MADAGASCAR'S EARLY WARNING SYSTEM

An Assessment of SMS Alert Performance



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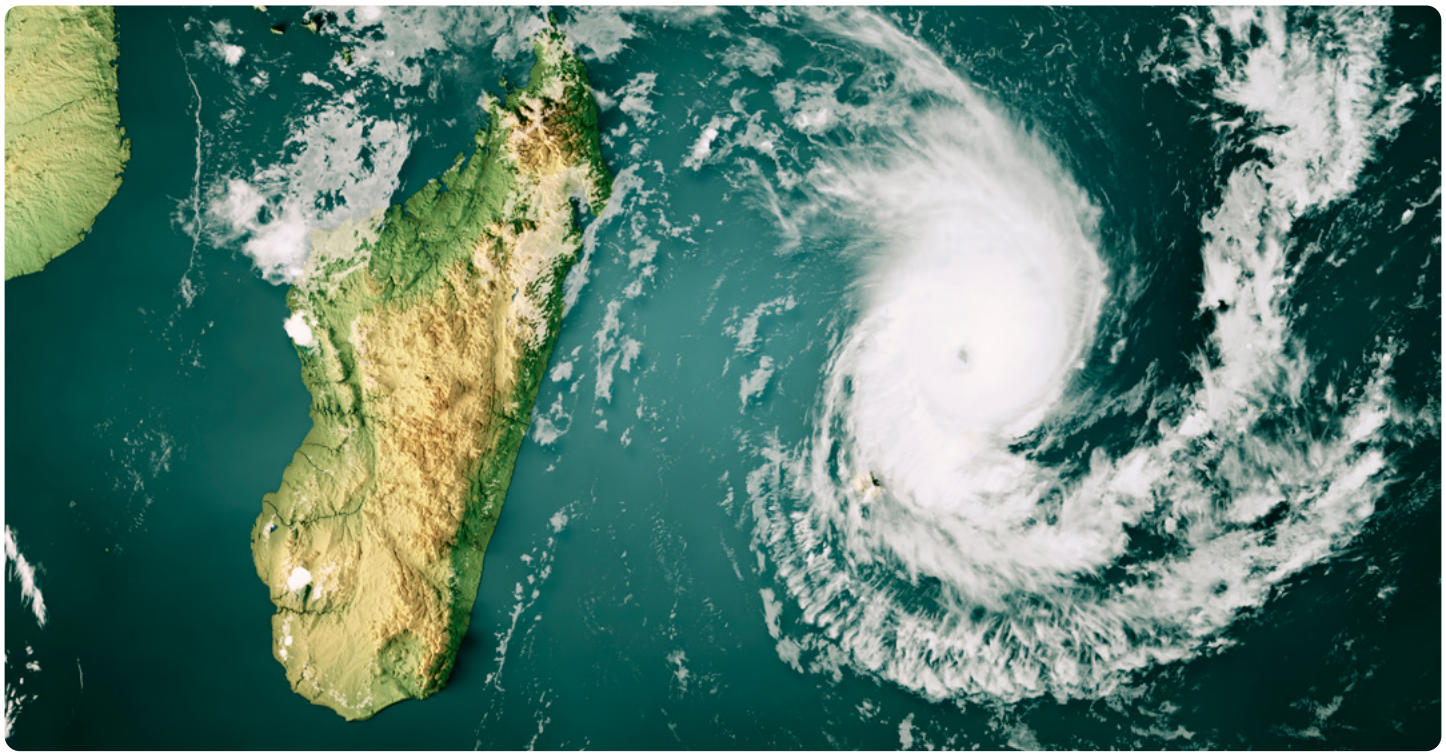
EXECUTIVE SUMMARY



Madagascar is one of the most exposed countries in the world to climate extremes, making timely and accessible early warning communication critical for saving lives and reducing economic losses.[1] SMS alerts play a key role in the national multi-hazard early warning system (EWS), in conjunction with radio, community relay mechanisms, and institutional communication channels.

While Cell Broadcast (CB) is a highly effective technology for early warning alerting, adopted for an increasing number of national systems, SMS remains an important operational solution for many countries due to existing infrastructure, regulatory arrangements and implementation timelines. To strengthen EWS in Madagascar and other countries using similar approaches, it is essential to understand how SMS performs in practice, and more broadly, the behavioural responses of populations to mobile alerts. This study examines how institutions in Madagascar implement SMS-based alerting and how communities receive, interpret and respond to these messages. Drawing on evidence from across the Malagasy EWS landscape, this report identifies opportunities to strengthen SMS-based warning systems, while providing an assessment approach that can be adapted in other contextually similar settings.

Findings indicate that while SMS is a key channel within Madagascar's EWS, its impact extends beyond direct delivery. Evidence from community members shows that factors such as phone sharing, network coverage, literacy and language determine who receives messages and how they respond, with many individuals accessing information indirectly through family, neighbours or radio. Consequently, the impact of such systems relies not only on successful message transmission, but also the method of circulation, confirmed by trusted sources, and translated into action. To strengthen impact, EWS stakeholders should integrate SMS into a multi-channel ecosystem where speed and scalability are reinforced by radio, local authorities and interpersonal networks, requiring coordinated governance, harmonised operations, and inclusive communication practices.



1. UNRIC (2026). Madagascar: one of the countries most exposed to climate extremes.

Drawing on evidence across institutions, MNOs and communities, this report highlights the following recommendations:

1.

Design EWS to support multi-channel alert dissemination, treating SMS as an important element within a wider alert chain, rather than the end point.

2.

Clearly identified senders strengthen public trust, helping to legitimise messages amid high volumes of spam SMS.

3.

Message clarity influences preparedness behaviour, with clear hazard identification, timing and potential impact enabling action.

4.

Operational coordination affects the consistency of alert dissemination, with clear and documented protocols improving reliability and consistency.

5.

Harmonised reporting is essential to monitor system performance, as variations can undermine efforts to strengthen a national EWS.

6.

Selective use of mobile alerts is essential to maintaining trust, as over-alerting can cause alert fatigue and reduce responsiveness.

INTRODUCTION

Early warning systems (EWS) are only effective when warnings lead to action. Successful warning dissemination depends on more than message delivery alone. Recipients frequently verify emergency alerts through trusted channels, such as radio broadcasts, local authorities and community volunteers, before deciding how to respond.

This report examines how SMS alerts function within Madagascar's EWS, looking at how communities receive, interpret and act on the messages. It draws on a comprehensive desk review, institutional stakeholder interviews, an SMS demonstration test conducted with Madagascar's disaster management agency the Bureau National de Gestion des Risques et des Catastrophes (BNGRC) and mobile network operators (MNOs), and qualitative fieldwork conducted in cyclone-prone areas.

At the time of this study, SMS alerts in Madagascar relied on administrative targeting, with messages sent to subscribers based on SIM registration addresses rather than real-time device location. This differs from location-based SMS (LB-SMS), which targets phones that are physically present in an affected area. After field research was completed, partners in Madagascar began piloting LB-SMS with national authorities. These activities have been referenced where relevant, but are not included in the analysis.

This report outlines the methodological approach, country context, and the structure of Madagascar's EWS before presenting findings on institutional and operational performance, community reception and behavioural response, and trends across regions and groups. The report then summarises the main insights and offers recommendations to strengthen SMS-based, multi-channel alerting.



METHODOLOGY

This study explores the use of SMS alerts within Madagascar's EWS, and how they are received, interpreted and responded to by recipient communities. To address this objective, the study has two primary data collection components.

