

EXPLORING RISK TOLERANCE UNDER UNCERTAINTY

GRINDAVÍK

Workshop on a Participatory
Risk-Tolerance Methodology
for Recovery Decisions
in Grindavík, Iceland

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This report is a knowledge product of the staff of The World Bank, Europe and Central Asia Disaster Risk Management (ECA DRM), and the Global Facility for Disaster Reduction and Recovery (GFDRR), with external contributions. It documents the design, conduct, and outputs of a participatory risk-tolerance workshop held on 18–19 June 2026, together with supporting analysis. The findings, interpretations, and conclusions expressed here do not necessarily reflect the views of the World Bank, its Board of Executive Directors, GFDRR donors, or the governments they represent.

This report is advisory in nature. It presents a recommended methodology for defining acceptable risk and developing an operational framework for risk-informed decision-making. It is intended to support discussion, planning, prioritization, and decision-making, but does not replace, renew, update, or supersede any existing official risk assessment, hazard assessment, legal determination, government mandate, regulation, or formal decision-making authority. Any use of the risk-acceptance thresholds or values in operational, regulatory, policy, or investment decisions remains the responsibility of the competent authorities and should be considered alongside applicable laws, official assessments, expert judgment, stakeholder consultation, and local decision-making processes.

The threshold ranges and indicator values reported here are illustrative outputs of a participatory exercise. They are not official standards and should not be read as such. Any formal adoption of criteria, thresholds, or measures is a decision for the responsible Icelandic authorities, informed by the comprehensive risk assessment now under way.

International cases are cited to illustrate transferable methods and lessons. They do not imply that thresholds, tolerability standards, or legal arrangements from other countries can be transferred directly to Iceland.

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A NOTE ON TERMINOLOGY

Discussions about living with volcanic risk use several closely related terms that are easy to confuse. This report uses them consistently, as follows.

Hazard assessment Scientific characterization of the volcanic hazards, their likelihood, intensity, spatial extent and possible scenarios. Led by the Icelandic Meteorological Office (IMO).

Comprehensive Risk assessment The structured authority-led process that integrates hazard assessment with exposure, vulnerability, existing protective measures, stakeholder-defined risk acceptance criteria, and other quantitative and qualitative evidence to evaluate risk and support decisions.

Risk tolerance The extent to which people and institutions are willing to live with a given level of risk in exchange for other benefits, under stated conditions.

Risk acceptance A decision made by an individual, community, or authority, to proceed despite a known level of risk, usually subject to conditions and safeguards.

Risk acceptance criteria The stakeholder-defined criteria against which the assessed risk is evaluated. They describe what is acceptable, conditionally acceptable and unacceptable.

Risk tolerance methodology The participatory methodology described in this report for developing provisional risk acceptance criteria.

Thresholds Specific values or ranges on an indicator that mark the boundary between acceptable, conditionally acceptable, and unacceptable situations. Those in this report are illustrative, participatory outputs.

Risk-informed decision-making Authority-led decisions that draw on the risk assessment and agreed criteria, rather than on hazard science alone.



EXECUTIVE SUMMARY

Grindavík is not facing a simple choice between “safe” and “unsafe.” It is deciding, under prolonged and shifting volcanic uncertainty, under what conditions people may live, work, stay temporarily, receive services and operate businesses, and what safeguards must be in place for those activities to remain tolerable.

WHY THIS WORK IS NEEDED

Since the volcanic and seismic activity that forced the evacuation of Grindavík in November 2023, the hazard baseline has changed and may remain elevated for years. The timing, location and consequences of future events cannot be forecast with the precision needed to settle every recovery decision. At the same time, monitoring, barriers, access controls, warning arrangements and emergency-response capacity have altered the practical risk. Recovery decisions must therefore be made while both the hazard and the effectiveness of safeguards continue to evolve.

This exposes a specific and under-recognized gap in disaster-risk governance. Many jurisdictions can map hazards, model life-safety consequences and impose emergency restrictions. Some also use quantitative tolerability concepts, including individual-risk thresholds or approaches based on the principle that risk should be reduced as low as reasonably practicable. Far fewer provide a structured method for deciding whether and under what conditions people may reside, stay overnight, attend school, maintain municipal services or continue business activity in a place exposed to prolonged, shifting volcanic risk.

Both Iceland and Europe provide important elements of this decision framework, but neither provides a complete answer. Iceland has a well-established regulatory precedent for acceptable natural-hazard risk through Regulation No. 505/2000, which defines differentiated life-safety criteria for avalanches and landslides according to occupancy and building use. At the European level, legislation and policy; including the Union Civil Protection Mechanism, the Floods Directive, Strategic Environmental Assessment, Environmental Impact Assessment and the Critical Entities Resilience framework, require risk assessment, preparedness, spatial planning and infrastructure resilience. Together these frameworks provide a strong foundation for managing natural hazards.

THE RISK TOLERANCE GAP

Neither Icelandic regulation nor European policy provides a structured methodology for determining under what conditions different activities remain tolerable during prolonged volcanic uncertainty, where scientific uncertainty persists, conditions evolve over time, and decisions cannot be reduced to a single annual probability of fatality.

Long-duration volcanic crises require authorities to consider not only life safety, but also evacuation capability, repeated displacement, continuity of municipal services, protection of vulnerable populations, psychosocial impacts, infrastructure

functionality, economic continuity, governance capacity, public trust and the cumulative consequences of living with uncertainty. Icelandic disaster research further demonstrates that disasters leave long-term psychosocial, health and community impacts that extend well beyond immediate mortality and physical damage. These dimensions are central to legitimate recovery decisions, yet they are rarely integrated into formal risk-tolerance frameworks.

THE WORLD BANK / GFDRR INITIATIVE

Against this background, the World Bank and the Global Facility for Disaster Reduction and Recovery (GFDRR), at the request of the Icelandic authorities, convened a participatory Risk-Tolerance Workshop on 18–19 June 2026 as part of the wider Grindavík recovery program. The workshop builds directly on the resilient recovery principles developed through the earlier World Bank/GFDRR Technical Advisory (TAFF) and is intended to inform the comprehensive risk assessment and recovery planning now being led by the Icelandic authorities.

The purpose was not to determine whether Grindavík is “safe” or “unsafe”, nor to replace scientific risk assessment, regulation or governmental decision-making. Rather, it sought to develop a transparent participatory methodology for defining the societal risk-tolerance criteria against which the results of the comprehensive risk assessments can subsequently be evaluated.

WHAT THIS REPORT AND METHODOLOGY CONTRIBUTES

This report presents an integrative methodology that bridges the longstanding gap between scientific risk assessment and societal decision-making. Rather than proposing an entirely new theory of acceptable risk, it synthesizes established concepts from acceptable-risk and ALARP thinking, participatory risk governance, adaptive management and multi-criteria decision analysis into a practical framework for prolonged volcanic crises.

The methodology distinguishes between acceptable, conditionally acceptable and unacceptable conditions; identifies non-negotiable safeguards; defines the mitigation measures required for conditional occupation; and provides a structured process through which scientific evidence, stakeholder-defined risk acceptance criteria, and governance considerations can be integrated into transparent, activity-specific decisions. In doing so, it fills the missing governance layer between hazard assessment and authority-led decisions.

The methodology presented in this report should therefore be understood as an integrative decision method rather than only as the output of a workshop. Its originality lies not in inventing acceptable-risk thinking, but it synthesizes established concepts from acceptable-risk and ALARP thinking, participatory risk governance, adaptive management and multi-criteria decision analysis into a practical framework for prolonged volcanic uncertainty:

- **Tolerability logic** that distinguishes acceptable, conditionally acceptable and unacceptable conditions.
- **Multi-criteria categorization** capable of combining quantitative and qualitative evidence without forcing all consequences into one metric.
- **Participatory risk governance** that makes explicit whose exposure matters, which consequences count, where disagreement exists and which safeguards must be in place before an activity can be justified.
- **Adaptive management** that allows thresholds, evidence and decisions to be reviewed as hazards, infrastructure, services and community circumstances change.

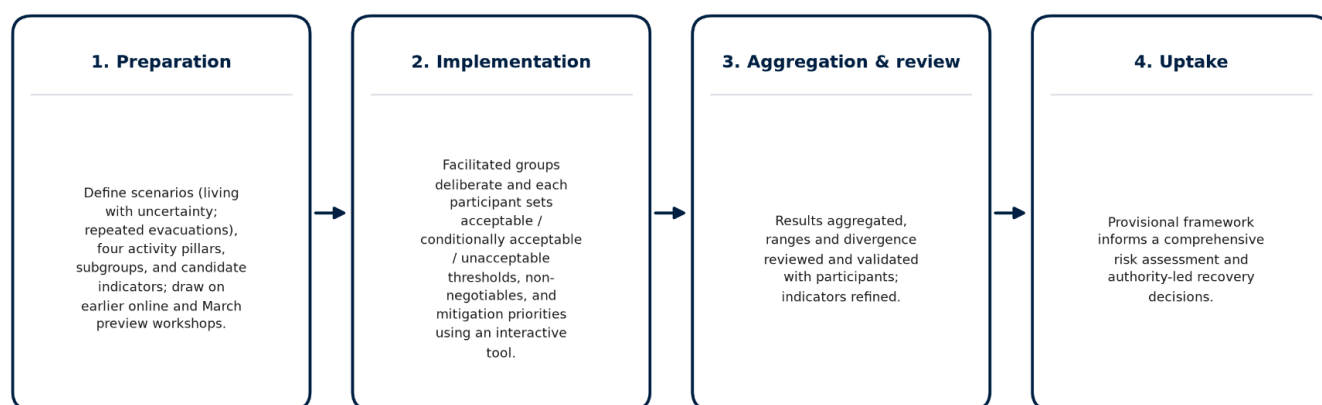
This combination fills the missing governance layer between comprehensive risk assessment and authority-led decisions. The participatory process defines the criteria against which risk will be judged; the comprehensive risk assessment then measures or models actual conditions; and the responsible

authorities decide whether activities may continue, continue conditionally, be restricted, or stop. Participation does not replace science or formal authority. It makes the value judgements that inevitably sit behind such decisions more transparent, structured and accountable.

THE WORKSHOP AND THE METHOD

The method separated four activity areas because permanent residence, temporary stay, municipal services and business operations create different exposure, vulnerability, benefits, safeguards and responsibilities. Participants considered two operating scenarios: prolonged uncertainty and repeated evacuations. For each activity area, they reviewed decision-relevant indicators, identified the boundaries between acceptable, conditionally acceptable, and unacceptable conditions, defined non-negotiables, and prioritized the mitigation measures that could make conditional activity tolerable.

The approach proceeded through preparation, facilitated deliberation, individual threshold setting, aggregation, review and validation, and connection to later a comprehensive risk assessment. Disagreement was not treated as noise to be averaged away. Variation was retained as evidence of different assumptions, values, definitions or information needs.



A participatory method — well suited to decisions under uncertainty; makes values, priorities and trade-offs explicit to inform technical assessment and authority decisions.

The participatory risk-tolerance methodology, from preparation to uptake.

MAIN FINDINGS (GRINDAVÍK / ICELAND-SPECIFIC)

The findings below are technical outputs specific to Grindavík and Iceland. They are provisional and intended to inform authorities at national and local level and their technical advisers.

- **A shared baseline of conditions:** Participants identified a common set of non-negotiable safety and governance conditions across all four activity areas: reliable warnings and communication, evacuation capability, emergency-response readiness, and effective control of unsafe areas.
- **Conditional, not binary:** Risk tolerance was generally understood as conditional rather than simply acceptable or unacceptable. For most indicators, participants identified a middle range in which activity could continue only if specified mitigation measures were in place and functioning.
- **Different activities, different criteria:** Tolerance differed markedly by activity. Residency placed greatest emphasis on housing, utilities, warnings, and evacuation; Temporary Stay on information and time to act; Municipal Services on governance and emergency response; and Business Operations on predictability and infrastructure.
- **Trust is part of the risk:** Clear, trusted, and accessible communication was treated as a core condition of tolerability. Participants emphasized one reliable source of information, regular updates, multilingual communication, and transparent explanations of closure, access, reopening, and recovery decisions.
- **Mitigation unlocks tolerance:** Conditional acceptance depended on concrete measures such as warning systems, evacuation exercises, backup power, rapid repairs, predictable rules, support for vulnerable residents, school and care continuity, and clear reopening arrangements.
- **Non-negotiables are operational:** The strongest limits were practical conditions that can be checked: active ambulance and fire services, usable evacuation routes, functioning utilities and communications, informed residents, continuity of essential services, and clear protection for vulnerable groups.
- **Community continuity matters:** Participants stressed that viable residence depends not only on housing and physical safety, but also on sports, community activity, social belonging, family support, and psychosocial wellbeing. These should be reflected more clearly in the indicator framework.

- **Variation is itself a finding:** Thresholds changed with the scenario, season, population, service affected, and frequency of disruption. Differences between participants should not be averaged away, as they reveal where definitions, evidence, or authority-led deliberation are still needed.

POLICY TAKEAWAY (FOR ICELANDIC DECISION MAKERS)

1.Anchor decisions in a comprehensive risk assessment process. The participatory risk acceptance criteria are inputs, not substitutes. The workshop's purpose was to provide a methodology and risk-tolerance criteria to feed a comprehensive risk assessment. The risk assessment itself, then determines whether conditions meet those criteria. The workshop findings should therefore support, not replace, a comprehensive risk assessment process led by the responsible authorities.

2.Sequence action around the shared safeguards first. The workshop's clearest cross-cutting finding is that a small set of conditions recurred as top-ranked and non-negotiable across all four activity areas: reliable warnings and communication, evacuation capability, and emergency-response capacity (fire, ambulance, police). Because these safeguards underpin residency, temporary stay, municipal services, and business operations alike, securing them is what unlocks activity across the board. They offer a natural first tier for prioritizing mitigation and for structuring risk-informed decisions, ahead of activity-specific measures.

3.Follow the staged “step-in, step-up” pathway. Because some decisions cannot wait for a full assessment, two complementary phases should proceed in parallel (Section 6.3). Step-in (Phase 1) focuses on urgent schooling and housing decisions, using the priority indicators, workshop thresholds, measures and non-negotiables already identified. Step-up (Phase 2) develops the comprehensive assessment across all areas, confirms thresholds and produces the full risk matrix under national and local authority ownership. Shared indicators—such as warnings, evacuation readiness, emergency response and trust—should use consistent thresholds across both phases.

4.Build local capacity. Applying and interpreting the framework requires dedicated capability. This requires professional expertise and experience in risk-management processes within the proposed steering arrangement, to carry both the comprehensive assessment and the near-term risk-informed decisions. Building this capacity in the municipality and community is what allows the framework to be used, updated, and trusted over time.

5. Develop the wider volcanic-risk framework. The workshop provides provisional operational criteria for Grindavík; it is not a substitute for national standards. As a long-term objective, building on Iceland's avalanche-risk precedent, the responsible authorities should pursue a multi-tiered framework that combines probabilistic volcanic-risk metrics, a societal tolerability principle such as ALARP, activity-specific operational thresholds and clear "if-then" rules linking assessed conditions to zoning, occupancy, closure, evacuation and reopening decisions.

WIDER SIGNIFICANCE

International experience shows that parts of this approach already exist: conditional reoccupation under monitored residual hazard, zoned access, long-term service adaptation, hazard-based land-use decisions and community-led recovery planning. What is less common is their integration into one transparent, activity-specific method for deciding conditional civic occupation under prolonged uncertainty.

The strongest contribution of the Grindavík methodology is therefore not a new universal threshold. It is a practical bridge between comprehensive risk assessment, societal tolerability and authority-led decision-making. It makes visible what is otherwise often left implicit: whose risk is being considered, which consequences matter, what conditions cannot fail, which measures can make residual risk tolerable and where disagreement reflects values rather than missing science.

For other communities exposed to volcanic, seismic, flood, wildfire, coastal or other long-duration hazards, the transferable value lies in the process rather than in the specific numerical thresholds. The method offers a way to move beyond the unhelpful question of whether a place is simply safe or unsafe and toward a more transparent and accountable question: under what conditions can people, institutions and authorities justify living and operating with residual risk?

HOW TO READ THIS REPORT

- Chapter 1 sets out the context, the initiative behind the work, and its objectives.
- Chapter 2 describes the methodology, from preparation to implementation.
- Chapters 3 and 4 present the results by activity area and the cross-cutting findings.
- Chapter 5 connects risk tolerance to risk assessment.
- Chapter 6 sets out how the findings inform recovery decisions.
- Annexes document participation, the wider workshop series, the interactive platform, and the methodological basis.

Scope note:

The threshold ranges and indicator values in this report are illustrative outputs of a structured participatory exercise. Any formal adoption, legal application or operational use remains the responsibility of the competent Icelandic authorities and should be informed by the comprehensive risk assessment, applicable law, expert judgement and continuing stakeholder consultation.



Source: Sigurður Ólafur Sigurðsson

1. CONTEXT AND OBJECTIVES

Grindavík is not facing a one-time choice between “safe” and “unsafe.” It is deciding under what conditions people can live, work, visit, and provide essential services in a town where the hazard has changed, the future remains uncertain, and the costs of both action and delay are substantial.

1.1 A TOWN LIVING WITH A SHIFTING HAZARD

Grindavík is a fishing town on the Reykjanes peninsula in south-west Iceland. In November 2023, intense seismic activity and magma movement beneath the town forced the evacuation of roughly 3,700 residents. The events were not confined to a single eruption or a clearly bounded recovery period. Ground deformation, fault movement and fissures affected parts of the town directly, while subsequent volcanic and seismic activity created continuing concerns about lava flows, volcanic gas, ground cracking, subsidence, damaged buildings and buried infrastructure.

The most difficult feature of the crisis is its duration. The hazard baseline has shifted, but the timing, location and consequences of future events cannot be forecast with the precision needed to settle every recovery decision. Grindavík is therefore dealing with what has been described in Icelandic discussions as ambiguous risk (*óræð áhætta*): the hazard is real and monitored, but its future course cannot be reduced to a single probability or end date. Long-term uncertainty is no longer simply a temporary disruption. It has become a condition shaping housing, schooling, municipal services, business operations, investment and family decisions.

At the same time, extensive protective and preparedness measures have changed the practical risk. Fissures and damaged areas have been mapped and controlled, major routes repaired, protective barriers constructed, warning and evacuation arrangements strengthened, and emergency responders have accumulated substantial experience. Several evacuations have been completed successfully. The issue is therefore not whether risk exists, but how hazard, exposure, vulnerability and the effectiveness of safeguards should be considered together, and how those conditions should be kept under review as the situation changes.

