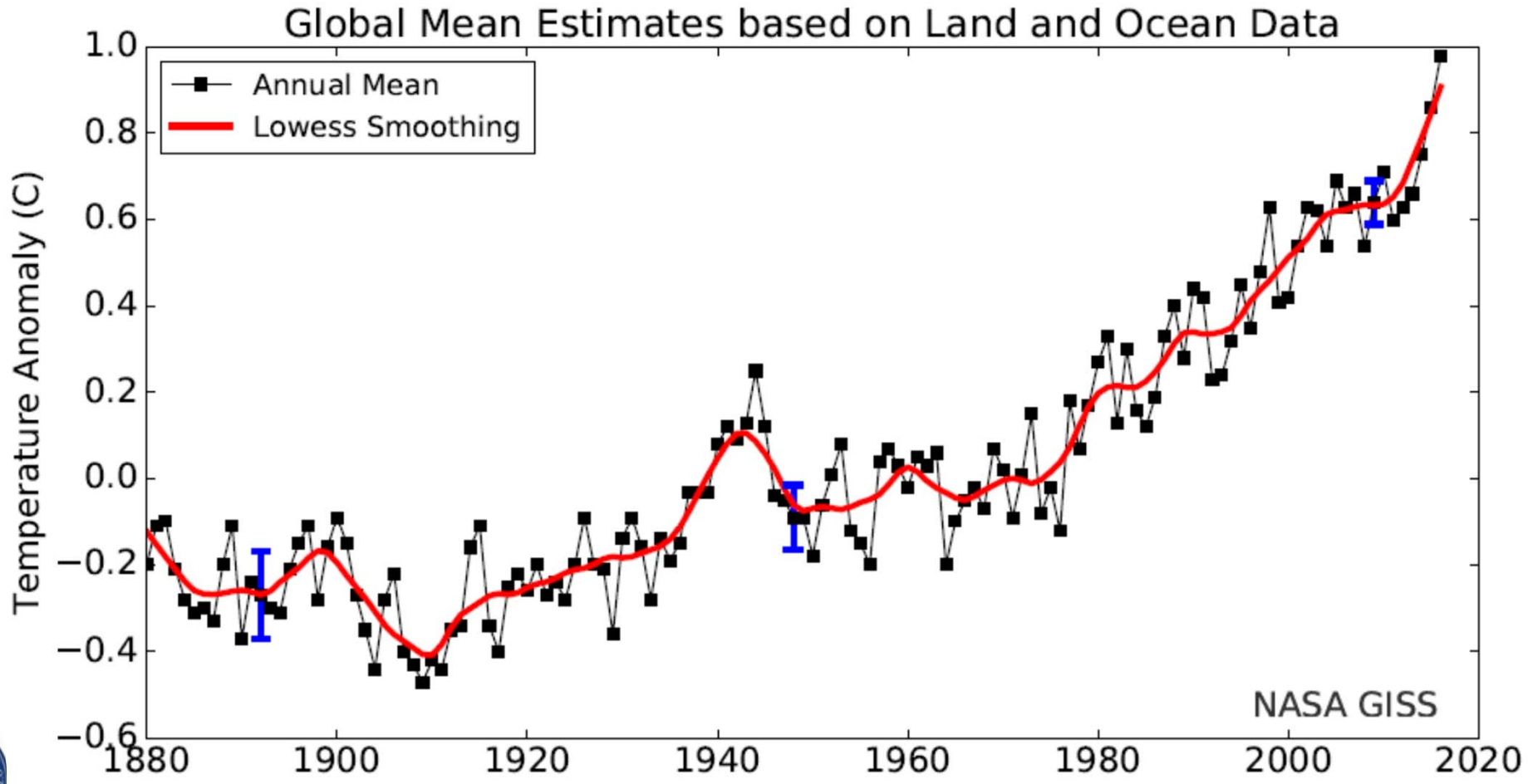
Environmental consequences Losses of fish species



