# COMMUNITY-BASED EARLY WARNING SYSTEM

Learning from Saint Bernard, Southern Leyte

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On the cover: Danilo Mancio, designated rain gauge observer of Barangay Bolod-bolod in Saint Bernard, checks a manual gauge. He records and reports these measurements every day. (ACCORD)

# Community-Based Early Warning System

## Learning from Saint Bernard, Southern Leyte


Staff of the Saint Bernard disaster risk reduction and management office check an automatic flood warning device placed along the banks of Tongao River in Mahayhay. The river usually overflows whenever there is heavy or continuous rain. Proper maintenance of devices ensures that the entire early warning system is functional and effective.

# I. INTRODUCTION

Natural hazards, climate change, and unrestrained ecosystem degradation are spawning extreme events, resulting in massive losses of lives and livelihoods. Early warning systems (EWS) are crucial in reducing the risks to which vulnerable communities are exposed: effective ones can save countless lives and livelihoods, and less effective ones can turn hazards into disasters and extreme events.

The Philippines has developed capacities for early warning. During typhoon Haiyan, it demonstrated that monitoring and warning, including the detection of the typhoon, functioned relatively well. Risk knowledge at the national level was equally sound, but there were gaps at the local government and community levels. Communities and local government units (LGU) did not expect the storm surge generated by Haiyan's strong winds. There was a lack of understanding of the phenomenon leading to inappropriate responses (Ahmed, 2015), and local capacities were simply overwhelmed by the extreme event.

EWS is a crucial disaster risk reduction (DRR) measure as it can provide the opportunity for individuals, communities, governments, businesses, and others to take timely action to reduce risks in advance of hazardous events. This, in turn, contributes to building community resilience. But for an EWS to be effective, it needs to be end-to-end, people-centered or community-based, and landscape-wide.

UNISDR (2017) describes an effective end-to-end and people-centered (or community-based) EWS as including four interrelated key elements:
(1) disaster risk knowledge based on the systematic collection of data and disaster risk assessments;
(2) detection, monitoring, analysis, and forecasting of the hazards and possible consequences;
(3) dissemination and communication, by an official source, of authoritative, timely, accurate, and actionable warnings and associated information on likelihood and impact; and
(4) preparedness at all levels to respond to the warnings received.

These four interrelated components need to be coordinated within and across sectors and multiple levels for the system to work effectively, and must include a feedback mechanism for continuous improvement. Failure in one component or a lack of coordination across them could lead to the failure of the whole system.

Community-based refers to an EWS that gives premium to community participation and ownership of the system. A landscape approach refers to an EWS that encompasess larger landscapes such as river basins or watersheds. It requires the harmonization of systems within a landscape, and cooperation among political and administrative units sharing the same landscape.

In the municipality of Saint Bernard in the province of Southern Leyte, the setting up of the EWS, among other DRR and climate change adaptation actions, was occasioned by a landslide that wiped out an entire barangay (village) in 2006. The event underscored the municipality's vulnerability to multiple hazards and the urgent need to improve preparedness. Through the collaboration of the municipal LGU, government agencies, civil society organizations, and community members, the EWS was instituted. In 2013, their community-based local flood EWS was recognized by the UN Sasakawa Award for Disaster Reduction for its innovative approach that combines technology and comprehensive social preparation. It was one of six projects from around the world that received the award.

This study presents Saint Bernard's experiences and lessons learned in setting up and managing the end-to-end, community-based, and landscape-wide EWS for floods, landslides, and tsunamis.

Residents of Saint Bernard in Southern Leyte cross the bridge to the memorial site for those who perished in the 2006 landslide. In the background, the mountain slope has once again turned lush, almost indifferent to the amount of rock and soil it has heaved over the entire village of Guinsaugon. (ACCORD)

## The 2006 Guinsaugon landslide: a wakeup call

A minor earthquake, preceded by two weeks of heavy rainfall, caused the collapse of the cliff face of a ridge straddling the Philippine Fault Zone, a large and active tectonic structure that traverses the entire length of the Philippines, burying alive at least 1,000 residents of Barangay Guinsaugon in hundreds of tons of rocks, mud, and debris. Among the dead were 246 students and seven teachers; only one child and an adult were rescued from the local elementary school buried in the avalanche. Eighty women taking part in the celebration of the anniversary of a women's health association also died.

