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Performance of GloFAS Flood Forecasts using proxy data in Uganda

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1 Introduction and background

Capabilities to forecast fluvial flooding are not equality spread across the globe and forecasting systems are especially limited in flood-prone low-income countries (Revilla Romero et al., 2014). The availability of higher spatial and temporal resolution remote sensing data and the increase in post processing technology have opened opportunities for fluvial forecasting at a continental and global scale (Emerton et al., 2016a) (Revilla-Romero et al., 2015). This means flood forecasts are available for regions where previously there were no forecasting capabilities. The availability of flood forecasts for flood-prone low-income countries does not directly lead to action being taken in case of flooding. The forecast based financing program of the Red Cross Climate Centre enables early action to be taken using probabilistic forecast information, with the aim of reducing the impacts of flooding (Coughlan de Perez et al 2015). The program uses a combination of forecast models including the Global Flood Awareness System (GLoFAS) and is active in multiple location including Tongo, Peru and Uganda. There are many factors at play to create an effective early warning system, including the performance of the forecast. Analysing the performance of forecasts is essential for the further improvement and development of an effective early warning system. However, in low-income countries with a low data availability this is a major challenge. This poster shows the performance of the GloFAS forecast using proxy flood event data in the North East of Uganda and poses the question: "How can the performance of forecasts be analysed when data is limited and uncertain?".

2 Uganda

Uganda is located in East Africa and borders Kenya, South Sudan, Democratic Republic of the Congo, Rwanda and Tanzania. Uganda is located at the equator and its climate can be categorised as tropical with a bimodal rainfall regime. The wet seasons are March to May and September to November. One of the regions where the Red Cross is using the GloFAS forecast is located in North Eastern Uganda. In this region of Uganda gauged rainfall and flow data is limited to a couple of gauges that are not available for this study. Alternative flood monitoring data is available from Flood Tags (FloodTags, 2017). The East Uganda Flood Tags have recorded flood events in the regions of Kotido, Abim, Amuria, Katakwi and Soroti. The flood events are recorded with their year, month, region, source of the data and description of the flood event. Two datasets are available, the confirmed and unconfirmed flood events. For this poster only confirmed flood events have been used.

Figure 1: Flooding in Katawi (IFRC, 2007)

3 Global Flood Awareness System (GLoFAS)

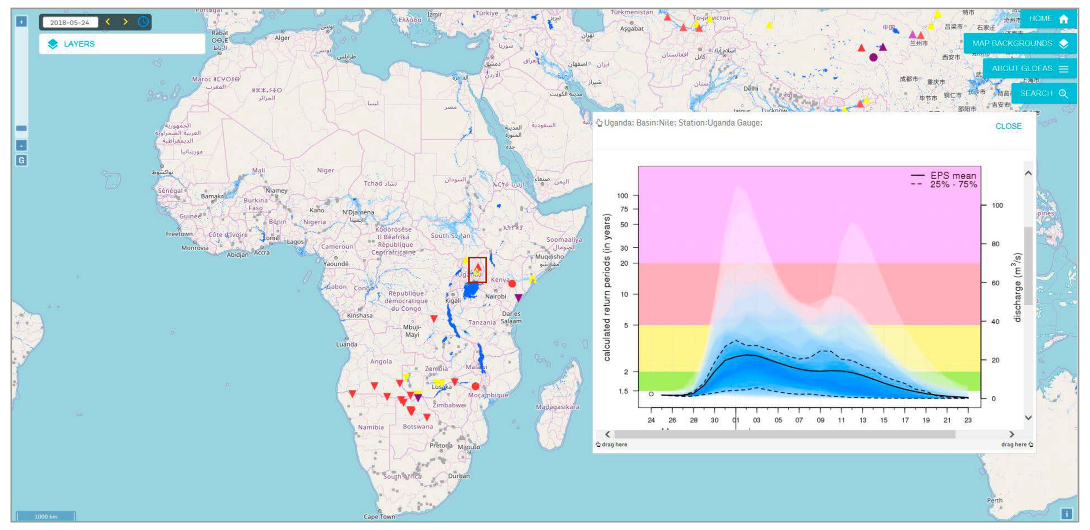

Figure 2: GLoFAS forecast for Soroti, Uganda (JRC et al., 2018)

