Bongani Mbatha, African News Agency/ANA

Flood **WARNINGS**

Natasha Ramdass reports on the development of an early warning system for Durban's eThekwini Municipality

Climate change is predicted to increase the frequency, intensity and impacts of extreme weather events, highlighting the urgency of being prepared for such natural disasters. In KwaZulu-Natal, and eThekwini Municipality in particular, flooding has been the main contributor to disaster-related events causing damage to property and infrastructure, as well as loss of life. Historically, these and many other types of weather-related disasters were responded to as they happened around the world. This is called a reactive response.

But what about weather forecasts? While these provide warnings about the rainfall an area would receive, the information is not necessarily enough to describe the impact on the ground. Who would be affected? How would they be affected? How badly? At what time? The eThekwini Municipality developed an early warning system to address these questions for the city of Durban and surrounding towns.

The nuts and bolts of early warning systems

An early warning system can be described as a chain of information communication systems, and comprises sensors, event detection and decision subsystems. To be effective, early warning systems need to actively involve the communities at risk, facilitate public education and awareness of risks, disseminate alerts and warnings, and ensure there is a constant state of preparedness.

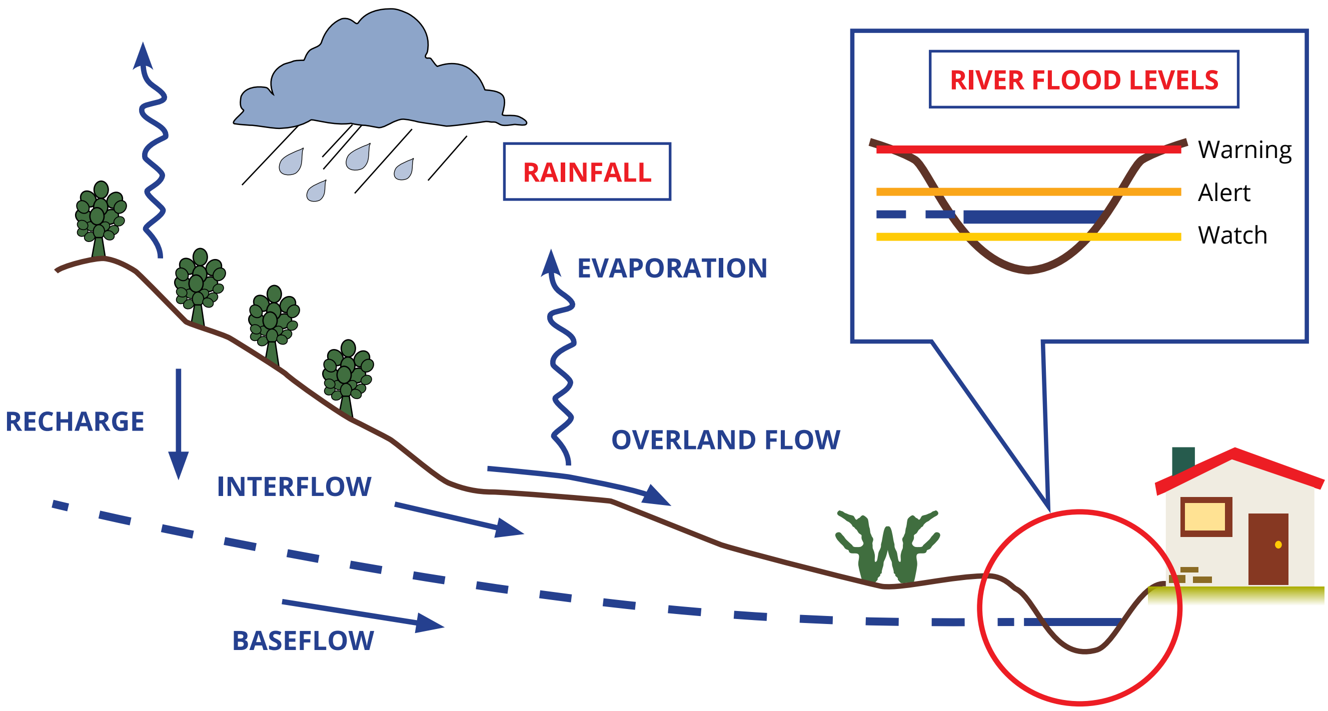
A complete and effective early warning system therefore supports four main functions:

1. **Risk analysis** – Understand what/who is going to be affected, how badly, and when.
2. **Monitoring and warning** – Understand how to track the risk and what kind of warning is related to that risk.
3. **Dissemination and communication** – The warning that is produced from the step above needs to be interpreted correctly. Understanding who the warning should go to, how it needs to be structured, and when it needs to get to the person or organisation is essential.
4. **A response capability** – Once the warning is sent out, there should be a planned response to that warning.

There are weather-related early warning systems that are able to manage multiple risks, including flooding, forest fires, snow storms and more, for entire continents, and others that manage a single risk for a single country or city. But there is no 'off the shelf' version – each is a fit-for-purpose system specifically designed to manage very specific needs of the organisation developing it.

The eThekwini Forecast Early Warning System

The eThekwini (Durban) Climate Change Strategy is a long-term plan based on projections for a rise in temperature and rainfall to the year 2065 and a 500 mm increase in rainfall between 2065 and 2100. In 2013, in anticipation



of an increased risk of damaging storms in the eThekwini Metro, the municipality's Engineering Unit set out to find a solution to better manage these storm events.

