United Nations / Germany international conference on "International Cooperation Towards Low-Emission and Resilient Societies"

Using of space technologies for glacier- and snow- related hazards studies

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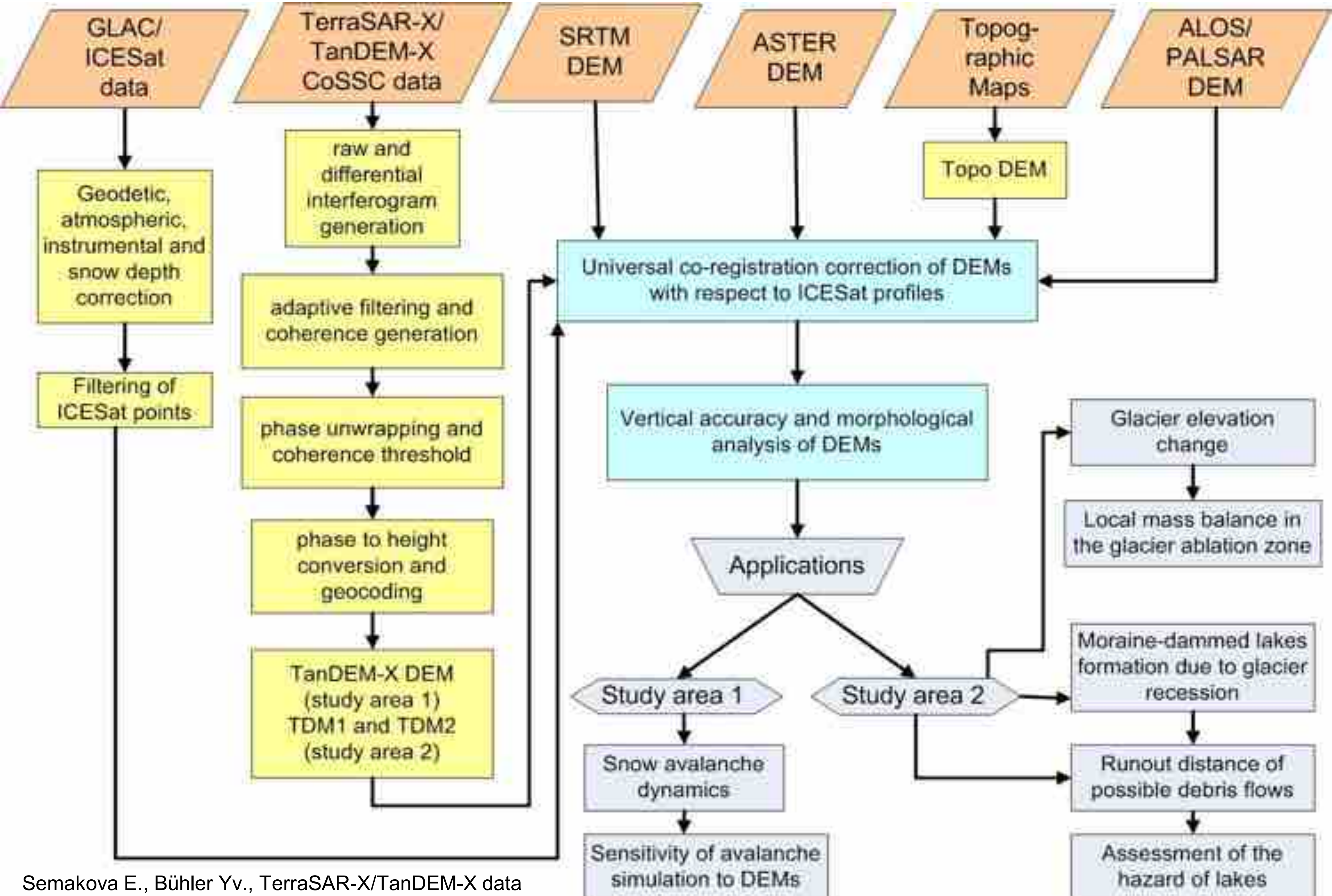
Climate of Uzbekistan is of arid and continental type with large seasonal and daily variations in air temperature. Distribution of precipitation across the territory is extremely uneven and closely associated with terrain elevation, disposition of mountain systems, direction of mountain slopes and other features of orography. (Third National Communication of the Republic of Uzbekistan under the UNFCCC)

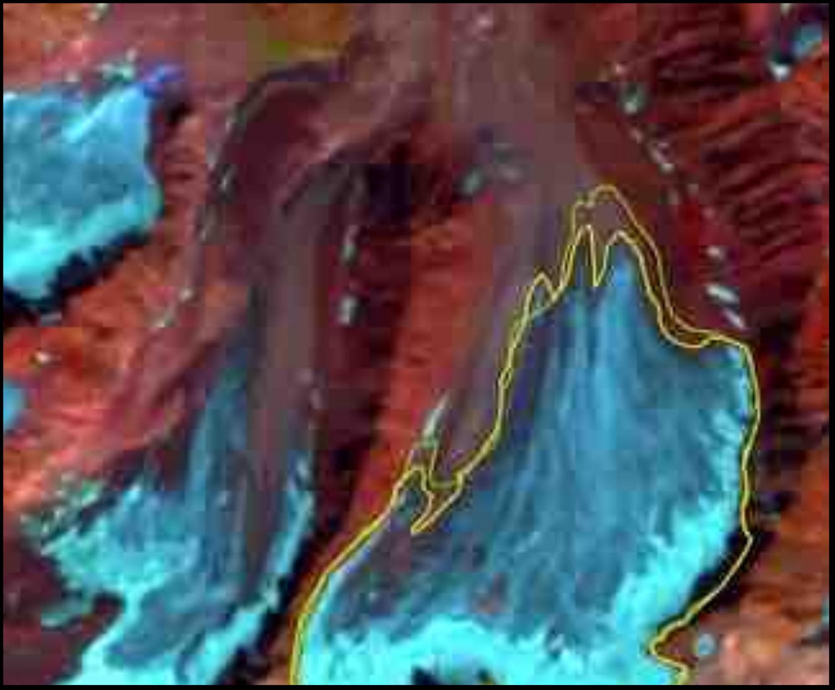
The Pskem River is a right-hand component of the Chirchik River that is the feeder of the Sir-Darya River (the Western Tien-Shan). The maximal part of glacierized area (36.4%) falls within elevation zone of 3600-3800 m. The elevation zone higher than 4000 m includes 2.2% of the glacierized area.

