**ARC River Flood Model (AFM-R)**

**UPDATE | Tropical Cyclone Idai Flooding: Southern Africa (March 2019)**

The powerful **Tropical Cyclone Idai** made landfall near the city of Beira during the night of 14 – 15 March 2019, causing severe flooding in Mozambique and Malawi, and making its way further inland to areas as far as Harare, Zimbabwe. The cyclone has been reported to have affected over 2.6 million people in its path, leaving upwards of 400 lives lost, key infrastructure damaged or destroyed, and communication, electricity and water supplies compromised. Already in early March, prior to the tropical cyclone making landfall, severe flooding was reported in Malawi and Mozambique as a result of Idai’s larger weather system during which several people were reported to have lost their lives, approximately 82 700 people were displaced and thousands of hectares of croplands were destroyed. Although the weather system is expected to weaken over the coming days, latent effects of the damages and losses already incurred are anticipated and further intense rainfall and widespread flooding is expected to continue in parts of the affected countries.

The purposes of this bulletin are to: 1) Provide an update based on the most recently available information regarding the ongoing flooding in Malawi, Mozambique and Zimbabwe, 2) Provide information regarding the current situation based on the most recently available data from the **ARC Flood Extent Depiction dataset (AFED)** and other relevant sources of spatial data with the intention to serve ARC Members States, humanitarian actors and partners in their efforts to support affected people, and 3) Provide brief background information regarding the capabilities of the AFED dataset, which forms the basis of the ARC River Flood Model (AFM-R) to detect and depict large-scale river flooding such as the flooding described above.

AFM-R is currently in its pilot phase and will be available to ARC Members States as of the next season.

**Overview:**

**Impacts of Tropical Cyclone Idai:**
The full impacts of the Tropical Cyclone, at this stage, remain unclear and the areas affected are subject to further potential devastation. The President of Mozambique has recently stated that the death toll from the flooding caused by, and preceding, the cyclone could exceed 1 000. Based on various sources the estimates as of 21 March 2019 may be summarised as follows:

- 242 lives lost in Mozambique, 139 in Zimbabwe with 189 people missing and approximately 56 lives lost in Malawi.
- Over 2.6 million people affected in Mozambique, Malawi and Zimbabwe with at least 400 000 people left homeless in Mozambique, 922 900 people affected in Malawi and 1 600 households (8 000 people) affected in Zimbabwe.
- 577 injuries recorded in Malawi since early March.
- 168 000 hectares of croplands damaged in Mozambique flooding prior to the Tropical Cyclone making landfall.
- Over 500 000 people isolated in Beira, Mozambique.
- Large dam-burst near Beira exacerbating the impacts of flooding.
- Homes and bridges swept away in south-eastern Zimbabwe.

**Further anticipated impacts:**
The weather system is expected to weaken as it moves inland over the weekend, however, significant rainfall and widespread flooding is expected to continue over the Sofala and Manica Provinces of Mozambique, eastern Zimbabwe, and southern Malawi. Further anticipated impacts include:

- Increased risk of flash floods across the regions affected.
- Disruption of infrastructure and water supply interruptions.
- Impacts on local food security due to the destruction of croplands.
- Exposure to water-borne diseases resulting from unsafe drinking water.
- Heightened possibilities for the escalation of gender-based violence against women and children.
- Additional negative impacts arising from the combination of recent droughts and currently ongoing flooding in Zimbabwe.
- Homes destroyed as a result of rockfalls in Zimbabwe.

**Response efforts:**
The Governments of Malawi, Mozambique and Zimbabwe have all mobilised financial, logistical and humanitarian resources for early response actions in the affected areas. Rescue workers and volunteers have been deployed to support local efforts for rescue and emergency relief. However, Governments of the affected countries have launched quick international appeals for emergency response and reconstruction.

- According to the Zimbabwe Red Cross Society the immediate needs for the people affected are shelter (due to the high number of people displaced), food and medical assistance. It was added that rescue efforts have been hampered by flash-floods and damaged infrastructure.
- The UN and humanitarian partners have and stepped in to provide: assistance in the form of air and road transportation facilitation, water-borne disease prevention measures to provide access to clean and safe water, promotion for the use of sanitation and hygiene facilities, assistance to help children gain access to nutrition, protection against the potential negative coping mechanisms among affected communities, and the provision of safe access to schools for children of affected households.
- ExxonMobil has committed to donate 300 000 USD for relief efforts.
- The EU has released 3.5 million Euros for emergency aid in the affected countries.
- The Tanzanian Government has provided 214 tons of food and 24 tons of medical supplies.
- The South African National Defence Force (SANDF) has been deployed to aid in rescue efforts.
- UNICEF is appealing for 20.3 million USD to support the governments of affected countries in assisting women and children impacted by the Tropical Cyclone and related flooding.
- The UN and humanitarian partners in Mozambique have appealed for 40.8 million USD to assist affected communities in a multisectoral response prioritising education, health, WASH, food security, protection and nutrition.


