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India's SACHET Public Warning System:
A Case Study in Mobile Alerting

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Contents

Executive summary

Timely and effective early warning systems (EWS) are critical for reducing the risks of disasters and saving lives. With 96% of the global population now covered by a mobile network,[1] mobile-based EWS have become a vital tool for disseminating alerts at scale. However, the effectiveness of these systems depends on their design, deployment and operational efficiency. This report presents a case study of India's SACHET public warning system – a valuable model for other countries seeking to enhance their public alerting capabilities.

SACHET is India's national public warning system[2], designed to provide fast, reliable and scalable disaster alerts via mobile networks. The system was developed according to eight design principles: it is integrated in India's disaster management framework, multichannel in the dissemination of alerts and timely in delivering messages. It is also inclusive, supporting multiple languages and accessibility needs, accountable, with clear governance structures, actionable, ensuring messages provide clear instructions, secure, with measures to prevent misuse, and compatible with different networks and technologies.

Mobile network operators (MNOs) are essential to the SACHET platform, serving as the backbone of alert dissemination. The system is integrated with India's four largest MNOs – Airtel, Jio, Vodafone Idea and BSNL – to support the integration of both location-based SMS (LB-SMS) and cell broadcast (CB). LB-SMS allows messages to reach all mobile users within a certain geographic area, ensuring broad coverage even for older devices. However, it can be slow due to network congestion and processing time. CB, on the other hand, delivers alerts instantly to all compatible devices within a defined area, making it more effective for emergency alerts.

1 GSMA. (2023). The State of Mobile Internet Connectivity Report 2024.
2 An EWS covers the entire process from disaster risk knowledge and hazard monitoring to emergency response. A public warning system is a subset of EWS, focused specifically on disseminating alerts to the public through channels like mobile networks, radio, TV and sirens.

Although it is still being tested, CB is a critical component of SACHET, offering near-instantaneous message delivery unaffected by network congestion. This makes it particularly effective for rapid-onset hazards like earthquakes and tsunamis, where seconds matter. CB also supports multilanguage messaging, ensuring alerts are accessible for diverse populations. However, device compatibility remains a challenge as not all mobile phones can receive CB messages. This requires ongoing efforts to expand the reach of emergency alerts and increase public awareness of the system. By combining both technologies, SACHET will balance speed, reach and reliability, ensuring that alerts are delivered quickly while maximising coverage for different types of mobile users.

This report highlights key lessons from the SACHET system:

- Adopting the Common Alerting Protocol (CAP) standardises alerts for seamless, multichannel dissemination.
- Integrating stakeholders through a centralised platform streamlines the validation and distribution of alerts.
- Multichannel dissemination expands the reach of public alerts while inclusivity measures like multilingual messages and accessibility features enhance accessibility.
- Testing and capacity building, including drills and training, improve system readiness.
- A user-centered design simplifies operations with automation and GIS-based targeting.
- Oversight and accountability ensure continuous improvements in speed, accuracy and public response.

This report focuses on the design and implementation of India's SACHET public warning system. While it provides insights into system functionality and technical considerations, it does not assess broader elements essential to effective EWS, for example, the integration of community-based EWS, behavioural responses to alerts and last-mile connectivity. It also does not evaluate the long-term sustainability of the system or the use of public feedback to make improvements. However, these are critical considerations in ensuring EWS translate into meaningful risk reduction and life-saving action.

01
Introduction

Over the past half-century, the frequency and impact of disasters worldwide have increased fivefold due to the worsening effects of climate change. As communities around the world grapple with escalating risks, EWS have never been more important.

The United Nations Office for Disaster Risk Reduction (UNDRR) defines EWS as "an integrated system of hazard monitoring, forecasting and prediction, disaster risk assessment, communication, and preparedness activities and processes that enables individuals, communities, governments, businesses, and others to take timely action to reduce disaster risks in advance of hazardous events."

When executed well, EWS can save lives, significantly reduce economic losses and prevent up to 30% of damage, with as little as 24 hours' notice.[3]

Despite these proven benefits, a third of the global population are still not covered by an effective EWS, leaving billions of people vulnerable.[4] The UN Early Warnings for All (EW4All) initiative seeks to close this gap by ensuring universal EWS coverage. Given that mobile networks cover an estimated 96% of the world's population, mobile phones are a powerful tool for scaling EWS.[5] Countries with robust EWS in place experience six times fewer disaster-related deaths than those without.[6]

In this context, India's national disaster alert system, SACHET, offers a compelling case study of how a Common Alerting Protocol (CAP)-enabled EWS can be scaled and integrated across a range of communication channels and different levels of government. Supported by India's largest mobile network operators (MNOs) – Airtel, Jio, Vodafone Idea and BSNL – and leveraging mobile technology, SACHET has communicated more than 44 billion hazard-specific mobile alerts[7] and exemplifies the potential for impactful and inclusive warning dissemination.

This report looks at SACHET as a model of an effective EWS. Of the four pillars of EWS – (1) disaster risk knowledge; (2) detection, monitoring and forecasting of hazards; (3) dissemination and communication; and (4) preparedness and response capabilities – this report focuses on pillar 3. It examines the design, implementation and performance of SACHET to highlight key lessons and good practices that other countries can adapt to develop or strengthen their own EWS.

The report begins by presenting India's disaster risk profile. It then examines the mobile landscape and its implications for alert dissemination, followed by an overview of India's institutional disaster management framework. It then focuses on the SACHET platform – its design principles, technical architecture and how alerts are generated, authorised and disseminated. These sections cover the CAP, location-based SMS (LB-SMS) and cell broadcast (CB) systems. The report concludes with challenges observed during implementation, feedback from key stakeholders and considerations for other countries looking to build or strengthen their own public warning systems.

3 GSMA. (2025). Mobile-Enabled Early Warning Systems: The GSMA and the Early Warnings for All Initiative.
4 WMO. (3 December 2024). "Early warnings for all: Empowering all to climate action".
5 GSMA. (2023). The State of Mobile Internet Connectivity Report 2024.
6 UNDRR. (2023). Global Status of Multi-Hazard Early Warning Systems.
7 Statistics provided by C-DOT.

02
Methodology

This research sought to understand the challenges, successes and lessons learned through the design and implementation of India's EWS, and to document lessons related to the use of mobile networks in India's EWS. The research was conducted in four phases, described below.

Phase 1:
Desk-based research

The first phase consisted of secondary research to understand India's climate-related risks and EWS. This included an examination of the country's vulnerability to natural hazards, an analysis of how digital and mobile tools are integrated in existing EWS infrastructure and an evaluation of the communication and dissemination channels used to issue disaster alerts to the public. The research team reviewed various secondary sources, which ranged from academic, peer-reviewed journals to grey literature, such as policy documents, case studies and technical reports.

Phase 2:
Stakeholder interviews

The second phase of the research consisted of semi-structured interviews with 11 key informants. Informants spanned national and subnational government agencies, civil society organisations (CSOs), MNOs, research institutions, think tanks and international donors. The interviews sought to validate findings from phase 1 and delve deeper into specific implementation, governance and technological considerations of India's EWS. Tailored questionnaires guided the interviews and reflected the unique roles and expertise of the stakeholders.

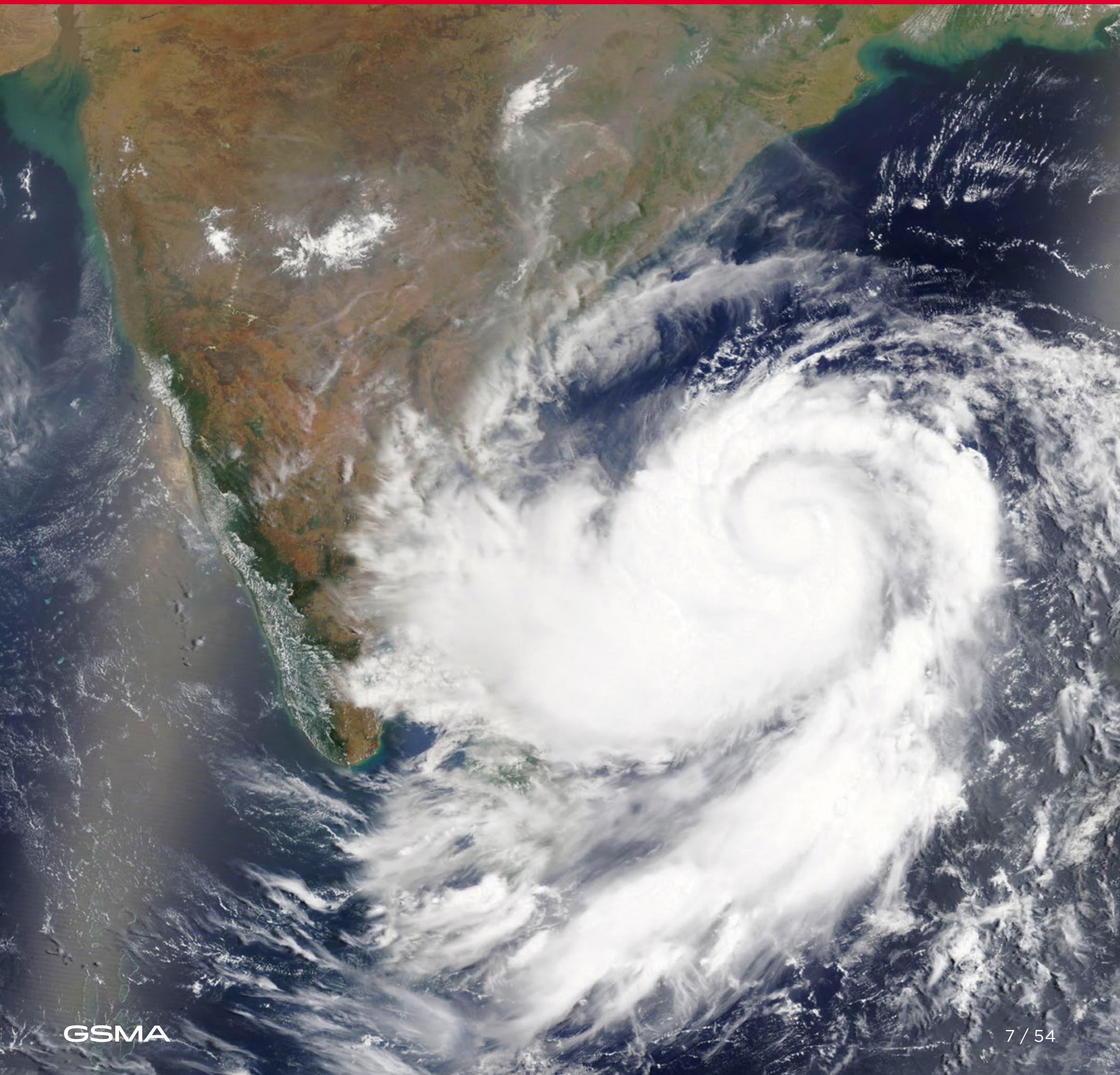
Phase 3:
Analysis

In this phase, the research team consolidated the findings of the desk-based review and stakeholder interviews. This identified the key design principles of India's disaster alert system and recommendations for best practices to strengthen and replicate public alert systems in other countries.

Phase 4:
Stakeholder roundtable discussion

For the final phase, a roundtable discussion was hosted with stakeholders to validate and refine the research findings. Participants included the same individuals interviewed in phase 2, as well as new stakeholders whose expertise in disaster risk management or mobile communications could offer fresh perspectives.

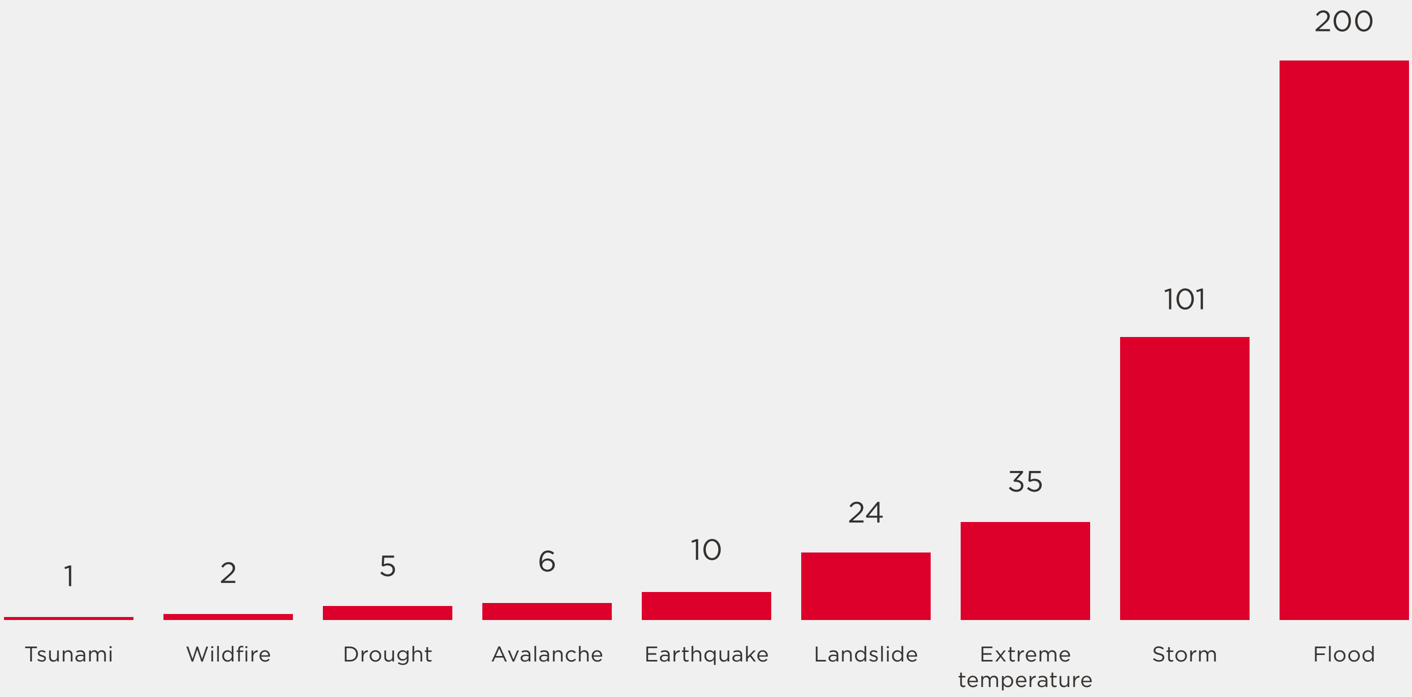
03
India's disaster risk profile



According to the World Risk Index, India has the third-highest disaster risk worldwide, surpassed only by the Philippines and Indonesia.[8] Between 2000 and 2024, India experienced approximately 384 major disaster events.[9] Floods accounted for more than half of these disasters, leading India to be called the "flood capital of the world." Other significant hazards include storms, extreme temperatures, landslides and earthquakes (see Figure 1). Climate change and environmental degradation have worsened the frequency and intensity of these hazards, which has heightened the vulnerability of people and critical infrastructure across the country.[10]

Figure 1

The frequency of major climatological, geophysical, meteorological and hydrological disasters in India, January 2000–June 2024



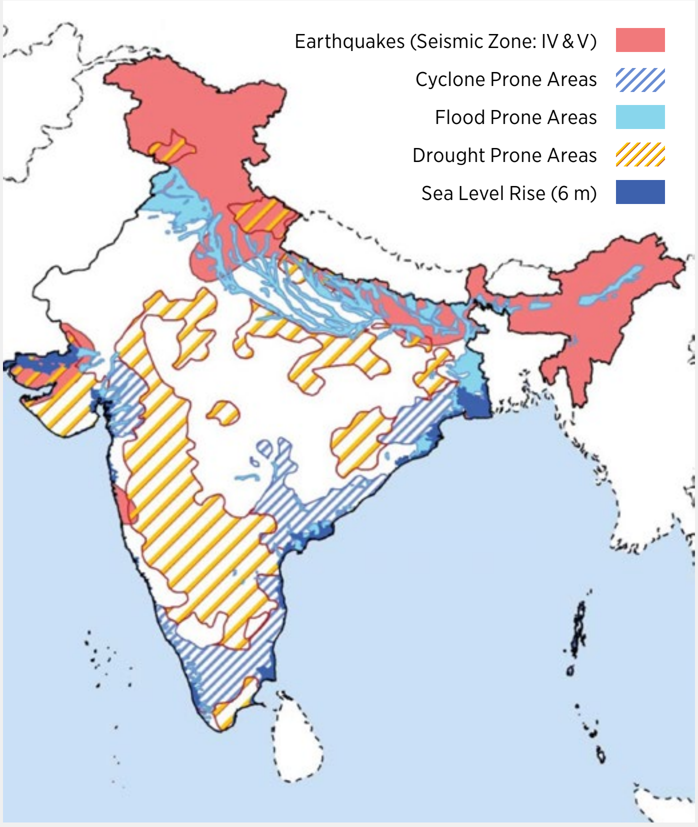
Source: EM-DAT

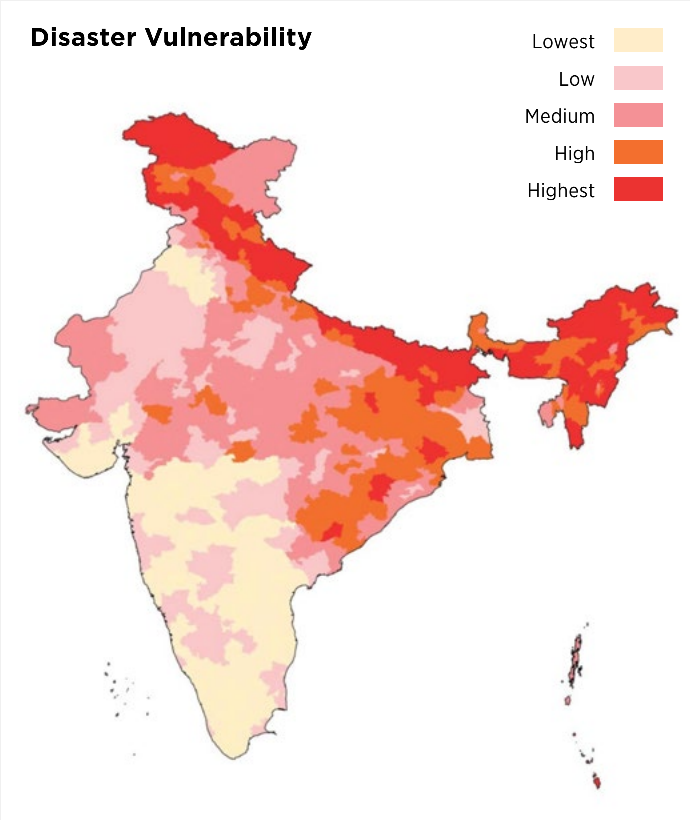
Globally, India also has the highest number of people exposed to natural hazards, with approximately 1 billion individuals at risk.[11] India's diverse topography includes the Himalayas, alluvial plains, hilly peninsular areas and coastal zones. This leaves 27 of India's 36 states and union territories, or approximately 85% of the country's landmass,[12] susceptible to one or more natural hazards (see Figure 2).[13] Furthermore, a study on climate vulnerability that mapped 640 districts in India found that 80% of Indians reside in districts prone to climate-related disasters (see Table 1).[14]

8 Bündnis Entwicklung Hilft and Institute for International Law of Peace and Armed Conflict (IFHV). (2023). WorldRiskReport 2023.
9 EM-DAT: https://www.emdat.be/
10 UNICEF. (n.d.). "Disaster risk reduction".
11 Bahree, M. (23 March 2016). "India Most Exposed to Natural Hazards". Forbes.
12 GIVE2Asia. (2019). "DisasterLink Country Profile: India".
13 NIDM. (n.d.). Do's and Don'ts for Common Disasters.
14 Chauhan, C. (27 October 2021). "75% of districts in India vulnerable to climate crisis, face risk of floods: Report". Hindustan Times.