1. SMS performance demonstration test

An SMS performance test was conducted in three locations: the East coast, the SAVA (Sambava, Antalaha, Vohemar, and Andapa) Region and Atsimo-Andrefana. The test aimed to assess delivery rates and observe MNO dissemination practices under current operational arrangements in Madagascar. The message content was designed to avoid simulating a live emergency and did not instruct behavioural action to avoid creating confusion or public concern.



The operational sequence was broadly consistent with Madagascar's SMS alerting approach:

Meteorological context
The General Directorate of Meteorology (DGM) input was simulated for the demonstration.

Message validation and authorisation
The BNGRC reviewed, validated, and authorised the test message and approved the target locations.

Transmission and coordination
The study team transmitted the BNGRC-validated message and targeting parameters to each MNO and coordinated their dissemination.

Geographic filtering
Each operator applied internal geographic filtering using its own subscriber classification systems.

Dissemination
Each operator disseminated the SMS independently within its own network.



Across all operators and regions, 16,947 SMS messages were sent, of which 13,440 were successfully delivered, corresponding to an overall delivery rate of 79%.

The test followed Madagascar's colour-coding system for emergency alerts to designate the threat level. Green indicates a non-immediate weather threat, yellow indicates a specific threat and red indicates imminent danger. Blue refers to post-event vigilance.

ACROSS ALL OPERATORS AND REGIONS

16.9K
SMS messages were sent to test recipients

13.4K
messages were successfully delivered

79%
Overall delivery rate achieved

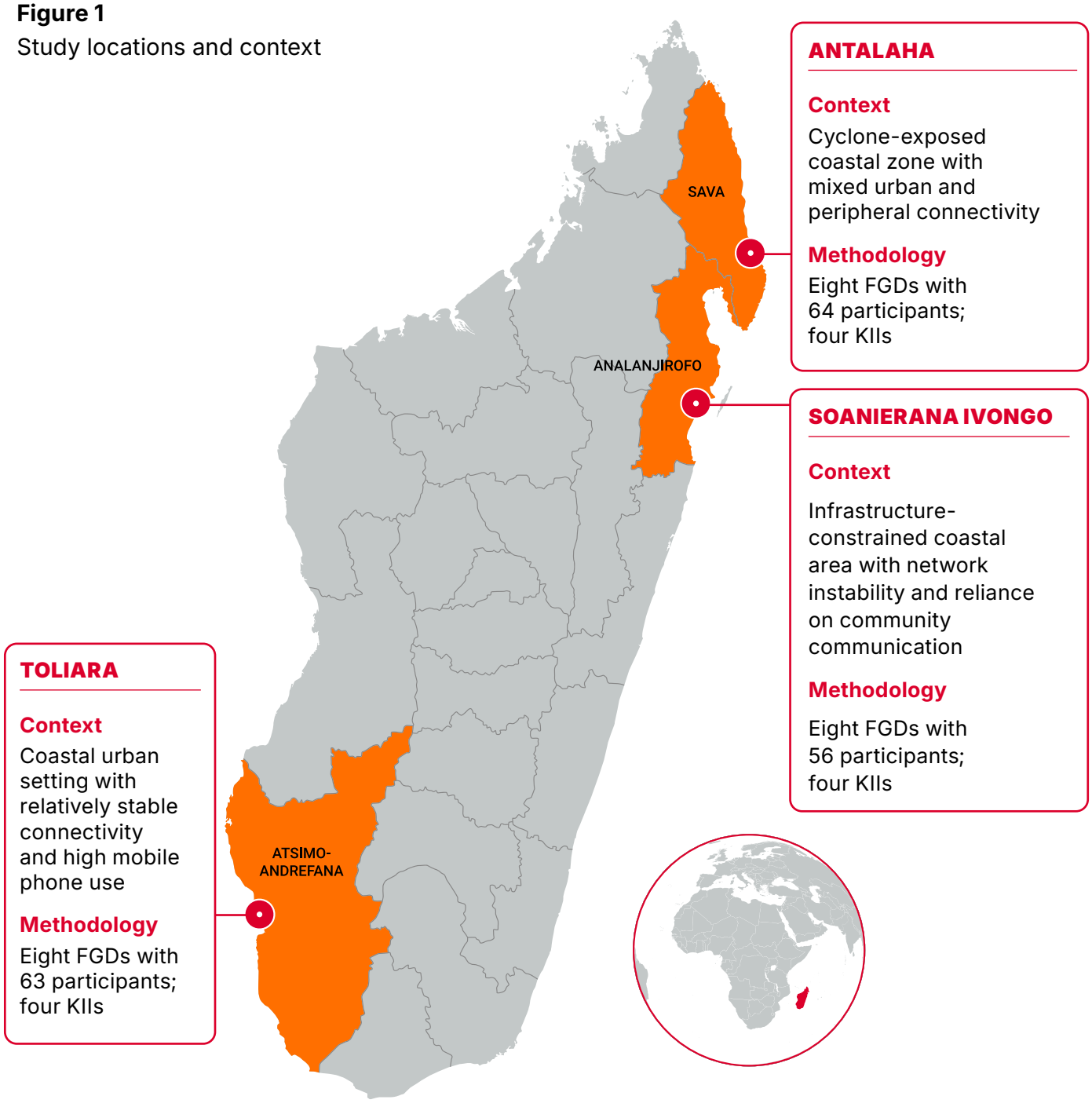
2. Qualitative field research

The qualitative research combined focus group discussions (FGDs) and key informant interviews (KIIs) to capture both community experiences and institutional perspectives of SMS-based early warning alerts. Throughout this report, participants are differentiated by those who received the test SMS directly and those who learned about it indirectly.

Fieldwork was conducted between December 2025 and January 2026 across three locations. The study included 24 FGDs with community members and 12 KIIs. In total, 183 community members participated in the discussions.

