



Monitoring of glacier recession in Wakhan National Park in 2019

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Shkhawr Payan Glacier in the Hindu Kush Mountain Range, Wakhan National Park, 6 October 2019, @Amruddin Sanjer, WCS Afghanistan.

Abstract

In the Hindu Kush Mountain Range of Wakhan WCS team re-visited five and two glaciers first visited in 2016 and 2018, respectively. In Big Pamir Mountain Range the team re-visited two glaciers first visited in 2017 and 2018, respectively. The ground terminus positions of these glaciers were geo-referenced and the extent of their recession since September - October 2018 measured with a tape meter. The glaciers ($n=8$) receded by an average of 6.4 m compared to 2018. Glacial lakes were found in *Ezik* (4) and *Keshnikhan* (2) valleys. Two of the four lakes in *Ezik* and the two lakes in *Keshnikhan* were already present in 2018. In *Keshnikhan* the lakes remained relatively small sizes, whereas those in *Ezik* increased in size as compared to 2018. Also two new lakes were recorded in *Ezik*, including one that exceeds in size the three others. The presence of new glacial lakes and general increase in retained waters in upper reaches of *Ezik* Valley may pose a risk of outburst floods in the future and call for preventive actions to be undertaken in *Ezik*, *Ptukh*, and *Neshtkhawar* villages.

Introduction

Evidence suggests an acceleration of glacier recession and mass loss in several key mountain regions of Central Asia (Khromova *et al.* 2006). The Wakhan district located in the northeast of Badakhshan Province in Afghanistan, also a national park since 2014, is the meeting point for three of the highest mountain ranges in Asia; the Hindu Kush, Pamir and Karakoram. Using a remote sensing methodology Haritashya *et al.* (2009) have found that in Wakhan 28 glacier-terminus positions out of 30 sampled glaciers had retreated between 1976-2003, and the largest average retreat was 36 m year⁻¹. The present report documents a follow-up survey to the previous surveys carried out in August and September - October 2017, and 2018 (Sanjer 2017, Sanjer and Ostrowski 2018) and documentq on the ground the retreat of a sample of glaciers in the Big Pamir and Hindu Kush mountain ranges of Wakhan National Park (WNP).

Methodology

The survey team was composed of Amruddin Sanjer (AS), Natural Resource Management assistant with the WCS project in WNP, and two community-rangers, Bakhsha (B) from *Kret* village, and Shukrallah (S) from *Keshnikhan* village.

On August 26th-4th September 2019, AS and B visited the two glaciers surveyed in the Big Pamir in 2018, then in late September and in early October 2019 AS and S visited the seven glaciers in the Hindu Kush that were measured in 2018 (Fig. 1).



Figure 1. Amruddin Sanjer, WCS, at the terminus point of *Sarkand* Glacier (here made of ‘black ice’), Hindu Kush Mountain Range, Wakhan District, Badakhshan Province, Afghanistan, 8 October 2019, @Shukrallah, WCS Afghanistan.

The positions of termini of all these glaciers were recorded with GPS (Garmin 60Sx, precision = $\pm 3-7$ m) as well as distances from the terminus point to the sides of the glaciers with the help of a laser telemeter (± 1 m). Well visible and seemingly permanent rocks located at the terminus point were then marked with “2019” in white or blue paint as a reference point for subsequent monitoring. The distances from the 2019 terminus point to the 2018 equivalent (identified by a painted rock marked “2018”) were measured with a tape meter.

In addition, in the visited area of Big Pamir and Hindu Kush the team recorded the presence of glacial lakes and evaluated their changes in size based on photographs taken in 2018. GPS positions of six lakes were recorded. Glacial lakes and termini points of glaciers were documented with photographs¹.

¹ Photographic documentation was incomplete in *Keshnikhan* Valley because of cold weather and defective camera batteries.