Global Climate Change



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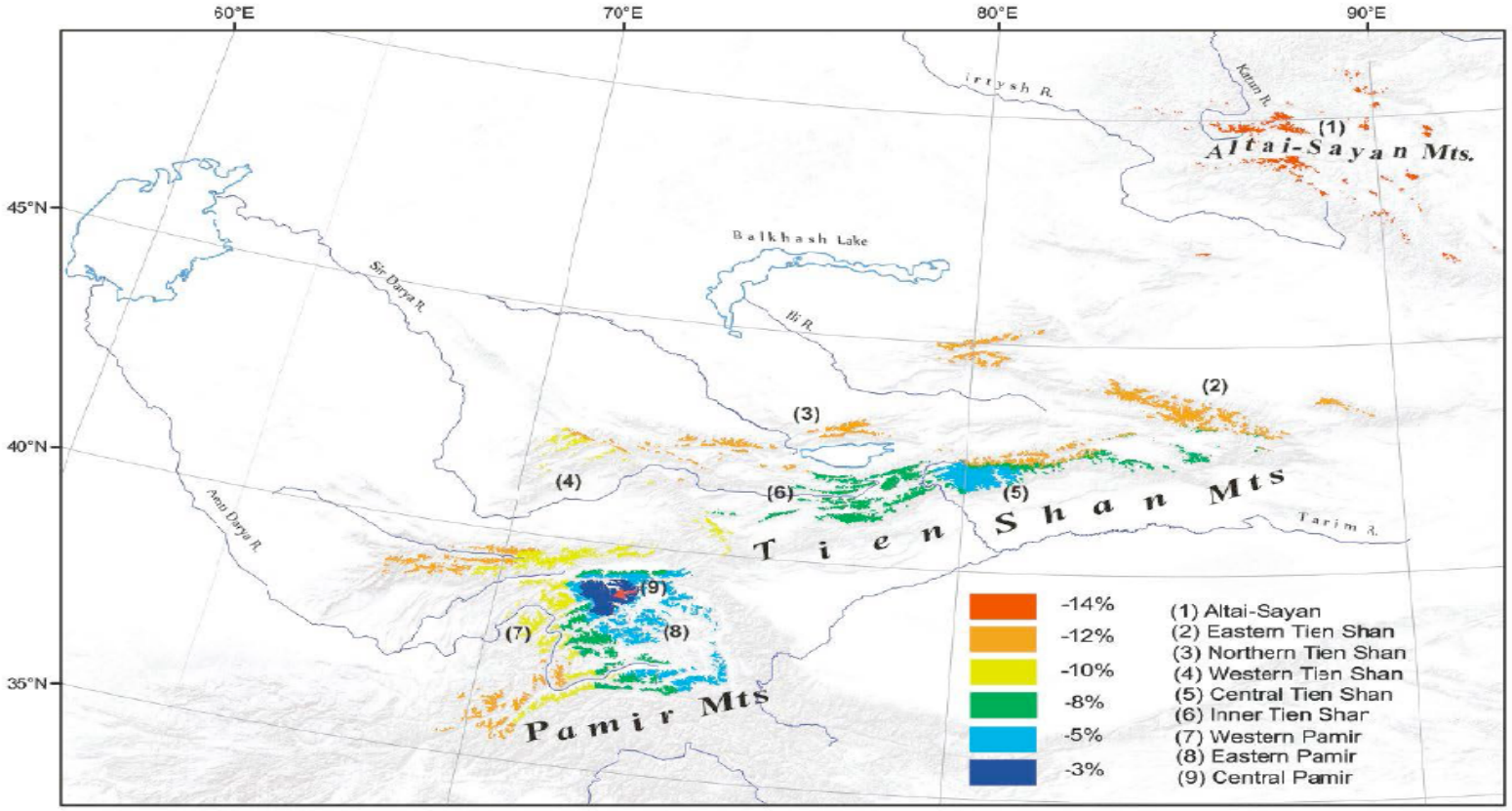
Climate Change: Losses of Glacier Area



Altai-Sayan, Pamir and Tien Shan. Remote sensing
- 1960s through 2008 (IPCC WG2)

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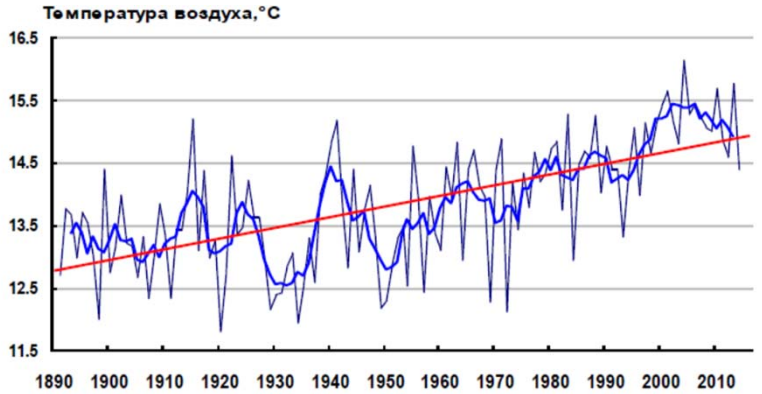
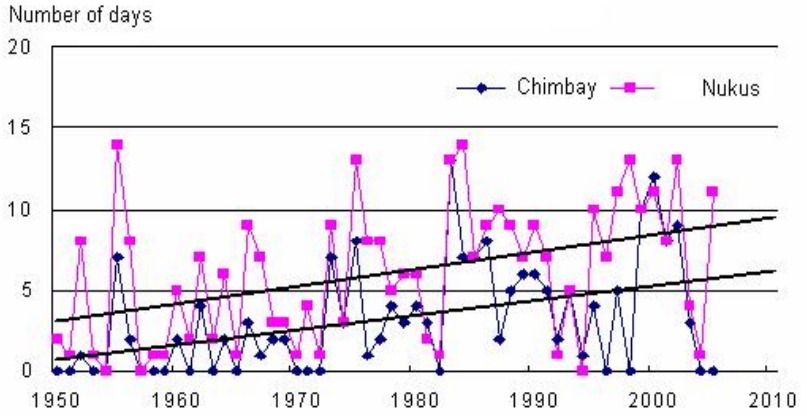
Manifested indicators of climate change in the ASB

- over Uzbekistan territory increase 0,29 °C/10 years (1950-2005);
- over Kazakhstan territory increase 0,26 °C/10 years (1936-2005);
- over Kyrgyzstan territory increase 0,08 °C/10 years (1883-2005);
- over Tajikistan territory increase 0,10 °C/10 years (1940-2005);
- over Turkmenistan territory increase 0,18 °C/10 years (1961-1995)



Changes in air temperatures in Tashkent
Trend=1.7 C/100 years



In Priaraliya number of days with high temperature (higher than 40°C) increased twice.