Figure 1

Study locations and context



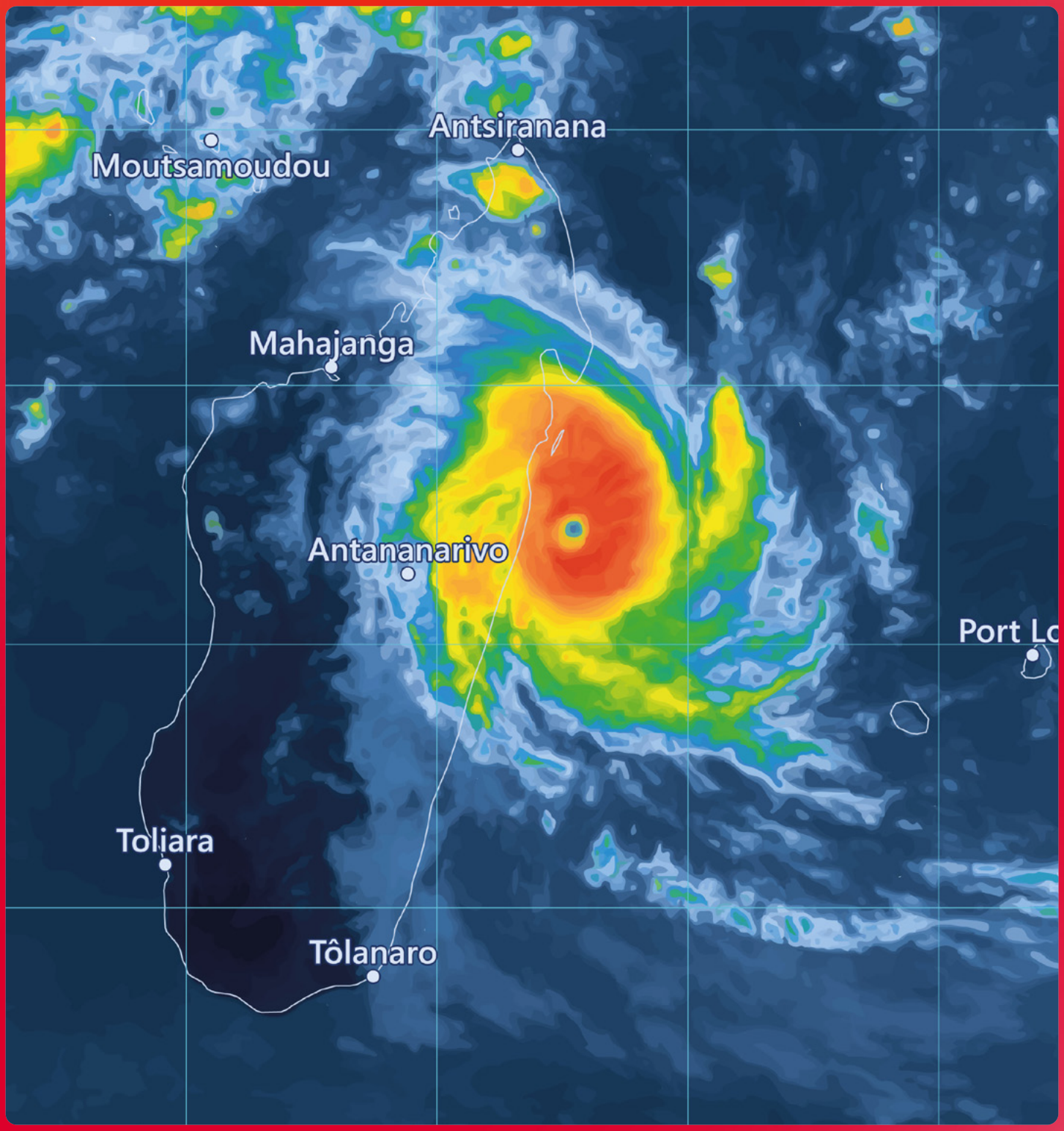
FGDs explored community experiences with alerts and compared perspectives across different groups. Discussions were organised by gender, age and whether participants had received the SMS directly or learned of it through other channels.

KIIs provided insight into the institutional and operational dimensions of early warning communication. Interviews were conducted with local authorities, community leaders and other actors involved in the dissemination or relay of warning information.

All discussions were conducted in Malagasy, with local dialects used where required. Informed consent was obtained from all participants prior to participation. Red Cross Malagasy volunteers helped recruit participants and introduced the research team to community leaders.



MADAGASCAR'S HAZARD PROFILE



Tropical cyclones regularly affect large parts of Madagascar, especially in coastal regions.[2] Cyclones bring strong winds, heavy rainfall, flooding and storm surges that damage housing and infrastructure, disrupt livelihoods, and limit access to essential services. Eastern, northern and southwestern coastal areas experience repeated exposure, and most cyclone seasons produce multiple storm events.[3] On average, three to four tropical storms impact the island each year, with historical events such as Enawo (2017), Ava (2018), Belna (2019), Batsirai (2022), Cheneso (2023), and Freddy (2023) resulting in major human, material and economic losses. In early 2026, cyclones Fytia (January) and Gezani (February) affected 681,000 people, with 73 deaths, over 60,200 people displaced and 122,000 homes damaged or destroyed.[4] In addition to cyclones, seasonal flooding frequently affects the eastern seaboard and major river basins, while persistent drought, driven by climate variability, consistently affects southern regions.

The recurrence of cyclone events places sustained pressure on national and local preparedness systems. Although intensity and trajectories vary from year to year, repeated exposure requires continuous monitoring, coordinated decision-making and effective communication to ensure that populations understand risk levels and take protective action before landfall.



Fisherman are particularly exposed to coastal and cyclone-related risks

4 TROPICAL STORMS

impact Madagascar each year

681K

PEOPLE AFFECTED

60K

PEOPLE DISPLACED

by Fytia and Gezani cyclones, with 73 deaths

122K

HOMES DAMAGED OR DESTROYED

"The SMS alerts help me anticipate bad weather. They allow me to adapt my fishing activities and take action to protect my home and my family. These messages are very important to me."

SAVA Region (Antalaha)
Male, fisherman

2. World Bank (n.d.). Climate Change Knowledge Portal: Madagascar. (Accessed 17 July 2026).
3. European Commission (2021). Madagascar. INFORM Risk Country Profile.
4. reliefweb (2026). Operation Update: Madagascar | 2026 Cyclones. OCHA.

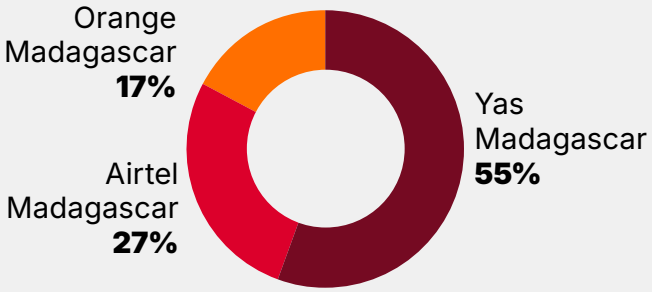
MADAGASCAR'S MOBILE LANDSCAPE

The mobile landscape in Madagascar has experienced significant expansion over the past 10 years, driven by investments from MNOs to enhance mobile broadband networks.[5] Madagascar has three national mobile operators: Yas Madagascar (55% market share), Airtel Madagascar (27% market share) and Orange Madagascar (17% market share);[6] who offer 2G, 3G, 4G and 5G services to approximately 98% of the country's population (around 33 million people).[7,8]

Madagascar's MNOs have greatly expanded mobile broadband coverage, reducing the coverage gap from 47% in 2016 to 10% in 2024.[9] The market penetration rate, regarding unique mobile subscribers, is approximately 44%. This is an increase from 29% in 2016, with high rates of multi-SIMing occurring in the Madagascan market.[10] As such, the number of unique mobile users is estimated at 21.8 million, with Madagascar's mobile usage gap equivalent to an estimated 9.8 million people.[11]

Smartphone market penetration in Madagascar has grown alongside broader adoption trends in Africa, but the pace of growth has been relatively slower. Smartphone penetration in Madagascar is around 40% (a substantial increase from five per cent in 2016) compared to Africa's average of 60% and the Eastern Africa average of 44%.[12] Madagascar has made significant progress in expanding mobile connectivity, but clear challenges remain to achieving universal inclusive mobile access.

National mobile operators market share:



Coverage gap:

Mobile broadband coverage has expanded **reducing the coverage gap** from



5. GSMA (2025). Reforming Mobile Sector Taxation in Madagascar: Addressing fiscal barriers to digital growth.
6. GSMA Intelligence.
7. GSMA Intelligence.
8. WHO (n.d.) Madagascar: Health data overview for the Republic of Madagascar. (Accessed 17 July 2026).
9. GSMA (2025). Reforming Mobile Sector Taxation in Madagascar: Addressing fiscal barriers to digital growth.
10. GSMA Intelligence.
11. GSMA Intelligence.
12. GSMA (2025). Reforming Mobile Sector Taxation in Madagascar: Addressing fiscal barriers to digital growth.

