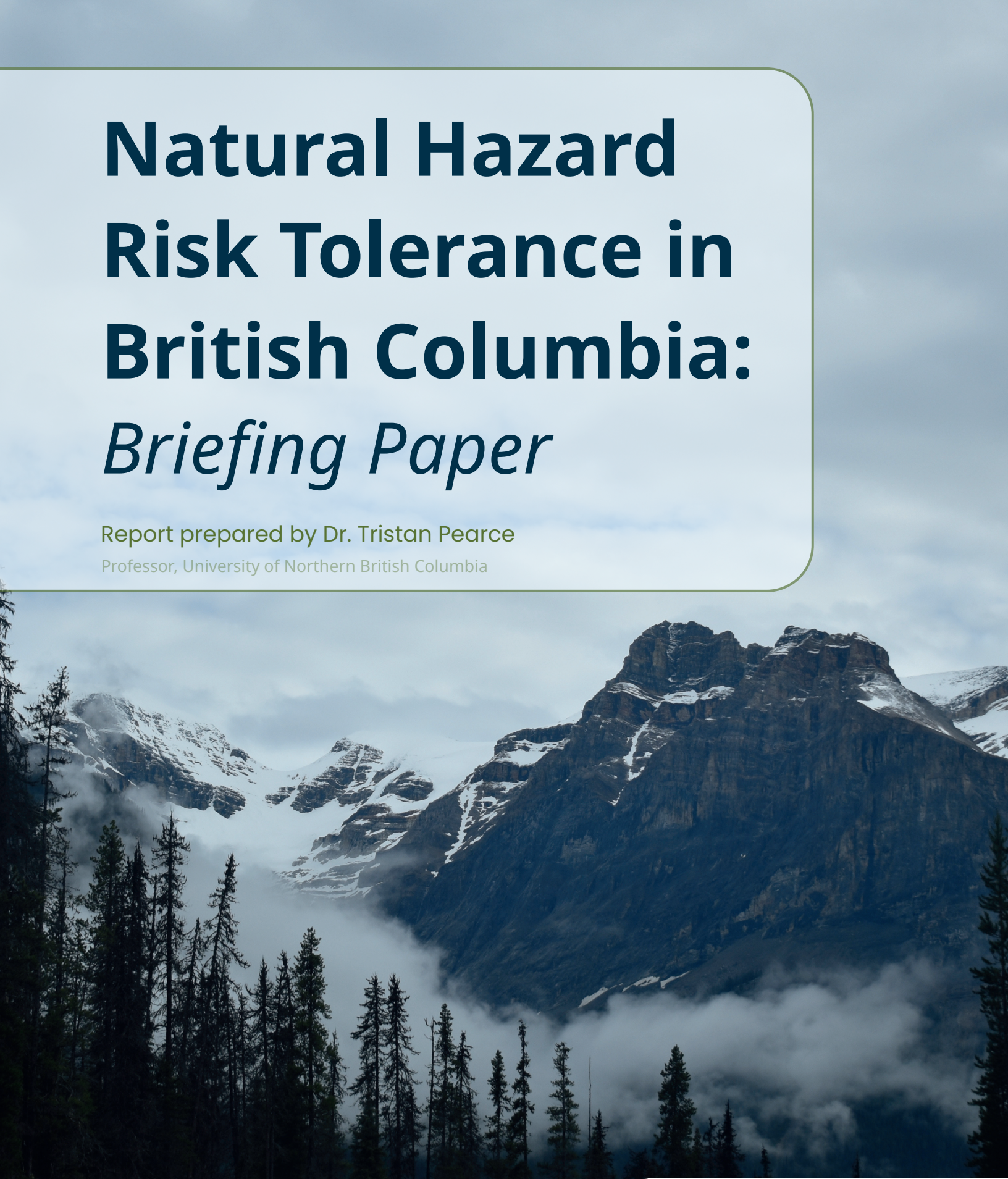
Natural Hazard Risk Tolerance in British Columbia:

Briefing Paper

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INTRODUCTION

The climate across British Columbia is changing, and the effects, such as increased frequency and intensity of wildfires, higher sea levels, shrinking mountain snowpack, rising temperatures, and intense storms are projected to continue and worsen in the coming decades. The concept of ***risk***[1] is a key aspect of how decision makers assess the potential adverse impacts of, and response options to, potential hazards[2]. Gaining a better understanding of risk gives decision makers the information they need to make informed choices to help protect themselves and their communities, before, during, and after disasters. Indeed, emergency planning cannot take place without first understanding what you are planning and preparing for.