The GLoFAS model has been setup with the aim to provide an overview of upcoming floods in large world river basins. GLoFAS forecasts using the Variable Resolution Ensemble Prediction System (VarEPS). It consists of a 51 member ensemble with a horizontal grid resolution of ~32 km with a forecast span of 10 days, and ~65 km with a forecast up to 15 days. Twice daily forecasts are available via the GLoFAS website on a 10 km grid and also for reporting points around the world, including Uganda (Figure 2). The surface runoff is produced by HTESSEL as part of the operational weather model at ECMWF. This is used to force the routing component which is Lisflood for both operational forecasts and the reforecasts (Figure 3).

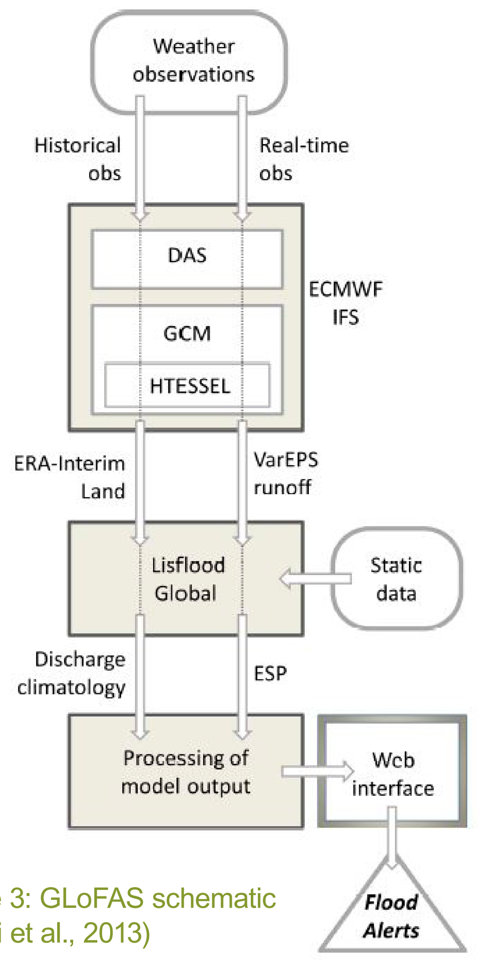

Figure 3: GLoFAS schematic (Alfieri et al., 2013)

4 Method

This analysis uses the GloFAS flow reforecast time series ranging from 2008-2016. Historical flood data from Flood Tag indicates in which months a flood has occurred. To compare GloFAS to the flood events in Flood Tags the most downstream pixel in the region as indicated by Flood Tags has been located (Figure 4). From this, hits, misses and false alarms were calculated. If the flood threshold was crossed in a forecast within the month in which a historic flood was recorded, this was scored as a hit. If an event was forecast but there was no historic flood recorded in that month it was recorded as a false alarm. If an event was recorded, but the flood threshold was not crossed that month, the event was recorded as a miss. These rates can be compared to the performance of the climatology to get an indication of the skill of the forecast. The climatology was calculated as the average flow on each day of the year using the initial condition from the reforecast GloFAS time series (2008-2016).