1.2 THE PRESSURES PULLING RECOVERY IN DIFFERENT DIRECTIONS

There is a strong desire to restore homes, livelihoods and community life. Residents and businesses have demonstrated remarkable resilience and place attachment. Many companies have continued operating despite higher transport, staffing and infrastructure costs. Community organizations have kept sports, cultural events and social activities alive, not merely as symbols of recovery but as practical support for mental health, belonging and social continuity. For those who want to return, prolonged restrictions and short-term arrangements can feel like an additional, human-made layer of uncertainty on top of the volcanic threat.

There is also a strong case for caution. Not all former residents are ready to return, and those who prefer to wait or have begun rebuilding their lives elsewhere are less visible in public debate. Children and families have experienced displacement differently. Some may benefit from returning to familiar networks; others may face renewed stress, very small school cohorts, limited peer groups or complex support needs. Older people, people with disabilities, households receiving social or health support, foreign-language speakers and others who may need assistance cannot be treated as if they face the same choices or have the same capacity to respond.

Institutions face their own constraints in the face of ongoing uncertainties. Municipal services must continue even when staffing, funding and mandates are uncertain. Fire, ambulance, policing, utilities and social services are part of what makes residence and economic activity tolerable, yet some of the arrangements supporting them are temporary or depend on unresolved cost-sharing. Businesses can often manage a short interruption, but find it much harder to plan when closure, access, insurance, financing and reopening rules are unpredictable. The municipality must consider its legal duties and financial capacity, while national authorities must balance public safety, fairness, expenditure and responsibility for decisions whose consequences cannot be known with certainty.

Trust runs through all these pressures. The risk assessment is expected to support decisions, but it is also viewed by some as a possible cause of delay. Different institutions sometimes communicate hazard, risk, restrictions and protective measures in different ways. When people cannot see how a conclusion was reached, which measures were considered, who has authority to decide, or who will pay for required safeguards, technical uncertainty can become institutional and social uncertainty. A credible process must therefore be transparent about both evidence and judgement.

A social-science view of the return decision

A social analysis carried out by the World Bank-GFDRR Team to stakeholders during the June 18 workshop added an important perspective. The analysis drew on a large-scale survey of 1,470 displaced Grindavík residents, conducted by Maskína between December 2025 and January 2026, approximately two and a half years after the November 2023 evacuation, and was supplemented by Icelandic national population register data tracking demographic changes between November 2023 and November 2025. It showed that return is not governed by one common calculation. Nearly 60 percent of respondents said return was unlikely, 17 percent were undecided, 14 percent intended to return, and a further 9 percent had already returned at the time of the survey. Among those intending to return, the dominant pull was affective: almost three-quarters cited simply wanting to live in Grindavík. Among those not intending to return, the dominant barrier was cognitive: 63 percent cited uncertainty about when eruptions would end.

The analysis framed this as place attachment pulling people home and threat appraisal holding them back, with housing and employment acting as structural anchors. It also identified a displacement paradox: those who had adapted best elsewhere were least inclined to return, while those struggling most and retaining the strongest ties to Grindavík were the most motivated to go back. This matters for risk tolerance. People do not enter the decision from equal positions, and willingness to return is not necessarily evidence of lower vulnerability. A returning population may include people with particularly strong attachment and elevated support needs, while those who choose not to return also require fair and sustained support. The analysis informed stakeholder deliberation but is not presented here as a separately published study.

1.3 ICELANDIC PRECEDENT AND RISK TOLERANCE FRAMEWORK

Iceland already has experience of translating acceptable natural-hazard risk into regulation. Regulation No. 505/2000, concerning avalanche and landslide hazard assessment and the classification and use of hazard areas, uses annual individual fatality risk as a central reference point. It does not apply one identical value to every use. The acceptable local risk is set more strictly for residential buildings, schools, children's homes, hospitals,

community halls and similar uses than for regular commercial workplaces, and more flexibly for holiday homes. The regulation explicitly reflects assumed occupancy and allows exposure to be assessed differently where the presence of people differs from those assumptions. It also permits stricter safety requirements where many people are expected or workplaces are crowded.

This precedent is important for Grindavík for two reasons. First, it establishes in Icelandic practice that acceptable risk is not purely a scientific output. It is a policy and regulatory judgement that connects a risk metric to occupancy, activity and the characteristics of those exposed. Second, it shows why a single town-wide label of "safe" or "unsafe" is insufficient. A school, a permanently occupied home, a daytime workplace, a short, supervised visit and a critical-infrastructure operation do not create the same exposure or demand the same level of protection.

But the avalanche framework cannot simply be transferred to Grindavík. No equivalent national standard currently exists for volcanic hazards, and a single annual fatality metric does not capture the specific decision problem created by prolonged volcanic unrest. Grindavík must also consider warning and evacuation performance, repeated displacement, infrastructure and service continuity, vulnerable groups, psychosocial effects, business interruption, governance, trust and the cumulative burden of uncertainty. The gap is therefore not a lack of hazard science. It is the absence of an agreed framework for judging what assessed volcanic risk means for different activities and what safeguards must accompany conditional use.

1.4 EU REGULATORY CONTEXT

The European Union provides an important regulatory framework for disaster-risk governance; although it approaches the issue from the perspective of risk assessment, preparedness and resilience, rather than defining acceptable levels of residual risk. Under the Union Civil Protection Mechanism, Member States are required to undertake national disaster-risk assessments, strengthen prevention and preparedness, and periodically assess disaster-risk-management capabilities. Complementary legislation, including the Floods Directive, the Strategic Environmental Assessment (SEA) Directive, the Environmental Impact Assessment (EIA) Directive, and the Critical Entities Resilience (CER) Directive; establishes requirements for hazard assessment, spatial planning, environmental assessment, stakeholder participation, and the continuity of essential services and infrastructure (European Parliament and Council, 2013; 2007; 2001; 2011; 2022).

This framework is important for Grindavík because it recognizes that effective disaster-risk management extends beyond hazard assessment to encompass institutional resilience, preparedness, infrastructure continuity and public safety. However, while EU legislation requires Member States to assess and manage disaster risks, it deliberately leaves decisions on acceptable levels of residual risk to national authorities. Consequently, the European framework does not prescribe under what conditions communities may continue to reside, operate businesses or maintain essential services under prolonged volcanic uncertainty.

For Grindavík, the European framework therefore provides an essential procedural and institutional foundation but not a methodology for determining tolerable occupation. Bridging this gap requires a framework that combines a comprehensive risk assessment with wider societal considerations; including evacuation capability, infrastructure and service continuity, vulnerable populations, governance capacity, public trust and the cumulative impacts of repeated disruption, within a transparent decision-making process

Why this work is needed

The earlier resilient-recovery advisory recommended a multi-tiered approach: long-term national standards for volcanic risk, potentially combining a general societal tolerability principle such as the ALARP with probabilistic hazard-specific metrics, and shorter-term operational thresholds for Grindavík developed through participatory processes. This workshop addresses the second need. It provides a method for defining provisional, activity-specific criteria now, while longer-term technical, legal and policy standards are developed through the responsible national processes. The report also shows where the participatory methodology on risk tolerance can be integrated as part of the ISO 31000 risk management process (see Chapter 2).

1.5 PURPOSE AND OBJECTIVES OF THE WORK

The recovery of Grindavík is led by the Icelandic authorities. The World Bank and GFDRR were asked to support one specific part of that effort: developing a participatory method for defining the criteria against which risk can be judged. The work builds on the earlier resilient-recovery advisory, which identified the absence of a volcanic acceptable-risk framework as a policy and regulatory gap and recommended both long-term national standards and short-term, activity-specific criteria for Grindavík.

The workshop did not seek a single community verdict on whether Grindavík should be occupied, nor did it attempt to replace hazard science, complete the comprehensive risk assessment, establish legally binding standards or make decisions on behalf of the responsible authorities. Its purpose was to make the value judgements that inevitably sit behind such decisions more explicit, structured and usable.

The work draws on six preparatory online workshops, a March preview exercise, the social analysis presented to stakeholders, the experience of residents, businesses, service providers and public authorities, and the June workshop itself. The preparatory sessions are described in Annex B. These inputs informed the scenarios, activity areas and candidate indicators tested in the workshop.

Objective	What it means in practice
Understand the decision context	Identify the groups, activities, vulnerabilities, institutional duties and practical constraints that shape tolerance of risk.
Define risk-acceptance criteria	Translate broad concerns into indicators and provisional ranges describing acceptable, conditionally acceptable and unacceptable conditions.
Identify the floor and the levers	Distinguish non-negotiable safeguards that must always hold from mitigation measures that can keep otherwise difficult conditions tolerable.
Connect participation to comprehensive risk assessment	Provide criteria that can be tested against monitored, modelled and observed conditions in the comprehensive risk assessment.
Support transparent, revisable decisions	Help authorities explain how decisions are reached and revisit them as hazards, protective measures, services and community circumstances change.
Contribute to longer-term framework development	Demonstrate a practical approach that can inform, but does not pre-empt, future national work on volcanic-risk criteria and standards.

1.6 HOW THE WORK INFORMS DECISIONS

The workshop forms one part of a wider risk-management process. Hazard assessment establishes what could happen, while risk assessment considers hazard together with exposure, vulnerability and the effectiveness of protective measures. Participatory risk acceptance criteria then define which conditions are considered acceptable, conditionally acceptable or unacceptable. The responsible authorities use these criteria alongside law, expert judgement, available resources and wider public responsibilities to support decisions.

This is an iterative process rather than a one-off verdict. As hazards, infrastructure, services, population patterns and available evidence change, both the assessment and the criteria may need to be reviewed. This is especially important in Grindavík, where risk includes not only future volcanic events but also the cumulative effects of prolonged uncertainty on daily life, public services and long-term planning.

The workshop produced a provisional framework of indicators, threshold ranges, non-negotiable conditions and mitigation priorities. Its value lies in making community experience, professional judgement and technical evidence more visible and structured, thereby supporting recovery decisions that are more explicit, consistent and accountable.

While no directly comparable methodology has been applied elsewhere, several international experiences informed the development of the approach used for Grindavík. Miyakejima (Japan) demonstrated the use of conditional reoccupation linked to changing volcanic conditions, Montserrat developed zoned governance and adaptive service provision under

prolonged volcanic risk, and Indonesia's Rekompak programme incorporated participatory processes into post-disaster recovery and resettlement. The Grindavík methodology integrates lessons from these and other experiences into a single participatory framework for developing provisional risk acceptance criteria alongside comprehensive risk assessment and formal decision-making. These examples, documented in Annex E, informed the methodology but not the specific thresholds, which remain context dependent.

Scope and limitations

The workshop did not establish legally binding thresholds, determine whether Grindavík is safe or unsafe, complete a comprehensive risk assessment, or make decisions on behalf of the responsible authorities. It tested a participatory methodology and generated preliminary criteria for further using in a comprehensive risk assessment, validation and authority-led consideration. Accordingly, the thresholds and classifications presented in this report should be understood as workshop-derived inputs rather than official standards, regulatory limits or formal determinations of acceptable risk.



Source: Sigurður Ólafur Sigurðsson

2. METHODOLOGY

This chapter describes the methodology underpinning the Grindavík Risk Tolerance Workshop and explains how participants identified risk-tolerance thresholds, non-negotiable conditions and mitigation measures, and how these outputs can inform a wider risk assessment and recovery process.

The methodology is designed to be transparent, reproducible and transferable, allowing readers who did not participate in the workshop to understand both the rationale and the process, and to adapt the approach to other hazards and recovery contexts. The framework is best understood as a participatory tolerability-and-sorting approach that combines three established approaches: tolerability-of-risk thinking (including ALARP), multi-criteria decision analysis (MCDA) and classification, and participatory disaster-risk governance.

Its contribution is not to introduce a new theory of acceptable risk, but to integrate these complementary approaches into a practical framework for prolonged volcanic uncertainty, where decisions depend not only on quantitative assessments of risk to life (i.e. casualty modelling) but also on evacuation capability, infrastructure continuity, psychosocial sustainability, governance and public trust. The methodology therefore provides a structured basis for distinguishing between acceptable, conditionally acceptable and unacceptable conditions without relying on a single universal risk threshold.

The methodology separates two related tasks.

First, the participatory process defines the risk acceptance criteria; that is, the conditions under which an activity is considered acceptable, conditionally acceptable, or unacceptable. Second, the comprehensive risk assessment determines the actual conditions using hazard assessments, vulnerability and risk modelling, monitoring, surveys, inspections, and other technical evidence, and compares those assessed conditions against the agreed criteria to evaluate risk and support decisions

2.1 METHODOLOGY AT A GLANCE

The methodology follows six sequential stages that translate stakeholder knowledge and technical understanding into a structured risk-tolerability framework. Together, these stages provide a transparent process for defining how scientific risk assessments can be interpreted to support recovery decisions. Although presented sequentially, the methodology is iterative and can be revisited as hazard conditions, scientific evidence, mitigation measures or community priorities evolve.

1.Establish the decision context. Define the decisions to be supported, the people and activities affected, the hazard scenarios, the relevant institutions, and the time horizon.

2.Translate concerns into indicators. Identify practical dimensions of safety, continuity, preparedness, governance, and recovery that can be discussed and later assessed.

3.Define acceptance ranges. For each indicator, identify the points at which conditions move from acceptable to conditionally acceptable and from conditionally acceptable to unacceptable.

4.Identify non-negotiable conditions. Specify the conditions that must always hold. Their failure creates a non-negotiable condition that cannot be offset by a good score elsewhere.

5.Identify and prioritize mitigation measures. Define the measures required to maintain conditional acceptance and rank the interventions that most increase confidence or reduce risk.

6.Aggregate, validate, and apply. Review ranges and differences with participants, refine unclear indicators, and use the resulting criteria as benchmarks in the comprehensive risk assessment and later decisions.

Importantly, the methodology does not itself determine whether conditions are acceptable. Rather, it establishes the criteria against which subsequent comprehensive assessments can be evaluated, ensuring that scientific evidence, stakeholder perspectives and governance considerations are brought together through a transparent and consistent decision process.

Setting Risk-Acceptance Criteria — Methodology at a Glance

Six linked stages, repeated as conditions, evidence, or community priorities change

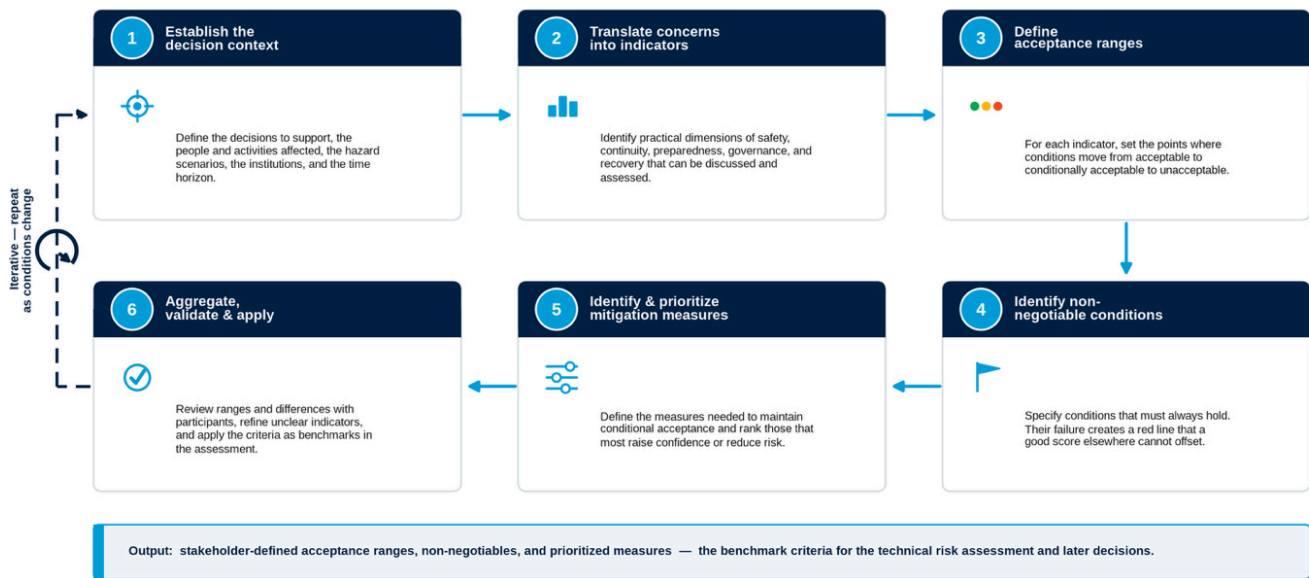


Figure 2-1 Overview of the six different stages of the methodology used in Grindavík, showing stakeholder-defined risk acceptance ranges, non-negotiables, and prioritized mitigation measures to be used as inputs for a comprehensive risk assessment for decision making.

2.2 WHERE THE METHODOLOGY FITS WITHIN ISO 31000

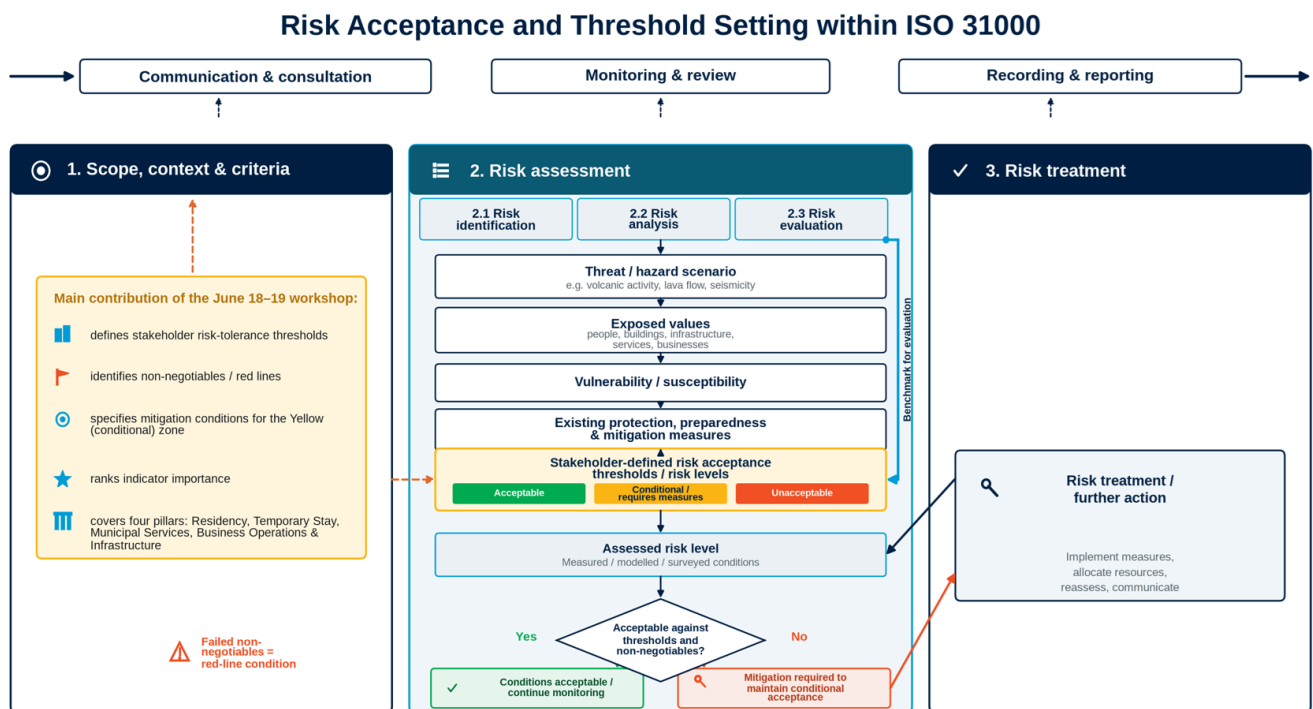


Figure 2-2 Showing the risk acceptance and threshold setting methodology within the ISO 31000 risk management framework.

