



**International
Standard**

ISO 22328-2

**Security and resilience —
Emergency management —**

Part 2:
**Guidelines for the implementation
of a community-based early
warning system for landslides**

Sécurité et résilience — Gestion des urgences —

*Partie 2: Lignes directrices pour la mise en oeuvre d'un système
d'alerte locale immédiat de glissement de terrain*

**First edition
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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO document should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 292, *Security and resilience*, Subcommittee SC 1, *Emergency management*.

This second edition cancels and replaces the first edition (ISO 22327:2018), which has been technically revised.

The main changes are as follows:

- this document has been aligned with the generic guidelines on EWS in ISO 22328-1, with the addition of specific information related to landslides. This document has also been aligned with ISO 22322 and ISO 22315.
- some terms have been removed from [Clause 3](#);
- the seven main sub-systems of landslide EWS have been revised to five main sub-system. The "Response capability" has been added as one of the main systems, and the previous three main sub-systems from the first edition have been merged into the "response capability" sub-system: (1) establishment of a disaster preparedness team; (2) development of an evacuation route and map; (3) development of standard operating procedures.
- [Annexes A](#) and [B](#) have been modified by adding ISO 22578:2022, Figures A.4 and A.6;
- [Annexes C](#) and [D](#) and the Bibliography have been updated.

A list of all parts in the ISO 22328 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Landslides are one of the commonly occurring natural hazards. Landslides can occur in different types of topographic and environmental settings. The occurrence of landslides can increase significantly due to uncontrolled land use development and human interference into slopes. In many countries, landslides cause substantial socio-economical losses and lead to environmental changes.

Landslide mitigation can be carried out both by structural and non-structural efforts. Structural mitigation includes adjustment of slope geometry, slope reinforcement, and protection and improvement of drainage systems, all of which involve a high cost. The alternative option of relocation is not practical for residents living in areas prone to landslides. As a result, non-structural mitigation can be effective in reducing disaster risk by improving the community's preparedness, for example, by implementing an early warning system (EWS).

This document complements the generic guidelines on EWS described in ISO 22328-1^[5] with specific information related to landslides. It is also complementary to the guidelines on public warning in ISO 22322^[4] as well as the guidelines on planning mass evacuations in ISO 22315.^[3]

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Security and resilience — Emergency management —

Part 2:

Guidelines for the implementation of a community-based early warning system for landslides

1 Scope

This document gives guidelines for the implementation of a community-based disaster early warning system (EWS) for landslides. It complements the generic guidelines in ISO 22328-1.^[5] It describes the methods and procedures, implementation methods and activities specifically related to landslides.

This document is applicable to communities vulnerable to landslides, without taking secondary/indirect effects into consideration.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 22300, *Security and resilience — Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 22300 and the following apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <https://www.electropedia.org/>

3.1

mass movement

displacement of materials such as soil, rock, mud, snow or a combination of matter down a slope under the influence of gravity

3.2

landslide

wide variety of processes that result in the slow movement downward and outward of slope-forming materials including rock, soil, artificial fill or a combination of these under the influence of gravity

4 Landslide early warning system

4.1 General

The community-based landslide EWS should be based on ISO 22328-1.^[5] It should involve community participation in the landslide risk reduction plan based on their understanding of landslide hazard, exposure, vulnerability and resilience.

4.2 Risk assessment

4.2.1 General

In addition to the guidelines on risk assessment in ISO 22328-1:2020, 4.2, [5] the following actions should be taken.

The community disaster preparedness teams should conduct a risk identification to understand the landslide hazard, exposure, vulnerability and resilience at a landslide-prone area. This includes identifying knowledge for developing a landslide risk reduction plan that includes:

- the identification of the environmental condition in vulnerable communities to classify the types of landslide according to References [7] to [9], and past, current and future ranges of landslide susceptibility as well as the potential triggers, hazards and the potential physical extent of landslides;
- an understanding of the indicators of ground movement (i.e. cracks and subsidence, appearance of water springs, fractures of structure and tilting poles and trees) to determine the past, current and future spatiotemporal landslide pattern and, based on that information, to propose the placement of landslide EWS instruments and an evacuation shelter;
- the past, current and future exposures and hazards as well as the vulnerability and resilience of assets, including people, related to landslides;
- assets enabling the affected community to move development away from the past, current and potentially-in-the-future affected landslide area and to restrict the establishment of new assets on the potentially prone area;
- land use and land reclamation relating to regulations by local government that have a significant impact on the intensity of landslide damage;
- the prioritization of investment in an EWS and evacuation infrastructure.