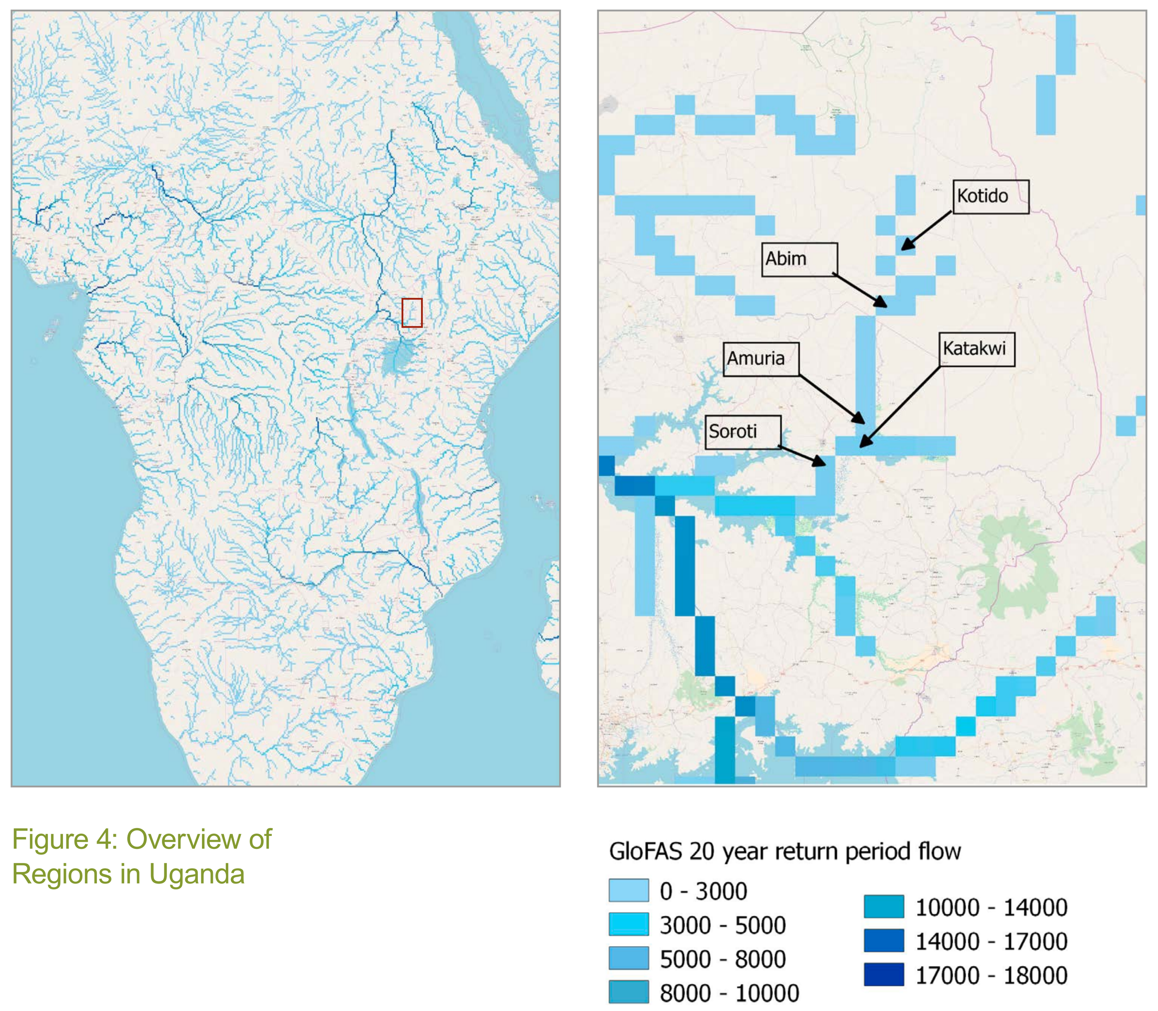

Figure 4: Overview of Regions in Uganda

5 Results

It is difficult to draw conclusion from the results of Kotido, Abim and Amuria. These upstream catchments are small in size (<10,000 km²) and/or have a low amount of recorded flood events (six or less). This means a single miss/hit flood event will have a large impact on the performance scores. The results for downstream regions of Katakwi and Soroti are more reliable as the catchment area is larger (>22.000 km²) and there are more recorded flood events (nine or more). Figure 5 and Figure 6 show the hit rate, false alarms and misses for the Katakwi and Soroti regions, for a range of flood thresholds based on the percentiles calculated using the simulated reforecast GloFAS time series from 2008-2016. The graphs show the results for forecast time zero (initial conditions), two, four, six and eight. These graphs show the performance of the ensemble mean, however the same analysis was done for the 50th percentile, the results were very similar. For the Katakwi region assuming the flood threshold is set at the 75th percentile the hit rate is 66% for the initial conditions and improves to 88% at lead times of two, four, six and eight hours compared to a hit rate of 77% for the climatology. In terms of actual events this means that at lead times of two, four, six and eight hours 8 out of 9 flood events were predicted, where as the initial conditions forecast 6 out of 9 and the climatology 7 out of 9. The miss rate shows a similar pattern with the initial conditions missing the most events at 33% assuming the flood threshold is set at the 75th percentile and the miss rate being lower for lead times two, four, six and eight at 11%.

