unesco

Aga Khan Agency for Habitat

ICIMOD

CARGC

GLOFCA

ADAPTATION FUND

# Cryosphere and related hazards in High Mountain Asia in a changing climate

1–4 November 2022 | Almaty, Kazakhstan

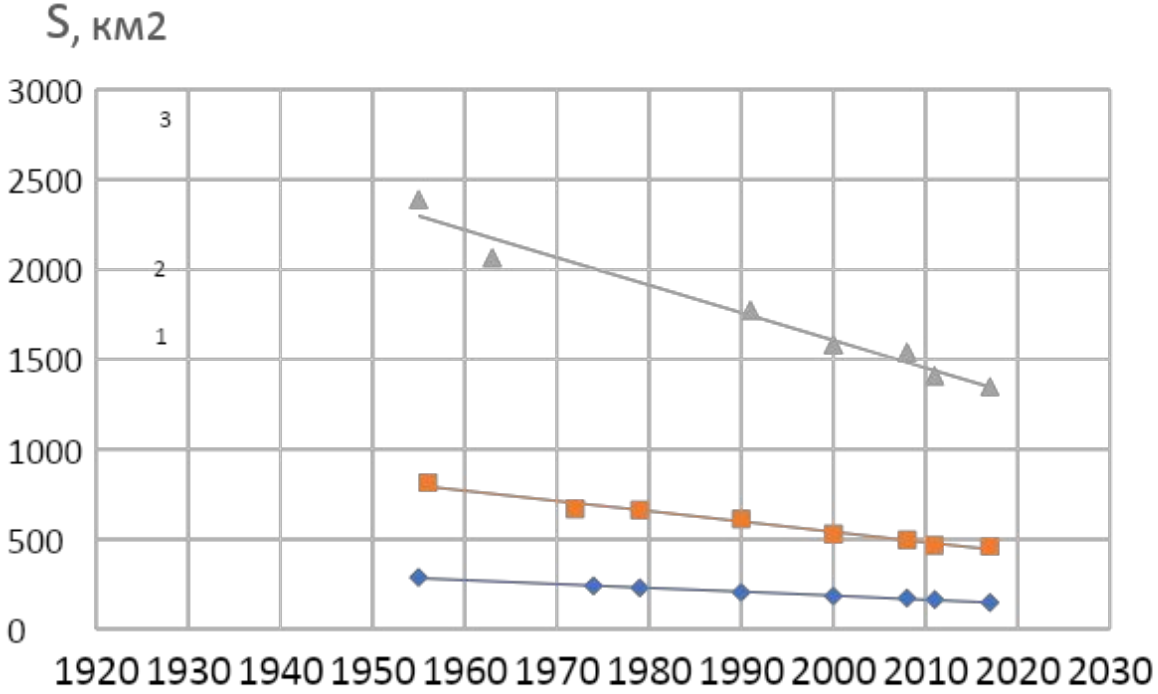
Presenter(s): I. Severskiy, V. Kapitsa, A. Kokarev, M. Tatkova, M. Shahgedanova, V. Morozova, Z. Usmanova, Z. Saydaliyeva, A. Yegorov

## Correcting spurious data in the catalogues of glaciers and re-assessing changes in the Tien Shan glacier systems with emphasis on the Syrdaria basin

# Decline in the glacierized area of Balkash-Alakol basin

***The changes of glaciers*** **were estimated based on the comparison of data of unified by the content glacier inventories.**

