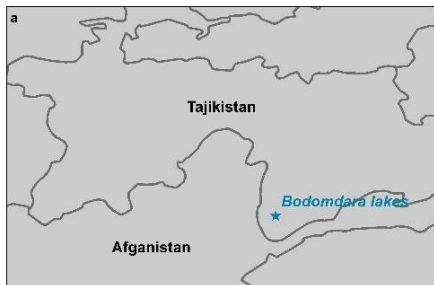# Modeling of glacial lake outburst in the Shakhdara river basin using the complex of mathematical models

V.A. Yudina (Kurovskaia), S.S. Chernomorets, I.N. Krylenko, T.A. Vinogradova, I.V. Krylenko, E.A. Savernyuk, A.G. Gulomaydarov, I.I. Zikillobekov, U.R. Pirmamadov, Y.K. Raimbekov.

Bodomdara river vallev

- The Darmaidovan River is a large left tributary of the Bodomdara River which is the left tributary of the Shakhdara River.
- The length of the Darmaidovan River is 12 km. The catchment area is 65.6 km^2
- The length of the Bodomdara River is 27 km, catchment area is 318 km^2
- In the upper reaches of the Darmaidovan River there are two glacial lakes: **Bodomdara Upper and Lower.**

Bathymetric map of Bodomdara Lower

Depth, m

	0 - 2
	2.1 - 4
	4.1 - 6
	6.1 - 8
	8.1 - 10
	10.1 - 12
	12.1 - 14
	14.1 - 16
	16.1 - 18
	18.1 - 21.8

| Lake	Absolute elevation, m	Water area, m^2	Length along the longitudinal axis, m	Maximum width, m	Maximum measured depth, m	Shape
lower	4289	52000	280	230	22.6	rounded, L/B=1.4
upper	4361	56100	360	200	no measurements	elongated oval, L/B=2.3
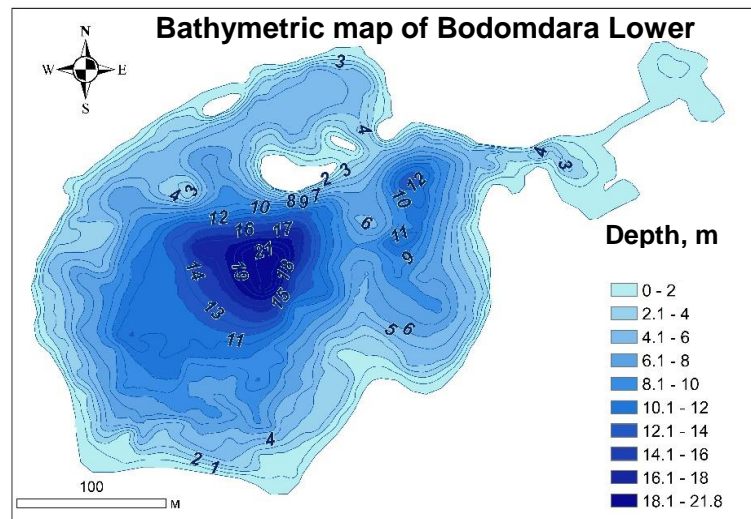
Chain of mathematical models

