Climate variability and extended-range flood forecasting for the Peruvian Amazon

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Communities in the Loreto region of Peru have adapted to live with the annual rise and fall of the river Amazon, but population growth has meant that the most vulnerable communities have expanded into the Amazon floodplain. This expansion has coincided with severe flooding above 'normal' high water levels, particularly in 2012 and 2015. Forecast-based Financing (FbF) is a project of the German and Peruvian Red Cross which aims to reduce risk to these vulnerable communities by taking preparation and risk reduction actions based on forecasts of an upcoming flood. However, the timescales needed to take action are long (e.g. several weeks to months ahead to buy materials and reinforce houses), and outside the capabilities of current forecasting systems.

In collaboration with the Peruvian Meteorological and Hydrological Agency in both Lima and Iquitos, the Joint Research Centre in Ispra, Italy, and the European Centre for Medium-range Weather Forecasts (ECMWF), the Global Flood Awareness System (GloFAS) is being calibrated and validated using local observations of river flow. The aim of this studentship is to address the research question: is the skill in seasonal precipitation forecasts over the Amazon basin sufficient to enable flood forecasting at seasonal timescales?

The student will begin with reviewing the current skill of two different configurations of the GloFAS hydrometeorological model (Alfieri et al. 2013) and seasonal precipitation forecasts in the region. A multi-model approach is needed to determine the importance of representing backwater effects on the Peruvian Amazon (Yamazaki et al. 2011).

From this the student will build a climatology to analyse the source areas of flow in the Amazon; currently the River Maranon is estimated by SENAMHI to contribute 60% of the flow at Iquitos, with the Ucayali contributing 40%, but more rigorous analysis is needed and the flow is known to be variable over time. This analysis will build a rigorous understanding of the climatic sources of this variability and how it contributes to the eventual flood magnitude at Iquitos as flood waves travelling along different tributaries coincide. Linking source areas of flow to predictability within the seasonal forecasting system will develop the ability to expand the limit of predictability of the Amazonian flood wave.

From this new scientific understanding the student will develop extended-range forecasts of flood flows in the Amazon, sharing the knowledge with Peruvian partners. The extended-range forecasts will provide a probability that flood danger levels will be exceeded, and using these forecasts, the Peruvian Red Cross will automatically take action to reduce risk in areas where the seasonal probability of flooding has increased.