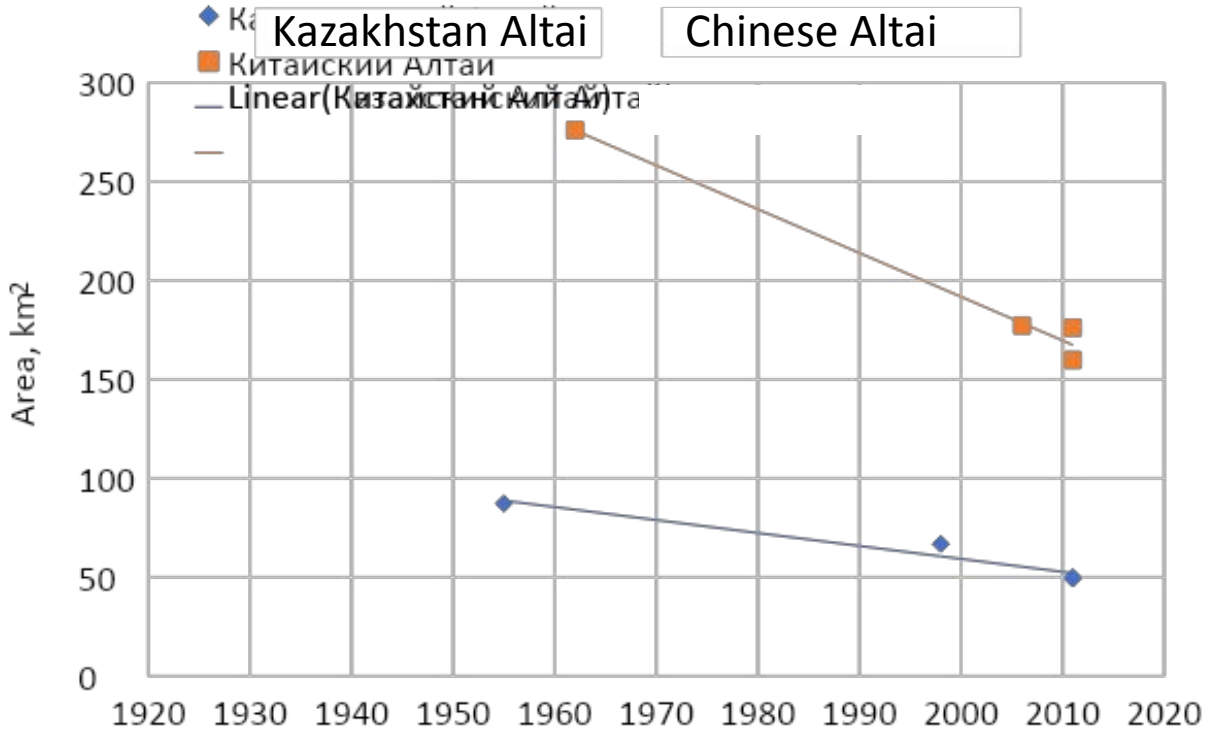
Balkhash-Alakol basin: Upper Ile (**1**), Zhetysu (Jungar) (**2**) and Northern Ile (**3**) glacial systems




**Changes in the glacial systems of the Balkash-Alakol basin,** which includes Ile-Kungey glacier system (8 glacier inventories from 1955 to 2017), Zhetysu (Jungarian) Alatau glacier systems (7 glacier inventories for the same period) within the Kazakhstan's territory and the Upper-Ile glacier system or Chinese part of Ile River basin (4 inventories from 1962/63 to 2012).
**This is one of the most studied regions.**

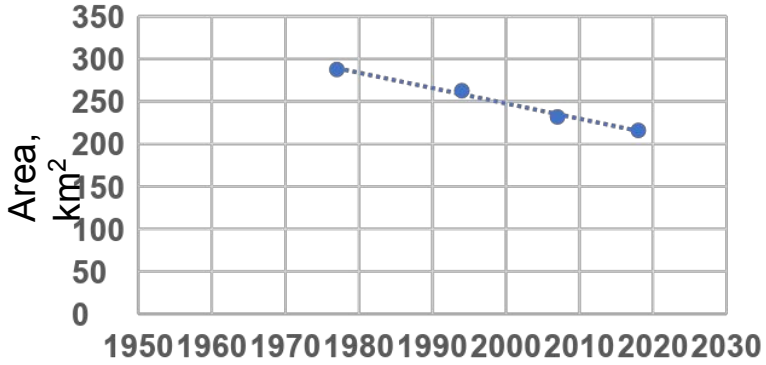
**Glacier area (clear ice) in the Balkash-Alakol basin is declining linearly at a rate of 0.73-0.75 % $a^{-1}$**

