



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

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3rd November 2022      lyudmilaslebedeva@gmail.com

# Hydrological significance of rock glaciers in the Ozernaya river basin, northern Tien Shan region

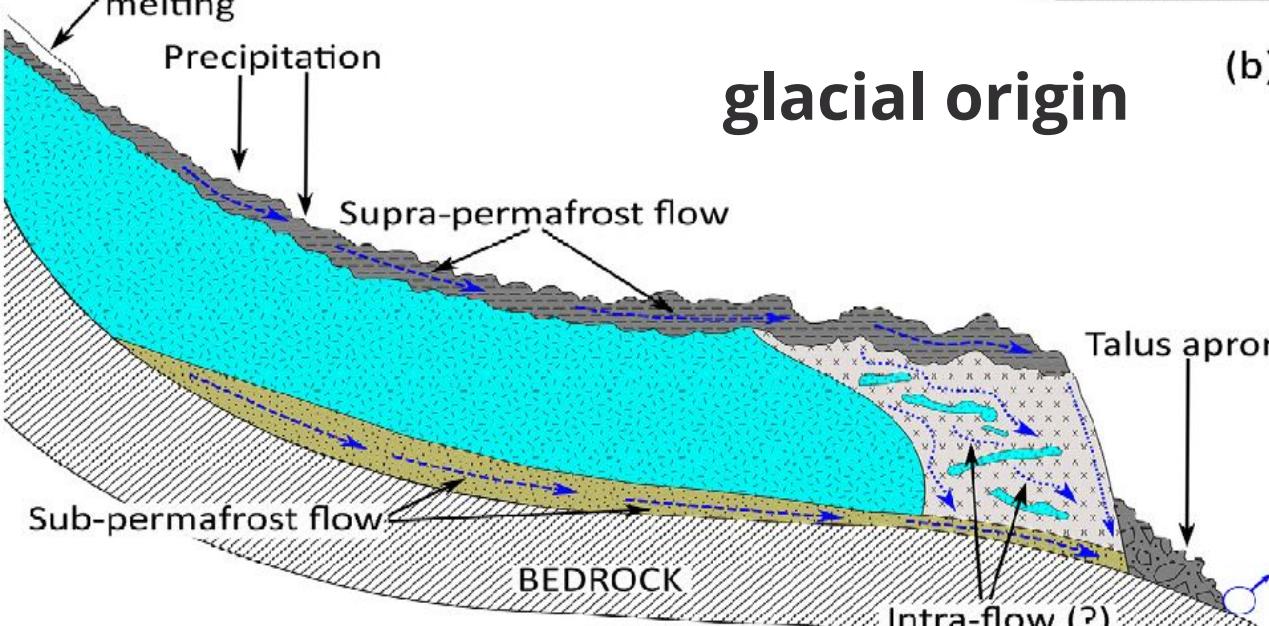
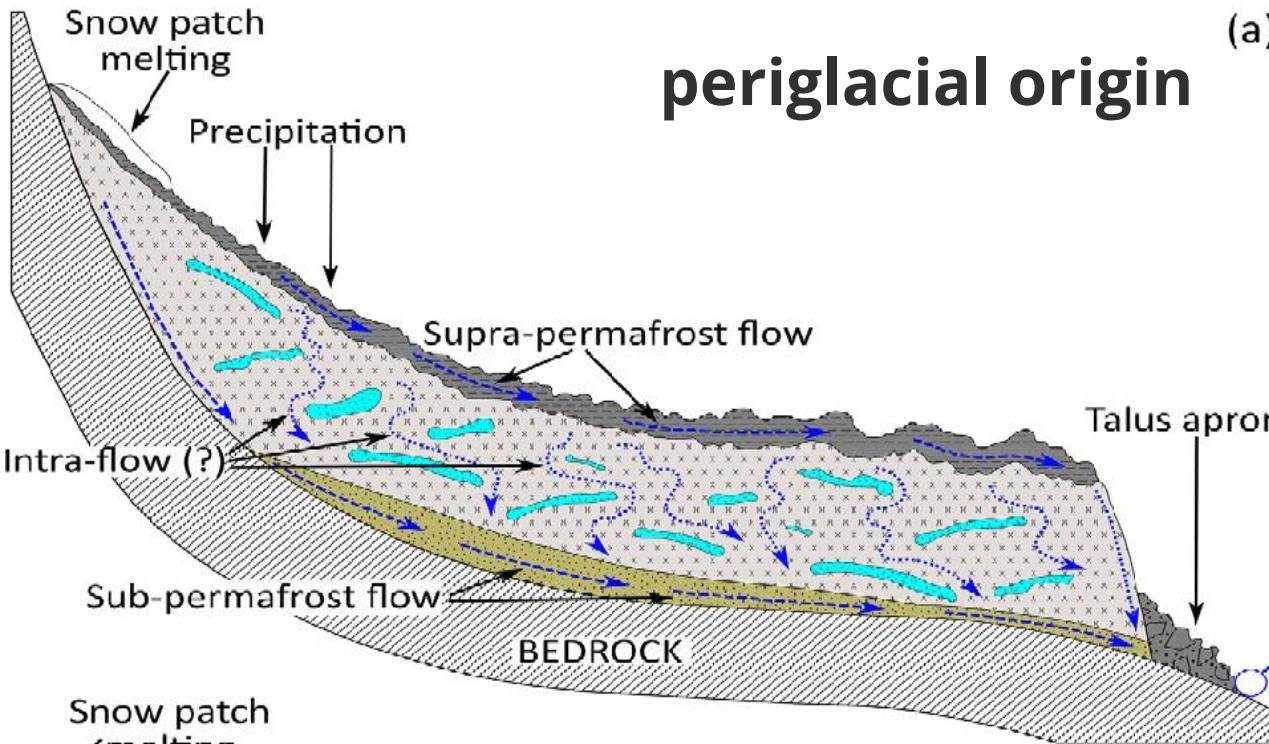


# The study aim Цель исследования



to study rock glacier streams in the Ozernaya river basin, northern Tien Shan, to evaluate potential hydrological significance of the three rock glaciers – Gorodetsky's, Morennny and Tourist

изучение ручьев с каменных глетчеров в бассейне р.Озерная, северный Тянь-Шань, для оценки гидрологической значимости трех каменных глетчеров

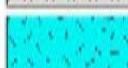


Jones, et al. 2019

# Runoff generation from the rock glacier

There are more than 73 000 rock glaciers in the world

There are over 1500 active rock glaciers in the Northern Tien Shan and the Djungar Ala Tau, Kazakhstan

-  Active layer (seasonally frozen)
-  Ice-rock mixture (perennially frozen)
-  Massive ice locally fractured / Ice lenses
-  Unfrozen till layer (subpermafrost aquifer)
-  Spring(s)