Risk assessments tend to emphasize quantifying risk, both in terms of likelihood and consequence. However, until risk is compared against risk tolerance criteria, it is impossible to know whether that risk is too high or not, or what could be done to reduce it so that it becomes tolerable. Understanding risk tolerance—our willingness to bear risk helps us decide how to manage the potential impacts of a hazard on the things we value, such as human life, health and well-being, environment, economy, areas of cultural importance, and buildings and infrastructure. An assessment of risk tolerance drives the allocation of finite resources for the development of adaptation pathways. Most natural hazards and disaster risk reduction literature acknowledge the need for risk tolerance criteria, but we lack an agreed approach for assessing risk tolerance. This is a critical gap that this briefing paper seeks to address. Using the findings from the complementary "Natural Hazard Risk Tolerance Scoping Review," we first document and examine definitions of risk tolerance and argue to expand definitions beyond traditional engineering thresholds to better reflect the lived experiences of communities. Next, we describe some approaches for operationalizing these expanded definitions of risk tolerance and discuss implications for decision makers in B.C.

1. "The likelihood that a hazard will occur, as well as the severity of possible impact to health, property, the environment, or other things of value" (Emergency Management B.C., 2020).

2. The potential occurrence of a natural or human-induced physical event or trend that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources (IPCC, 2022a).

THE STATE OF RISK ASSESSMENT IN B.C.

Methodologies for risk assessment and analysis have evolved in B.C. The hazard, risk, and vulnerability analysis tool (HRVA) helps guide decisions to mitigate, prepare, respond and recover from hazards that pose a risk to the region of interest in B.C. The HRVA uses risk scores (*risk = likelihood x consequences*) to prioritize hazards for a particular community or location. Evaluating risk via HRVA was a mandate in Section 2(1) of the Local Authority Emergency Management Regulation of the B.C. Emergency Program Act, which applied to local authorities such as municipalities or regional districts. The HRVA is offered as an online tool to Indigenous communities and local authority representatives who have a



Fig 1. *9-Steps in the B.C. HRVA Tool (Emergency Management BC, 2020).*

Business BCeID account, in which information about a community and the surrounding areas is entered in a nine-step process and the tool produces a report. An offline version of the HRVA Tool is available in the 96-page companion guide.

In 2023, the Emergency Program Act was replaced by the Emergency and Disaster Management Act, which will require risk assessments, emergency management and business continuity plans for public sector agencies, critical infrastructure owners and operators, and local authorities (Government of British Columbia, 2025). Regulations and updated methodologies for risk assessment are forthcoming.

How we understand and manage risk using common risk assessment methods, including the HRVA Tool, can be broadly conceptualized by understanding the hazard, understanding community risk and resilience; understanding the hazard likelihood, assessing consequences; and identifying risk reduction strategies. An assessment of risk tolerance, our willingness to bear risk, is missing from the analysis. An assessment of risk tolerance is needed to reconcile different community members' tolerance of risk and help guide the development of adaptation pathways that are congruent with local ideals. To accomplish this, an agreed upon and consistent terminology for risk tolerability is needed.

EXPANDING THE DEFINITION OF RISK TOLERANCE

The common definition for risk tolerance focuses on what is acceptable, or tolerable risk. Risk above this threshold is considered *unacceptable or intolerable* . A goal of risk management is to reduce risk below the tolerable threshold and 'As low as Reasonably Practicable' (ALARP). Risk tolerance thresholds may vary depending on the risk assessment framework used, are determined independently of any individual risk assessment, and reflect the conditions of the hazard-prone area. Results from individual risk assessments are compared to these pre-defined thresholds and timeframes to assess risk tolerance. Here, risk tolerance is often treated as a numerical threshold or target level such as the Probability of Death of an Individual (PDI). These

assessments tend to focus mostly on the nature of the hazard and possible impacts, and focus on reducing vulnerability to an outcome of the hazard event (e.g., number of deaths, costs of damage). These assessments can be conducted at an individual or group level by extending the same factors as individual risk across the total population within the potentially impacted zone. Differing levels of risk tolerance can also be given to different types of infrastructure and land use, reflecting their relative importance to the community. This approach provides a broad understanding of the potential impact of a single hazard event, but does not capture the differing levels of risk tolerance among community members or the multiple pathways in which a hazard event could impact the system.