Figure 2

Geographic distribution of natural and climate-induced hazards and vulnerability





Source: Chakraborty et al.

India's heightened vulnerability to disasters is also tied to a complex web of socio-economic, institutional and environmental factors. Unsustainable practices, such as deforestation, rapid urbanisation and unsound agricultural methods, have led to environmental degradation, which has intensified the impact of disasters.[15]

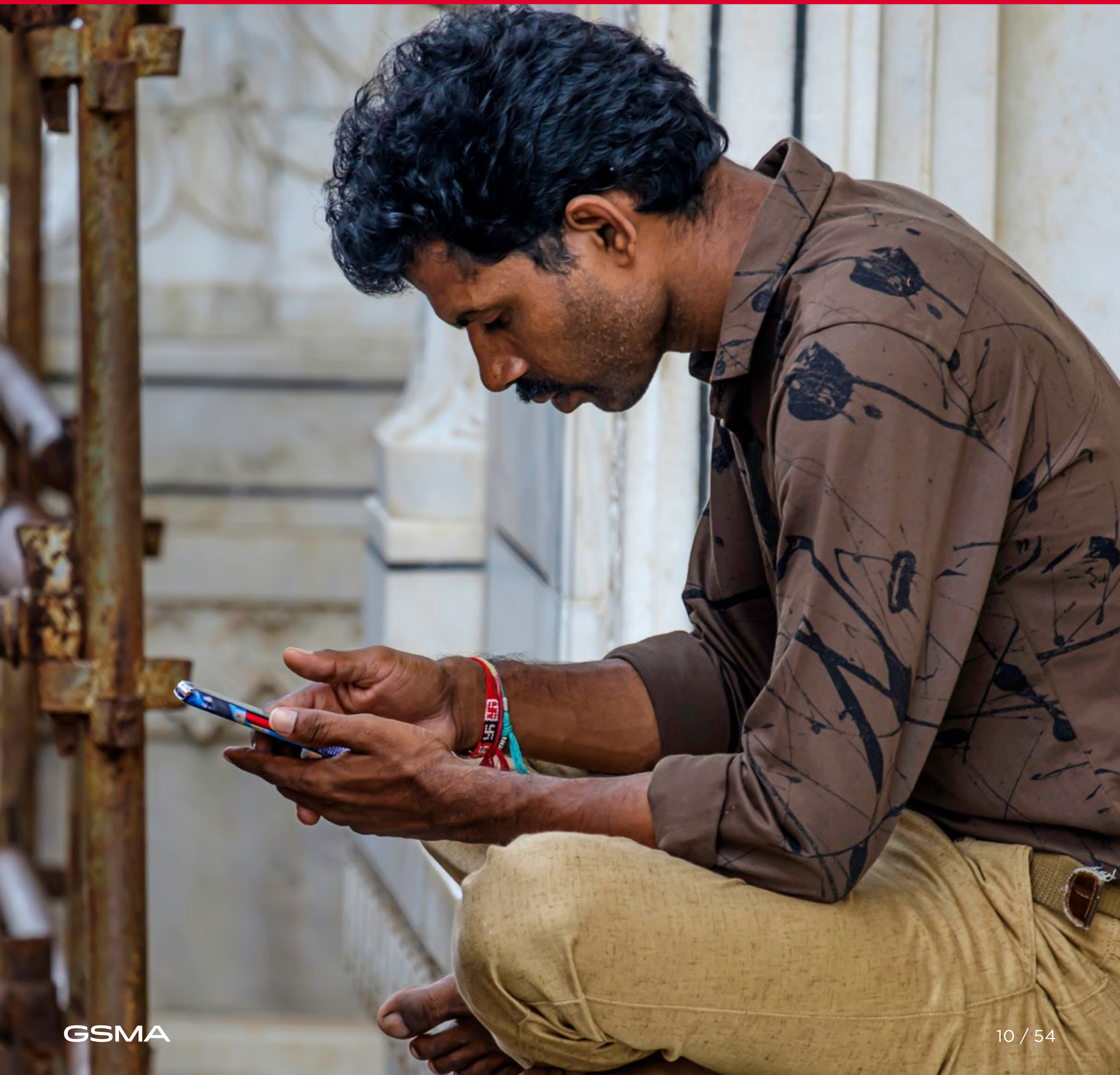
Human-induced activities and population pressures also force many communities to settle in disaster-prone areas, such as floodplains and unstable slopes.[16] These areas often lack proper infrastructure and technical safety standards, which compound disaster risks.[17] Poverty makes people even more vulnerable, as poorer populations are often forced to live in low-cost, unsafe housing in marginal, high-risk areas. As a result, they are disproportionately affected by hazards such as floods, landslides and earthquakes.[18]

The economic toll of disasters in India is substantial. On average, the country loses 2% of its GDP annually to disasters.[19] The Asian Development Bank (ADB) estimates that from 2019 to 2023, India had approximately USD 56 billion in losses and damages, and more than 54 million people were affected by weather-related disasters.[20] The World Meteorological Organization (WMO) places these annual losses due to extreme weather and climate change even higher at around $87 billion.[21]

The impact of $1 in losses differs dramatically depending on who experiences it. For wealthier individuals, disaster-related damages may lead to financial setbacks, while for the poor, such losses can destroy livelihoods and push families deeper into poverty.[22] A narrow focus on aggregate losses fails to account for the disproportionate burden of disasters on India's most vulnerable populations.

15 UNDP. (2012). Disaster Management in India.
16 PRB. (2011). Disaster Risk and Vulnerability: The Role and Impact of Population and Society.
17 Agrawal, N., Gupta, L. and Dixit, J. (2021). "Assessment of the Socioeconomic Vulnerability to Seismic Hazards in the National Capital Region of India Using Factor Analysis". Sustainability, 13(7).
18 NIDM. (2014). Country Profile.
19 UNDP. (2012). Disaster Management in India.
20 Prasad, G.C. (16 May 2024). "India hit by a fourth of Asia Pacific's USD 230 bn economic loss due to weather disasters". Livemint.
21 Singh, Y. (27 October 2021). "India Suffered $87 Billion Average Annual Loss From Extreme Weather Events: UN". The Wire.
22 World Bank. (2016). Unbreakable: Building the Resilience of the Poor in the Face of Natural Disasters.

04
India's mobile landscape and implications for early warning systems



India has made significant progress in expanding mobile network coverage in the past decade. This has significantly enhanced the country's capacity to disseminate critical public and early warning alerts. In 2014, only 61% of the population had 3G access while 4G coverage was just 2%. By 2022, both 3G and 4G reached nearly 99% of the population.[23] Mobile phone subscription has risen significantly alongside network coverage. Even after reaching nearly half the population by 2014, mobile penetration has grown by over 60% to reach 72% by 2024.[24] Despite this progress, there are still major barriers limiting the effectiveness and reach of mobile-based early warning alerts.

Key challenges for mobile-based EWS in India

- **Mobile coverage gaps:** Of the nearly 600,000 villages in India, 25,000 are still not covered by a mobile network.[25] This leaves entire communities unable to receive emergency alerts and especially vulnerable during disasters.
- **Mobile ownership gaps:** With 72 unique mobile subscribers for every 100 people, India still lags behind many global peers in mobile adoption, despite significant progress over the last two decades.[26]
- **Compatibility gaps:** India's 204 million basic and feature phone users risk missing critical disaster alerts, as many older or cheaper models lack cell broadcast (CB) support or have the feature deactivated.[27]
- **Gender gaps:** Only 54% of women (aged 15–49) have personal access to a mobile phone compared to 91% of men – a disparity that undermines disaster preparedness.[28]
- **Rural-urban divide:** Mobile phone use in rural areas lags behind urban areas – 65% compared to 81%. This limits the reach of time-sensitive disaster warnings outside urban centres.[29]

23 ITU. (n.d). DataHub.
24 GSMA Intelligence. Note: Mobile penetration figures are based on unique mobile subscribers, rather than total SIM connections. This methodology accounts for individuals who may own multiple SIM cards or devices, providing a more accurate estimate of the proportion of the population that actually uses mobile services.
25 Ali, S. (3 February 2022). "Over 25,000 villages lack mobile connectivity, govt data shows". Business Today.
26 GSMA Intelligence (2024).
27 GSMA Intelligence (2024).
28 UNFPA. (December 2023). Asset Ownership by Women in India: Insights from NFHS Data. Analytical Paper Series #6.
29 MOSPI. (2023). Multiple Indicator Survey in India.

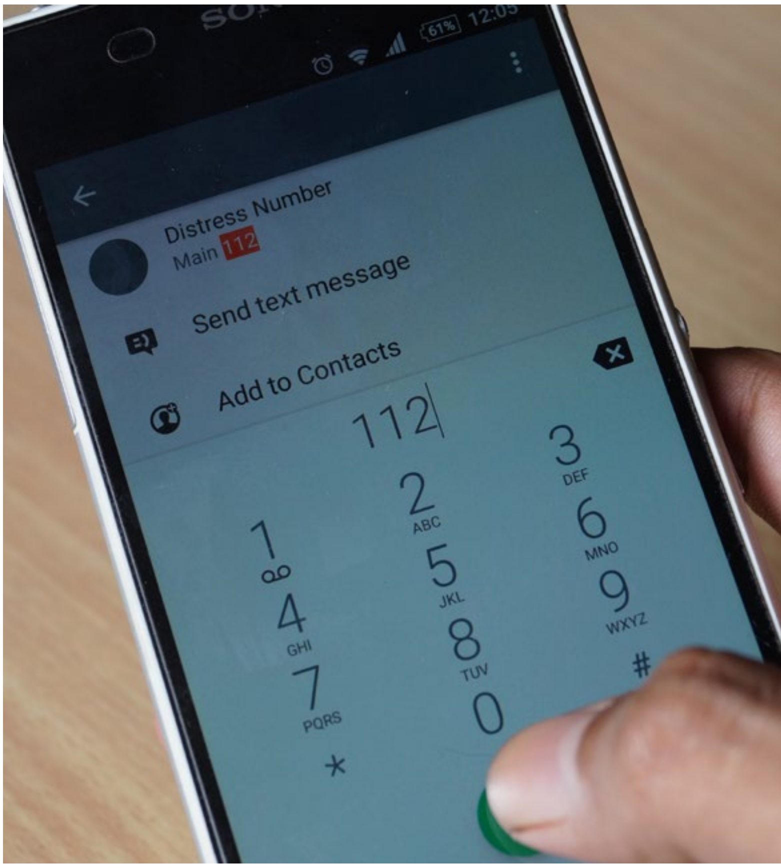
05
India’s approach to disaster management

Over the years, India's approach to disaster management has shifted from a focus on response to a proactive, technology-driven approach. This aligns with global disaster risk reduction (DRR) frameworks and reflects India's growing commitment to build resilience to natural and human-induced disasters.

A vital step in this journey was the formulation of the National Disaster Management Plan (NDMP), introduced in 2016 and revised in 2019. The NDMP serves as a strategic framework that guides government agencies through all phases of the disaster management cycle, from preparedness to recovery, and promotes disaster-resilient development nationwide.[30]

The NDMP aligns closely with India's international commitments to DRR. It integrates the principles of three pivotal global frameworks adopted post-2015: the Sendai Framework for Disaster Risk Reduction (SFDRR), the Sustainable Development Goals (SDGs) and the Paris Agreement on Climate Change (UNFCCC). It also incorporates the Prime Minister's Ten Point Agenda on Disaster Risk Reduction.[31] The NDMP therefore offers a cohesive and forward-looking approach to managing disaster risk and has helped build a culture of prevention, mitigation, preparedness and response.[32]

The Government of India has substantially increased funding for EWS and risk mitigation measures due to its commitment to DRR.[33] Investments since 2014 include $278.76 million to strengthen EWS and $6 billion allocated to mitigation initiatives from 2021 to 2025.[34] Additionally, $23 billion has been earmarked for disaster preparedness, response and recovery efforts.[35]

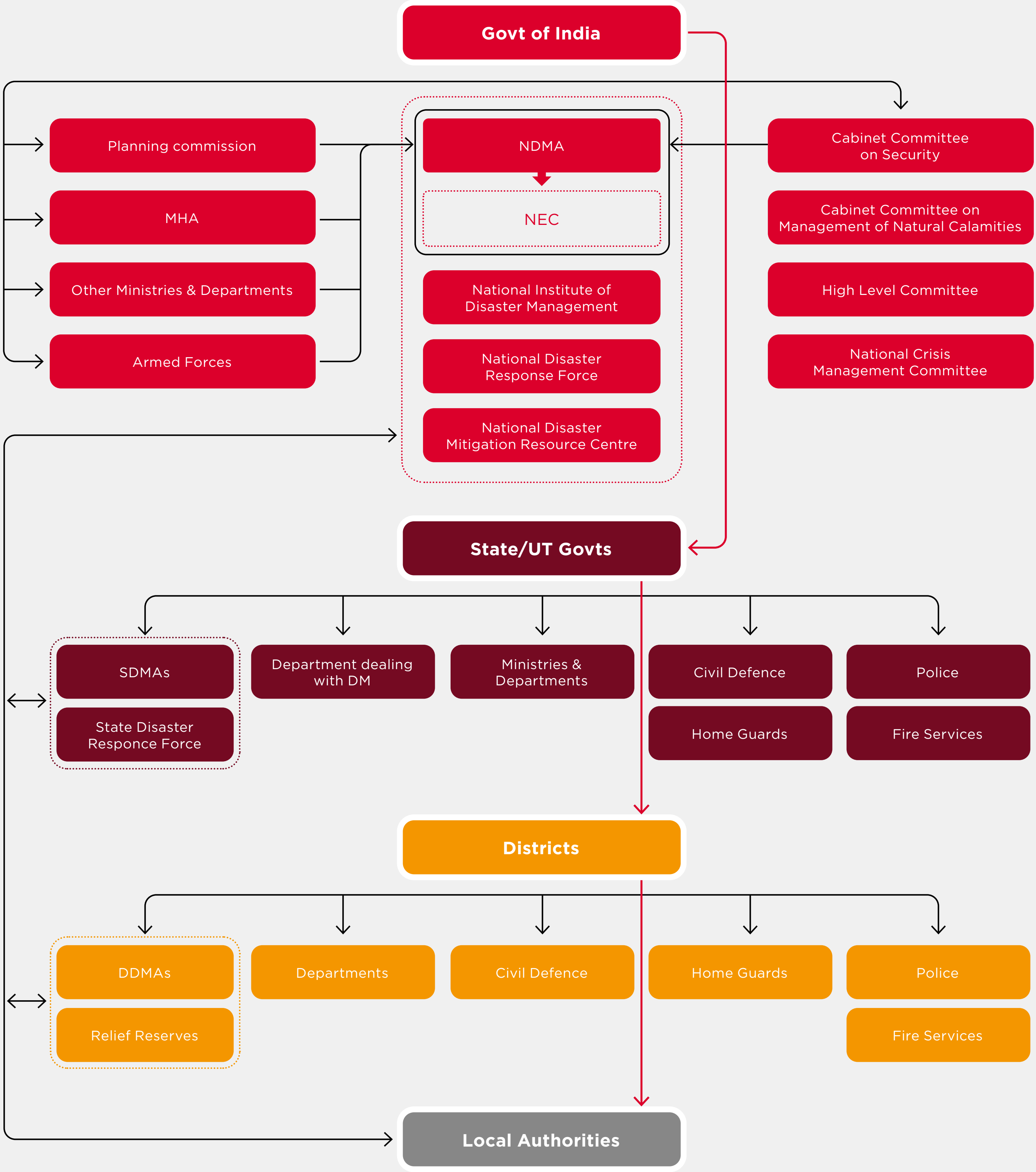


30 PIB Delhi. (10 December 2024). Disaster Preparedness and Climate Resilience.
31 NDMA. (n.d.). Prime Minister's Ten Point Agenda on DRR.
32 PIB Delhi. (10 December 2024). Disaster Preparedness and Climate Resilience.
33 Thakur, P. (20 May 2023). "India has significantly increased funding for disaster risk reduction". Times of India.
34 PIB. (31 July 2024). "Union Home Minister and Minister of Cooperation Shri Amit Shah participates in debates in both the houses of Parliament on the situation arising out of landslides in Wayanad, Kerala". Press release.
35 PM India (18 May 2023). Midterm Review of Sendai Framework for Disaster Risk Reduction (2015–2030).