ISO 31000 treats risk management as a continuous process that includes establishing scope, context, and criteria; risk identification; risk analysis; risk evaluation; risk treatment; communication and consultation; monitoring and review; and recording and reporting. The main contribution of the June workshop and this report sit within the definition of context and risk criteria, while also informing later evaluation and treatment decisions.

Risk criteria describe what would be acceptable, conditionally acceptable, or unacceptable. Assessed conditions describe what monitoring, modelling, surveys, inspections, exercises, or expert judgement show. A decision can only be made by comparing the assessed condition with the agreed criterion and checking whether all non-negotiable conditions are met.

2.3 ICELANDIC REGULATORY PRECEDENT AND THE GAP FOR VOLCANIC RISK

The methodology was not developed in a regulatory vacuum. Iceland's Regulation No. 505/2000 provides an established domestic example of acceptable-risk criteria for avalanches and landslides. Article 11 expresses acceptable local risk as the annual probability of death for an individual and differentiates the acceptable value according to building use and expected occupancy.

Use recognized in Regulation No. 505/2000	Acceptable local annual fatality risk	Occupancy assumption reflected in the regulation
Residential buildings, schools, children's homes, hospitals, community halls and similar buildings	Less than 0.3 per 10,000 per year	75 percent occupancy for residential buildings; child-centered and care uses are grouped with the stricter criterion.
Commercial buildings with regular work	Less than 1 per 10,000 per year	40 percent occupancy.
Holiday homes	Less than 5 per 10,000 per year	5 percent occupancy.

The regulation also allows the presence of people to be assessed differently where actual occupancy differs from these assumptions, provided the assessment is substantiated. It recognizes that stricter demands may be justified where large numbers of people are expected or workplaces are crowded. This is more than a technical adjustment: it demonstrates a regulatory principle that acceptable

risk depends on how a place is used, how long people are exposed and who is present.

The Grindavík methodology carries forward that principle but does not carry forward the avalanche numbers. The volcanic setting involves different hazard mechanisms, warning characteristics, spatial and temporal uncertainty and potential consequences. It also presents decision dimensions that are not adequately captured by annual individual fatality risk alone. These include repeated evacuation, interruption of utilities and essential services, support for vulnerable people, psychosocial impacts, business continuity, trust and governance.

The earlier resilient-recovery advisory therefore proposed a multi-tiered approach:

- Long-term national standards for volcanic risk, developed through the responsible scientific, legal and policy processes.
- A general societal tolerability principle, potentially using an approach such as "As Low As Reasonably Practicable" (ALARP), to consider whether residual volcanic risk has been reduced as far as is reasonably achievable and to benchmark it against other risks to life.
- Probabilistic, hazard-specific metrics to support long-term infrastructure placement, spatial planning and development.
- Short-term operational criteria for Grindavík, developed with authorities, businesses, residents and service providers and differentiated by activity and population group.
- Clear "if-then" protocols that connect monitored conditions and risk levels to zoning, access, occupancy, closure, evacuation and reopening decisions.

June workshop contributes to the last two elements. It is a method for eliciting provisional operational criteria under current uncertainty. It does not determine a national ALARP boundary, calculate probabilistic volcanic fatality risk or establish a legal standard. Those require separate analysis, legal review and authority-led adoption. The workshop instead identifies what must be assessed and what conditions stakeholders consider necessary for different activities to remain tolerable.

Methodological implication

The avalanche precedent explains why activity differentiation is legitimate. The volcanic gap explains why the workshop had to go further: from one fatality metric to a multi-dimensional set of criteria covering safety, continuity, preparedness, vulnerability, governance and recovery.

2.4 PREPARATION: SETTING THE PARAMETERS

Two operating scenarios

Because the hazard is open-ended, participants were asked to reason about two scenarios rather than a single forecast: (A) living with prolonged uncertainty, in which activity remains elevated and unpredictable over an extended period; and (B) repeated evacuations, in which people and services must withdraw and return more than once. These scenarios framed the questions without asking participants to predict the volcano.

	Scenario A: Living with Uncertainty	Scenario B: Repeated Evacuations
Status	Magma accumulation continues; the hazard remains elevated and unresolved.	Active volcanic or seismic conditions require evacuation for shorter or longer periods.
Core question	What conditions remain acceptable while people, services and businesses operate under a continuous, unresolved threat?	What conditions are acceptable when evacuation and disruption become recurring features of life?
Primary threshold logic	Sustained service levels, readiness and maximum tolerable ongoing disruption.	Time to evacuate, duration of closure, speed of restoration and ability to restart safely.

Four activity areas

The process separated four activity areas because exposure, vulnerability, acceptable disruption, and decision responsibility differ by activity. This avoids treating the town as having one uniform level of acceptable risk. The activities are also informed by Icelandic risk-management practice: Regulation No. 505/2000 which differentiates acceptable risk according to building use and expected occupancy and vulnerability categories.

Activity	Focus	Scope for Indicators
I. Residency	Living permanently in Grindavík.	General population, vulnerable groups, housing, utilities, schools, care, evacuation and community life.
II. Temporary stay	Being present for limited periods, for work, property care or short visits.	Visitors, contractors, consultants, property access, information, supervision and rapid evacuation.
III. Municipal services	Functionality of schools, social services, emergency services and other local-government functions.	Emergency services, education, social services, care, staffing, governance, funding and mutual aid.
IV. Business operations and infrastructure	Continuity of enterprises, workforce and the infrastructure on which they depend.	Workforce, planning horizons, access, utilities, transport, financial resilience and reopening.

The activity areas are not intended to imply that one group's life is valued differently from another's. They recognize differences in exposure duration, degree of choice, vulnerability, societal function, available safeguards and the consequences of interruption. Child-centered activities and permanent residency generally require stricter conditions because exposure is sustained and the consequences of failure are high. Daytime or specialist operations may sometimes be tolerable under more restrictive access, stronger supervision, shorter exposure and verified evacuation arrangements.

Inputs from earlier engagements

Preparation drew on a March preview exercise, six preparatory online workshops, the earlier resilient-recovery advisory, the social analysis presented to stakeholders and the evolving comprehensive risk-assessment process. These sources were used to identify the decisions that required support, the activity distinctions that mattered and the candidate indicators to test. The datasets from the earlier workshops were not merged statistically with the June results; they served as design and contextual inputs and are documented separately in the annexes.

Indicator design

For each activity area, the team prepared six candidate indicators. An indicator had to describe a decision-relevant condition that participants could understand, judge and later assess. Indicators could represent physical conditions, service performance, preparedness, governance, social resilience or operational continuity. This wider scope is deliberate: a fatality-risk metric may remain an important technical input, but it cannot by itself answer whether a school, municipal service, business or household can function tolerably under repeated uncertainty and disruption. The full indicator definitions are provided in Annex F.

A good indicator should be

Specific enough to be interpreted consistently; relevant to a decision; measurable through modelling, monitoring, surveys, inspections, exercises, or expert judgement; sensitive to changes in conditions; and linked to actions that can maintain or improve tolerability.

2.5 THE DESIGN OF RISK ACCEPTANCE CRITERIA

The central design task was to convert broad concerns into a structured set of criteria. For each indicator, participants considered five linked elements.

Element	Question answered
Indicator importance	How important is this indicator relative to the other indicators in the same activity area?
Acceptable range	What condition can continue with routine monitoring and maintenance?
Conditional range	What condition can continue only if defined safeguards or mitigation measures are in place and verified?
Unacceptable range	At what point is the condition no longer tolerable and corrective action or cessation is required?
Non-negotiable conditions	Which conditions must always be present, regardless of the indicator score or the performance of other measures?

Thresholds and tipping points

Each indicator used two tipping points. The first marked the transition from acceptable to conditionally acceptable. The second marked the transition from conditionally acceptable to unacceptable. Where the underlying quantity was continuous, such as time, percentage, frequency, or number of people, participants were encouraged to place the tipping point directly on a continuous scale rather than choose from broad categories.

- **Acceptable** means that the condition is within the agreed range and can continue with monitoring and normal management.
- **Conditionally acceptable** means that the condition is tolerable only if specified measures are present, effective, and verified.
- **Unacceptable** means that the assessed condition has crossed the agreed limit or that a non-negotiable condition has failed, making the condition intolerable. As long as the nonnegotiable condition is met the condition can be made conditionally tolerable with specified measures.

Non-negotiable conditions

Non-negotiable conditions are absolute requirements that cannot be traded against benefits elsewhere in the framework. They are not simply high priority indicators. They operate as override rules. If a non-negotiable condition fails, the relevant activity is treated as unacceptable even if other indicators remain within acceptable ranges.

- Examples include functioning warnings, safe evacuation capability, emergency response capacity, control of restricted areas, and continuity of essential services.
- A non-negotiable should be stated as a clear condition that can be verified. Broad aspirations should be translated into operational requirements, such as a defined response capability, a tested evacuation route, or confirmed support for vulnerable households.
- Nonnegotiables should be few, transparent, and justified because they have strong consequences for decisions.

Mitigation measures and conditional acceptance

Mitigation measures are the actions that can keep a condition within the acceptable range or allow a conditionally acceptable situation to remain tolerable. They are central to the methodology because the middle range is not a passive grey zone. It is conditional on measures being present and working.

Measure type	Illustrative examples
Preventive	Protective works, access controls, warning systems and household preparedness.
Readiness	Evacuation exercises, response plans, backup systems, staff arrangements and mutual-aid agreements.
Continuity	Backup power, rapid utility restoration, school continuity, care plans and temporary accommodation.
Governance	One official source of information, clear decision criteria, defined responsibilities, stable funding and reopening protocols.
Recovery	Financial support, business-interruption arrangements, psychosocial support and community recovery measures.

Decision rule

Mitigation can maintain or restore conditional acceptance, but it cannot compensate for the failure of a non-negotiable condition. Non negotiables define the floor. Mitigation determines whether conditions above that floor remain tolerable.

2.6 IMPLEMENTATION: RUNNING THE EXERCISE

The June workshop was held over two days and engaged about 35 participants in five facilitated groups. Residency was covered by two groups because of its breadth and priority. The other activity areas each had one group.

- Day 1 in Grindavik grounded the discussion in the physical setting, reviewed the hazard and recovery context, introduced the scenarios and indicators, and began the elicitation of thresholds and priorities.
- Day 2 in Reykjavik reviewed emerging findings, clarified definitions, validated thresholds and non-negotiable conditions, ranked mitigation measures, and connected the results to the wider risk assessment process.

Facilitated deliberation and individual judgement

Judgements were captured through two complementary modes. Facilitated discussion allowed participants to explain their reasoning, challenge assumptions, identify missing conditions, and explore disagreement. Individual entry preserved each participant's judgement and prevented apparent consensus from masking differences.

- Each group had a facilitator responsible for pace and a rapporteur responsible for reasons, disagreements, and suggested changes.
- Participants answered individually after group discussion. Consensus was not required.
- The process began with live polling and moved to a purpose-built web application that allowed continuous threshold setting, comments, importance rankings, non-negotiable ratings, and mitigation rankings.
- The same indicator was considered separately under both scenarios where scenario conditions were expected to change tolerance.

Question sequence for each indicator

1. Clarify the indicator. What exactly is being judged, for whom, over what period, and under which scenario?

2. Identify the acceptable range. What level is tolerable with routine monitoring and no additional measures beyond normal practice?

3. Identify the conditional range. At what point are additional measures required, and which measures must be present?

4. Identify the unacceptable range. At what point should the activity stop, be restricted, or trigger immediate corrective action?

5. Test for a red line. Are there any non-negotiable-conditions whose failure would make the activity unacceptable regardless of the numerical threshold?

6. Rank importance and measures. How important is the indicator, and which measures most increase confidence or tolerability?

2.7 AGGREGATION, INTERPRETATION, AND VALIDATION

Individual responses were aggregated to show the range and central tendency of judgements. The purpose was not to average away disagreement. Variation was treated as information about different values, different assumptions, unclear wording, or a need for further evidence.

- Where answers clustered, the range provided an initial indication of shared judgement.
- Where answers diverged, facilitators examined whether the difference reflected values, scenario interpretation, population assumptions, service definitions, seasonality, frequency, or missing information.
- Participants reviewed the aggregated results, corrected errors, refined wording, identified missing indicators, and validated the main findings.
- Importance rankings were used to support prioritization, but they did not override non-negotiable conditions.

2.8 FROM WORKSHOP CRITERIA TO RISK ASSESSMENT AND DECISIONS

The workshop outputs become operational only when actual conditions are assessed. Each indicator therefore needs an assessment method and a responsible owner. Depending on the indicator, evidence may come from hazard models, monitoring systems, surveys, administrative records, inspections, exercises, operational audits, or structured expert judgement.

Type of evidence	Examples	Use
Modelled or monitored	Hazard intensity, ground movement, road access, utility disruption, building condition.	Estimate the physical or operational condition.
Survey or administrative	Warning comprehension, household preparedness, vulnerable household support, staff availability, trust.	Measure social, service, and organizational conditions.
Inspection or exercise	Evacuation route usability, response time, backup system readiness, access control.	Verify that safeguards and non-negotiables work in practice.
Expert judgement	Conditions that cannot yet be measured directly or require interpretation across evidence sources.	Provide a transparent interim assessment with documented assumptions.

For each indicator, the assessed value is compared with the agreed range. If it is acceptable, the activity can continue with monitoring. If it is conditionally acceptable, the required measures must be verified and maintained. If it is unacceptable, or if a non-negotiable has failed, corrective action, restriction, or further authority review is required. Results can then be assembled in a traffic light matrix, while multicriteria analysis may provide a decision-support score using an aggregated value across different indicators. The relevant public authorities remain responsible for interpreting the evidence and making the final decision.

2.9 ADAPTING THE METHOD TO OTHER CONTEXTS

The methodology is transferable as a process, not as a set of numerical thresholds. Another location can use the same sequence while changing the scenarios, activity areas, indicators, evidence sources, legal context, and decision responsibilities.

- Begin with a clearly defined decision, not with a generic discussion of risk.
- Use locally plausible scenarios that distinguish operating conditions without requiring participants to predict the hazard.
- Separate activities or populations when exposure, vulnerability, responsibility, or acceptable disruption differs.
- Co-design indicators with technical experts and affected stakeholders, and test whether each indicator can later be assessed.
- Keep non-negotiables distinct from high-priority mitigation measures and state them as conditions that have to be met for risk to be acceptable.
- Define the measures required for conditional acceptance at the same time as the thresholds.
- Preserve disagreement and document the reasons behind it.
- Assign ownership for monitoring, reassessment, communication, and formal decisions.
- Review the framework when hazards, infrastructure, services, law, governance, or community priorities change.

2.10 LIMITATIONS AND SAFEGUARDS

- The workshop was a structured deliberative exercise, not a population survey. Its findings are not statistically representative of all residents or of Iceland.
- The results reflect the participant mix, the scenarios, the indicator wording, and the information available at the time.
- Thresholds should not be treated as official standards until they have been technically assessed, legally reviewed, and adopted through the relevant governance and decision-making processes.
- Some indicators may require subdivision because a single category can combine services or conditions with very different consequences.
- The method should not force false precision. Where evidence is weak or disagreement is large, the framework should record uncertainty and trigger further analysis or deliberation.
- Communication, consultation, monitoring, review, and recording should continue throughout the process, in line with ISO 31000.

Why a participatory method

Under ambiguous risk, the central difficulty is not only estimating the hazard but also deciding how much disruption is tolerable. This is a question of values as much as data. A participatory method is well suited to such decisions because it makes values, priorities, and **trade-offs** explicit. It can build shared understanding and legitimacy, and it produces criteria that a comprehensive risk assessment can then test. It complements the risk assessment process rather than substituting for it. The methodological basis, including the acceptable risk and tipping point logic and the multicriteria techniques used to organize the results, is set out in Annex E.



3. RESULTS BY ACTIVITY AREA

This chapter presents the results for each of the four activity areas. For each, it reports which indicators participants treated as most important, the key takeaways, the illustrative threshold ranges (acceptable / conditionally acceptable / unacceptable), the absolute non-negotiables, and the priority mitigation measures. The threshold values are participatory outputs and illustrative examples, not official standards. Each section opens with why the area matters.

3.1 RESIDENCY

Why it matters: permanent residency is the most demanding activity. Whether households can live in Grindavík depends not only on physical access to homes, but on reliable warnings, manageable evacuation, habitable housing and utilities, continuity for children and vulnerable residents, and confidence that official decisions can be trusted when conditions change. Participants attached the strictest conditions to this area.

Indicator importance (rank 1 = most important)

Rank	Indicator	Mean rank
1	PR3 — Housing & utilities	1.33
2	PR1 — Warnings & understanding	1.60
3	PR2 — Evacuation readiness	3.22
4	PR6 — Uncertainty & community	4.33
5	PR5 — Essential support	4.67
6	PR4 — Schools & childcare	5.78

Key takeaways

- **Lowest tolerance:** physical safety, evacuation capability, trust, fairness, and clear decision-making attracted the least tolerance. Continuity of everyday life carries comparatively higher tolerance.
- **Higher tolerance:** economic and housing security showed comparatively higher tolerance once safety was assured.
- **A critical gap:** sports and community support were identified as vital for mental health and community resilience.