A review of best practices around the world revealed that the solution was a marriage between engineering skills and information technology – a perfect example of Industry 4.0. Over the next seven years, a team of technical professionals advanced this idea into a structured, first-in-Africa, Forecast Early Warning System (FEWS). Initially intended for flood early warnings, the potential to apply this system to other early warnings such as water quality, risk assessments, coastal and real-time data management was recognised as time progressed. Hence, FEWS evolved from a Flood Early Warning System into the Forecast Early Warning System.

The flood early warnings are currently operational and are assisting the municipality in managing potential flood disasters, so let's focus on how these warnings work.

Risk analysis

To understand the risk associated with a possible storm, we first need to simulate what would happen with a certain amount of rain. How much it rains and where it falls is predicted by meteorologists. The South African Weather Service (SAWS) is the only body legally mandated to issue weather predictions in our country.

Falling raindrops may get absorbed into the ground, or get trapped on the surface as ponds or puddles, or even evaporate, but the remaining drops flow overland to form runoff that eventually gets into rivers and streams. Using the SAWS three-day rainfall predictions, this journey of the raindrops can be simulated through hydraulic engineering (a discipline of civil engineering) to understand where we would expect flooding, when and how badly. The FEWS team within eThekwini's Engineering Unit has done this by simulating the entire city's ground conditions using engineering design software, together with some smart computer programming, to model – or simulate – flooding in the following three days. Why three days? Because weather patterns change dynamically and a seven-day forecast is less reliable than a three-day forecast.

Once this was accomplished, all known flooding hotspots in the city were monitored against the simulation outputs. The house in the illustration above represents a typical hotspot along a river bank or in a floodplain, and could constitute homes in a suburb or an informal settlement, an industrial building, an economic zone or other site that would be adversely affected by flooding. The FEWS identified approximately 200 hotspots, each of which has been analysed and categorised in accordance with its particular risk exposure.

Monitoring and warning

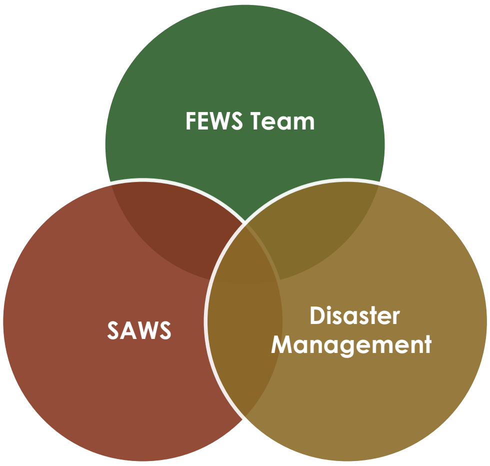
The thresholds (watch, alert and warning) shown for different levels of the river in the illustration represent the monitoring levels that the simulation checks against. For each threshold that is crossed by the simulated water levels, predefined notifications are triggered and sent to the FEWS team, who then interrogate these messages and evaluate the risk probability with the help of SAWS (for weather pattern validation).

The identified risk then initiates real-time monitoring to track and validate the forecasted storm impacts. This is done using telemetry – the automated collection and transmission of data from instruments such as rain gauges, water level gauges and wind gauges. Weather radars are also used to track the movement of storm clouds.

This means that while the flood warnings for eThekwini are issued by SAWS, the FEWS team is an active contributor to the 'impact-based' warnings for the region, and translates each warning to a local level.

Dissemination and communication

When a flooding threat is identified or suspected, communication between the FEWS team, SAWS and the



city's disaster management practitioners commences. These three spheres provide essential information to the success of the early warning system. The FEWS team coordinates the technical aspects of the system, while SAWS provides the raw data required to run forecasted flood simulations, and Disaster Management coordinates actions in response to the early warnings. Communication between these spheres results in the information that is required for the response to the early warning. The public, emergency services, municipal officials and other groupings all require a different interpretation of the warning in order for them to respond effectively. For instance, while meteorologists at SAWS may require technical information, disaster management practitioners require location, time and severity of the risk in order for effective response, and the public only need to understand what to do and when.

During the disaster event, all three spheres meet and communicate directly at eThekwini Municipality's Disaster Operations Centre.

Risk response

The last function of a typical early warning system is the risk response capability. This function is entirely the responsibility of eThekwini Municipality's Disaster Management Unit, which coordinates the response to the early warning. This is done by developing predefined response plans for every level of risk, for every known risk location. To help get the right message to the right people at the right time, a list of stakeholders, including emergency services representatives, high-risk infrastructure managers, politicians and municipal decision makers are kept informed at all times through different platforms.

What's next?

The flooding component of the eThekwini FEWS will officially be launched this year, although it has been operational since 2019. However, since this system is a first of its kind in South Africa, as well as Africa, the learning never stops for the team. Risk hotspots will continue to be identified, while the system itself will continue to grow and improve. There are plans to develop a similar early warning function for coastal disasters in the near future.

An early warning system needs a network of good relationships to make it a success, so the eThekwini FEWS team has joined a global flood–climate change working group to share information and learn from each other on how to address unique challenges, such as predicting mudslides, similar to the April 2019 event in Durban. Knowledge sharing is paramount, because disasters are everyone's problem.

Natasha Ramdass is a civil engineer with eThekwini Municipality, which she joined shortly after completing her B.Eng. Hons (Civil) degree at the Universiti Teknologi Petronas in Malaysia in 2010. She completed an MBA at the University of KwaZulu-Natal in 2018.

Bongani Mbatha, African News Agency/ANA

2020

Quest Volume 16 Number 2 2020

Academy of Science of South Africa (ASSAf)

Academy of Science of South Africa (ASSAf)