The municipality's geographical characteristics render it prone to almost all hazards, especially landslides and frequent flooding. The town is bounded by mountains on its west, north, and east, and its plains are bisected by a river that drains from these mountains. Strong rains make the river swell, flooding the plains. Most residents of the flood-prone plains of the town evacuate at least 10 times a year to protect themselves. Flood waters stagnate for up to three to four days in low-lying areas.

Hazard events are frequent; many residents consider these a "normal" part of their lives and are apathetic toward DRR-related activities. This is compounded by the lack of DRR and early warning-related systems. The Barangay Disaster Coordinating Council is considered to exist only on paper, with members unaware of their duties. There was no Evacuation Plan, much less an EWS, leading to residents evacuating in a haphazard, scattered manner, and only when floodwaters had already risen to alarming levels.

All this changed after the Guinsaugon landslide in 2006 claimed many lives and inflicted massive property damage. Not only was there an influx of support from

various government agencies and civil society organizations to rebuild the affected communities, the disaster instilled in many residents a commitment to becoming better prepared for hazards and disasters. Preparedness activities introduced to the municipality included the setting up of EWS. The Philippine Institute of Volcanology and Seismology (PHIVOLCS) set up a tsunami EWS and conducted evacuation drills (see Box 1); and, later, established a rainfall-induced landslide EWS. CARE, with technical support from the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), set up a community-based flood EWS, and the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) set up an automated EWS.

The municipal LGU subsequently led CARE and GIZ to harmonize their respective systems into one flood EWS with a built-in redundancy for enhanced effectiveness.

# II. STRATEGIES

## The Saint Bernard Flood Early Warning System (EWS)

Saint Bernard municipality's flood EWS, which covers the whole Hinabian-Lawigan watershed, includes end-to-end elements of risk knowledge, monitoring and forecasting, warning and dissemination, and response. Feedback was an added element to the system.

### 1. Risk Knowledge

After the 2006 Guinsaugon landslide, various state science and technology agencies assisted the municipality in risk assessments. PAGASA, PHIVOLCS, and the Mines and Geosciences Bureau (MGB) provided hazard maps and scientific information. These were combined with local knowledge to serve as inputs to risk reduction plans and contingency plans, including EWS and evacuation plans, among others. Local risk knowledge was strengthened through participatory risk assessments, training, public awareness activities, and evacuation drills carried out by CARE and partners with support from the European Civil Protection and Humanitarian Aid Operations (ECHO). Two cycles of the Disaster Preparedness ECHO (DIPECHO) programming facilitated the setting up of Saint Bernard's EWS.

**2. Monitoring**

PAGASA provided technical guidance when rain gauges and water level gauges were installed throughout the Hinabian-Lawigan watershed. Special attention was given to upstream devices since the level of precipitation at the headwaters determines the severity of the floods in communities downstream. Gauges were also installed in slope areas vulnerable to landslides induced by heavy rains. The gauge readings are regularly transmitted via two-way radio to the operational center run by the municipal LGU.

CARE helped set up the community-based flood EWS. It made use of manual equipment, mindful that automated equipment has technical limitations such as the inability to function during power outages or if the cellular network is down. It also installed manual rainfall and water level gauges in barangays not covered by the GIZ devices.

A rain gauge located at the municipal hall, with a sign written in the local language

Alongside CARE, GIZ also implemented a DRR program that had a watershed-based local flood EWS as a component. The system used a combination of automated and manual equipment (rain gauges, tide gauges, automatic weather station) installed across the 30 barangays comprising the municipality, thereby covering a total land area of 10,020 hectares. The GIZ also provided a computer set, generator set, and two-way radio communication system.