Threshold Ranges

Indicator	Acceptable (Green)	Conditionally Acceptable (Yellow)	Unacceptable (Red)
Warning & information (PR1)	95–99% of households receive official alerts; 100% know plans and routes	Coverage slips below the agreed level	Less than 95% of households unaware of plans or routes
Vulnerable support (PR2)	95–100% of vulnerable households have confirmed support	Confirmed support vulnerable households of less than 95%	More than 5% of Vulnerable households without confirmed support
Utility disruption (PR3)	Short-term only; immediate restoration post-evacuation	Approaching the monthly tolerance band	Disruption of essential utilities exceeds 24 hours
School continuity (PR4)	Schooling maintained	—	Schooling disrupted more than 5 days per month

Absolute non-negotiables (mean importance, 1–5)

Condition	Score
Reliable warnings and communication	5.0
Evacuation capability (safe routes, transport, tested procedures)	5.0
Emergency response capacity (police, fire, ambulance, EMS)	4.9
Control of hazard zones, unsafe buildings, and access	4.9
Protection of vulnerable residents	4.7
Essential utilities and infrastructure	4.5
Trustworthy governance	4.4
Continuous, safe access to schooling	4.1
Essential social and care services	4.0

Participant added non-negotiable;

Without active ambulance and fire services within a defined response time, residency is entirely unacceptable. Participants stressed that the division of services (ambulance, police, fire) matters individually, not just as a whole, and that the preparedness plan needs to be “100% and all working together.”

Priority mitigation measures — validated ranking

Participants ranked the measures that would most increase their willingness to accept residency. The validated rankings are shown for each scenario (1 = highest-priority lever).

Scenario A — living with prolonged uncertainty

Rank	Mitigation measure
1	Emergency response capacity (fire, ambulance, evacuation exercises)
2	Warning and communication system (trusted source, multilingual alerts, regular updates)
3	Utility resilience measures (backup power, telecoms, heating contingencies, rapid repairs)
4	Predictable rules and forward planning (clear criteria, advance notice, stable rules)
5	Support for vulnerable residents (care plans, medication plans, psychosocial support)
6	School and childcare continuity (receiving schools, remote learning, youth activities)
7	Household preparedness program (registration, checks, household plans, drills)
8	Psychosocial and community recovery support (mental health, sports, community events)
9	Financial and insurance support (compensation, insurance clarity, housing cost support)

Scenario B — repeated evacuations

Rank	Mitigation measure
1	Rapid school and childcare restart (receiving schools, remote learning, youth activities)
2	Evacuation training and exercises (household drills, transport, testing systems)
3	Psychosocial and community recovery support (mental health, community events, family support)
4	Financial and insurance support (compensation, insurance clarity, housing cost support)
5	Temporary housing arrangements (alternative accommodation, family reunification)
6	Predefined evacuation and return protocols (clear triggers, return criteria, responsibilities)
7	Continuity of health and social care (medication continuity, transfer of care, follow-up)
8	Rapid utility restoration (priority repairs, restoration targets, backup systems)

Reviewer note: some measure groups are broad. Psychosocial support alone would rank higher as an early intervention, whereas community recovery (sports, events) can wait longer — worth splitting in future rounds.

Residency — Acceptable to Unacceptable thresholds

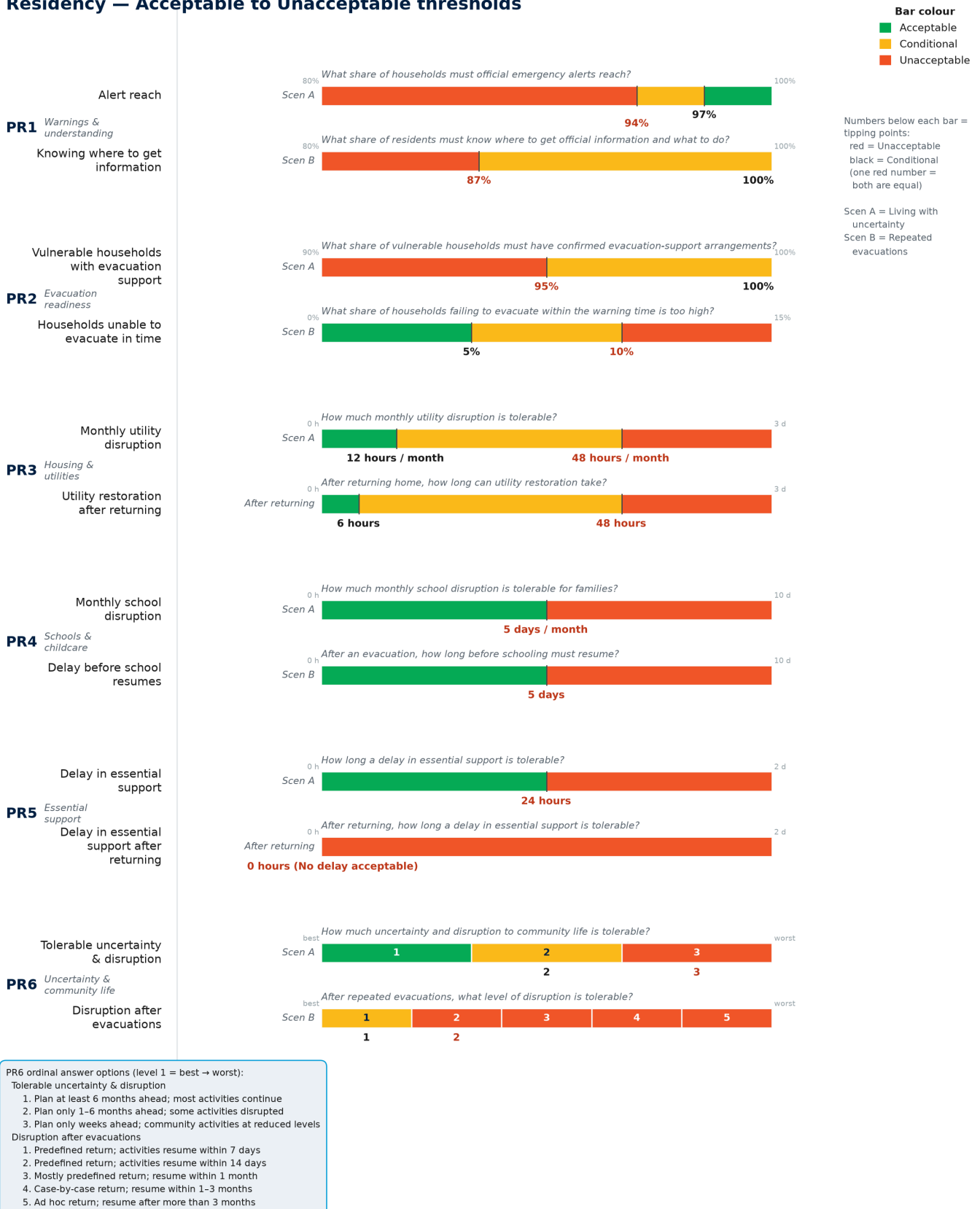


Figure 3.1 — Residency: final risk-acceptance thresholds by indicator and scenario (Scenario A = living with uncertainty; Scenario B = repeated evacuations).

3.2 TEMPORARY STAY

Why it matters: temporary presence for tourists, contractors, consultants, and visitors carries different risks from permanent residency. The central challenge is that temporary users may be less familiar with the area and harder to reach, so being informed and able to leave quickly matters most. Results are for one group of 12 respondents.

Indicator importance (rank 1 = most important)

Rank	Indicator	Mean rank
1	TP1 — Information & alerts	1.00
2	TP6 — Time to act	2.00
3	TP5 — Utility continuity	3.00
4	TP4 — Numbers present	4.33
5	TP3 — Overnight limits	4.83
6	TP2 — Access control	5.83

Key takeaways

- **Non-negotiables:** reliable warnings were the strongest non-negotiable. Evacuation capability, exclusion-zone control, emergency response, and communications connectivity were treated as core prerequisites for any temporary presence.
- **Essentials:** temporary users must know where to get information, understand what it means, and know what to do — “communication is number 1, 2, and 3.”
- **Missing condition:** the main gap is not a new indicator but stronger accountability for temporary users — who is responsible for them, how they receive updates, and how they are guided if conditions change.

Threshold Ranges

Indicator	Acceptable (Green)	Conditionally Acceptable (Yellow)	Unacceptable (Red)
Information awareness (TP1)	≥80% awareness of evacuation procedures	—	Below the 80% awareness threshold
Access control (TP2)	Restricted areas fenced, signed, and regularly inspected	Controls partially in place	Restricted areas not controlled
Capacity limits (TP4)	Up to 2500 temporary users (Up to 2,000 users for repeated evacuations)	Strict management measures from 2,500 to 3,000 users	Above 3,000 temporary users (Above 2,500 for repeated evacuations)
Utility disruption (TP5)	Restoration within 4 hours before resuming activity	Restoration delayed between 4 and 24 hours	Disruption beyond 24 hours (beyond 4 hours for repeated evacuations)
Protective-action time (TP6)	Above 60 minutes of available action time	Additional measures required below 30–60 minutes	Below 30 minutes available action time

Absolute non-negotiables (mean importance, 1–5)

Condition	Score
Reliable, immediate warnings	5.0
Evacuation capability	4.2
Effective control of restricted areas and exclusion zones	4.2
Emergency response remains available to assist temporary users	4.2
Communications connectivity (mobile networks, comms systems)	4.2
Organizer preparedness (response plans and responsibilities)	3.7
Minimum continuity of essential utilities	3.5
Minimum repair and recovery capability	2.8
Protection of vulnerable visitors	2.5

Priority mitigation measures — validated ranking

Assuming the essential non-negotiables are met, the mitigating actions/measures, most likely to increase willingness to accept temporary presence were ranked as follows (the group confirmed it was content with this result).

Rank	Mitigation measure
1	Clear and regularly updated risk information
2	Regular preparedness exercises and safety briefings
3	Strong cooperation between authorities and local stakeholders
4	Visible monitoring, patrols, and safety oversight
5	Predictable access, closure, and reopening decisions

The remaining measures (overnight/accommodation arrangements, financial support, community and sports activities, psychosocial services) were available but not ranked in the top tier for this group.

Temporary Stay — Acceptable to Unacceptable thresholds

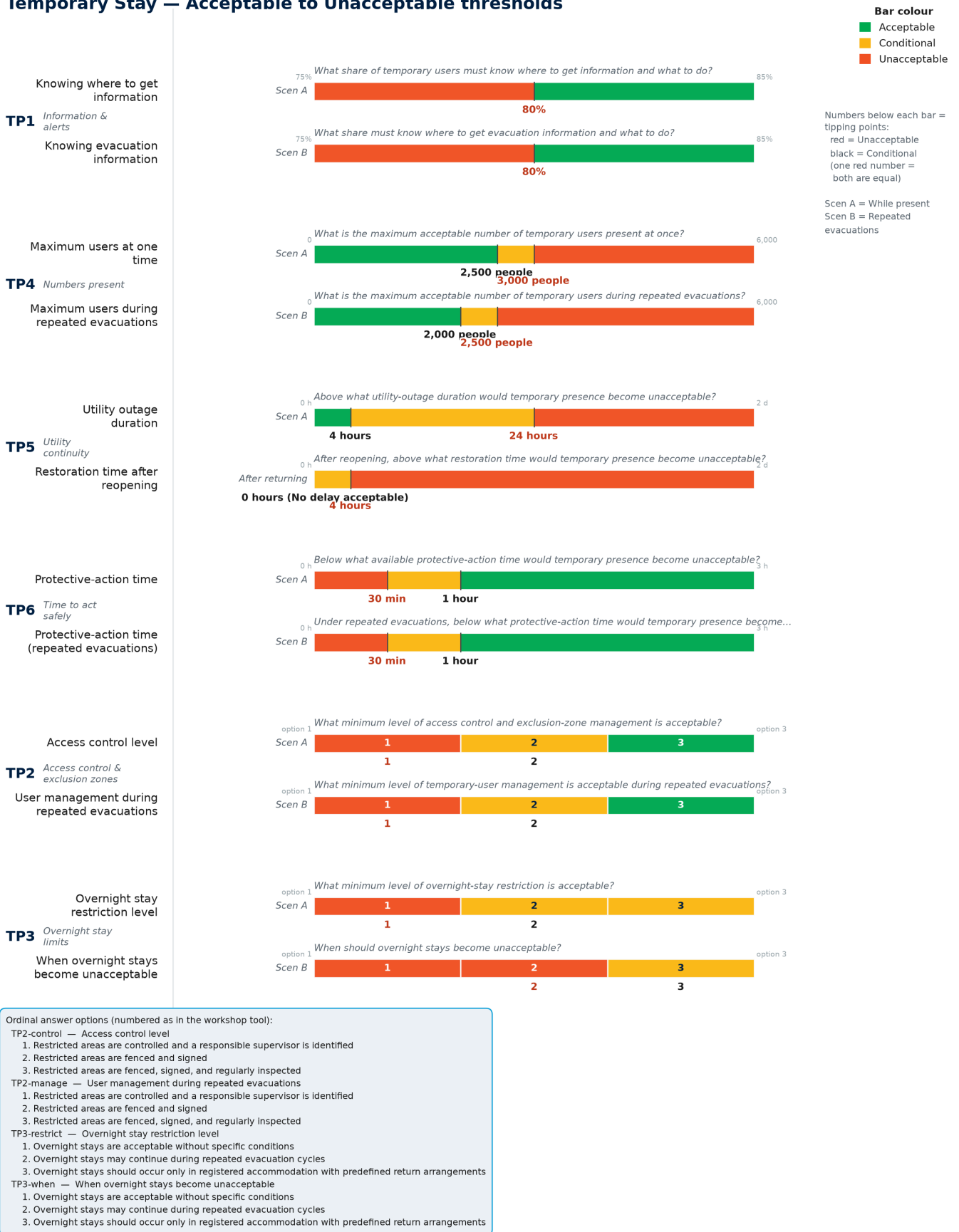


Figure 3.2 — Temporary Stay: final risk-acceptance thresholds by indicator and scenario.

3.3 MUNICIPAL SERVICES

Why it matters: municipal services, such as schools, social services, child protection, care for vulnerable people, and emergency services, are what allow a community to function at all. Participants emphasized that these services can become fragile when mandates expire, funding is temporary, and responsibility is spread across several organizations. Results are for one group of 8 respondents.

Indicator importance (rank 1 = most important)

Rank	Indicator	Mean rank
1	MS6 — Governance & funding	1.00
2	MS5 — Emergency services	2.00
3	MS4 — Vulnerable support	3.00
4	MS3 — Child protection	4.25
5	MS2 — Staffing	4.75
6	MS1 — Access	6.00

Key takeaways

- **Lowest acceptance:** trust, fairness, clear decisions, and physical safety.
- **Critical need:** rapid restoration of essential functions — specifically emergency response, child protection, social services, and care for disabled and older populations. Emergency-response readiness was the highest-ranked municipal-services indicator.
- **Coverage:** open comments indicated the indicator set was felt to be "all covered."

Threshold Ranges

Indicator	Acceptable (Green)	Conditionally Acceptable (Yellow)	Unacceptable (Red)
Service access (MS1)	≥95% access	Concern triggers at 95% access	Strictly unacceptable below 90% access
Service delays (MS2)	Acceptable for most services up to two weeks	Some tolerance ends at one month	General service access unacceptable beyond one month
Child protection (MS3)	Disruption acceptable up to one week	Conditionally acceptable at around one week of disruption	Entirely unacceptable around two weeks
Vulnerable resident support (MS4)	Lapse of support acceptable for up to 24 hours	Concern begins at 24 hours post-evacuation	Unacceptable at 48 hours
Emergency response (MS5)	No lapse in response is acceptable	—	No delay is acceptable

Absolute non-negotiables (mean importance, 1–5)

Condition	Score
Clear evacuation procedures for staff, schools, and users	5.0
Secured funding and responsibilities for exceeding normal capacity	4.8
Continuity of legally mandated social and child protection services	4.5
Trusted risk information via a single, clear channel	4.3
Minimum continuity of essential utilities	4.0
Clear closure, access, and reopening rules communicated in advance	4.0
Vulnerable residents identified, contacted, and supported	3.8
Receiving arrangements agreed with other municipalities/providers	2.3

Priority mitigating measures — validated ranking

Mitigating actions/measures that would most increase confidence in municipal services, ranked (1 = highest priority).

Rank	Mitigating measure
1	Regular public updates on risk, services, and reopening conditions
2	Regular evacuation exercises with schools, staff, and service users
3	Live overview of vulnerable residents and support needs
4	Child-friendly and multilingual information channels
5	Clear Plan B and Plan C for each major municipal service
6	Updated contact information for residents and service users
7	Named service coordinators for key service areas
8	Cooperation agreements with neighboring municipalities

Group comments highlighted important definition issues: the split between municipal- and state-delivered services creates grey areas; family-support and social-support services were considered one domain; and staffing kindergartens vs primary schools differs enough to warrant separate questions.

Municipal Services — Acceptable to Unacceptable thresholds



Figure 3.3 — Municipal Services: final risk-acceptance thresholds by indicator and scenario.

3.4 BUSINESS OPERATIONS & INFRASTRUCTURE

Why it matters: businesses have largely adapted to living with uncertainty, but continued operation depends on predictability, reliable infrastructure, workforce continuity, clear operating rules, and the ability to shut down, evacuate, and restart. Results are for one group of 12 respondents; the numeric rankings for this activity area were captured on the group's validated worksheet, as the live poll recorded no results.

Indicator importance (rank 1 = most important)

Rank	Indicator	Mean rank
1	BO1 — Predictability	1.00
2	BO2 — Infrastructure	2.00
3	BO3 — Workforce	3.00
4	BO4 — Access & recovery	4.00
5	BO5 — Financial	5.00
6	BO6 — Communication & trust	6.00

Key takeaways

- **Non-negotiables:** businesses can access facilities to secure critical assets when safe, clear evacuation procedures, employees can evacuate safely when conditions change, warning and evacuation systems work reliably.
- **Essentials:** essential functions, such as enhanced winter road maintenance and transport access must continue or be restored quickly. Emergency response, local stockpiles of critical materials and equipment and business interruption compensation arrangements.

