Early Warning for All in Volcanology: Case Study Series

EW4All (Early Warning for All) is a global initiative as launched by UN Secretary-General António Guterres in 2022 to strengthen early warning systems and ensure communities at risk receive timely information. The EW4All approach is structured around four pillars:

1. Disaster risk knowledge and management (led by UNDRR)
2. Detection, observation, monitoring, analysis, and forecasting (led by WMO)
3. Warning, dissemination and communication (led by ITU)
4. Preparedness and response capabilities (led by IFRC)

As a follow-up to the "*Advancing Volcanic Hazards in EW4All*" workshop that took place in Geneva, Switzerland, between 7–9 July 2025 in association with the IAVCEI Scientific Assembly (See IAVCEI Newsletter No. 3, October 2025), a dedicated series of case-study contributions that highlight practical examples of cross-pillar collaboration in volcanic early warning will be published in the IAVCEI newsletters. This edition: Case study 2.

Each case study provides key elements of the EW4All pillars, such as:

- Examples of a project, activity;
- Initiatives demonstrating inter-pillar integration;
- Reflections on how EW4All pillars have been addressed and interconnected; and
- Insights into challenges, lessons learned, and successes in implementation.

The goal of this series is to enhance awareness, stimulate discussion, and encourage exchange of best practices across the EW4All and volcanological communities. We hope these contributions will inspire further collaboration and help bridge scientific expertise, operational needs, and societal preparedness.

We will begin by featuring case studies contributed by workshop participants and warmly encourage broader engagement from the IAVCEI community. Members interested in sharing their own experiences or initiatives are invited to contact us for inclusion in future editions (please contact Costanza.Bonadonna@unige.ch).

We warmly thank all contributors for sharing their perspectives and experiences, and we look forward to expanding this collection over time.

EW4All in volcanology – Case Study 2: The UWI Seismic Research Centre's Response to the 2020–2021 La Soufrière eruption, St. Vincent

Introduction: The Role of the UWI Seismic Research Centre

The University of the West Indies SeismicResearch Centre (UWI-SRC) is the regional institution responsible for monitoring volcanic, seismic and tsunami hazards across the English-speaking Eastern Caribbean. Acting on behalf of its contributing governments, the SRC provides continuous monitoring, hazard and risk assessment, and authoritative scientific advice to national disaster management agencies, decision-makers and the public. A central element of its mandate is to enable risk-informed action through timely, credible and clearly communicated early warnings in small island developing states (SIDS).

The 2020–2021 eruption of La Soufrière volcano in St. Vincent represented one of the most significant volcanic crises in the Caribbean in recent decades and provided a real-time demonstration of how integrated early warning systems operate under conditions of high uncertainty.

Volcanological and Risk Context

La Soufrière volcano, St.Vincent, is the most active subaerial volcano in the Eastern Caribbean, with a long history of explosive eruptions and severe societal impacts. The 2020–2021 eruptive episode began on 27 December 2020 with effusive lava dome growth following a period of subtle unrest. This phase persisted for over three months before a rapid transition to explosive activity on 9 April 2021, producing multiple explosive eruptions through to 22 April 2021.

The eruption generated a complex suite of hazards, including volcanic gas emissions, ashfall, pyroclastic density currents, ballistic projectiles and lahars. Approximately ~16,000 people were evacuated from the northern part of the island prior to the onset of explosive activity. Although the eruption caused widespread environmental, agricultural and infrastructural damage, there was no direct loss of life attributable to volcanic hazards.

Figure 1: A timeline overview of the 2020-21 eruption of La Soufrière volcano showing key volcanic activity, communication products and information used by The UWI Seismic Research Centre (UWI-SRC) during the volcanic crisis to update the public about events happening at the volcano (from Joseph et. al 2022).

Risk was shaped not only by volcanic processes but also by social and geographic factors, including steep terrain, dispersed rural communities, climate-sensitive livelihoods and the concurrent COVID-19 pandemic. These conditions highlighted the need for early warning systems that integrate scientific monitoring with preparedness, communication and response.

Figure 1 depicts the chronology of the eruption showing how multi-parameter monitoring data and observations were translated into scientific assessment, communicated warnings, and preparedness and response actions. SRC scientists continuously integrated seismic, deformation, RSAM and surface observations to develop evolving interpretations of volcanic behaviour under conditions of high uncertainty. These assessments were communicated through regular advisories and briefings to national authorities and the public, supporting timely decisions, including the early evacuation of communities at highest risk prior to the onset of explosive activity.

Cross-Pillar Early Warning for All (EW4All) in Practice

The SRC's response to the La Soufrière eruption illustrates the interdependence of all four EW4All pillars and demonstrates how integrated early warning systems can function effectively in a resource-constrained SIDS context (**Figure 2**).