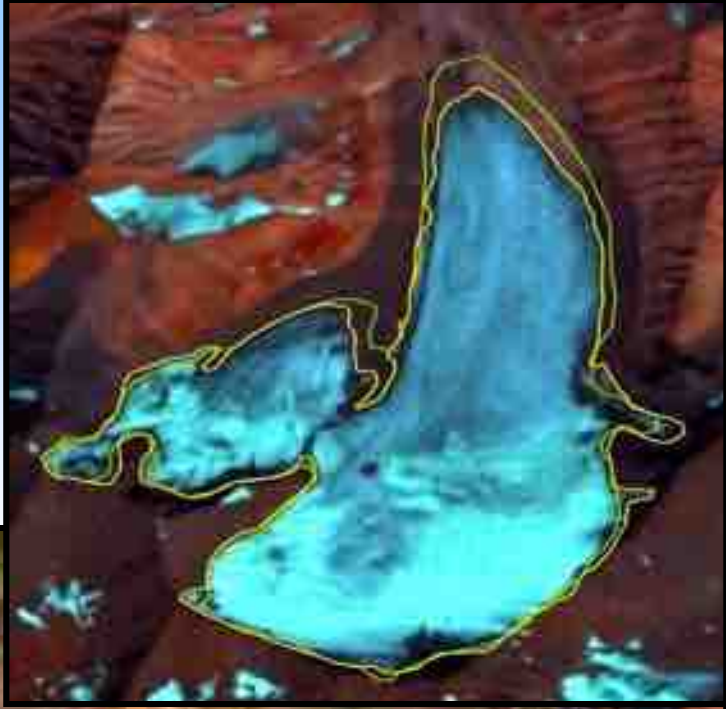
Using of space technologies for assessment of glacier- and snow avalanches related hazards



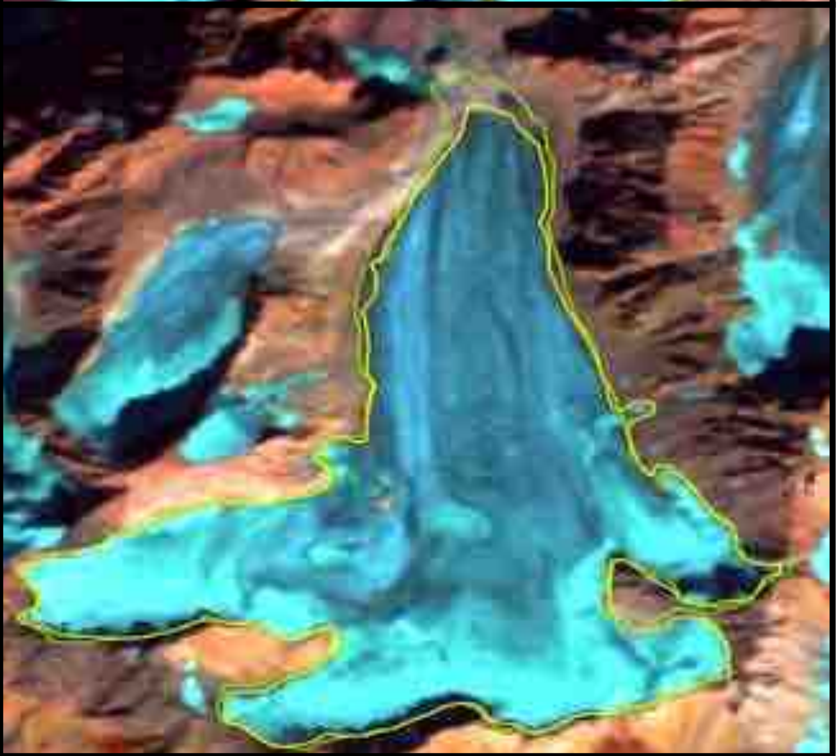
Semakova E., Bühler Yv., TerraSAR-X/TanDEM-X data for natural hazards research in mountainous regions of Uzbekistan. JARS, 11(3), 036024 (2017).