Results

Glaciers monitored since 2016 in the Hindu Kush

During the last year:

- *Sarkand* Glacier retreated by 16 m (52.4 m in 2016-2018);
- *Kandkhan* Glacier retreated by 7.5 m (9.6 m in 2016-2018);
- *Kharich* Glacier retreated by 6 m (23.0 m in 2016-2018);
- *Keshnikhan* Glacier retreated by 5.1 m (21.9 m in 2016-2018);
- *Shkhawr Payan* Glacier retreated by 11.5 m (34 m in 2016-2018) (Fig. 2).

Glaciers monitored since 2018 in the Hindu Kush

During the last year:

- *Takan* Glacier retreated by 3.5 m;
- *Kret* Glacier retreat by 4 m.

Glaciers monitored since 2017 in Big Pamir

During the last year:

- *Doshakh* Glacier retreated by 5 m (Fig. 3).

Glaciers monitored since 2018 in Big Pamir

During the last year:

- *Rastdara* Glacier retreated by 9 m.

See also Appendix 1.



Figure 2. Detail of the melting front of *Shkhawr Payan* Glacier, Hindu Kush Mountain Range, Wakhan District, 6 October 2019, @Amruddin Sanjer, WCS Afghanistan.



Figure 3. Measurement with a tape-meter of the annual recession of *Doshaq* Glacier, *Ezik* Valley, Big Pamir Mountain Range, Wakhan District, 27 August 2019, @Amruddin Sanjer, WCS Afghanistan.



Figure 4. Photograph of a new small glacial lake (‘*Ezik 3*’) beneath *Rastdara* Glacier (4,537 m asl), *Ezik* Valley, Big Pamir Mountain Range, Wakhan District, Badakhshan Province, Afghanistan, 27 August 2019, @Amruddin Sanjer, WCS Afghanistan.

Glacial lakes

WCS team recorded four glacial lakes in the upper reaches of *Ezik* Valley in Big Pamir, and another two in *Keshnikhan* Valley (Appendix 2). Two of the four lakes in *Ezik* had already been recorded in 2018 (noticeably one was not photographed as very small) as well as the two lakes in *Keshnikhan* Valley. In this latter valley one of the lakes was recorded and mapped in 1970 (see Shroder and Bishop 2007) and was found to be almost dry with frozen under soil and remaining surrounding blocks of ice. AS visited this lake in July 2008 and reported that there was still standing water. The second lake in this valley was small, seemingly smaller in size than in 2018.

In *Ezik* Valley the two lakes reported in 2018 increased in surface and volume. Also two new lakes were discovered (Figs. 4&5). One of them, born from *Rastdara* Glacier, exceeded in extent any of the three others. Its perimeter was estimated at 400 m - 500 m (6 min walk) (Fig. 5).



Figure 5. Downhill photograph of a new, large ($>1,500 \text{ m}^2$), glacial lake (4,522 m asl) identified as ‘*Ezik 4*’ (see Appendix 2) beneath *Rastdara* Glacier, *Ezik* Valley, Big Pamir Mountain Range, Wakhan District, Badakhshan Province, Afghanistan, 27 August 2019, @Amruddin Sanjer, WCS Afghanistan.

Discussions and conclusions

As anticipated from observations made in 2017 and 2018 the monitoring of a sample of glaciers in Wakhan confirmed a very dynamic situation characterized by ice melting, the continuous and significant recession of glaciers compared to 2016, 2017 and 2018 and the existence of unmapped glacial lakes. The terminus position of the glacier in *Sarkand* Valley was difficult to assess accurately because it appeared to be covered in debris and was based on an average between clean ice, debris-covered ice, and ice-free or ice-cored moraines. Consequently the relatively large retreat (i.e. 16 m) ‘measured’ between 2018 and 2019 for this glacier has to be considered with caution (Fig. 6). On the contrary the terminus positions of the eight other glaciers (6 in Hindu Kush and 2 in Big Pamir) were straightforward to determine, as they were made of clean ice and a well-demarcated ice front. The average retreat of these eight glaciers between September-October 2018 and



Figure 6. Measuring glacier terminus position is sometimes difficult when covered in debris, such as for *Sarkand* Glacier, Hindu Kush Mountain Range, Wakhan District, Badakhshan Province, Afghanistan, 8 October 2019, @Amruddin Sanjer, WCS Afghanistan.

