Development of early warnings for precipitation-induced hazards in Central Asia by application of ECMWF forecast products

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Key Messages

- Producing reliable forecasts capable of capturing the rainfall values is challenging in complex mountain terrain due to the forecast uncertainty and computational cost especially in data-scarce regions. Central Asia is one of these regions, where extreme rainfall leads to flash floods and debris flows in the mountains and foothills.
- In this study, we evaluate and compare the skills of two probabilistic forecasts developed by ECMWF: standard Ensemble Forecasts (ENS) which consists of an ensemble of 51 members and ecPoint Rainfall[1] (99 member values) produced by statistical post-processing of ENS and delivers probabilistic forecasts of rainfall totals for points within a model gridbox (18 km resolution) that can be particularly useful in the mountains of Central Asia.
- We discuss on designing and maintaining effective early warning systems for debris flows in Central Asia and the implementation of impact-based forecasting in the region as a next step of the study.

Investigation area 35-50 N, 50-80 E

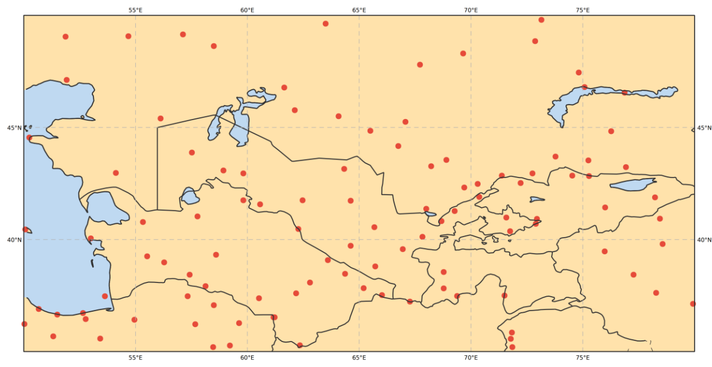

Fig 1. Map showing the Central Asia (35-50N, 50-80E) and SYNOP rain gauge sites used in verifications for this study

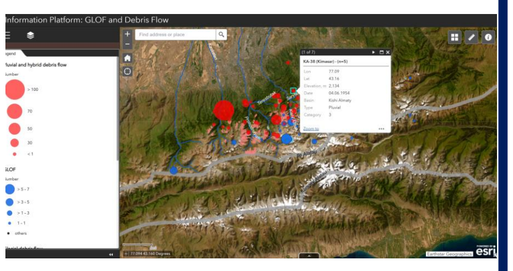

Fig 2. Information platform on debris flows in Central Asia. Source: Shahgedanova et al. (in preparation)

1 Data

– ECMWF forecasts (ENS & ecPoint[1])
– Observations (SYNOP)
– Debris flows data

2 Methods

– Nearest Neighbour
– General ROC verification for probabilistic forecasts
– AROC
– Brier Score
– CDF analysis