# Decline in the glacierized area of Ertis River basin

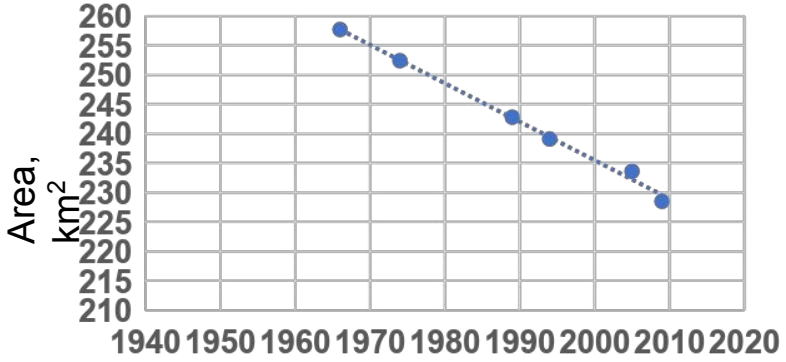



The total glacierized area in the Chinese (Mongolian) Altai and Kazakh part of Ertis River basin declining an average rate of to 0.74% $a^{-1}$ and 0.76% $a^{-1}$, respectively.
This rate is in line with the rate of glacier area decline in the Balkash-Alakol basin over the same period.
The same rate is typical of the glacier area change in the outer ridges of Gissar-Alay and Tien Shan.

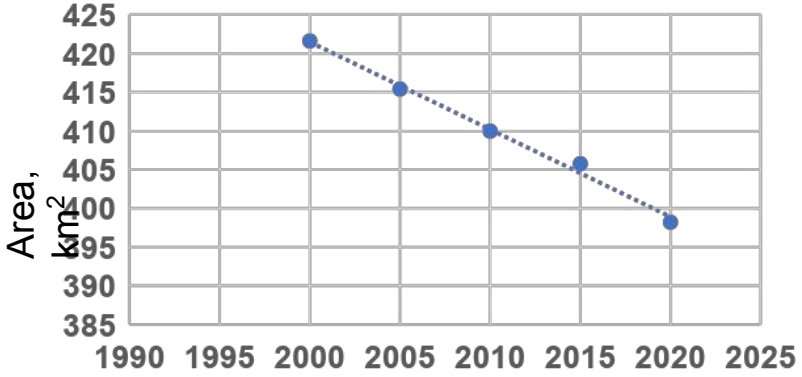
# Change in the glacierized area in High Asia



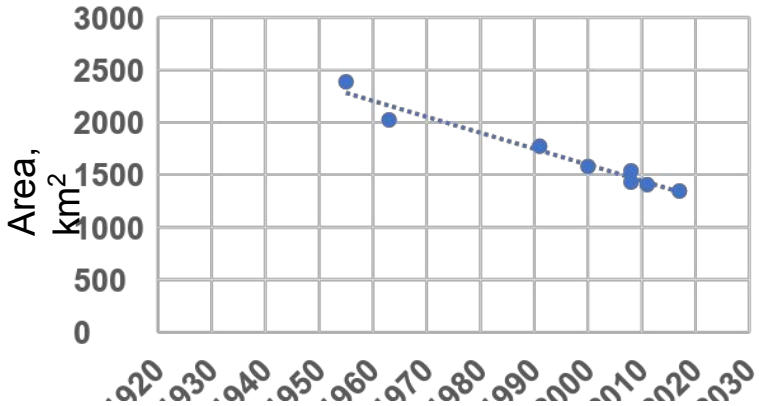

Eastern Tien Shan, Borokhoro Mountains (Yanan Li, 2020)



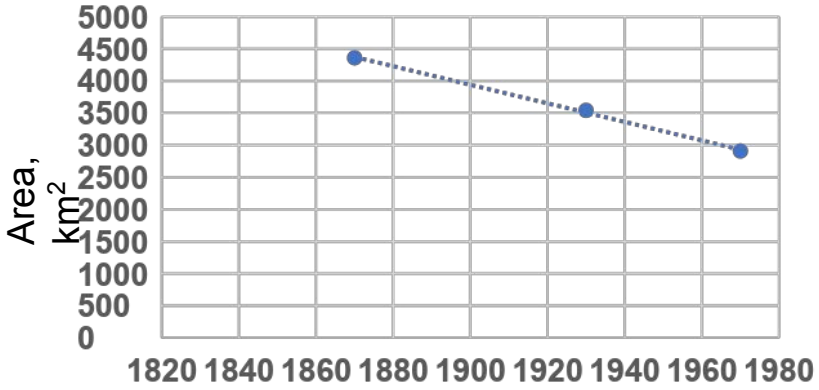

Gongga Mountains Tibetan Plateau (Pan et al., 2012)




