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Met Office
INPA Instituto Nacional de Pesquisas da Amazônia
INPE Unidade de Pesquisa do MCTI
Cemaden Centro Nacional de Monitoramento e Alertas de Desastres Naturais
Newton Fund

Briefing Note

A briefing on research from the Climate Science for Service Partnership (CSSP) Brazil for decision-makers

Supporting flood forecasting for better disaster risk management

The Amazonian floodplains have been the life-line for indigenous and traditional populations in Brazil for centuries, supporting activities such as agriculture, livestock production, fisheries and forestry – all intrinsically related to the water cycle (Junk et al., 2014). Is this way of life being threatened by changes in the water cycle due to global warming? The Climate Science for Service Partnership (CSSP) between Brazil and the UK is developing a new method to forecast floods to protect areas such as the Amazon region from the impacts of severe climatic events - PEACFLOW. This pilot study produces forecasts with similar skill to operational ones but with a longer lead time, which will benefit preparedness and disaster management of future floods.

Need for flood risk management plans with a longer lead time

The increasing frequency and magnitude of floods in the last two decades has caused considerable environmental and socio-economic losses in many regions of the Amazon basin (Marengo and Espinoza, 2016). Although some studies have estimated an increase in flood risk in this basin (de Andrade et al., 2017), most towns in this region still lack operational flood forecasts and integrated flood risk management plans.

During the last ten years, the Central Amazon region has been affected by seven severe flood events (2012, 2013, 2014, 2015, 2017, 2019 and 2021) reaching the critical threshold to declare an emergency. To prevent and mitigate severe impacts on the urban and rural populations and on socio-economic sectors, seasonal forecasts of severe flood events with a longer lead time are required, to provide a reliable decision-making tool for policy-makers.

New method for seasonal forecasts of flood events

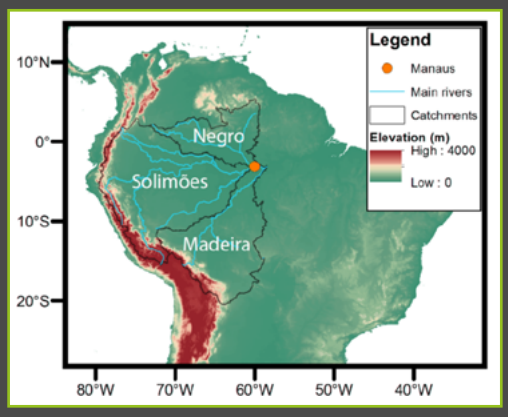
CSSP Brazil is developing a new system to forecast the annual maximum water level for the Negro River at Manaus, Brazil, with longer lead times than current operational models. The models may be expanded to other strategic locations in the Amazon basin in the future.

The river usually reaches its annual maximum water level at the end of June. This new system is designed to support the official flood forecasts issued by the Brazilian Geological Survey (CPRM) in Manaus at the end of March each year, providing essential information for effective implementation of disaster risk management actions.

Predicting the Evolution of the Amazon Catchment to Forecast the Level Of Water (PEACFLOW)

The CSSP Brazil project PEACFLOW is focused on developing forecast models for annual maximum water levels for the Negro River at Manaus, Brazil, using a multiple linear regression approach – a statistical technique used to predict the value of a variable based on the value of several other variables (or predictors). The new method includes the use of various predictors from preceding months, such as rainfall, river water level and Pacific and Atlantic Ocean conditions.

Flood levels in the Negro River usually occur between May and July and are strongly influenced by the rainfall from November to February, as its large floodplains delay the flood wave by months (Schöngart and Junk, 2007). This delay and the regularity between the rainfall and peak water level allows for the development of skilful statistical forecast models that can issue forecasts by March. Using dynamical seasonal rainfall forecasts to predict the January and February rainfall can extend the lead time of these forecasts by one or two months.



The Negro, Solimões and Madeira Rivers (blue lines) and their catchment basins (regions bounded by black lines) contribute to the river water level at Manaus (yellow circle).

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How does it perform against operational forecast models?