3 Verification

– standard ENS
– ecPoint Rainfall product
– Verification period March-May 2022

Results

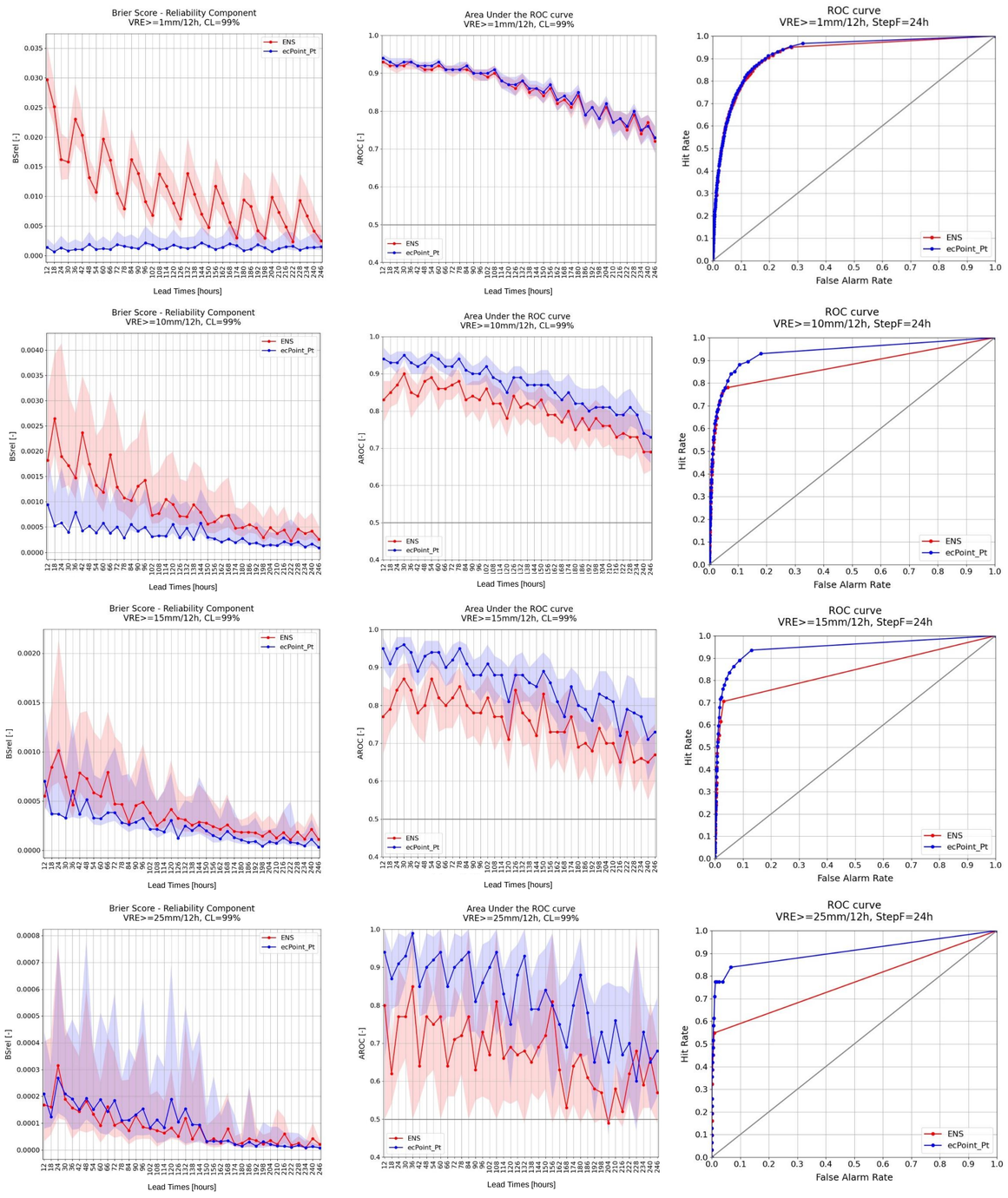

Fig 3. Forecast verification scores for MAM 2022 using SYNOP observations for the Central Asian region. Left column displays BSrel metrics, middle column shows AROC and right column ROC curves of forecast products ENS (red line) and ecPoint (blue line) for a different thresholds: ≥1, ≥10, ≥15 and ≥25mm/12h.

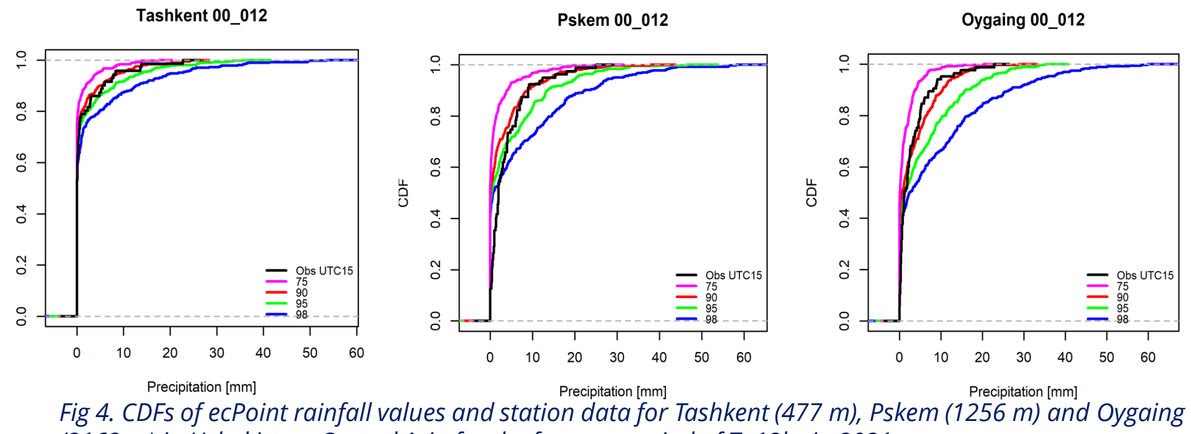

Fig 4. CDFs of ecPoint rainfall values and station data for Tashkent (477 m), Pskem (1256 m) and Oygaing (2162 m) in Uzbekistan, Central Asia for the forecast period of T+12hr in 2021