Kaidu-Kongue M., Southern Tien-Shan (Li-Chen Wang et al.,2021)




The Chinese part of the Ile Basin (Kogutenko et al., 2021)

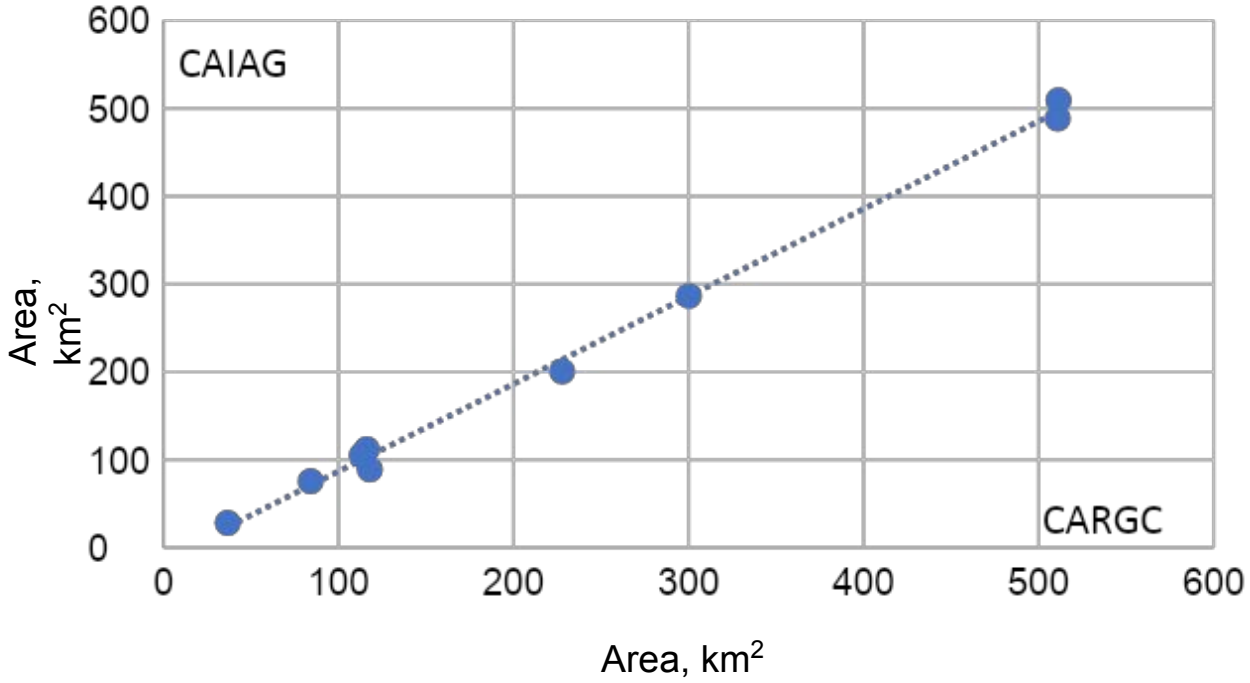



High Asia Mountains (Chen J, Ohmura A. 1990)

In view of these results, it is reasonable to assume that the glaciers of the Syrdaria basin also decreased linearly. But, when trying to assess these changes, doubts arose about the reliability of the data of previous catalogs of glaciers.

## Regarding the reliability of our estimates

In addition to the first glaciers inventory created in the frames of the USSR Glacier Catalog program, there are two complete glaciers inventories of Syrdaria basin: our glaciers inventory as of 2013-2014 and glaciers inventory of Kyrgyzstan (Shabunin, 2018) as of 2013-2016.

