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Leveraging Technology in the Face of Disaster

Written by:

Naomi Ng'ang'a, Boneya Hindada, Swabira Abdulrazak, Jack Amayo, Njenga Kelvin, Priyanka Patel, Safia Verjee

For any inquiries contact:

info@icha.net

Introduction

Globally, extreme weather events are rising primarily due to climate change fueled by global warming. Africa is experiencing a surge in natural hazards such as droughts, floods, and storms. In East Africa, limited observational data and complex natural variability make it challenging to analyze specific climate changes and detect human influence. Coupled with development challenges like poverty and limited access to essential services, many African countries struggle to manage these hazards, leading to significant loss and damage. As global temperatures continue to rise, Kenya faces increasingly severe weather patterns, that cascade effects on its population and economy.

Recently, Kenya experienced above normal rainfall during the period March-April-May (MAM) 2024, which caused widespread devastation, through flooding, landslides, and mudslides affecting 43 out of 47 counties. This has had a tragic human cost, with an approximate 100,228 households affected, 54,205 households displaced, 294 fatalities and more than 65,000 acreage of crops loop affected as of 30th May 2024. As one of the worst flooding events experienced in the recent past, relief efforts relied heavily on both traditional methods of assistance and emerging technological tools. This article outlines how the Kenya Red Cross Society (KRCS) through the International Centre for Humanitarian Affairs (ICHA), leveraged technology to support disaster management efforts. It summarizes the benefits of the use of technology in disaster management and relief efforts and highlights the need to continue investing in, testing, and scaling up technological solutions to ensure better preparedness for future disasters.

A village made inaccessible by road due to floods

Digital Technologies for Preparedness, Response, and Recovery

Innovation and technology in humanitarian action are vital for mitigating vulnerabilities and building resilience, especially amidst diminishing resources and escalating crises. The growing involvement of tech companies in global philanthropy is a plus and is meant to accelerate this digital transformation. From crowd-sourced data in crisis mapping to predictive early warning systems, digital innovations capture a large diversity of tools meant to improve disaster preparedness, response, and recovery. However, effective deployment strategies and strategic partnerships for scaling are essential to prevent the potential failure of promising innovations.

The Kenya Red Cross Society (KRCS) through the International Centre for Humanitarian Affairs (ICHA) (KRCS "Think tank"), has been at the forefront of leveraging digital transformation in disaster management. ICHA, with its extensive expertise in drone technology, satellite imagery, and climate information played a crucial role in coordinating technological efforts to enhance the effectiveness of the relief efforts. Below are some of the ways the team leveraged cutting-edge technology to improve disaster response and recovery:

Satellite Imagery and Machine Learning techniques

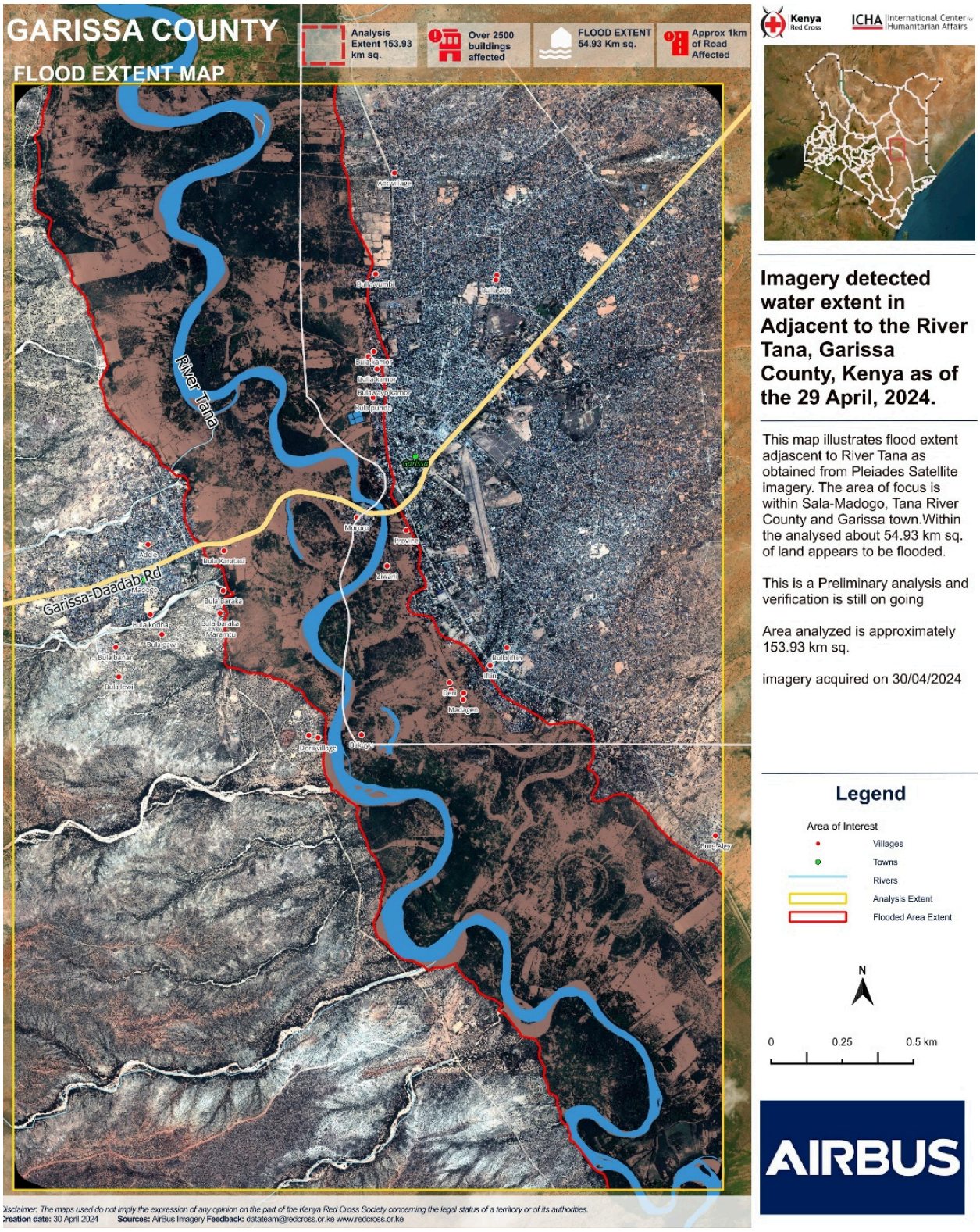
Satellite imagery is an invaluable tool for conducting rapid assessments of disaster-affected areas. It allows the KRCS to evaluate flood impacts on infrastructure and identify the most severely affected regions, ensuring efficient aid delivery. The team, coordinated by ICHA, leveraged both open-source satellite imagery from Sentinel 1 & 2 satellites as well as premium sources such as Pleiades. Through a longstanding partnership with the Airbus Foundation, the data team was able to task the Pleiades satellite to capture high-resolution (optical and radar) images of specific flood zones within 24 hours. These detailed datasets enabled swift assessments of flood extent and infrastructural damage, allowing for comparisons of pre- and post-disaster conditions.

Additionally, ICHA leveraged machine learning analytics to determine flood extents by distinguishing between flooded and non-flooded areas. A large portion of the task included creating training datasets by assigning classes to the pixels in the satellite imagery and conducting supervised classification using the Support Vector Machine algorithm. One of the learnings from this flood experience is leveraging on existing tools and models to increase efficiency during response phase where analysis and results are required at moment's notice. This can include pre-done analysis/ notebooks or leveraging on existing pre-trained models such as Prithvi flood segmentation models or openly available training datasets to improve on timely delivery.

However, this technology does have its limitations. Optical satellite imagery is only available during the day and in clear weather conditions. Cloud cover within satellite imagery can significantly impede accurate interpretation and classification of pixels accurately since clouds obscure the views underneath. This results in limited insights that can be generated.