Glaciers shrinkage and glacial lakes expansion

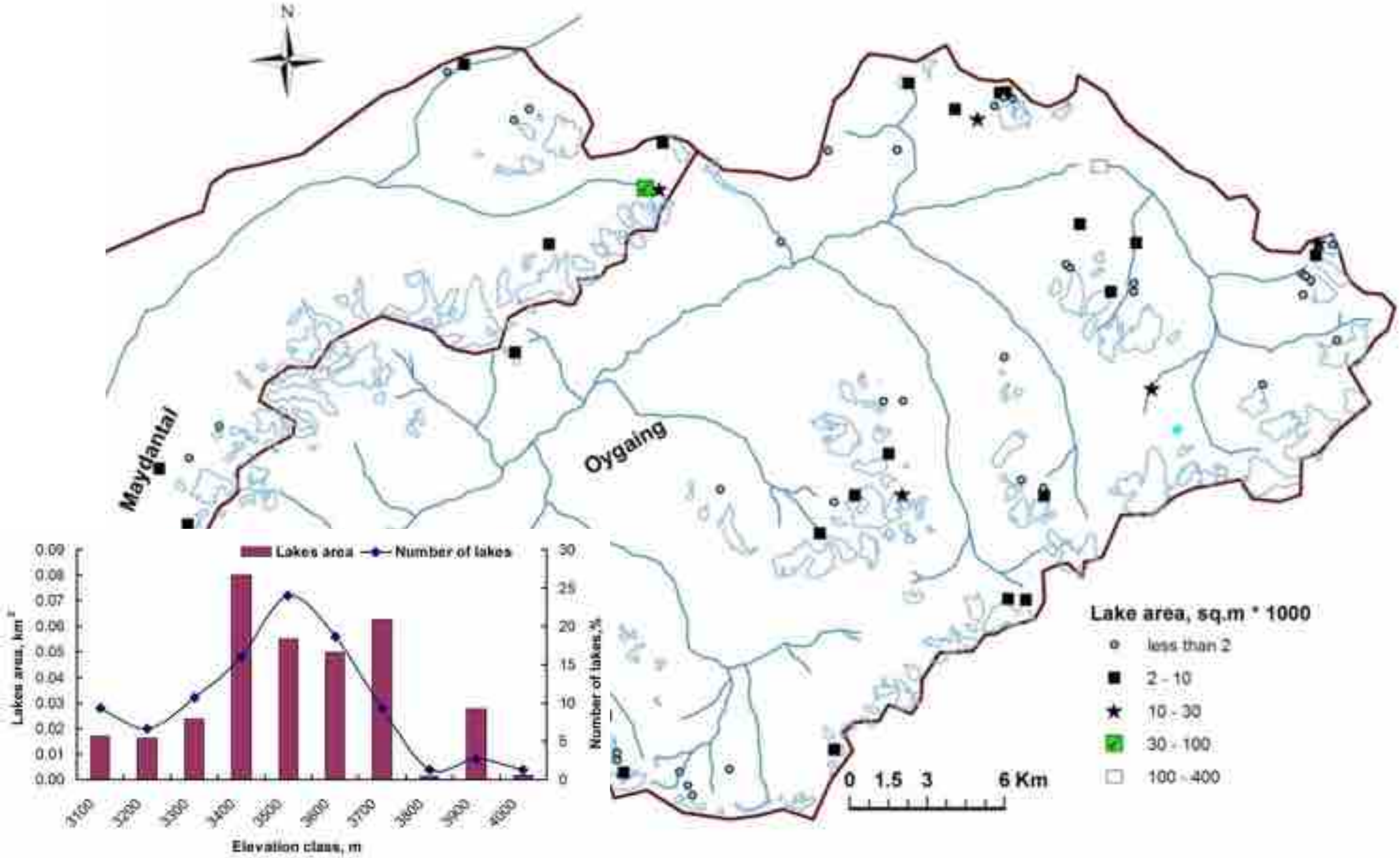




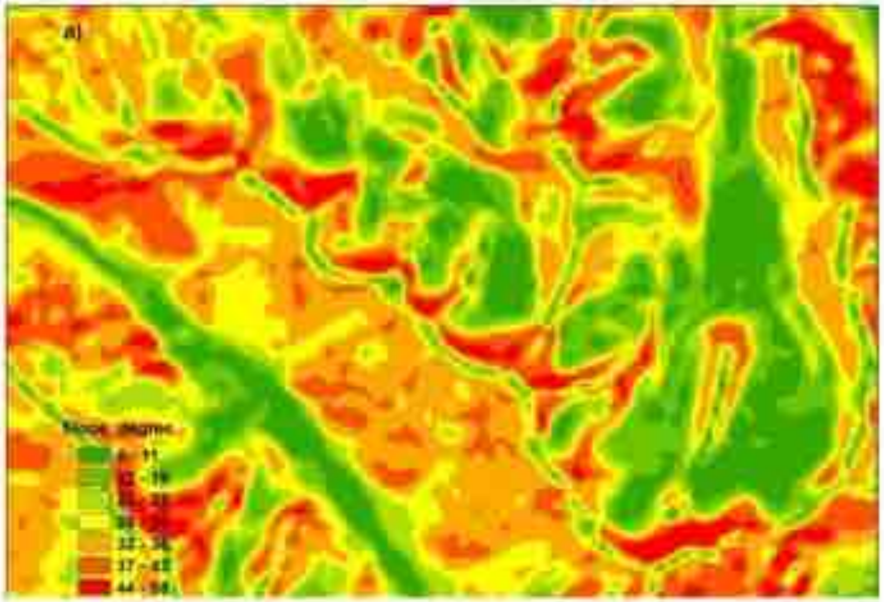
Landsat 14.09.2017
23.09.2000

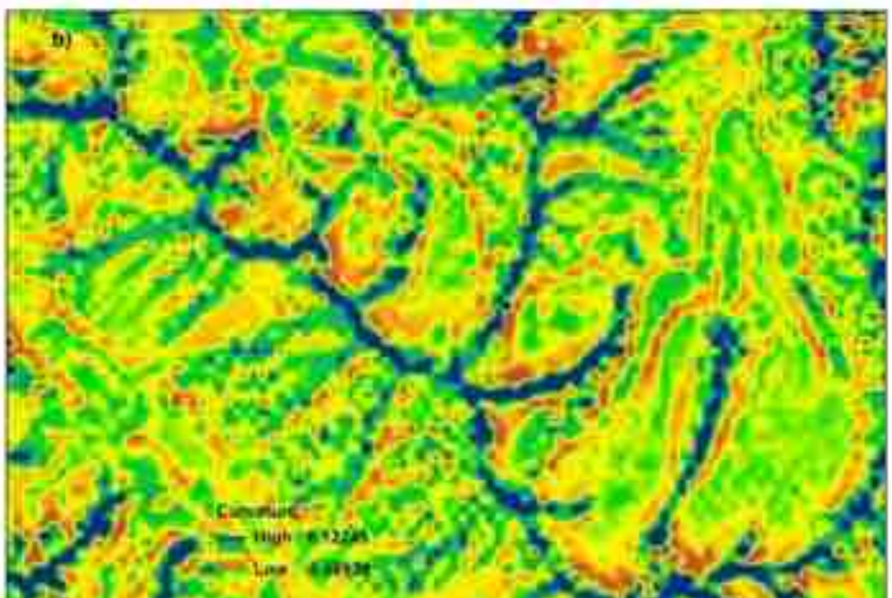


