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Supporting Information for

**Glacier branch lines and glacier ice thickness estimation for debris-covered glaciers in the Central Tien Shan**

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**1. Auxiliary Figure**

**Figure_S1_rev2.tif**

**Figure S1:** Workflow for branch line generation using glacier outline, DTM and glacier velocity data as input datasets.

To account for deflections from the centre position, e.g. at the confluence of multiple glacier branches, velocity information under the assumption that the branch line and local velocity maximum coincides can be considered (this part of the workflow is grayed out).

The implementation of the adjustment contains the generation of perpendicular traverses along the branch line with a width of 300 m and a sampling distance of 60 m – in accordance with the geometric resolution of the glacier velocity raster – and the calculation of the local velocity maximum along the profile by fitting a Gaussian curve to the data. A velocity adjusted branch line can finally be generated by applying a least square adjustment to minimize the discrepancies between the current position of the branch line and the local velocity maximum. For Koxkar and South Inylchek Glacier the resulting shifts after affine transformation were small with about 50-150 m and 25-50 m. Therefore, this part of the workflow was not applied to the branch line networks shown in the paper.

Figure_S2_rev2.tif

**Figure S2:** Illustrated workflow for glacier branch line generation.

Figure_S3_rev2.tif

**Figure S3:** Branch lines based on vector-based least-cost-path approach in comparison to branch lines based on the approach of Le Bris and Paul (2013) using RGI 5.0 glacier outlines. L(Emin-Emax): Branch line between highest and lowest point, Lmax: Longest branch line.

**2. Auxiliary Tables**

**Table S1:** Input datasets

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Date** | **Type** | **Data** | **Spatial resolution** | **Usage** |
| 25 Aug 2002 | Satellite image | Terra ASTER (NIR, 3N) | 15 m | Velocity |
| 28 Aug 2003 | Satellite image | Terra ASTER (NIR, 3N) | 15 m | Velocity |
| 16 Aug 2010 | Satellite image | Landsat TM (NIR, 4) | 30 m | Velocity |
| 03 Aug 2011 | Satellite image | Landsat TM (NIR, 4) | 30 m | Velocity |
| 09 Sep 2013 | Satellite image | Landsat OLI (pan) | 15 m | Velocity |
| 12 Sep 2014 | Satellite image | Landsat OLI (pan) | 15 m | Velocity |
| Feb 2000 | DTM | SRTM3 | 90 m | Flow line / Ice thickness |