Interpretation of Radar imagery can become a challenge especially with features which have the same reflective properties as water. This can lead to false positives, where non-water features are mistakenly identified as water. Additionally, the aerial perspective of optical satellite images can make it challenging to detect damage on the sides of buildings.

Another important factor to consider is cost, as acquiring high-quality or detailed imagery can be expensive. The cost of satellite imagery is influenced by factors such as spatial and spectral resolution, the extent of coverage, and the timing of acquisition. Expedited requests often come with higher fees.



See image 1: Analysis of flood extent and impact in Tana River.

Drones

Remotely Piloted Aircraft Systems (RPAS), commonly known as drones, played a crucial role in search and rescue operations and in mapping affected areas to complement satellite imagery. The KRCS received substantial support from partners in deploying drone technology as part of its humanitarian efforts. Collaborations with Kenya Uncrewed Air Systems Association (KUASA), Amazon Web Services (AWS), Help.NGO, and the Internet Society (ISOC) provided the KRCS response teams with access to volunteer drone pilots, drone equipment, and data processing infrastructure. ICHA coordinated these efforts, enabling the drone team to assist in flood response operations across eight counties—Nairobi, Machakos, Kajiado, Kijabe, Kisumu, Busia, Garissa, and the Tana Delta—over three weeks in May.

The potential for deploying drones for disaster response was demonstrated during the Mai Mahui flash flood/mudslide incident in Nakuru County. In this devastating event, which resulted in approximately 50 fatalities and extensive property damage, drones were crucial for conducting searches, damage assessments, and hazard evaluations. The urgency to save and retrieve bodies along a 15 km stretch immediately after the incident highlighted the need for swift and efficient drone deployment.

The drones proved invaluable for corridor mapping along the Season river, where most of the destruction occurred. The high-resolution imagery provided by the drones enabled responders to identify locations where bodies had been carried and to pinpoint areas where debris had accumulated. This facilitated efficient search and debris removal operations. Additionally, through the mapping conducted, a pre- and post-analysis was conducted to determine the number of structures or houses damaged. The comparative advantage of drones over satellite imagery lies in their ability to deploy them in an instance, to capture highly detailed imagery, capable of identifying objects smaller than 10 cm. Additionally, they can fly below the clouds on cloudy days and generate terrain information, enabling further analysis.

The drones were also utilized to monitor and assess the threat level of a hazardous area. This area, a natural depression or sinkhole where water was accumulating without any outlet, posed a

significant concern for downstream residents who feared debris-laden flash floods. By conducting detailed mapping, the drones provided terrain and volume analysis, which allowed stakeholders to gain a clearer understanding of the situation.

Image 2: A map of the land slide in Mai Mahiu captured by the Wingtra One drone

On April 23, 2024, after an hour of assisting a search and rescue operation in Katangi, Machakos County, a volunteer drone pilot from Kenya Flying Labs (KFL), working under the KRCS drone unit, successfully guided the rescue team to a five-year-old child who had been missing for three days.

The child was found in a water-locked village, with the nearest ground support approximately three kilometers away. This rescue process was supported by KRCS Machakos branch Red Cross Action Teams (RCAT) responding to reports from the boy's family, who reported that he had been missing.

The RCAT lead was able to guide the drone pilot on which path to follow to locate the boy and through this, the drone pilot located the boy successfully, he managed to take a video of the current situation and brought back this information to the Kenya Defense Forces (KDF) team who then proceeded with the chopper to rescue the boy.

Figure 3: Drones supporting aqua rescuers

Drones were also used to supplement satellite imageries in conducting rapid assessments of disaster-affected areas to understand population affected by floods as shown in figure 4.