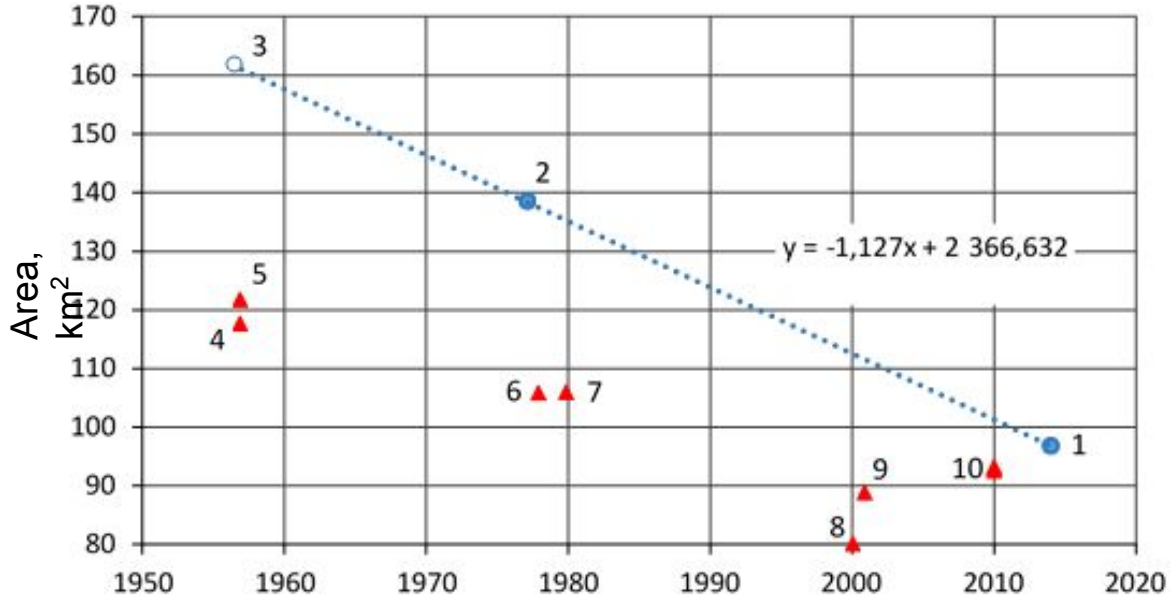



Correlation of the glaciers area data of our inventory (CARGC) and glaciers area data of inventory made in Kyrgyzstan (CAIAG)

Data on the area of glaciers in both inventories are almost identical. Unfortunately, both inventories characterize the condition of the Syrdaria glacial systems only for the one time period - 2013-2016. To assess changes of glaciers in the sub-basins of the rivers-tributaries of Syrdaria, we have created new catalogs of glaciers for 1-2 time periods.

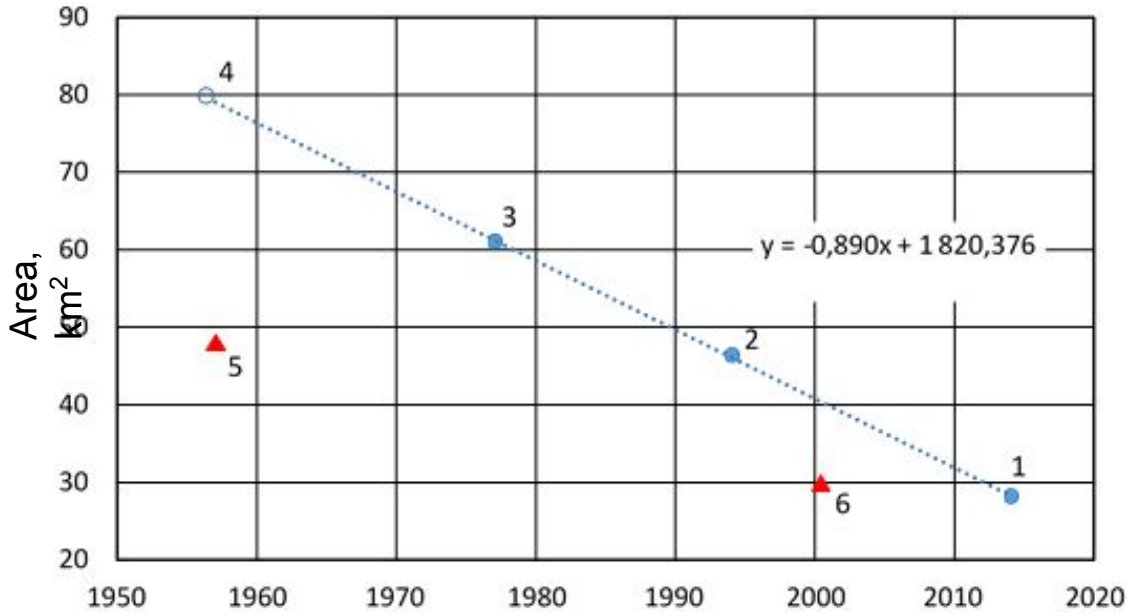
# Changes in the glacierized area in the Syrdaria River basin