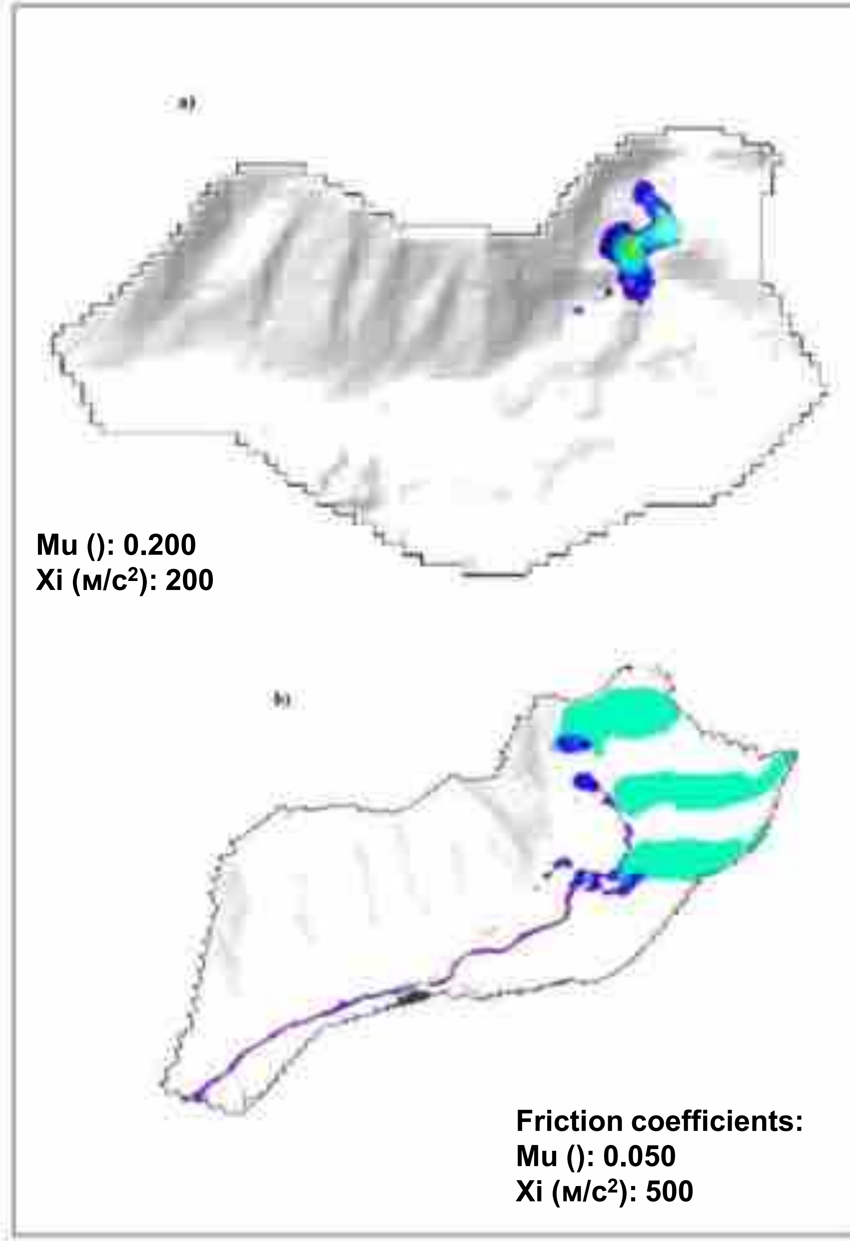
For 2000 – 2017, change in glacier area in the Pskem River basin is -2,8 %.
In according with helicopter observations in 1999-2000, the glacial lakes' number was 32.
There are more than 80 lakes in 2017.