4.2.2 Understanding the landslide hazard

Proper understanding of the landslide susceptibility and hazard requires knowledge of the factors that initiate landslide occurrence (e.g. rainfall, earthquake, poor land management), landslide characteristics, and the likelihood and magnitude of landslide occurrence.

A landslide susceptibility and hazard map should be developed and updated by a community-preparedness team to identify the geographical and geological areas susceptible to landslide occurrence. This map is then developed into an evacuation plan (see examples in [Annexes A](#) and [B](#)). The landslide susceptibility or hazard map should:

- actively involve public participation in its development;
- address local knowledge;
- follow guidance from landslide experts (see [Annex D](#)).

4.2.3 Understanding the landslide vulnerability

A vulnerability and resilience assessment analyses the exposed assets, conditions and capacities the community at risk has to deal with related to the landslide susceptibility and hazard. It considers the physical, economic, institutional, social and cultural dimensions of community vulnerability.

The landslides and potential consequences should be documented and mapped for people or communities located in landslide-prone areas.

4.2.4 Development of landslide risk reduction plan

The vulnerability and resilience assessment should be linked to the higher-level landslide risk reduction plan (district, province, national), integrated with the results of the risk assessment, documented and accessible to interested parties, and updated as required following regular review.

In addition to the guidelines on developing the general risk reduction plan given in ISO 22328-1,^[5] the landslide risk reduction plan should consider the landslide triggering and controlling factors, slope inclination, movement mechanism, landslide-covered areas and elements at risk in landslide-prone areas.

4.3 Dissemination and communication of knowledge

In addition to the guidelines on dissemination and communication of knowledge given in ISO 22328-1:2020, 4.3,^[5] the community disaster preparedness team should take the following actions:

a) develop a public display of landslide information, which describes:

- 1) a landslide hazard map;
- 2) how to respond in the community;
- 3) information such as the landslide-prone area, historical data, current information and potential future changes;
- 4) the exposure of assets and their vulnerability and resilience towards landslides, an evacuation map and routes, shelters and assembly points;
- 5) a landslide response guide;

NOTE See the examples in [Annexes A](#) and [B](#).

b) develop and disseminate customized public education materials to meet local understanding, which describes:

- 1) the landslide susceptibility and hazard in the area;
- 2) understanding the landslide risk, landslide early warning, the exposed assets and their vulnerability and resilience, and evacuation;
- 3) location-specific landslide risks;

c) conduct public education, campaigns and/or advocacy, for example:

- 1) annual public outreach and educational activities;
- 2) national, state and regional campaigns using social media;
- 3) community landslide safety workshops, town hall meetings, or similar public meetings; and
- 4) door-to-door safety campaigns targeted at residents and businesses living or working in community's the landslide hazard zone.

The public education materials described in b) should be distributed appropriately, e.g. to schools within the community.

4.4 Monitoring and warning service

In addition to the guidelines on the monitoring and warning service given in ISO 22328-1:2020, 4.4,^[5] and ISO 22322,^[4] the following actions should be taken.

The monitoring system to support the landslide EWS should at least be able to:

- monitor triggers such as precipitation or earthquakes, to measure the trigger intensity within a certain period;
- measure surface movement including remote sensing information and surface deformation meters to identify the deformation on the land surface in a certain period and region;
- measure subsurface changes including the general structure of the mass, the variable parameters such as soil moisture and pressure, and the water table to identify the changes of inherent patterns which determine the slope stability in a certain period.

See [Annex C](#) for additional tools that can be used to improve the system accuracy.