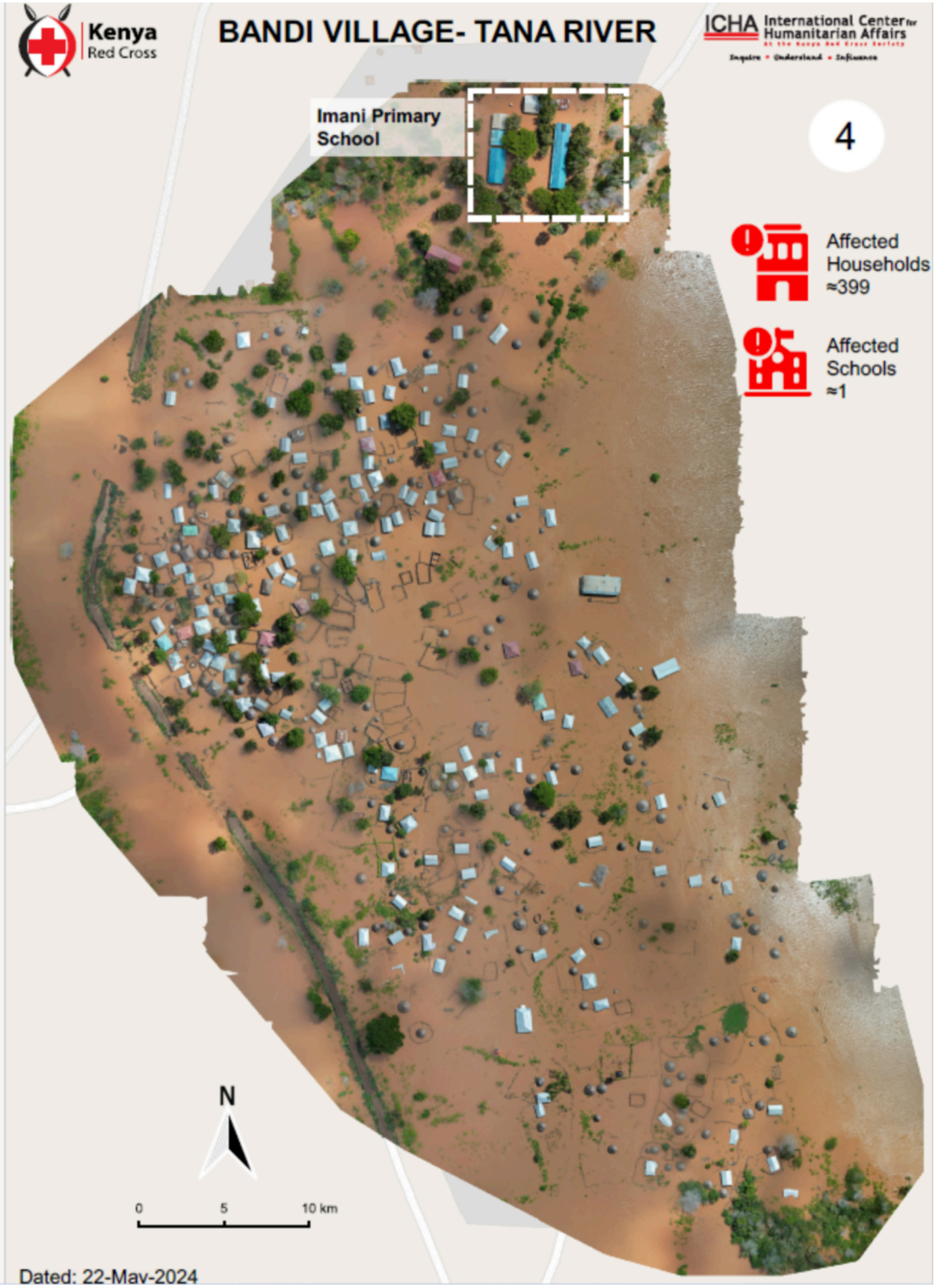


Figure 4: Drone image of a marooned village in Tana Delta

Drone operations in disaster zones present significant challenges, requiring meticulous coordination with other ground-based relief efforts to prevent collisions and disruptions. Despite these obstacles, the use of drones has shown tremendous potential in enhancing disaster response capabilities. The KRCS, with ICHA's support, continues to explore the use of drones for the delivery of essential supplies, such as blood, anti-venom, and food packages during emergencies.