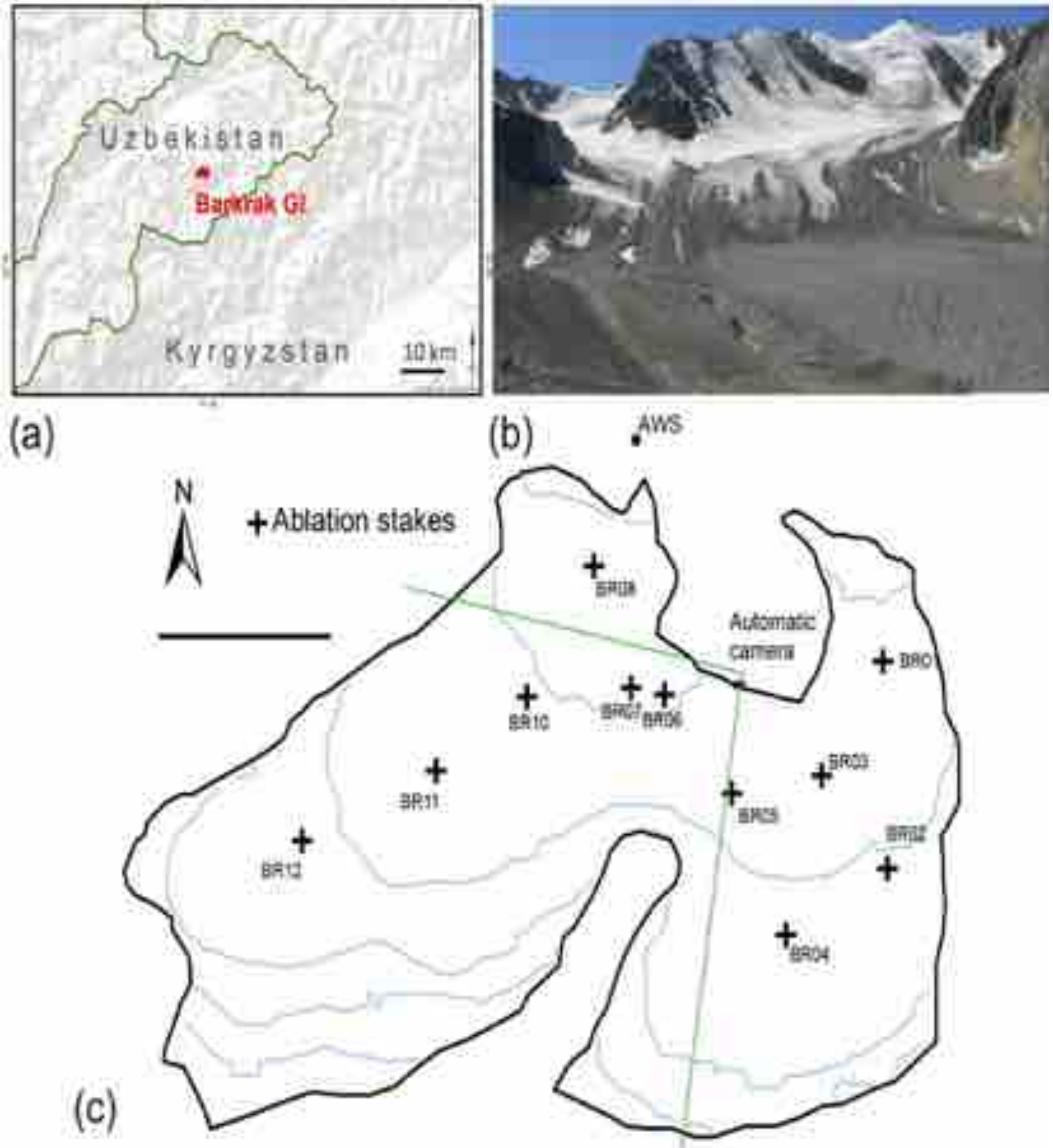
TanDEM-X DEM for estimating glacial lakes outburst affected areas and the lakes’ potential hazard



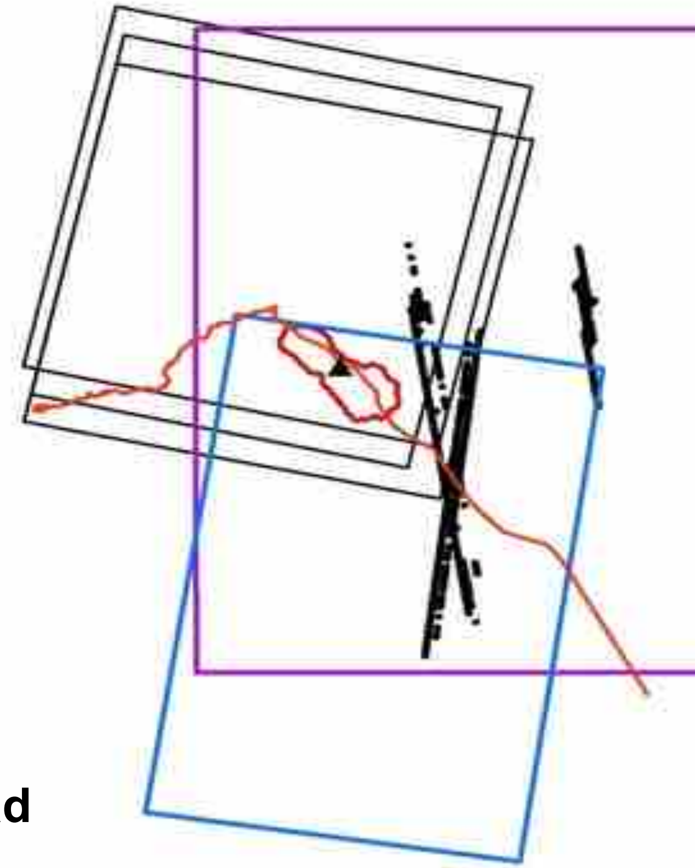




Mass balance network (c) on Barkrak Middle Glacier with corresponding (overview) map (a) and picture (b): M. Hoelzle et al.: Re-establishing glacier monitoring in Kyrgyzstan and Uzbekistan, Central Asia: EGU- 2017.



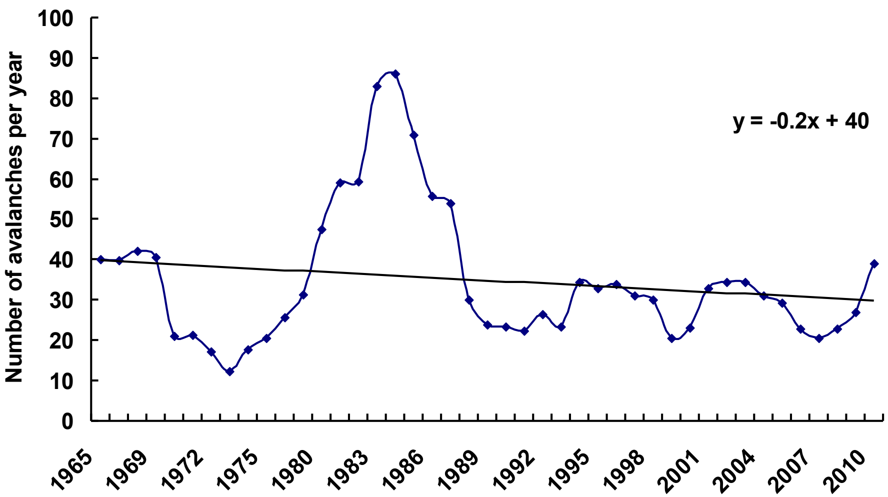
Change in open part area of the Bakrak Middle Glacier for 2000-2017 is -5%. Average annual local mass balance in the ablation zone of the glacier is −0.82 ± 0.36 m w.e. for the period from 2000 to 2012, given an ice density of 0.9 g/cm^3 and DEMs differences (Terrasar-X/TanDEM-X DEM and SRTM).