DISASTER MANAGEMENT AND EWS GOVERNANCE

Madagascar's EWS operates within a formal disaster risk management framework established under Law No. 2015-031 on the National Policy for Disaster Risk Management, which created the National Framework for Risk and Disaster Management (under the governance of the Conseil National de Gestion des Risques et des Catastrophes (CNGRC).[13]

This framework is further supported by the National Strategy for Disaster Risk Management 2016-2030, which defines institutional roles and long-term objectives for strengthening preparedness and EWS.[14]

Within this architecture, early warning involves four main steps:

1. **Hazard monitoring and forecasting**
2. **Risk analysis and alert validation**
3. **Institutional coordination and decision-making**
4. **Multi-channel public dissemination**



Fokontany in Antalaha, a key local structure for community coordination and information relay

13. Government of Madagascar (2016). Politique Nationale de Gestion des Risques et des Catastrophes.
14. PreventionWeb (n.d.). Madagascar: National disaster risk management strategy 2016–2030. UNDRR.

The DGM provides the meteorological data, forecasts and technical bulletins that serve as the foundation for risk analysis and warning decisions. They also provide regular updates on trajectories, intensity and expected impacts during cyclone events. Based on these inputs and predefined thresholds, the National Office for Risk and Disaster Management (BNGRC) serves as the national coordinating authority for disaster risk management and early warning,[15] validating and issuing public alerts in coordination with sectoral ministries and decentralised authorities.

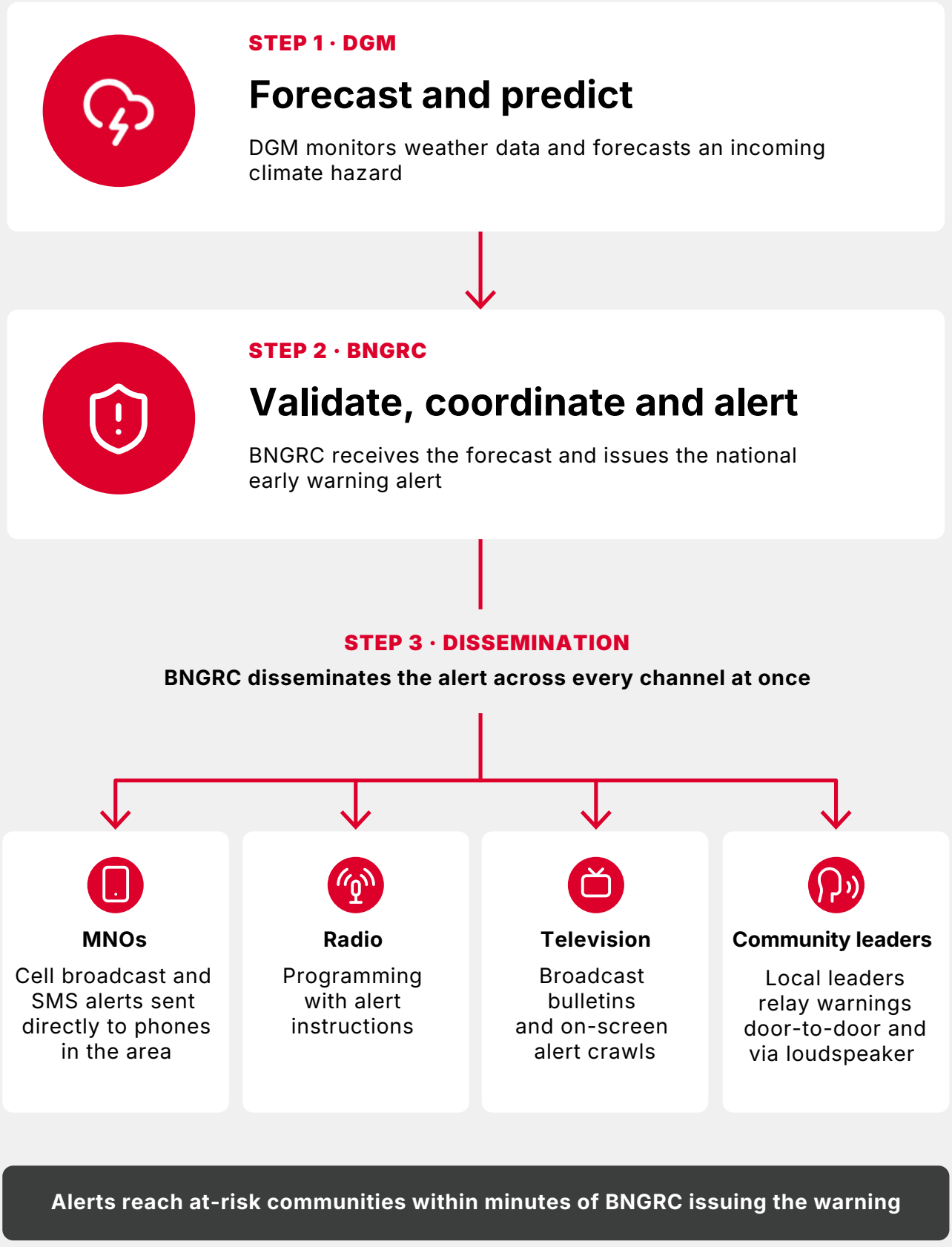
Once validated, alerts are transmitted through the Regional Committees for Risk and Disaster Management (CRGRC) down to district (CDGRC), commune (CCGRC), and fokontany (CLGRC) tiers. At the community level, local rescue teams (ELS) and Malagasy Red Cross (CRM) volunteers bridge the last-mile gap through door-to-door dissemination and local radio broadcasts.[16] These institutions coordinate to maintain consistent messaging, clear identification of the issuing authority, and alignment between technical information and public communication. At subnational and community levels, local authorities and humanitarian actors reinforce alerts through additional dissemination channels and local mobilisation practices.

Operational procedures for emergency communication are detailed in the National Contingency Plan, which defines alert triggers, communication flows, and the chain of command during cyclone and flood events.[17] Operational procedures for emergency communication are detailed in the National Contingency Plan, which defines alert triggers, communication flows, and the chain of command during cyclone and flood events.[18] These contingency plans outline the use of both traditional dissemination channels (radio, community authorities, local disaster committees) and digital channels, including SMS alerts.



15. Government of Madagascar (2019). Decret No2019-1958 fixant l'organisation, le fonctionnement et les attributions du Bureau National de Gestion des Risques et des Catastrophes (BNGRC).
16. Anticipation Hub (2026). Getting ahead of Tropical Cyclone Gezani in Madagascar: the Malagasy Red Cross Society activates its EAP for cyclones.
17. Humanitarian Library (2013). Plan De Contingence National Cyclones et Inondations.
18. Humanitarian Library (2013). Plan De Contingence National Cyclones et Inondations.

Figure 2:
National early warning communication



SMS IN MADAGASCAR'S EWS ARCHITECTURE

Since 2013, Madagascar's EWS has progressively incorporated digital communication tools to complement broadcast and community-based mechanisms. Under the current governance structure, SMS acts as the main mobile channel for public alerts, with Madagascar's three licensed MNOs—Airtel, Yas and Orange—transmitting validated alert messages to their subscribers using operator-managed systems.

During the 2022 cyclone season, more than 11 million SMS alerts were disseminated nationwide through coordinated efforts between the BNGRC, MNOs and humanitarian partners,[19] and in 2026, SMS alerts were disseminated during cyclones Fytia and Gezhani. According to UNICEF, early warnings and safety messages were disseminated via SMS and other channels, reaching more than 42,000 people to support protective actions at the household level.[20] These deployments demonstrate how SMS has become an integral part of Madagascar's multi-channel EWS, enabling timely communication during emergencies. Alignment with international best practice—particularly the use of CB or LB-SMS—represents a key ambition for strengthening EWS through geo-targeted, near-instantaneous alert delivery at scale.