The institutional structure of disaster management in India

Figure 3

The organisational structure of India's disaster management system



Source: NIUA

India's disaster management structure involves coordination among government agencies at the national, central, state, district and local levels. The NDMA spearheads these efforts and is responsible for developing the disaster management policies and guidelines followed by different ministries, national government departments and state governments.[36] The NDMA receives support from institutions such as the National Institute of Disaster Management (NIDM), which focuses on capacity building, and the National Disaster Response Force (NDRF), which provides specialised response capabilities.

In most cases, state governments carry out disaster management, with the central government playing a supporting role as requested by the state government. States and union territories manage disaster risks through state disaster management authorities (SDMAs). The SDMAs are tasked with implementing state-specific disaster management plans in alignment with national guidelines laid out by the NDMA.[37]

At the district level, district disaster management authorities (DDMAs) play a pivotal role in executing disaster management activities on the ground. These authorities coordinate with local departments, such as the police, fire services, civil defence and home guards, to ensure effective response and relief measures. Local authorities, including municipal corporations and panchayats, form the frontline of disaster response with a focus on immediate relief and rehabilitation efforts.[38]

Challenges in disaster communication

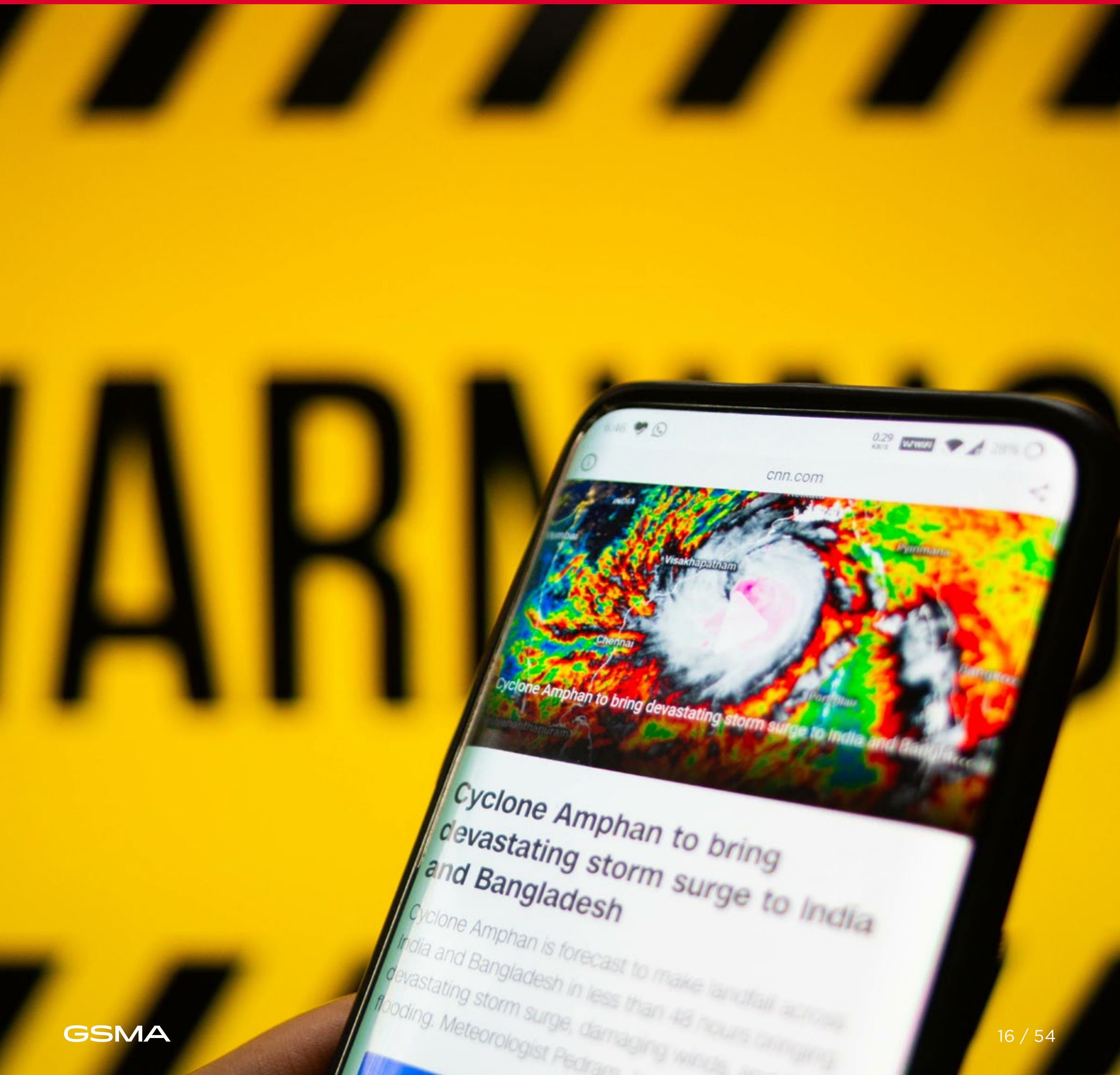
Despite significant technological advances, the lack of an integrated mechanism for timely and localised dissemination of disaster alerts has long plagued India's disaster management framework. Historically, disaster warnings in India were disseminated through traditional channels, such as newspapers, radio, television and, more recently, the internet and SMS.[39] However, there have been several challenges with these methods:

- **Preconfigured SMS lists**: Traditional SMS-based alerts relied on preconfigured contact lists, which were often outdated and failed to reach live mobile phones in a specific geographical area. This excluded many individuals physically present in disaster zones, such as travellers or migrant workers.
- **Lack of geotargeting**: Alerts were disseminated to a wide area and often irrelevant to recipients outside the affected zones. This caused confusion and diminished the credibility of the alerts.
- **Limited accessibility**: Messages were rarely delivered in local languages, which left large segments of the population unable to understand the warnings or act on them.
- **Fragmented communication**: Multiple agencies disseminated warnings manually or through uncoordinated processes, leaving at-risk communities without sufficient lead time to prepare and act.[40,41,42]

The Indian Government set out to develop an integrated disaster alert solution to address these challenges. The solution was intended to deliver timely and accurate alerts, including to those in remote and underserved areas. The system would use India's information and communications technology (ICT) infrastructure to enable geotargeted, multilingual and multichannel dissemination of disaster alerts. This led to the creation of the SACHET platform.

36 Ministry of Home Affairs, Government of India. (2011). Disaster Management in India.
37 NDMA. (2019). National Disaster Management Plan.
38 MHA. (2022). National Policy on Disaster Management (NPDM).
39 Basu, S. et al. (30 June 2024). "A Multi-modal Approach Towards Public Alerting and Effective Communication in Disaster Scenarios: Implementation in the Indian Context". Information Technology in Disaster Risk Reduction.
40 Ibid.
41 Interview with C-DOT.
42 Interview with Manu Gupta, SEEDS India.

06
SACHET: a CAP-enabled integrated alert system



The Common Alerting Protocol

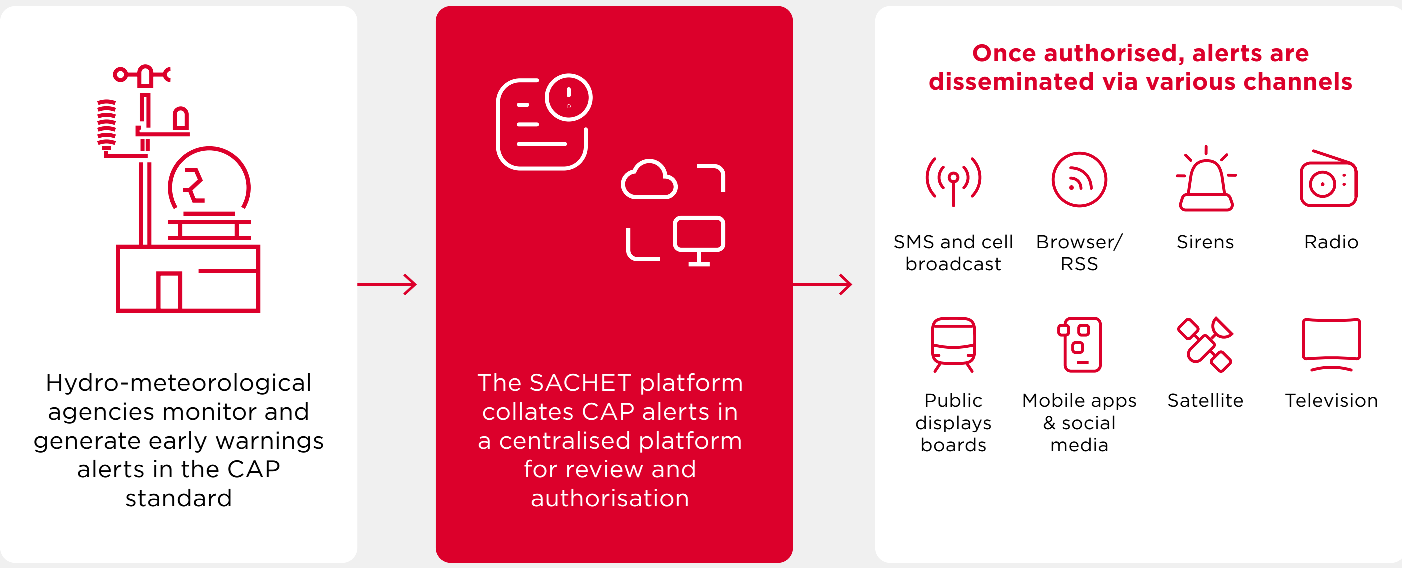
The ITU-T X.1303 Common Alerting Protocol (CAP) is an international standard designed to improve emergency alert and public warning systems. CAP was created by OASIS and adopted by the International Telecommunication Union (ITU). It uses an XML-based format to deliver consistent warning messages across multiple systems at once. This standardised approach promotes interoperability as it enables a single message to reach various warning channels simultaneously, enhancing the effectiveness of alerts and simplifying dissemination. CAP also lowers costs and reduces operational complexity by removing the need for multiple custom interfaces across the many warning sources and dissemination systems used for all-hazard alerts.[i,ii]

i GSMA. (2023). Cell Broadcast for Early Warning Systems: A review of the technology and how to implement it.
ii ITU. (n.d.). Common Alerting Protocol and Call to Action.

SACHET is an integrated alert system built on the Common Alerting Protocol (CAP) framework to standardise and streamline India's disaster alert process. Conceptualised in 2018 under the leadership of the NDMA, SACHET bridges communication gaps between national hydrometeorological forecasting agencies and disaster management authorities. By bringing these key stakeholders together on a centralised IT platform, SACHET ensures that disaster alerts are generated, authorised and disseminated through multiple channels to at-risk communities.

Figure 4

How alerts are disseminated through SACHET



Backed by a 10-year funding commitment of INR 3.54 billion (approximately $43 million),[43] SACHET was developed and is fully maintained by the Centre for Development of Telematics (C-DOT) – a government research and development organisation. Retaining end-to-end control over the technology allows the government to continuously refine SACHET, align it with national priorities and enable swift responses to emerging threats.

SACHET is designed to provide support at every stage – before, during and after a disaster.[44] The goal of the system is to provide the right information at the right time to the right people, enhancing India's preparedness and resilience in the face of natural and human-induced crises.

Figure 5

Use-cases of SACHET at each stage of an event

Pre-event

- Hazard-specific early warning alerts
- Farmer and fisherfolk advisories
- Helpline numbers
- Evacuation instructions

During the event

- Disaster-related updates
- Information about shelters and safe places nearby
- Helpline numbers

Post-event

- Relief-related information

Source: C-DOT

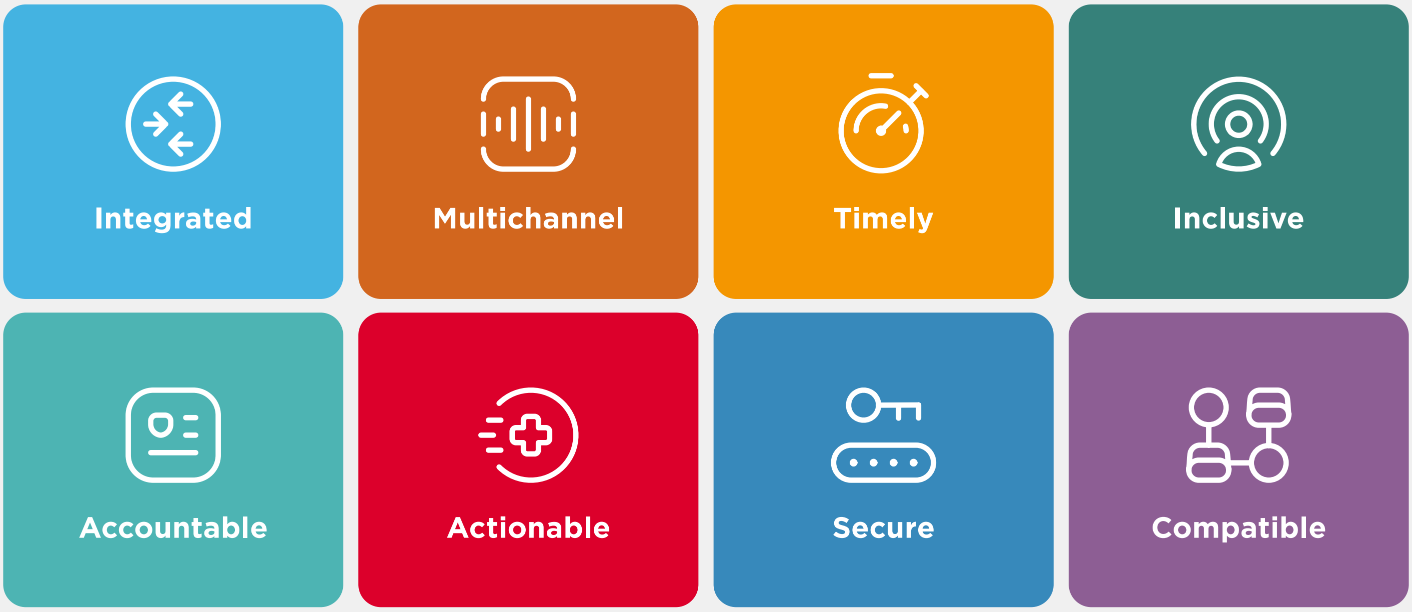
43 Telecom Regulatory Authority of India (TRAI). (3 November 2021). Tariff issues related to SMS and Cell Broadcast alerts disseminated through Common Alerting Protocol (CAP) platform during disasters/non-disasters.
44 C-DOT. (2022). Introduction and Overview: CAP-Integrated Alert System.

SACHET's design principles

The SACHET platform has eight core design principles to address the complexities of disaster communication in India (see Figure 6). This section explores how these design principles enhance the functionality and effectiveness of the platform.

Figure 6

Key design principles of SACHET



Integrated

SACHET's foundational principle of integration addresses a critical vulnerability in disaster management: fragmented coordination between the agencies that generate alerts, called alert-generating agencies (AGAs), and those that authorise and disseminate them, called alert-authorising agencies (AAAs). SACHET consolidates these agencies on a single digital platform to eliminate operational silos and ensure seamless communication between them. This integration transforms disjointed workflows into a unified, real-time process that accelerates the disaster alert process.[45]

Alert-generating agencies (AGAs)

AGAs are specialised hydrometeorological agencies that monitor, detect and forecast natural and human-induced potential hazards. They use the CAP format to produce early warnings, which covers risks such as cyclones, earthquakes, floods and more.

This CAP-based alert ensures critical details like geographical area, severity, certainty, time frame and recommended actions, are communicated clearly.