September-October 2019 was 6.4 m. The level of retreat after one year of monitoring is comparable to the average of 7.5 m recession measured between 2017 and 2016, 9 m recession between 2016 and 2017, and to the average of 5.5 m/year between 1976 – 2003 estimated by remote sensing (Haritashya *et al.*, 2009). Further monitoring of the selected glaciers is granted.

The present mission confirmed (as in 2018) that no visible glacier remains within 250 m of the terminus position in 2003 of the three glaciers AF5X14231001, AF5X14231002 and AF5X14231003 (Fig. 8) in Big Pamir (Haritashya *et al.*, 2009), although some underground ice cores may still be present locally (Fig. 7). This observation supports that the recession rate exceeded an average of 15 m year⁻¹ for the last 15 years. In support of this hypothesis is the fact that AF5X14231002 and AF5X14231003 had among the highest retreat rates of all studied glaciers by Haritashya *et al.* (2009), respectively at 23.7 m year⁻¹ and 34.6 m year⁻¹



Figure 7. Ice-cored moraines mixed with underground ice (outlined in yellow) remaining from the receded part of a glacier in upper reaches of Ezik Valley, Big Pamir Mountain Range, Wakhan District, Badakhshan Province, Afghanistan, 27 August 2019, @Amruddin Sanjer, WCS Afghanistan.

over the period 1976-2003. Some isolated very large blocks of ice still remain in the area (i.e. *Rastdara*), or underground patches of ices covered with moraines.

The *Keshnikhan* Glacier, at the western end of the Wakhan corridor has been extensively studied in the past (see Shroder and Bishop 2007) and has a similar configuration to the majority of glaciers in Afghanistan. The terminus occurred at about 4,400 m in 1970 (Shroder and Bishop 2007), during the present survey the terminus point (i.e. *Takan*) was measured at 4,495 m, almost 100 m higher in altitude nearly 50 years later (Fig. 9), confirming its recession.

The presence of new glacial lakes is also remarkable and confirms the melting process affecting the glaciers of the Hindu Kush and Big Pamir mountain ranges of Wakhan. The lake observed in *Keshnikhan* Valley was of small size (ca. 40-50 square m), possibly even smaller in size compared to 2018, but deep (not crossable on foot). The four lakes recorded in *Ezik* Valley were much larger in size, the largest one (*'Ezik 4'*) was newly formed and