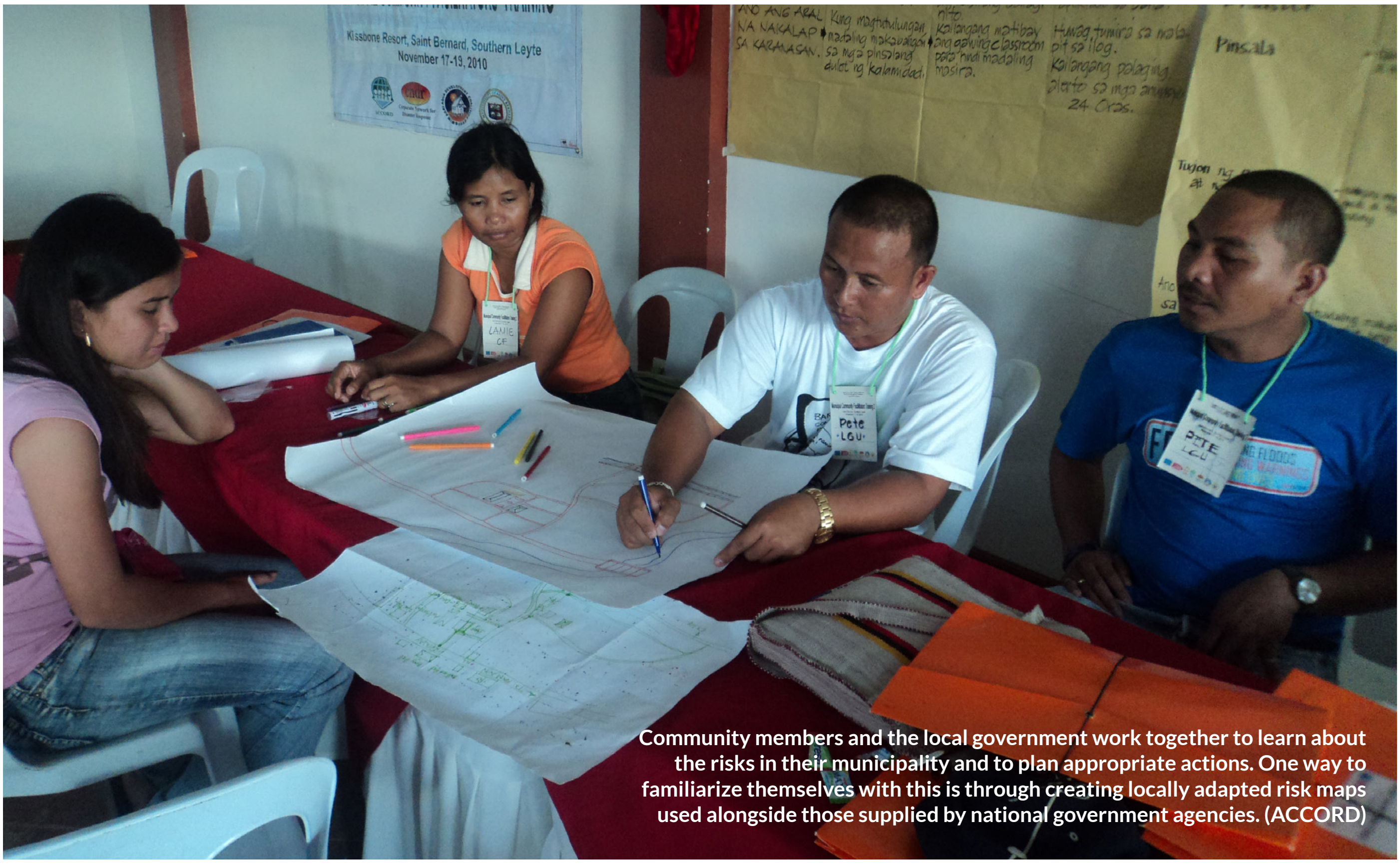
The LGU of Saint Bernard municipality led in unifying and harmonizing GIZ's and CARE's respective EWS projects. It also led in improving the EWS and contingency plan after later incidents of serious flooding and rain-induced landslides prompted the need to integrate climate projections in the municipality's risk assessments, EWS, and contingency plans.

**3. Warning and Warning Dissemination**

Data from the telemetered rainfall and water level gauges are transmitted through short message service (SMS) to the operation center being managed by the municipal LGU. For the manual rainfall and water level gauges, barangay officials and CARE community facilitators (volunteers) monitor these and send the data to the operation center also by SMS or two-way radio. The operation center analyzes the data and subsequently recommends to the proper authority, usually the mayor, the corresponding warning or alert level. Upon approval, the operations center issues the warning to barangay officials via two-way radio and mobile phone.

**4. Action**

Upon receipt of the warning, the barangay disaster risk reduction and management committee mobilizes according to their own EWS and contingency plan. The appropriate warning is communicated to households through multiple means such as public address systems, mobile phone, two-way radio, and communication teams going around thecommunity to disseminate the warning, usually using megaphones. Households take appropriate action based on their knowledge of the barangay contingency plan. If evacuation is required, households proceed to designated pick-up points where municipal and barangay LGU vehicles will collect and transport them to their designated evacuation centers.




