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Review Article

Relationship of Vulnerability and Risk Perception, with Community Resilience to Natural Disasters: Systematic Review of Scientific Evidence

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Abstract *- Disaster risk reduction requires understanding the prior conditions of exposed populations, beyond the physical event. This systematic review evaluates how vulnerability and risk perception are related to community resilience to earthquakes, tsunamis, floods, landslides and debris flows (known as huaicos in the Andes), thus integrating the three components that the literature usually analyzes separately. The research question is formulated through the PEO framework, including Context (C), and the search is executed in Scopus and Web of Science for the 2022-2026 period, following the PRISMA 2020 guidelines and 106 are included for the total review. The findings show that the impacts transcend material damage and reach physical and psychological health, housing, basic services, mobility and livelihoods. The most frequently reported vulnerability conditions are economic limitations, households with dependent members, poorly diversified livelihoods, housing and service deficiencies, educational and informational gaps, mobility restrictions and institutional weakness, while risk perception is most often associated with previous experience, knowledge of the hazard, sociodemographic traits, access to information and institutional trust. The relationship with resilience is neither direct nor proportional: social capital, local knowledge and collective efficacy can offset part of these adverse conditions, although not always, and perceiving more risk does not imply greater response capacity. Unlike previous reviews, which examined vulnerability, risk perception or resilience separately, this synthesis integrates the evidence on how the three interact at the community level and links the conditions identified to the risk management measures reported to address them.*

Keywords *- Natural disasters, Risk management, Risk perception, Community resilience, Vulnerability.*

1. Introduction

Emergencies and disasters can generate negative impacts on societies, affecting their health, well-being, and way of life, as well as the continuity of essential services in the community also being affected, manifesting both immediately and in the long term. Likewise, since there is an interdependence between different sectors, the interruption of one or several services can produce both social and economic consequences, and in turn, affect the functioning of other services [1].

Within that context, phenomena of natural origin, such as, for example, earthquakes, floods, cyclones, storms, forest fires, volcanic eruptions and landslides, can be considered as natural hazards whenever they have the potential to cause damage in a community, its property or infrastructure. In this way, these hazards can trigger the occurrence of a disaster, thus giving rise to adverse consequences; under this perspective, the term natural disaster refers to those disasters that have their origin in a physical phenomenon of natural character [2].

However, the occurrence of a phenomenon by itself cannot necessarily imply the generation of a disaster, since the risk of a disaster depends on different components. These components of risk have been in evolution among disciplines and communities as they developed their own frameworks, in order to understand and explain why similar hazards produced very different consequences. After understanding that knowing the hazard by itself was insufficient to explain risk, disasters began to be interpreted as the result of the interaction between natural hazards and multiple social factors. One of the earliest approaches to defining risk described it through the relationship between hazard and vulnerability. Subsequently, in 1979, the Office of the United Nations Disaster Relief Coordinator (UNDRO) expanded this approach by incorporating exposure as a third component, establishing a model that became widely used and remained influential in disaster risk reduction. This understanding was later revised during the development of indicators associated with the Sendai Framework for Disaster Risk Reduction 2015–2030. In this context, the United Nations General Assembly proposed

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a model in which disaster risk is shaped by four interconnected factors: the threats that may arise, the people and assets that could be affected, their susceptibility to harm, and their ability to cope with the consequences [3]. The United Nations Office for Disaster Risk Reduction (UNDRR) [4] also includes this understanding of risk in the terms it uses to explain and address disaster risk reduction. Seen this way, the same earthquake, flood, or landslide can be a minor disruption for one community and a disaster for another. Much of that difference lies in the conditions people already live in before the event, in how they understand the danger, and in what they are able to do about it. Understanding these conditions is therefore the starting point for any risk management effort that seeks to reduce impacts rather than simply respond to them.