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Source: Uzgidromet

Uzbekistan in brief

Historical heritage – 7,000 monuments

Ecosystems – 7 types

Flora – 4,500 species (9% endemics)

Fauna – 14,900 species of invertebrates and 714 species of vertebrates

Natural Protected Areas – 3.5 mln hectares

Total area – 447 400 km^2 *(4th in CIS)*

Population – 35 million *(2nd in CIS)*

Borders with all Centralasian states and Afghanistan

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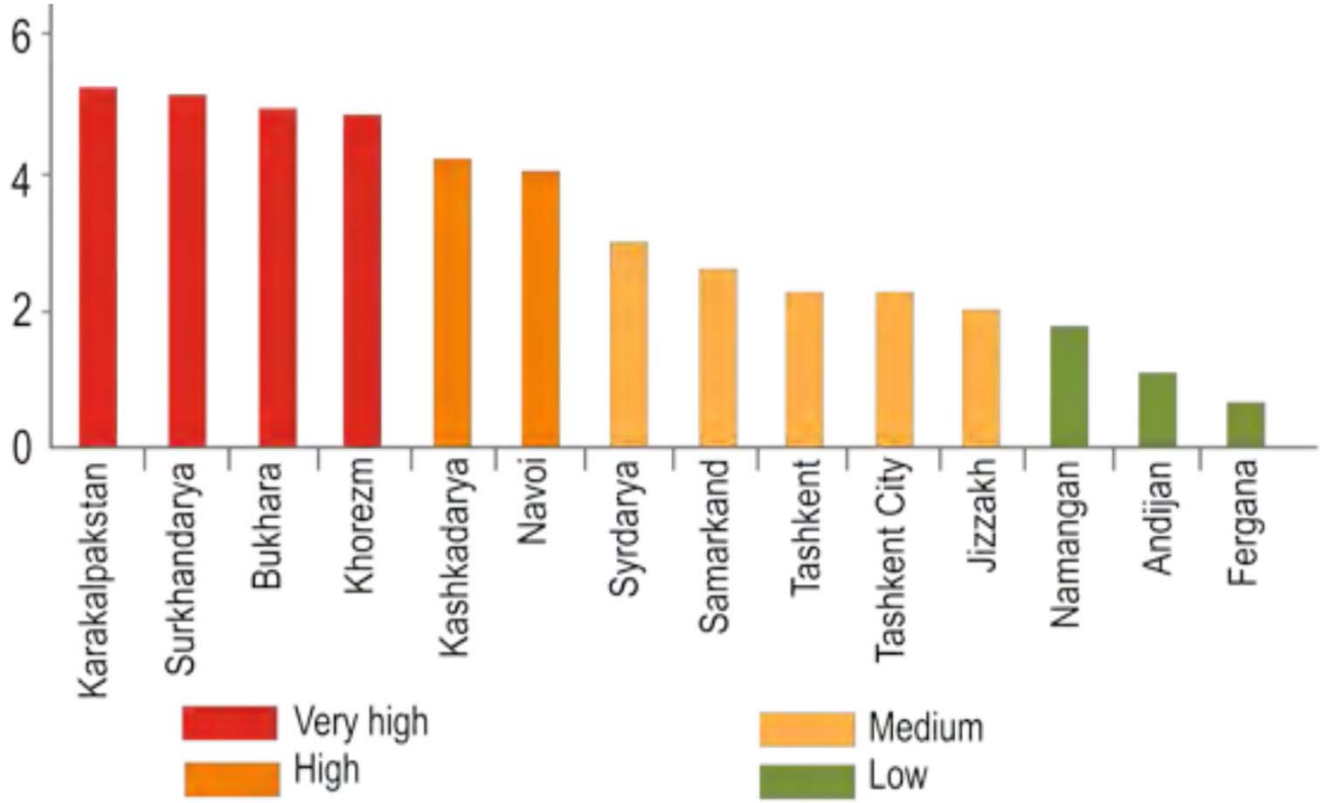
The vulnerability of Uzbekistan's provinces to climate change



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Climate Change: Manifested indicators of climate change in the ASB

- Warming trends in ASB is higher than global averages!
- Number of warm days is increasing faster than global average – risk of heatwaves in the future
- Extension of duration of the dry hot period
- Increase of number of days with heavy precipitation and high precipitation variability
- Reduction of snow reserves in mountains and degradation of glaciation
- More often occurrences of the extreme events
- Increase of evaporation over the plain and foothill territory
- Increase of occurrence of droughts and the extreme low water period
- Increase of irrigation norms is possible: up to 2050 - 7-10%; up to 2080 - 12-16%

Surface water resources in the ASB, (km3/year)

Country	River Basin		Total Aral Sea Basin	
	Syrdarya	Amudarya	km3/a	%
Kazakhstan	2.516	—	2.51	2.2
Kyrgyzstan	27.54	1.65	29.19	25.2
Tajikistan	1.005	58.7	59.73	51.5
Turkmenistan	—	1.40	1.405	1.2
Uzbekistan	5.56	6.79	12.35	10.6
Afghanistan and Iran	—	10.8	10.81	9.3
Total Aral Sea basin	36.62	79.4	116.02	100

The Role of Water in the ASB Countries

- ✓ A water supply for the whole population
- ✓ 23% of the national income
- ✓ Employment of 34% of the people
- ✓ Food independence
- ✓ Environmental security
- ✓ Generation of 38% of electric energy
- ✓ $1 of irrigated agriculture's output to $2.3 of associated effect

Contemporary water issues in the ASB under climate change

The limited and growing scarcity of water resources.

Uneven distribution of water resources.

Relatively low water use efficiency (especially in agriculture).

Progressive deterioration in water quality

Water and land degradation, ecosystem disturbance:

Desertification, biodiversity loss.

Population growth in Central Asia exceeds global rates.

Intensification of economic processes, growth use of water resources.