Community members and the local government work together to learn about the risks in their municipality and to plan appropriate actions. One way to familiarize themselves with this is through creating locally adapted risk maps used alongside those supplied by national government agencies. (ACCORD)

Warnings and warning dissemination, however, are ineffective if people do not know exactly how to respond. As such, drills, trainings, and public awareness efforts — which include house-to-house information campaigns, leafleteering, focus group discussions, and mass assemblies — were also carried out to communicate how the EWS works, the characteristics of the contingency plan, and how communities ought to participate in implementing the contingency plan. The drills were conducted in increasing complexity, beginning with the participation of only one barangay, and progressing to simultaneous drills covering several barangays and involving the municipal disaster risk reduction and management council (MDRRMC).

**5. Feedback**

After action reviews (AARs) were conducted after the drill. These AARs provided inputs aimed at improving the EWS, evacuation plan, and the contingency plan as a whole. AARs were also conducted following actual hazard events for the same purpose – to draw lessons that would feed into improving the EWS and the contingency plan. The AARs serve as the feedback loop that completes the end-to-end character of the Saint Bernard EWS.

## III. CHALLENGES

A 2010 review of the Saint Bernard EWS revealed the following:

With the exception of Panian and Malinao, other barangay LGUs were inconsistent in observing, recording, and reporting data from rainfall and water level-monitoring devices hosted by their localities.

Moreover, 33% of communications equipment in the system are no longer functioning, as both telemetry signals (for the automated gauges) and SMS messages (for the non-automated ones) were inconsistent and fluctuated.

As a result, the exchange of information between the MDRRMC and the barangay LGUs, a key component of the EWS, was adversely affected.

In general, the town's technical capacity is still considerably limited. For example, the LGU has a limited number of personnel who can quickly interpret all the data received by the town Operations Center from all the devices.

In 2011, a landslide in the barangay of Bolod-bolod, following days of continuous heavy rainfall, revealed that the risk assessment for the community overlooked the previously mentioned hazard because it did not have a history of landslide occurrences. Moreover, climate projections were not considered in earlier risk assessments that formed the basis for early warning systems. The failure to issue an appropriate warning contributed to the deaths of three residents and the massive loss of livestock. Learning from this, the stakeholders of the EWS resolved to integrate climate change projections in the EWS and overall contingency plans of Saint Bernard. A landslide EWS was subsequently set up by PHIVOLCS (see Box 2).

Other challenges encountered by the LGU and communities of Saint Bernard are the complexity of maintaining several hazard-specific EWS to account for multiple hazards frequently affecting the town; the lack of continuity in the support from the town's Local Chief Executive, and bureaucratic processes concerning early warning and action at the higher administrative levels of government.

Among the difficulties in maintaining several hazard-specific EWS is interpreting different kinds of data, coordinating different kinds of actions, and ensuring coherence across the different EWS.

The new local chief executive who took office in 2010 had weaker support for the risk reduction plan of the Municipal Disaster Risk Reduction Office (MDRRMO). Bureaucratic bottlenecks between the barangay and municipal LGUs, between the LGUs and national government agencies, and even among barangay LGUs often impede the decision-making of barangay LGUs at a time when urgent and crucial actions are needed.

**Participation from offices such as Health, Engineering, Municipal Environment and Natural Resources (MENRO), communities, and other sectors is ensured in disaster risk reduction trainings and workshops. In these sessions, participants learn about not only the risks and hazards the municipality is facing, but also their responsibilities once these occur.**