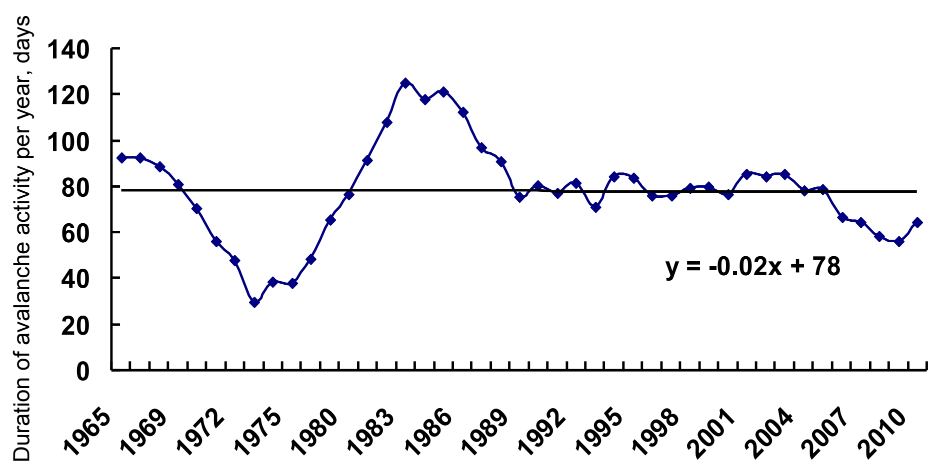


Snow- related hazards along the road

The indicative climatic characteristics affected on snow and avalanche regime and the possible change in this regime for T_w + 1°C and X_w + 10%

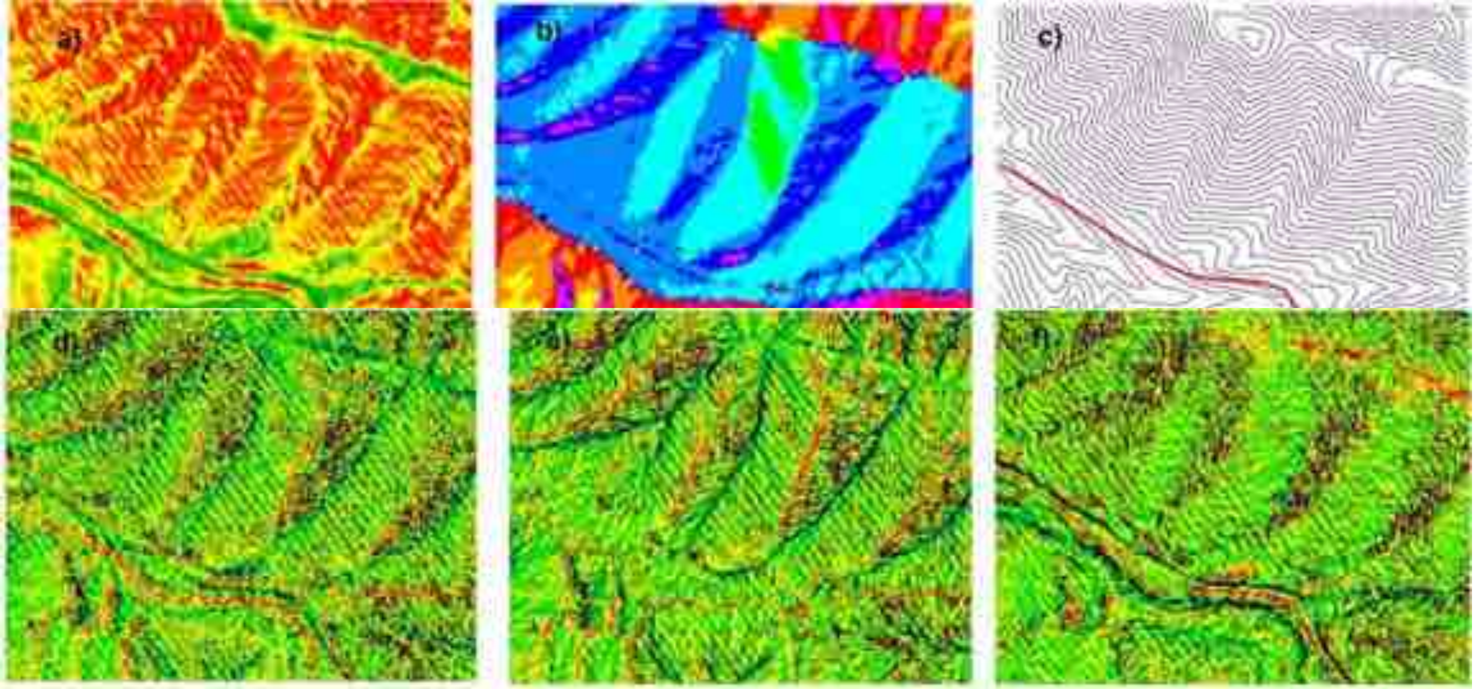
Snow and avalanche characteristics	Climate indexes		Change, %
Maximal snow depth for winter period	t(XI-III), t(I)	Σx(I-III)	0
Number of days with snow cover	t(XI, I, IV)	Σx(XI-III)	0
Number of avalanches per year	t(XI-III)	Σx(I-III)	-11
Duration of avalanche activity per year	t(XI, I, IV)	Σx(XI-IV)	-11
Number of days with avalanches	t(XI-III)	Σx(XI-IV)	- 20
Maximal volume of avalanches	t(XI-IV)	Σx(I-III)	- 9
Total volume of avalanches	t(XI-IV)	Σx(I-III)	- 30