# Why rock glaciers are important for hydrology?

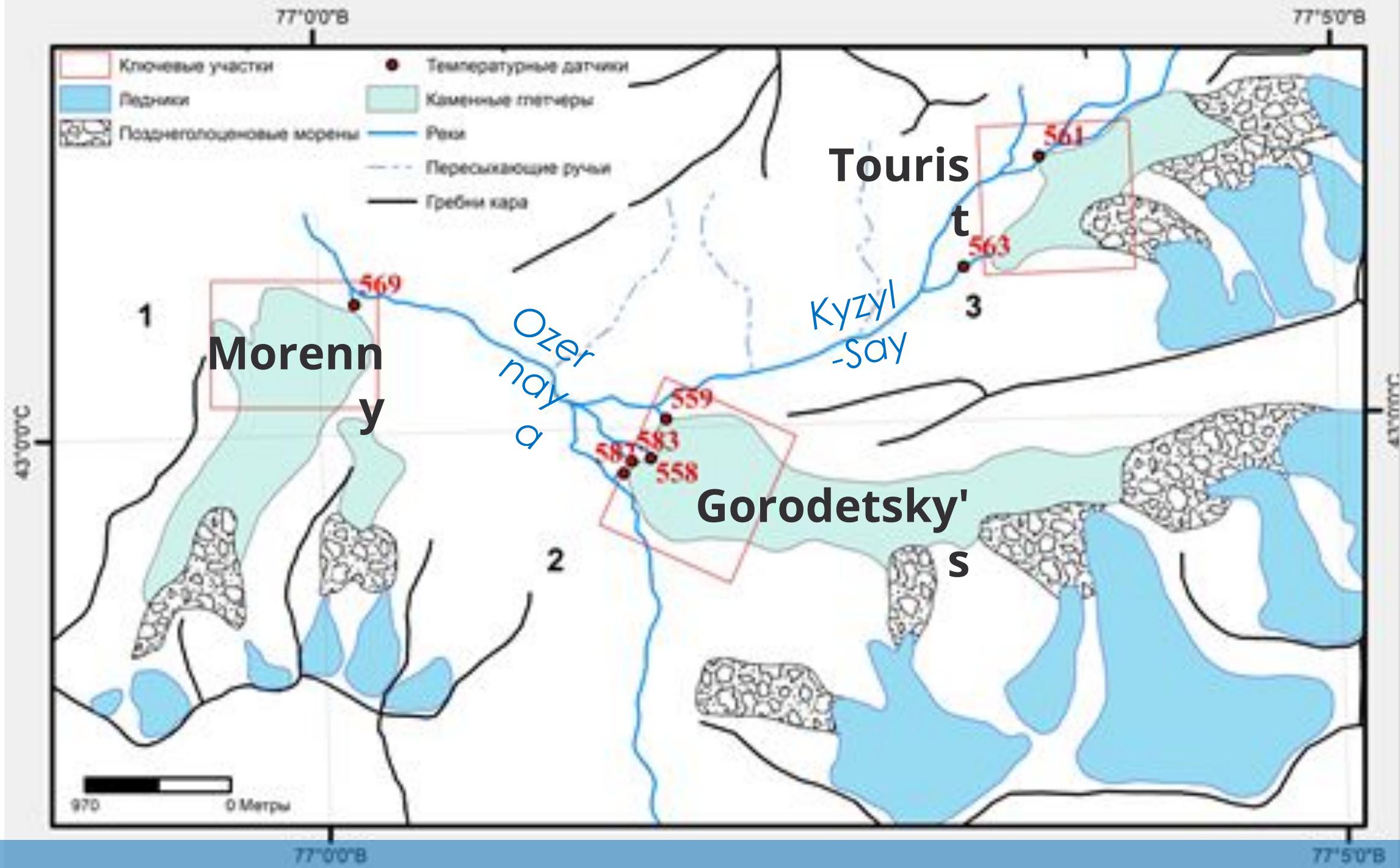
**water storage occurs as ice, snow and water at long-term, intermediate-term and short-term timescales**

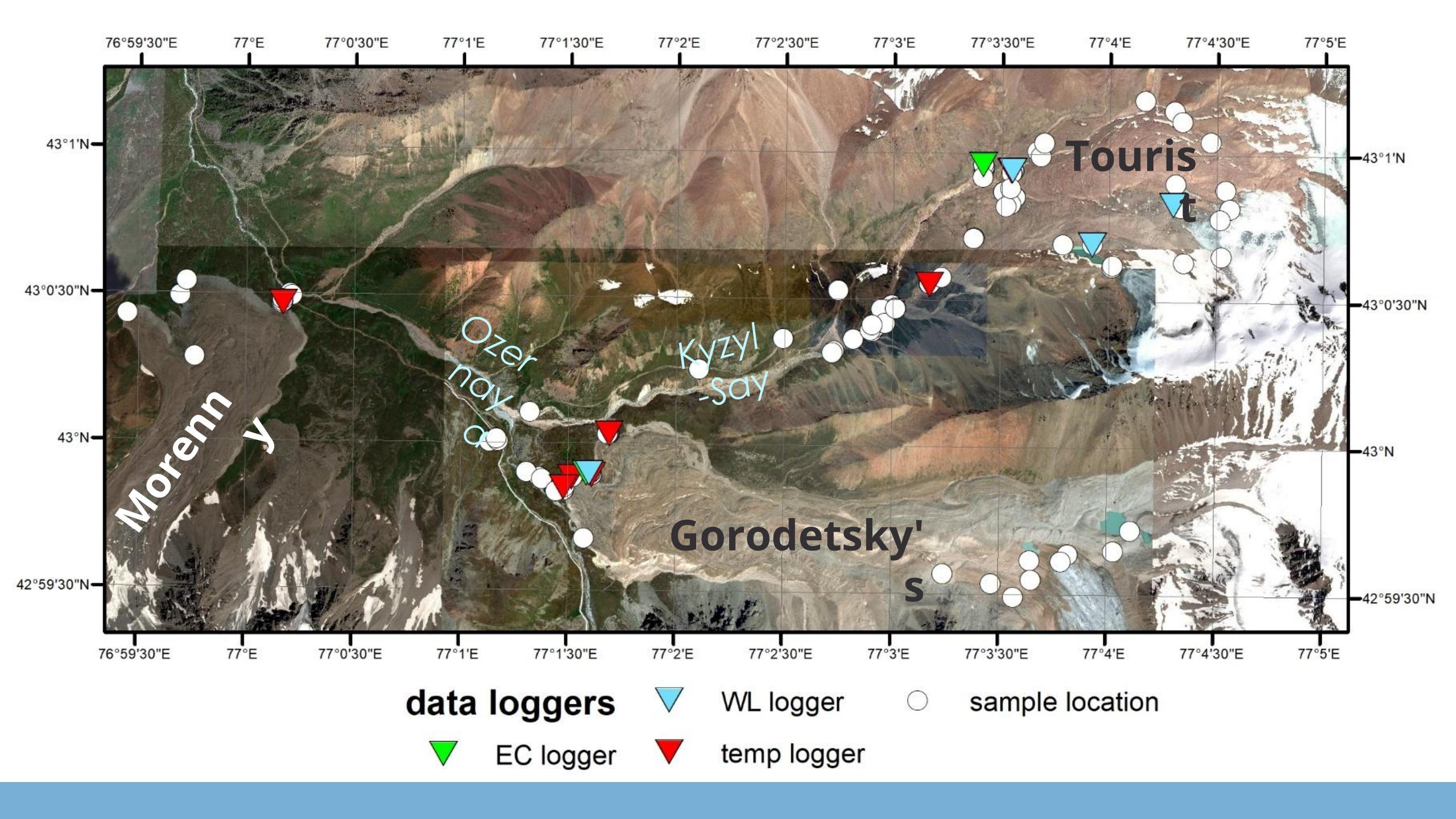
**climatically more resilient than glaciers**