Vulnerability is one of the factors that helps explain how disasters may affect individuals, communities, and systems. Over time, its meaning has varied across different fields of study, leading to several definitions. According to the UNDRR, vulnerability is linked to physical, social, economic, and environmental factors that can leave individuals, communities, property, and essential systems more exposed to harm when dangerous events occur [4]. This has made vulnerability an important consideration in studies of risk and hazards, as well as in the development of measures to reduce their impact. Its understanding has also changed over time, moving from a fixed view to one that recognizes how vulnerability can vary across places and periods, particularly when different hazards interact [5]. Several studies examine vulnerability at different scales and consider various dimensions, including physical, social, political, ecological, and economic aspects [6]. The extent of vulnerability may change depending on how living conditions, financial resources, the surrounding physical environment, and the actions of institutions influence one another; these circumstances can make people and communities more vulnerable, help lessen their difficulties, or leave their situation unchanged [5].

The way people and communities understand the dangers posed by natural disasters can influence how they act when faced with such events. It refers to how people personally assess the risks they face, based on their understanding and interpretation of potential threats. This perception can influence their willingness to take steps toward preparedness, prevention, and adaptation. People who have a better understanding of the risks may be more likely to adopt preventive measures. However, this connection is not always straightforward, as being aware of a potential danger does not necessarily lead to action, and some communities remain poorly prepared despite recognizing the risks they face [7, 8].

People's beliefs, personal experiences, financial circumstances, and relationships with others can shape how they view potential dangers and the decisions they make when facing them. As these factors differ from one person to another, people may experience the same event and view its risks in different ways [8, 9]. For an evaluation of risk perception, both cognitive evaluations and affective responses can be considered. For the case of cognitive evaluations include aspects such as perceived probability and severity, while affective responses include states such as concern, fear and anxiety. However, there is no standardized measure for the evaluation, which could be described as multidimensional and heterogeneous, since they depend on the hazard evaluated, specific populations, geographic, socioeconomic and cultural contexts [8, 10].

Resilience is another important aspect of how communities deal with disasters. When difficult events occur, people, communities, and the systems that support them may face serious challenges. Their capacity to deal with these situations depends on how well they can endure the difficulties, return to their usual activities, adjust to changed circumstances, and find new ways of moving forward when needed. Its assessment covers different levels, from individuals and households to community groups and government institutions. Likewise, not all groups of a community start from the same conditions in the face of a disaster, making its distribution non-uniform, so resilience strategies require considering the needs, capacities and specific characteristics of its members and of the community context [11, 12]. On the other hand, resilience can also be observed during different phases of natural disaster, from existing conditions and the capacity they have to resist, to immediate coping strategies, long-term adaptation and the new conditions that are reached [13].

Resilience is closely tied to the other two components, although the nature of these links is still debated. Some authors treat vulnerability and resilience as opposite ends of the same scale, while others see them as interdependent or merely correlated concepts that developed along separate paths [14]. Risk perception, in turn, has been described as one of the processes through which communities build resilience, since it shapes how they understand adaptation options, make decisions and take preventive action [15]. Yet, as noted above, recognizing a danger does not guarantee that people will act on it [7, 8], which suggests that the path from perception to resilience depends on other conditions, many of them related to vulnerability.

Despite this growing attention, the evidence on how vulnerability, risk perception and resilience come together in exposed communities remains fragmented. Recent reviews have tended to examine each component on its own: how vulnerability has been conceptualized and measured [5], what shapes risk perception [9] and how it is assessed in relation to preparedness [8], or how community resilience is evaluated [13] and supported by social capital [15]. Studies that consider the three components together are mostly local case studies, partial associations or models built for a single setting, each

with its own definitions, scales of analysis and disaster phases, which makes their findings hard to compare. As a result, there is still no integrated picture of which conditions make communities more susceptible, how people come to recognize and interpret risk, and under what circumstances these factors strengthen or weaken their capacity to resist, adapt and recover. This gap also has practical consequences: when these components are addressed separately, risk management may focus on isolated factors, for instance raising awareness among households that lack the resources to act on it [7, 8]. This review addresses that gap by bringing together recent evidence on how vulnerability and risk perception relate to community resilience to earthquakes, tsunamis, floods, landslides and debris flows (huaicos).