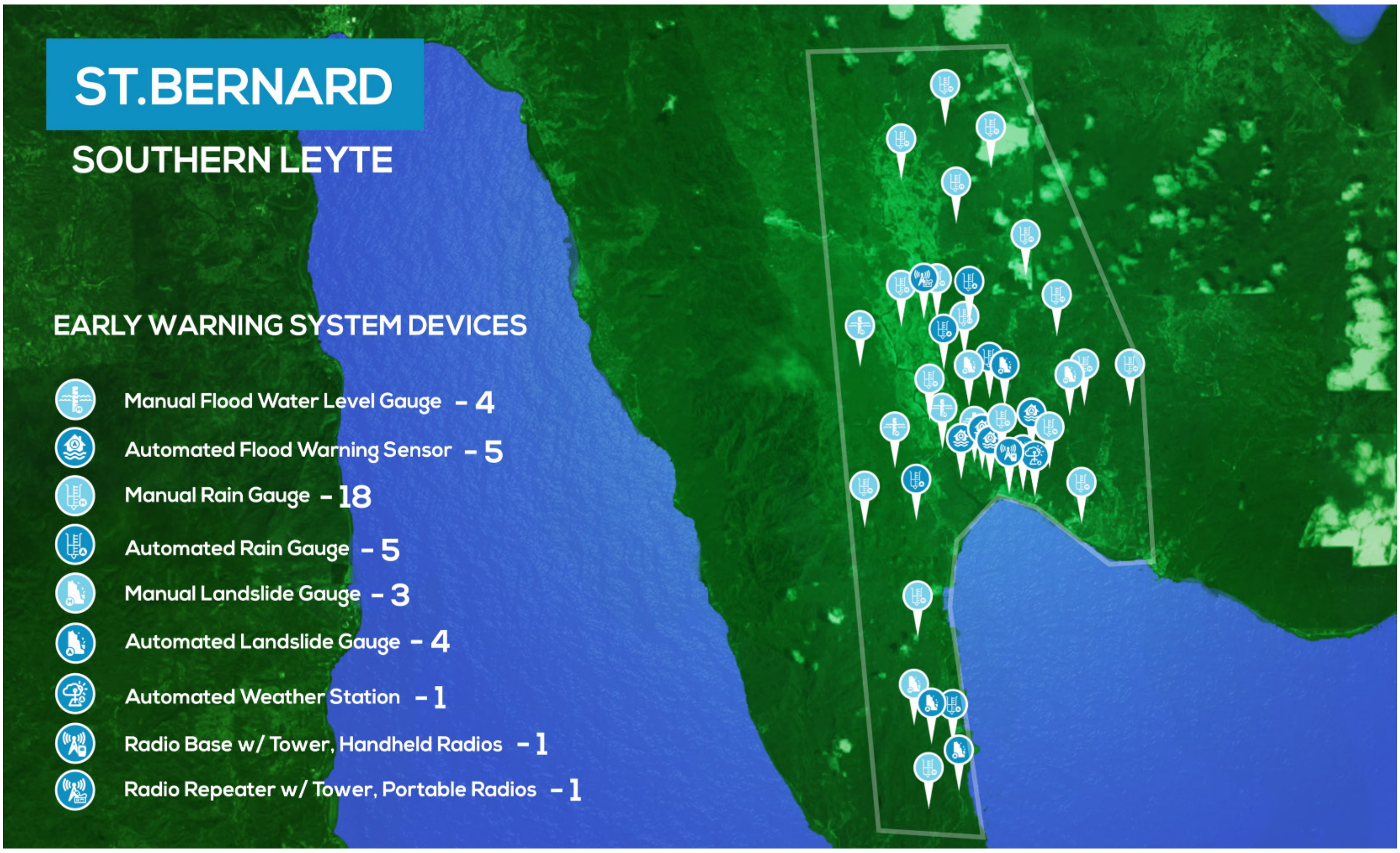
Despite the challenges, the EWS for flood, as well as for landslides and tsunami, remain in place, sustained by the MDRRMO and the communities. Buy-in of the communities of the whole EWS, as a result of community participatory processes, was able to overcome the challenges.

In the case of the EWS tools, people and organizations assigned to various components of the EWS with varying tasks took to learning and understanding their roles to heart. This enabled a coherent integration of the various components into a whole working system. Despite the lack of support from the LCE at one stage, people at the barangay level carried on with their duties and responsibilities in the EWS.

The barangay LGU officials overcame bureaucratic bottlenecks by communicating and coordinating with each other instead of waiting for decision-makers from provincial, regional, and national levels of government.

Among all the hosts of the EWS stations in the municipality, Barangay Panian is one of the most faithful in its duties, and serves as a role model for other barangays in the town to emulate. Rainfall and water-level reading has become one of the standard tasks of barangay officials during their weekly turns as "official-of the-day." Those who fail to record and report the readings are fined PHP 150 per day. As a result, Panian is gradually establishing localized rainfall thresholds for floods. These thresholds in turn helped guide disaster planners and responders so that they'll know when the rain can be considered heavy enough before a disaster occurs.