Expanding the definition of risk tolerance beyond traditional engineering thresholds is essential in the context of climate hazards because these thresholds often focus narrowly on structural or technical performance, overlooking broader systemic, social, and ecological vulnerabilities (Berkhout and Dow 2023; Magnan, O'Neill & Garschagen 2023; Spencer et al. 2024). Relying solely on technical thresholds risks underestimating the full spectrum of harm, particularly cascading failures across infrastructure, ecosystems, and communities (Simpson et al. 2021; Simpson et al. 2023; Ford et al. 2024). Furthermore, narrowly defined thresholds can inadvertently institutionalize inequity by ignoring the differentiated impacts of climate hazards on vulnerable populations (Berkhout 2024). Marginalized communities often live in areas where infrastructure is already under strain or poorly maintained, and they may lack the resources to recover from even tolerable levels of risk (Roa et al. 2025).

Community engagement in hazard risk assessment is essential to identify sensitivities, adaptive capacity, and the potential economic costs of inaction (Conway et al. 2019). Taken together, identified vulnerabilities help to determine how resilient a system is to a particular hazard and over different timeframes. Consideration of the diverse groups of community members who might bear the consequences of the hazard event or risk management must be taken into account, including cultural protocols and norms. It is suggested that policies aligned with risk tolerance thresholds will enable consistent and effective management of the risk. Hazard risk management is considered a continuous process, and risk tolerance needs to be constantly re-assessed and management processes reviewed as exposure, vulnerability and tolerance change over time.

DEFINING RISK TOLERANCE THRESHOLDS

Some argue that having agreed-upon terminology for risk tolerances could allow legislation and associated policies to describe risks in a consistent manner and provide direction to the response appropriate to that level of risk. Table 1 provides example terminology used to define risk tolerability thresholds or levels. Each example uses three levels of tolerability. In Aotearoa (New Zealand), the agreed terminology for risk tolerability is acceptable, tolerable, and intolerable (New Zealand Government 2023). Results from individual risk assessments are compared to these thresholds to contextualize the results, and then guide risk management interventions. In the

context of sea-level rise and flood management in the State of Maryland, U.S.A., the terminology used for risk tolerability is high tolerance for flood risk, medium tolerance for flood risk, and low tolerance for flood risk (McClure, Land and Vogel, 2024). Similarly in the State of California, the terms used are low risk aversion, medium-high risk aversion, and extreme risk aversion (California Sea Level Rise Guidance, 2024). These categories, in both cases, pertain to different types of land uses, community assets or facilities, buildings and structures, and their relative importance as defined by community members. Using the risk tolerance approach, decision makers' tolerance for sea-level rise can be used to select a hazard model (i.e., relative sea-level rise) to plan for within the range of available estimates. For example, projects with low tolerance/extreme risk aversion for flood risk should consider relative sea level rise estimates that are unlikely to be exceeded during the project's lifespan. Projects with medium to high tolerance/medium-high and extreme risk aversion for flood risk should consider relative sea level rise estimates that are more likely to be realized during the project's lifespan because the consequences of flood impacts are less severe or adaptations to minimize impacts are readily available.

Location	Risk Tolerability Terminology		
North Vancouver, CAN	Acceptable	As low as reasonably practicable (ALARP)	Unacceptable
New Zealand	Acceptable	Tolerable	Intolerable
Maryland, U.S.A	High tolerance	Medium tolerance	Low tolerance
California, U.S.A	Low risk aversion	Medium-high risk aversion	Extreme risk aversion

Table 1. *Risk terminology usage examples*

It is important to remember that given the importance of community engagement in hazard risk assessment, community involvement and input in all stages of the assessment, including defining risk tolerance thresholds is essential (Ford et al. 2024). Community member knowledge, perspectives, and project characteristics all contribute to the determination of risk tolerance. Given different geographies, perspectives, and tolerance to a hazard, the determination of risk tolerance is subjective. Table 2 provides an example of terminology and project characteristics for determining the level of risk tolerance adapted from Maryland's 2023 sea level rise projection assessment report. For the purposes of this example, the term "project" refers to any private, local, and government planning, regulatory, or site-specific effort that should consider and incorporate hazard projections.