Roles and responsibilities of AGAs

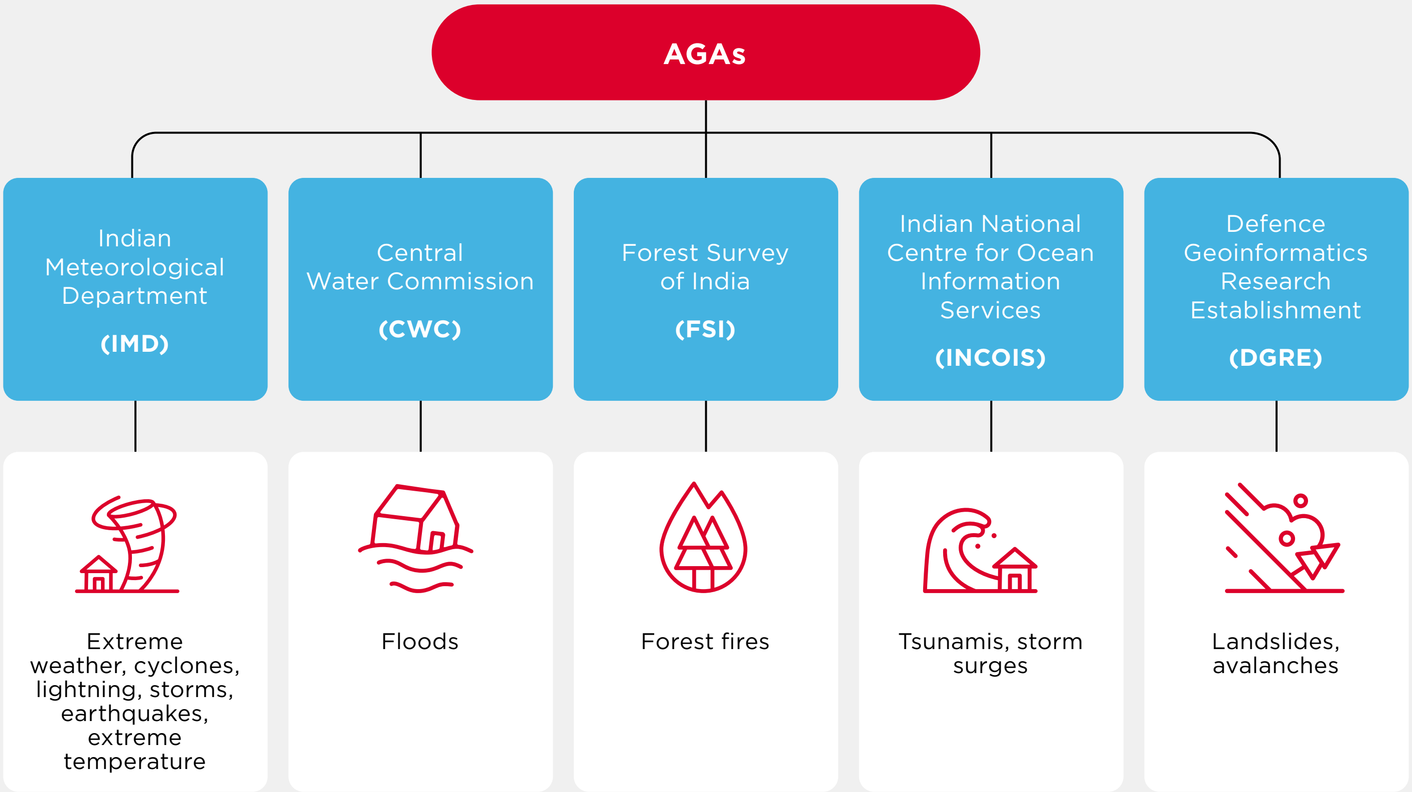
- Hazard monitoring and detection: AGAs continuously track environmental and meteorological parameters to identify early signs of disasters.
- Data analysis and forecasting: AGAs apply sophisticated models to predict when and where hazards might strike, along with their likely impacts.
- Issuing early warnings: AGAs create and relay CAP-formatted alerts to relevant authorities, including AAAs, for subsequent action.

In India, the SACHET platform integrates five AGAs. Each agency is responsible for different hazards, as depicted in Figure 7.[46,47]

45 Interview with C-DOT.
46 Ibid.
47 C-DOT. (2022). Introduction and Overview: CAP-Integrated Alert System.

Figure 7

AGAs and their responsibilities



Alert authorising agencies (AAAs)

In India, state disaster management authorities (SDMAs) serve as AAAs. SDMAs are statutory bodies established to manage and mitigate disasters at the state level. India has 36 SDMAs, each responsible for disaster management within its respective state or union territory.[48] On the SACHET platform, SDMAs receive, review, refine and authorise alerts generated by AGAs. They also decide how and when these alerts should reach local populations.

Roles and responsibilities of AAAs

- **Refine target areas:** AAAs use GIS-based tools to determine the exact geographic scope of the hazard.
- **Craft actionable alerts:** AAAs translate and simplify messages into regional languages to ensure clarity and tailor content to local contexts.
- **Determine dissemination channels:** AAAs decide whether to send alerts via mobile, radio, television, public announcements or other means based on urgency and accessibility.
- **Authorise alert release:** AAAs approve and send out alerts immediately or schedule them for future dissemination, depending on how critical they are.[49]

SACHET unifies the entire alert process as it consolidates communications between AGAs and AAAs in a single interface. When an AGA generates a CAP-based alert, it is automatically routed to the relevant SDMA via an application programming interface (API) determined by the geographical parameters of the alert. The SDMA then validates the content of the alert, ensures it is clear and relevant, makes any necessary adjustments, such as language translation and local context, and finalises the scope of dissemination. Once authorised, the alert is broadcast through predetermined channels, either immediately or at a scheduled time, streamlining what can otherwise be a cumbersome process prone to delays.[50]

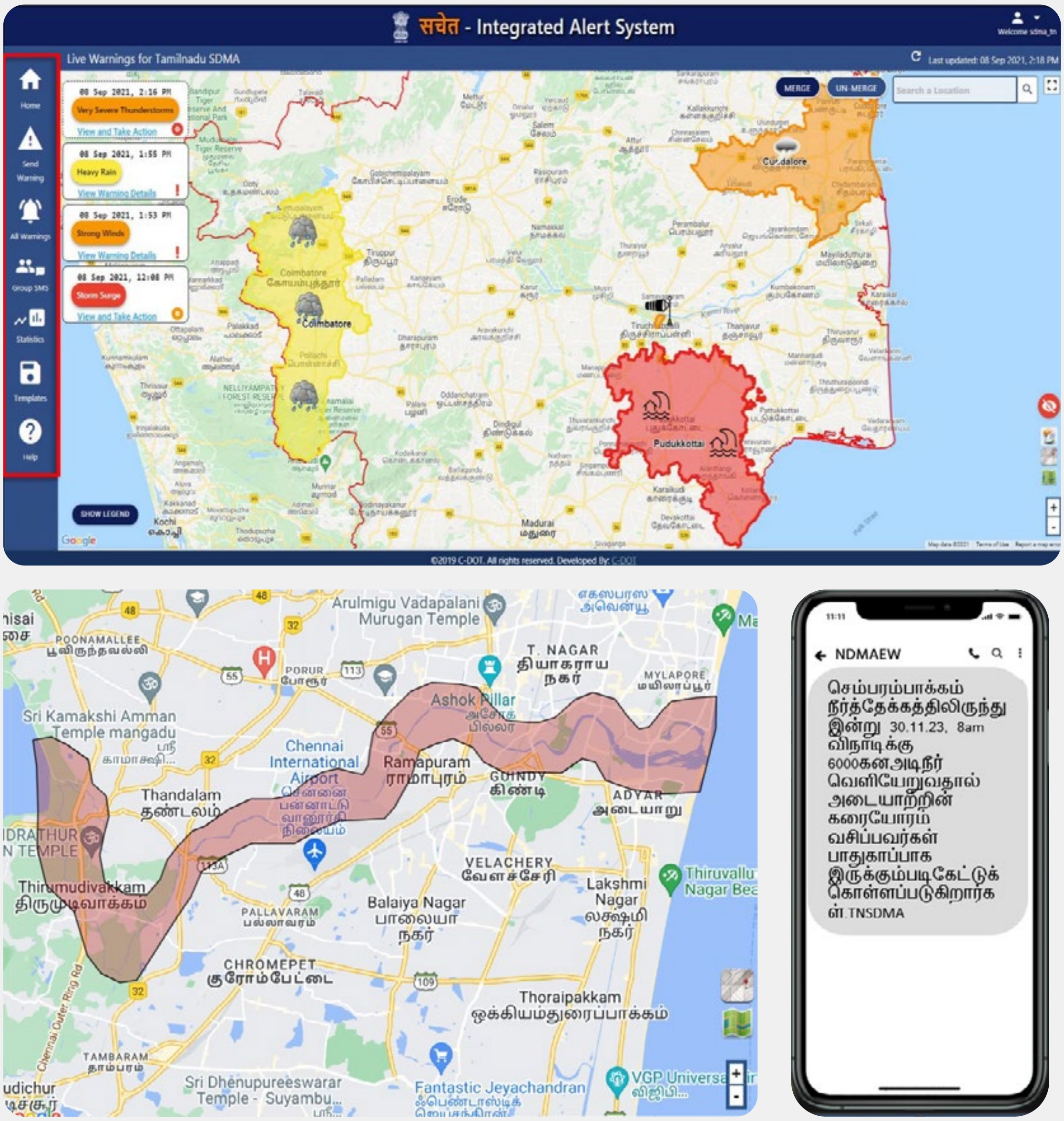
48 NDMA. (n.d.). "State Disaster Management Authorities".
49 C-DOT. (2022). Introduction and Overview: CAP-Integrated Alert System.
50 Interview with C-DOT.

SACHET replaces manual methods, such as emails and phone calls, with automated APIs to eliminate bottlenecks in data transmission. SDMAs gain immediate access to relevant alerts that must be acted on, complete with built-in tools for precise geographic targeting via GIS tools and multilingual translation. Enhanced coordination significantly shortens the time from hazard detection to public notification, enabling swifter and more effective disaster responses.[51,52]

Combining the technical expertise of AGAs with the local governance capabilities of SDMAs ensures that alerts are accurate, timely and actionable. For instance, if the India Meteorological Department (IMD) flags an impending flood, it sends a CAP alert to the Tamil Nadu SDMA via SACHET. The SDMA refines the alert by excluding unaffected districts, translates it into Tamil and prioritises text notifications for coastal areas, all on the same platform.

Figure 8

Example of a geotargeted flood alert disseminated by SMS using SACHET



Source: C-DOT

51 C-DOT. (2022). Introduction and Overview: CAP-Integrated Alert System.
52 NDMA. (2022). "Objective, Overview and Progress", Nodal Officers Workshop: Common Alerting Protocol (CAP)-based Integrated Alert System.

Figure 9

Alert dissemination flow and coordination process between AGAs and AAAs

AGAs generate alerts through the CAP standard

↓

The generated alerts are automatically fed into the SACHET platfom through APIs

↓

Alerts are forwarded to the relevant SDMA

↓

The SDMA reviews, validates and configures or modifies the alert as needed

→

This includes target area selection or modification, definition of warning details and translation to regional languages

↓

The SDMA selects suitable dissemination channels

↓

The SDMA decides to disseminate the alert immediately or schedules it for later

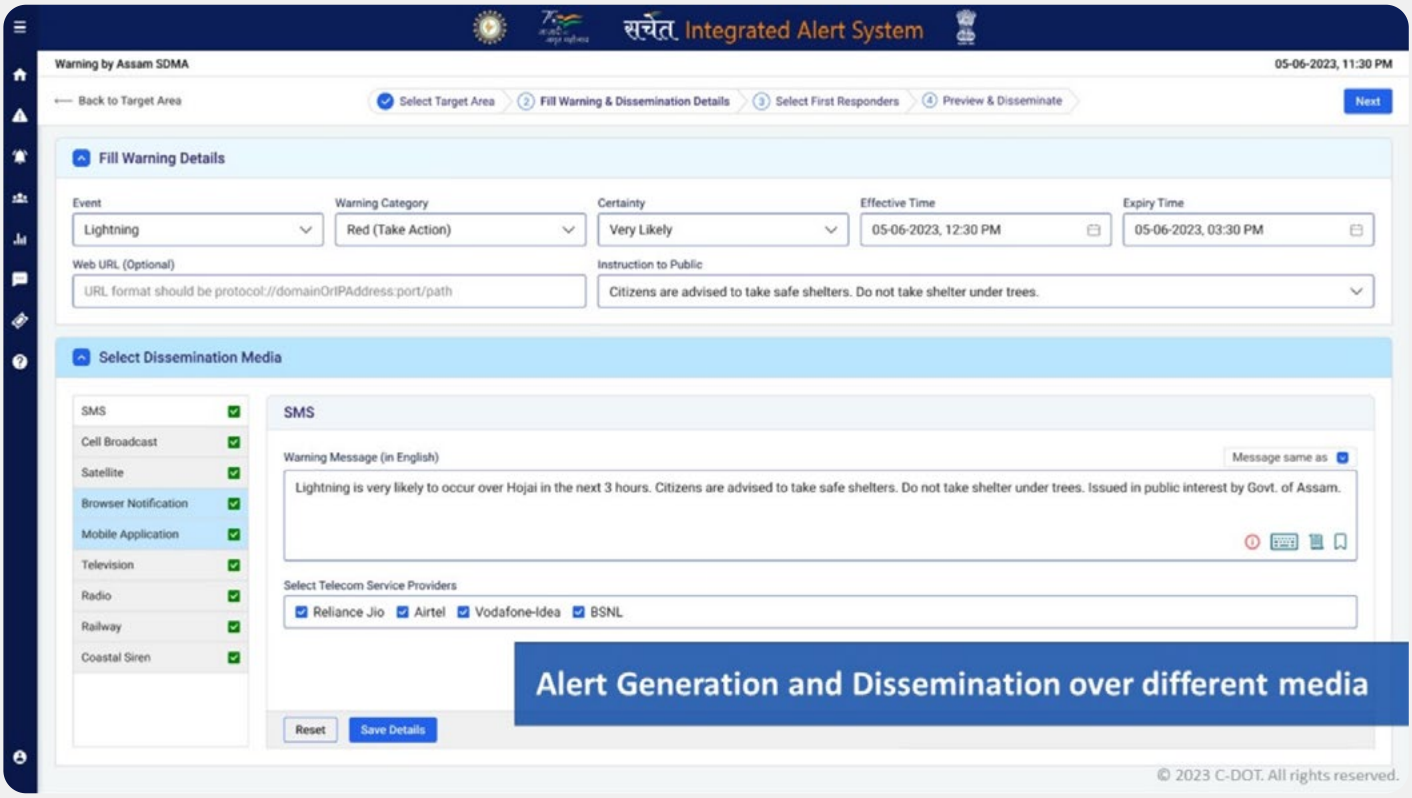
Multichannel

The SACHET platform uses CAP to simultaneously deliver disaster alerts across multiple communication channels. The CAP format standardises alert messages and ensures they are compatible with a range of dissemination channels, such as SMS, mobile apps, TV, radio, social media, RSS feeds, browser notifications, satellite messaging, coastal sirens and railway station boards.[53] The ability to disseminate alerts across several channels at once is particularly critical in emergencies when minor delays in communication can worsen risks and increase casualties.

Disseminating alerts through multiple communication channels increases the likelihood that recipients can see and act on them, as different communication methods cater to different demographics, geographies and access levels. For instance, rural communities may rely on radio or SMS, while urban residents may receive alerts via mobile apps or social media. This redundancy ensures that if one channel fails or is inaccessible, others can still deliver the message. Previous GSMA research has also found that a multichannel approach enhances trust and increases the likelihood of action, as information is verified on multiple channels.[54]

Figure 10

Example of an alert being generated and disseminated through multiple channels in SACHET



Source: (ITU)

53 Basu, S. (n.d.). CAP (Common Alerting Protocol) based Integrated Alert System. C-DOT.
54 GSMA. (2024). Enhancing inclusion in mobile-enabled risk communications: Lessons from South Africa.

Timely

Timely dissemination of alerts is critical because different hazards present unique challenges based on their lead times and potential impact. Immediate hazards, such as earthquakes, landslides, tsunamis and lightning, allow little to no preparation time. They require systems that can issue warnings instantaneously to mitigate harm. Meanwhile, slower developing threats, such as floods or cyclones, require timely and adaptable alerts to ensure public safety through continuous updates as the situation evolves.[55]

Figure 11

Disaster-wide impact area and lead time matrix for effective alert dissemination

	Immediate	< 30 mins	< 6 hours	< 6 hours
Large impact area	• Earthquake • Landslides	• Tsunami • Earthquake aftershocks	• Floods • Thunderstorms • Wildfires	• Cyclones • Extreme temperatures
	• Avalanche • Human-made disasters, such as gas leaks	• Lightning		• Drought
	Requires immediate disaster and relief information	Requires alerts within minutes to minimise the loss of life and property	Requires timely alert dissemination to allow the public to take shelter	Requires periodic alert dissemination to update the public

Source: DOT

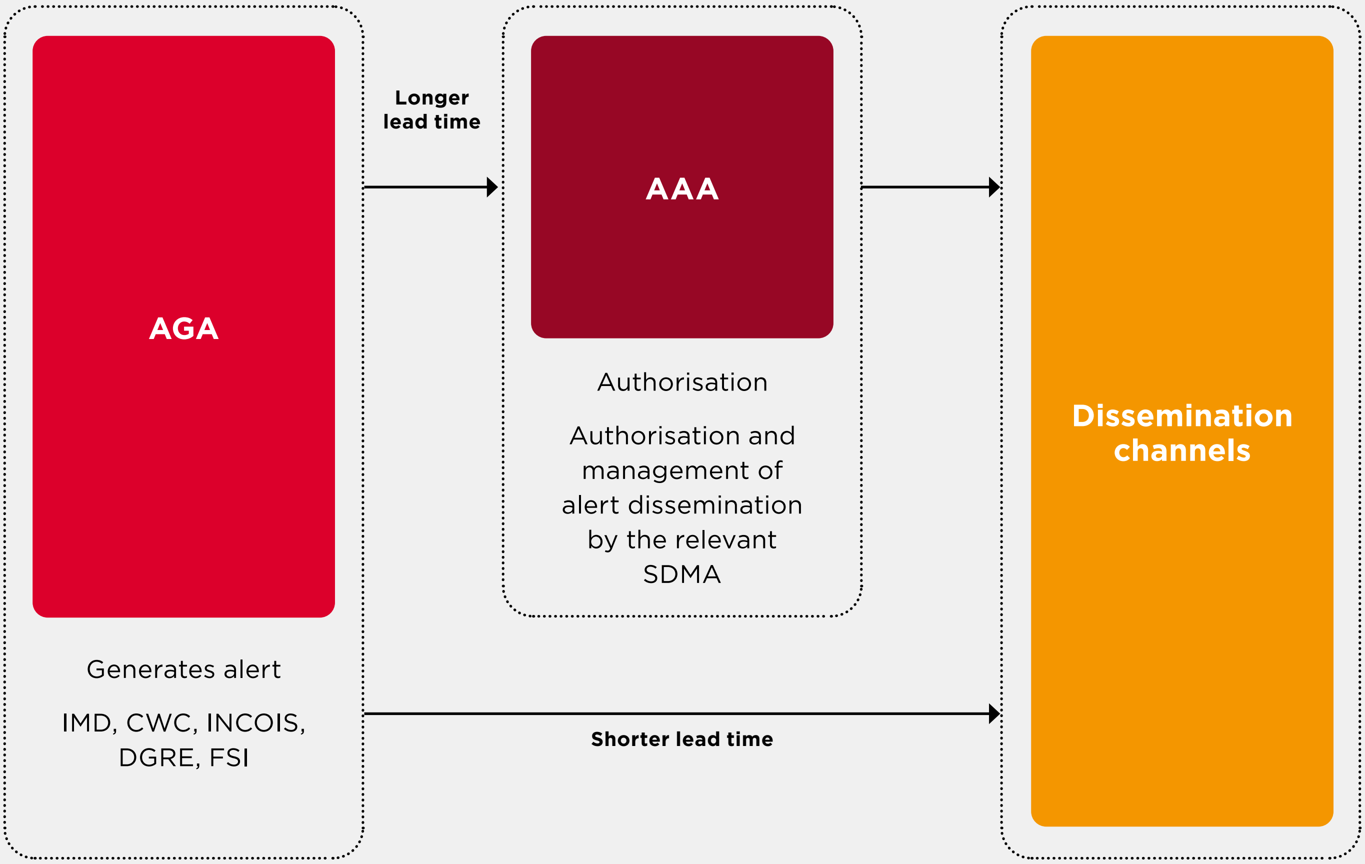
55 Agrawal, S. (n.d.). Early Warning Systems: Role of Telecom.