The experience of Panian and Saint Bernard as a whole shows the importance of relying on grassroots participation as opposed to outside technical experts, and on systems as opposed to merely deploying technical equipment. Reliance on the latter has been the norm in the Philippine development sector in general. The supposed beneficiaries have no meaningful roles, being reduced to ensuring the maintenance and upkeep of the equipment. Such a setup leaves meaningful decisions, some of which are of a life-and-death urgency, to people divorced from the realities on the ground. The interest of the people in their roles, albeit token, decreases in time.




## IV. LESSONS LEARNED

From the foregoing case of Saint Bernard, the following efforts are being underscored to set up and sustain effective early warning systems:

1. The consistent application of a community-based, end-to-end, landscape approach to early warning across hazard types — i.e., flood/typhoon, earthquake, tsunami, and landslide — helps ensure the effectiveness and sustainability of various EWS. Complementing this is a rights-based approach applied to all DRR activities.

2. The support of local authorities and ownership by communities should be secured and sustained. Participatory approaches, and engaging key stakeholders in all phases of designing, setting up, and maintaining EWS can generate support and ownership, enabling communities to embrace and continue the program as their own. This can serve as a buffer against loss of local government unit support arising from shifts in local political alignments. Local authority and community ownership is key to effective and sustainable EWS. These elements of the EWS should be continually developed.

3. Risk assessments should be done with the people's participation. Local knowledge and familiarity with the hazards should be complemented with scientific information such as projected effects from climate change. Existing EWS elements in the community should be identified and integrated into the EWS design. New EWS must be harmonized and achieve synergy with preexisting EWS, if there are any, to avoid redundancies and confusion among the communities who will serve as end-users and beneficiaries. The risk assessment should cover the entire landscape, e.g., entire watershed, coastal zone, or hilly or mountainous region, instead of merely patches of areas.

4. The coherence of the local-level EWS and contingency plan in accordance with guidelines and protocols emanating from higher levels of authority should be balanced with their applicability in the local context.

5. The EWS must be incorporated in the contingency plan. In turn, the evacuation plan must be aligned with longer-term plans such as the disaster risk reduction and management plan, local climate change action plan, comprehensive development plan, and comprehensive land use plan.

6. Sustained technical support should be secured from national government agencies such as PAGASA and PHIVOLCS, so that they can assist in developing and improving the EWS. They are very willing to help in setting up and maintaining EWS, and the participation of qualified agencies would help enhance the technical qualities of the EWS. They can help identify the best and most appropriate locations where equipment can be set up, design the warning levels and communications protocols, and train locals to monitor the equipment themselves. Aside from PAGASA and PHIVOLCS, coordination with other state science agencies such as the DENR-MGB, the National Mapping and Resource Information Authority (NAMRIA), and the National Disaster Risk Reduction and Management Council (NDRRMC), as well as the academe, should also be continued in relation to risk mapping and EWS activities.

7. Wide awareness among community members about the EWS and the contingency plan should be created. The success of the EWS and the effectiveness of LGU and community responses depend on aweness of risks and knowledge about the EWS and the appropriate response to disseminated warnings.

8. Regularly test the effectiveness of EWS and contingency plans through community drills, which are also effective means for raising awareness and increasing knowledge on how to reduce risks. Aim for 100% participation of households located in high-risk locations in the drills. Extensive public awareness activities prior to the drill should also be done.

9. AARs or reflection and learning sessions should be conducted after drills and hazard events to identify strengths and weaknesses, draw lessons, and apply these in enhancing the EWS and contingency plans.

## Tsunami Early Warning System

The tsunami early warning system (EWS) covers low-lying, mostly coastal areas of Saint Bernard mapped by PHIVOLCS as tsunami-prone. Markers have been set up in the municipality to delineate these high-risk zones. Directional markers have also been set up, pointing to the elevated areas inland where at-risk population would need to evacuate in the event of a tsunami warning or an actual strong earthquake experienced by the local population.

A tsunami warning issued by PHIVOLCS is received by the municipal local government unit through the Disaster Risk Reduction and Management Councils. The local government units also directly access issued warnings by following PHIVOLCS on Twitter and Facebook, and indirectly through television and radio broadcasts. Information from various sources are triangulated for accuracy, and verification from official sources is carried out. Warnings are localized and transmitted to barangay officials through an installed public address system, hand-held radio, and SMS. At the barangay level, the warning is disseminated via public address system, Barangay Warning Committee members going house-to-house, and through text messages.