For more information visit our website: www.africanriskcapacity.org
Detection and Mapping:

AFED Depictions of Recent Flooding in Malawi, Mozambique and Zimbabwe:

- The ARC Flood Extent Depiction (AFED) makes use of Satellite-based Microwave Data in combination with Digital Elevation and Persistent Water Distribution data to produce depictions of Non-persistent Surface Water which represents the distribution of large-scale river flooding.
- The map below shows the extent of non-persistent surface water detected by the ARC Flood Extent Depiction (AFED) v05r00 during the periods of flooding described above. Flooding detected during the period prior to Idai making landfall (5–14 March, 2019) is shown in orange whilst flooding detected post–Idai making landfall (15–20 March 2019) in deep red.
- The depictions indicate flooding along the river Zambezi between Tete and the Shire-Zambezi confluence as well as the river Shire flowing southwards towards the confluence prior to Idai making landfall. Widespread flooding was detected during the post-landfall period along the Shire, the post-confluence stretch of the Zambezi and the coastal areas north of the Zambezi.
- Flooding in and around Beira was initially not detected. This is possibly due to the inability of the microwave sensors to ‘see’ through rain and/or possible interference with the microwave signal from the ocean. Widespread flooding was, however, detected in AFED depictions from 18 March onward in the south of Beira where the river Buzi flows into the Indian Ocean.
- Some flooding was detected in the east of Zimbabwe from 18 March onward. Based on the available reports it is expected that the AFED layers made available in the coming days will depict more flooding in Zimbabwe.
- More information regarding the ARC River Flood Model (AFM-R) and AFED is provided in the section that follows.

For more information visit our website: www.africanriskcapacity.org
More About AFM-R:

AFM-R Model Concept:
- Following a nearly two-year consultative process with more than 15 countries across the continent, flooding has consistently, in addition to droughts, been identified as another major risk to food security. Upon request from Member States, the Research & Development (R&D) Department initiated the development of an index-based flood model in 2014. ARC Ltd will use the resulting flood index for underwriting river flood insurance, which will be the first sovereign index-based flood insurance in its kind. To this end, the ARC Secretariat contracted in 2015 and has since been collaborating with Atmospheric and Environmental Research, Inc. (AER) to develop the daily input dataset to the ARC River Flood Model (AFM-R). Through a series of iterations that involved the regular evaluation of modelled outputs and the implementation of adjustments to the algorithm based on feedback from in-country experts and ARC’s R&D Department, the resulting ARC Flood Extent Depiction (AFED) (v05r00) was released in August 2018.
- In parallel to the abovementioned efforts, ARC’s R&D Department has developed the AFM-R Index, which has undergone a number of revisions informed by input from pilot countries. It should be noted that, due to the type of satellite data used, AFED and the resulting AFM-R index have been designed to detect large-scale river floods and do not target coastal floods, flash floods or urban flooding due to drainage imperfections.
- AFED is the daily flood data underlying the insurance product. To meet ARC’s requirements, AFED is: pan-African, objective, historical (1998-present), and updated in near real-time with methods consistent with historical processing.

The ARC Flood Extent Depiction (AFED):
- AFED Flood Depiction Features are as follows:
  - Uses daily passive microwave remote sensing with topographic downscaling using Digital Elevation Model (DEM) data.
  - Detects long-lasting (>2-3 days) floods in wide (>2 km) flood plains.
  - ~ 90 m postings, over all of Africa, daily, 1998-present.
  - Continuing near real-time coverage from AMSR-2 and GMI sensors.
- AFED data are managed and analysed using the Africa RiskView Flood Data Explorer (FDE) software tool, an ARC in-house developed tool that allows for the extraction of flood depictions and derived data and automatically updates when new AFED data become available.
- Daily flood depiction data are combined with exposure data (e.g. population distribution/density data, land use/cover-derived cropland distribution data) and further aggregated to an agreed-upon polygon level (e.g. Sub-River Basin Level) within the FDE environment. The accuracy of the estimates provided in the output time series is highly dependent on that of the input data. The current default exposure layer in FDE is the 1km resolution Landscan™ dataset and ARC R&D is continuously sourcing and testing alternative datasets such as WorldPop, the University of Columbia’s High Resolution Settlement Layer (HRSL) and the European Space Agency’s Africa-wide Landcover Map to achieve more accurate estimates of flood exposure and derive time series used as input metrics for the calculation of AFM-R Index.

The AFM-R Prototype River Flood Index:
- The AFM-R Index is designed to use the polygon-level time series variables as the basis for triggering payouts to countries. ARC collaborates with in-country experts to identify the ideal input data to derive exposure layers and to define the ideal and most flexible aggregation polygon definitions using historical flood-extent maps.
- The polygon-level time series data are used directly as input metrics and to derive additional metrics to calculate a daily index value that characterises the polygon-specific magnitude of flooding throughout the time series.