The Communication Technology Regulatory Authority (ARTEC)[21,22,23] on Media and Communication Code is responsible for mobile communications regulation, however these provisions apply primarily to commercial and bulk SMS.



19. UNICEF (2022). Madagascar Country Office: Cyclone Ana-Batsirai-Dumako-Emnati Update No. 2.
20. UNICEF (2026). Flash update #2 Cyclones Fytia and Gezhani.
21. ARTEC (2006). Decret N°2006-213 Instituant L'Autorite De Regulation Des Technologies De Communication De Madagascar (ARTEC).
22. ICT Policy Africa (2014). Loi No. 2014-024 sur les transactions électroniques.
23. CNLEGIS (2020). Decret No. 2020-006 Portant augmentation de salaire des Fonctionnaires, des Agents des Collectivités Territoriales Décentralisées et des Etablissements Publics Nationaux, et des Agents non encadrés (EFA, ELD, ECD, EMO, ES).

Message development and the dissemination process

MNOs currently use a list-based targeting model for dissemination by creating recipient lists from subscriber registration data linked to administrative areas. As this data reflects declared residence rather than real-time phone location, targeting remains static and may not account for population mobility during hazard periods. This creates a risk of missed alerts for exposed communities and poor targeting accuracy. Individuals at risk might not receive alerts without real-time location data, especially in areas where people are displaced, while others may receive unnecessary alerts.[24]

After validation, the approved message content and targeting details are sent to each MNO.

Each operator then uses its own internal filtering, scheduling, and routing logic to send the alert to subscribers. Operators may use the same sender ID, yet dispatch timing, routing and reporting can vary by network. SMS delivery can be vulnerable to network congestion, which often occurs during natural hazards due to a spike in traffic, meaning critical messages fail to reach intended recipients promptly.[25] Conveying comprehensive emergency information within the SMS 160-character limit can also be challenging.[26] This limitation demonstrates the importance of multi-channel alerting, which serves not only to validate mobile-based alerts, but also to relay necessary detailed information to affected communities.



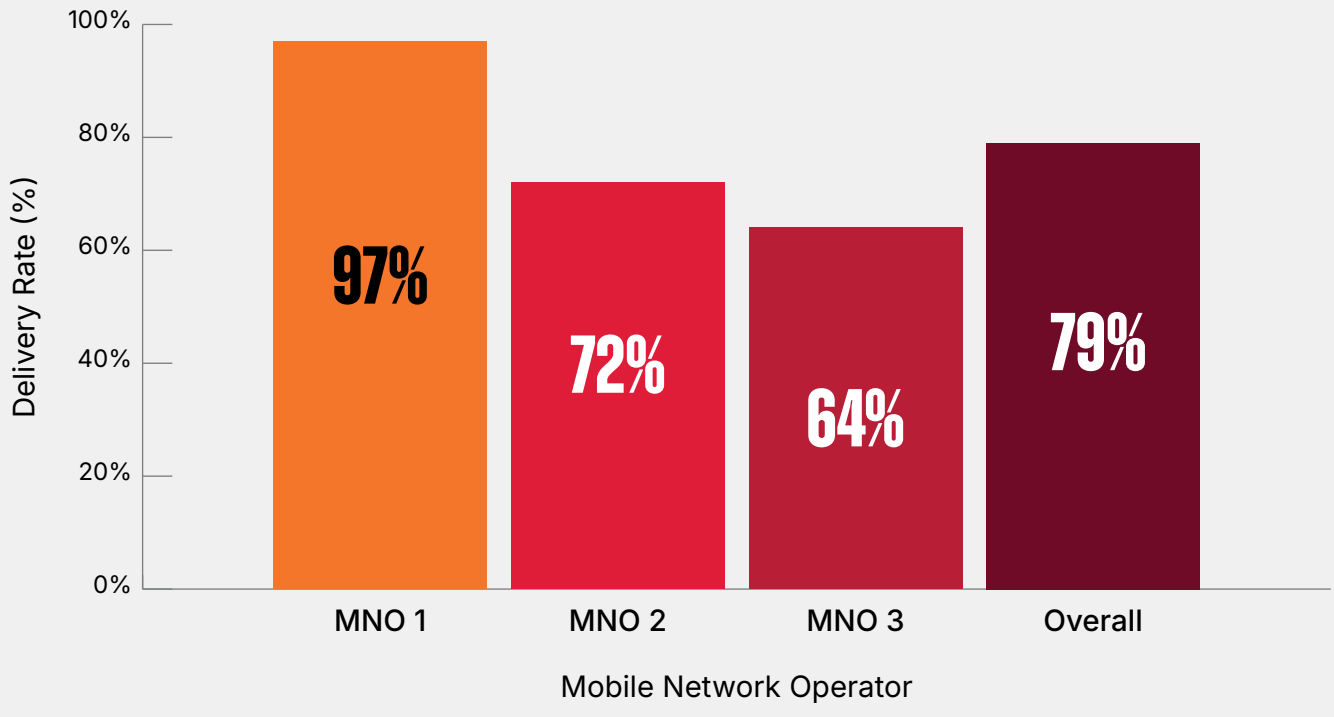
24. PreventionWeb (2023). Mobile-based early warning systems: For effective and inclusive alerting. UNDRR.
25. Intersec (2024). Location-based SMS for targeted alerts.
26. PreventionWeb (2023). Mobile-based early warning systems: For effective and inclusive alerting. UNDRR.

THE SMS PERFORMANCE TEST

An SMS performance test was conducted in three locations—the East coast, the SAVA Region and Atsimo-Andrefana—to explore the use of SMS alerts within Madagascar's EWS, and how they are received, interpreted and responded to by recipient communities. Across all MNOs and target areas, the test disseminated 16,947 SMS messages. Operators reported delivering 13,440 messages and not delivering 3,507, for an overall delivery rate of 79%. Delivery rates varied significantly by operator; MNO 1 reported 97% successfully delivered overall, while MNO 2 reported 72% and MNO 3 reported 64%.