	High tolerance for risk	Medium tolerance for risk	Low tolerance for risk
Description	Hazard impacts are expected and have minimal impact.	Some impacts can be tolerated and impacts can be variable.	Hazard has detrimental impacts.
Possible project characteristics	Low impact, importance or consequence to the community and/or replacement cost	Medium impact, importance, or consequence to the community and/or replacement cost	High impact, importance, or consequence to the community and/or replacement cost
	Easy or likely to adapt	Moderately easy or somewhat likely to adapt	Difficult or unlikely to adapt
	Little to no implications for public function and/or safety	Moderate implications for public function and/or safety	Substantial implications for public function and/or safety
	Low sensitivity to frequency and exposure to hazard impact	Medium sensitivity to frequency and exposure to hazard impact	High sensitivity to frequency and exposure to hazard impact

Table 2. *Example Project characteristics to consider when determining the level of risk tolerance (Adapted from Maryland's 2023 Sea Level Rise Projections)*

High tolerance for risk: project/project areas determined to have a high risk tolerance should have low impact, importance or consequence to the community, a low replacement cost, and little to no implications for public safety or the ability of the community to carry on day-to-day functions. For example, in the context of sea level rise, this might include an unpaved coastal trail with an alternative route available.

Medium tolerance for risk: project/project areas determined to have a medium risk tolerance should be able to tolerate some impacts. Community day-to-day functions may be affected, but the impacts are likely concentrated to a specific area and critical functions are not compromised. These projects should have the potential to adapt over time.

Low tolerance for risk: project/project areas determined to have a low risk tolerance should be highly important to the community or irreplaceable. These projects are highly sensitive to potential impacts, and public safety and/or community day-to-day functions would be substantially impacted if the hazard impact occurs. The likelihood or capacity to replace or adapt the project is low. This category often pertains to community assets or facilities such as emergency shelters, hospitals,

power stations, water treatment plants, other critical infrastructure, or places of high community importance as defined by community members.

There are likely to be different levels of hazard risk tolerance for certain projects and project areas. Levels of risk tolerance can thus be assigned to sub-areas or structures included in the project area. For example, a community that is exposed to wildfire hazard may assign a high-risk tolerance to natural or open spaces, and a medium or low risk tolerance to residential areas and power transmission lines.

ASSESSMENT OF RISK TOLERANCE

Just as there are different terminologies to describe risk tolerability, there are a variety of approaches to hazard and risk assessment. Noting that hazard and risk methodologies have been developed to fit specific purposes, they should however, result in a clear level of known risk based on an understanding of the hazard, exposure, and vulnerability for the system of interest. An assessment of risk tolerance can either be included early in a risk assessment, before an assessment of exposure or vulnerability, and to determine what hazard models and projections are used and adaptation pathways considered (i.e., Maryland and California examples), or later in the assessment once the level of risk is known (i.e., Aotearoa example). Here, the known level of risk is considered next to risk tolerance thresholds to identify what can be tolerated and what adaptations might be possible.

Noting that climate change interacts with many hazards, it makes sense to include an assessment of risk tolerance early in a risk assessment to guide what emission scenarios and projections are used to identify potential consequences from a future hazard event. For example, using the terminology for risk tolerability and levels defined in Table 2, the following questions adapted from Maryland's 2023 Sea Level Rise Projections could be considered for a project or project area when determining the appropriate level of risk tolerance. These questions would be asked once the hazard has been identified and the project type, goal, and area have been defined.

- Is the project area currently impacted by the hazard? If so, how often and whom/where is affected?
- What are the public function and safety implications?
- What is the cultural, recreational, and/or historical value to the area?
- What is the sensitivity to impact?
- For site-specific projects:
    - Is replacement an option?
    - What are the associated costs or implications if the site is impacted by the hazard event?
    - Upon completion, how flexible is this project to being modified to withstand future impacts?