**May exist even under positive mean annual air temperature**

**Modify chemical composition of streams**

*Jones et al, 2019*





# Field work in 2019

Installation of water temperature and level loggers

Intermittent water sampling for chemical and isotopic analysis

# Field work in 2020-2021

Automated measurements of water EC, temperature and level

Water discharge measurements

Water sampling for chemical and isotopic analysis



# Three rock glaciers and rock glacier (RG) creeks under the study



Moreny

а) каменный глетчер Моренный



Gorodetskoy's

б) каменный глетчер Городецкого



Tourist

563



# Discharge measurements

Morennny RG creek – 1.7-2.1 l/s

Gorodetskogo RG creek1 – 360-440 l/s

Gorodetskogo RG creek2 – 513-586 l/s

Glacier creek – 4-46 l/s

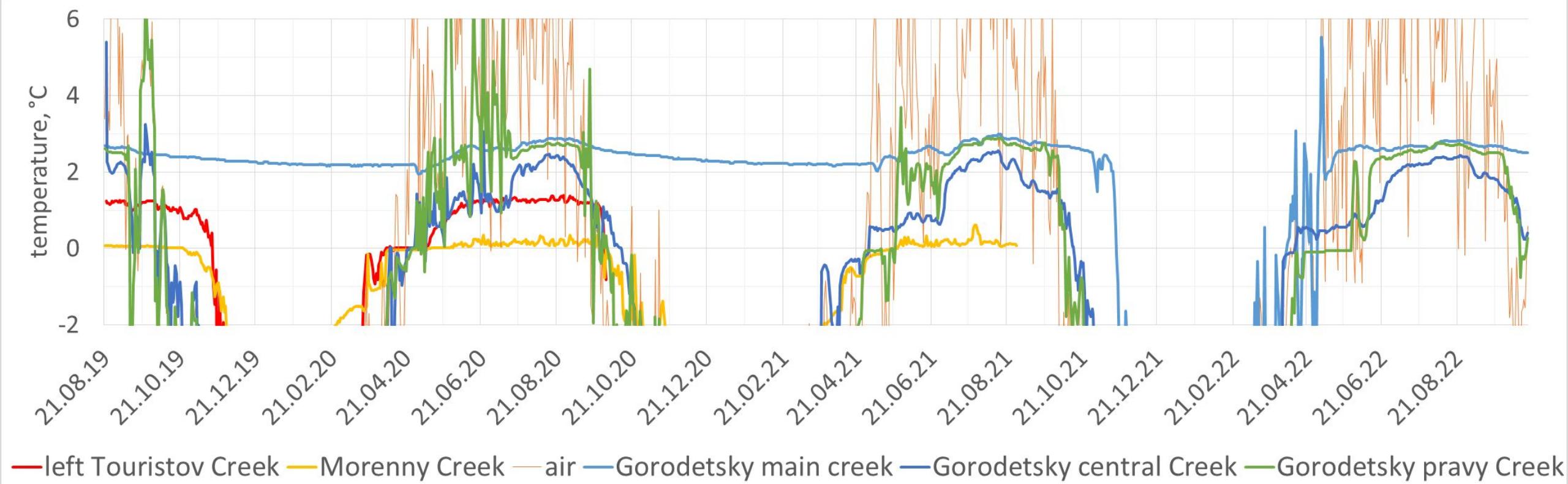


# Temperature of rock glacier creeks

Flow in spring starts earlier than air temperature exceeds 0°C

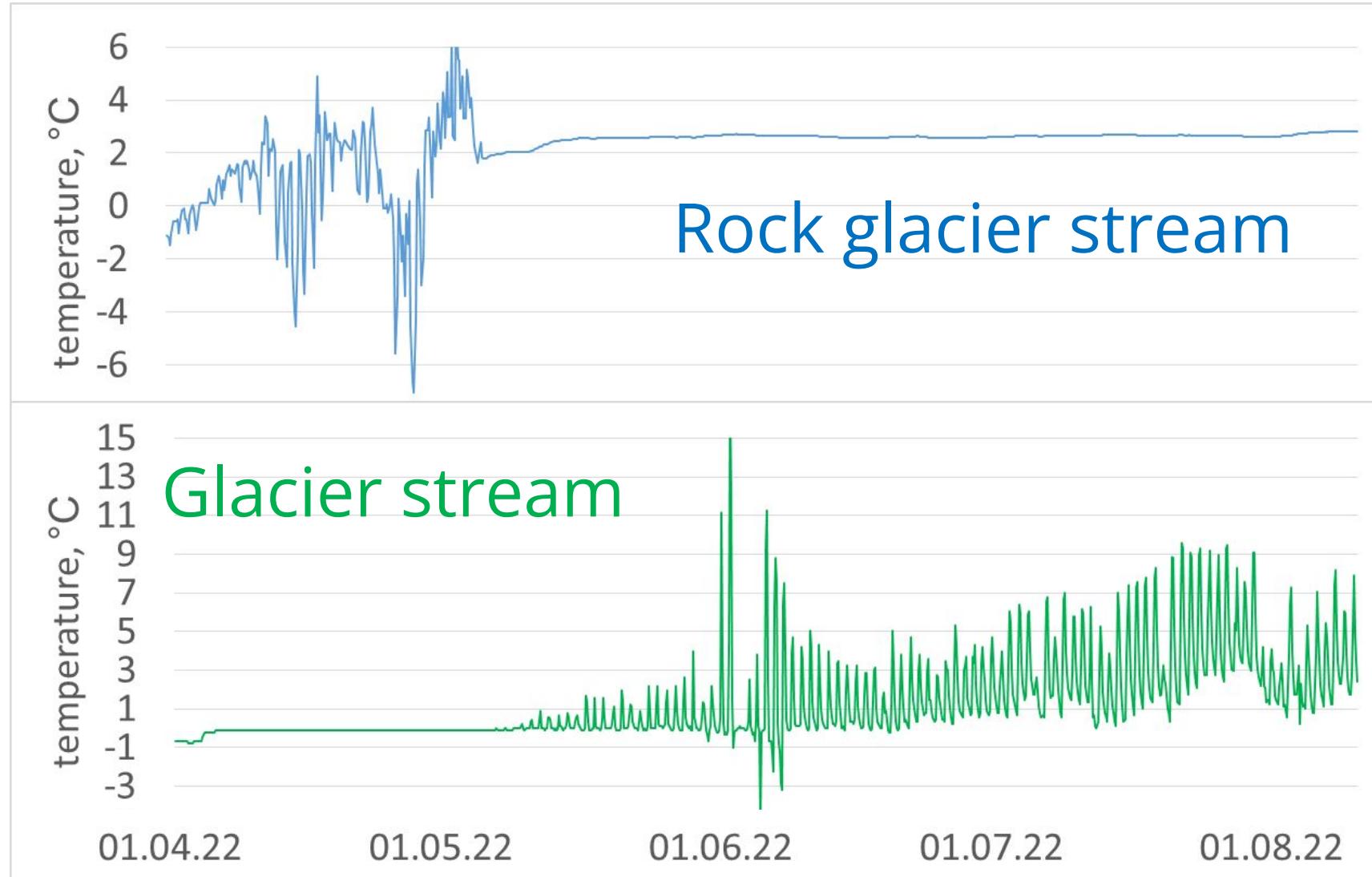
Morenny RG Creek is the coldest with 0°C that suggests that Morenny rock glacier contains ice