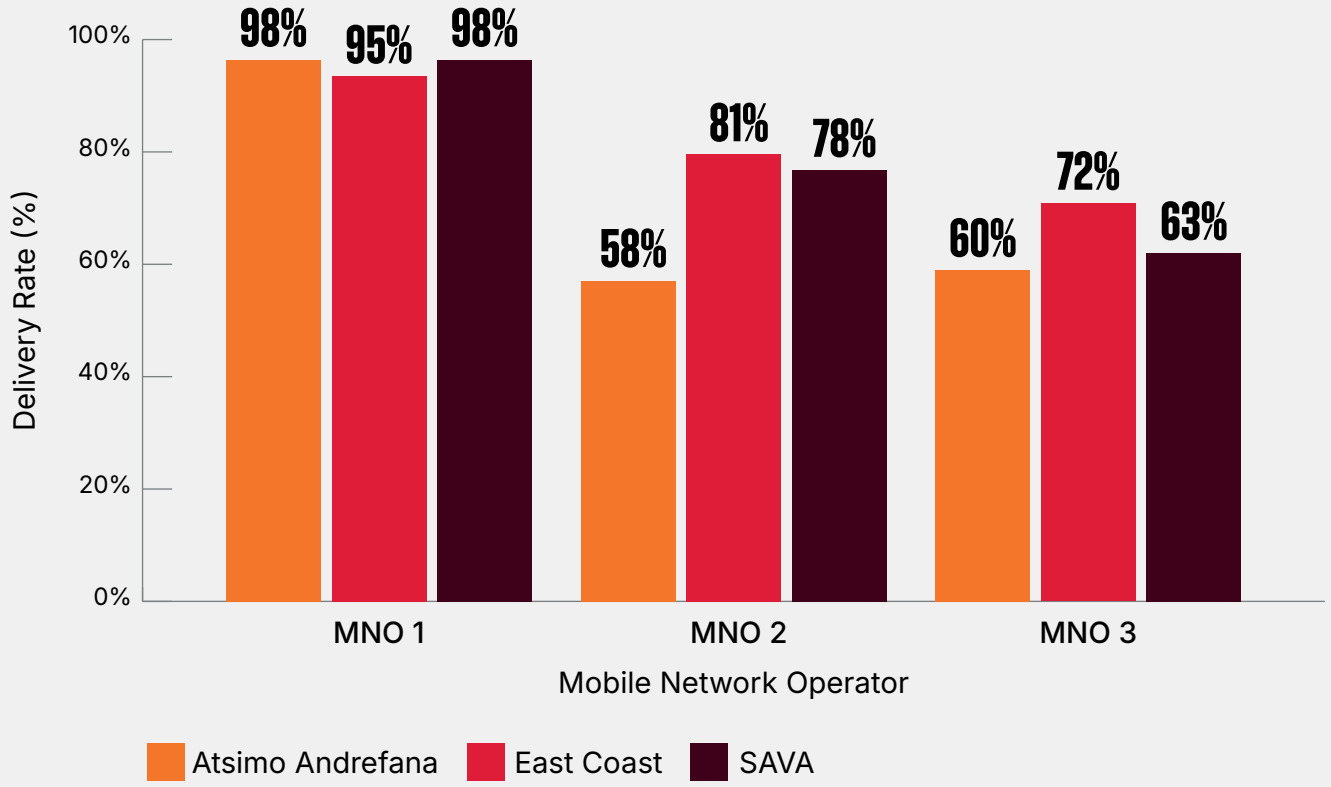
During the demonstration test, each operator followed its own process for generating and consolidating data and figures, which may account for minor variations in delivery rates.

Figure 3:
SMS delivery rate by MNO



Overall, delivery was higher on the East coast in Analanjirofo and Atsinanana (86%) than in SAVA (80%) and Atsimo-Andrefana (71%). Differences in delivery rates likely reflect variations in the accuracy of subscriber databases, the proportion of inactive or unreachable SIM cards, network routing conditions, and the internal order in which messages were sent. As the test followed standard operating procedures rather than emergency-priority transmission, these results reflect baseline system performance under good operating conditions.

Figure 4:
SMS delivery rate by MNO



The test provided partial insight into delivery timing. Message-level timestamps provided by one of the MNOs had an average delivery delay time of 17.5 seconds, with a higher delay average in SAVA than in other regions. The dataset also showed considerable variation, with maximum delays exceeding two hours in some instances. This contrasts to CB, which broadcasts emergency alerts instantly and simultaneously to all phones within range of a cell tower, rather than individual delivery.

These differences in delivery delay time may reflect network conditions, whether handsets are switched on, or other unknown factors rather than a clear system-wide failure. Short average delivery times in one operator's dataset suggests prompt delivery for many messages after dispatch, but does not demonstrate end-to-end performance for the system as a whole, which could still be affected by routing, queuing, or network management during a real emergency. Longer delivery delays may be explained by temporary handset unavailability (e.g., devices switched off and later reconnected), intermittent network coverage in geographically dispersed or lower-density areas such as SAVA, or internal message queuing during periods of high network traffic. Because SMS operates on a store-and-forward architecture, delayed delivery can occur when handsets reconnect to the network after temporary disconnection. The data does not indicate widespread systemic delay but instead illustrates variation in delivery times affecting a small proportion of messages.

Where operators provided information regarding failures, the main factors were related to whether handsets were switched on and network coverage conditions. Non-delivery was primarily due to recipients being out of service area (57%) or handsets being switched off (38%). Other technical causes, such as invalid or inactive numbers, SIM registration inconsistencies, and system-level delivery errors, accounted for the remaining failures.

Non-delivery was primarily due to recipients being out of service area (57%) or handsets being switched off (38%).

Out of service area



Switched off



Although each category accounted for a small share of failures, together they highlight underlying database and routing issues that are not directly related to real-time network coverage. The lack of consistent failure categories across MNOs limits the ability to compare reasons for non-delivery and benchmark performances across operators. SMS dispatch times differed across MNOs, reflecting differences in internal approval processes, message workflows, and platform readiness.

Table 1:
Comparison of SMS dispatch timing across MNOs during performance of the demonstration test

Operator	Dissemination time	Notes
MNO 1	11:45 hours	Single message dispatch sequence
MNO 2	11:54 hours	Single message dispatch sequence
MNO 3	13:00–16:00 hours	Staggered message dispatch across target areas

The staggered dispatch reflects differences in how operators currently manage SMS dissemination. While each MNO completed the test successfully, recipients would not receive alerts at the same time during real emergencies due to the lack of a synchronised message release.

Overall, the test provides a partial proof of concept for large-scale, region-targeted SMS dissemination using a harmonised sender ID. However, it also highlights several structural constraints that affect performance monitoring and system comparison across operators. These include differences in reporting detail, timestamp precision, delivery delay reporting, and the way failures are classified. The lack of interoperable dissemination architecture and harmonised reporting standards makes it challenging to monitor system performance in real time or compare results across MNOs. Addressing these gaps would strengthen monitoring, improve performance access capacity and increase confidence in the system's reliability during high-risk events. However, as the community research findings demonstrate, delivery statistics alone do not fully capture the effectiveness of SMS alerts for emergency warnings.



KEY FINDINGS: COMMUNITY RECEPTION AND RESPONSE



While SMS delivery is critical, it is only the beginning of the communication chain for emergency alerts. This section examines how recipients engaged with the SMS alerts once received; how they interpreted messages, decided whether to act and shared information within their communities.

These findings are based on 24 FGDs with 183 participants and 12 KIIs across the three locations (Toliara, Antalaha and Soanierana Ivongo).



In all three locations, SMS alerts were considered as one source of information among other sources. Receiving an SMS did not guarantee that participants read it carefully, understood it clearly, or acted on it. Many participants discussed the message with others before choosing a course of action. Some participants were alerted through the radio or by local authorities, neighbours or family members. Receiving the SMS directly did not always determine the respondent's level of understanding or their response plan.

Awareness and trust

Participants across all three locations reported familiarity with SMS alerts as part of the national EWS. Messages clearly identified as sent from the BNGRC inspired more trust as respondents could distinguish them from commercial messages. In most community discussions, respondents indicated they would immediately trust and prioritise BNGRC-identified messages.

In contrast, messages from unknown numbers prompted greater caution. Many participants referred to the large number of promotional or fraudulent SMS they regularly receive. While only a few participants openly expressed strong scepticism, most said they would verify an unidentified message before trusting it. Clear sender identification enabled people to read and trust messages more quickly.

Verifying alerts through other channels remained normal practice. Across all 24 community discussions, participants indicated they would confirm the SMS with at least one additional source, including Radio Nationale Malagasy, Chefs de Fokontany (village leaders), Red Cross volunteers, or community discussions, reflecting a widespread expectation that important information would be consistent across several trusted sources.

KIIs with local organisations explained that while SMS alerts attract attention, radio and community authorities help people understand the message and to feel confident about acting on it.