Rather than treating these components in isolation, it examines the impacts that disasters leave on communities, the factors behind their vulnerability and their perception of risk, the ways in which these conditions shape resilience, and the risk management measures that may strengthen it. The research question was framed using the Problem, Exposure, Outcome (PEO) framework with an added Context (C) component, and studies published between January 2022 and September 2026 were selected following the PRISMA 2020 guidelines. This review differs from previous syntheses in four respects.

First, rather than focusing on a single component, it examines vulnerability, risk perception and resilience together, so that their interactions can be identified instead of assumed. Second, it brings together five hazards, including landslides, which a recent meta-analysis identified as poorly investigated in risk perception research [9], and debris flows, known as huaicos in the Andean region. Third, it centers on what communities actually do: studies that only reported indices or general associations were excluded, so the evidence focuses on capacities, responses and strategies. Finally, it connects the conditions identified with the risk management measures reported for them, providing an evidence base for interventions that address these components jointly rather than in isolation.

2. Review Methodology

2.1. Formulation of Research Question

The formulation of the research question was based on the PEO framework in addition to a Context (C), being an adaptation of the PEO framework. This was considered because the framework can be adjusted according to the characteristics and breadth of the review [16]. This framework provides a basis for defining the main question of the review and deciding how to find and select relevant studies. It also helps establish which studies should be considered and which should be left out. The elements that make up this framework are shown in Figure 1.