Case study 20/04/2022

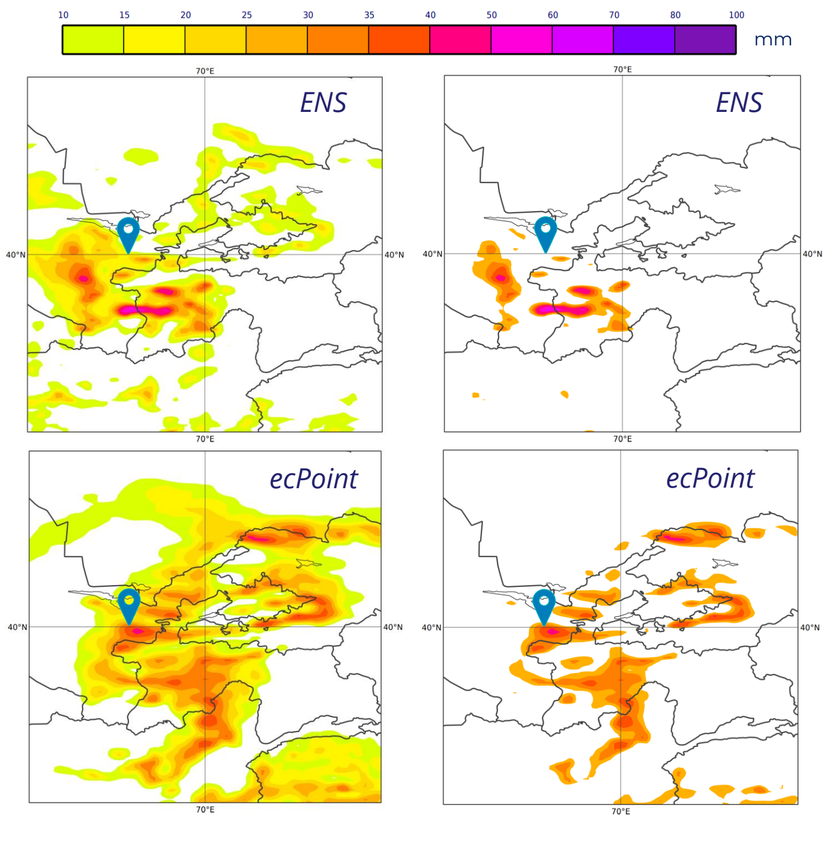

Fig 5. 95th percentiles of 10mm/12h (left panel) and 25mm/12h (right panel) rainfall forecasts for T+42h lead time 20/04/2022 from raw ENS and ecPoint products.

- 5 fatalities and extensive damages
- destructive event with the return period of 50 years
- of 31.5 mm rainfall within 2 hrs in Gallaorol station, Uzbekistan

Debris flow area

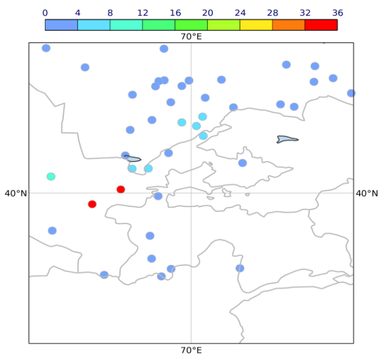

Fig 6. 12 hr accumulated rainfall observation 20/04/2022

Conclusion & Future Outlook

- Verification trials in Central Asia show that the performance of ecPoint Rainfall depending on the forecast lead-time can be a good proxy for the range of point rainfall values to define the warning areas of debris flow risk over the study area.
- In the next step, we will be identifying rainfall threshold inducing debris flows in the region.
- Delivering forecast for early warning in National Hydrometeorological Services of the Central Asian countries.
- Development of early warning of debris flow events in High Mountain Asia (HMA) using point based ecPoint Rainfall forecasts. This study will be conducted under the Schlumberger Foundation Fellowship programme (2023-2024).

References

1. Hewson&Pillosu (2021) A low-cost post-processing technique improves weather forecasts around the world. https://doi.org/10.1038/s43247-021-00185-9
2. Wilks, D.S. (2011) Statistical Methods in the Atmospheric Sciences. 3rd Edition, Academic Press, Oxford

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