Pillar 1: Disaster Risk Knowledge

Long-term investment in hazard assessment and risk knowledge formed the foundation of the response. The SRC maintained updated volcanic hazard maps, eruption scenarios and impact assessments for La Soufrière, informed by historical eruptions and ongoing research. These products underpinned evacuation planning and were embedded within national emergency preparedness frameworks well before the onset of unrest. Community-based risk reduction initiatives, including the Volcano-Ready Communities Project, enhanced local understanding of volcanic hazards and response actions in high-risk zones.

Volcanic behavior	Background unrest	Effusivedome growth **(Dec 2020)**	Escalating activity	Explosive eruption **(9 Apr 2021)**
Monitoring observations (SRC)	Seismicity **(VT → tremor)**	Deformation **(accelerating)**	Dome growth / **extrusion & seismicity ↑**	RSAM / **energy release ↑**
Scientific assessment	Effusive eruption; **no clear explosive precursors**	Increasing activity; **possible escalation**	High likelihood of **explosive transition**	
Warnings & response	Alert level escalation	Formaladvisories **to NEMO**	Evacuation of **northern communities**	Ongoingguidance **during eruption**

Figure 2: An Integrated Early Warning Chain for the 2020–2021 La Soufrière Eruption, St. Vincent: from monitoring signals to decision-making and response under uncertainty. The schematic highlights how all four EW4All pillars functioned together as a coherent system, demonstrating that effective early warning in volcanic crises depends not only on detection and forecasting, but equally on trust, communication, and preparedness.

Pillar 2: Detection, Monitoring and Forecasting

Duringtheeruption, theSRCimplementedintensified,24/7 multi-parameter monitoring, integrating seismicity, deformation, gas emissions, visual observations and satellite-based remote sensing. A key innovation was the development of evolving conceptual models and structured expert elicitation to assess the likelihood of eruptive transitions under conditions of high uncertainty. These approaches enabled the SRC to anticipate and communicate the potential for escalation from effusive to explosive activity, despite limited precursory signals.

Pillar 3: Warning Dissemination and Communication

Monitoringoutputs were translated intoactionable information through sustained, multi-channel communication. The SRC worked closely with the National Emergency Management Organisation (NEMO) to ensure consistent, harmonised messaging to decision-makers and the public. Regular scientific briefings, press conferences, radio and television interviews, social media updates and visual communication products were used to convey evolving hazards, uncertainty and recommended protective actions. Maintaining transparency and a continuous presence helped sustain public trust and counter misinformation during a prolonged crisis.

Pillar 4: Preparedness and Response

Scientificadvicefromthe SRCdirectly informed national preparedness and response actions, including the early evacuation of communities at highest risk. The SRC remained embedded within national response structures throughout the crisis, providing ongoing guidance on ashfall impacts, lahar risk, aviation hazards and conditions for phased re-entry. The effectiveness of response actions reflected prior investments in preparedness planning, inter-agency coordination and community engagement.

Challenges, Successes and Lessons Learned

Challenges included rapid changes in eruptive behaviour, high levels of uncertainty and sustained public and political attention. Maintaining round-the-clock operations over several months placedsignificant demands on limited humanand technical resources,while the COVID-19 pandemic constrained evacuation logistics, shelter management and community engagement.

Successes included early evacuation decisions informed by scientific assessment and trusted communication, resulting in no direct volcanic fatalities. Strong science–policy relationships enabled timely, decisive action, while regional and international scientific partnerships expanded analytical capacity during critical phases of the crisis.

Key lessons for EW4All include the central importance of trust built through long-term engagement prior to crises; the need for early warning systems to be people-centred as well as technology- driven; and the requirement for all four pillars to function together as a coherent system. Regional institutions such as the SRC play a critical role in sustaining this integration for SIDS.

Concluding Reflections

The 2020–2021 eruption of La Soufrière demonstrates how EW4All principles can be operationalised during a complex volcanic crisis in a small island developing state. The experience highlights the value of integrated, multi-pillar early warning systems that link scientific monitoring to decision-making and community action. As EW4All is advanced globally, lessons from St. Vincent offer transferable insights for volcanic regions worldwide, particularly those facing compounded vulnerabilities and resource constraints.

References

- Joseph,E.P., Camejo-Harry, M., Christopher, T. et al. Responding to eruptive transitions during the 2020–2021 eruption of La Soufrière volcano, St. Vincent. Nat Commun 13, 4129 (2022). https://doi.org/10.1038/s41467-022-31901-4
- Richard E. A. Robertson, Jenni Barclay, E. P. Joseph, R. S. J. Sparks, 2024. "An overview of the eruption of La Soufrière Volcano, St Vincent 2020–21", The 2020–21 Eruption of La Soufrière Volcano, St Vincent, R.E.A. Robertson, E.P. Joseph, J. Barclay, R.S.J. Sparks. https://doi.org/10.1144/SP539-2023-95

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