The SACHET platform implements different standard operating procedures (SOPs) for alert dissemination to address these varying needs. SOPs are tailored to the lead time of each hazard (see Figure 12 below). AGAs generate initial alerts for hazards with longer lead times. These alerts are then transmitted to SDMAs via the SACHET platform. The SDMAs authorise, modify and determine the appropriate timing to deliver alerts to the public and first responders. This process ensures that alerts are refined and contextually relevant before they are issued.

However, the alert dissemination process is streamlined for hazards with extremely short lead times to save critical time. In such cases, AGAs can bypass the SDMA authorisation step and issue alerts directly to the target population and first responders through the SACHET platform. This flexibility is crucial in scenarios where every second counts, as it eliminates potential delays and facilitates immediate action.[56]

Figure 12

Alert dissemination policy based on lead time



Source: IMD

56 Chug, S. and Nath, S. (2024). "Recent Advances in Social Weather, Common Alert Protocol, and Dissemination Services through APIs in India Meteorological Department". Quarterly Journal of Meteorology, Hydrology & Geophysics. Vol. 75, No. 1.

Inclusive

India is one of the world's most linguistically diverse countries, with 121 languages spoken by 10,000 or more people.[57] Early warning systems must address this diversity to ensure all population segments can understand disaster alerts. The SACHET platform supports the dissemination of alerts in 23 languages. These include English, Hindi and 21 regional languages recognised under the Eighth Schedule to the Constitution of India.[58] This multilingual capability ensures that alerts are regionally relevant, accessible and understandable by a large population.

SDMAs play a critical role in translating alerts generated by AGAs. While AGAs typically issue alerts in English, SDMAs translate these messages accurately into regional languages for dissemination. SACHET has an auto-translation feature that converts warnings into regional languages to streamline this process. This reduces the burden on SDMAs and saves valuable time during emergencies. The platform also supports simultaneous dissemination of messages in multiple languages.

Inclusivity in SACHET extends beyond language to address accessibility for people with disabilities and those with limited literacy. The implementation of cell broadcast (CB) technology incorporates features that make disaster alerts more accessible. Emergency messages remain on-screen until the user acknowledges them. They are accompanied by a sound or vibration that lasts at least 30 seconds, ensuring that the alerts capture the recipient's attention.

Furthermore, smartphones and feature phones in India are required to support auto-readout of CB messages in English, Hindi and regional languages using an Indian accent (see the section on cell broadcast). These features are particularly valuable for individuals with visual impairment or limited literacy, as they provide an auditory mechanism to receive critical alerts.[59,60]

Figure 13

Major languages spoken in India's states

Source: Maps of India

57 PTI. (1 July 2018). "More than 19,500 mother tongues spoken in India: Census". Indian Express.
58 TEC. (2020). Integrated Disaster Management System Using Common Alerting Protocol.
59 Agrawal, A. (19 September 2024). "Emergency alert system obligations on mobile OS providers as well". Hindustan Times.
60 C-DOT (n.d.). "C-DOT Cell Broadcast Solution".

Accountable

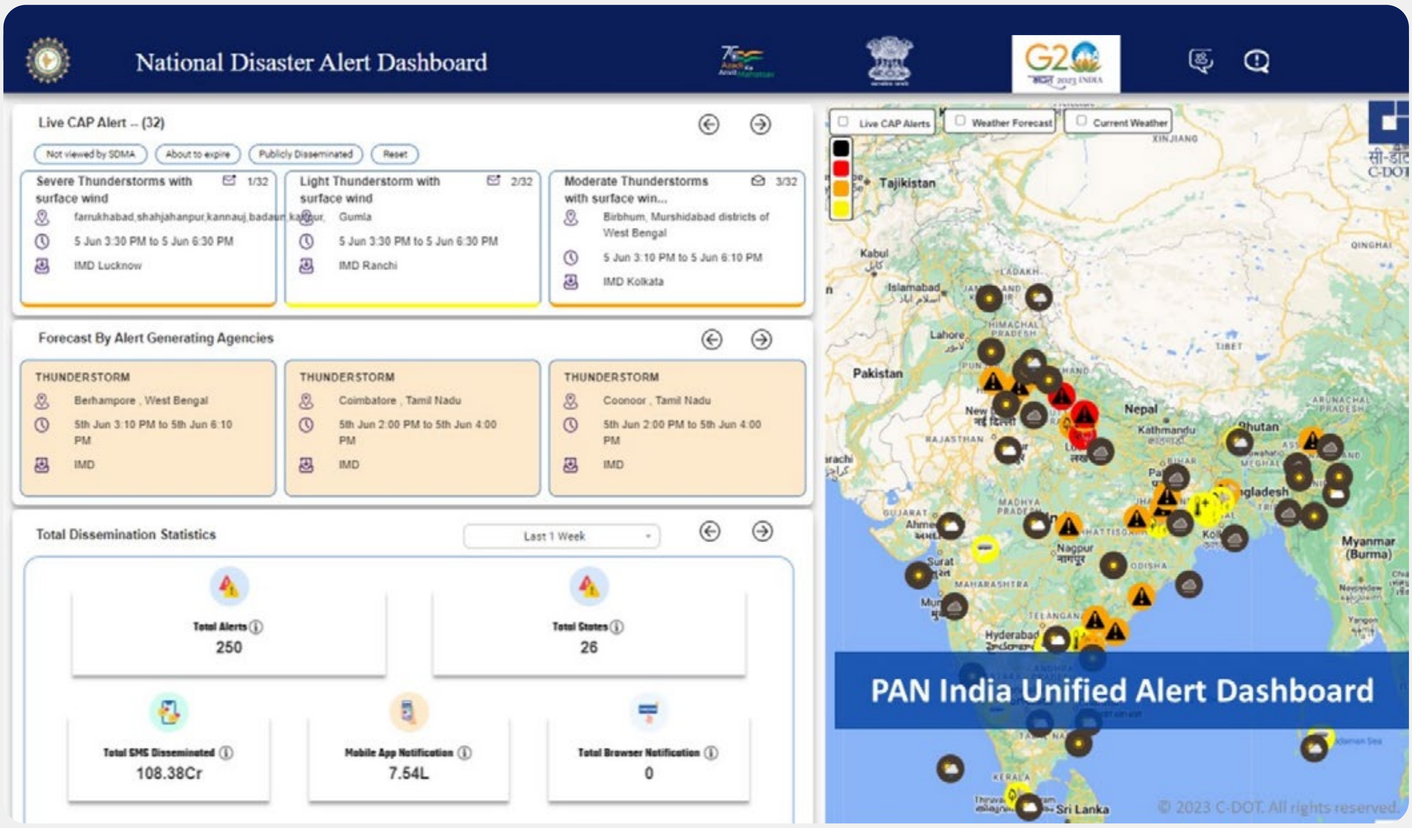
Accountability and transparency are central to the SACHET platform, ensuring that SDMAs act effectively on disaster alerts generated by AGAs. The NDMA oversees the platform through a centralised monitoring and review system that tracks the performance of SDMAs and ensures adherence to established protocols.

The NDMA exercises oversight via a centralised dashboard (see Figure 14) that aggregates detailed statistics on the activities of all SDMAs. This includes data, such as alerts generated by AGAs, the dissemination status of those alerts, the number of messages sent, the channels used and the time taken to disseminate them. While each SDMA has access to its own dashboard to manage its activities, only the NDMA can view the consolidated data for all SDMAs. This structure maintains interagency transparency and upholds the operational autonomy of individual SDMAs. The dashboards summarise real-time and historical data, which provide actionable insights on the effectiveness of alert dissemination and identifies areas for improvement.

The NDMA periodically reviews SDMA activities to ensure adherence to protocols and enhance accountability. These reviews evaluate whether alerts are being disseminated to the right audience through suitable channels and with the correct information. In cases where dissemination is inadequate or delayed, the NDMA conducts an inquiry with the SDMA to understand the reasons for noncompliance. This mechanism ensures that lapses are identified and addressed promptly, which fosters a culture of responsibility and continuous improvement.[61]

Figure 14

A national dashboard that shows various analytics on SACHET usage



Source: NDMA

61 Interview with the NDMA and C-DOT.

Actionable

The SACHET platform is designed to enhance action through an intuitive and efficient operational mechanism for SDMAs. Its colour-coded alert system uses red, orange, yellow and green to classify and communicate the severity and urgency of potential disasters, from most severe to least severe.[62] This system simplifies decision-making for SDMAs and ensures that the public receives clear and actionable information.

This colour-coded system allows SDMAs to prioritise responses through a clear categorisation of risks and ensures that authorities and the public can respond appropriately and efficiently during emergencies.

Additionally, the SACHET platform includes a GIS-based mapping feature that adds a layer of precision to alert dissemination. Alerts are paired with targeted geographical information that highlights the affected area. This enables SDMAs to adjust the area polygon if needed and ensure that warnings are directed exclusively to affected populations. This targeted approach minimises the risk of over-alerting or inaccurate alerts, which could desensitise the public to warnings and weaken trust in the alert system.

Table 4

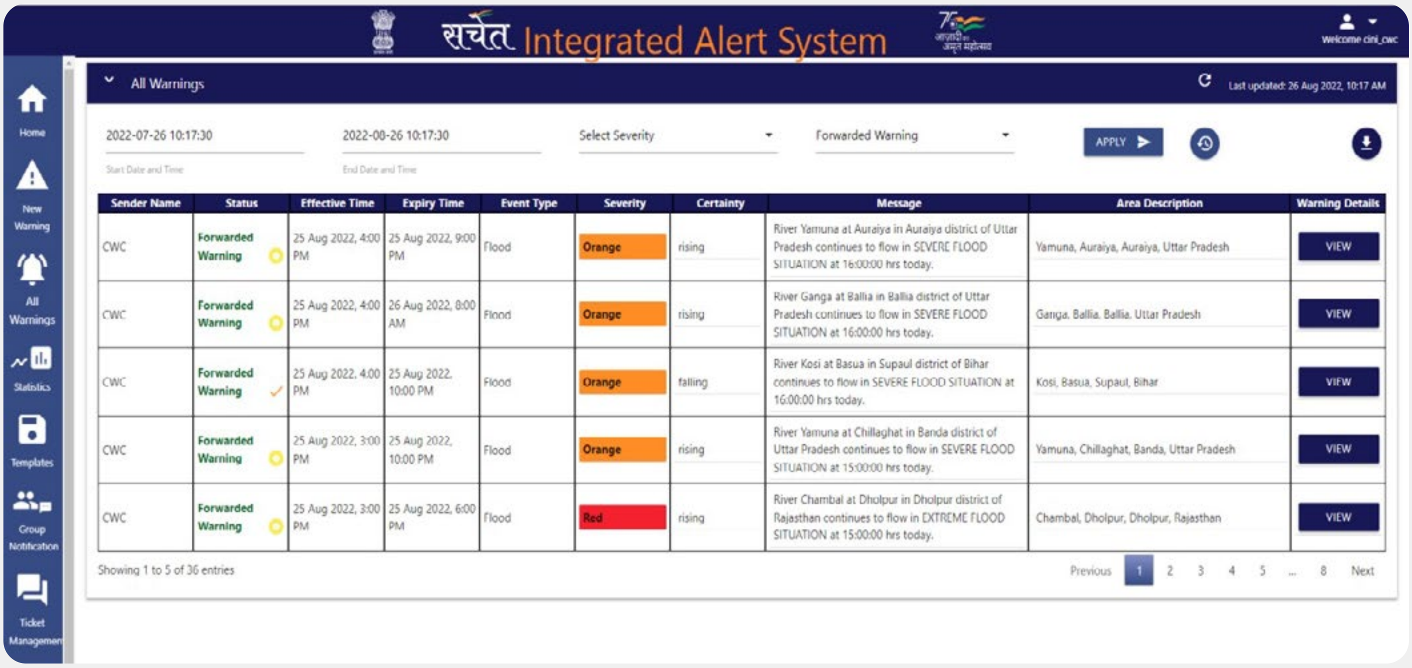
Colour-coded warning categories

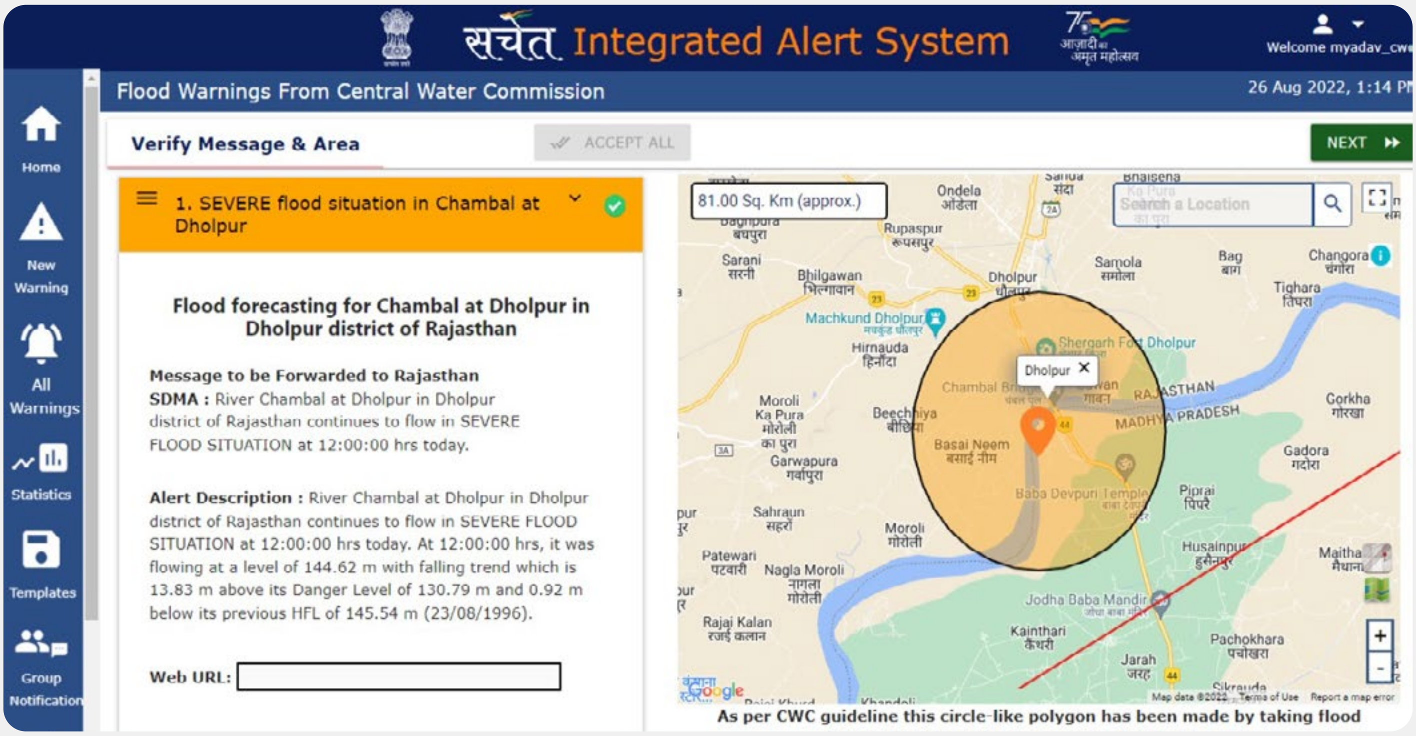
Warning category	Explanation
Red alert (take action)	This is the highest level of warning issued for extremely severe or life-threatening situations. It indicates that immediate action, such as evacuation or emergency measures, is needed to safeguard lives and property.
Orange (be prepared)	This signals a significant weather or disaster threat that may escalate to an emergency. It calls for preparedness and caution and advises authorities and the public to remain vigilant. This alert is typically issued when there is high likelihood of severe weather or disasters that could disrupt daily activities or pose a moderate to high risk to life and property.
Yellow (be updated)	This alert is issued for conditions that may require awareness but do not pose an immediate danger. It often serves as an early warning for weather events that may intensify or cause localised disruptions.
Green (no action)	This indicates the lack of significant weather threats or disaster risks at present. It signifies normal conditions and may also declare that a previous alert has been lifted.