Data from the monitoring system should be transferred to the community preparedness team to be processed to produce early warning messages in different formats.

The dissemination and communication system for a landslide warning should be integrated between the national authority, the community preparedness teams and the community at risk.

The community preparedness team should have the capacity and capability to receive landslide warning messages from the local and national authority and to disseminate the message to the community at risk.

4.5 Response capability

In addition to the guidelines on response capability given in ISO 22328-1:2020, 4.5,^[5] the following actions should be taken:

- a) assigning tasks to the community disaster preparedness team, including:
 - 1) receiving warning information from the data monitoring control centre in the field;
 - 2) disseminating information, guidance and warning to communities;
 - 3) leading the evacuation;
- b) determining the evacuation shelters, which should fulfil the following criteria:
 - 1) be located in a safe area;
 - 2) can accommodate a large number of people to take shelter in a short amount of time;
 - 3) provide a communication channel to disseminate the needs of sheltered people, but also to provide updated information on the current hazard and risk situation to the sheltered people;
- c) developing a landslide evacuation map and routes, which should:
 - 1) be based on the available landslide susceptibility and hazard information, and also consider the geological and geomorphological risk assessment;
 - 2) involve the community in the preparation phase to incorporate local knowledge concerning accessibility and difficulties to reach or to take a certain path.
- d) developing a standard operating procedure (SOP) containing evacuation decisions related to the landslide alert in accordance with ISO 22328-1,^[5] which should:
 - 1) explain the who, what and how of the landslide warning chain from the authority to the community;
 - 2) announce the level of the landslide warning;
 - 3) be confirmed by local governments as the official reference for all those involved in landslide early warning.

[Annex B](#) gives an example of an evacuation map and route, including the symbols used.

[Annex C](#) gives an example of a framework for disseminating warnings and evacuation commands for landslide EWS.

[Annex D](#) gives an example of an evacuation SOP for each landslide alert level.

4.6 Commitment of the authority and the community at risk to the sustainability of the landslide early warning system

In addition to the guidelines given in ISO 22328-1,^[5] in order to maintain the sustainability of the landslide EWS, as well as to support the disaster preparedness team, there should be a commitment between the authority and the community.

For the sustainability of EWS, the authority and the community should conduct a joint complete assessment, including the historical data, the current situation and potential future development paths, in order to evaluate the situation reliably and to improve a given or potential landslide risk which involves all levels (landowners, community, local authority, national authority).

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Annex A (informative)

Example of a public display of landslide evacuation plan sign

Figure A.1 shows an example of a public display of a landslide evacuation plan sign.



NOTE This public display is an example and can be adjusted or improved.

SOURCE ISO 22578:2022, Figure A.6,^[6] with modification — the landscape has been changed and the sign replaced with ISO 22578:2022, Figure A.4.