Gorodetsky RG Creeks are warm with temperature 2°C



# Temperature of glacier and rock glacier creeks

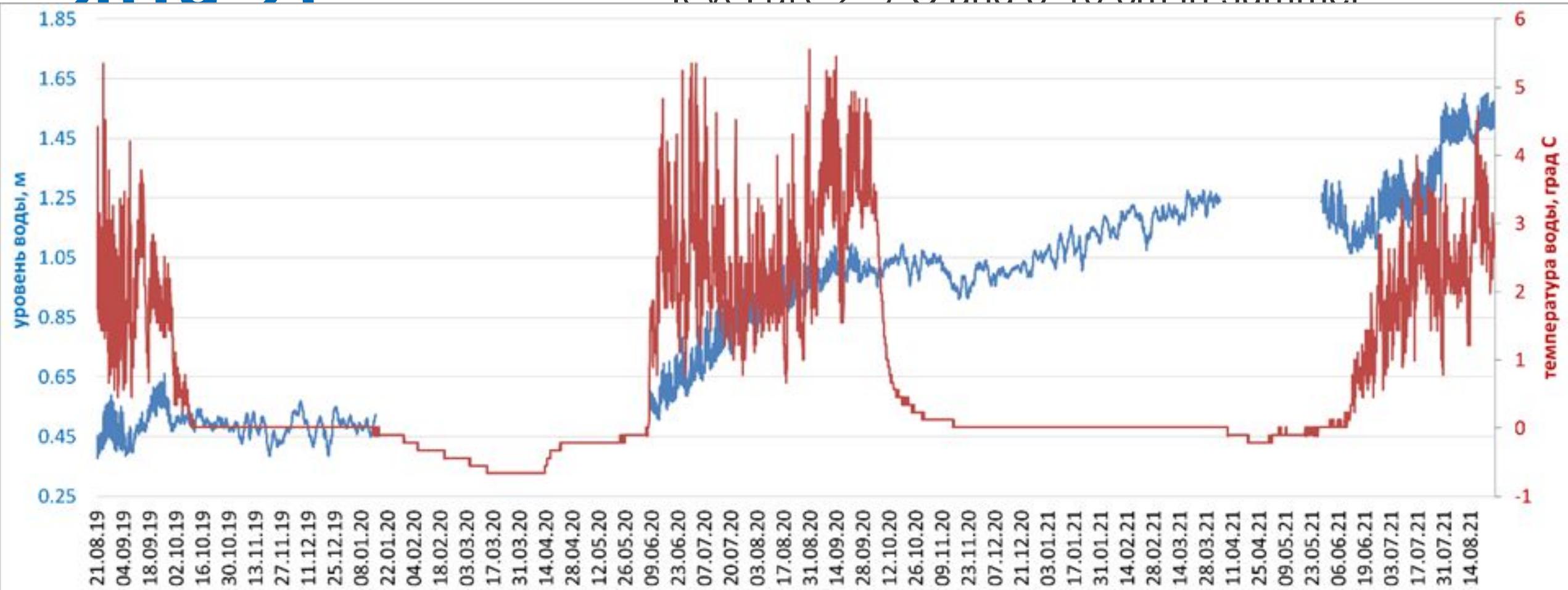
Rock glacier streams are stable in terms of water temperature without any intraday fluctuations, while glacier streams have pronounced diurnal cycles



# Lake temperature and level 2019-21

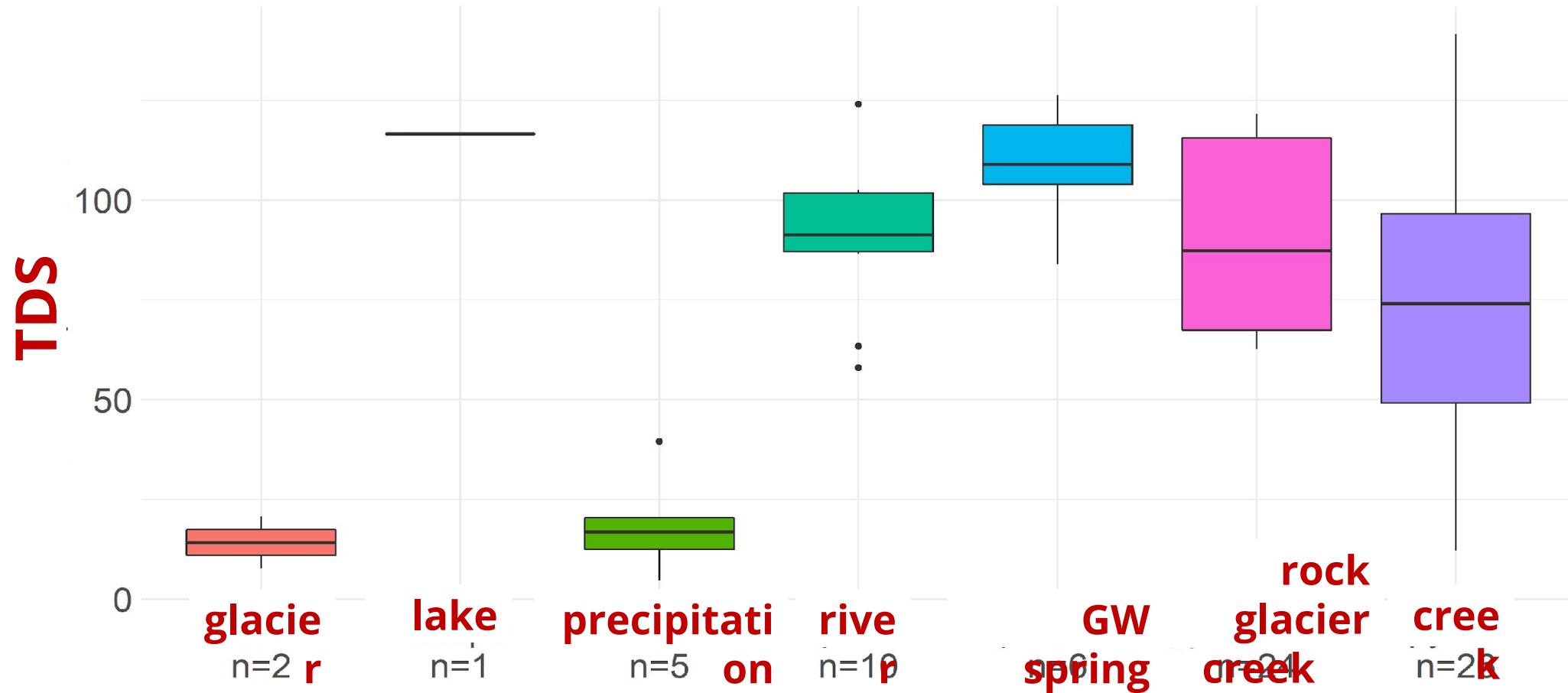
Water level has been increasing by 1.5 m in 2 years

