ARC River Flood Model (AFM-R)

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

Two weeks have passed since Tropical Cyclone Idai tore through the coast of Southern Africa. The cyclone made landfall on March 15 near the port city of Beira, bringing heavy winds and rains. Two major rivers in Mozambique, the Buzi and the Pungue, burst their banks, submerging entire villages and leaving hundreds of people dead, thousands displaced, others are still missing. The cyclone resulted in massive destruction in Sofala, Zambezia, Manica and Inhambane provinces. Cyclone Idai’s tail caused damage, loss of life and severe injuries in Zimbabwe’s Chimanimani and Chipinge districts as well as southern Malawi.

It is reported that the cyclone affected about 2.7 million people in its path, leaving upwards of 700 lives lost, key infrastructure damaged or destroyed, and communication, electricity and water supplies compromised. About 400,000 hectares of crops were destroyed. The extent of the damage is still unfolding in all three countries as access to affected areas is slowly being regained. It is expected that the death toll will continue to rise. Over the next 24 hours, moderate to heavy rain with thunderstorms are forecast in the central and northern Provinces of Mozambique. Moderate rain is expected in Masvingo, Matebeland South and Manicaland Provinces of Zimbabwe as well as southern region of Malawi.

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 the affected 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 three countries are still battling to recover from the impact of cyclone Idai. The number of fatalities are expected to increase as flood water recedes and more bodies are discovered. Impacts are likely to be exacerbated by the development of secondary hazards such as cholera outbreaks and other waterborne diseases. Based on various sources the estimates as of 28 March 2019 may be summarised as follows:

- **Mozambique**: Over 534 lives lost; 1,500 injured; 72,260 houses damaged/destroyed; 129,000 displaced; 500,000 hectares of crops damaged. The estimated number of people affected currently stands at 1.85 million.
- **Zimbabwe**: 259 lives lost; 172,200 injured; 4,500 displaced; 327 missing. The estimated number of people affected currently stands at 250,000.
- **Malawi**: 60 lives lost; 672 injured; 86,980 displaced. The estimated number of people affected currently stands at 868,895.
- Five cases of cholera have been reported in Mozambique.

FURTHER ANTICIPATED IMPACTS:
The weather system has weakened since Idai initially made landfall, however, forecasts indicate a high probability of rainfall over north to central Malawi and the north-eastern and southern regions of Mozambique. Moderate to heavy rain with thunderstorms are forecast in the central and northern Provinces of Mozambique. Moderate rain is expected in Masvingo, Mat South and Manicaland Provinces of Zimbabwe. Further anticipated impacts include:

- Increased risk of flash floods across the regions affected.
- Heightened risk of infectious disease outbreak and psychological trauma.
- 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 the current drought and recent flooding in Zimbabwe.

- Continued rockfalls in Zimbabwe due to saturated unstable soil.
- Severe loss of livestock, fisheries and other sources of income.
- Delays in stabilisation of water/electricity, communication due to damaged infrastructure and also fuel supplies due to damaged petroleum pumping equipment a Beira.

RESPONSE EFFORTS:
Governments are leading efforts to conduct assessments as access to affected areas increases. Flash appeals for international support have been launched.

- Direct Relief staff in Mozambique including local doctors, first responders are working with government officials to help coordinate an ongoing shipment of medical aid to the broader region.
- Collaboration between UNICEF and UK Aid under the leadership of the Mozambique government have re-established part of water supply by the 22nd of March in Beira and further water trucking operations have also been put in place by the government.
- The UN, humanitarian partners and South African National Defence Force are continuing with air and road transportation rescue efforts.
- 96 International Deployed Assets, of which 53 are military assets and 43 civilian assets supporting the response efforts.
- The Disasters Emergency Committee (DEC) has raised £18 million since launching an appeal on 21 March to help people affected.
- The US Department of Defence to provide US$6.5 million in humanitarian assistance to Mozambique.
- Emergency humanitarian aid packages from HM King Mohammed VI of Morocco was sent to the Republic of Mozambique.
- Canada provided initial funding of $3.5 million to support humanitarian organizations responding to the affected countries.
- IFRC issued a Revised Emergency Appeal for 31 million Swiss francs for 200,000 people for 24 months.
- SADC has activated its Disaster Risk Management Fund providing US$200,000 to the affected countries and also urged its Member States to consider ex-ante financing mechanisms such as disaster insurance.

Read more at: Int.DisasterCharter, ReliefWeb, AfricaNews, ReliefWeb.Int, ECHO, UN-OCHA-WFP-USA-DOD, Morocco, IFRC, Businesslive and UNOCHA

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—27 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.
- Flooding was detected in Zimbabwe from 18 March onward in Masvingo, Matabeleland and Manicaland.
- More information regarding the ARC River Flood Model (AFM-R) and AFED is provided in the section that follows.
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 LandscanTM 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 Values that characterise the relative severity of flood events in a given area of interest.

AFED Depiction compared to Optical Imagery

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.

AFM-R R Index Calculation and Thresholding (Nigeria, 2012)