Threshold Limits

Indicator	Acceptable (Green)	Conditionally Acceptable (Yellow)	Unacceptable (Red)
Planning horizon (BO1)	More than 7 days acceptable	1 to 7 days of planning horizon conditionally acceptable	Below 24 hours is unacceptable
24-hour window (BO1/BO2/BO4)	Re-entry, facility access, and utility restoration within 24 hours	-	Re-entry after 1 day not acceptable
Closure limits (BO1)	Once per month and short in duration (less than 3 days)	—	>72 hours continuous, or more than once per month
Closure without financial support (BO5)	7 days	Between 1-2 weeks	More than 2 weeks
Workforce tolerance (BO3)	Staffing at 90%+	Support required as staffing falls below 90%	Operating below ~50% essential staff
Workforce return (BO3)	Return within 24 hours	Return delayed between 1 to 7 days	Return delay exceeds 7 days

Non-negotiables

Even where outage durations remain below the defined time thresholds, any of the following automatically renders the situation unacceptable for operations:

- no functional backup or alternative supply exists
- safety risks to staff, customers, or the public escalate
- critical data or communications cannot be maintained
- perishable goods or essential services are compromised
- regulatory or legal obligations cannot be met
- loss of access to site, ports, or roads prevents operations
- breakdown of trust in information or response mechanisms

Priority mitigating measures — validated ranking (Table 5)

Mitigating actions/measures, that would most increase businesses' willingness to tolerate risk and continue operating, ranked (1 = highest priority).

Rank	Mitigating measures
1	Enhanced winter road maintenance and transport access
2	Regular communication and information sharing
3	Formal business involvement in decision-making
4	Clear escalation levels and decision criteria
5	Business interruption compensation arrangements
6	Local stockpiles of critical materials and equipment
7	Improved backup power and infrastructure resilience
8	Temporary accommodation for essential workers
9	Defined reopening conditions
10	Faster access following closure or evacuation
11	Faster restoration of utilities and services
12	Earlier notice of likely restrictions or closures

Group comment: business owners' trust scores reflect the level they want to reach — to date they have experienced little trust. The business interruption window discussed was around 14 days per year.

Business Operations & Infrastructure — Acceptable to Unacceptable thresholds



Figure 3.4 — Business Operations & Infrastructure: final risk-acceptance thresholds by indicator and scenario.



4. CROSS-CUTTING FINDINGS AND THE INTEGRATED FRAMEWORK

Reading across the four activity areas reveals patterns that no single area shows on its own. This chapter first presents the cross-cutting findings, then interprets them by distinguishing the technical results from their implications, and finally brings thresholds, mitigation measures, and non-negotiables together in an integrated matrix for each area.

4.1 WHAT RECURS ACROSS ALL ACTIVITIES

- **A shared baseline of minimum conditions.** a small set of conditions recurred as non-negotiable in every area: reliable warnings and communication, evacuation capability, emergency-response readiness, and control of restricted and hazard zones. Together, these are the minimum safety and governance conditions that participants identified as common across all activities.
- **Communication and trust as the connective tissue.** communication, trust, fairness, and clear decision-making were repeatedly singled out. A conditionally acceptable situation can remain tolerable when information is clear and timely, but a breakdown of trust in information or response is itself an automatic red line.
- **Tolerance depends on the scenario.** thresholds differed between Scenario A and Scenario B (e.g. benchmarking daily access, financial compensation, workforce availability, delay in essential support, vulnerable households without support). The same indicator needs scenario-specific thresholds.

4.2 INTERPRETING THE RESULTS

The findings above are technical outputs. Their interpretation in terms of what they imply for decisions is set out here, kept distinct from the raw results. Three patterns stand out: which indicators matter most, where thresholds are strictest, and where opinion varied most.

Where decisions matter most

- **Residency** — housing & utilities (PR3) and warnings & understanding (PR1) — the practical conditions for daily life, plus knowing what is happening and what to do.
- **Temporary Stay** — information & alerts (TP1) and time to act (TP6) — visitors must be reachable and have enough warning to leave safely.
- **Municipal Services** — governance & funding (MS6) and emergency services (MS5) — keeping mandated and emergency functions running, properly resourced.
- **Business Operations** — predictability (BO1) and infrastructure (BO2) — advance notice and reliable utilities and access above all.

Where thresholds are strictest

- **A near-absolute safety baseline** — warning and evacuation conditions attract the strictest thresholds everywhere; even 1–5% of households unable to evacuate in time is judged unacceptable.
- **Tight utility restoration** — utilities must typically be restored within hours, not days; for temporary presence, disruption beyond 24 hours is unacceptable.
- **Care services have short fuses** — child protection and vulnerable-resident support have short tolerances — around 24 hours for vulnerable-resident support and about one week for child protection. No delay is tolerated in restoring emergency services.

Where opinion varied most

- **Context drives spread** — several thresholds depend heavily on context — utility tolerance depends on which utility is out and the season; schooling tolerance depends on whether disruption recurs monthly or rarely.
- **Definition ambiguity** — overlaps (family vs social support; kindergarten vs primary staffing) produced divergent answers because people were effectively answering slightly different questions.
- **Scenario sensitivity** — Scenario B thresholds were generally stricter and harder to set, as some participants benchmarked against children while others assumed adults tolerate longer.

The indicator set is not static

Participants proposed additions to consider in the next revision — for example, standalone insurance/business-interruption clarity; a single source of truth with tailored, multilingual communication; a measurable indicator of public trust in civil authorities; all-season evacuation-route reliability; and separating family-support from social-support services and kindergarten from primary-school staffing. These are recorded for future rounds, not treated as settled indicators.

4.3. MITIGATION MEASURES AND NON-NEGOTIABLES MATRIX

Thresholds, mitigation measures, and non-negotiables work together, not as separate lists. The matrices below bring them into a single view for each area, in importance-rank order. For each indicator they show the mitigation measures most relevant to keeping it acceptable or conditionally acceptable, and the absolute non-negotiables that apply. Mitigation measures unlock conditional acceptance; non-negotiables cannot be traded away. If one fails, no mitigation makes the situation acceptable. The mapping is a starting reference to be confirmed with the relevant working group.

4.3.1 Residency

Indicator (importance rank)	Most relevant mitigation measures — unlock conditional acceptance	Applicable absolute non-negotiables
PR3 — Housing & utilities (rank 1)	Utility resilience (backup power, telecoms, heating, rapid repairs); rapid utility restoration; household preparedness programme.	Essential utilities reliably available (4.5); hazard zones and access controls clear and enforced.
PR1 — Warnings & understanding (rank 2)	Warning and communication system (trusted source, multilingual alerts, regular updates); predictable rules and forward planning.	Reliable warnings and communication (5.0); trustworthy governance — transparent communication, public confidence (4.4).
PR2 — Evacuation readiness (rank 3)	Emergency response capacity; evacuation training and exercises; predefined evacuation and return protocols; temporary housing.	Evacuation capability (5.0); emergency response capacity (4.9); hazard zones and access controls enforced (4.9).
PR6 — Uncertainty & community (rank 4)	Utility resilience (backup power, telecoms, heating, rapid repairs); rapid utility restoration; household preparedness programme.	Trustworthy governance — transparent communication, public confidence (4.4).
PR5 — Essential support (rank 5)	Support for vulnerable residents (care and medication plans, psychosocial support); continuity of health and social care.	Protection of vulnerable residents (4.7); essential social and care services — child protection, home care, disability (4.0).
PR4 — Schools & childcare (rank 6)	School and childcare continuity (receiving schools, remote learning, youth activities); rapid restart.	Children have continuous access to safe, appropriate schooling (4.1); child protection (4.0).

4.3.2 Temporary Stay

Indicator (importance rank)	Most relevant mitigation measures — unlock conditional acceptance	Applicable absolute non-negotiables
TP1 — Information & alerts (rank 1)	Clear, regularly updated risk information; strong cooperation between authorities and local stakeholders.	Reliable warnings — timely warnings and clear instructions (5.0); communications connectivity (4.2).
TP6 — Time to act (rank 2)	Regular preparedness exercises and safety briefings; predictable access, closure, and reopening decisions.	Evacuation capability — temporary users can evacuate safely and quickly (4.2); organiser preparedness (3.7).
TP5 — Utility continuity (rank 3)	Visible monitoring, patrols, and safety oversight; strong cooperation between authorities and local stakeholders.	Minimum continuity of essential utilities — electricity, telecoms, water (3.5).
TP4 — Numbers present (rank 4)	Predictable access, closure, and reopening decisions; visible monitoring and oversight.	Effective control of restricted areas and exclusion zones (4.2); emergency response available to temporary users (4.2); protection of vulnerable visitors (2.5).
TP3 — Overnight limits (rank 5)	Regular preparedness exercises and safety briefings; predictable access, closure, and reopening decisions.	Protection of vulnerable visitors (2.5); organiser preparedness (3.7); emergency response (4.2); evacuation capability (4.2).
TP2 — Access control (rank 6)	Visible monitoring and patrols; strong cooperation; predictable access, closure, and reopening decisions.	Effective control of restricted areas and exclusion zones (4.2); minimum repair and recovery capability (2.8).

4.3.3 Municipal Services

Indicator (importance rank)	Most relevant mitigation measures — unlock conditional acceptance	Applicable absolute non-negotiables
MS6 — Governance & funding (rank 1)	Regular public updates on risk, services, and reopening; named service coordinators; clear Plan B and Plan C.	Funding and responsibilities secured for services exceeding normal capacity (4.8); trusted risk information via one clear, updated channel (4.3).
MS5 — Emergency services (rank 2)	Regular evacuation exercises with schools, staff, and users; clear Plan B and Plan C for each major service.	Clear evacuation procedures and routes for residents, staff, schools, users (5.0); closure/access/reopening rules communicated in advance (4.0).
MS4 — Vulnerable support (rank 3)	Live overview of vulnerable residents and support needs; updated contact information; cooperation agreements.	Vulnerable residents identified, contacted, and supported during disruption/evacuation (3.8).
MS3 — Child protection (rank 4)	Child-friendly and multilingual information channels; regular evacuation exercises with schools; cooperation agreements.	Legally mandated municipal services continue, including social services and child protection (4.5).
MS2 — Staffing (rank 5)	Named service coordinators; cooperation agreements with neighboring municipalities.	Receiving arrangements agreed with other municipalities/providers if services relocate (2.3).
MS1 — Access (rank 6)	Clear Plan B and Plan C for each major service; updated contact information.	Minimum continuity of essential utilities — electricity, water, heating, telecoms (4.0).

4.3.4 Business Operations & Infrastructure

Indicator (importance rank)	Most relevant mitigation measures — unlock conditional acceptance	Applicable absolute non-negotiables
BO1 — Predictability (rank 1)	Earlier notice of likely restrictions or closures; clear escalation levels and decision criteria; defined reopening conditions.	Warning and evacuation systems work reliably; road access and evacuation routes usable; clear evacuation procedures (5.0).
BO2 — Infrastructure (rank 2)	Improved backup power and infrastructure resilience; local stockpiles; faster restoration of utilities and services.	Electricity for critical operations; water, heating, sewage functional; telecoms and alerts reach people; minimum utility continuity (4.0).
BO3 — Workforce (rank 3)	Temporary accommodation for essential workers; enhanced winter road maintenance and transport access.	Employees can evacuate safely when conditions change; clear evacuation procedures (5.0).
BO4 — Access & recovery (rank 4)	Enhanced winter road maintenance; faster access following closure or evacuation; faster restoration of utilities.	Road access and evacuation routes remain usable; businesses can access facilities to secure critical assets when safe.
BO5 — Financial (rank 5)	Business interruption compensation arrangements; local stockpiles of critical materials.	Insurance / business-interruption clarity — proposed as a new non-negotiable.
BO6 — Communication & trust (rank 6)	Regular communication and information sharing; formal business involvement in decision-making.	Fire, ambulance, and emergency response remain available; warning systems work reliably.

4.4 ADDITIONAL INDICATORS SUGGESTED BY PARTICIPANTS

The indicator set is explicitly not static. Participants proposed additions that should be considered when the framework is next revised — some as new indicators, some as new non-negotiables:

Non-negotiables	Activity area	Suggested addition
Ambulance and fire services must be available within a defined response time	Residency	Add or strengthen as a Residency red-line condition; participants stated residency cannot be acceptable without ambulance and fire services.
Designated owner for crisis services provided by the fire service, ensuring continuity of those services	Residency	Keep as proposed non-negotiable / governance requirement.
All residents informed of emergency plans, evacuation routes, and general preparedness	Residency	Add as a strengthened non-negotiable under PR1 Warning reach and comprehension;
Retail, services, schools, preschools, healthcare, and elderly care must remain available	Business / cross-activity area	Keep, but mark as cross-activity area because it affects business continuity, residency, municipal services, and schooling.
Breakdown of trust in information or response mechanisms	Business / cross-cutting	Treat as a red-line override; the draft already frames breakdown of trust in information or response as automatically unacceptable for operations.

Indicator Changes	Activity area	Suggested addition
Insurance / business-interruption clarity as a standalone indicator	Business Operations & Infrastructure	Add as a new indicator or strengthen BO5 Financial Resilience and Business Viability.
One source of truth / tailored communication channels: official information through multiple channels, tailored to limited Icelandic/English speakers, children, and accessible-language needs	Residency / cross-cutting	Add as cross-cutting communications sub-indicator under PR1, TP1, and BO6, or as a separate communications indicator if the framework is expanded.
Public trust in civil authorities: at least 75% of residents should have full trust in decisions and support from civil authorities	Residency	Add as a measurable trust/confidence sub-indicator under PR6 or PR1; could also support governance scoring.
All-season evacuation-route reliability: evacuation roads kept open and in good condition, especially in winter snow/ice conditions	Residency / Business / Temporary Stay	Add as sub-indicator under PR2 Evacuation manageability, and also link to Business access and Temporary Stay evacuation.
General healthcare access	Residency / Municipal Services	Add under PR5 Health, social care, and vulnerable-household continuity or MS1 Access to Municipal Services.
Everyday municipal service continuity, including postal services and waste collection	Residency / Municipal Services	Add as a livability/service-continuity sub-indicator under PR6 or MS1.
Sports, community cohesion, and psychosocial resilience	Residency	Add as a sub-indicator under PR6 Household Preparedness, Predictability, and Community Livability; comments specifically linked sports and community belonging to mental health and resilience.
Separate family support and social support services	Municipal Services	Split existing service-continuity indicators where needed, because participants noted some domains were being mixed.
Separate kindergarten/preschool staffing from primary-school staffing	Municipal Services / Education	Split future questions or indicators, because staffing realities differ enough to affect thresholds.

Free-text responses in the workshop reinforced the addition of new indicators or changes to indicators as well as non-negotiable conditions across the four activity areas.



5. CONNECTING RISK ACCEPTANCE THRESHOLDS TO A RISK ASSESSMENT

The workshop results should be understood as an important input into a future risk assessment, not as a risk assessment in themselves. The workshop clarified what stakeholders consider acceptable, conditionally acceptable, or unacceptable across a set of locally relevant indicators. These stakeholder-defined thresholds provide a decision anchor but they do not replace the need for a structured, evidence-based assessment.

The core relationship

The risk acceptance workshop defined the benchmark. The risk assessment determines whether Grindavík meets, falls short of, or exceeds that benchmark.

For each indicator with a defined threshold, the risk assessment should produce an actual value that can be assessed against the stakeholder-defined acceptable, conditionally acceptable, and unacceptable ranges.

5.1 OPERATIONALIZING THE THRESHOLDS

The logic is illustrated using indicator PR2 — the percentage of vulnerable households with confirmed evacuation-support arrangements. The same approach applies to all indicators.

Assessed value	Category	Required action
≥ 90% confirmed support	Acceptable / Pass	Continue monitoring and maintain arrangements.
80–90% confirmed support	Conditionally acceptable / Conditional pass	Verify all vulnerable households are identified, reachable by alerts, and have practical evacuation-support arrangements.
< 80% confirmed support	Unacceptable / Fail	Immediate corrective action required before residency conditions can be considered acceptable.

5.2 MATCHING EVIDENCE TO INDICATORS

The framework blends different types of evidence, using the most appropriate method to assess the risk level for each indicator, which is then judged against its risk-acceptance level.

Model-based risk indicators (physical)	Survey-based risk indicators (social)
Electricity disruption duration	Household preparedness levels
Heating and water disruption	Warning system comprehension
Road access and evacuation route viability	Temporary visitor awareness rates
Building damage and habitability	Vulnerable household evacuation support
Emergency access constraints	Staff availability and retention
Utility restoration timelines	Public trust in official information

Where neither modelling nor survey evidence is sufficient, a semi-quantitative expert-judgement process can be used. The aim is not to force all indicators into one method, but to translate each into an assessable value comparable against the stakeholder-defined thresholds.

5.3 AN ILLUSTRATIVE TRAFFIC-LIGHT MATRIX

Once risk levels are assessed against thresholds, results can be brought together in a traffic-light matrix: indicators on one axis, activity areas on the other, each cell shown as Pass, Conditional (conditionally acceptable, mitigated), or Fail, with a flag where an absolute non-negotiable has failed; a condition that mitigation measures cannot override. The example below shows the format only; the cells are placeholders, not assessed results for Grindavík.

Illustrative Risk-Assessment Matrix

Example output of a confirmation exercise + risk assessment, by pillar and indicator (ranked 1 = most important).

Residency	Temporary Stay	Municipal Services	Business Operations
PR3 Housing & utilities Conditional	TP1 Information & alerts Pass	MS6 Governance & funding Conditional	BO1 Predictability Pass
PR1 Warnings & understanding Pass	TP6 Time to act Pass	MS5 Emergency services Pass	BO2 Infrastructure Conditional
PR2 Evacuation readiness Pass	TP5 Utility continuity Conditional	MS4 Vulnerable support Conditional	BO3 Workforce Conditional
PR6 Uncertainty & community Conditional	TP4 Numbers present Conditional	MS3 Child protection Fail	BO4 Access & recovery Fail
PR5 Essential support Fail	TP3 Overnight limits Pass	MS2 Staffing Conditional	BO5 Financial Conditional
PR4 Schools & childcare Conditional	TP2 Access control Fail	MS1 Access Pass	BO6 Communication & trust Pass

Pass — within acceptable range
Conditional — concerning; acceptable only if mitigation in place
Fail — exceeds tolerable threshold

Fail = an associated absolute non-negotiable has failed (overrides the indicator status and must be resolved first).

