

Quantifying contributions of runoff components to streamflow in Central Asian glacierized basins

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Global Institute for Water Security



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- Background & Study basins
- Methods for quantifying contributions of runoff components & Results

Central Asian High Mountains



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What do glaciers look like in Central Asia





Moulin

Crevasse





Runoff components contributing to streamflow





Definition 1 based on water source: Ice melt%+Snowmelt%+Rain%=100%



Definition 2 based on flow pathway:

Ice melt%+Snowmelt%+Rain%+groundwater%=100%

groundwater (red), ice melt (blue), snow melt (orange), rainfall-runoff (green) Lutz et al. 2014

Weiler et al. 2018

Study basins





Glacier measurement & water sampling





- Background & Study basins
- Three methods for quantifying contributions of runoff components & Results

End-member mixing approach (EMMA)

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End-member mixing approach

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EMMA: Traditional end-member mixing approach Bayesian_O: Bayesian method using Oxygen and EC Bayesian_OH: Bayesian method using Oxygen, Hydrogen and EC

Uncertainty range:

EMMA>Bayesian_O>Bayesian_OH

Stepwise calibrated hydrological modeling

Hydrological modeling

Processes coded in WASA:

- Snow melt
- Glacier melt and glacier dynamics
- Infiltration
- Soil water movement
- Evapotranspiration
- Runoff generation
- Runoff routing in river network
- Retention in reservoirs

AGU PUBLICATIONS

Water Resources Research

RESEARCH ARTICLE 10.1002/2017WR021966

The Value of Hydrograph Partitioning Curves for Calibrating Hydrological Models in Glacierized Basins

Key Points: • The HPC-based method (1) delivers model-internal consistency Zhihua He¹, Sergiy Vorogushyn¹, Katy Unger-Shayesteh¹, Abror Gafurov¹, Olga Kalashnikova³, Elvira Omorova⁴, and Bruno Merz^{1,2}

He et al. (2018)

Stepwise calibrated hydrological modeling

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Isotope-aided hydrological modeling

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Isotope-aided hydrological modeling

How do the three methods compare

- In a Central Asian glacierized basin with a size of 230 km², glacier coverage is 17%, and annual mean precipitation is 550 mm (1970-2016): Annual contribution: Ice 18%, Snow 22%, Rain 15%, Groundwater 45%
 Melting season: Ice 24%, Snow 25%, Rain 10%, Groundwater 41%
- Hydrological modeling and EMMA tended to estimate the **mean contributions closely**, with the difference smaller than 5%.
- EMMA estimated contributions showed much larger uncertainty than hydrological modeling. Water isotopes significantly helped reduce uncertainty in the modeled contributions

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Thank you for your attention!

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