62 India Meteorological Department. (2021). Standard Operation Procedure – Weather Forecasting and Warning Services.

Figure 15

An example of a geofenced and colour-coded warning sent by the Central Water Commission to the Rajasthan SDMA





Source: CWC

To support actionable responses, the SACHET platform promptly notifies SDMAs of new alerts. When an AGA generates an alert, the system sends email and phone notifications to designated authorities in the SDMA. This ensures time-critical alerts are acknowledged and acted on without delay and reduces the risk of oversight.

Figure 16

Example of a notification sent to a designated SDMA official to inform them of a newly generated alert that may require review and dissemination

Search in mail

Active

18 of 685

Thunderstorm with Lightning warning received from IMD Bengaluru at 28 Aug 2022, 7:05 AM

Inbox ×

cap-india@gov.in via gov.in

to

Sun, Aug 28, 7:05 AM (1 day ago)

Hi,

Following warning has been issued by IMD Bengaluru:

Event	Severity	Certainty	Message	Concerned Area
Thunderstorm with Lightning	WATCH	Very Likely	Thunderstorm with Lightning is very likely to occur over Bellary, Chitradurga, Koppal, Tumkur in next 3 hours. ಮುಂದಿನ 3 ಗಂಟೆಗಳಲ್ಲಿ, ಬಳ್ಳಾರಿ, ಚಿತ್ರದುರ್ಗ, ಕೊಪ್ಪಳ, ತುಮಕೂರಿನಲ್ಲಿ ಸಿಡಿಲು, ಗುಡುಗು ಸಹಿತ ಮಳೆಯಾಗುವ ಸಾಧ್ಯತೆ ಇದೆ.	Bellary, Chitradurga, Koppal, Tumkur districts of Karnataka

Please login to सचेत - CAP Integrated Alert System to disseminate the message to public in the specified area.

Thanks & Regards,
Support Team,
सचेत - CAP Integrated Alert System
C-DOT, India

PS: Please note that this is a system generated e-mail, please do not reply to this email.

Source: Karnataka SDMA

Secure

Robust security is essential for the SACHET platform, given its role in alert dissemination across India. SACHET implements a stringent two-factor authentication (2FA) protocol for registered authorities at SDMAs and AGAs to safeguard against unauthorised access and potential misuse.

When users access the SACHET web portal, they must enter their unique user ID and password. Then, a one-time password (OTP) is dispatched to the user's registered mobile device and email address. The user must enter the OTP to complete the login process. This ensures that only authorised people can access the system. Moreover, during the dissemination of alerts, OTP verification is initiated again to confirm the legitimacy of the action and prevent unauthorised dissemination of information.[63]

Additionally, SACHET is hosted on the National Informatics Centre's (NIC) MeghRaj Cloud, which provides a secure and resilient infrastructure for government applications. MeghRaj Cloud incorporates security features, which include web application firewalls (WAF) that scan all inbound web traffic to block attacks and inspect HTTP responses to prevent data loss. Attempts to hack or gain unauthorised access to the SACHET system have been prevented due to the firewall and other security features provided by MeghRaj Cloud.[64]

63 TEC. (2020). Integrated Disaster Management System Using Common Alerting Protocol.
64 Interview with C-DOT.

Compatible

The dissemination of national alerts through various communication channels has traditionally been a challenge due to variations in hardware and software capabilities. Although the SACHET platform uses the CAP standard for streamlined communication, not all infrastructure was natively CAP-compliant, such as railway station boards, NavIC and GAGAN satellite receivers, TV stations and radio channels. Retrofitting or replacing such a vast array of hardware nationwide would have been prohibitively expensive and time consuming.

To address this, C-DOT developed custom networking interfaces. These interfaces could convert CAP messages into formats compatible with nonCAP-compliant systems. These interfaces worked as translators to ensure alerts generated within the CAP framework could be adapted to the specific technical requirements of different communication channels.[65,66,67]

Figure 17

Alerts disseminated through the SACHET platform displayed on television channels and railway station boards

Source: (Left) MIB; (Right) NDMA

65 Interview with C-DOT.
66 ISRO. (31 August 2022). Integration of NavIC with CAP.
67 Basu, S. (2022). Issues and Challenges with AGAs, AAAs & ADAs in CAP. C-DOT.

Testing and feedback

The NDMA conducted a pilot test in Tamil Nadu to ensure seamless nationwide roll-out of the SACHET platform from March 2019 to August 2021. The NDMA collaborated with C-DOT and the Department of Telecommunications (DoT) for the pilot test. It functioned as a proof of concept with limited functionality to validate the platform's core capabilities before full-scale implementation.

Under this pilot, the Tamil Nadu State Disaster Management Authority (TNSDMA) served as the alert-authorising agency (AAA), while the IMD and CWC served as alert-generating agencies (AGAs). Major telecoms providers, including Airtel, BSNL, Reliance Jio and Vodafone Idea, were responsible for the delivery of location-based SMS (LB-SMS) to targeted regions.

Over the course of the pilot, approximately 123.2 million LB-SMS alerts were issued in Tamil and English for 15 major hazard events, such as floods, cyclones and heavy rains. The success of the pilot paved the way for the nationwide launch of SACHET. The platform officially commenced on 23 August 2021 after the NDMA and C-DOT signed a Memorandum of Understanding (MoU).

In preparation for the full-scale deployment, the NDMA and C-DOT conducted mock drills and training programmes for SDMAs and AGAs. These sessions provided officials with hands-on experience with the system. Throughout the pilot and the early stages of roll out, C-DOT actively gathered feedback from both SDMAs and AGAs to refine and enhance the SACHET platform.

Challenges and feedback

Challenges with the SACHET platform were discussed at a workshop organised by the NDMA in collaboration with C-DOT on 31 August 2022. The event brought together key stakeholders, including AGAs and SDMAs from across India, to discuss challenges, share feedback and propose improvements to the platform. Tables 5 and 6 below summarise the key insights shared.[68]

Table 5
Feedback on SACHET from SDMAs

Challenges and feedback	Description
Imprecise targeting of alerts	A major challenge was the lack of precise geographical targeting in alerts. For example, the IMD's nowcast warnings – short-term forecasts for the next 24 hours – issue alerts across entire districts, even if only a small area is at risk. This broad approach often triggers "false alarms", with residents receiving warnings unrelated to their immediate location. Over time, such inaccuracies can weaken public trust in the alert system. To address this, SDMAs urged AGAs to provide more geographically precise alerts to ensure they are disseminated exclusively to affected communities.[69]
Character limitations	The limited character count (160) posed challenges in conveying detailed and actionable warnings, especially in regional languages. SDMAs suggested increasing the character limit to ensure clear and comprehensive communication.[70]
Specialised warnings for vulnerable groups	SDMAs highlighted the need for tailored warnings for specific groups, such as fisherfolk and farmers, to address their unique vulnerabilities.[71]
Integration of predefined geographies	The platform's GIS tool could not import predefined shape files or KML files of frequently targeted areas (hazard-prone areas). Including these files would streamline geographic selection and reduce dissemination time during emergencies.[72]
Enhanced area selection tools	Dropdown menus for area selection were limited to the district level, which made them less precise. The expansion of this functionality to include granular, block-level targeting would enable quicker and more specific alerts.[73]
Integration of coastal sirens	Coastal regions remain vulnerable to disasters like cyclones and tsunamis. SDMAs requested that coastal sirens be integrated in the platform to enhance warning capabilities in these areas.[74]

68 NDMA. (2022). "Nodal Officer Workshop on CAP & ERSS".
69 NDMA. (2022). Karnataka's SDMA experience with using SACHET.
70 NDMA. (2022). Tamil Nadu's SDMA experience with using SACHET.
71 Basu, S. (2022). Issues and Challenges with AGAs, AAAs & ADAs in CAP. C-DOT.
72 NDMA. (2022). Tamil Nadu's SDMA experience with using SACHET.
73 NDMA. (2022). Karnataka's SDMA experience with using SACHET.
74 Basu, S. (2022). Issues and Challenges with AGAs, AAAs & ADAs in CAP. C-DOT.

Table 6
Feedback from AGAs

Challenges and feedback	Description
SOPs when lead time is less	For hazards or disasters with very short lead times (less than 30 minutes), AGAs suggested they should be permitted to disseminate alerts directly without the need for prior authorisation from SDMAs. This would significantly reduce delays and ensure timely alerts reach communities at risk.[75]
Manual alert entry	Entering alerts manually is time consuming and requires a lot of resources. AGAs recommended automating CAP alerts through APIs to expedite the process and reduce the burden on staff.[76]
Feedback from SDMAs	AGAs observed that SDMAs did not disseminate some of the alerts they generated. The lack of a robust feedback mechanism to clarify why certain alerts were not disseminated or acted upon compounded this issue. The workshop underscored the need for more effective communication and reporting between AGAs and SDMAs and highlighted these areas as critical for improvement.[77]
First responder notifications	AGAs expressed the need for group SMS APIs to notify first responders promptly during emergencies.[78]

Challenges noted by C-DOT

Excessive use of the alerting system in noncritical situations was a significant concern. For instance, one SDMA disseminated 124 million SMS notifications during a cyclone, even though it remained 300 kilometres offshore with no immediate threat to the state.[79] Such over-alerting, which includes unnecessarily large target areas, repeated messages and nondisaster-related uses, exerts undue pressure on telecoms networks and erodes public confidence in alerts.

False alarms and frequent alerts have the potential to desensitise the public and diminish the perceived urgency of legitimate warnings. The C-DOT recognised these challenges and implemented corrective steps. C-DOT collaborated with the NDMA to organise workshops and training sessions for SDMAs to reinforce best practices, refine the selection of target areas and ensure alerts are proportional to the actual threat level.[80]

75 Ibid.
76 Basu, S. (2022). Issues and Challenges with AGAs, AAAs & ADAs in CAP. C-DOT.
77 Singh, S.R. (2022). Role of CWC and Integration with CAP Platform. CWC.
78 Basu, S. (2022). Issues and Challenges with AGAs, AAAs & ADAs in CAP. C-DOT.
79 Agrawal, S. (n.d.). Early Warning Systems: Role of Telecom. DOT.
80 Interview with C-DOT.

Extending the reach of alerts: the use of mobile networks for dissemination

MNOs are the backbone of alert dissemination and play a pivotal role in the SACHET platform. MNOs use their extensive reach and mobile networks to enable the delivery of alert messages through two types of technology: location-based SMS (LB-SMS) and cell broadcast (CB). These technologies ensure that alerts can be targeted geographically to reach populations in specific areas. While both technologies serve the same purpose, they differ in function and application. Table 7 highlights the key differences between LB-SMS and CB.

Table 7
Key differences between LB-SMS and CB

	LB-SMS	CB
Technology type	Point-to-point messaging	Point-to-multipoint broadcast
Message delivery	Sent to individual devices based on their cell-based location; requires identification of subscriber numbers	Sent to all devices in a specific area without the need to know individual phone numbers
Supported devices	Works on virtually all devices that support SMS, including feature phones	Newer devices are typically compatible with CB but capability has to be explicitly enabled
Network dependence	Relies on SMS channels; suffers from potential delays during network congestion but improved in 4G/5G networks	Operates as part of mobile network signalling; works even during network congestion or shutdown
Message length	160 characters per message, but can use concatenated SMS for longer messages	Maximum of 1,395 characters
Message display	Delivered as standard SMS; requires the user to open and read the message manually	Automatically displayed on-screen with a special ringtone and vibration; requires user acknowledgement
System assurance	Provides individual delivery reports and situational awareness (real-time statistics on delivery)	Does not confirm delivery to recipients
Infrastructure requirements	Uses existing SMS systems; integrates with MNO networks for low-cost implementation	Requires CB-compatible handsets and additional network elements such as cell broadcast entities (CBEs) and cell broadcast centres (CBCs)
Privacy concerns	Mobile numbers and other data remain within MNO networks, compliant with privacy laws	Protects user privacy as no personal data is required for delivery

Source: EENA

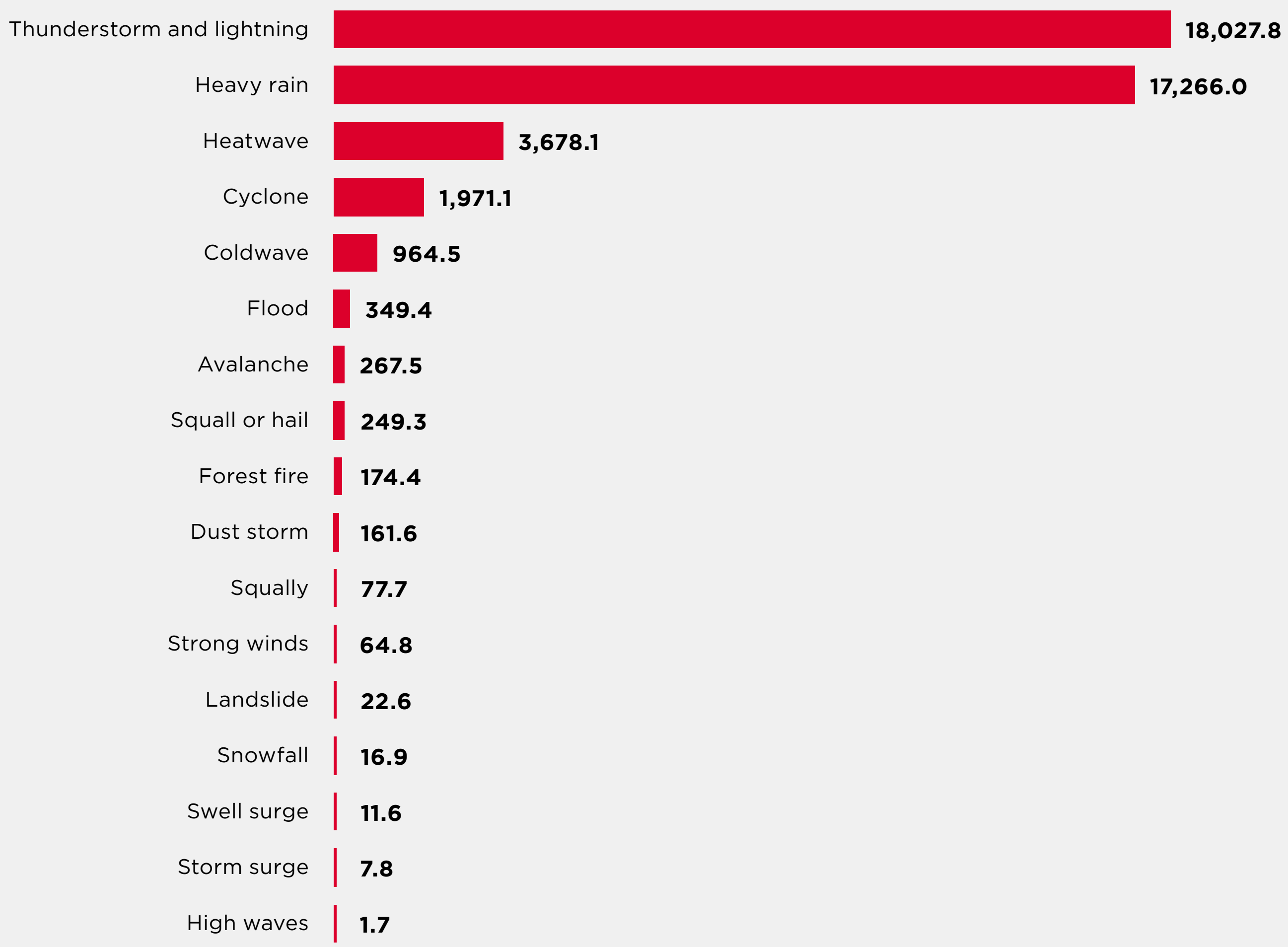
Location-based SMS

The SACHET system has integrated four of India's largest MNOs: Airtel, Jio, Vodafone Idea and BSNL. These MNOs account for 99.84% of the country's wireless network market and serve nearly 900 million subscribers as of 31 October 2024.[81]

Since its inception, the SACHET system has issued more than 30,640 alerts through multiple dissemination channels, including SMS, mobile apps, web browsers and satellite systems, such as GAGAN and NaviC. Notably, more than 10,510 alerts, which represent approximately 34.3% of all warnings, were disseminated via LB-SMS, which led to the delivery of more than 44.34 billion messages. These LB-SMS alerts addressed various hazards and were disseminated in 15 languages, including English, Hindi and 13 regional languages.