Changes in the area of glaciers
of the Pskem River basin




1, 2, - our inventories; 3 - our calculated data;
4 - (Inventory, 1968); 5 - (Shchetinnikov, 1976);
6 - Karandayeva, 2013; 7 - (Shchetinnikov, 1997);
8 - (Randolph, 2015); 9 - (Karandayeva, 2013);
10 - (Semakova, 2015)

Changes in the area of glaciers
Chatkal River Basin




1, 2, 3 - our inventories from satellite images;
4 - our calculated data; 5 - (Inventory, 1970):
6 - (Randolph, 2015).

**Similar problems were found in the basins of the Naryn and Karadarya rivers, the rivers of the northern slopes of Turkestan and Alay ranges (Syrdaria basin), Seldara River basin (Pamir)**

# Problem solving

The above considered results are presented for the only purpose to attract attention to the problem. Deviations of the data from previously created glaciers inventories from real data are often so considerable that they exclude the possibility of using the results of previous glaciers inventories to assess the current and forecasted dynamics of glacier and water resources without correcting the results of the inventories.

It is clear that from among the known inventories it makes sense to correct the data of only the first glaciers inventory in order to be able to assess the inter-basin/inter-regional differences in the dynamics of glacial systems over the same by duration period.

The availability of data from one high-quality inventory provides a solution of the problem on the basis of a stable ratio of the glacierized area in an particular basin and glacierized area of the corresponding glacial system. This is the basis of the methodology for monitoring of mountain glacial systems (Severskiy, Shesterova 2011, Severskiy et al.. 2016).