Diurnal variations of water temperature and level are 2-5°C and 5-10 cm in summer



# TDS of 74 water samples

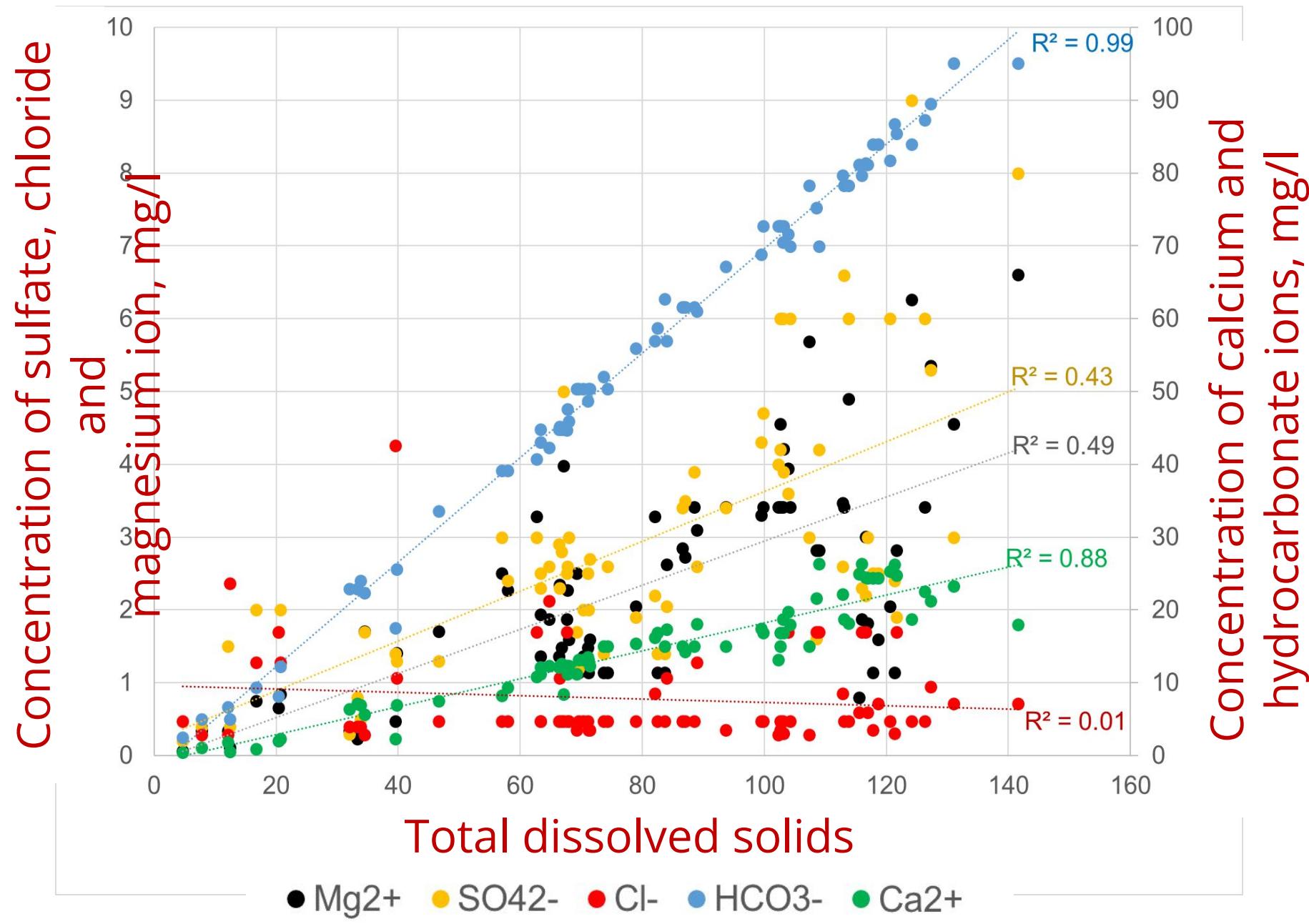
TDS is from 5 to 140 mg/l



# Relationships between TDS and major ion concentrations

All samples are calcium-bicarbonate type of water

Only some samples of precipitation are sodium bicarbonate type

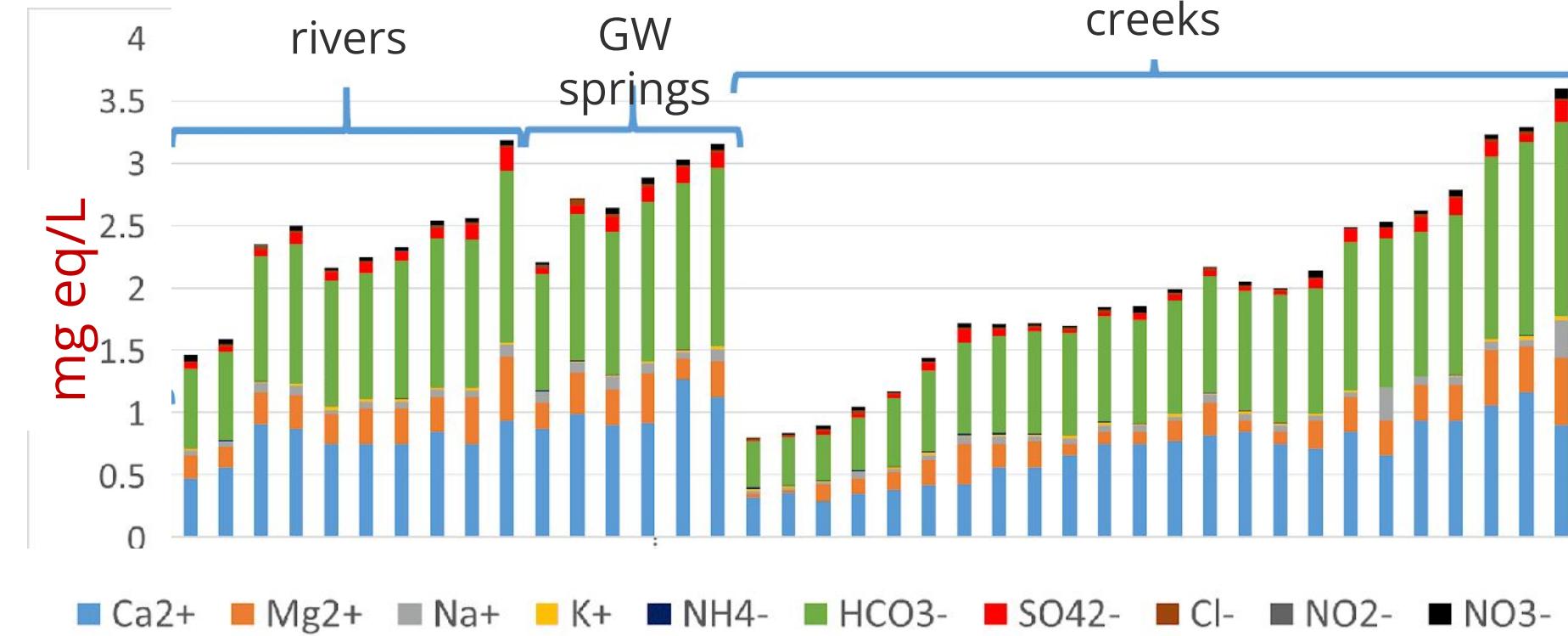