Participants also noted a preference against frequent messaging from authorities, which they said reduced their likelihood of responding.

> "When an alert is received, there is no time to lose. We immediately disseminate the information in the village using local criers, through public verbal announcements, so that everyone is informed."
>
> **Analanjirofo Region (Soanierana Ivongo) – Female, FGD participant**



These findings demonstrate the complementary roles of different communication channels in engendering awareness and trust. The effectiveness of SMS alerts often depends on how well they align and complement existing communication networks, such as radio or community leaders.

Rather than serving as a stand-alone system, the SMS warning system in Madagascar functions as part of an integrated early warning ecosystem in which institutional credibility is established through multi-channel consistency.

Message reception, access and information sharing

The test SMS was not received by all participants, and of those who received the message, not everyone read it. Infrastructure limitations and daily phone habits influenced whether individuals noted the message.

In Soanierana Ivongo, almost all FGDs reported unstable network coverage. Participants described frequent signal interruptions, difficulties accessing the network at certain times of the day, and variations in reception quality by location. Several groups also noted delays in receiving messages and frequent service disruptions, especially during bad weather. Additionally, some participants missed messages because their phones were switched off or out of battery when the alert was sent.

In Antalaha, participants described uneven network coverage across operators and locations, particularly outside urban areas.

In Toliara, coverage was generally perceived as better, however several groups reported overlooking SMS messages due to the high volume of commercial messages they regularly receive.

Multi-SIM use was common in all regions. Participants highlighted that alerts sometimes arrived on secondary or inactive SIM cards, leading to messages being missed or read only after a delay. Frequent phone sharing also reduced reliability of access. Many participants noted that household members who relied on shared phones might not receive messages promptly or that the messages were removed before they could be read.

Participants who did not directly receive an SMS learned about the alert through alternative sources. Older adults, people with limited literacy, and those without personal phones often obtained alert information through other channels, such as radio, Chefs de Fokontany, Red Cross volunteers, neighbours or family members. Young people frequently relayed information quickly, sometimes using social media. Several groups mentioned that oral explanations sometimes provided more clarity than an SMS.

These findings highlight how communities may compensate for access barriers through informal sharing practices. While infrastructure and access conditions, including network coverage, electricity and multiple SIM use, can create unequal pathways to direct SMS access, many communities actively work around these constraints. Delivery statistics alone do not fully capture the cascading reach of SMS alerts in practice.

> "When I receive a cyclone alert by SMS, I prepare immediately. I warn my family, stock essential supplies, and secure my home so we are ready."
>
> **SAVA Region (Antalaha) – Male, FGD participant**

Message comprehension and interpretation

Participants did not interpret all message formats in the same way. Across all three locations, participants recognised the colour-coded alert levels and associated them with cyclone risk. However, many said that colour codes alone did not clearly communicate the recommended actions, with some reporting that the wording was too formal or difficult to understand.

In Toliara, colour-coded alerts sparked discussion but rarely prompted immediate action. In Antalaha, several groups said they would wait for confirmation on the radio before acting on a colour code. In Soanierana Ivongo, participants understood the colour system but did not react to it unless someone explained it orally.

Participants across all locations reported a better understanding of the impact-based cyclone message. They explained that specifying the type of hazard, its timing and its severity made the message easier to interpret and feel more urgent. Message wording influences how people interpret alerts and whether they take protective action, with clear and specific messages helping communities to move quickly from awareness to action.

Language was also reported as playing a key role in comprehension. Several groups suggested that messages would be easier to follow if they were written in the local dialect or explained by radio or community leaders. Participants who were less comfortable with formal written Malagasy were more likely to rely on oral explanations.

Group discussion often helped people understand the message. In several community discussions where participants did not receive a direct message, participants demonstrated clear comprehension once the message was read aloud and discussed. These collective discussions helped clarify the meaning for everyone.



Behavioural responses to alerts

Research participant response was determined by how the alert was written and the perception of the severity of the situation.

Across all 24 FGDs with community members, the colour-coded SMS mainly prompted discussion and verification. Participants would read the message, discuss it, and confirm via the radio or local authorities before taking further steps. They described this as normal behaviour during cyclone season.

The SMS alert performance test prompted clearer intended action. In all community discussions, participants described specific steps they would take, such as securing roofs, preparing food and water, protecting children and vulnerable household members, coordinating with neighbours, and preparing for possible evacuation. Many said they would begin preparing while simultaneously verifying the information through the radio or local leaders.

The difference between these message types illustrates how clarity reduces ambiguity and aids decision-making. Effective alerting relies on rapid dissemination as well as providing information that people can easily understand and act on.

It is worth noting that receiving an SMS alert alone did not automatically trigger protective action. Participants' responses depended on several additional social factors, including perceived risk, housing conditions and socio-economic status affecting feasible actions available, as well as the perceived ability to act.



A MALAGASY FAMILY'S WEATHER JOURNEY:

To demonstrate the warning to action journey for SMS alerting in Madagascar, a representative family example has been created. This persona represents a synthesis of users and their contexts, and has been developed based on themes and common characteristics observed in the research, including access to technology, age, location, network coverage and reliance on community and broadcast channels to verify alerts.

Using the family persona, a hypothetical 'weather journey' was created to illustrate their personal experience of natural hazards, showing how these characteristics shape the way alerts are received, understood and acted upon.

THE ZAFIHAJA FAMILY



HAJA

Age: 42

Position: Father

Role: Fisherman

Digital profile: Haja has a basic phone registered under his name.



TIANA

Age: 38

Position: Mother

Role: Sells fish at the local market

Digital profile: Tiana shares her husband's phone when he is out fishing.



HASINA

Age: 67

Position: Grandmother

Role: Lives with Haja, Tiana and their children

Digital profile: Hasina has no phone of her own and relies on neighbours and the radio.

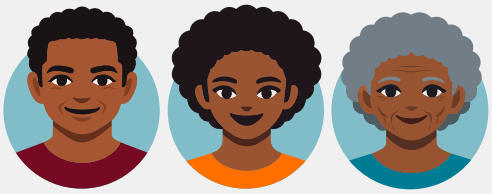
Household:

Haja and Tiana have three children (aged 4, 9 and 14). They live in a coastal fokontany in the SAVA Region, an area of mixed urban and peripheral connectivity, prone to repeated cyclone exposure. The household has patchy network coverage that worsens in bad weather, and electricity is inconsistent, so charging is not always reliable.

Trust and information habits:

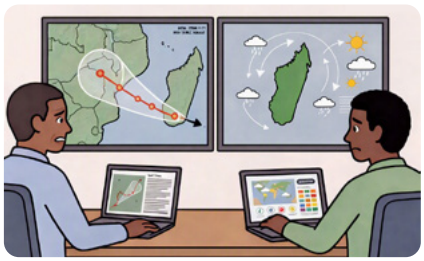
The family trusts messages clearly marked from BNGRC, but treats unknown numbers with suspicion, due to the high levels of spam SMS they receive. They rarely act on one source alone. Haja asks his fellow fishermen, Tiana talks to her neighbours, and Hasina waits to hear from the Chef de Fokontany for confirmation.

THE ZAFIHAJA FAMILY'S WEATHER JOURNEY



BEFORE THE DISASTER:

1.



BNGRC validates a cyclone alert based on DGM forecasts and authorises its dissemination to Airtel, Yas and Orange.

2.



Haja's phone receives the SMS mid-morning while he is out on the boat. The message is yellow, indicating the cyclone will make landfall in the next 48 hours, and carries the BNGRC sender name, which he recognises immediately.

3.



