Machine Learning for Early Warning Systems

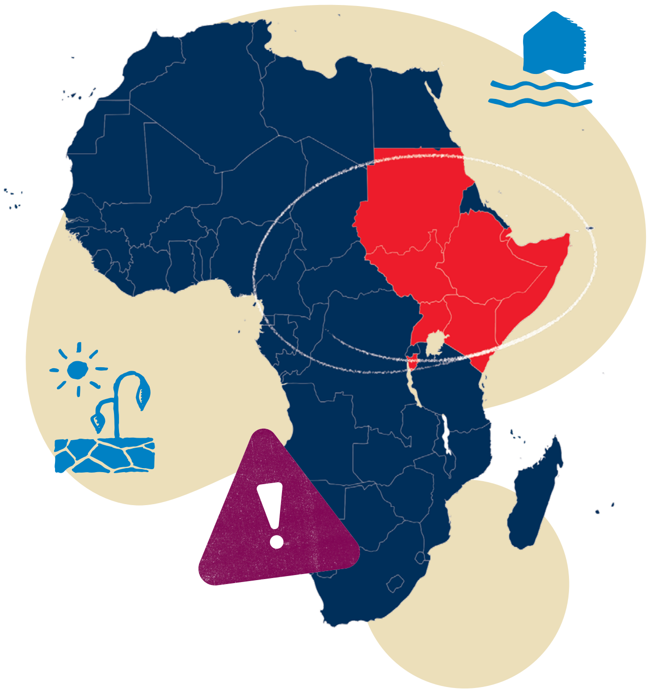
Today, a unique opportunity exists within the humanitarian community to reimagine the role of technology in building the resilience of vulnerable communities against the increasing frequency of extreme weather events.

The **World Food Programme (WFP)** with grant support from **Google.org**, is collaborating with the **University of Oxford, IGAD Climate Prediction and Applications Centre (ICPAC), Kenya Meteorological Department (KMD), European Centre for Medium-Range Weather Forecasts (ECMWF) and the Ethiopia Meteorological Institute (EMI).**

Together, they are leveraging their expertise in artificial intelligence, weather prediction, early warning systems and emergency response to protect lives and livelihoods in Eastern Africa.

November 2023

At a time when the impacts of climate change and conflict are escalating humanitarian needs, and with only one-third of the world having access to life-saving early warnings, innovative solutions are imperative to prevent and mitigate the impacts of predictable severe weather events. One of these solutions is anticipatory action (AA), which triggers the delivery of lifesaving actions in the critical window between an early warning alert and the impact of a severe weather event. However, if we are to build trust in early warnings, enabling governments to implement AAs at scale, early warning systems (EWS) must demonstrate reliable predictions of extreme weather events at the localized level, days and weeks ahead of time.



> *If this can be achieved, early-warning will be the ubiquitous go-to tool to help society become more resilient to the ever-greater intensity of weather extremes*
>
> **Professor Tim Palmer**[1]

Yet, despite the knowledge that investments in EWS are worth at least ten times their development costs relative to the damages they offset[2], the tools and resources needed for strengthening these systems remain a barrier for most National Meteorological and Hydrological centres.

Machine Learning & Advanced Neural Networks

Generative Adversarial Networks (GAN) are a type of machine learning and neural network model commonly used in image enhancement. They can transform low-resolution images into high-resolution ones, all without the need for costly supercomputers. Oxford University has adapted this technology to improve the accuracy of rainfall forecasts. They have taken global models (which provide lower-resolution forecasts) and fine-tuned them to be useful at local levels (yielding high-resolution results). This is accomplished by using many past examples of weather forecasts, together with the actual observed rainfall, allowing it to "learn" how to enhance the forecasts. Importantly, this method requires less costly computational power than traditional local area models. Initial findings indicate that this approach not only matches but even outperforms existing techniques[3], especially in forecasting extreme rainfall events.

> *There is a practical requirement for the application of machine learning in improving weather forecasts, and Google support for this project is commendable.*
>
> **Dr Guleid Artan Director ICPAC**

1 https://ppe-openplatform.wmo.int/en/WP1TP
2 Adapt Now: A Global Call for Leadership on Climate Resilience
3 A Generative Deep Learning Approach to Stochastic Downscaling of Precipitation Forecasts

Partnerships

Skillful early warnings and weather forecasts delivered by national and regional meteorological centres like KMD, EMI and ICPAC play a vital role in any effective disaster risk management system. These centres provide tailored forecasts and alerts crucial for agriculture, water management, and public safety. Additionally, ICPAC, serving as the regional centre of excellence in climate science and application, ensures coordinated efforts to help member states tackle climate risks and adapt to climate change.

The technical support from ECMWF, coupled with their global medium-range weather forecasting model and the longstanding collaboration with WFP, forms the foundation of this project's objective. Availing their expertise, data, and computational resources, ECMWF's support has been instrumental and is a testament to their long standing support of AA[4], recognizing that forecasts alone could never reach their full value unless early warnings are translated into actions.

Image Credit: ICPAC/Edwin Kiplagat

The Future

With partners in place, support from Google.org and the collective interest to challenge the status quo, the next steps entail training meteorological centres to run, adapt, and optimize the GAN model to the complex rainfall patterns in eastern Africa. This includes establishing baseline scores to assess the reliability of the current forecasts, enabling progress tracking in forecast improvements using GAN, and adapting the GAN for seasonal and sub-seasonal forecast timescales.

WFP remains committed to innovation aimed at shifting from reactive to proactive risk management. WFP is dedicated to supporting government partners in enhancing their capacities to deliver skillful early warning systems. However, we recognize that this mission requires collective action. We need partnerships with both public and private sector organizations that bring their technical expertise and funding to pre-arrange financing and strengthen capacity in early warning systems and anticipate risks before they escalate into disasters. Strengthening early warning systems to enable action before disasters, not only saves more lives and livelihoods, but it is also a more efficient, cost-effective, and dignified approach to humanitarian response.

3 https://www.ecmwf.int/en/about/media-centre/news/2022/ecmwf-forecasts-help-provide-early-warnings-and-early-actions

With support from:

ECMWF
Google.org
IGAD ICPAC
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UN WFP World Food Program USA
Ethiopian Meteorology Institute
UNIVERSITY OF OXFORD
WFP World Food Programme

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