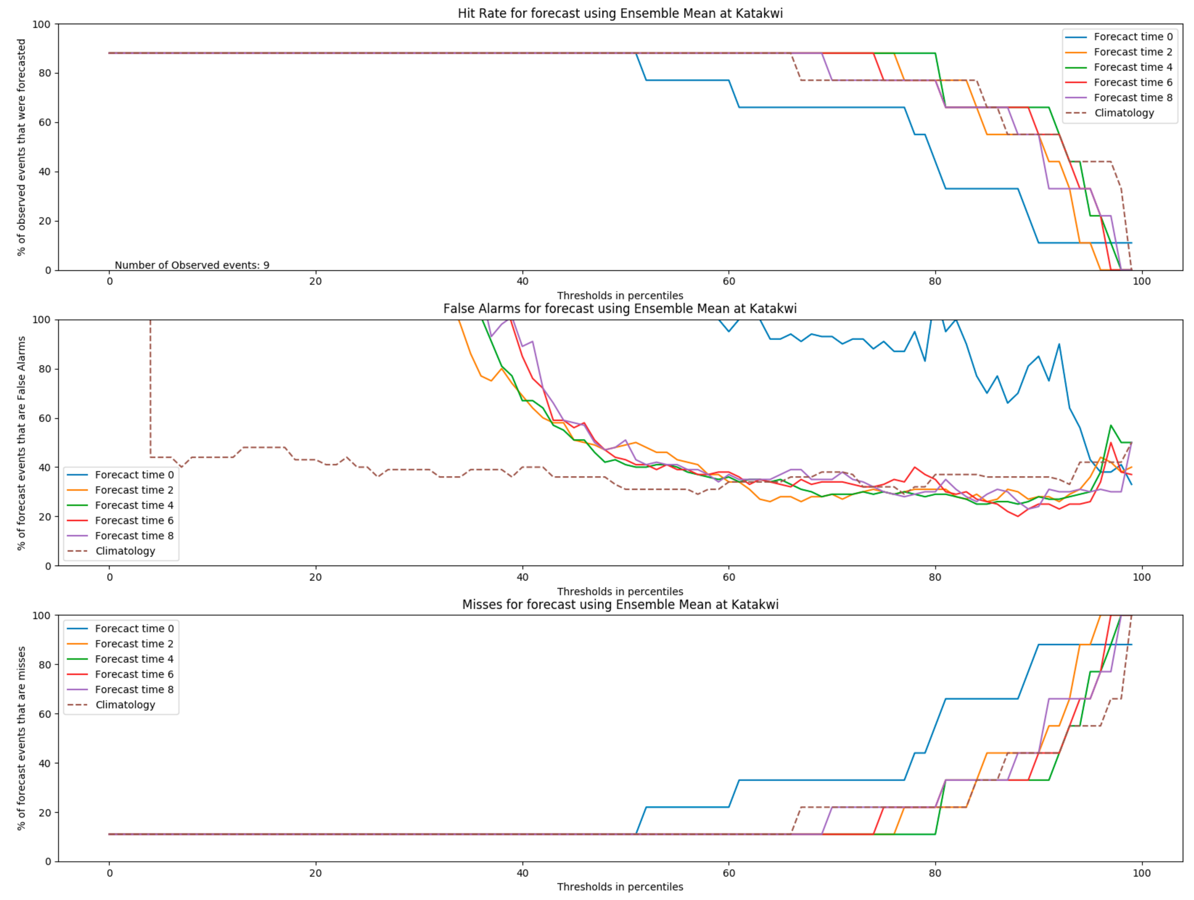

Figure 5: Hit rate, False Alarms and Misses of GloFAS forecasts for Katawi, Uganda