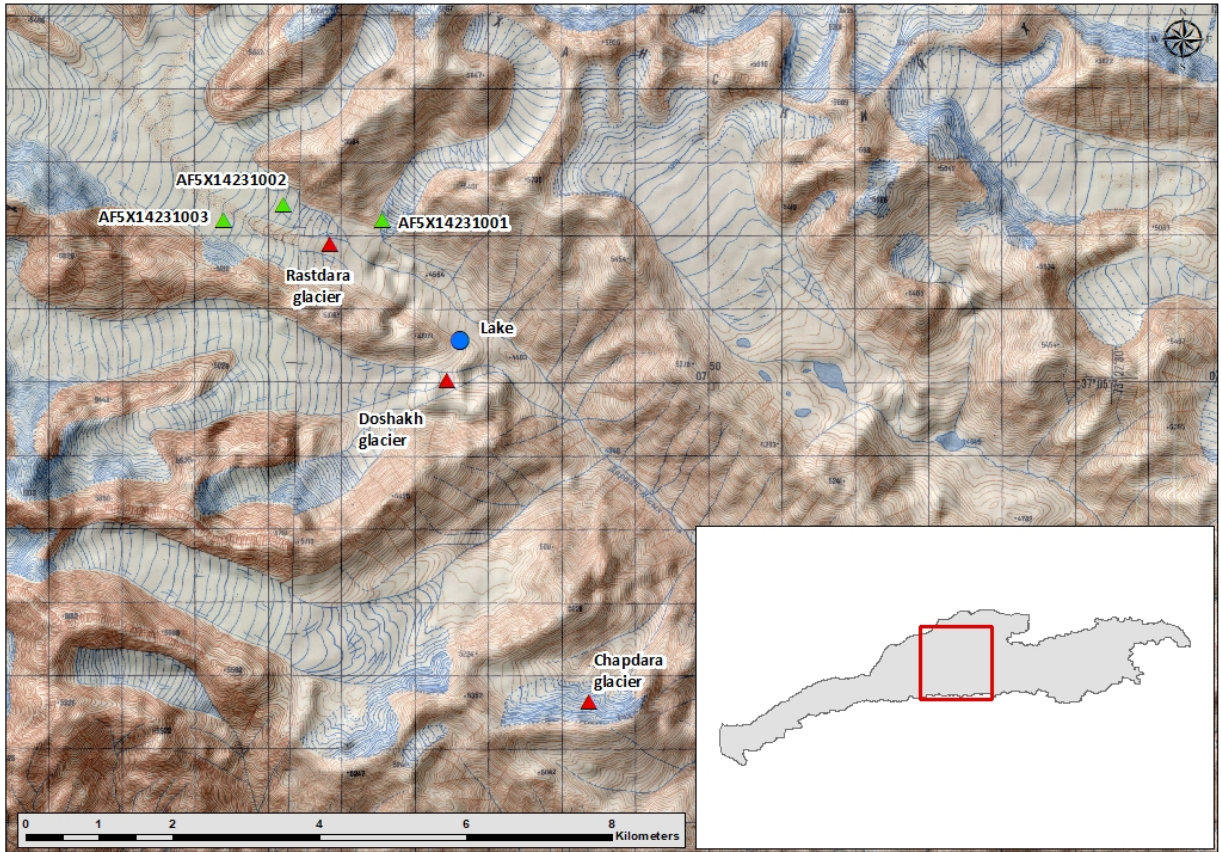


Figure 8. Visited glacier termini in August 2018 (red triangles), 2003 glacier termini (green triangles) (Haritashya *et al.* 2009), and the main area of formation of glacial lakes (blue dot) in August 2018 & 2019 in Big Pamir Mountain Range, Wakhan District. The Russian topographic layer was produced in the 1980's.

was estimated >1,500 square meter in surface. The collection of glacial lakes in the upper reaches of this valley represents several thousands or possibly tenth of thousands cubic m of water. Although they are located 8 hrs-walk from the nearest human settlements, the volume of water retained in these lakes has markedly increased (more than tripled) compared to 2018 and the risk of outburst floods from these lakes warrant further monitoring of the situation in 2020 and immediate information of the populations living in the area comprised between *Neshtkhawar* and *Ptukh* villages in the Wakhan Valley. Although few people reside in this area, there are extensive agriculture fields.

