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Estimating flood forecast performance using inundation data in Soroti, Uganda

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1. Introduction

Interest from the humanitarian and insurance sectors into using global flood forecasts products in remote areas mean that questions around the uncertainty, reliability and skill of global flood forecasts at a local scale are becoming increasingly relevant. The International Federation of Red Cross and Red Crescent Societies (IFRC) are running the Forecast-based Financing (FbF) program that aims to enable access to humanitarian funding for preventative action which can decrease impact of a disaster.

Funds will be released based on forecast information and risk analysis. FbF has been piloted in 16 locations including Uganda. For flood warning FbF uses the Global Food Awareness System (GloFAS). This piece of work looks into the performance of global flood forecasts for users at a local level in north east Uganda. The question that is being answered is: "Can Earth-Observation based gridded flood data be used to assess the accuracy of a global flooding forecasting system in north-east Uganda?".

2. Location, data and models

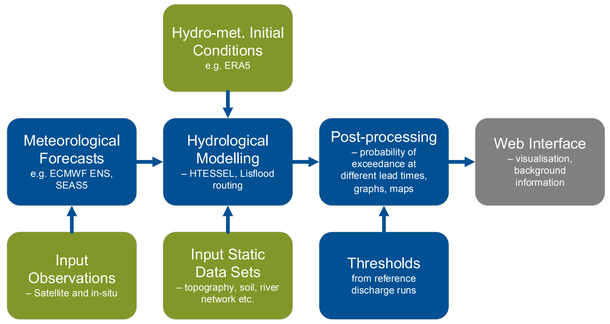
The regions where the Uganda Red Cross Society uses GloFAS forecasts include the North Eastern part of the Lake Kyoga catchment in which the Rivers Okok, Oker and Lake Bisina are located. The centre of the catchment is characterised by an extensive system of seasonal and permanent wetlands. Flooding takes place in this area owing to runoff from the mountains slopes in the east and the backwater effect from Lake Kyoga in the south west.

Data and models used for this assessment include:

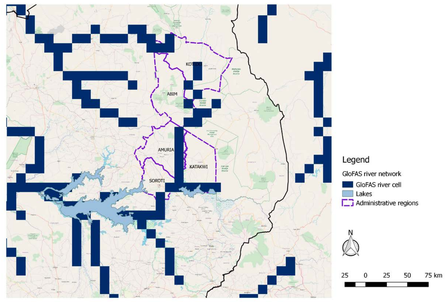
> GloFAS: which provides predictions of floods in large world river basins (Alfieri et al., 2013). GloFAS version 2 – 30 days is a 51 member ensemble of stream flow prediction (forecast length of 30 days). GloFAS version 2 consists of a chain of input data and models that together produce a stream flow forecast (see flow diagram). For this research GloFAS forecast reruns have been used. The figure shows the Rivers Okok, Oker and Lake Bisina as represented in GloFAS version 2.

> The African Flood Extent Depiction (AFED) dataset is created by Atmospheric and Environmental Research (AER) and uses satellite data to detect flooding. The AFED was created for African Risk Capacity (ARC) (ARC, 2019). The AFED uses inundation data from satellite remote sensing data (microwave sensors) to map the flooded fraction of a pixel on a daily time scale from 1992 to 2019.

> FloodTags have used reports of extreme weather events in local newspapers to produce records of historic flooding for the North East of Uganda (Kotido, Abim, Katakwi and Soroti). Automated procedures are used to read and interpreted articles from newspapers. Two newspapers, Daily Monitor and New Vision, were analysed. (FloodTags, 2019).



Schematic of GloFAS version 2 - 30 day.



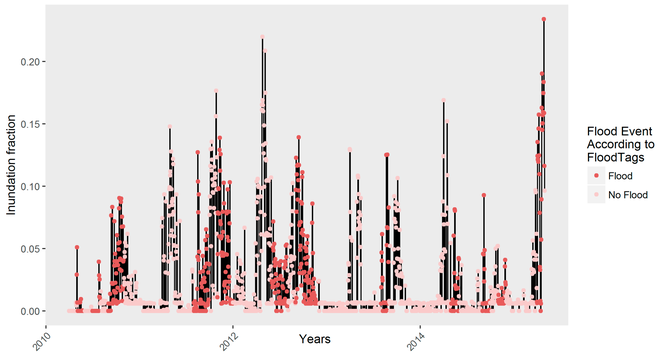
Rivers Okok, Oker and Lake Bisina as represented in GloFAS version 2.