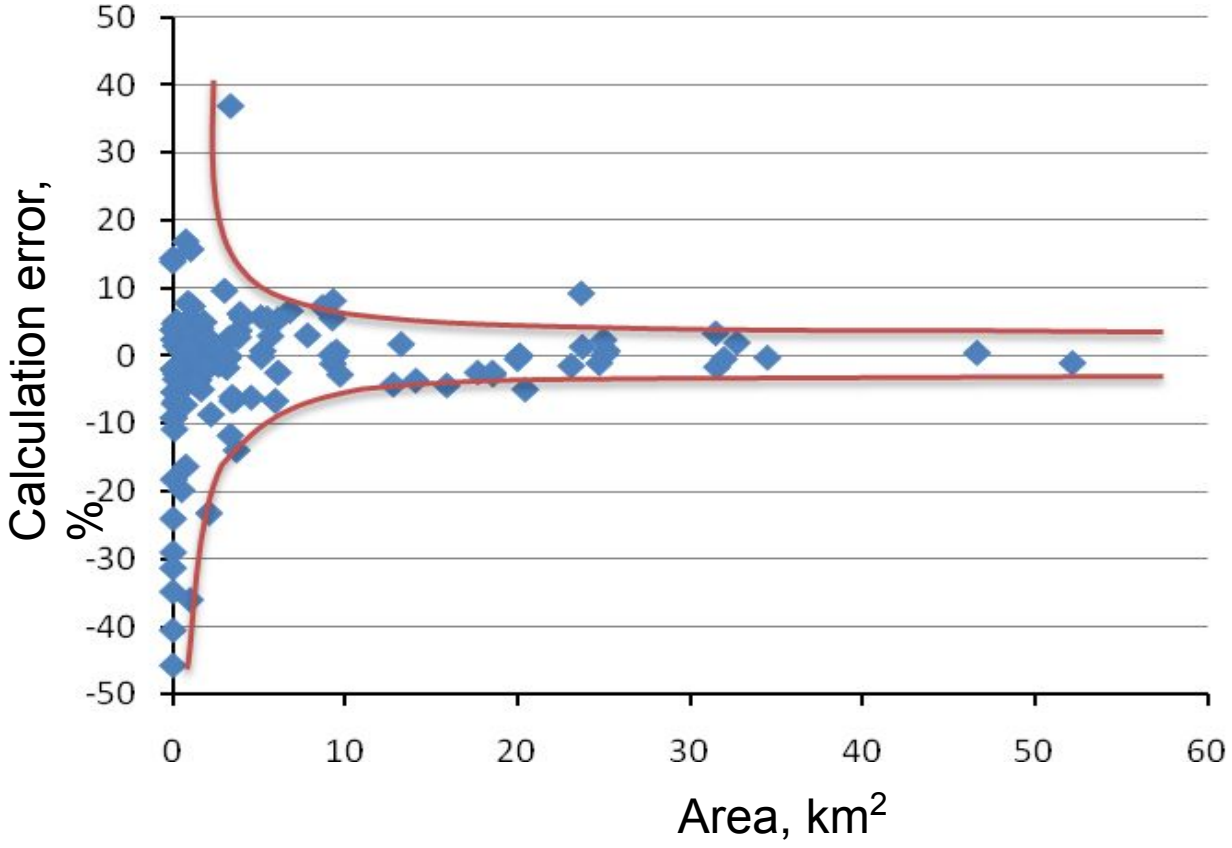
## Change in the share of the areas of glaciers of particular basins in the total glacierized area of the northern slope of Ile Alatau

| Year | Uzun-Kargaly | Shamalgan | Kaskelen | Aksai | Kargaly | U. Almaty | K. Almaty | Talgar | Esik | Turgen |
|---|---|---|---|---|---|---|---|---|---|---|
| 1955 | 4,5 | 0,9 | 4,7 | 4,7 | 1,4 | 11,8 | 3,2 | 39,2 | 17,2 | 12,4 |
| 1974 | 4,6 | 1,3 | 5,7 | 5,4 | 1,3 | 11,1 | 3,0 | 38,2 | 16,8 | 12,6 |
| 1990 | 4,7 | 0,9 | 4,7 | 5,0 | 1,3 | 10,3 | 3,2 | 39,4 | 17,6 | 12,7 |
| 2008 | 4,6 | 0,8 | 5,0 | 5,4 | 1,4 | 10,1 | 3,3 | 39,2 | 18,3 | 11,9 |

The ratios of the area of glaciers in an individual basin and glacierized area of the corresponding glacial system are stable over the time (Severskiy 2011, Severskiy et al., 2016).
This provide opportunity for operational monitoring of the glacial systems and research of the causes of inter-basin and inter-regional differences in their response to climate change.

# The error of calculation of glacierized area of the entire glacial system using glacierized area of an individual basin