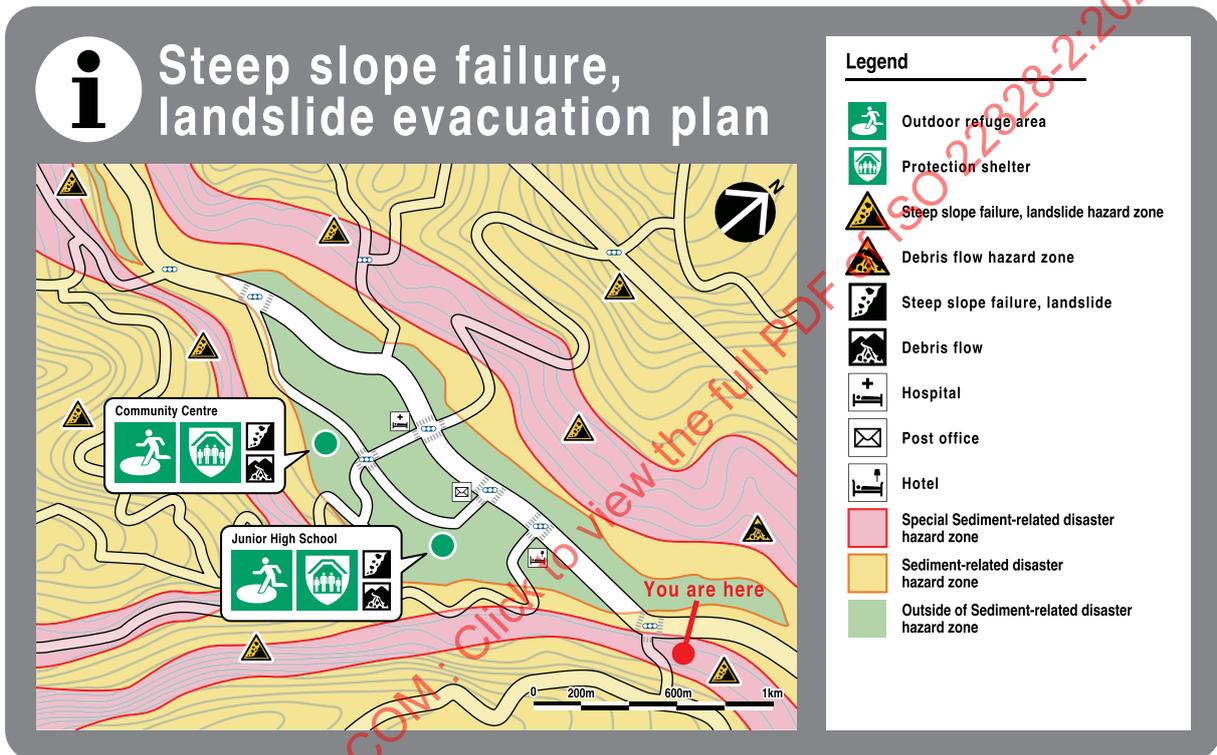
Figure A.1 — Example of a public display of a landslide evacuation plan sign

Annex B (informative)

Example of an evacuation plan sign

Figure B.1 shows an example of an evacuation plan sign. It is not necessary for the evacuation map to include the scale but only to indicate the north direction, which can be placed in the legend. The north direction does not necessarily face up, depending on the local customs.

When setting up an evacuation route, the appropriate symbols from ISO 7001^[1] and ISO 7010^[2] should be used.



NOTE This map is an example and can be adjusted or improved.

SOURCE ISO 22578:2022, Figure A.4.^[6]

Figure B.1 — Example of an evacuation plan sign

Annex C
(informative)

Example of a framework of landslide warning and evacuation command

Figure C.1 shows an example framework of how landslide warnings and evacuation commands are disseminated in an EWS.