3. Event identification from inundation data

Values of the AFED are inundation fraction per grid cell with values ranging between zero and one, where one is fully inundated (open water) and zero is dry.

Different methods of extract the AFED data were tested and extracting location specific inundation at the catchment outlet was considered most effective.

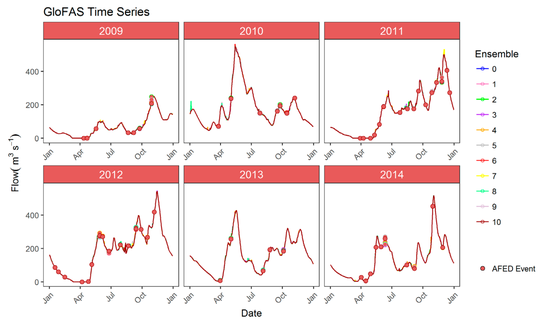
The figure shows how the AFED peaks correspond to the recorded flood events from FloodTag.



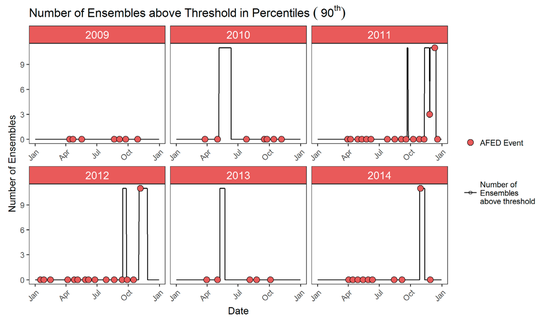
Correspondance between AFED peaks and FloodTags.

4. Results

The selected AFED events can be plotted together with the GloFAS flow series to see if the forecast peaks coincide with the recorded flood events in FloodTags, shown below. In general there does not appear to be a relationship between the two datasets.



The figure below shows the number of ensembles crossing the 90th percentile threshold as a time series, with the events from the AFED data as points. When the line goes above 6 and warning would be issued. If warnings would he issued during events, points would coincide with the line being >6, this is not the case.



Hits, misses and false alarms can provide an insight in the accuracy of a forecast model. Four different ways of assessing the False Alarm Ration (FAR) are presented:

	Warning	No warning
Flood	Hit	Miss
No flood	False alarm	Correct rejection

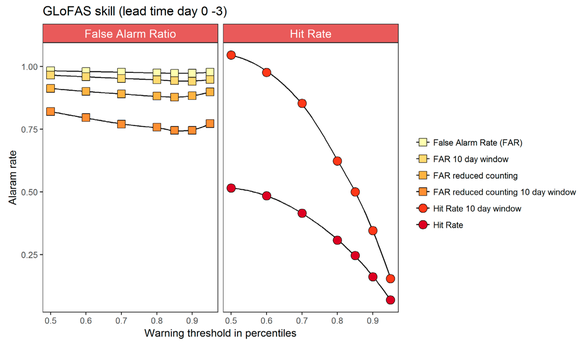
> FAR using day by day comparison – False alarms were counted for every day that the GloFAS forecasts provide a warning, but the AFED data does not indicate there is an event.

> FAR with reduced counting – Due to the differences between inundation data and flow data there are issues with double counting the same event and due to this the False Alarm Ratio (FAR) will be overestimated. This is addressed by counting the first occurrence of a false alarm after which a second false alarm is counted after 6 days, this removes large blocks of false alarms.

> FAR with a 10 day window – In accordance with GloFAS guidance any warning within 10 days of an events are considered hits, not false alarms.

> FAR with reduced counting and a 10 day window – this approach combines the two approaches described above.

The figure below shows that the FAR is problematically high and in order to achieve a satisfactory hits rate the flooded threshold in GloFAS needs to be set to the 80th percentile.



5. Discussion and conclusion

Global models have been found to be able successfully reproduce the hydrology of major river basins (Siderius et al., 2018) (Hirpa et al., 2018) (Bernhofen et al., 2018) . However, global models can struggle to capture local hydrological processes (Fleischmann, 2019), especially in regions with river deltas, arid and semi arid zones and wetlands (Trigg et al., 2016). When applied regionally, global models can provides a first approximation of the hydrology, but this doesn't necessarily mean the performance is good enough for the decision making they are aimed at. GloFAS vs2 has shown to be able to simulate seasonal trends and recorded flood events for North Easter Uganda. Further analysis using the AFED data as a best representation of observations indicates that GloFAS forecast are likely to result in too many false alarms in order for the forecasts to be applied for humanitarian action.

References

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