When a strong earthquake is experienced locally, residents in the identified tsunami-prone areas would have to proceed immediately to pre-identified safe zones in case the earthquake triggers a locally generated tsunami and the local government unit would no longer have time to ascertain the location of the earthquake's epicenter or whether the earthquake has the potential to trigger a tsunami. In case of a far-field tsunami – one that originates from a distant source and therefore provides greater leadtime – the alert is coursed through the formal communication chain. When the local government unit has determined that the threat of either a locally generated or far-field tsunami has passed, an order to return home is issued.


Tsunami-prone areas such as Barangay Hindag-an place signs in strategic areas as part of their disaster preparedness plan. (ACCORD)

Public awareness activities have been carried out by PHIVOLCS, the local government unit, and organizations like CARE about the hazard, the warning, and the corresponding actions at-risk communities need to carry out. These are also incorporated in the community-based disaster risk reduction trainings conducted by CARE among communities and municipal local government unit.

This tsunami EWS has been tested several times already, such as when a strong earthquake was locally felt, as well as when a far-field tsunami alarm was raised, and the local government unit and the communities subsequently activated their EWS. For example, the municipality responded to far-field tsunami alerts following the Chile earthquake in 2010, and more recently the Mexico earthquake in 2017. On August 31, 2012, following a strong earthquake that occurred at the Philippine Trench east of Eastern Samar province, PHIVOLCS issued a tsunami alert shortly after the event and the municipal and barangay local government units and tsunami-prone communities activated their EWS. No significant wave appeared, but the event provided an opportunity for the local government units and communities and government agencies to demonstrate the effectiveness of their tsunami EWS. Gaps were also identified in order to further strengthen an end-to-end system.

## Landslide Early Warning System

The Saint Bernard landslide early warning system (EWS) was set up starting 2012. The municipality was selected as one of 50 project sites across the Philippines for the Landslide Early Warning System (LEWS) Protocol, developed by the Dynaslope Project of PHIVOLCS-DOST. The LEWS Protocol provides operational guidelines for communicating and responding to landslide risks. The Dynaslope Project aims to provide highly accurate and timely landslide warning and information; develop cost-effective monitoring and EWS for landslides; and empower partners to lead in reducing risks from landslide hazards down to the barangay level.

| ALERT LEVEL | DESCRIPTION | RECOMMENDED RESPONSE FOR LGU/LLMC | RECOMMENDED RESPONSE FOR THE COMMUNITY |
|---|---|---|---|
| A0 | No significant ground movement | Proceed with routine monitoring | Proceed with daily activities |
| A1 | Recent rainfall, earthquake, and/or other landslide-related event may trigger landslide | Prepare to assist households at risk in responding to higher alerts [A2 or A3] | Prepare to respond to higher alerts [A2 or A3] |
| A2 | Significant ground movement observed in the last 24 hours | Prepare to evacuate the households at risk.<br><br>If conditions are safe, monitor every 4 hours | Prepare to evacuate |
| A3 | Critical ground movement observed in the last 48 hours; landslide may be imminent | Evacuate the households at risk | Evacuate |

The landslide EWS set up in Saint Bernard, in barangays Bolod-bolod and Lipanto, is guided by the Dynaslope vision of a people-centered EWS that encompasses four key elements: risk knowledge, monitoring and warning service, dissemination and communication, and response capability.

Building on earlier community risk assessments carried out by the municipal local government unit and the barangays using both indigenous and scientific information, landslide risk assessment was updated. Risk knowledge is continually updated by a team of geologists and engineers from PHIVOLCS and this information is relayed to the community and LGUs through quarterly seminars and meetings.

Monitoring and warning service is provided by PHIVOLCS through the installation of tilt sensors and rain gauges and relaying of data received from these sensors to the community. Aside from sensor data, the community, through a local landslide monitoring committee (LLMC), also contributes data from ground measurements obtained from the field observation points deployed by the geologists. The committee also provides immediate and timely field observations for sensor data validation. The LLMC is composed of volunteer community members trained by PHIVOLCS.

The LLMC receives direct communication from PHIVOLCS in the form of early warning information based on processed and analyzed data. The early warning information is in the form of alerts. The committee is responsible for communicating early warning information to the households at risk.

The landslide EWS is incorporated in the local contingency plan. The quality of the formulated contingency plan, familiarity of at-risk households and the barangay with the components of the plan, and the frequency by which the contingency plans are tested through community drills influence the capacity of community members and local authorities in responding to actual hazard events. The effective support of LGUs is particularly important in strengthening response capacities.

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