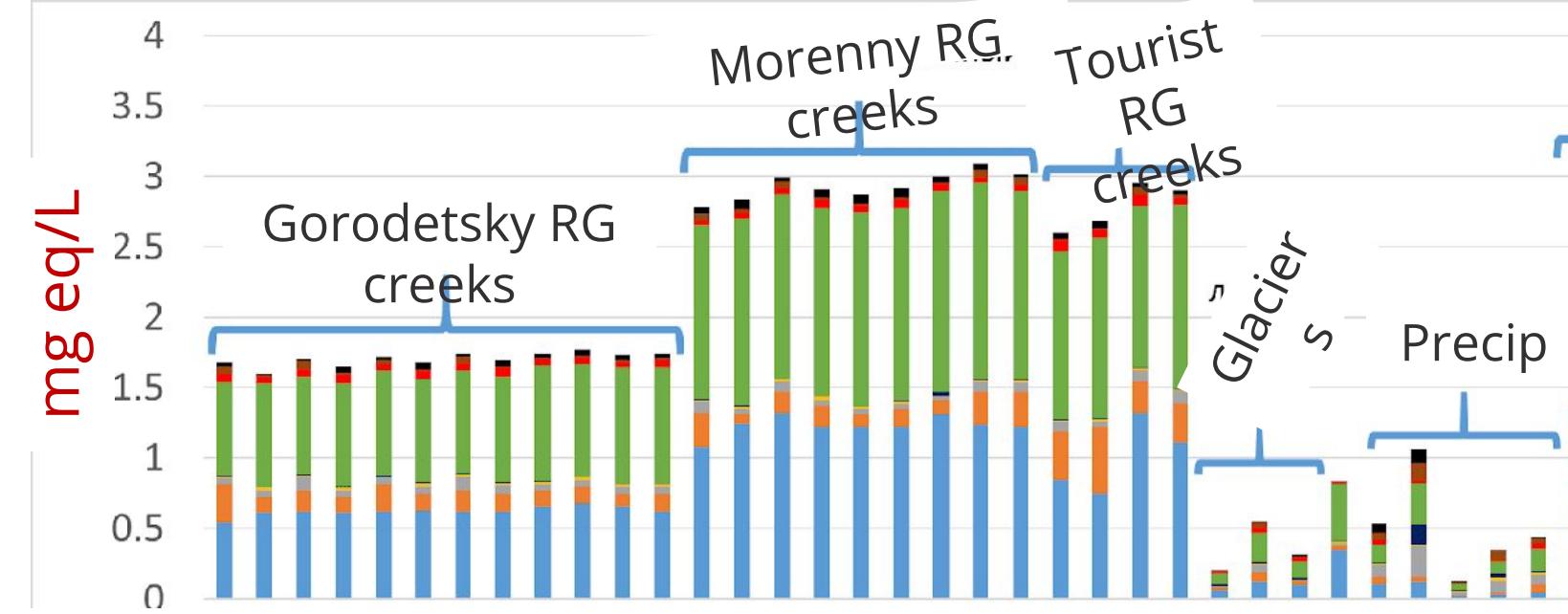


# Major ion concentrations

Precipitation have low fraction of calcium and bicarbonates and high fraction of sodium and chlorides

In **glacier melt waters** calcium, magnesium, bicarbonates and sulfates dominate

Fraction of magnesium is relatively low in **Morenny RG creeks** and high in **Touristov RG creeks**