**Used data for the Altai, Pamirs, Gissar-Alai and Tien-Shan (Ile and Jungarian Alatau)**

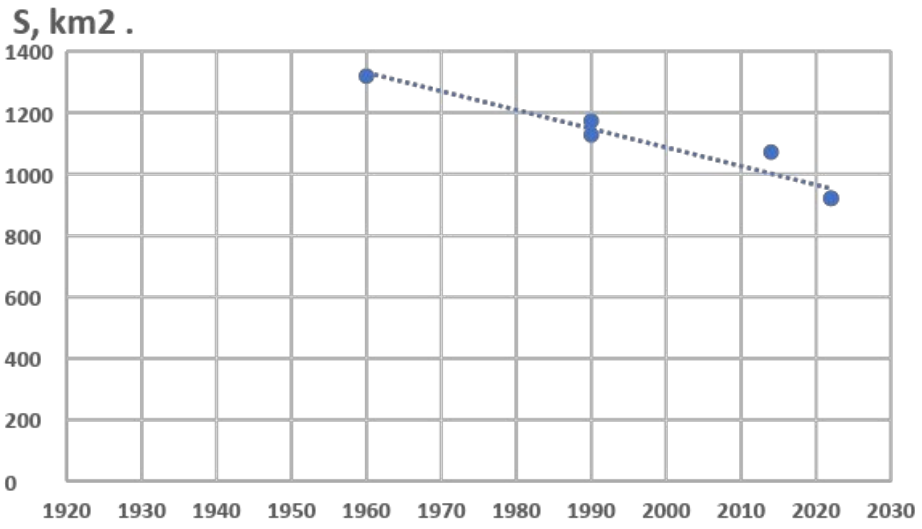



The error of calculating the total glacierized area of a corresponding glacial system does not exceed ±10% for the control basins with glacierized area of 5 $km^2$ and is less than ±5% for the control basins with glacierized area in excess of 10$km^2$.

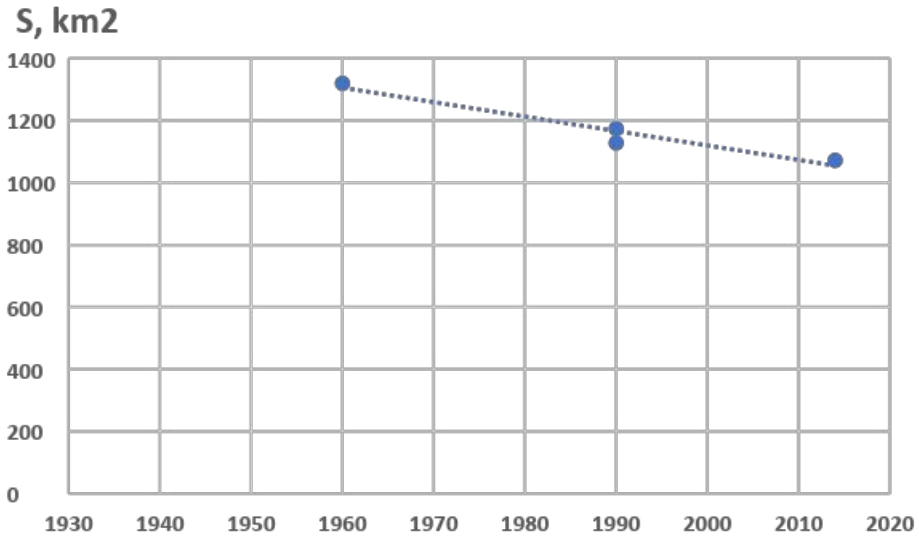
(Severskiy, Shesterova 2011, Severskiy et al., 2016)

# Changes in the glacierized area in the Naryn River basin

For the period from 1960 to 2022




For the period from 1960 to 2014




**The acceleration of the reducing of the glacier area after 2014 is likely**

# Conclusion

The well-studied glaciers of the Balkash-Alakol basin have been decreasing linearly over the past 60 years at an average rate of 0.73-0.75% per year in terms of area and about 1% per year in terms of ice volume. Glaciers of Ertis (Irtysh) River basin were declining linearly and, with rare exceptions, the same situation is observed in most  mountainous regions of High Asia.

The data on the glacierized area in the Syrdaria basin, provided in most of the previous inventories, are significantly (up to 30-40% or more) underestimated and cannot serve as a basis for assessing current and forecast changes in glacial and water resources without preliminary correction.

There is no need to correct the data of all previous glacier inventories. The spurious  data of the first glaciers inventory of the studied basin need to be corrected in order to assess inter-basin/inter-regional differences in the response of glacial systems to climate change over the same by duration period..

The stability of the relationship between the area of glaciers in an individual basin and the glacierized area of the corresponding glacial system is a good basis for correcting the spurious data in the previous inventories.

The results of our research confirm that the glaciers of Syrdaria basin have been decreasing linearly over the past 60 years.

# Thank you

unesco

Aga Khan Agency for Habitat

ICIMOD

CARGC

GLOFCA

ADAPTATION FUND