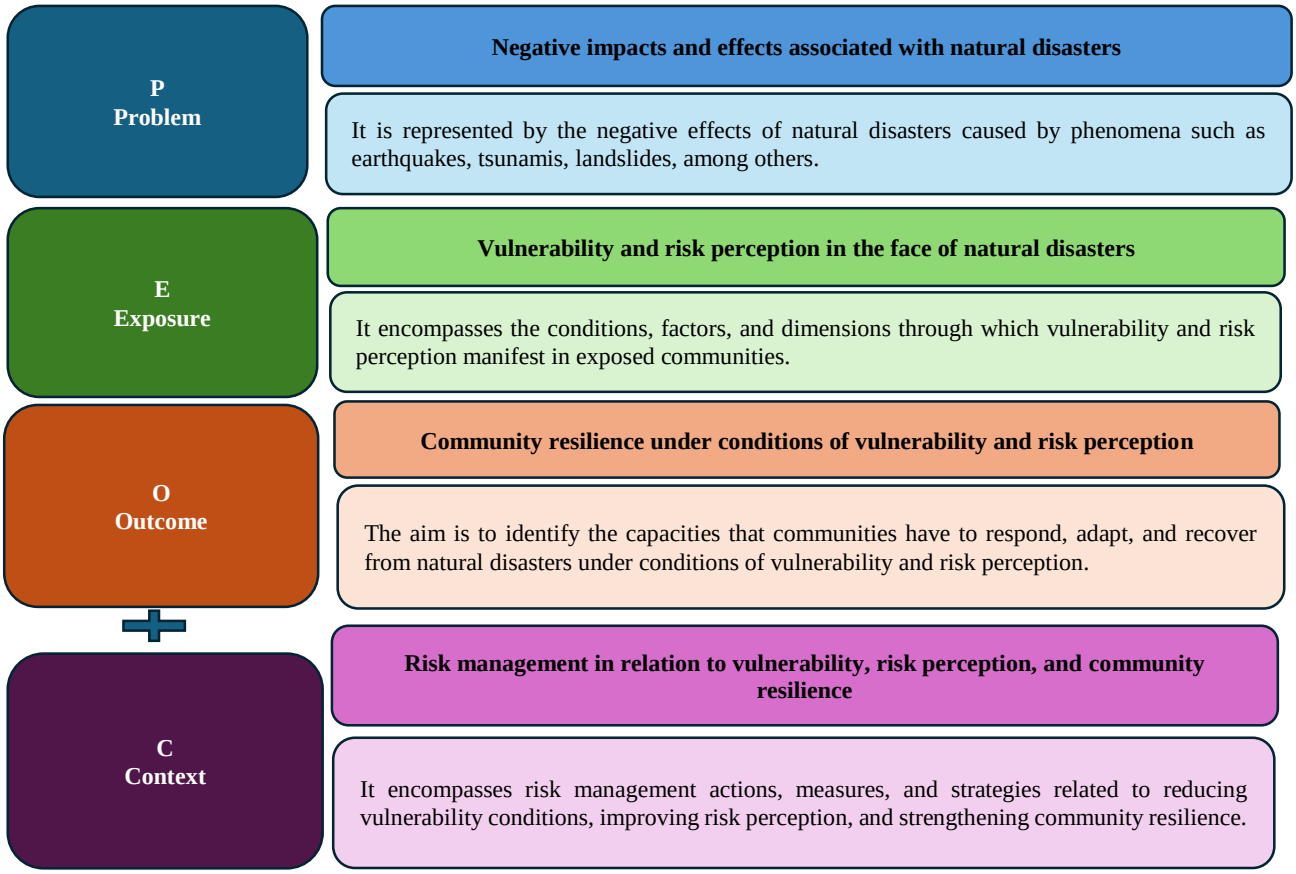


Fig. 1 Definition of the components of the PEO+C framework

Therefore, after defining the components, Figure 2 presents the research question and the complementary questions, which allowed guiding the review, as well as the analysis of the scientific evidence based on the central aspects of the present study.

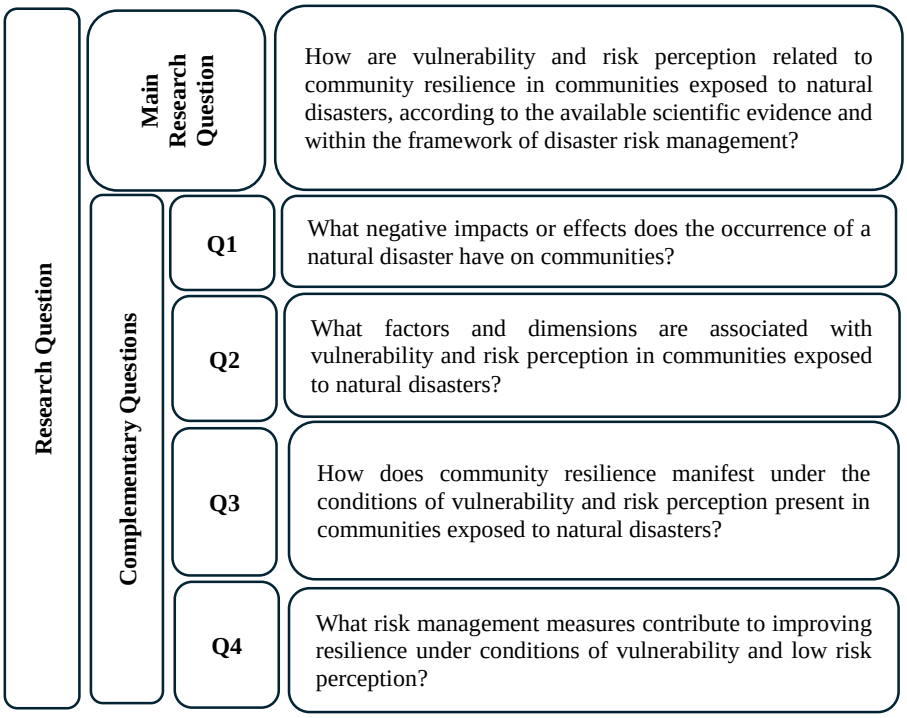


Fig. 2 Formulation of the research question and complementary questions

2.2. Literature Review through the PRISMA 2020 Guidelines

The Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020 guidelines served as the basis for the systematic literature review, allowing the identification and selection of studies to be documented in a clear, organized, and transparent manner. Following the search in the selected databases, duplicated records were removed to avoid considering the same study more than once. The remaining studies were then examined based on the established eligibility criteria. Through this process, the studies that met the requirements were identified and included in the final review [17].