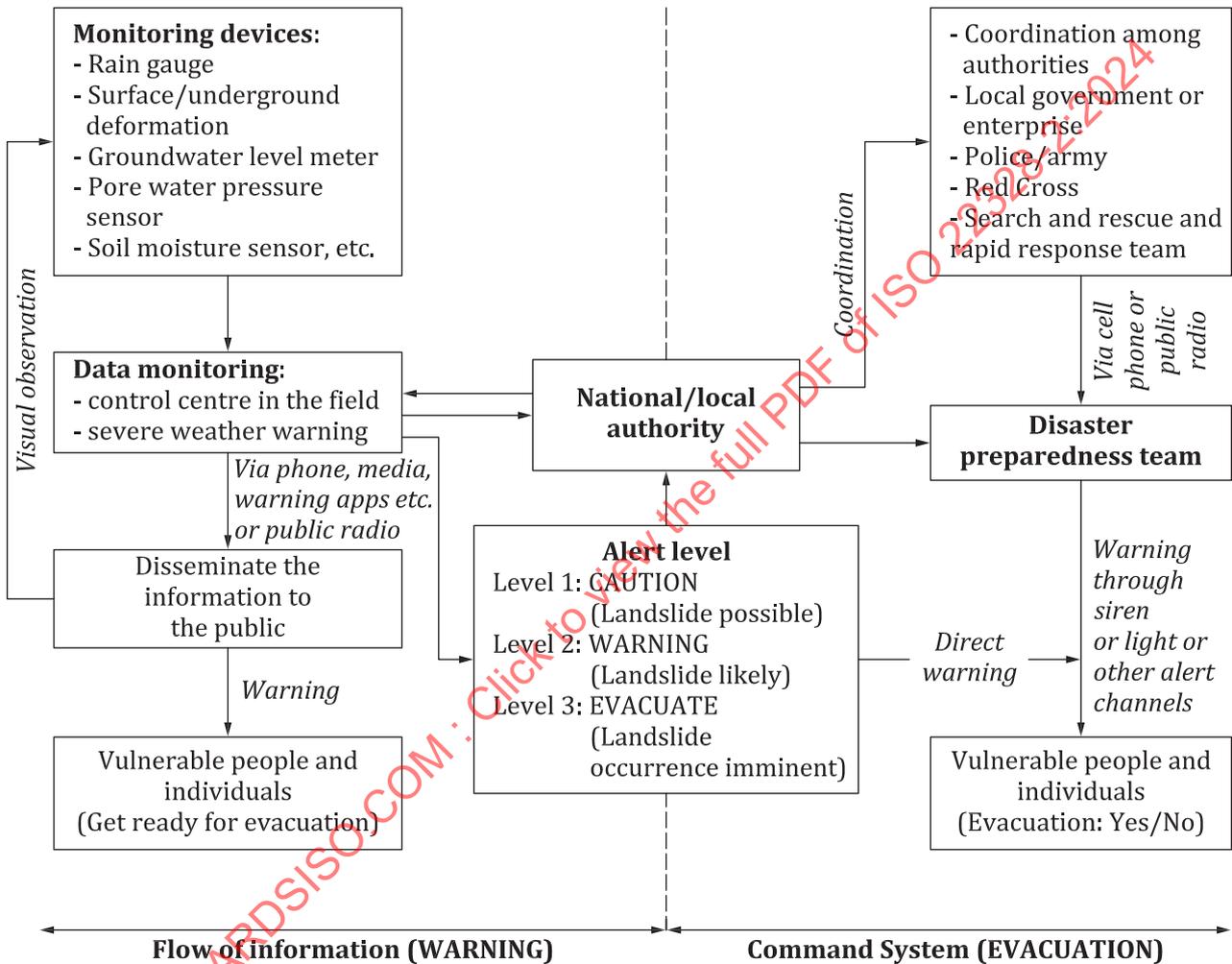


Figure C.1 — Example of a framework of landslide warning and evacuation command

Additional tools can be used to improve the accuracy of the EWS, such as:

- underground deformation meters to measure the deformation underground through the movement of the sliding plane within a certain period of time;
- groundwater level meters to measure changes in groundwater level in the landslide zones, mounted inside the borehole;
- pore water pressure sensors to measure changes in pore water pressure on the landslide mass, installed in the borehole;
- soil moisture sensors to measure the changes of water level in the landslide mass;

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- devices to monitor surface displacements, including terrestrial, aerial and/or satellite remote sensing survey, as well as stakes to monitor mass movement in a horizontal and vertical direction of motion.

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Annex D
(informative)

Example of an evacuation standard operating procedure

[Table D.1](#) shows an example of a standard operating procedure for each landslide alert level.

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Table D.1 — Example of an evacuation standard operating procedure

Alert level	Criteria and sign	Action by the preparedness team	Action by individuals	Action by the local authority
Level 1: CAUTION	<p>Criteria: Determined by rainfall measurement</p> <p>Sign: “yellow” light and/or siren that sounds “caution, high rainfall” or other sound signs show the lowest alert level or depending on the local conditions</p>	<p>— The team leader assembles the disaster preparedness team and provides the instructions</p> <p>— The data and information division checks the condition of the monitoring devices and collects data from the community, informs the alert level and encourages preparing essential items to bring</p> <p>— The disaster preparedness team provides periodic reports to the team leader and local authority</p>	<p>— Be aware and prepared</p> <p>— Prepare personal belongings and an evacuation kit</p> <p>— Follow the instructions of the disaster preparedness team</p>	<p>— Receives report from the disaster preparedness team</p> <p>— Checks the conditions in the field and maintains coordination with the disaster preparedness team</p>