ILLUSTRATIVE ONLY — statuses are examples to show the format; actual values come from the Phase 1/2 confirmation exercise and risk assessment.

Figure 6.1 — Illustrative traffic-light risk matrix. The cell colors and flags shown here are placeholder examples to demonstrate the format only; they are not assessed results for Grindavik.

This visualization is included to show the format the comprehensive risk assessment can ultimately produce. The actual colors would be populated only once real assessed values are available for each indicator.

5.4 MCDA SCORING AS COMPLEMENTARY DECISION-SUPPORT

A multi-criteria decision analysis (MCDA) score can complement; but not replace, the traffic-light assessment. The traffic-light matrix shows whether each individual indicator is acceptable, conditionally acceptable or unacceptable. The MCDA builds on this by assigning a score to each indicator and then combining these scores, using agreed importance weights, into a single score for each activity area. This provides an overall picture that complements the traffic-light matrix and helps compare activity areas in a consistent way. The score is a decision-support tool rather than a pass/fail test. If an activity area's overall score falls below an agreed discussion threshold, it signals that the evidence and trade-offs should be examined more closely before a decision is made.

Score (per indicator)	Meaning
2 — comfortable	Value in the acceptable range, or a conditionally acceptable condition fully mitigated to an acceptable level.
1 to 2 — improving with mitigation	Value in the conditionally acceptable range, with mitigation increasingly in place; the score rises as mitigation becomes more complete and reliable.
1 — conditional, mitigation incomplete	Value in the conditionally acceptable range, with required mitigation absent, incomplete, or unverified — discussion needed.
0 — below discussion threshold	Value in the unacceptable range — a structured discussion is required before any decision; it is a prompt to deliberate, not an automatic veto.

The indicator scores are then combined, using their agreed importance weights, to produce an activity area score. This score provides a simple summary of how each activity area performs across all of its indicators, while still allowing decision-makers to examine the underlying traffic-light results for individual indicators. The MCDA complements the traffic-light matrix; both are decision-support tools. Final decisions remain with the responsible authorities, informed by the relevant multi-agency working groups or appropriate decision making bodies.

5.5 KEEPING THE FRAMEWORK ADAPTIVE

Grindavík's risk context is dynamic, so the framework must not be static. Thresholds should be reviewed and adjusted when new hazard scenarios emerge or scientific uncertainty shifts, when infrastructure is permanently strengthened, or when governance, communication, or public trust improves. New indicators identified during the assessment can be added, provided corresponding thresholds are established transparently and consistently. The elicitation methodology itself is also not fixed: it evolved from open Mentimeter polling to a structured interactive application over roughly six online workshops in 2026, and it should continue to be refined as the work matures.



6. FROM WORKSHOP FINDINGS TO RECOVERY DECISIONS

This chapter sets out how the findings feed into the recovery decisions being taken by the Icelandic authorities. It first explains the purpose of the proposed steps, then summarizes the key technical and policy recommendations, describes a staged pathway, and closes with reflections on wider applicability.

6.1 WHY THESE STEPS

The value of the steps below is that they turn a difficult, open-ended problem into a practical, articulated, and adjustable process. They allow complex decisions to be made in a structured way informed by both hazard science and community values, while a fuller assessment is developed. The work is intended to be continuous and iterative, not a one-off exercise: the thresholds, indicators, and methodology are designed to be maintained and reused as conditions evolve.

One risk deserves particular attention. Over time, the composition of Grindavík's population may change; proportionally more people seeking affordable housing or needing social support may move in, relative to former residents who return. The future community may therefore differ from the pre-eruption one. Authorities should be aware of the longer-term social consequences of near-term decisions; a comprehensive risk assessment can surface these, and, because it takes time, a simpler risk-based examination can flag them sooner.

6.2 KEY RECOMMENDATIONS

Technical recommendations

1. Use the framework as an input. Treat the provisional indicators, threshold ranges, non-negotiables, and mitigation priorities as inputs to be confirmed, not as final standards.

2. Match evidence to indicators. For each indicator, choose the appropriate assessment method (modeling, survey, monitoring, or expert judgement) and estimate an actual value to compare against the thresholds.

3. Make results legible. Present results through the traffic-light matrix and use MCDA scores if applicable, flagging any failed non-negotiable as an automatic non-acceptable risk.

4. Resolve overlaps. Agree consistent thresholds where the same indicator appears across more than one activity area.

Policy recommendations

1. Settle governance. Clarify mandates, decision rights, and roles for the recovery period so responsibilities are predictable as circumstances change.

2. Anchor in risk analysis. Use the participatory criteria to support the comprehensive risk assessment led by the responsible authorities; not to substitute for it.

3. Invest in coordination. Resource coordination between national and local levels and among the many organizations involved.

4. Build local capacity. Build local capacity to interpret and apply the framework, ideally through a dedicated steering arrangement with skilled project management.

6.3 A STAGED PATHWAY: STEP IN, THEN STEP UP

Because a full comprehensive assessment takes time, but several decisions cannot wait, the next steps follow two complementary stages that run in parallel.

1. Step-in (Phase 1) — focus first on the most critical, time-sensitive decisions — above all schooling and housing — assessing only the most important indicators now, using the workshop thresholds, measures, and non-negotiables already available. Results feed into Phase 2.

2. Step-up (Phase 2) — in parallel, build the full comprehensive risk assessment across all areas and indicators, confirm thresholds, and produce the full traffic-light matrix and MCDA scores, with full ownership by the responsible national and local authorities.

Phase 1 focus — schooling and housing

For the two most time-critical decisions, the workshop results already provide a starting compilation of key indicators, priority measures, and non-negotiables.

Decision	Compiled from the workshop results
Schooling (2026–2027)	Key indicators: PR4, PR1, PR2, PR5; MS3, MS2, MS5; TP2. Priority measures: rapid school/childcare restart; regular evacuation exercises; child-friendly, multilingual single-source information; named coordinators; psychosocial support. Non-negotiables: continuous safe schooling (4.1); mandated services incl. child protection (4.5); reliable warnings (5.0); evacuation capability (5.0); ambulance and fire within a defined response time.
Housing (rebuy, leasing, renting, return)	Key indicators: PR3, PR1, PR2; TP5; MS5; BO1/BO2/BO5/BO6. Priority measures: utility resilience and rapid restoration; predictable rules and forward planning; multilingual single-source communication; financial and insurance support; targeted evacuation plans. Non-negotiables: essential utilities reliably available (4.5); reliable warnings (5.0); evacuation capability (5.0); hazard zones and access controls enforced (4.9); trustworthy governance (4.4).

Several indicators (warnings, evacuation readiness, emergency response, trust) are common to both decisions, so working groups will need to agree consistent thresholds where they overlap.

6.4 CONFIRMATION AND WORKING GROUPS

Both stages need a confirmation process before results are relied upon. The workshop outputs are a strong starting point but should be confirmed by a small group combined with expert judgement refining definitions where indicators were too broad and resolving the largest variations noted in Section 4.2. Working groups are recommended for each priority issue, with stakeholder participation. Each group would review the methodology, draw conclusions, and pair each decision with mitigating actions.

6.5 A NOTE ON LEGAL AND ADOPTION DIMENSIONS

Adopting criteria or thresholds is an authority decision with legal dimensions. The workshop outputs are inputs to that process, not binding requirements. International experience suggests that clarity about which criteria are legally binding ("hard") and which are advisory ("soft") helps avoid confusion later; a lesson for Iceland to apply in its own legal context, not a template to import.

6.6 CONCLUDING REMARKS AND WIDER APPLICABILITY

Grindavík exposes a gap that many risk-management systems eventually confront. Comprehensive risk assessments can estimate hazard, exposure and potential loss, but they cannot by themselves determine what conditions society is prepared to accept, for which activities, for how long, and subject to what safeguards. Those judgements become especially difficult where the hazard is persistent, the timing of future events is uncertain, and recovery decisions cannot simply be postponed until the threat has passed.

Iceland does not begin from a blank slate. Its avalanche-risk framework provides an important national precedent: acceptable risk can be expressed quantitatively, embedded in regulation, and differentiated according to occupancy and activity type. That precedent demonstrates the value of clear, legally grounded criteria. It also reveals the limits of relying on a single life-safety metric when the decision context is more complex. For Grindavík, tolerability depends not only on estimated fatality risk, but also on whether warnings reach people, evacuation can be completed, vulnerable groups are supported, utilities and emergency services remain functional, disruption can be absorbed, and responsibilities are clear and financed.

The longer-term comprehensive risk assessment may therefore include quantitative life-safety metrics analogous in form, though not necessarily in value or application, to those used for avalanche risk. Such estimates would be important, but they should sit within a broader decision framework rather than determine tolerability on their own. A low modelled fatality risk does not by itself establish that permanent residency, schooling, temporary access or business activity is acceptable if evacuation arrangements are unreliable, essential services are fragile, or repeated disruption creates serious social and institutional consequences. Conversely, elevated hazard does not automatically make every activity equally intolerable where exposure can be limited and safeguards can be demonstrated.

This points to three connected tracks. **Step-in** uses the provisional criteria, non-negotiables and priority measures to support urgent decisions that cannot wait. **Step-up** completes the comprehensive Grindavík risk assessment, tests actual conditions against the criteria, refines the operational thresholds and assigns responsibility for monitoring and review. **A third, longer-term track** would develop a national framework for volcanic risk, including probabilistic life-safety metrics, societal tolerability principles, treatment of uncertainty and legally grounded guidance for spatial planning, infrastructure, occupancy and recovery. The workshop contributes to that direction of travel, but it does not substitute for the scientific analysis, legal review, political agreement and formal adoption that national standards would require.

The distinctive contribution of this work is therefore not a new universal threshold. It is a practical bridge between three domains that are often treated separately: comprehensive risk assessment, public and stakeholder judgement, and authority-led decision-making. The method makes visible what is otherwise left implicit: whose risk is being considered, which consequences matter, what conditions are non-negotiable, which measures can make residual risk tolerable, and where disagreement reflects values rather than missing science.

International experience supports this logic. Conditional reoccupation on Miyakejima combined exposure thresholds with continuous monitoring, restricted zones and mandatory preparedness. Long-duration volcanic zoning, exclusion, daytime-only access under certain phases and interdependence between hazard restrictions and essential service continuity in Montserrat is a useful example connecting occupation conditions, zoned governance and long-term service adaptation. Finally, while not a decision rule for acceptable volcanic risks, Rekompak program embedded technically informed siting and reconstruction choices within community-led planning that illustrates participatory approaches in recovery governance. Other recovery contexts have similarly combined zoning, monitoring, participation, phased return and institutional safeguards. None provides a ready-made model for Grindavík, but together they show that criteria-based and participatory approaches can strengthen the risk assessment process without replacing it.

For other communities living with volcanic, seismic, flood, wildfire or other prolonged natural-hazard uncertainty, the transferable value lies in the process:

The process in a nutshell

Begin with the decisions that must be made; separate activities and populations where exposure, vulnerability and responsibility differ; define the conditions that would make each activity acceptable, conditionally acceptable or unacceptable; identify the safeguards that cannot fail; and then test those criteria through a comprehensive risk assessment and continuing monitoring.

The numerical thresholds, legal standards and institutional arrangements must remain context-specific. The method, however, is widely applicable. It offers a way to move beyond the unhelpful question of whether a place is simply “safe” or “unsafe” and toward a more transparent and accountable question: **under what conditions can people, institutions and authorities justify living and operating with residual risk?** That is the question Grindavík is confronting now, and it is one that many communities’ facing long-term environmental uncertainty will increasingly need to answer.

ANNEX A. PARTICIPATION AND WORKING GROUPS

The two-day workshop of 18–19 June 2026 was conducted in five pre-assigned working groups, supported by a facilitation team. To protect participant privacy, this report lists institutions and roles only; individual names are not published. Threshold voting took place on 18 June. Not all participants attended on both days.

A.1 FACILITATION AND PRESENTING TEAM

The workshop was facilitated by a joint team drawn from the following institutions:

- Prime Minister's Office (Grindavík project management)
- World Bank team (Disaster Risk Management specialists)
- Icelandic Meteorological Office (volcanic hazard coordination and research)
- Verkís — risk and safety consultancy

A.2 INSTITUTIONS REPRESENTED ACROSS THE WORKING GROUPS

Participants across the five groups represented national government, the municipality and its civil protection structures, emergency and response agencies, utilities, the scientific community, the private sector, and independent risk and safety experts. The institutions represented included:

National government and policy

- Prime Minister's Office
- Ministry of Social Affairs and Housing
- Ministry of Education and Children
- Department of Civil Protection and Emergency Management (National Commissioner of Police)

Municipality, civil protection and community

- Municipality of Grindavík (mayor, municipal council, culture affairs, assets and utilities, safety management, harbour master)
- Grindavík Civil Protection Committee
- Grindavík fire service
- Grindavík Þorbjörn search and rescue (SAR)
- UMFG sports club
- Icelandic Red Cross
- Þórkatla (property company)
- Suðurnes Prosperity Council

Emergency response and law enforcement

- Suðurnes District Police
- Suðurnes fire service
- Department of Civil Protection and Emergency Management

Science, utilities and infrastructure

- Icelandic Meteorological Office (Natural Hazards Services)
- HS Veitur (utilities)

Private sector and independent experts

- Grindavík businesses (multiple)
- Risk and safety consultancies — Verkís, Efla, Öruggr, Elfa, COWI, VSS, and independent consultants

A.3 GROUP SIZES BY DAY

Attendance differed between the two days. The counts below reflect the number of participants present in each group on each day; threshold voting took place on 18 June.

Working group	18 June (voting)	19 June
Residency 1	6	6
Residency 2	7	6
Temporary Stay	7	7
Municipal Services	7	7
Business Operations & Infrastructure	7	8

Note: not all participants attended on both days. Group sizes are modest and were assembled to reflect relevant institutional perspectives; the consultations were not designed to be statistically representative of the Grindavík population.

A.4 WORKSHOP FLOW AND METHOD

The workshop followed a structured participatory process: ground the hazard, build a shared understanding, elicit risk tolerance in facilitated groups, then review the results and integrate them into a decision-making framework.

Day 1 — Grounding the hazard and defining risk tolerance levels (Grindavík)

Time	Session	Purpose
09:00–09:30	Welcome & Objectives (Steinarsson / Ayhan)	Anchor public risk perception and outline the two-day workflow.
09:30–10:15	Context Presentations (Hjálmarsdóttir / Khazai / Serenko)	Review prior online and March workshops and the social dimensions of displacement.
10:15–10:45	Grounding the Science (IMO / Barsotti)	Briefing on seven hazards and geophysical realities, including less visible ground deformation and subsurface cracking.
10:45–11:30	Grindavík Hazard Explorer (Daniell)	Interactive mapping of hazards, assets, vulnerabilities, and protective measures.
12:30–13:00	Mechanics Briefing (Khazai)	Overview of the risk tolerance framework and threshold-setting approach.
13:00–16:15	Group Exercises 1 & 2	Facilitated risk tolerance elicitation across the four thematic areas.
16:15–16:30	Reflections and Recap	Day 1 reflections.

Day 2 — Reviewing results and building the framework (Reykjavík)

Time	Session	Purpose
09:00–10:15	Reporting Back	Group rapporteurs present key concerns and non-negotiables per area.
10:15–11:30	Review of Results (Khazai / Daniell)	Interactive review of consensus, divergence, and cross-cutting issues.
12:30–14:00	Putting It All Together (Khazai)	Integrate thresholds and non-negotiables into decision-making frameworks.
14:00–14:30	Workshop Close	Recap, next steps, and closing remarks.

ANNEX B. PREPARATORY ONLINE WORKSHOPS

The June in-person workshop was the culmination of an extended engagement rather than a standalone event. In early-to-mid June 2026, the Grindavík Emergency Coordination (GEC) organized approximately six online workshops with stakeholders from and beyond Grindavík. Around 80 stakeholders took part in total. These sessions progressively refined the concerns that the June threshold-setting exercise then tested in depth.

The six preparatory workshops were grouped around three broad themes:

Society in Grindavík

- Children and vulnerable groups
- Social, welfare, health and education services
- Infrastructure, housing and residency, organisations and society

Economy

- Threats to operations, business continuity, present status, and future vision for economic activity

Framework

- Risk-assessment methodology
- Safety in Grindavík and emergency response

Across these sessions, participants discussed threats to operations, the safety of people, present challenges, current status, future vision and endurance, mitigation actions, and appropriate scales. The results fed directly into the World Bank workshops held in Grindavík and Reykjavík in June, alongside the 18 March online workshop (see Annex C). This report keeps the preparatory, March, and June datasets separate; the preparatory sessions provided qualitative input that informed the design of the four-activity area indicator sets, and are not merged with the June threshold results.

ANNEX C. THE 18 MARCH RISK-TOLERANCE WORKSHOP

This companion note summarizes the rapid two-hour participatory online workshop held on 18 March 2026 and shows how its findings connect to — and were later confirmed by — the two-day workshops of 18–19 June 2026. It is a standalone summary; its results are reported separately and are not merged with the June threshold data.

C.1 WHAT THE MARCH WORKSHOP FOUND

The March 18 workshop was a rapid participatory preview of an acceptable-risk process for Grindavík under continued volcanic unrest. It convened 30 participants from 15 organizations working in four mixed groups (residential return; commercial and industrial activity; tourism; and schools). Participants judged each risk factor on a five-step acceptability scale (A1–A5), where A1 marks the most protective position — high safety margins and minimal tolerance for harm or disruption — and A5 the highest tolerance, covering conditions normally considered unacceptable for most activities. In practice only the three most protective steps (A1–A3) were used; no group selected A4 or A5. Five findings stood out:

- A bounded space — no group accepted high-risk outcomes — every response across all 16 factors stayed within the three most protective steps (A1–A3), with none at A4 or A5.
- Warnings first — the reliability of warning and communications systems was the single least-negotiable condition (mean tolerability 1.00, with 100% of votes in the most protective category), followed by fatality risk, trust in authorities, and emergency-response capacity.
- A strict core — participants separated protections that must stay strict (warning systems, institutional trust, life safety) from burdens that could be managed operationally (road access, evacuation, temporary economic disruption).
- A sectoral divide — schools and residential return took a protective, safety-first posture, while tourism and commercial activity took a more operational, continuity-first posture, still within moderate bounds.
- Consistent with survey evidence — the patterns aligned with the November 2023 household survey of roughly 3,700 evacuated

residents, in which uncertainty about when eruptions will end was the most-cited barrier to return.