2.2.1. Search Strategy

Scopus and Web of Science were the two databases used to identify relevant studies, taking into account the time interval from January 2022 to the present (September 2026), and primary studies in both English and Spanish were considered. On the other hand, the natural hazards that will be included in the review are earthquakes, tsunamis, landslides, debris flow (huaico) and floods. In this sense, and once the complementary questions to be addressed had already been defined, six groups of terms were defined according to the field to search and these are shown in Table 1. After that, two search equations in common were formulated for both databases, these being a combination with Boolean operators of the six groups as shown in Table 2.

Table 1. Groups of search keywords

Group	Terms
I	(“earthquake” or “landslide” or “debris flow” or “huaico” or “huayco” or “flood” or “tsunami”) and (“community*” or “population” or “people”)
II	“impact” or “consequence” or “effect”
III	“vulnerab*”
IV	“risk perception” or “perceived risk” or “risk assessment” or “hazard perception”
V	“resilien*”
VI	“disaster risk management” OR “risk reduction” OR “disaster preparedness” OR “risk mitigation” OR “disaster prevention” OR “community disaster risk management”

Table 2. Combination of keywords

Combination	
1	I and II and (III or IV) and V
2	I and (III or IV) and VI

2.2.2. Identification

After carrying out the search in the databases, for the first string, 1003 and 549 records were obtained in Scopus and Web of Science, respectively, having a total of 1552. For the case of the second string, 1195 and 1037 records were obtained in Scopus and Web of Science, respectively, reaching 2232 records.

From all of this, the total number of records was 3784. After that, the elimination of duplicates was carried out, which were 1319, thus leaving 2465 as unique records. Likewise, below are shown the eligibility criteria that will be used in the screening phase.

Inclusion Criteria

- Studies that were developed based on a population facing a natural disaster.
- Studies that report the effects that a community presents in the face of a natural disaster.
- The studies that report the conditions of vulnerability or risk perception presented by communities, as well as their factors or dimensions.
- Studies that address how community resilience manifests itself under conditions of vulnerability and/or risk perception.
- Studies that report risk management measures, actions or strategies related to the reduction vulnerability of the community, improvement of its risk perception and strengthening its community resilience.

Exclusion Criteria

- Studies that simultaneously address natural hazards, when the results cannot be differentiated independently.
- Studies that only report levels, indices or general associations of community resilience, with vulnerability and risk perception, without identifying their capacities, responses, actions, strategies adopted by communities.

These criteria did not require each study to jointly examine vulnerability, risk perception, and community resilience. Studies addressing at least one of these components in populations exposed to the hazards under consideration were included, either in isolation or in relation to the other components, provided that they contributed information on the conditions, capacities, responses, or strategies of communities. Only a subset of the studies directly analyzed the relationships between the components; in the remaining cases, these relationships were established through the synthesis and integration of findings from different studies.

2.2.3. Screening

The review by title and abstract of the studies was carried out, reaching 162 that had the potential to contain information according to what was required for the review, so 2303 studies were excluded. Then, each source was searched to obtain the full text. However, it was not possible for 33 studies due to access limitations such as subscriptions, thus obtaining 129 studies that were again analyzed in greater depth by the eligibility criteria.

From said process, 23 were excluded for not meeting three criteria. The first was 6 studies for addressing multiple hazards and without having differentiated results for the analysis. In the second, 15 studies were excluded for reporting the interaction information of vulnerability, risk perception or resilience in a general way, without identifying content on capacities, responses, actions or strategies of communities. Finally, 2 studies were excluded, since their approach was territorial, technical or technological, without evaluation in the population.

2.2.4. Inclusion

After the entire filtering process, finally 106 studies were included for the review, which are considered those that will provide evidence to answer the research questions. Figure 3 shows the summary diagram about the selection process.