Figure 18

Location-based SMS dissemination by type of hazard, in millions



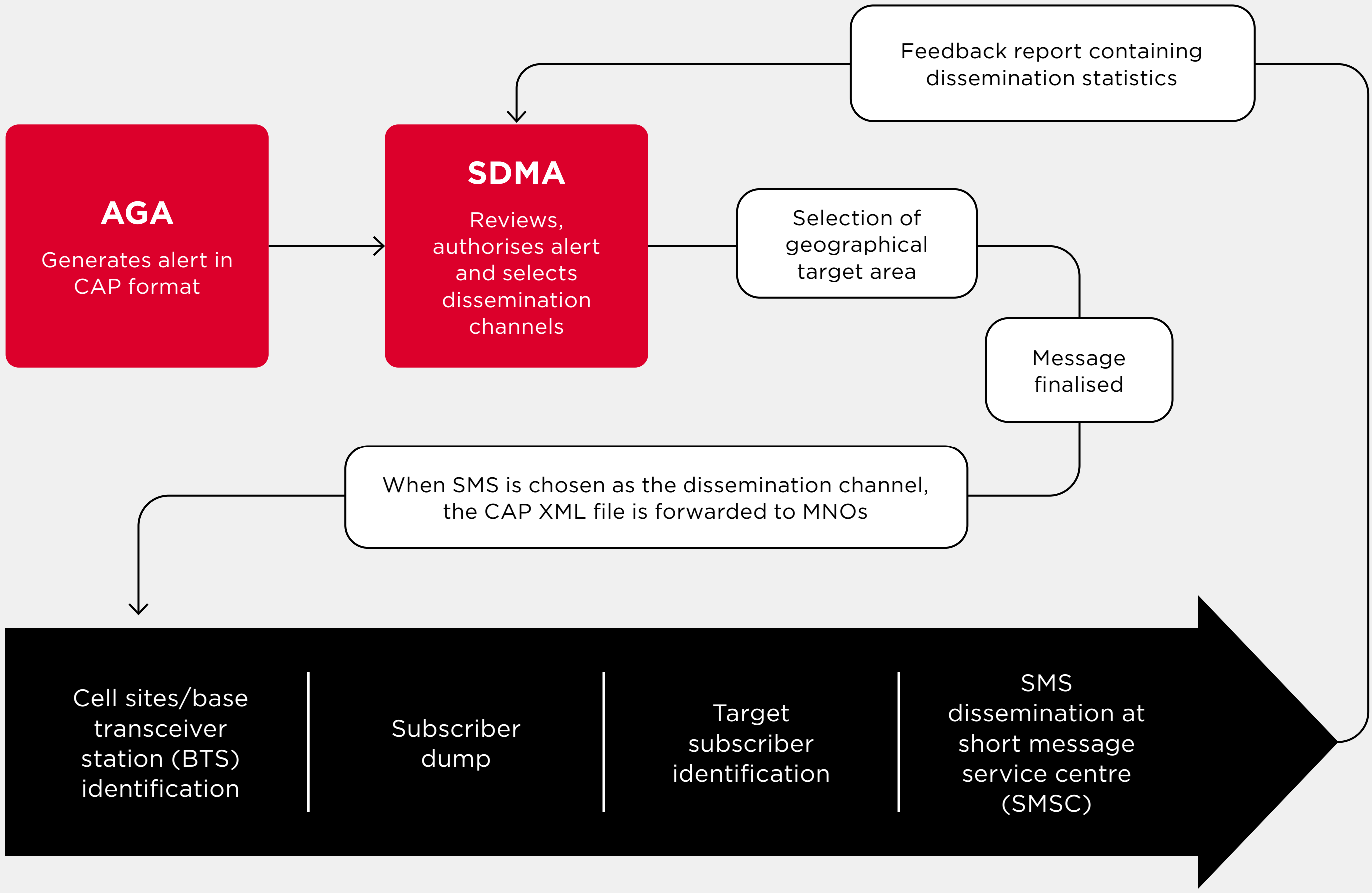
Source: C-DOT

81 PIB Delhi. (26 October 2024). "Highlights of Telecom Subscription Data as on 31st August, 2024".

Alert dissemination process

Figure 19

Alert dissemination process using LB-SMS



Source: DoT

When LB-SMS is selected as the dissemination channel, a CAP file is sent from the SACHET platform to MNOs. This file contains essential information, including the geographic area to which the alert should be sent.[82]

The MNOs identify which cell towers[83] correspond to the target area. To determine recipients, MNOs retrieve data on active mobile users connected to the identified towers. This process, known as a "subscriber dump," ensures that only those in the affected area receive the alert and complies with data protection regulations to safeguard user privacy.

Once recipients are identified, the alert message is entered in a queue and sent via the MNO's messaging system – the short message service centre (SMSC).[84] After the process is completed, MNOs generate a performance report containing key metrics, including delivery time and number of targeted recipients reached. This helps disaster management authorities assess whether the alert was sent effectively and reached the intended population.

82 TEC. (2020). Integrated Disaster Management System Using Common Alerting Protocol.
83 In this context, "cell towers" refer to the network's cell sites or base stations which facilitate mobile communication within a defined geographic area.
84 Agrawal, S. (n.d.). Early Warning Systems: Role of Telecom. DOT.

Challenges in using LB-SMS

C-DOT has collaborated with MNOs and conducted numerous tests and mock drills to evaluate system performance and identify areas for improvement.

Tables 8 and 9 highlight the key challenges encountered and measures taken to reduce dissemination times.

Table 8:

Challenges in using LB-SMS

Challenge	Description
Time required for subscriber data extraction	The retrieval of active subscriber data – the subscriber dump – is one of the most time-consuming steps. Depending on the traffic load and number of cell sites involved, this step can take up to 90 minutes. The delay is particularly pronounced in high-density areas, where the volume of subscriber data is significantly larger.
Real-time filtering of subscribers	After retrieving the subscriber dump, the data must be filtered to identify users within the target area. This process is resource-intensive, as it involves analysing large datasets in real time. The challenge is amplified in high-density areas, where the increase in data volumes can slow down processing and cause delays.
Network congestion and SMS dissemination capacity	The dissemination of SMS messages through the SMSC can be delayed due to network congestion and the limited capacity of SMSCs to handle large volumes of messages simultaneously. This is especially critical during emergencies when millions of messages need to be delivered in a short time, often during periods of peak network usage. The queueing of messages adds to the delay.
Geographic targeting accuracy	When a mobile device is physically located within a designated alert area but connects to a cell tower outside that area, it can result in the device missing critical alerts. This issue is particularly common near the edges of target areas, where devices may connect to neighbouring cell towers beyond the target area and lead to alert delivery failures.

Source: DOT, NIDM

Steps taken by MNOs to improve SMS dissemination time

Table 9

Activities MNOs undertake to improve SMS dissemination time

Activities	Description
Pre-fetched subscriber dump	A pre-fetched subscriber dump is created periodically for priority regions to reduce reliance on time-consuming live data retrieval. Combining pre-fetched data with the live dump speeds up the dissemination of alerts.
Parallel processing for subscriber identification	Parallel processing techniques have been introduced to streamline the identification of target subscribers. This approach divides and analyses subscriber data simultaneously across multiple processing units to reduce the time needed for filtering, even when the system handles large datasets in high-density areas.
Improved SMSC capacity	SMSC infrastructure has been enhanced to support greater message throughput. Scalable hardware and software solutions, alongside load balancing and message prioritisation, ensure faster dissemination of millions of SMS alerts without overwhelming the network.
Data logs for monitoring and optimisation	Comprehensive logging systems have been implemented to track all stages of the LB-SMS workflow, from subscriber data extraction to SMS dissemination. These logs help identify bottlenecks and inefficiencies and provide actionable insights for continuous system improvements. Real-time monitoring also ensures technical issues are resolved quickly.

Source: DoT

Integrating cell broadcast in SACHET

The need for cell broadcast

For hazards and disasters with short lead times like earthquakes and tsunamis, speed is critical. LB-SMS can face delays due to network congestion and slow processes, making it a less suitable method for such hazards.

In contrast, CB technology offers near-instantaneous dissemination and can deliver alerts to millions of users within seconds without congestion or reliance on subscriber data. The Government of India recognised these advantages and has prioritised the integration of CB technology as an additional alert dissemination channel in the SACHET platform.[85] C-DOT has been collaborating with MNOs to implement CB functionality as part of SACHET and testing is already underway.

85 TRAI. (2022). The Telecommunication Tariff (Sixty Ninth Amendment) Order, 2022.

How cell broadcast works

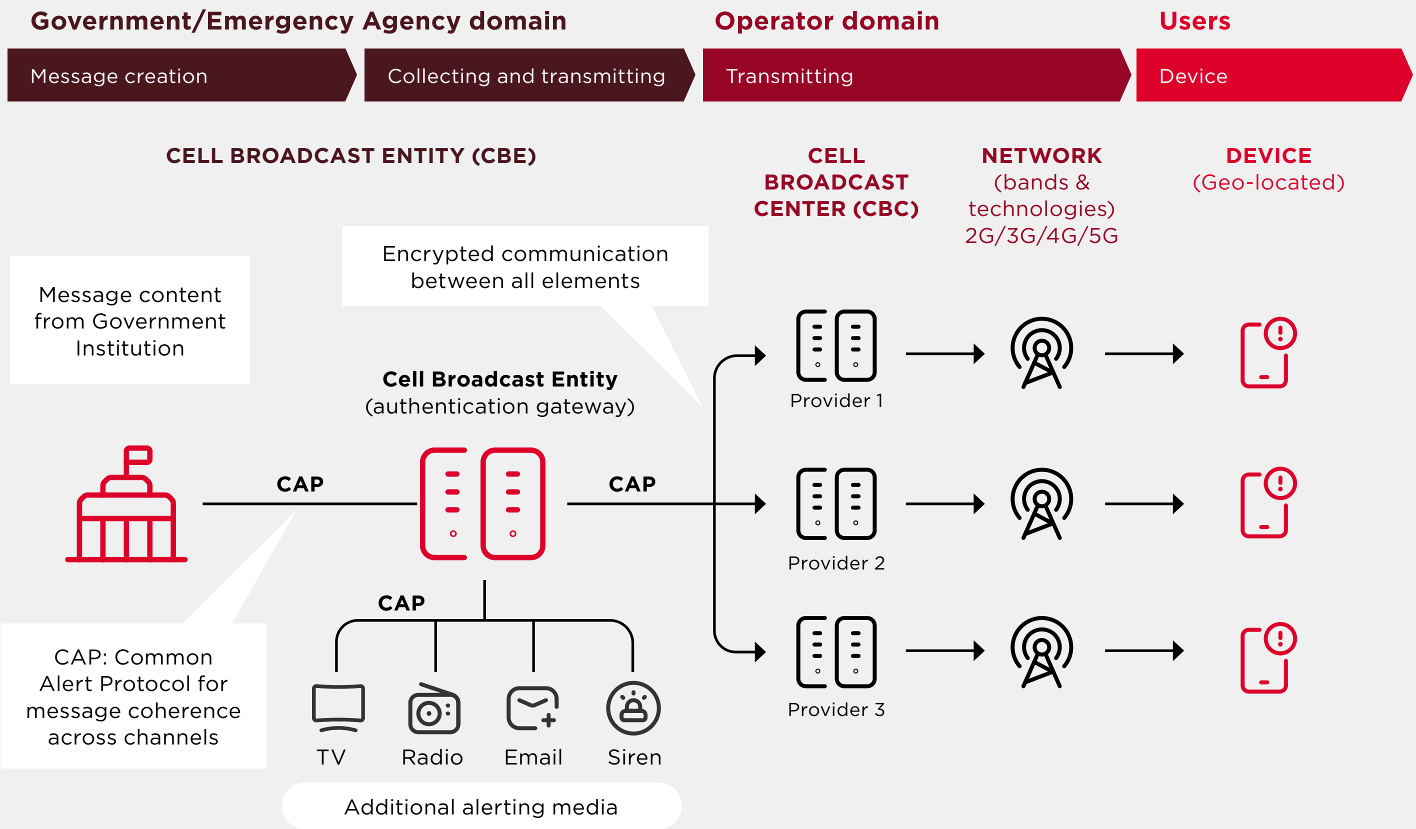
Unlike LB-SMS, CB requires specialised infrastructure to function, which includes both hardware and software. The process begins with the cell broadcast entity (CBE), an interface through which authorised agencies, such as NDMAs, create and authenticate alert messages. In the context of SACHET, the CBE defines the content of the alert and specifies the geographic area for dissemination. Once finalised, the alert is transmitted securely to the cell broadcast centre (CBC).

The CBC serves as the hub to process and transmit alerts within an MNO's network. Depending on the implementation, MNOs can opt for either a decentralised CBC system where each operator manages its own CBC or a centralised system where a shared CBC serves multiple networks. Most MNOs prefer decentralised systems due to privacy and security concerns.[86]

The CBC determines which base stations or cell towers should broadcast the alert based on the geographic area specified by the CBE. It processes and formats the alert to meet the technical requirements of different network technologies, such as 2G, 3G, 4G and 5G. After processing, the CBC transmits the alert to the required radio access network (RAN), which then broadcasts the alert to all compatible mobile devices in the designated area.[87,88,89]

Figure 20

Alert dissemination process through cell broadcast



Source: Telefonica

86 GSMA. (2023). Cell Broadcast for Early Warning Systems: A review of the technology and how to implement it.
87 ITSAR. (n.d.). Cell Broadcast Centre (CBC).
88 TRAI. (3 November 2021). Tariff issues related to SMS and Cell Broadcast alerts disseminated through Common Alerting Protocol (CAP) platform during disasters/non-disasters.
89 ETSI. (2020). Technical Specification: Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); Technical realization of Cell Broadcast Service (CBS) (3GPP TS 23.041 version 15.2.0 Release 15).

India's cell broadcast alert system

India's Cell Broadcast Alert System (CBAS) is designed to accommodate the country's vast linguistic diversity, accessibility needs **and** mobile technology landscape. By focusing on device compatibility and inclusive design, the implementation of CBAS aims to maximise reach and ensure that critical emergency alerts are delivered effectively to all citizens.[90],[91]

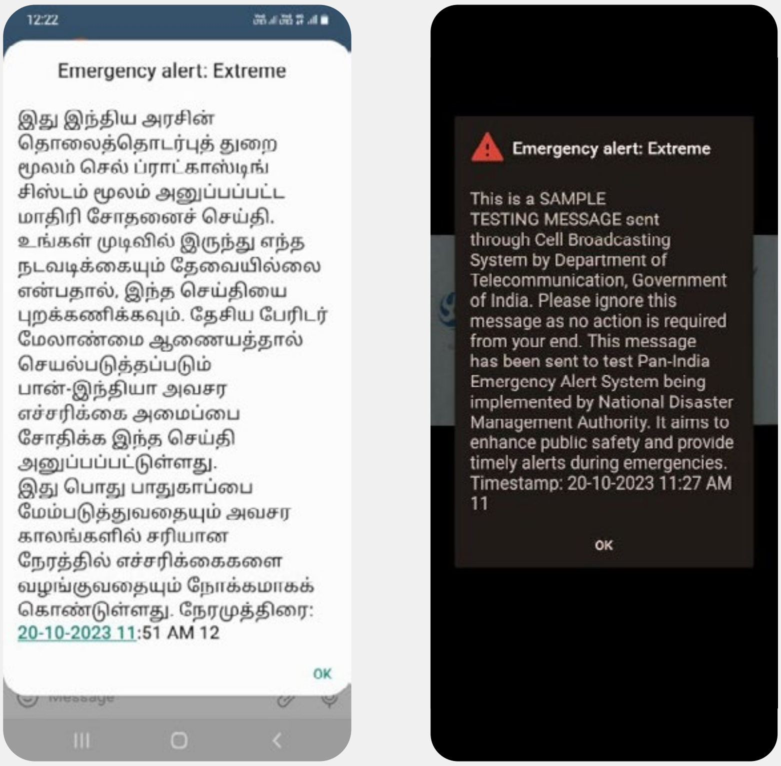
Key features of India's CBAS implementation include:

- **Mandatory device support:** In 2023, the Department of Telecommunications updated its regulations to mandate that all new smartphones and feature phones sold in India must be capable of receiving CB messages. Devices sold within the past four years that already support CB must also receive necessary updates to ensure CB functionality.
- **Multilingual support:** All eligible devices are required to support CB messages in English and all 22 Indian languages listed in the Eighth Schedule to the Constitution of India, ensuring widespread access and understanding across linguistic communities.
- **Auto-readout capability:** Devices must offer an automatic read-aloud feature for CB messages in English and all 22 constitutionally recognised Indian languages. This ensures that users with visual impairment or low literacy levels can understand alerts without additional assistance.
- **Alert display:** CB messages must remain visible on the device screen until the user acknowledges them. During this time, the device emits a distinct sound and vibrates for at least 30 seconds to draw attention to the alert. Every message is stored on the device for at least 24 hours.

Source: Gazette of India

Figure 21

Example of a test cell broadcast alert disseminated in Tamil and English



Source: Live Chennai

90 Agrawal, A. (19 September 2024). "Emergency alert system obligations on mobile OS providers as well". Hindustan Times.
91 C-DOT. (n.d). "C-DOT Cell Broadcast Solution".

Challenges with CB deployment

- **Deployment and integration of CBCs:** MNOs are required to deploy and integrate a CBC into their networks. This involves ensuring compatibility with existing network infrastructure such as 3G, 4G, 5G and with the CBE used by authorised alerting agencies.
- **High costs:** The implementation of CB systems requires substantial investment to procure and deploy CBCs and upgrade legacy infrastructure. Operational costs to maintain, monitor and train personnel add to the financial burden.[92,93]
- **Legacy network limitations:** Many older network elements in the RAN, such as the Base Station Controller (BSC) and Radio Network Controller (RNC), lack native CB functionality. These components often require software upgrades or, in some cases, hardware replacements, which delay the deployment process.
- **Integration complexity in multivendor networks:** Networks that use equipment from multiple vendors, such as Ericsson, Nokia and Huawei, face additional challenges during integration. Each vendor's equipment comes with unique configurations and compatibility requirements, which call for custom development, extensive testing and ongoing coordination with vendors.
- **Device compatibility issues:** A significant proportion of India's population uses feature phones, which do not have CB capabilities. Even CB-enabled devices often have the feature disabled by default, which further limits the effectiveness and reach of the technology.[94]

The financial model for MNO engagement in India's EWS

A regulated tariff framework established by the Telecom Regulatory Authority of India (TRAI) governs the financial model for the dissemination of disaster alerts via SMS and CB. Under this model, alerts disseminated during disaster situations or in preparation for such events, as specified under the Disaster Management Act, 2005, are exempt from charges for both SMS and CB.