TERA messages

The Trilogy Emergency Rapid Response Alerts (TERA) are geo-located Short Message Service (SMS) messages designed to target areas most vulnerable to specific hazards, such as floods. KRCS has obtained express approval and exemption from the Communications Authority of Kenya (CAK) to send these mass messages during disasters. During the MAM floods, with support from Safaricom, KRCS utilized the TERA SMS system to send over 70 million early warning messages to 38 of the 47 counties at risk of flooding. These warnings, provided in both English and Swahili, were based on climate forecast information from the Kenya Meteorological Department. ICHA played a crucial role in this process, with their climate experts continuously disseminating climate forecasts and assisting in drafting these early warning messages. By delivering timely information on anticipated floods and recommended safety measures, this communication enabled residents to take precautionary actions, thereby reducing the risk of casualties and property damage.

Emergency Toll Free Number 1199

The 1199 KRCS toll-free number was instrumental in providing assistance and support to those affected by the floods during the MAM flood period. Widely utilized by the public to report incidents and request aid, this number also offered free psychosocial tele-counseling sessions, offering a quick and accessible means for individuals to receive help and information during the disaster. Additionally, it streamlined relief efforts by enabling rescue teams to quickly identify those in need and reach them as swiftly as possible.

Value of Partnerships:

Technology actors come together to support floods response

The Special Envoy for Tech within the Government of Kenya (GoK) convened various partners to support KRCS in developing digital solutions to enhance flood response and relief efforts. This collaboration was fostered through the sharing of ideas, data, and insights among diverse stakeholders. By partnering with tech firms such as International Business Machines Corporation (IBM), Environmental Systems Research Institute (ESRI), Microsoft, Meta Platforms, Inc. (META), Amazon Web Services (AWS) and others, KRCS successfully integrated advanced private-sector technologies for humanitarian use.

AWS provided cloud-based solutions to store and manage data from various sources, ensuring seamless access to information for all disaster response stakeholders. ESRI's geographic information system (GIS) technology enabled detailed geospatial analysis, helping KRCS visualize flood impacts. IBM and Microsoft contributed technical expertise and resources, enhancing data analysis by processing large volumes of data quickly to understand the impacts of floods across various sectors. META assisted in developing a KRCS WhatsApp platform for disseminating critical information and coordinating relief efforts

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Such collaboration fosters smarter solutions and more inclusive partnerships, allowing tech companies to lend their expertise and resources in various ways to support frontline emergency responses.

Kenya Red Cross RCAT team responding to MAM floods

What did we learn?

- **Adaptability is key -** The ability to quickly integrate new technologies into the traditional response frameworks was crucial in managing the dynamic challenges posed by the floods. For instance, utilizing drones and satellite imagery allowed KRCS to gather real-time data and adjust strategies on the fly. This adaptability not only improved the immediate response but also provided a framework for how KRCS can handle future emergencies with greater flexibility and efficiency.

- **Collaboration enhances capacity -** In any disaster, the value of collaboration cannot be understated. The need for strong partnerships between local and international actors, whereby expertise and access to resources are complementary to ground needs and expertise is critical. These partnerships allowed KRCS to leverage advanced data analytics, cloud computing, and geospatial analysis, which improved their overall efficiency and effectiveness. A multi-agency coordinated approach, having all hands-on deck by marrying different expertise and capacities serves as the ultimate boost to the KRCS surge capacity.

- **Timeliness in early warning communication is key -** Timeliness is essential when it comes to early warning communication of any emergency, any delay in sending out the message can result to compromised trust. There was an instance where some communities received the early waring communication late, this experience however taught us the importance of having robust early warning mechanisms in place for disaster preparedness and risk reduction.

- **Use of tech-enhanced situational awareness -** The use of technology greatly enhanced KRCS situational awareness. Real-time data from satellites and drones provided them with a comprehensive view of the flood situation. This allowed for informed decision-making and targeted interventions, ensuring that resources were allocated efficiently and effectively. With accurate, up-to-date information, KRCS was able to prioritize areas with the greatest need and coordinate response efforts more effectively. This technological advantage not only improved the immediate response but also set a precedent for how we can utilize similar tools in future disaster scenarios.

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