The methodological quality of the included studies was assessed using the Mixed Methods Appraisal Tool (MMAT), version 2018, an instrument designed for reviews that integrate qualitative, quantitative, and mixed-methods studies, as is the case in this review. Each study was first classified according to its design and then assessed using the five criteria established by the instrument for that category, each with the response options “Yes,” “No,” or “Can’t tell.” Studies based on modeling or simulation, which do not fully fit the instrument’s categories, were assessed as quantitative descriptive studies.

The assessment was conducted independently by the authors of this review, and discrepancies were resolved by consensus. Following the instrument’s recommendations, no overall score was calculated, and no studies were excluded based on their quality.

For each included study, the hazard analyzed, the country, the study design, the year of publication, and the information reported on disaster impacts, vulnerability factors, factors associated with risk perception, manifestations of community resilience, and risk management measures were extracted and recorded in a data matrix. Based on this matrix, a frequency analysis of damage, vulnerability factors, and risk perception factors was conducted.

The categories for this analysis were constructed inductively: the damage and factors identified in each study were first recorded using the terminology employed by their authors and then grouped according to similarities in content through an iterative process until distinct categories were obtained. Coding was performed by the authors, and discrepancies were resolved by consensus.

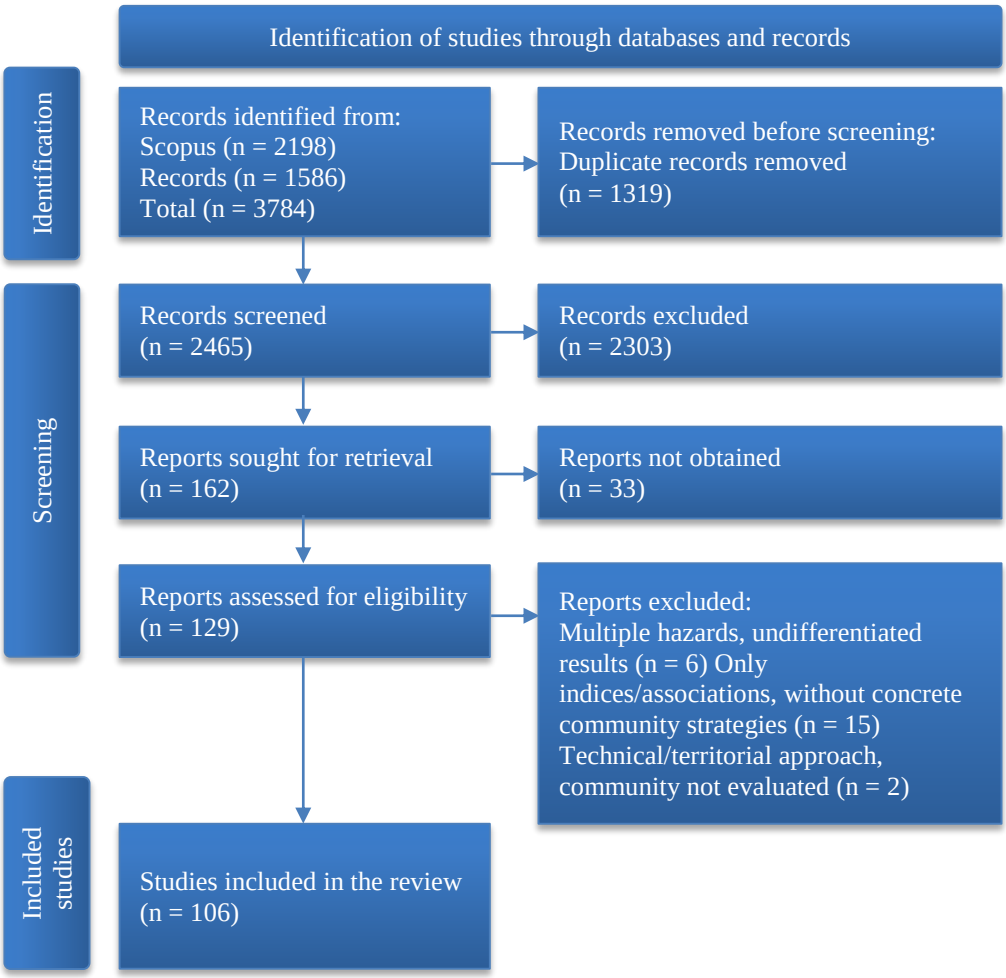


Fig. 3 PRISMA 2020 flow diagram. Page et al. [17]