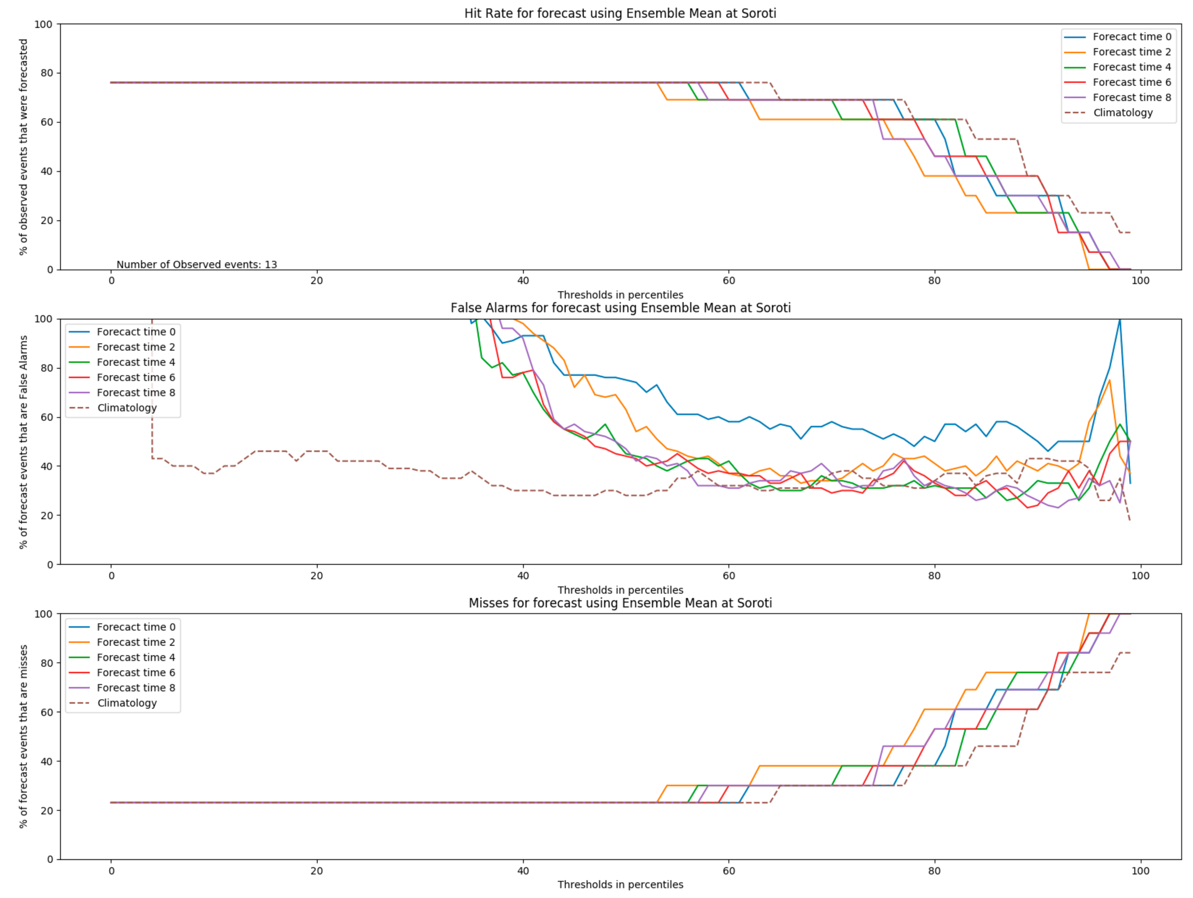

Figure 6: Hit rate, False Alarms and Misses of GloFAS forecasts for Soroti, Uganda

6 Conclusion

The performance of the GloFAS forecast in terms of percentage hits and misses is good compared to the Red Cross target of not acting in vain no more than 50% of the time. When the performance is compared to the climatology the results are less encouraging with the climatology performing very similarly to the forecast and occasionally outperforming the forecasts.

7 Discussion

From using this proxy data it is possible to estimate the hits, misses, false alarms and correct rejections. The assumption can be made that the hit rates are fairly accurate, as it is unlikely that a reported flood was incorrectly reported. The calculated false alarm rates however are more uncertain, as it is likely not all floods were reported, especially minor floods. This will also affect the misses and the correct rejection scores. However, the uncertainty of the observed data is not represented within these scores. Many existing skill scores like the brier scores and ROC curves use all four above mentioned scores without being able to correct for the uncertainties in the flood event data. The two main questions that require answering in future are:

> Which skill score can account for uncertainty in the flood event data?
> If there are no existing scores what are the characteristics of a skill score that could account for uncertainty in the flood event data?

8 References

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