The student will undertake a 3 month placement with the Red Cross Red Crescent Climate Centre during their studies. This is anticipated to consist of 1 month working alongside Juan Bazo and the FbF team in Lima to help understand the goals and challenges of FbF, followed by further placements to share results, such as to SENAMHI and the Red Cross teams in Iquitos on the Amazon river.
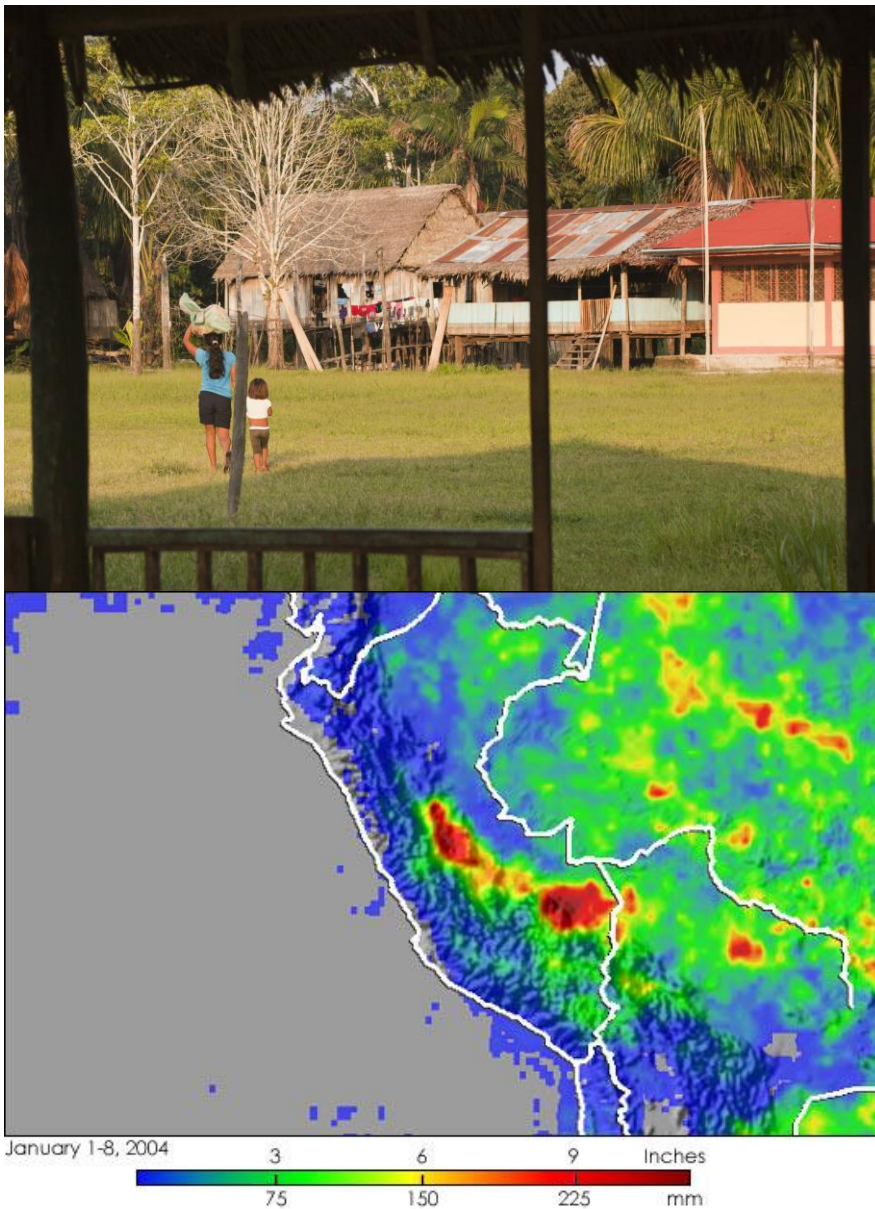
Top: Vulnerable communities living alongside the River Amazon. Bottom: TRMM data showing heavy rainfall over the upper River Ucayali catchment, a major tributary of the River Amazon.

Training opportunities:
The student will undertake the PhD training planning required by SCENARIO considering researcher development courses, Masters level modules (e.g. Preparing for Floods, Atmospheric modelling) as appropriate to the student's academic background and experience. As appropriate further training in Spanish language and Python programming will also be required. The student would be expected to attend a Summer School, e.g. the Swiss Climate Summer School, as well as several of the formal training courses at ECMWF (e.g. supercomputing, use of ECMWF products and their retrieval) as well as bespoke informal training carried out by the flood forecasters at ECMWF and JRC.

The student will carry out a **3-month placement** with the Red Cross Red Crescent Climate Centre during their studies; working in Lima and the project areas in Peru alongside the Forecast-based Financing pilot study team. The student will also work in partnership with SENAMHI in Peru, drawing on expert local knowledge to enhance the understanding of Peruvian climate variability and forecasting challenges.

Student profile:
This project would be suitable for students with a degree in meteorology, physical geography or environmental Science. Students will be required to work in a unix programming environment with python or similar, previous experience is not essential as training will be provided. Students should either be able to speak Spanish or be

willing to undertake lessons at the University during their first year.

Funding particulars:

References:

Alfieri, L., Burek, P., Dutra, E., Krzeminski, B., Muraro, D., Thielen, J., & Pappenberger, F. (2013). GloFAS–global ensemble streamflow forecasting and flood early warning. *Hydrol. Earth Syst. Sci*, *17*(3), 1161-1175.

Yamazaki, D., Lee, H., Alsdorf, D. E., Dutra, E., Kim, H., Kanae, S., & Oki, T. (2012). Analysis of the water level dynamics simulated by a global river model: A case study in the Amazon River. *Water Resources Research*, *48*(9).

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