MSc Thesis

Discipline: Hydrology and Water Resources Management

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Title

Which precipitation and temperature product to choose in Central Asia?

Short description

Gridded data products (mostly precipitation and temperature but also snow cover) are increasingly used as forcing for regional hydrological models in data-scarce regions. Many gridded precipitation products heavily rely on station data availability for bias correction. Where only a few stations are available, their use in data assimilation can lead to spurious trends[1,2]. Faulty model forcing of course invalidates any attempt at hydrological forecasting.

For this study, we are interested in Central Asia where the livelihoods of millions of people rely on water from sparsely monitored high mountain zones. Several studies are available, that compare a selection of data products over Central Asia[3] but we would like to specifically have the validity of the temporally and spatially highly resolved WSL CHELSA v2.1[4,5] data product in comparison to other daily data products assessed. We use the CHELSA data extensively in the modelling workflow we are teaching in Central Asia[6,7].

The goal of the study is a comparative analysis of the available daily data products in Central Asia (precipitation, temperature, snow). The student further will improve an existing hydrological modelling workflow[6] by implementing a weighted ensemble approach (for example dynamic Bayesian averaging[8]) to include multiple gridded data products as forcing in the existing modelling workflow. Ultimately, a hydrological model of the Zarafshan headwater basin is implemented and the climate change impact on water availability for hydropower use and downstream irrigation is assessed. The improved workflow will be documented in an online-course book on hydrological modelling in Central Asia[6].

References

1. Zandler, H., Haag, I. & Samimi, C. Evaluation needs and temporal performance differences of gridded precipitation products in peripheral mountain regions. *Sci. Rep.* **9**, 15118 (2019).
2. Marti, B. *et al.* Gauge locations, basin outlines and characterization for 301 locations and discharge time series for 136 of these gauge locations in Central Asia. (in preparation).
3. Haag, I., Jones, P. D. & Samimi, C. Central Asia's Changing Climate: How Temperature and Precipitation Have Changed across Time, Space, and Altitude. *Climate* **7**, 123 (2019).
4. Karger, D. N. *et al.* Climatologies at high resolution for the earth's land surface areas. *Sci. Data* **4**, 170122 (2017).
5. Karger, D. N., Wilson, A. M., Mahony, C., Zimmermann, N. E. & Jetz, W. Global daily 1 km land surface precipitation based on cloud cover-informed downscaling. *Sci. Data* **8**, 307 (2021).
6. Marti, B. S., Zhumabaev, A. & Siegfried, T. A comprehensive open-source course for teaching applied hydrological modelling in Central Asia. *Hydrol. Earth Syst. Sci.* **27**, 319–330 (2023).
7. Siegfried, T. & Marti, B. *Hydrological Modelling in Semi-Arid Central Asia*. (hydrosolutions GmbH, 2022). doi:10.5281/zenodo.6349983.
8. Qi, W., Liu, J., Yang, H. & Sweetapple, C. An ensemble-based dynamic Bayesian averaging approach for discharge simulations using multiple global precipitation products and hydrological models. *J. Hydrol.* **558**, 405–420 (2018).

Note: A reduced version of the Master thesis can be done as Master project.

Requisites: This thesis requires a strong interest in environmental data analysis, solid use of R (or of another scripting language) for large data analysis and basic GIS skills.

Relevant courses and knowledge: Hydrology, Probability and Statistics

Number of Students: 1 student