The unit of counting was the study. Each study was counted only once per category, regardless of how many times it mentioned the damage or factor. Since a single study could report several of them, it could appear in more than one category; therefore, the sum of the frequencies exceeds the total number of included studies. When a factor could correspond to two categories, it was assigned to the one that best represented the way in which the study analyzed it. For example, religious beliefs were coded as sociocultural factors, and fatalism and optimism as psychological characteristics.

Educational and informational gaps were the exception, as they were coded under both components when justified by the study: as vulnerability conditions when they limited the capacity to prepare or respond, and as risk perception factors when they were analyzed as determinants of how risk was assessed.

Consequently, the frequencies indicate how many studies addressed each category rather than the magnitude of its effect. The studies supporting each category are cited in the description of the results, and the complete coding matrix is available upon request from the corresponding author.

3. Results

3.1. Included Studies

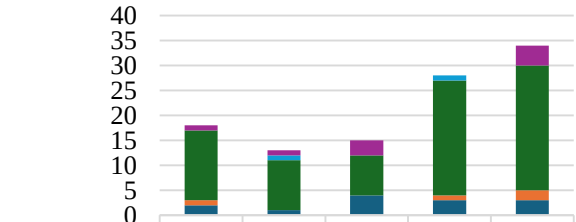
Table 3 presents the number of studies from each year for each hazard addressed by the authors. Although the number of studies is 106 for the review, in the table 108 were presented in total because two studies jointly evaluated two hazards. The first was a 2022 study where it evaluated earthquakes and tsunami, and the second was in 2026, which also addressed the same phenomena. Therefore, the number was based on the total hazards studied.

Table 3. Studies carried out by type of hazard and year of publication

Hazard	2022	2023	2024	2025	2026	Total
Earthquake	2	1	4	3	3	13
Tsunami	1	0	0	1	2	4
Flood	14	10	8	23	25	80
Debris flow	0	1	0	1	0	2
Landslide	1	1	3	0	4	9
Total	18	13	15	28	34	108

On the other hand, Figure 4 shows the distribution of the progress of the studies by year, taking into account the type of

hazard. In general, the trend is increasing in the number of studies focused on identification of vulnerabilities, analyzing risk perception and its relationship with resilience and its strengthening; however, the trend for each hazard is very different, and even a greater predominance of studies that address floods with respect to the others can be noted. This suggests that few studies on earthquakes, tsunamis, landslides and debris flows have documented the damage suffered by populations, the conditions that made them vulnerable and the way their resilience was strengthened after these events. In fact, several of these studies, such as those by Nkouaga [18] on earthquakes and Moreschini et al. [19] on tsunamis, analyze preparedness and risk perception rather than documenting the impacts of a specific event.



	2022	2023	2024	2025	2026
Landslide	1	1	3	0	4
Huaico	0	1	0	1	0
Flood	14	10	8	23	25
Tsunami	1	0	0	1	2
Earthquake	2	1	4	3	3

Fig. 4 Frequency of studies by year and hazard

3.2. Negative Impacts of Natural Disasters on Communities

3.2.1. Effects on People's Health

Some of the impacts generated by the occurrence of a natural disaster in the community are the direct effects on their health in different dimensions. People may suffer serious injuries, and in the most severe cases, these events can claim their lives, as documented in the events analyzed by Bhusal et al. [20], Thiri [21], Mugisho et al. [22], Tjahjono et al. [23] and Goto et al. [24] for earthquakes, tsunamis, floods, landslides and debris flows, respectively. Likewise, alterations are also identified which compromise the state of health during and after the disaster. For the case of floods, infectious and transmissible diseases may occur, as well as develop chronic diseases or worsen the pre-existing conditions of some disease, according to what is reported by Mugisho et al. [22] and Gutiérrez-Murillo et al. [25].