Additional water demand 700-800 million m3 per year.

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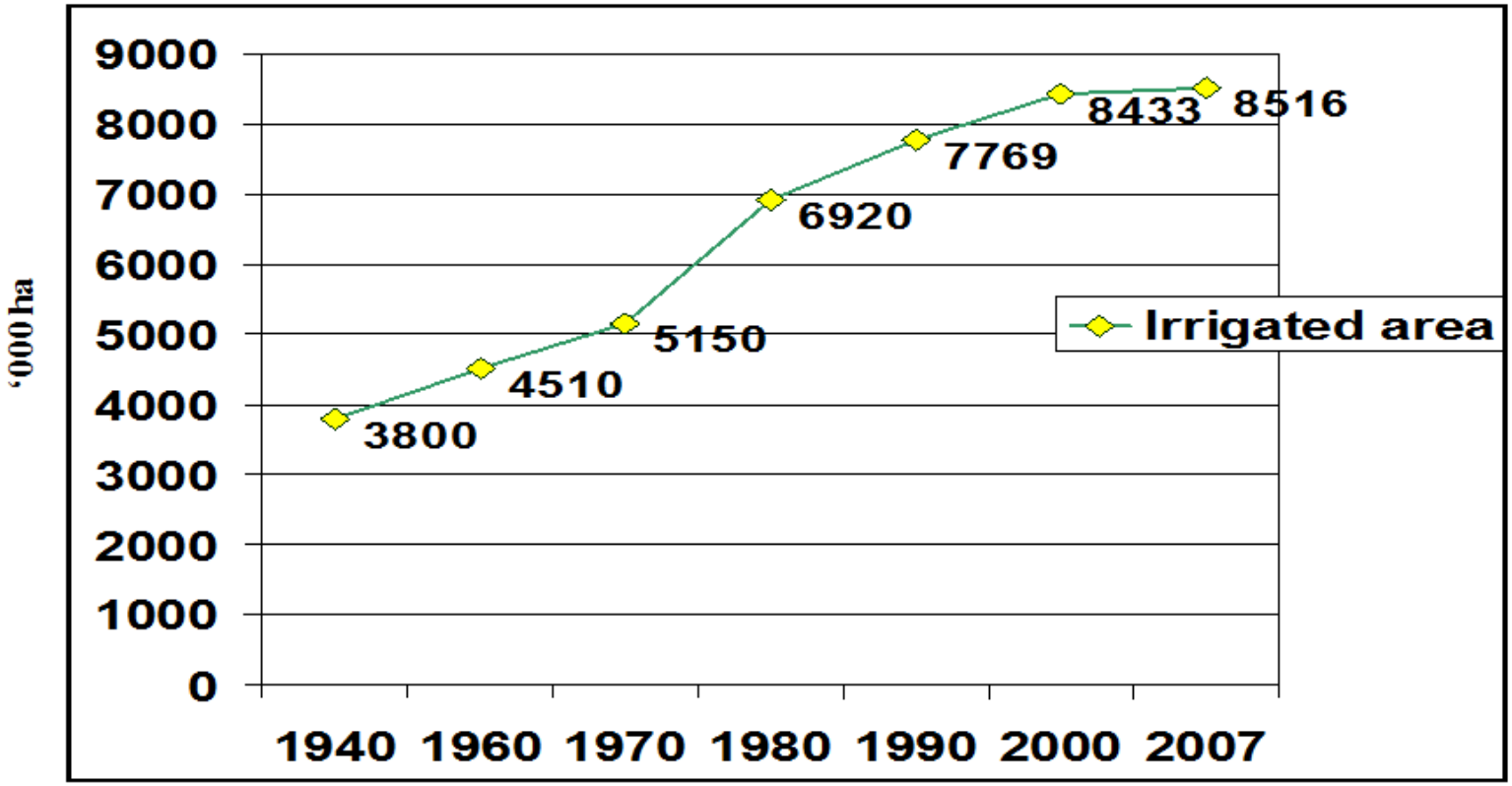
Increase of the irrigated lands of the Aral Sea Basin



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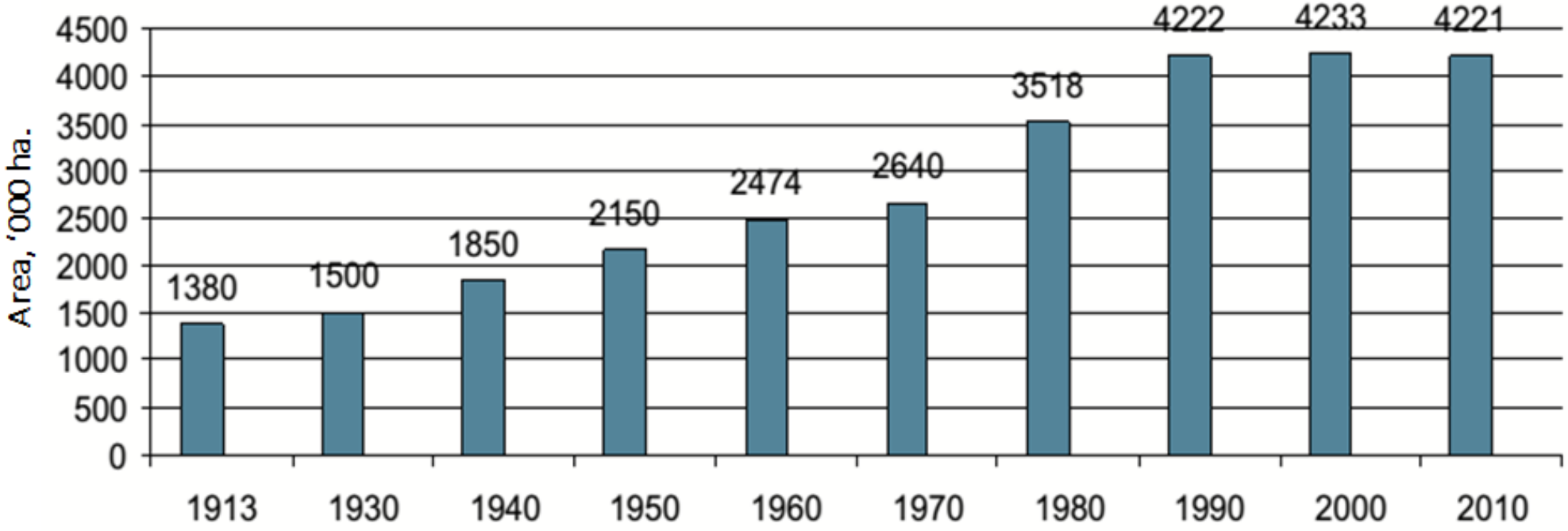
Agriculture in Uzbekistan