Lake outburst hydrograph → **Hydrograph of debris flow wave** → **Spatial distribution of depths and flow velocity, hydrographs in the marked sections**
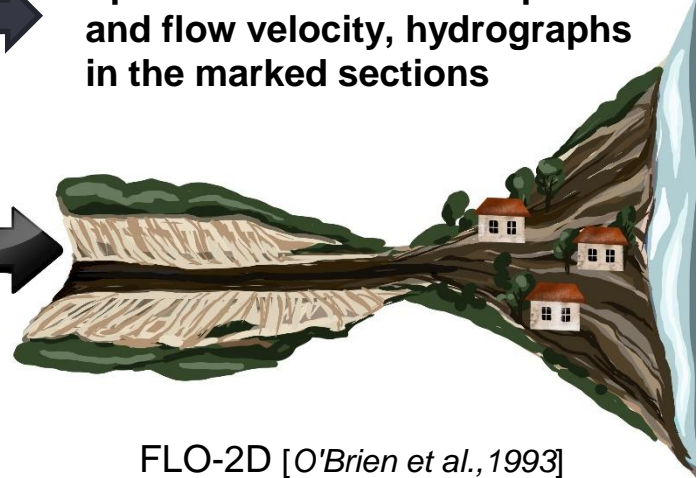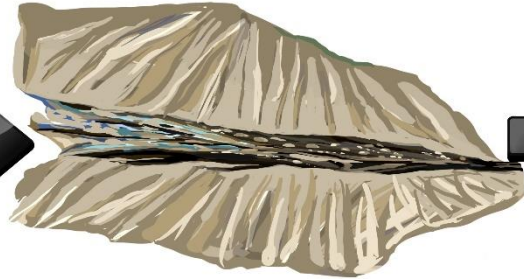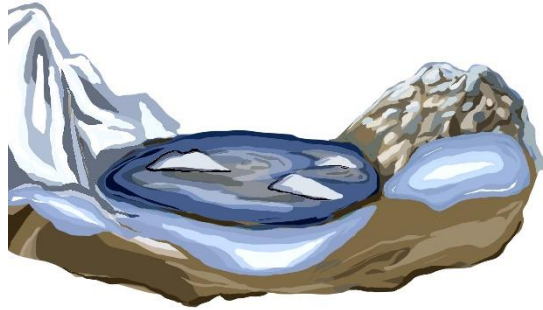
Model of lake outburst [*Vinodradov,1977*]

transport-shift model [*Vinogradova, Vinogradov, 2017*]

FLO-2D [*O'Brien et al.,1993*]

FLOVI program [Yudina, 2022]

Initial data

I scenario

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┌─────────────────┐
│  Model of lake  │
│    outburst     │
└─────────────────┘
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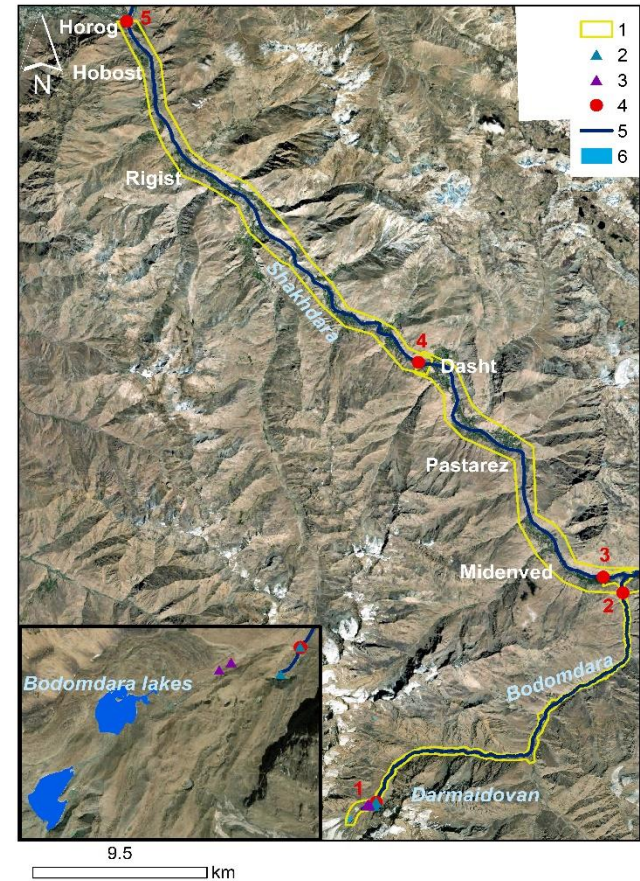
II scenario

```
┌─────────────────┐
│  Empirical      │
│  formula        │
└─────────────────┘
```

```
┌─────────────────┐        ┌─────────────────┐
│ Transport-shift │ ─────► │  FLO-2D model   │
│     model       │        │                 │
└─────────────────┘        └─────────────────┘
```