For alerts outside the purview of the Act, such as those sent in nondisaster scenarios, the tariff for SMS is capped at INR 0.02 per message while CB-based dissemination remains free in all cases. This framework creates a clear distinction between disaster and nondisaster use cases, with CB consistently prioritised as a cost-free dissemination method. MNOs report that in practice, the cost recovery mechanism for non-disaster alerts has not been operationalised.[95]

The tariff order by the TRAI also specifies that tariffs will be reviewed after two years based on the operational experience gained from the SACHET platform. This provision allows the Indian Government and MNOs to refine the financial model based on lessons learned alongside emerging challenges.[96]

MNOs shoulder most of the infrastructure costs to support these services. These costs include capital expenditures (CAPEX) to procure and deploy CBCs, upgrade network infrastructure and increase network capacity. They also incur operational expenditures (OPEX) for activities, such as system maintenance, testing and hiring and training staff. While the government has built the CBE/SACHET platform, which it wholly finances and maintains, MNOs bear all remaining costs of alert dissemination through their networks.

92 TRAI. (2024). VIL comments to TRAI Consultation Paper on Tariff issues related to SMS and Cell broadcast alerts disseminated through Common Alerting Protocol (CAP) platform during disasters/non-disasters.
93 Key informant interview, MNO.
94 Interview with C-DOT and MNO.
95 Consultation with MNO.
96 TRAI. (2022). The Telecommunication Tariff (Sixty Ninth Amendment) Order, 2022.

07
Considerations for implementing effective public warning platforms

Based on insights gained from the implementation of India's SACHET public warning system, the following considerations are designed to help countries develop similar systems that address key issues related to the design, deployment and operation of public warning platforms.

#1 The CAP standard

Countries that intend to implement early warning systems should adopt the Common Alerting Protocol (CAP) as the standard format for emergency alerts. The CAP provides a predefined, structured template that ensures alerts generated by different forecasting agencies are consistent and coherent. This template captures critical information, such as the type of hazard, geographic area, severity, urgency, certainty, effective date and time, among other factors, in a standardised format.

The CAP offers two major advantages. First, it enables forecasting agencies to create alerts with all necessary details presented in a uniform structure. Second, it allows dissemination authorities to efficiently review, edit and modify the CAP alert before it is issued.

Additionally, the standardised format of the CAP provides a single data source to simultaneously distribute alerts across multiple channels, including SMS, CB, television, radio, RSS, satellite systems, public sirens, railway station boards and mobile apps. This multichannel dissemination capability ensures broader reach and minimises the time and effort required to relay alerts through various mediums.

#2 Stakeholder integration and coordination

Effective public warning systems rely on the seamless integration of organisations that generate alerts, such as meteorological, geological and hydrological agencies, private companies and disaster management authorities that review and disseminate alerts. A centralised platform is needed to unite these stakeholders and collect and manage alerts generated from a variety of sources. This would ensure that alerts are reviewed, validated and refined consistently to suit local needs before being disseminated to affected populations.

Consolidating efforts in a single platform eliminates the inefficiencies that result from fragmented workflows or disconnected processes. AGAs can focus on providing timely hazard-specific data while NDMAs can refine and adapt the alerts through geotargeting, regional language translations and contextual adjustments to make them relevant and actionable for the public.

#3 Multichannel dissemination

Disseminating alerts across multiple channels ensures critical information reaches all segments of society regardless of location, demographics or access to technology. Platforms such as SMS, CB, internet browsers, satellite networks, television, radio, social media, mobile apps, sirens and public display systems, ensure broad coverage and redundancy so that alerts are delivered even if one channel fails. This approach enhances accessibility, timeliness and reliability to ensure no one is left uninformed during emergencies.

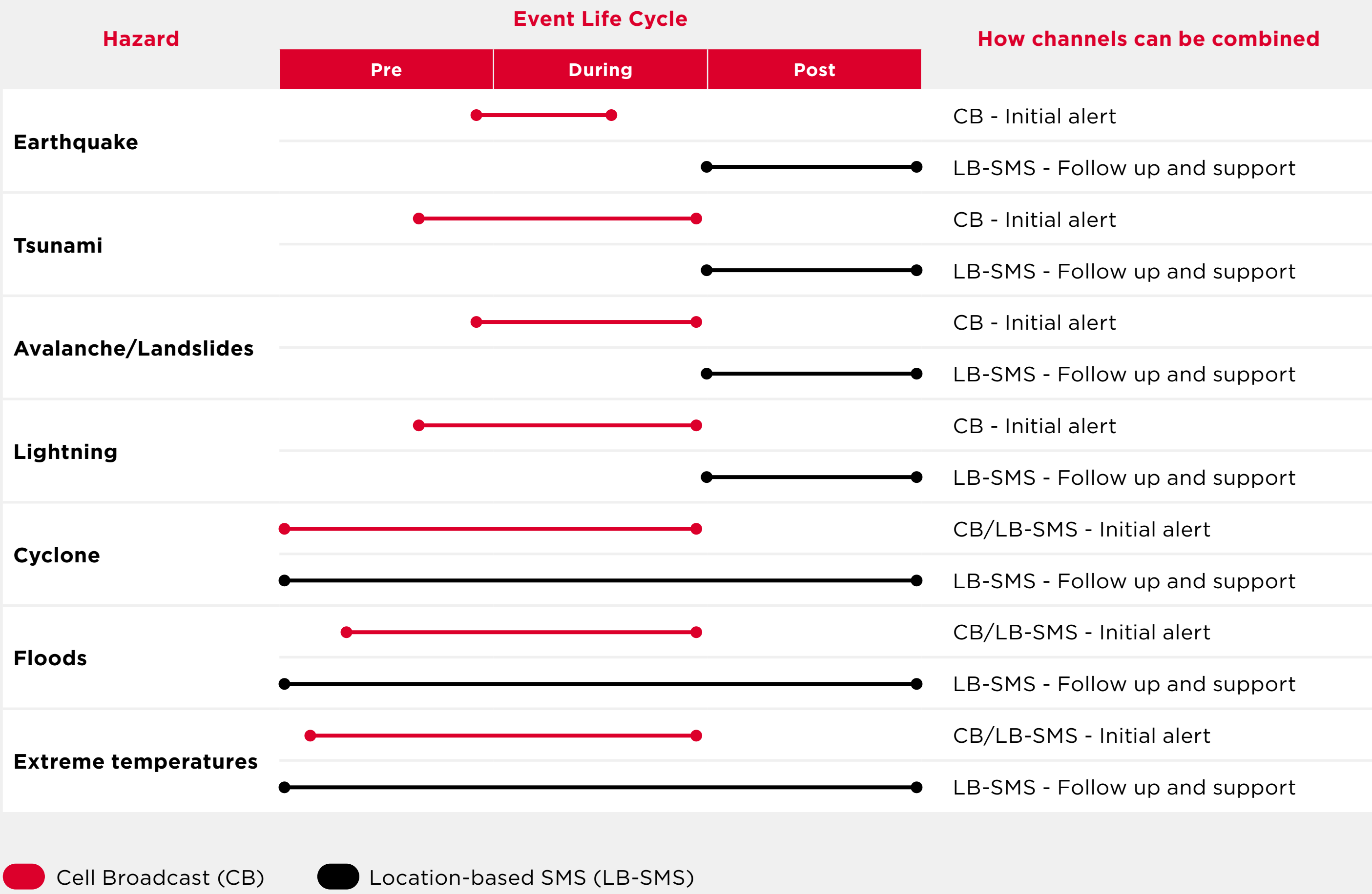
#4 A hybrid approach to the use of mobile networks

A hybrid approach that combines LB-SMS and CB offers a more comprehensive and effective solution to disseminate alerts on mobile networks. While both technologies are highly efficient, each has inherent limitations that prevent 100% coverage or effectiveness for the duration of an incident. A hybrid model, on the other hand, leverages the strengths of both technologies to ensure a robust and flexible public warning system that can adapt to different emergencies.

CB excels at delivering instant, wide-scale alerts to all compatible devices in a target area, which makes it invaluable for hazards with extremely short lead times, such as earthquakes, flash floods, lightning or tsunamis, when immediate action is critical. LB-SMS complements this by reaching a broad audience, including those with feature phones, and supports follow-up messages and detailed, ongoing communication during prolonged emergencies, such as cyclones or post-crisis recovery efforts. Together, these technologies significantly enhance the reach, reliability and contextual relevance of alerts.

Figure 22

How LB-SMS and CB can be combined to address different needs before, during and after disasters



Source: NDMA

#5
Inclusivity considerations

Alert systems should be designed to ensure they reach all segments of the population, including those with different linguistic, physical and accessibility needs. Alerts must be provided in the languages the targeted communities speak, supported by robust translation tools and verified by multilingual personnel to ensure accuracy and cultural relevance. This approach helps ensure that messages are clearly understood by everyone.

CB systems can play an important role in addressing accessibility needs. Features such as text to speech can assist individuals with visual impairments or reading difficulties, while visual cues, such as screen flashing and device vibrations, can help notify those with hearing impairments. By incorporating these capabilities, public warning systems can ensure that critical information is delivered equitably.

#6
Testing and capacity building

Testing and capacity building are essential for the successful deployment and sustained operation of a disaster alert system, as they help to identify and address technical and operational gaps to improve system readiness. They also encourage stakeholder buy-in and usage of the system as intended. Key considerations for testing and capacity building include:

- **Pilot testing** in a smaller geographic region before a nationwide roll out ensures that the alerting system can be evaluated end to end, from the generation and authorisation of alerts to dissemination. Engagement with all relevant stakeholders during the pilot phase reveals potential technical, operational and communication gaps. Addressing these issues before full deployment enables necessary improvements to be made, minimises risks and ensures a smooth nationwide roll out.
- **Collaborative testing with MNOs** is essential to optimise the performance of dissemination channels, such as LB-SMS and CB, including precise geographical targeting, faster dissemination and higher delivery success rates. Stress tests under simulated high-traffic conditions will also help ensure that the system remains reliable and effective during large-scale emergencies.
- **Training and mock drills** are critical to ensure stakeholders can operate the disaster alert system effectively. Training provides essential knowledge of SOPs and system functions, while mock drills offer practical, hands-on experience for trainees to respond to simulated emergencies. Together, they support better familiarity with the system, build coordination and enhance overall response readiness.
- **Standard operating procedures** are essential to ensure stakeholders take coordinated and consistent action. They outline roles and responsibilities for each phase of the alert process, including alert generation, authorisation and dissemination. SOPs also provide specific protocols for different scenarios, types of hazards and severity levels. This structured approach minimises confusion and ambiguity and ensures swift, accurate responses regardless of the situation.

#7 User-centred design considerations

A user-centred design approach simplifies operations and reduces potential errors in public warning systems, making them more efficient and reliable. By including practical and intuitive features, these systems can reduce the time it takes to create actionable alerts and support good decision-making during emergencies.

Key design considerations include:

- **Automated notifications:** The delivery of alerts, such as phone or email notifications, to authorities responsible for dissemination, ensures that stakeholders can review and act on new warnings quickly to reduce delays.
- **GIS tools:** Geographic information system (GIS) tools can make it easier to define affected areas for alerts. Pre-set areas for commonly affected regions can streamline the process and save time during emergencies.
- **Language translation:** Integrated translation tools allow alerts to be issued in multiple languages, which improves accessibility in regions with diverse populations.
- **Colour-coding alerts:** A colour-coded system for alerts visually indicates severity and priority levels, which allows authorities to assess a situation quickly and respond accordingly.

#8 Sustainable financial models

India’s financial model for public warning systems requires MNOs to cover infrastructure and operational costs with limited government support. This places a significant financial burden on MNOs, which may not be sustainable in the long term or suitable for all contexts.

MNOs are critical partners of public safety communication. To ensure MNO engagement remains sustainable, governments could consider subsidising costs or creative financing options. These could include the use of universal service funds, tax incentives, reduced licensing fees or in-kind contributions, such as the government’s use of MNOs’ core infrastructure.[97] Such measures would ease the financial burden on MNOs and encourage broader participation and investment in public safety initiatives.

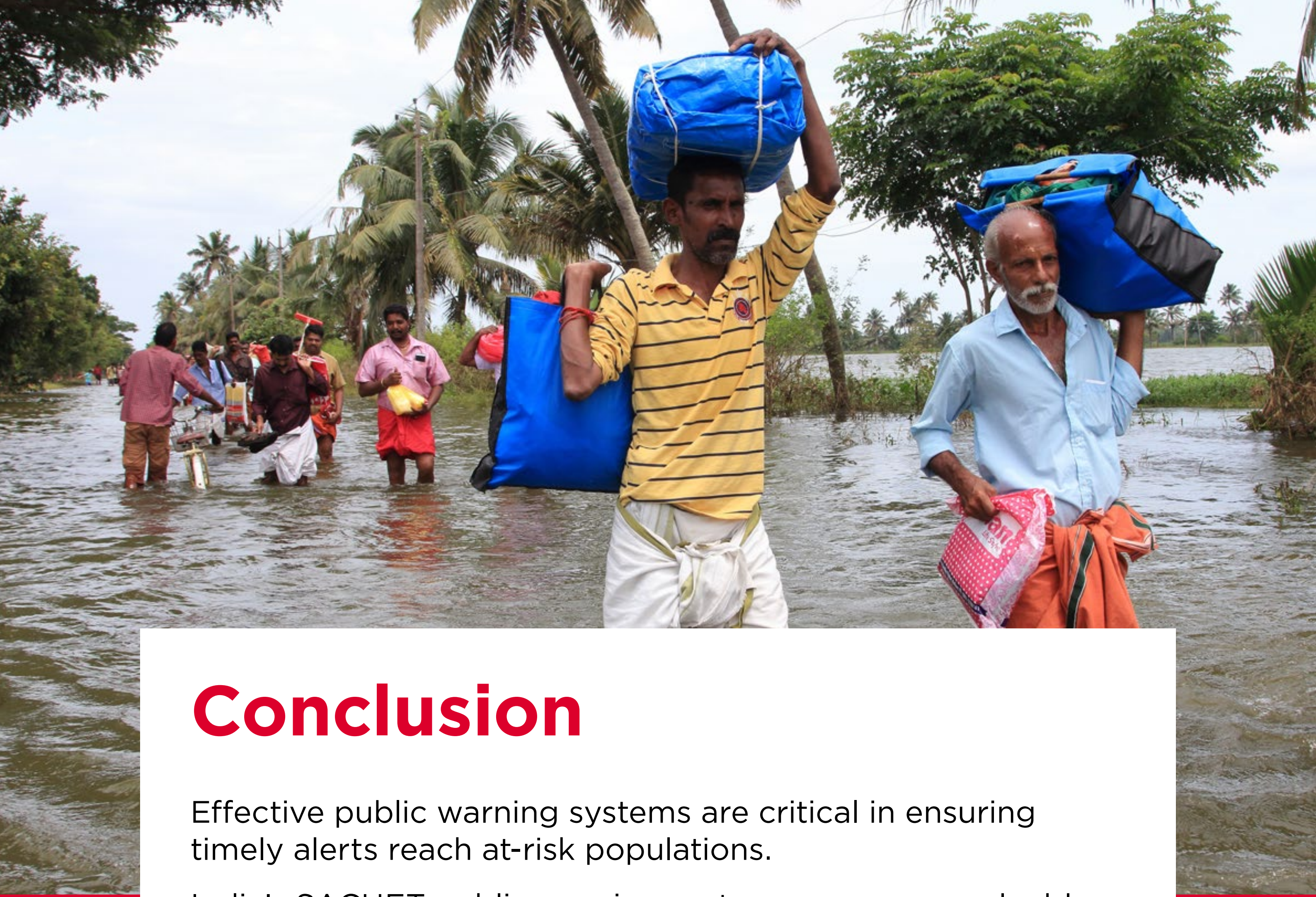
97 GSMA. (2023). Cell Broadcast for Early Warning Systems: A review of the technology and how to implement it.

#9
Periodic review and mechanisms for oversight and accountability

Periodic reviews and mechanisms for oversight and accountability help ensure that the alerting platform operates efficiently and achieves its intended objectives. Regular assessments can address key questions, such as:

- Are alerts issued with sufficient lead time based on the nature of the hazard?
- Is the content of the alerts clear, actionable and relevant?
- Are alerts delivered in suitable languages to reach diverse populations?
- Are multiple dissemination channels being used effectively to maximise reach?
- Is the geotargeting of alerts accurate and consistent with the intended areas?
- Do generated alerts prompt action from the relevant authorities?
- Do failures or significant delays occur in the dissemination of alerts?
- Does the current financial model help governments and MNOs adapt to emerging challenges and technological advancements?

A designated authority can support this process if it oversees the performance of the system and ensures compliance with established protocols. If this authority can access key data and statistics through a well-designed dashboard, it can significantly enhance its ability to monitor system usage. A transparent and user-friendly dashboard will permit real-time tracking of performance metrics and make it easier to identify gaps, enforce accountability and ensure the platform is used effectively.



Conclusion

Effective public warning systems are critical in ensuring timely alerts reach at-risk populations.

India's SACHET public warning system serves as a valuable case study, demonstrating how design principles, such as integration, multichannel dissemination, inclusivity and accountability, contribute to an effective platform. While it is still undergoing testing and full implementation, by combining CB and LB-SMS, SACHET balances speed and coverage.

Key lessons from the implementation of SACHET include the importance of adopting standardised protocols like the CAP, strengthening stakeholder coordination, ensuring accessibility and investing in testing and capacity building. By incorporating these considerations, countries can develop resilient, efficient and scalable public warning systems, enhancing their ability to mitigate the risk of hazards and protect lives.

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