# Specific hydrochemistry of rock glacier creeks

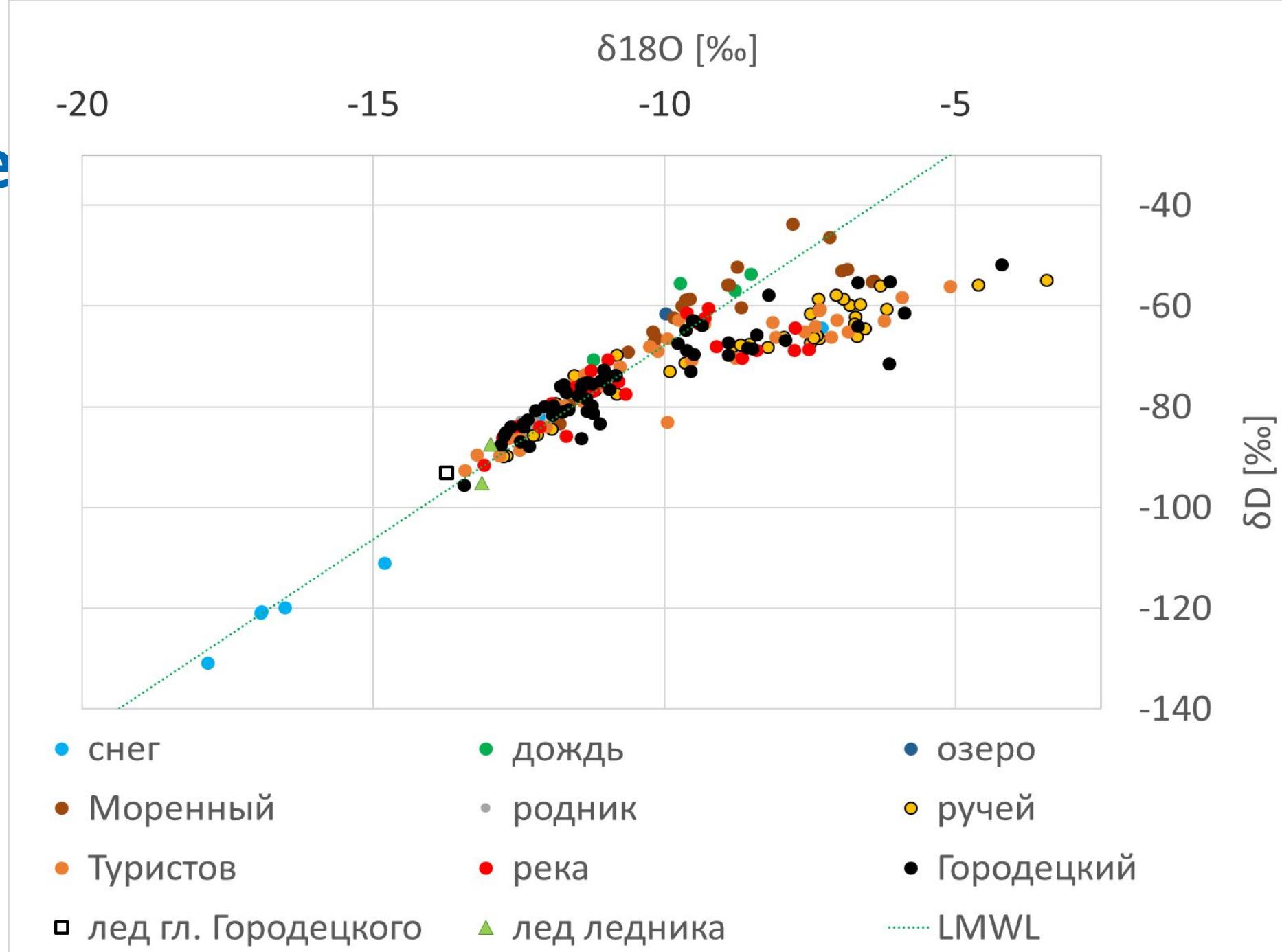
TDS of Gorodetsky RG creeks is 63-71 mg/l, Morennny creeks – 108-122 mg/l and Touristov creeks – 103-122 mg/l

**Fraction of magnesium ions** is relatively low in Morennny RG creeks (5-16%), high in Touristov RG creeks (14-37%) and have intermediate values in Gorodetsky RG creeks

**Fraction of sulfate ions** in Gorodetsky RG creeks is higher (5-8%) than in Morennny RG creeks (2-4%)

It suggests either different water sources of creeks or different chemical composition of rocks and different time of interaction between water and rock

# Water stable isotopes



# Conclusions

Gorodetsky's rock glacier should be classified as dead, while Morenny and Tourist rock glaciers have internal ice.

Rock glacier streams are stable in terms of water level, temperature and electrical conductivity without any intraday fluctuations, while glacier streams have pronounced diurnal cycles of water quantity and quality.

The streams of the three studied rock glaciers differ in TDS, temperature, and dominant major ions due to different lithology, rock glacier structure and varying time of water-rock interaction.

The dynamics of the water isotopic composition suggests that lakes could contribute to the streams in the second half of the warm season.



# Thank you

Special thanks to  
colleagues from Institute  
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Republic of Kazakhstan  
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Regional Glaciological  
Centre for support and  
assistance in field trips  
and water chemical  
analysis