- The agriculture is a key economic sector in Uzbekistan, currently providing about 18% of the GDP with 27% of employment in this sector.
- The irrigated lands make up only 10% of the total farmland in Uzbekistan, but provide more than 90% of all agricultural products.
- The irrigated lands are characterized by low level of fertility and low humus content, usually not more than 1-2% organic matter.
- Due to poor conditions of the irrigation network and ineffective water resources management, the losses in the irrigation networks are estimated to be about 40%.

Irrigation development in Uzbekistan



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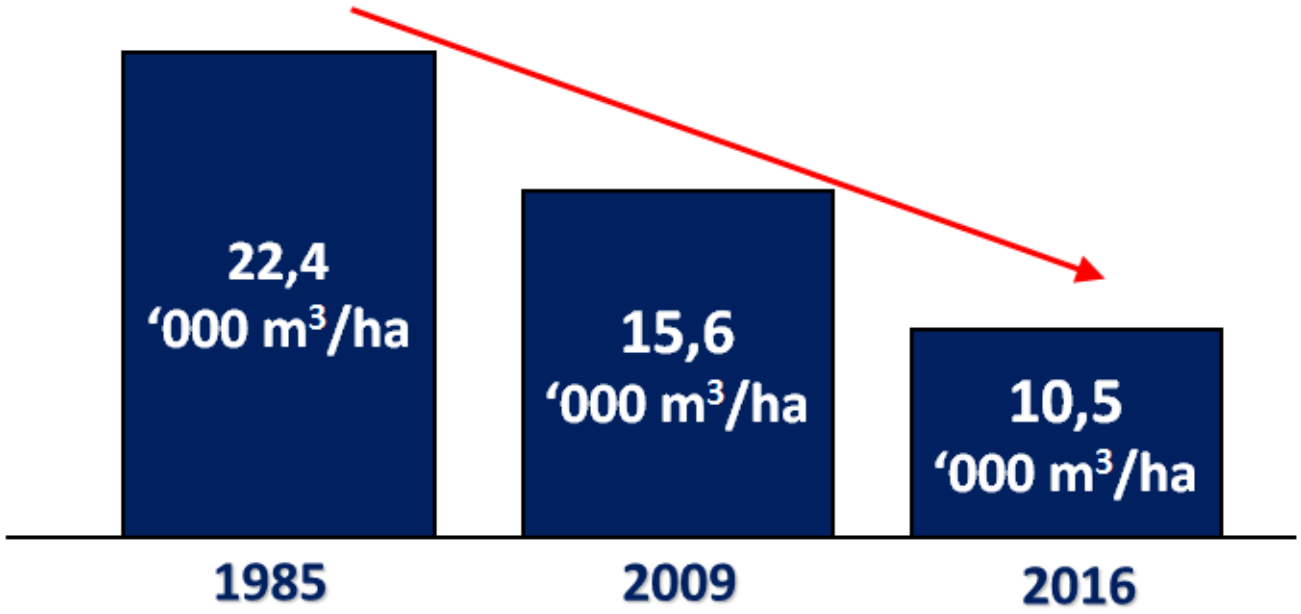
Water resources management in Central Asia

Specific water consumption for hectare of irrigated lands in Uzbekistan *(thousands m^3)*