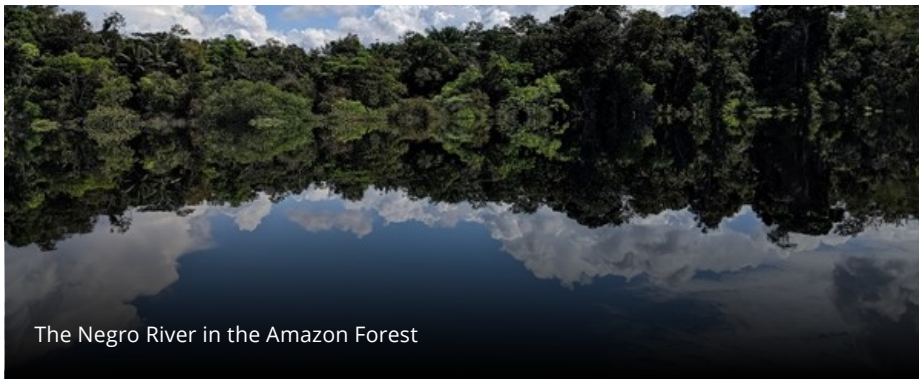
The new PEACFLOW forecast models for the annual maximum water level (flood level) for the Negro River were developed by finding the best model fit to weather and river data between 1903 and 2004 (the 'training' period). The most important variable to be used as a predictor in the multiple regression approach was rainfall over the Negro, Solimões and Madeira river catchments.

The PEACFLOW models used as input either observations of weather variables and river levels, or data from the ECMWF seasonal ensemble forecast. Flood forecasts were made in the middle of January, February and March for each year between 2005 and 2021 (see Figures on the right). These forecasts were compared to flood forecasts made by current operational models used by the Brazilian agencies CPRM and INPA (the National Institute of Amazonian Research).

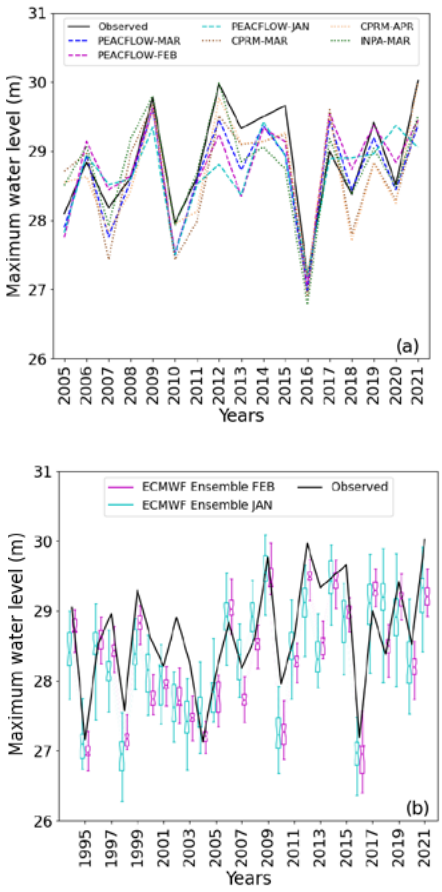
Forecasts made by the PEACFLOW models in March, using observations as input, showed similar skill to forecasts from current operational models in April.

Forecasts made by the PEACFLOW models in February, using the ECMWF seasonal ensemble forecast as input, showed similar skill to forecasts made by current operational models in March.

This pilot study shows the PEACFLOW forecasts offer similar skill with a longer lead time, which will benefit preparedness and disaster management in the face of future flood events.



The Negro River in the Amazon Forest



Flood forecasts of the annual maximum water level at Manaus created by existing operational models and the PEACFLOW models using (a) observations and (b) the ECMWF seasonal ensemble as input. The black line shows the observed values for annual maximum water level at Manaus.

- The methods developed in this project can also be used to develop forecast models for flood and drought levels over other regions of the Amazon basin.
- Fully automated PEACFLOW models are provided in a GitHub repository at https://github.com/achevuturi/PEACFLOW_Manaus-flood-forecasting.

This work was produced by the University of Reading, the UK Centre for Ecology and Hydrology (UKCEH), INPE, INPA and Cemaden.

References

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