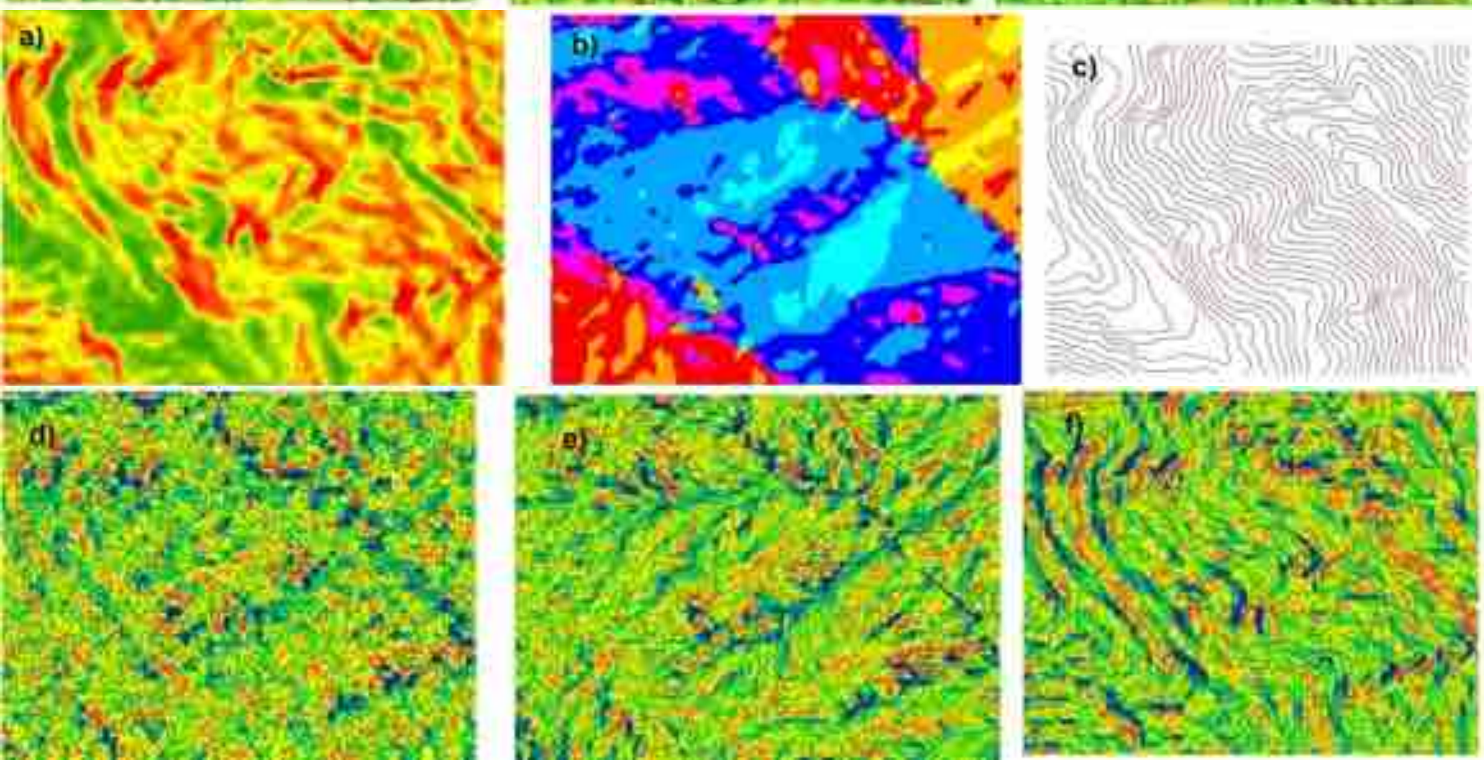
DEMs features

TerraSAR-X /TanDEM-X

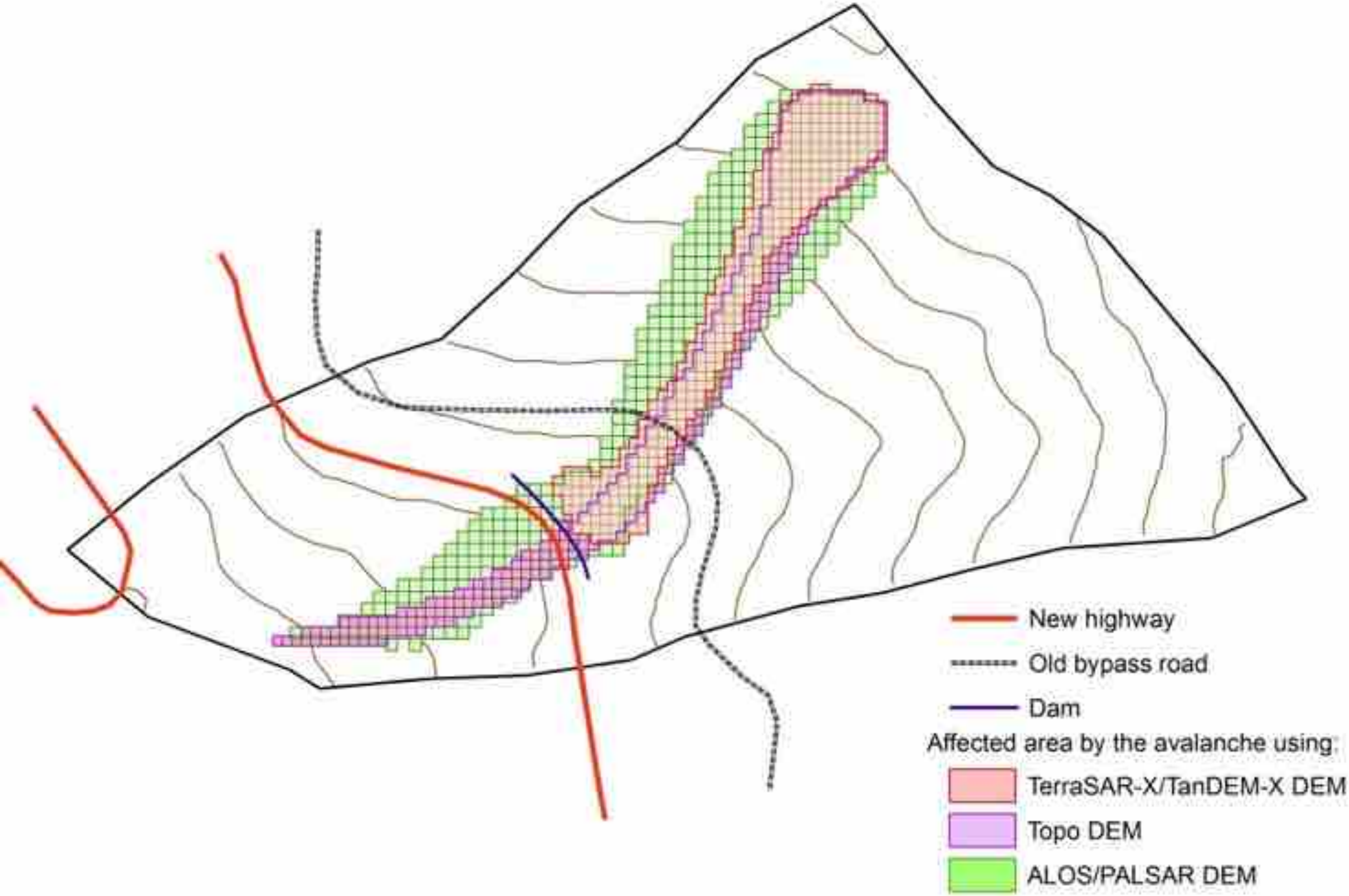


- a) Slope,
- b) Aspect,
- c) 20 m contour lines,
- d) Curvature,
- e) Plan curvature,
- f) Profile curvature

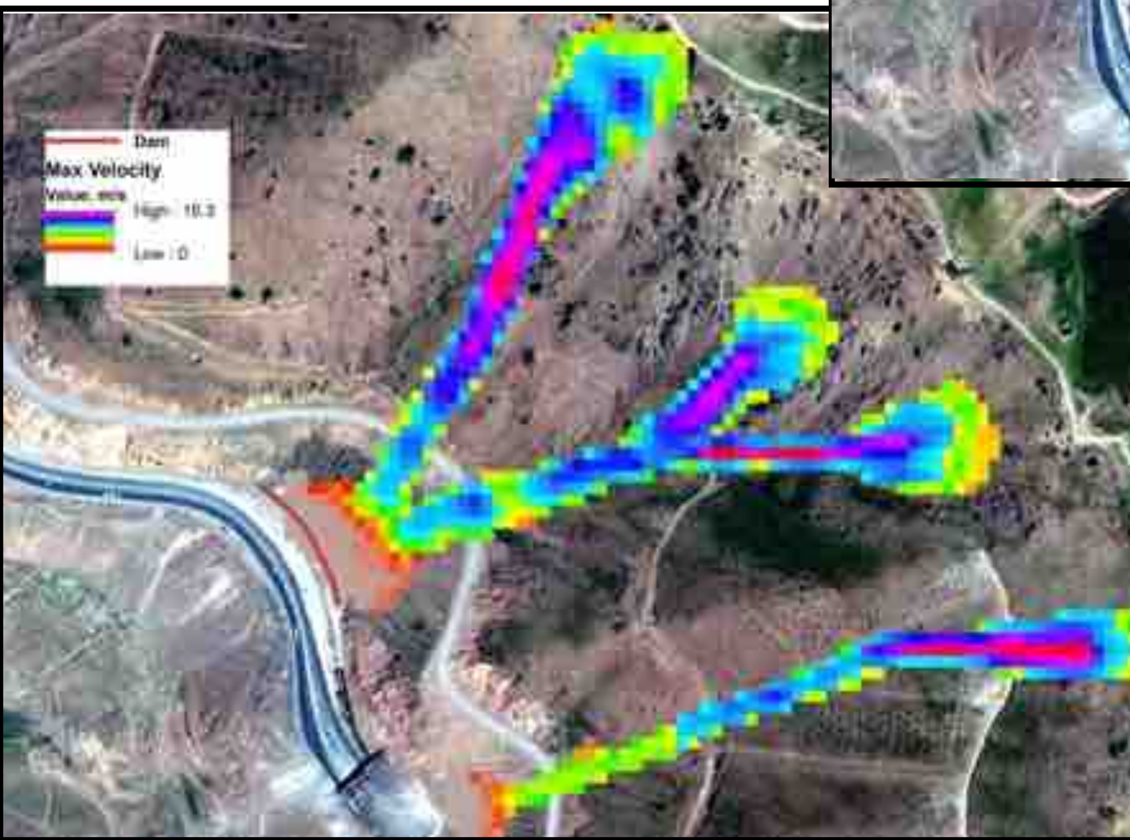
ALOS PALSAR DEM



Snow avalanche numerical simulation using RAMMS software



Maximum flow velocity and deposit height simulations using TanDEM-X DEM



Conclusions

- Glaciers are one of the “essential climate variables” in the Global Climate Observing System. They play a key role for assessing climate change effects such as estimating sea-level rise, regional changes in runoff and impacts of natural hazards.
- Space monitoring is becoming an increasingly important and integrative component for changes in glacier area and glacier thickness and related natural hazards assessment.
- Different techniques such as remote sensing, in-situ measurements, and modelling need to be combined to generate high-quality products
- Application of debris flow simulations with using of suitable DEM of summer time acquisitions allows assessing a potential risk of the glacial lakes.
- Numerical snow avalanche simulations with using of current DEM of winter time acquisitions is a helpful tool to tackle this hazard.
- Future work could be related with installation of new detecting instruments of snow avalanche and debris flow release and of weather stations at high elevation zones to find the relationships between investigated parameters and identify the hazards features on satellite images.

Thank you very much for your kind attention!