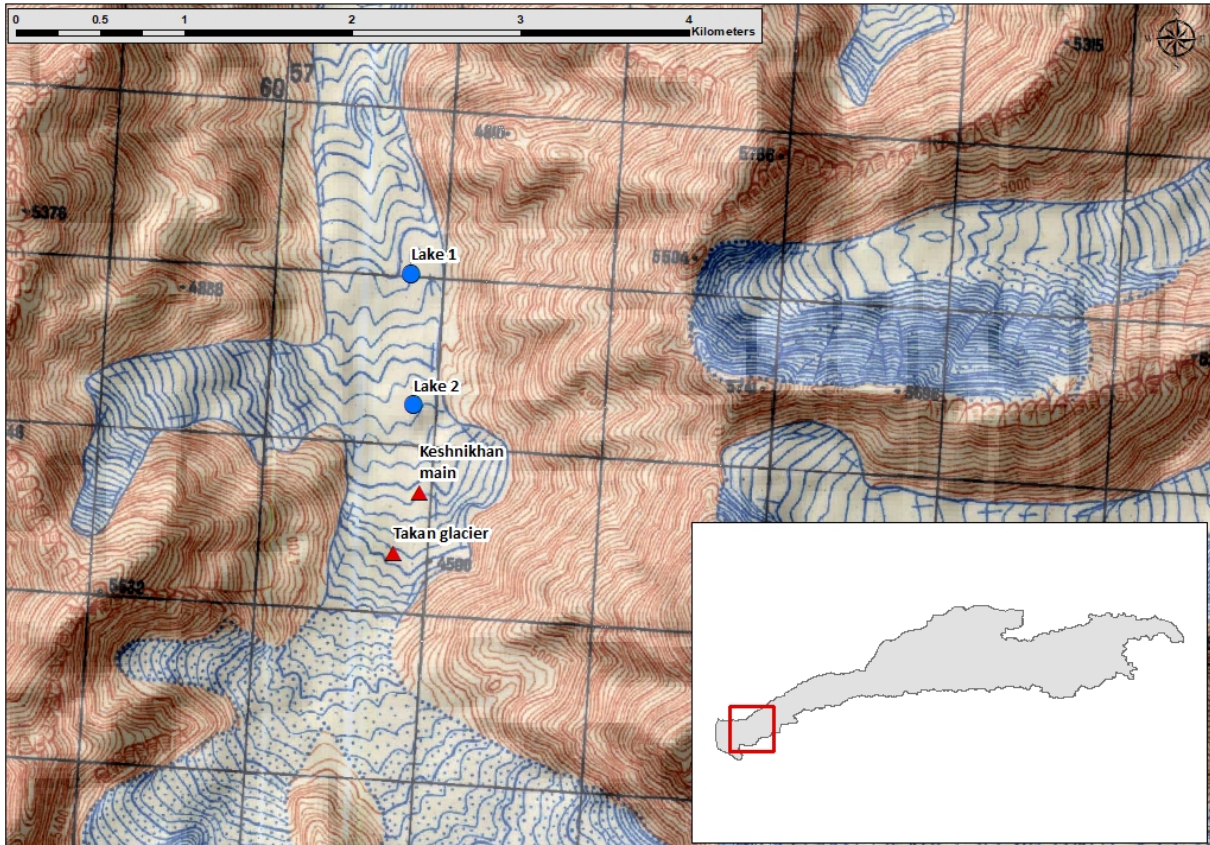


Figure 9. Visited termini of glaciers (red triangles), and two glacial lakes (blue dot) in *Keshnikhan* Valley, Wakhan District, Hindu Kush Mountain Range in October 2018 & 2019. The Russian topographic layer was produced in the 1980's.

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Appendix 1. Terminus locations and side measurements (width) of glaciers monitored in 2019

Glacier name	Date (dd-mm)	Location terminus (UTM)	Annual Retreat (m)	Dist. to right (m)	Dist. to left (m)
<i>Doshakh</i>	27-08	346459 - 4105317	5	20	36
<i>Rastdara</i>	28-08	344858 - 4107174	9	30	20
<i>Sarkand</i>	08-10	285045 - 4091740	16	199	50
<i>Kandkhan</i>	28-09	328261 - 4085300	7.5	46	283
<i>Kharich</i>	27-09	323849 - 4086454	6	53	321
<i>Keshnikhan</i>	04-10	757200 - 4056468	5.1	24	15
<i>Takan</i>	04-10	757642 - 4055652	3.5	60	90
<i>Shkhawr Payan</i>	06-10	765390 - 4055757	11.5	70	64
<i>Kret</i>	26-09	318562 - 4086784	4	50	56

Appendix 2. Locations of reported glacial lakes in 2019

Lake name	Date (dd-mm)	Location terminus (UTM)	Altitude (m)	Surface area compared to 2018
<i>Ezik 1</i>	27-08	346618 - 4105885	4524	Increased
<i>Ezik 2</i>	27-08	346479 - 4106162	4538	Increased
<i>Ezik 3</i>	27-08	346475 - 4106281	4537	New
<i>Ezik 4</i>	27-08	346231 - 4106464	4522	New (>1,500 m ²)
<i>Keshnikhan 1</i>	04-10	757639 - 4057310	4203	Same
<i>Keshnikhan 2</i>	04-10	757707 - 4056533	4337	Decreased