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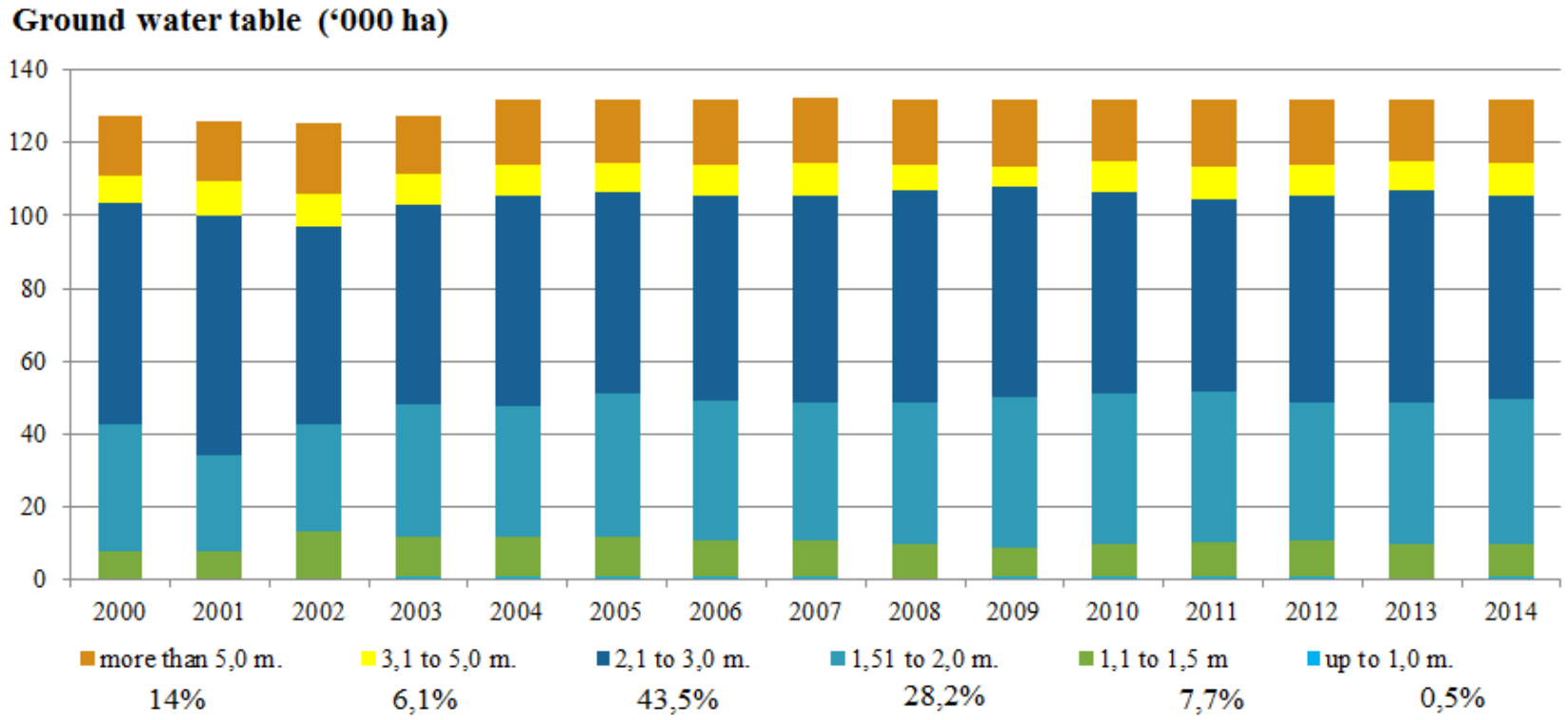
Temporal dynamic of the groundwater table depth in the irrigated areas of the Navoi province



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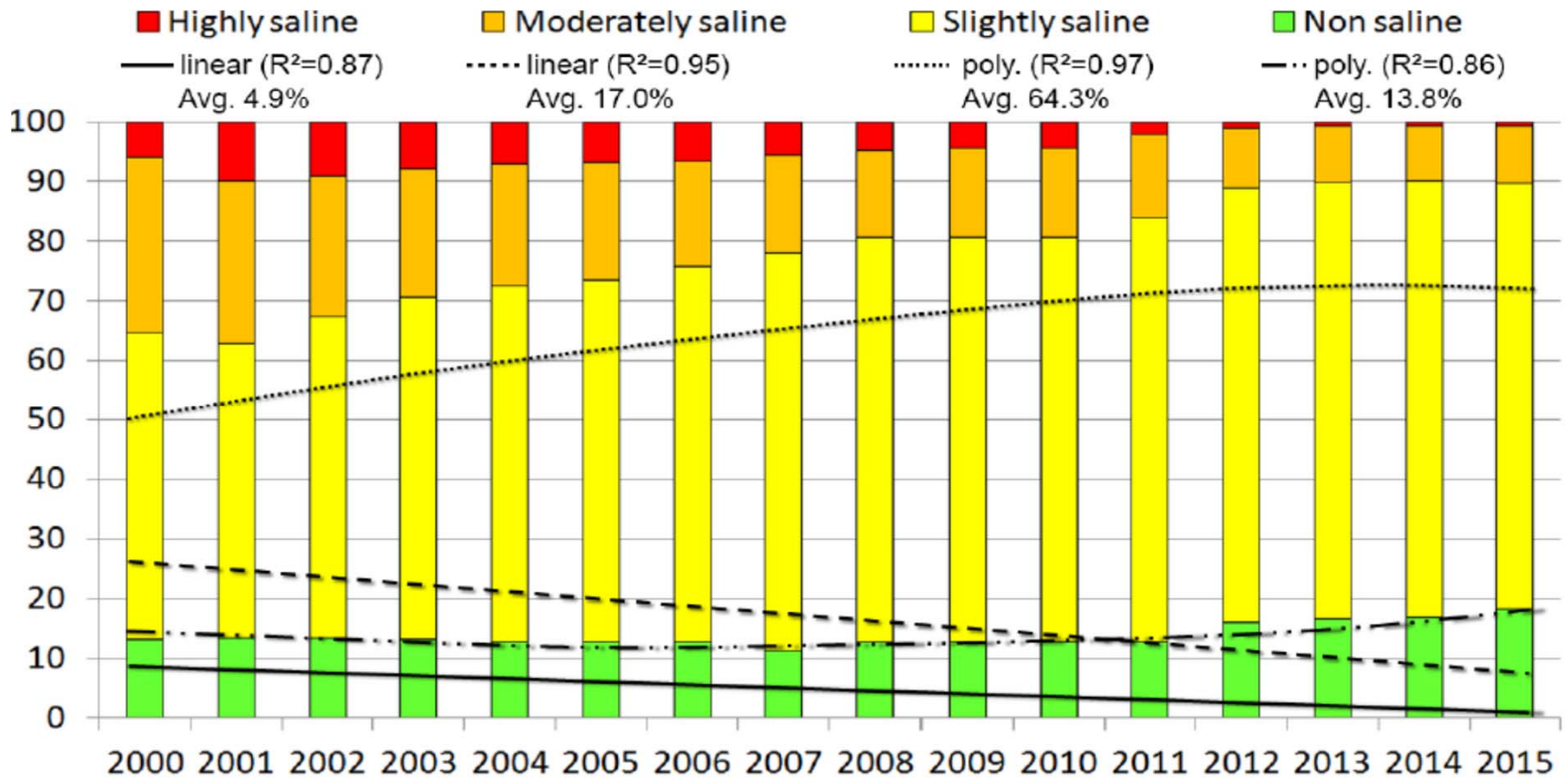
Temporal soil salinization dynamics