Tiana does not see the message because she has no access to the shared device until Haja returns that evening.

4.



Hasina is notified about the alert first from a neighbour who heard the alert on the radio, before anyone in the household has read the SMS.

5.



The family's second phone, registered on a different network, also receives an alert, but it sits unread in a drawer.

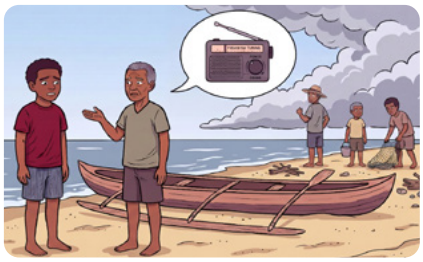
DURING THE DISASTER:

6.



The message sparks conversation once the family is together, but does not prompt immediate action on its own. The wording feels formal and the yellow colour code alone does not instruct them what to do.

7.



Haja walks down to the beach to ask other fishermen what they have heard. Several mention a follow-up announcement on the radio with more specific detail.

8.



A second, SMS message follows with clear, key information: Cyclone Bertha, imminent danger: landfall expected within 24 hours, prepare for flooding, landslides, damage to buildings and power outages. This generates a sense of urgency and is specific enough to act on.

9.



The family begin securing the house, storing food and water, charging their electronics and gathering the children.

Haja coordinates with neighbouring fishermen to pull the boats further inland and secure nets and equipment.

10.



A local leader moves door-to-door throughout the fokontany, repeating the emergency announcements. This explanation feels more trustworthy to Hasina than an SMS alert.

11.



As the weather worsens, network coverage becomes patchy and a follow-up red alert message arrives, telling recipients to relocate to safe shelter, delayed due to network congestion.

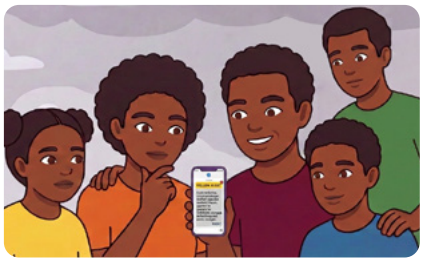
POST-DISASTER:

12.



With their neighbours, the family begin assessing the damage caused by the cyclone.

13.



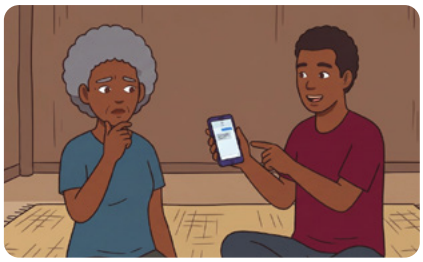
The family agrees the second message made the real difference as it gave them clear instructions to follow.

14.



The BNGRC send a follow-up blue alert SMS confirming Cyclone Bertha has passed, but warning recipients to stay vigilant to damaged infrastructure.

15.



Hasina says that even with access to a phone, she would have waited for someone to explain the message to her directly. The SMS alone would not have been sufficient.

16.



The family shares what they learned from this cyclone with neighbours who had not received an alert directly, continuing the same informal relay that had reached them earlier that day.

RECOMMENDATIONS

This study has identified several lessons, demonstrating how technical delivery, operational coordination, message design, and community communication practices shape the effectiveness of mobile-enabled EWS.

1. Design EWS to support multi-channel alert dissemination

Delivery rates do not fully reflect how alerts reach or are understood by communities. Individuals often learn about SMS alerts or verify them through radio broadcasts, local authorities, and social networks, while network instability, older devices, electricity access, shared devices, literacy levels and multi-SIM use all influence how people receive and interpret SMS alerts. EWS design should therefore consider SMS as one element within a wider alert chain rather than its end point, with other channels built in as functional, coordinated parts of the alert chain to ensure at-risk communities receive accurate and consistent information.

2. Clear sender identification strengthens trust

Clear sender identification serves as an essential credibility filter within a high volume of commercial and fraudulent SMS messages. Participants consistently perceived messages as legitimate when the BNGRC was clearly identified as the sender, demonstrating the importance of visibly identifying the issuing authority of emergency alerts.

3. Message clarity influences preparedness behaviour

Participants consistently described alert messages that clearly state the hazard type, expected timing, and potential impact as easier to understand and more actionable than abstract or purely colour-coded formats.

Clear wording and specific language help people move more quickly from awareness to preparedness, as message design plays an important role alongside dissemination speed.

4. Operational coordination affects the consistency of alert dissemination

The current system in Madagascar relies on bilateral coordination between the BNGRC and MNO. Each MNO manages its own internal dissemination process, which can result in variations in dispatch timing and procedures arising during message transmission.

While this model enables message transmission, strengthening operational coordination, for example by establishing a documented alert transmission protocol and strengthening coordination across communication channels, can improve reliability during emergencies. This can also support the progressive development of a national EWS where mobile alerts, broadcast media and community communication mechanisms operate in a coordinated and mutually reinforcing manner. Overall, clear coordination procedures can ensure consistent dissemination occurs during emergencies.

5. Harmonised reporting is required to monitor system performance

The SMS performance test revealed differences in delivery reporting formats, delivery delays, data availability, monitoring practices and failure categorisation across operators. These variations make it difficult to compare performance and monitor the system in real time, and can undermine efforts to strengthen a national EWS.

Standardised reporting standards, consistent definitions for key metrics, clear procedures enabling the routine sharing of delivery reports and periodic technical reviews can help institutions review delivery performance and strengthen oversight of a mobile-enabled alert system.

6. Selective use of mobile alerts is essential to maintaining trust

Careful consideration of when and how frequently mobile alerts are issued is critical to sustaining public trust. Excessive alerting can lead to alert fatigue, reducing attention and responsiveness over time.

Messages should also remain within the 160-character SMS limit to ensure their delivery as a single message, maintain message clarity and avoid confusion caused by message fragmentation.

CONCLUSION

Madagascar's SMS-based EWS demonstrates that effective early warnings depend as much on factors such as institutional coordination and message design as they do on technical delivery.

The research highlights how SMS transmission rates alone cannot provide a full picture as to alert reach and impact. Emergency alerts function most effectively within coordinated systems where complementary channels confirm messages and enable interpretation. In Madagascar, the BNGRC's institutional authority, combined with clear sender identification and simple, impact-based hazard information, strengthens community trust and response. Regulatory oversight and documented protocols between government authorities and MNOs create consistency across alert dissemination.

A distinctive feature of Madagascar's model is the role of community-based communication practices, through which information extended beyond initial SMS recipients via households and local leadership networks, expanding audiences and embedding emergency messaging into localised social structures. This informal reach was seen as most effective where messages were clear, particularly regarding hazard type, timing and expected impact, which communities noted as more actionable. Underpinning both dynamics were infrastructure realities. Network instability, device age, electricity access and literacy levels all influence not only who receives messages, but how they are understood.

Madagascar's experience demonstrates that national EWS requires dedicated attention to delivery performance, institutional cooperation and alignment across communication channels. While enabling conditions may vary across countries, the principles underpinning this system, focused on coordinated systems, clear institutional authority and multi-channel reinforcement, offer insights for strengthening mobile-enabled EWS for other emerging systems in hazard-prone contexts. The assessment approach used in this study, combining institutional analysis, technical performance testing and community research, provides a practical framework that can be replicated in other countries to evaluate both the operational performance and community effectiveness of SMS-based EWS. As these systems mature, ensuring emergency alerts reach all communities, particularly those most vulnerable, will remain central to their capacity to move beyond delivery to action, and ultimately save lives.

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