- ALOS PALSAR, 12.5 m
- UAV data for the Bodomdara river fan, 3 m
- Bathymetric survey of Lake Bodomdara Lower
- Average discharge of the Shakhdara river

1 - boundaries of modeling according to FLO-2D, 2 - boundaries of a potential debris flow source (I scenario), 3 - boundaries of the adding zone (II scenario), 4 - sections for calculating hydrographs according to FLO-2D, 5 - rivers, 6 - lakes.

Results of modeling

| Scenarios	Outburst volume thousand m³	Discharge of outburst flood, m³/s	Discharge of debris flow wave, м³/c	Time of maximum , h
I	328	167	459	0.96
II	700	430	840	0.4

1 – upper part of the Darmadoivan River valley, 2 – mouth of the Bodomdara River, 3 – Shakhdara River downstream the cone of the Bodomdara River, 4 – Shakhdara River downstream the cone of the Dasht River, 5 – Shakhdara River at the confluence with Gunt River: I – according scenario I with outburst volume 328000 m³; II – according scenario II with outburst volume 700000 m³.
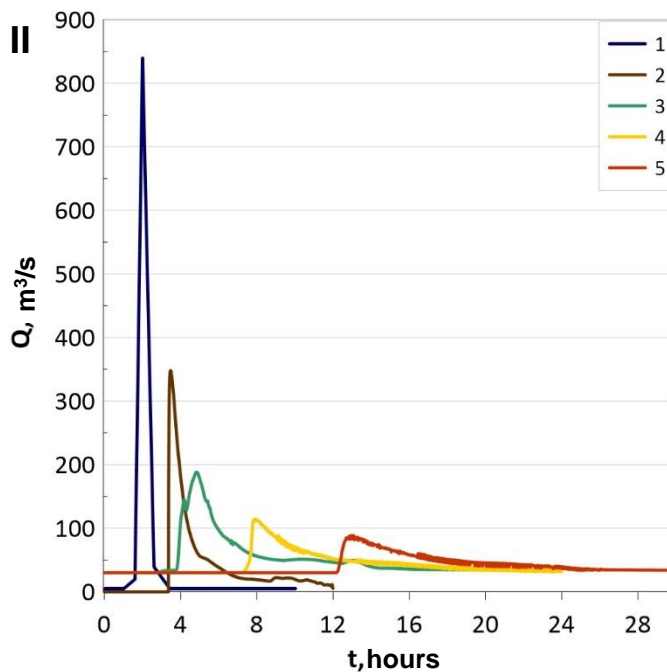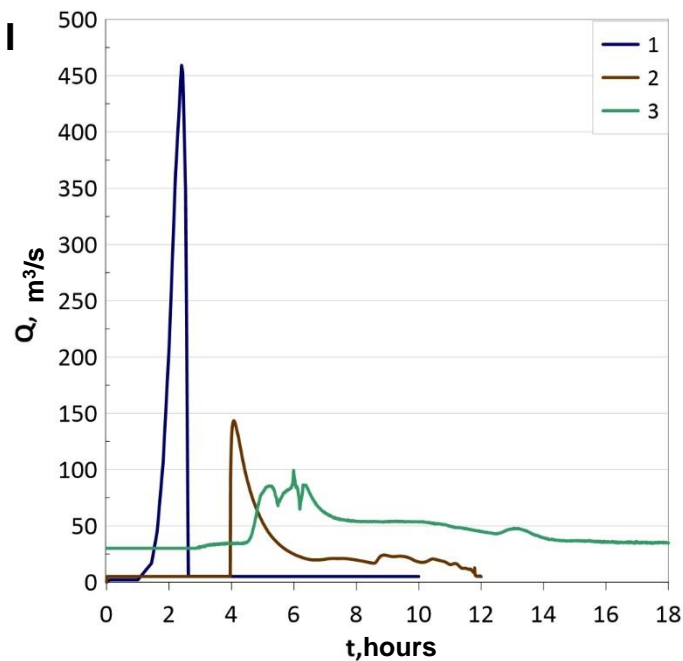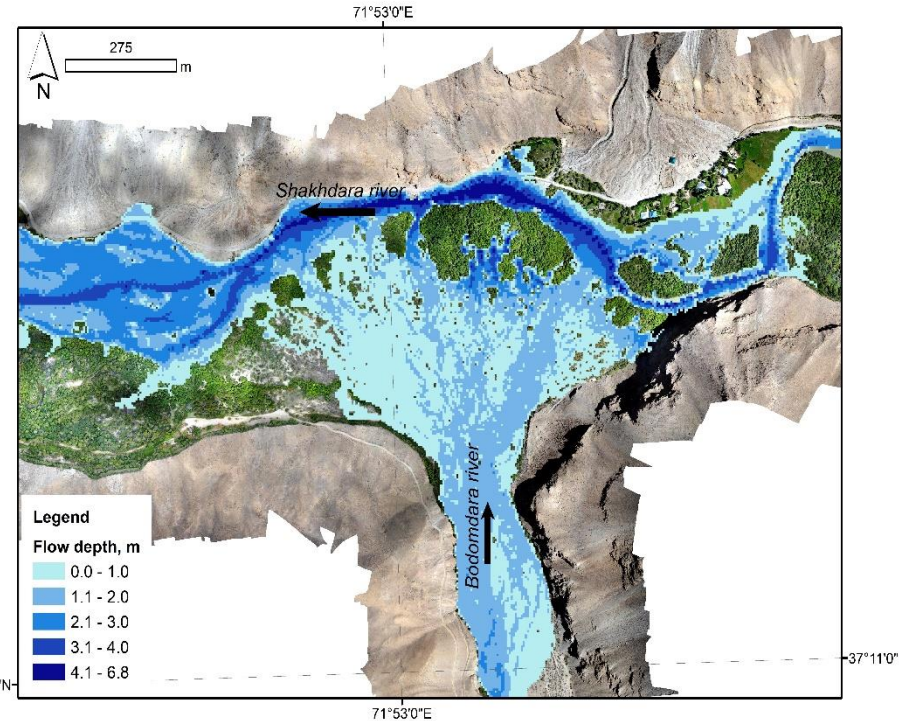
Results of modeling