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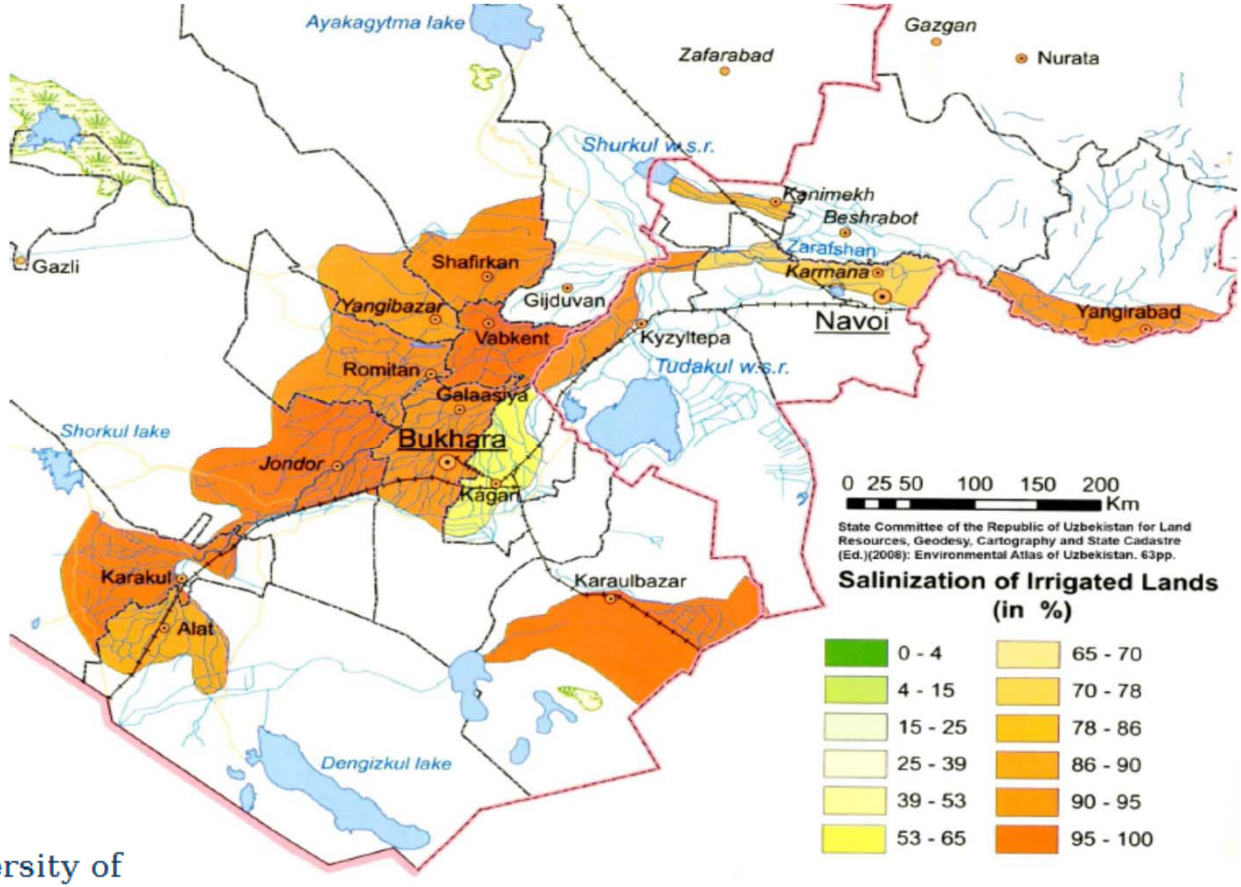
The map of the soil salinization (Bukhara region)



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The Collector-drainage water in the ASB

- With the development of irrigation and drainage systems in the ASB and the intensive reclamation of new irrigated lands, up to 30-40 km^3 of return flow was formed out of the total volume water resources, 110-120 km^3, which constitutes about 30% of water resources.
- From of the total return water 6% is used for irrigation, discharge into rivers is 29%, and more than 65% is diverted to the local depressions.
- The accumulation of a huge amount of highly mineralized and polluted return flow with toxic salts, pesticides, residues of mineral fertilizers has a negative impact on the environment, and may be a serious environmental problem for the region.
- The annual volume of discharged salts in the composition of return flow is estimated to be more than 70-80 mln tons.