Because participants never used the two lowest-protection steps, the June workshops retired the A1–A5 scale altogether. Instead of a single ordinal rating, June adopted a tipping-point method that places each indicator into one of three zones — acceptable, conditional, or unacceptable — with the boundaries between them set directly by participants.

C.2 HOW MARCH CONNECTS TO JUNE

The March findings map directly onto the June conclusions. June participants likewise identified reliable warnings, evacuation capability, and emergency-response readiness as the strongest non-negotiables — captured in the message that "communication is number 1, 2 and 3." June confirmed that tolerance is not uniform across activities, echoing March's sectoral divide and supporting differentiated, activity-specific thresholds. The central March recommendation — to deepen the rapid preview — was realised in June, where the two-hour familiarisation session became a full two-day deliberative process with factor-by-factor threshold setting and a validation stage.

C.3 METHODOLOGICAL DIFFERENCES

Dimension	March 18 workshop	June 18–19 workshops
Format and duration	Rapid two-hour evaluation session	Full two-day deliberative process with iteration and a validation stage
Acceptability scale	Five-step A1–A5 scale (A1 most protective, A5 highest tolerance)	Activity-specific thresholds with traffic-light status and staged step-in / step-up logic
Factors assessed	16 factors common to all activities, across four dimensions	Same dimensional logic, expanded into detailed per-activity indicator sets and scored non-negotiables
Activities covered	Residential return; commercial and industrial; tourism; schools	Related but not identical set: residency; temporary stay; municipal services; business operations
Scenario	One shared scenario of continued unrest around Svartsengi	Two structured scenarios (prolonged uncertainty; repeated evacuation)
Status of outputs	Stakeholder judgments and priorities — explicitly not formal thresholds	Negotiated threshold ranges and decision rules intended to inform assessment and authority decisions

Read together, the March preview and the June workshops tell a consistent story, and the convergence strengthens confidence in both sets of results.

ANNEX D. THE GRINDAVÍK HAZARD / RISK-ACCEPTANCE WEB PLATFORM

A web-based discussion tool was developed to support a shared understanding of volcanic hazards, exposure, and risk-acceptance thresholds. It was used during the June 2026 workshop to give participants a common visual baseline before and during the threshold-setting exercises. Participants retain access to the platform beyond the workshop, so it can continue to support discussion and future rounds.

Status of the platform

The platform was designed for workshop discussion only. It is not an official hazard assessment, risk assessment, or operational decision-making system. Hazard information was presented for illustrative purposes, drawn from the Icelandic Meteorological Office and associated reference layers, and does not replace scientific assessment or official hazard communication.

D.1 TWO CONNECTED COMPONENTS

Interactive hazard mapping — separating the combined hazard picture into seven individual layers relevant to Grindavík:

- Vent opening — where new eruptive fissures may open, often with little warning
- Lava flow — areas effusive lava could reach, affecting buildings, roads, utilities, and access
- Tephra fall — the possible ash footprint, reducing visibility and air quality
- Gas pollution — where volcanic gases could reach harmful concentrations
- Fault movements — ground displacement affecting roads, pipelines, and infrastructure
- Ground collapse — where the surface may give way into hidden voids
- Earthquakes — seismic shaking associated with magma movement and faulting

Risk-acceptance workshop tools — supporting the four-activity area process: setting thresholds; ranking indicator importance; identifying missing indicators; scoring non-negotiable conditions; and ranking mitigation measures that could make a conditional situation acceptable.

D.2 HOW THE PLATFORM SUPPORTED THE WORKSHOP

- **Shared baseline** — a shared hazard baseline, so all participants worked from the same combined map, individual layers, and exposure overlays.
- **Structured questions** — structured risk-tolerance questions, focusing participants on acceptable, conditional, or unacceptable conditions rather than on validating the science.
- **Better method** — an improved threshold-setting method: visual Red and Yellow handles made the tipping-point logic clearer than the initial open-polling format and showed averages, ranges, and individual responses.
- **A bridge** — a bridge to future assessment: the platform records thresholds, rankings, non-negotiables, and mitigation measures for later comparison against assessed risk levels.

An interactive lava-scenario component allowed participants to explore modelled lava advancement at selected intervals (for example, 90 and 180 minutes), toggle likelihood categories and reference layers, and consider effects on access, barriers, evacuation routes, and service continuity. It was a discussion interface, not a new lava-flow model, drawing on Icelandic Meteorological Office and Landmælingar Íslands reference layers.

D.3 HAZARD MAPPING COMPONENT

The first part of the platform was developed to support a shared understanding of the hazard context. The Icelandic Meteorological Office presented the hazard methodology and the combined hazard map as part of the workshop. The IMO hazard map provides an aggregate hazard score for the assessed area, which is useful as a headline view of the overall hazard picture. However, workshop participants also needed to understand the individual hazard components behind that combined score.

The platform therefore separated the combined hazard picture into the seven individual hazard layers relevant to Grindavík. This helped participants see how different hazards vary spatially and how they relate to the town, roads, infrastructure, buildings, defense structures, lava barriers, lava extent, fissures, and other reference layers.

The hazard component was used to support discussion of:

- which individual hazards contribute to the combined hazard picture;
- where different hazards are most relevant spatially;
- how hazard layers relate to exposed values such as people, buildings, roads, utilities, services, and businesses;
- how lava scenarios may affect Grindavík under different assumptions; and
- how the hazard context informs later risk tolerance discussions.

The platform does not calculate risk directly. It shows hazard, and in some cases exposure and defense-structure overlays, as context for the risk acceptance discussion.

D.4 INDIVIDUAL HAZARD LAYERS

The individual hazard layers were included to help participants understand the specific hazard components behind the combined map. This was important because each hazard has a different spatial pattern, time dynamic, and implication for decision-making.

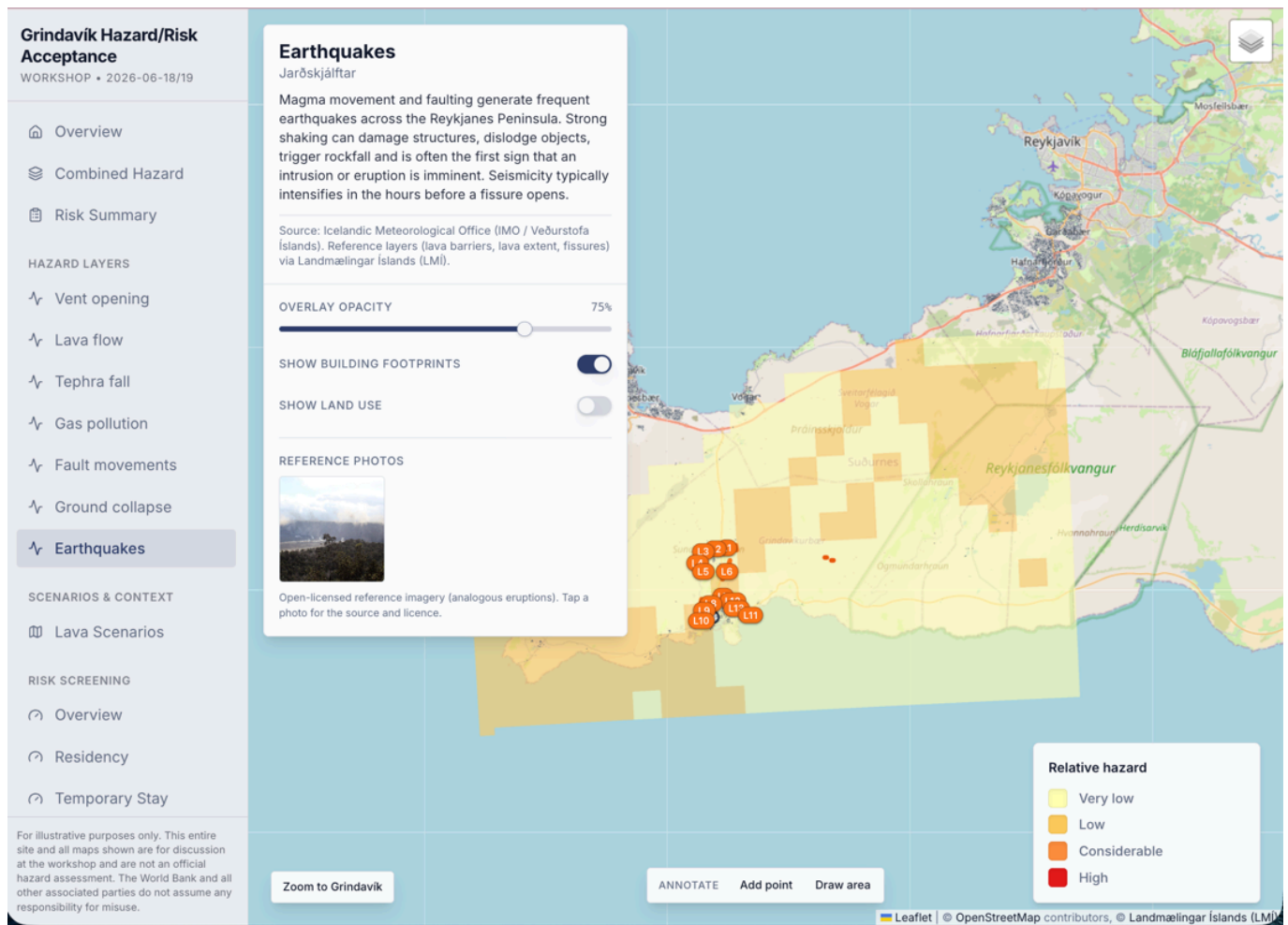
The platform included the following individual hazard layers:

- **Vent opening:** areas where new eruptive fissures and vents are most likely to open at the surface. This hazard is important because it can develop rapidly and may provide little or no warning once a fissure propagates.
- **Lava flow:** areas that effusive lava could reach once an eruption is underway. This layer is relevant for buildings, roads, utilities, barriers, industrial areas, and access routes.
- **Tephra fall:** the possible footprint of ash and coarser volcanic material during explosive phases. Tephra fall can reduce visibility and air quality, contaminate water and disrupt transport.
- **Gas pollution:** areas where volcanic gases such as sulphur dioxide and carbon dioxide could reach harmful concentrations. Gas can travel downwind and accumulate in low-lying

or sheltered areas.

- **Fault movements:** areas where magma intrusion and tectonic strain may cause ground displacement along faults and fractures, affecting roads, pipelines, utilities, buildings, and infrastructure.
- **Ground collapse:** areas where ground may collapse into hidden cracks, voids, or cavities. This hazard is particularly difficult because the surface may appear intact until it gives way.
- **Earthquakes:** seismic shaking associated with magma movement and faulting across the Reykjanes Peninsula, with potential impacts on structures, slopes, rockfall, objects, and preparedness conditions.

Together, these layers made the combined hazard picture easier to interpret and helped workshop participants distinguish between hazards that directly affect physical assets and hazards that affect safety, access, communication, exposure, and service continuity.



D-1 Earthquake Hazard map showing IMO's relative earthquake hazard levels

D.5 INTERACTIVE LAVA SCENARIOS AND SUPPORTING LAYERS

The platform also included an interactive lava-flow scenario component. This allowed participants to explore modelled lava-flow advancement after eruption onset, with scenario views showing estimated lava coverage and thickness at selected time intervals, including 90 minutes and 180 minutes. Users could switch between likelihood categories, adjust the opacity of the lava overlay, show or hide building layers, and view supporting reference layers such as lava barriers, infrastructure, roads and affected areas.

The lava scenario function helped participants consider how changing hazard conditions could affect:

- road access;
- lava barriers and defense structures;
- buildings and infrastructure;
- evacuation routes;
- service continuity; and
- areas where operational restrictions may be needed.

The component was not intended to produce a new lava-flow model or replace official hazard assessments. It was used as a visual discussion and decision-support interface for the workshop, drawing on available lava-flow scenario information and reference layers from the Icelandic Meteorological Office.

D.5 RISK ACCEPTANCE COMPONENT

The second part of the platform supported the risk acceptance and threshold-setting work. On the first day of the workshop, participants used Mentimeter to evaluate tipping points: the point at which a condition becomes unacceptable, and the point at which it becomes conditionally acceptable. However, the question formats available in Mentimeter — mainly multiple choice, ranking, and scale questions — were not always intuitive for threshold-setting. Some participants found it difficult to interpret the Red and Yellow tipping-point logic using those formats. The platform was therefore extended into a more visual threshold-setting tool for Day 2. This allowed participants to review and adjust threshold values using a clearer interface. The Risk Thresholds section allows users to set thresholds for each indicator across the four activity areas:

- Residency;
- Temporary Stay;
- Municipal Services; and
- Business Operations & Infrastructure.

For each indicator, the user can set:

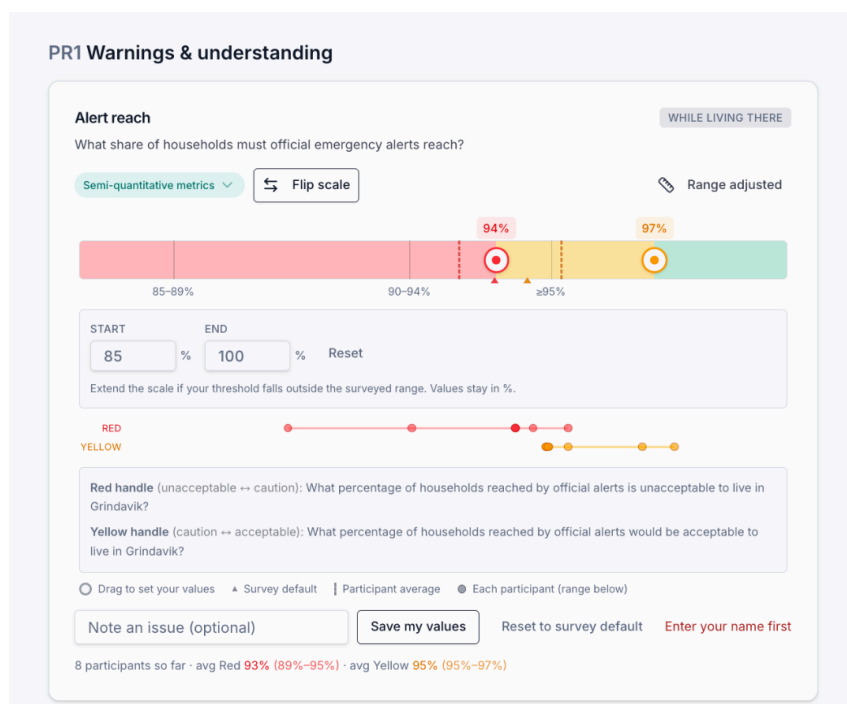
- the **Red threshold**, where the condition becomes unacceptable;
- the **Yellow threshold**, where the condition moves from acceptable to conditional;
- the **Acceptable range**, where the condition remains within the stakeholder-defined acceptable zone; and
- the **Conditional range**, where the condition may be tolerable only if mitigation measures are in place.

For continuous indicators, the interface uses drag-gable Red and Yellow handles on a horizontal scale. For example, under the Residency activity area, indicator PR1 — Warnings & understanding, participants could set the threshold for what share of households must receive official emergency alerts while living in Grindavik under prolonged uncertainty. Moving the Yellow handle defines where the condition becomes acceptable; moving the Red handle defines where it becomes unacceptable. The space between the two handles represents the conditional zone.

If participants considered that there should be no conditional zone, the Red and Yellow handles could be placed on the same value. This creates a direct boundary between acceptable and unacceptable. The tool also displays:

- the current live value which is set based on the analyzed workshop results;
- the participant average;
- the range of participant responses;
- individual participant data points;
- the current live value;
- the scenario being assessed;
- the question instructions for the Red and Yellow handles; and
- an optional note field where participants can flag issues with the question.

Importantly, users can also adjust the displayed range if they feel the default scale is too narrow or too wide. This was useful where participants felt that the relevant acceptance threshold needed to be shifted left or right of the initial scale.



D.6 CONTINUOUS AND ORDINAL THRESHOLD SETTING

The platform supports both continuous and ordinal threshold-setting.

For continuous indicators — such as percentages, hours, days, or numbers of people — participants can move Red and Yellow handles along a scale. This allows the exact tipping point to be captured more clearly than in a fixed multiple-choice format.

For ordinal indicators — where the answer is based on qualitative levels rather than continuous values — the interface allows participants to select Red and Yellow tipping points from a set of defined options.

This distinction between continuous and ordinal indicators was important because different indicators require different measurement logic. Some thresholds are best expressed as a precise value, such as a percentage of households reached by alerts. Others are better expressed through ordered descriptors, such as levels of household planning certainty or disruption to community life.

D.7 RISK ACCEPTANCE: RANKINGS, MISSING INDICATORS, NON-NEGOTIABLES, AND MEASURES

The Risk Acceptance section of the platform stores and displays the additional judgement inputs collected during the workshop. This includes ranking information, missing indicator comments, non-negotiable scoring, and mitigation-measure rankings.

Indicator importance ranking

For each activity area, participants ranked the six indicators according to importance. This provided a way to identify which indicators were most decision-critical within each thematic area. These rankings were later used in the report to help interpret which indicators should receive greater weight in a risk assessment or MCDA framework.

Missing indicators

The platform also allowed participants to suggest missing indicators. This was important because the indicator set was not treated as final or closed. Participants were able to identify gaps or refinements.

Non-negotiable conditions

The platform also collected scores for candidate non-negotiable conditions under each activity area. These were scored on a scale from 1 to 5, where 1 means not essential and 5 means absolutely essential. These non-negotiables are important because they

act as red-line conditions. If a non-negotiable fails, the situation should be treated as unacceptable even if some other indicators fall within the conditional or acceptable range.

Measures that can support conditional acceptance

Finally, the platform allowed participants to rank measures that could increase willingness to accept a conditionally acceptable situation. These measures were ranked separately for:

- prolonged uncertainty; and
- repeated evacuations.

D.8 LIMITATIONS AND DISCLAIMER

The platform was created for workshop discussion and learning purposes only. It should not be interpreted as an official hazard map, official warning product, formal risk assessment, or operational decision-making system.

The hazard layers were based on information presented for the workshop and available reference layers. The platform does not independently validate the hazard data, does not calculate risk, and does not determine whether residency, temporary stay, municipal services, or business operations are safe or unsafe.

The risk acceptance component records stakeholder inputs, thresholds, and rankings developed through the workshop process. These outputs are important inputs to a future risk assessment, but they are not a substitute for a comprehensive risk assessment, official decision-making, or scientific monitoring.