The level of tolerance for the hazard risk can then be used to select the appropriate range of hazard model projections (e.g., sea-level rise projections, flooding projections, temperature and precipitation projections, ice sheet models) that will be used to evaluate the extent and depth of present-day and

and future impacts. This assessment could include the impact on natural, cultural, historic, and human resources, critical infrastructure, businesses, and residents, including underserved and overburdened populations. The outcome of this assessment is used to develop adaptation pathways that increase resiliency to the hazard(s) and include contingency plans if projections are exceeded.

INTEGRATING RISK TOLERANCE INTO B.C.'S RISK ASSESSMENTS

To integrate risk tolerance into B.C.'s risk assessment framework, a multi-dimensional and participatory approach is needed. While the HRVA provides a structured method for assessing hazard likelihood and consequences, it lacks mechanisms for evaluating whether identified risks are tolerable. Embedding risk tolerability into the HRVA and risk assessment process would enhance its utility by aligning risk assessment with community values, adaptive capacities, and long-term resilience goals. We propose five steps to consider for integrating risk tolerance into the HRVA:

1. **Social, cultural, and equity dimensions should help define risk tolerance thresholds**, complimenting the more technical metrics. For example, Indigenous and other communities may deem any loss of sacred land or biodiversity as intolerable or may emphasize intergenerational responsibility and relational understandings of land and well-being in defining what is tolerable (Ford et al. 2020; Redvers et al. 2022). Marginalized communities often face disproportionate exposure and limited adaptive capacity; including cultural protocols, historical land use, and community-defined priorities can ensure that risk tolerability assessments do not inadvertently institutionalize inequities. Participatory mapping, community workshops, and scenario planning can help document these diverse perspectives (see Indigenous Engagement Requirements Summary 2023).

2. **Project-specific risk tolerance thresholds need to be developed**, reflecting the fact that risk tolerability is subjective, context-dependent, and will likely vary among and within populations and varying by the hazard. Thresholds should be co-developed with local community members, including Indigenous communities, municipal planners, emergency responders, and vulnerable populations. For example, if a project area experiences frequent flooding and detrimental impacts now, an increasing risk of damage may influence the willingness of decision makers and community members to accept the risk of potential future flooding.

3. **Risk tolerability could be assessed after Step 4 "Assessing hazard likelihood" in the HRVA and before Step 5 "Assessing consequences"** (Figure 1), thereby allowing decision makers to contextualize the likelihood of a hazard within the community/project's capacity and willingness to bear its potential impacts. For example, a wildfire with moderate likelihood may be tolerable in a sparsely populated area with strong fire response

infrastructure, but intolerable in a more populated region with limited evacuation routes.

4. **Risk tolerance should be monitored over time** to account for any changes, such as new information, updated projections, observed changes in the nature of the hazard(s), or changing community values. The HRVA should incorporate a feedback mechanism to update tolerability thresholds based on post-event evaluations, infrastructure changes, or demographic shifts, aligning to principles of adaptive management (Haasnoot et al. 2024).

5. **Risk tolerance can help decision makers prioritize how, when, and where they invest in risk mitigation measures**, enabling more nuanced decision-making as part of Step 7 in the HRVA. For instance, decision makers may have a higher tolerance for risk when considering projects with a shorter lifespan, minimal consequences, flexibility to adapt, lower levels of uncertainty, or low economic burden as a result of a hazard. However, for longer lasting projects with less adaptive capacity, high consequences from a potential hazard event, and higher levels of uncertainty, decision makers may want to take the more precautionary approach to risk management.

There are uncertainties in any type of risk assessment. The precautionary principle should be used where there are threats of serious or irreversible damage to enact cost-effective measures to manage risk. Risk tolerance also needs to be considered at different scales, including at national, regional, and local levels, depending on the scale of the hazard(s), relevant importance to different levels of society, and risk management governance. Regardless of the risk assessment tool used, incorporating risk tolerance demonstrates a commitment to ensuring that the potential impact of hazard(s) and responses are considered within the social and environmental context of the impacted area.

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