I scenario considers the outburst of Lake Bodomdara Lower (328 thousand m³); II scenario – cascade outburst of Lakes Upper and Lower (700 thousand m³)
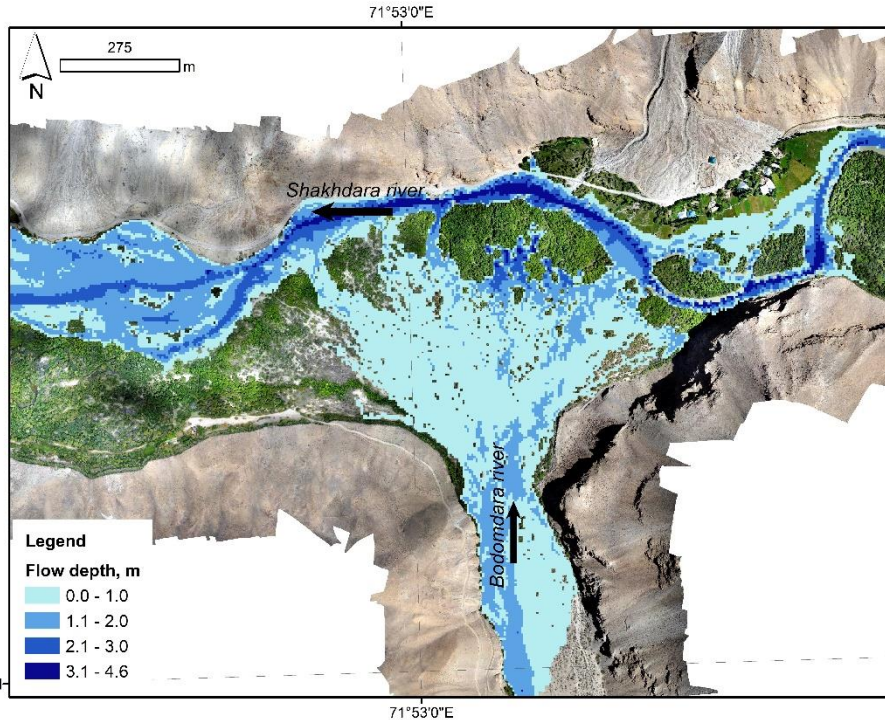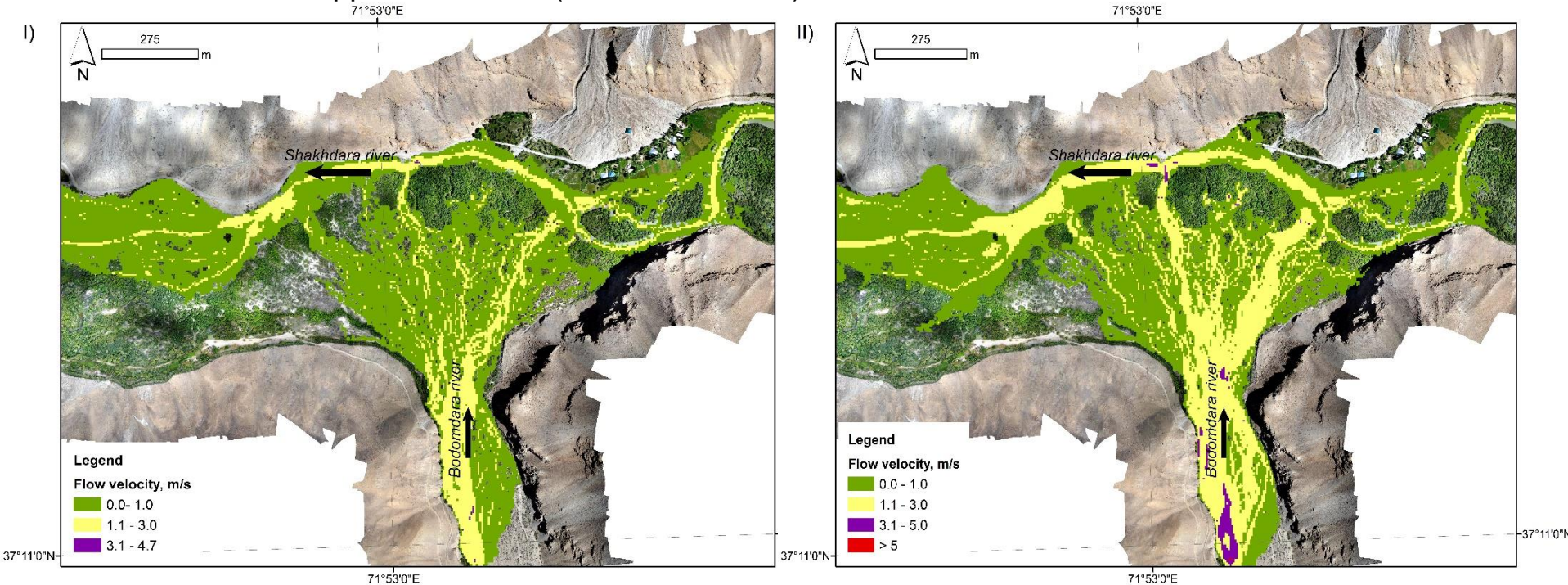
Results of modeling

I scenario considers the outburst of Lake Bodomdara Lower (328 thousand m^3); II scenario – cascade outburst of Lakes Upper and Lower (700 thousand m^3)

Thank you for attention!