Aga Khan Agency for Habitat

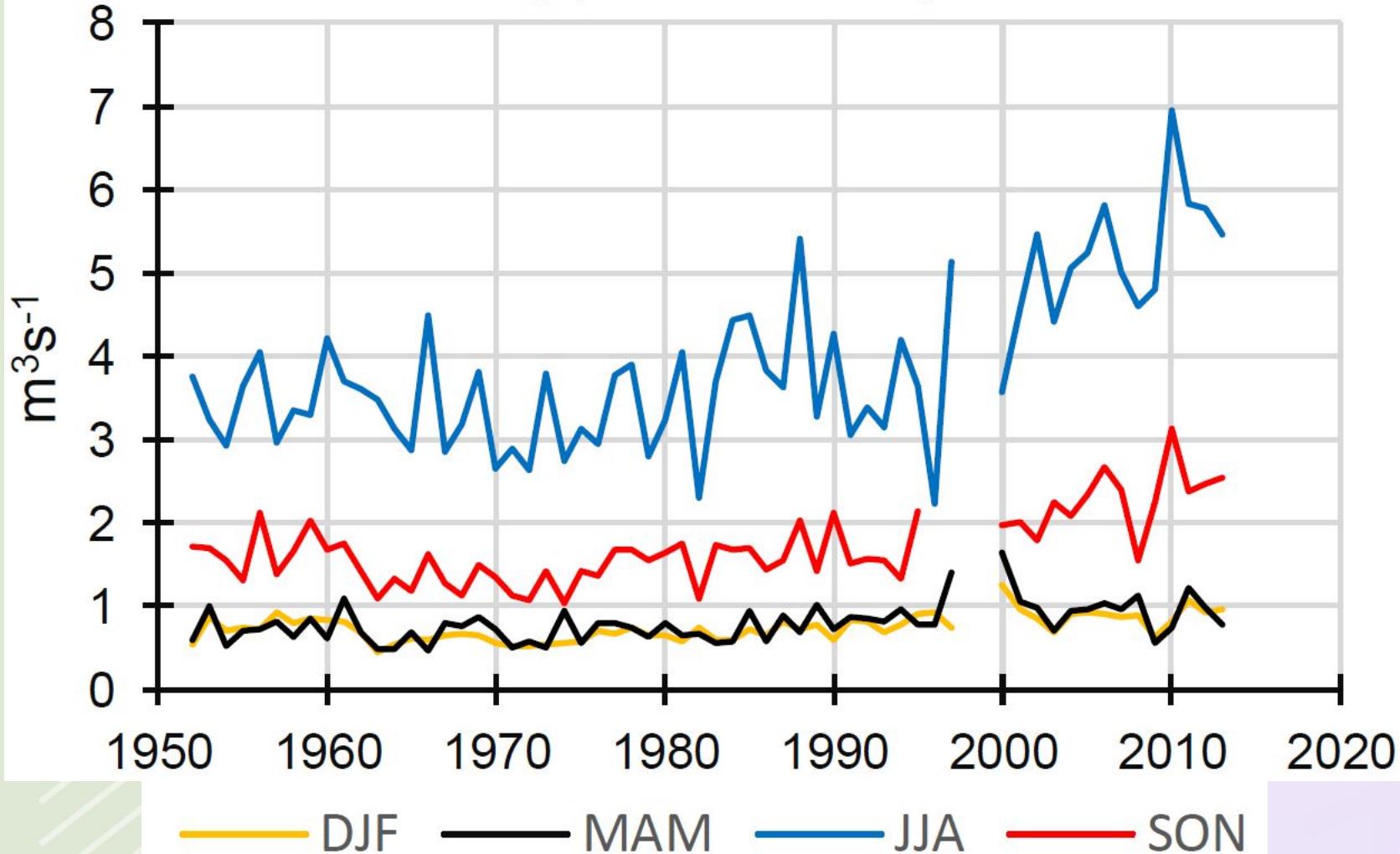


ICIMOD



ADAPTATION FUND

### (c) Ulken Almaty



# Thank you

Shahgedanova et al -  
2018



# Section Break

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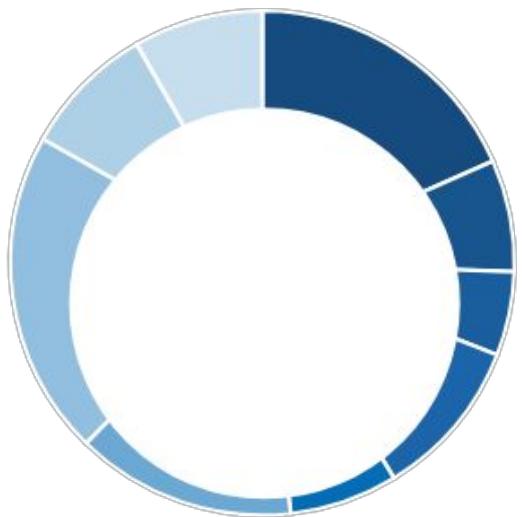
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# Presenting graphs and tables

FIGURE 3.5 CHART TITLE



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- mno
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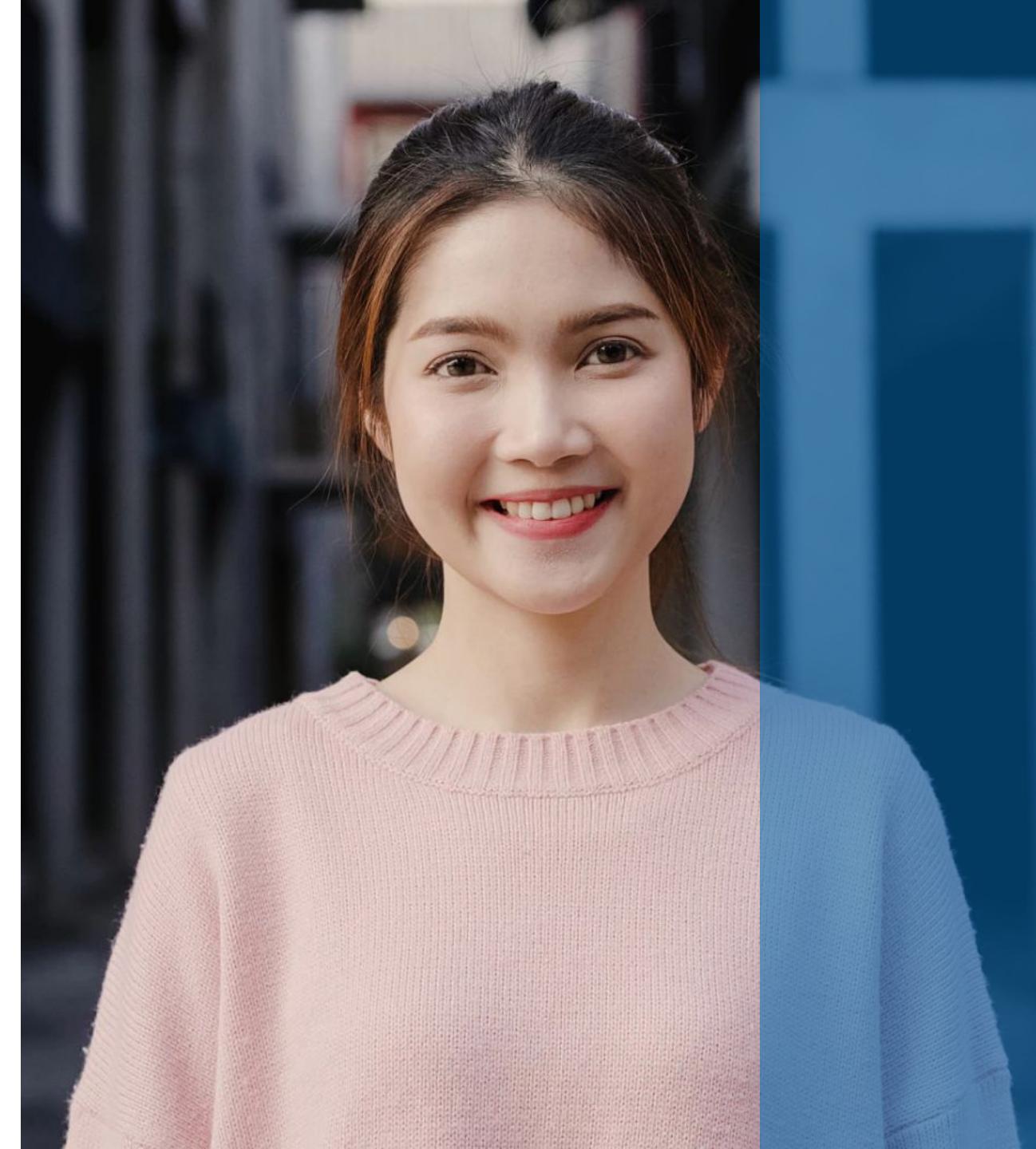
| District     | Geogs selected | Households in the district | Percentage interviewed (%) |
|--------------|----------------|----------------------------|----------------------------|
| Chuka        | Darla          | 769                        | 3.3                        |
| Dagana       | Tshendegang    | 361                        | 2.1                        |
| Samtse       | Dorokha        | 645                        | 12.6                       |
| Sarpang      | Chuzom         | 972                        | 5.4                        |
| Tsirang      | Patshaling     | 607                        | 3.1                        |
| Bumthang     | Chumi          | 53                         | 37.7                       |
| <b>Total</b> | -              | <b>3,194</b>               | <b>4.9</b>                 |

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**This slide has a variation as shown in the next**



# Title not more than two lines

Use this slide for presenting photos in landscape and text along with it

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