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Share of CDW in the ASB countries

Country	The volume of water use for irrigation, million m^3	CDW from irrigation are formed, million m^3	Share of CDW in the volume of flow for irrigation, %
Kazakhstan	7959	1600	20,1
Kyrgyzstan	3100	1700	54,8
Tajikistan	10150	3050	33,9
Turkmenistan	16788	3800	22,6
Uzbekistan	56660	18400	32,5
Total in the Aral Sea Basin	94657	29550	31,2
Syrdarya basin	35089	11950	34,1
Amudarya basin	59568	17600	29,5

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Conclusions and Recommendations

- Sustainable use and management of irrigated lands in Uzbekistan is essential for securing food production under the situation of climate change, decreasing water resources and growing population and economy especially in the face of limited irrigated land.
- The regional effects of the global warming might not lead to an immediate decreasing of quality of irrigated lands, but a significant reduction of the available yields of agricultural production has to be expected in the long term.
- Development of monitoring of quantity and quality of the water in the basin of the rivers the Amu Darya and the Syr Darya, equipment by modern means of the account of volume and quality of river waters.
- Realization of research and engineering-design works on clearing, regeneration of collector-drainage waters for reuse, demineralization of salty waters.

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Acknowledgements

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Published materials related to the scope of the symposium

Monographs:

1. **Kulmatov, R**. *The problems of management of water-land resources in Aral Sea Basin.* Germany. LAP LAMBERT Academic Publishing, *Germany* . 2017, 57 pp.
2. **Kulmatov, R**. *Sustainable Development Indicators of lower Zarafshon region and their practical evaluation (Uzbekistan)*, LAP LAMBERT Academic Publishing, *Germany*. 2018, 110 pp.
3. **Kulmatov R**., Rasulov A. *Sustainable Development of the Indicators of the Zarafshan region and their practical evaluation*, 2018. Tashkent. "University press". 157 pp (in Uzbek).
4. Jiaguo Qi, S, Pueppke, R Kulmatov etc. Chapter 5. The Complexity and Challenges of Central Asia's Water-Energy-Food Systems. In book: *Landscape Dynamics of Drylands across Greater Central Asia: People, Societies and Ecosystems. Springer Nature Switzerland AG 2020G. Gutman et al. (eds.), April 2020.* DOI: 10.1007/978-3-030-30742-4_5.

Reviewed research journals:

1. **Kulmatov, R.,** Mirzaev, J., Jilili, A., Karimov, B: Challenges for the sustainable use of water and land resources in the Djizakh irrigation zone (Uzbekistan) under changing climate and salinization. *J. Of Arid Land,* (2019), in press.
2. **Kulmatov, R**., Groll, M., Rasulov, A., Soliev, I., Romic, M*:* Status quo and present challenges of the sustainable use and management of water and land resources in Central Asian irrigation zones - the example of the Navoi region (Uzbekistan). *Quaternary International, 464 (2018), 396-410.*
3. Groll, M., **Kulmatov, R.,** Mullabaev, N., Opp, C., Kulmatova, D. Rise and Decline of the fishery industry in the Aydarkul-Arnasay lake system (Uzbekistan)–Effects of reservoir management, irrigation farming and climate change on an unstable ecosystem. *Environmental Earth Sciences.* (2016) 75:921. DOI 10.1007/s12665-016-5691-5

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4. Kulmatov, R., Mirzaev, J., Jilili, A., Karimov, B: Challenges for the sustainable use of water and land resources in the Djizakh irrigation zone (Uzbekistan) under changing climate and salinization. *J Arid Land (2020) 12(1): 90–103.* https://doi.org/10.1007/s40333-020-0092-8

5. Kulmatov, R., Groll, M., Rasulov, A., Soliev, I., Romic, M*:* Status quo and present challenges of the sustainable use and management of water and land resources in Central Asian irrigation zones - the example of the Navoi region (Uzbekistan). *Quaternary International, 464 (2018), 396-410*

6. Groll, M., Opp, Ch., **Kulmatov, R.**, Ikramova, M. & Normatov, I., Water quality, potential conflicts and solutions – an upstream-downstream analysis of the transnational Zarafshan River (Tajikistan, Uzbekistan). WIT Transactions on Ecology and The Environment, Vol 196, 2015. *Environmental Earth Sciences (2015) 73, pp. 743-763,* DOI: 10.1007/s12665-013-2988-5.

7. **Kulmatov, R.**, Rasulov, A., Kulmatova, D., Rozilhodjaev, B., Groll, M., The Modern Problems of Sustainable Use and Management of Irrigated Lands on the Example of the Bukhara Region (Uzbekistan). *Journal of Water Resource and Protection, 2015, 7, 956-971.Published Online August 2015 in SciRes. http://www.scirp.org/journal/jwarp*

8. Groll, M., Opp, Ch., **Kulmatov, R.**, Sun, Z., Normatov, I., Berhardi, A., Ikramova, M., and Stulina G. Managing Central Asia's transboundary rivers: case studies of the Zarafshan (Tajikistan/ Uzbekistan and Tarim(Kergyzstan/China) rivers*. Collected articles 8th International Conference on Sustainable Water resources management.* ***2015****, WIT press, UK, pp. 149-163.*

9. **Kulmatov, R.** Problems of Sustainable Use and Management of Water and Land Resources in Uzbekistan. Journal of Water Resource and Protection, 2014, 6, 35-42. http://dx.doi.org/10.4236/jwarp.2014.61006.

8. Kulmatov R., Opp Ch., Groll M., Kulmatova D. Assessment of Water Quality of the Trans-Boundary Zarafshan River in the Territory of Uzbekistan. *Journal of Water Resource and Protection, (2013)* 5,17-26.

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Thank you for your attention!

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