The platform should therefore be understood as an explanatory and participatory interface. Its value lies in helping stakeholders view the same hazard and exposure context, define risk tolerance thresholds more transparently, and connect those thresholds to future risk assessment and decision-making.

ANNEX E. METHODOLOGICAL NOTE AND REFERENCES

This note situates the workshop approach within established risk-management practice. It draws on four families of reference methods, adapted to Grindavík's participatory context. None of these methods was applied as a formal certification; they informed the design of the three-zone thresholds, the traffic-light matrix, and the MCDA scoring described in Chapter 5.

E.1 REFERENCE METHODS

1. **BBK (German Federal Office of Civil Protection and Disaster Assistance) risk-matrix methodology:**

a scenario-based approach to analysing risk across several consequence dimensions (people, economy, environment, infrastructure and supply systems, and intangible or societal impacts), informing the multidimensional indicator sets. This is directly relevant to Grindavík because risk cannot be reduced to one metric. Risk tolerance depends not only on potential fatalities, but also on evacuation capacity, warning reliability, service continuity, vulnerable residents, schools, business interruption, public trust, governance and community functioning. Note: The BBK methodology itself builds upon earlier scenario-based risk and vulnerability analysis methods developed by the **Swedish Emergency Management Agency (KBM)** and subsequently the **Swedish Civil Contingencies Agency (MSB)**.

2. Health and Safety Executive (HSE). (2001). Reducing Risks, Protecting People: HSE's decision-making process. London: HSE: the ALARP and tolerability-of-risk logic underpinning the three-zone structure used throughout: acceptable, conditionally acceptable (tolerable with measures), and unacceptable.

3. MCDA sorting methods: sorting and classification methods (such as **ELECTRE TRI**) that assign conditions evaluated on several criteria into ordered categories using reference profiles. This informs the logic behind classifying assessed conditions as acceptable, conditional, or unacceptable. See for example: the **ELECTRE TRI** approach which is relevant to the Grindavík approach developed, because assessed conditions are classified into acceptable, conditional and unacceptable categories. The methodology is described in: Bouyssou, D., Marchant, T., & Pirlot, M. (2022). "A theoretical look at **ELECTRE TRI-nB** and related sorting models." *4OR — A Quarterly Journal of Operations Research*.

4. International Civil Aviation Organization (ICAO). Safety Risk Management: a practical operational reference for using a risk matrix to visualize risk levels and link them to tolerability categories and required actions; the basis for the illustrative traffic-

light presentation. This provides a practical operational reference for the traffic-light logic used in the Grindavík framework.

E.2 EU AND ICELANDIC POLICY

1. Government of Iceland. (2000). Regulation No. 505/2000 on Hazard Zoning due to Snow- and Landslides, Classification and Utilisation of Hazard Zones, and Preparation of Provisional Hazard Zoning (Reglugerð nr. 505/2000 um hættumat vegna ofanflóða, flokkun og nýtingu hættusvæða og gerð bráðabirgðahættumats). Ministry for the Environment. Official regulation:

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3. Decision No. 1313/2013/EU on a Union Civil Protection Mechanism. Official EUR-Lex text. Especially relevant are the provisions on risk assessment, disaster-risk-management planning, capability assessment, prevention, preparedness, and the definition of risk-management capability in relation to risk levels acceptable in the Member State. Stable official EUR-Lex source.

4. European Commission, EU Civil Protection Mechanism. Official DG ECHO overview page explaining the mechanism's role in disaster coordination, prevention, preparedness, risk assessments, early warning, rescEU, and the ERCC. Stable official Commission source.

5. Directive 2001/42/EC on the assessment of the effects of certain plans and programs on the environment. Official EUR-Lex/ELI source. Particularly relevant for land-use planning, environmental assessment, and the requirement to consider significant effects on population, human health, material assets, climate, and related factors. Stable official EUR-Lex source.

E.3 INTERNATIONAL CASES

1.Miyakejima, Japan. Conditional reoccupation under monitored volcanic hazard: Following the 2000 eruption and complete evacuation of Miyakejima, permanent residents were allowed to return in 2005 under a framework of continuous sulfur dioxide monitoring, defined exposure thresholds, evacuation procedures and mandatory preparedness measures. This represents one of the closest international analogues to Grindavík, demonstrating how long-term occupation can be managed under continuing volcanic hazard through monitored residual risk rather than the complete removal of risk (Kochi et al., 2017).

2.Montserrat. Adaptive volcanic zoning and long-term service continuity: The Soufrière Hills eruption led to decades of dynamic hazard zoning, exclusion areas, phased access arrangements and continuing adaptation of infrastructure and essential services. Rather than a single decision on return, Montserrat demonstrates how occupation, governance and service delivery can evolve alongside changing volcanic conditions. The experience highlights the importance of integrating hazard assessment with institutional capacity, infrastructure resilience and long-term recovery planning (Wadge et al., 2014; Sword-Daniels et al., 2014).

3.Indonesia (Rekompak). Participatory recovery and community-led reconstruction: The World Bank-supported Rekompak programme embedded community participation within technically informed settlement planning and post-disaster reconstruction following major earthquakes and volcanic eruptions in Indonesia. Although it does not establish acceptable-risk thresholds, it provides an important example of how communities can participate meaningfully in recovery decisions while operating within technical and hazard constraints. Its principal relevance to Grindavík lies in governance, stakeholder engagement and transparent decision-making (World Bank, 2011; World Bank, 2012).

E.4 REFERENCES

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3.Bouyssou, D., Marchant, T., & Pirlot, M. (2022). A theoretical look at ELECTRE TRI-nB and related sorting models. 4OR, 20(4), 507–543. <https://doi.org/10.1007/s10288-022-00501-9>

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9.European Parliament and Council of the European Union. (2001). Directive 2001/42/EC of the European Parliament and of the Council of 27 June 2001 on the assessment of the effects of certain plans and programmes on the environment. Official Journal of the European Communities, L 197, 30–37. <https://eur-lex.europa.eu/eli/dir/2001/42/oj>

10.Kochi, T., Iwasawa, S., Nakano, M., Tsuboi, T., Takebayashi, T., & colleagues. (2017). Influence of sulfur dioxide on the respiratory system of Miyakejima adult residents six years after returning to the island. Journal of Occupational Health, 59(4), 313–326. <https://doi.org/10.1539/joh.16-0256-OA>

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ANNEX F. RISK ACCEPTANCE INDICATOR DEFINITIONS

This appendix sets out the full risk acceptance indicators used in each of the four thematic areas, together with their working definitions and the context that explains why each matters. The wording preserves the definitions presented to participants during the workshop as closely as possible. Each activity area uses six indicators (PR/TP/MS/BO 1–6).

F.1. RESIDENCY

Residency in Grindavík depends on whether households can live with continued volcanic uncertainty while maintaining safety, essential services, basic predictability, and community life. Stakeholders emphasized that return to residency is not only a question of physical access to homes, but also of reliable warnings, evacuation manageability, housing habitability, functioning utilities, support for vulnerable residents, continuity for children and families, and confidence that official decisions and services can be trusted when conditions change.

Key themes: warning reach, comprehension, and trusted official information; evacuation manageability and emergency response for households; vulnerable-household support; housing habitability and critical utilities; education, childcare, and youth continuity; health and social care continuity; household preparedness and predictability; community activities, sports, and psychosocial resilience; safe road access; and trust in civil authorities.

PR1 Warning reach, comprehension, and official information channel

Residents receive official warnings and information through trusted channels, understand what the information means, and know what action to take before, during, and after changes in volcanic activity or evacuation status.

Why it matters: Residency cannot be considered acceptable if households do not receive, understand, and trust official information. Stakeholders placed very low tolerance on failures in warning reach and comprehension, with strong emphasis on residents knowing where to obtain official information and what actions to take. The concern is not only whether an alert is sent, but whether it reaches households, is understood by all groups, and provides clear instructions for protective action.

PR2 Evacuation manageability and emergency response for households

Households can evacuate within the available warning time, including vulnerable households that require confirmed support arrangements, and

emergency response services remain capable of assisting residents when conditions change.

Why it matters: Evacuation capability was ranked as the most important residency indicator. Stakeholders treated failure to evacuate households, especially vulnerable households, as one of the least tolerable conditions for residency. This indicator reflects the need for clear evacuation routes, confirmed support for vulnerable residents, accessible emergency plans, and available fire, ambulance, police, and civil protection response. Residency becomes unacceptable if residents cannot leave safely when instructed or if emergency support cannot be relied upon.

PR3 Housing habitability and critical utilities

Homes remain safe and habitable, and critical utilities such as electricity, heating, water, telecommunications, and road access are sufficiently reliable to support permanent residency.

Why it matters: Even if physical access to Grindavík is possible, residency depends on whether homes can function as homes. Stakeholders indicated low tolerance for disruption to essential utilities and restoration delays after evacuation. This indicator captures whether households can rely on heat, power, water, communications, and basic infrastructure, and whether disruption levels remain within tolerable limits. It also reflects the need for rapid restoration after evacuation and for clear information on when housing and utility conditions are safe enough for return.

PR4 Education, childcare, and youth continuity

Children and young people can continue education, childcare, youth activities, and daily routines with limited disruption, and families can rely on clear arrangements when schools or childcare services are interrupted.

Why it matters: Residency for families depends heavily on continuity for children. Stakeholders treated repeated or prolonged school and childcare disruption as a key factor affecting whether families can realistically return or remain in Grindavík. This indicator reflects not only formal schooling, but also childcare, youth continuity, social routines, and the

stability needed for children's wellbeing. Where disruption occurs, families need predictable arrangements, rapid resumption, and additional support.

PR5 Health, social care, and vulnerable-household continuity

Health, social care, home support, and services for vulnerable households remain available without unacceptable delay, including support for older people, disabled residents, households needing social care, and residents requiring practical assistance during evacuation or return.

Why it matters: Stakeholders placed low tolerance on delays in essential support, especially after evacuation or during disrupted conditions. Residency cannot be treated as acceptable if vulnerable residents lose access to essential care, home support, healthcare, or social services. This indicator reflects the need to identify vulnerable households, maintain contact, provide evacuation and return support, and ensure that essential services continue even when normal arrangements are disrupted.

PR6 Household preparedness, predictability, and community livability

Households can plan their daily lives with sufficient predictability, understand what repeated disruptions may mean, and continue participating in community life, including social, cultural, sports, and support networks.

Why it matters: Long-term residency depends not only on safety and services, but also on whether people can live a stable and meaningful life in Grindavík. Stakeholders highlighted uncertainty, reduced community activities, and loss of social cohesion as important pressures on resilience and mental health. Participant comments specifically noted the protective role of sports, community belonging, and social cohesion. This indicator therefore captures household preparedness, planning horizons, return arrangements, community continuity, psychosocial resilience, and confidence that life in Grindavík remains livable under continued uncertainty.

F.2. TEMPORARY STAY

Temporary presence means people who are in Grindavík for visits, events, work tasks, tourism, family visits, organized activities, or short stays, but who are not permanent overnight residents. It is not limited to daytime visits — it may include controlled overnight stays such as short-term accommodation, work-related stays, or event-related visits. Stakeholder discussions suggested that acceptable risk thresholds for overnight stays are generally lower than for daytime activities.

Indicator definitions

TP1 Information, understanding, and alert accountability

Temporary users can obtain, understand, and act on official safety information.

Why it matters: This reflects one of the strongest workshop messages — “communication is number 1, 2 and 3.” The concern was not simply whether visitors received an alert, but whether they knew where to obtain information, understood what it meant, and knew what to do.

TP2 Controlled access to permitted areas and enforceable exclusion zones

Temporary users only access areas that are clearly permitted, with hazardous areas visibly excluded and restrictions actively enforced.

Why it matters: The question is whether temporary users and visitors can clearly understand where they can and cannot go.

TP3 Overnight stay restrictions

Under what conditions should temporary users be allowed to stay overnight, and when should temporary presence become limited to daytime use only?

Why it matters: This operationalizes one of the most important policy transitions: overnight temporary use → essential overnight use → daytime only → no temporary presence. Previous workshops did not define temporary presence as daytime only, but suggested tolerance for overnight presence was substantially lower than for daytime activities.

TP4 Temporary presence relative to management capacity

Temporary presence remains at a scale that can be safely informed, supported, supervised, evacuated, and accommodated using available services, infrastructure, and emergency arrangements.

TP5 Essential utility continuity

Temporary presence is only permitted when essential utilities remain available or can be restored within an

acceptable timeframe.

Why it matters: Reliable access to electricity, water, and telecommunications repeatedly emerged as a fundamental prerequisite for safety, operations, communication, evacuation, and service continuity. Participants linked utility failures to broader consequences, including loss of information, reduced emergency-response effectiveness, disruption of activities, and reduced ability to safely support people present in Grindavík.

TP6 Time available for safe protective action

Temporary users have sufficient time to receive warnings, understand instructions, and reach a safe location before conditions become unsafe.

Why it matters: Warning effectiveness depends not only on when an alert is issued but also on whether people can understand instructions, decide what to do, and move safely using available evacuation routes. Temporary users may require more time than residents because they are less familiar with local hazards, routes, and procedures.

F.3. MUNICIPAL SERVICES

Municipal services underpin safety, wellbeing, and daily life in Grindavík. Discussions highlighted that resilience depends not only on hazard management, but also on maintaining essential services, emergency response, clear procedures, and support for vulnerable residents during prolonged uncertainty.

Key themes: service continuity during disruptions; emergency response capacity; evacuation and contingency planning; support for vulnerable residents; workforce, housing, and staffing; clear communication and guidance; critical infrastructure reliability; and multi-agency coordination.

Indicator definitions

MS1 Access to municipal services

Residents can continue accessing essential municipal services when normal arrangements are disrupted. Municipal services include:

- Schools and childcare
- Social services
- Child protection
- Services for disabled people
- Services for older people
- Home nursing and home support
- Youth, leisure, and community services

Why it matters: Residents need confidence that if services are disrupted, they will know where services continue, who is responsible, and how support can still be accessed.

MS2 Staffing and local capacity

Municipal resilience depends not only on the number of staff available, but also on experience, local knowledge, specialist expertise, housing availability, staff wellbeing, and the ability to access backup personnel when needed. Critical staff include:

- Emergency responders — police, fire, and ambulance
- Teachers and childcare staff
- Social workers
- Child protection staff
- Home nursing staff
- Staff supporting disabled and older residents
- Municipal coordination and service personnel

MS3 Child protection

Children and young people remain safe, supported, and able to continue learning and participating in

everyday life during prolonged uncertainty and repeated evacuations.

Why it matters: This reflects workshop concerns regarding education, childcare, safeguarding, wellbeing, and maintaining a sense of normality for children and families.

MS4 Support for vulnerable residents

Vulnerable residents are identified, monitored, and supported so they do not lose access to essential care, welfare support, or evacuation assistance during prolonged uncertainty or repeated evacuations. Vulnerable residents include:

- Disabled people and disabled children
- Older people needing support
- People receiving home nursing or home support
- People dependent on medication, meals, daily assistance, or assistive devices
- Children and families receiving social services or child protection support
- Foreign-language households or others not easily reached through standard communication
- Residents who may need assistance to evacuate

MS5 Emergency services readiness

Emergency services have the agreements, staffing, response capacity, and coordination needed to support safe residence, service delivery, and reopening during prolonged uncertainty or repeated evacuations. Emergency services include:

- Fire service response
- Ambulance and medical transport
- Police presence and visibility
- Mutual aid from neighboring areas
- Multi-agency response coordination
- Exercises, alerting, and response plans

MS6 Governance, responsibilities, and funding

Responsibilities, mandates, funding, and decision-making arrangements are clear enough to sustain municipal services during prolonged uncertainty and repeated evacuations.

Why it matters: This focuses on whether the system can answer four practical questions — who is responsible, who activates plans, who pays, and who coordinates when circumstances change. It reflects concerns that municipal services can become fragile when mandates expire, funding is temporary,

reimbursement is unclear, and responsibility is spread across several organizations.

F.4. BUSINESS OPERATIONS & INFRASTRUCTURE

Businesses in Grindavík have largely adapted to living with uncertainty, but continued operations depend on maintaining essential conditions. Stakeholders emphasized that the challenge is not only safety, but also predictability, reliable infrastructure, workforce continuity, clear operating rules, and the ability to evacuate, restart, and recover when conditions change.

Key themes: workforce safety, staffing, and commuting; shutdown, evacuation, and restart of operations; electricity, water, telecommunications, transport, and emergency services; access rules, closures, and reopening conditions; business continuity, financial resilience, and insurance; and predictable decision-making, communication, and coordination.

Indicator definitions

BO1 Operational predictability and restart readiness

Businesses can plan, shut down, evacuate, protect assets, re-enter facilities, and restart operations through clear, predictable, and agreed operational arrangements.

Why it matters: Uncertainty about closures, reopening, access, evacuation arrangements, and decision-making creates major operational challenges. Clear escalation levels, predictable procedures, and defined re-entry arrangements are critical for planning staff, supplies, customer commitments, and business continuity.

BO2 Infrastructure and service continuity

Businesses have access to the minimum infrastructure services required to maintain operations, protect assets, and recover from disruption.

Why it matters: Participants repeatedly emphasized the need to define the minimum infrastructure and service levels required for businesses to continue operating, including electricity, water, telecommunications, heating, transport access, and emergency services.

BO3 Workforce availability and reliability

Businesses can maintain sufficient staffing levels through reliable commuting, workforce retention, and accommodation arrangements.

Why it matters: This reflects concerns regarding

workforce availability, recruitment, employee turnover, commuting challenges, accommodation, and willingness to work in Grindavík under prolonged uncertainty and repeated disruption.

BO4 Operational access and recovery

Businesses can access facilities, protect critical assets, and recover operations within acceptable timeframes.

Why it matters: This reflects concerns regarding access to facilities, protection of valuables and equipment, inspections, repairs, recovery activities, and the resources needed to restore operations following disruption.

BO5 Financial resilience

Businesses can continue operating under prolonged uncertainty and repeated disruption without financial support for an acceptable period of time.

Why it matters: Participants highlighted uncertainty around interruption costs, wages, insurance, closures, evacuations, and restarting operations as key factors affecting whether businesses could continue operating in Grindavík.

BO6 Communication and trust

Businesses have confidence that decisions affecting operations are transparent, predictable, consistently applied, and communicated clearly.

Why it matters: This reflects recurring themes regarding trust, transparency, communication, access rules, escalation arrangements, reopening conditions, and ongoing dialogue between businesses, authorities, infrastructure providers, and emergency responders.