On the other hand, Tan et al. [26] found that, four years after an earthquake, households that already had insufficient income or debts before the event were about twice as likely to report worse general health, while Goto et al. [24] recorded more than 100 people injured in a community exposed to debris flows. Another aspect is psychosocial effects: for earthquakes, Yılmaz [27] reports deeper trauma and threats to the psychological well-being of refugee students, and Mahathamnuchock [28] describes immediate emotional distress and fear during the event, while in tsunamis, Thiri [21] documents displacement and the dismantling of social ties. In a study on floods, Mugisho et al. [22] reported trauma and mental shock; in landslides, Tjahjono et al. [23] included the psychological and social recovery of victims among their post-disaster strategies; and, in debris flows, Goto et al. [24] identified traumatized residents and the provision of free post-disaster psychological therapy. In this way, it is understood that in addition to presenting physical consequences in society, it also reaches emotional well-being. On the other hand, effects related to malnutrition were also presented in specific contexts such as Mugisho et al. [22], who identified it in populations affected by floods, while Valencia Londoño and Valencia Londoño [29] recorded limited health-system attention to child acute malnutrition in post-landslide resettlement sites.

3.2.2. Effects on the Physical and Functional Environment of Communities

Although the reported damages depend on other characteristics of the hazard, there are similarities in them. For the case of earthquakes, Bhusal et al. [20] report hundreds of thousands of houses destroyed or damaged, while, in another context, Mahathamnuchock [28] describes cracks in homes and damage to water tanks and community facilities. Similar damages occur in tsunamis, as Thiri [21] documents the destruction of most houses in the affected town centers and the physical destruction of settlements. In flood situations, they were also similar, according to what Ali et al. [30] records destruction of houses occurs, as Pazhuhan et al. [31] reports in addition to adding the deterioration of urban infrastructure and productive units. Likewise, in disasters occurring due to landslide, total destruction can be reached according to Raška et al. [32]. In the same way, these effects are also observed with the occurrence of debris flows, as Goto et al. [24] report more than 400 homes damaged or destroyed. Another aspect is the blockage of evacuation and access routes: Duan and Fei [33] show that blocked or damaged roads reduce evacuation success in earthquake scenarios, while Tjahjono et al. [23] report a landslide that blocked road access and isolated 115 households for several days. In floods, Singh and Bhagwan [34] report the disruption of water supply and sanitation and Lopa et al. [35] repeated damage to roads, while Freimund et al. [36] identify the impairment of sewage systems and water contamination.

On the other hand, interruptions of energy, telecommunications and connectivity also appear in floods, as Pazhuhan et al. [31] report the destruction of communication infrastructure and Singh and Bhagwan [34] the disruption of electricity, and in landslides, where the consequences of past events surveyed by Zárate Torres [37] include electricity outages and water supply interruptions, and Raška et al. [32] document damage to water pipelines. For landslides, Anthwal

et al. [38] also report damage to residential buildings and to critical infrastructure such as roads, utilities and water supply systems. The effects extend in the same way in agricultural and productive spaces, although this is in contexts where said spaces are near. Floods can cause losses of crops and livestock according to what was reported by Ali et al. [30], and Danraka et al. [39]. For its part, Pazhuhan et al. [31], records effects on productive units, as well as on other infrastructure linked with economic activity. In landslide cases, Aosaf et al. [40] identifies alterations in the agricultural environment and soils, while Raška et al. [32] document the closure of businesses. Reports are also observed on environmental quality and in facilities for community use, thus, according to Mahathamnuchock [28], for a seismic context, the turbidity of streams can be reported. In a flood situation, Freimund et al. [36] appreciate water contamination by fecal discharges and erosion processes, while in landslides Raška et al. [32] and Aosaf et al. [40] point out alterations of the terrain and soils. To this are added damages to educational, health and community infrastructure observed by Thiri [21], who reports severe damage to the town hall, police and fire stations and the public hospital, and by Lopa et al. [35], who report repeated damage to schools.

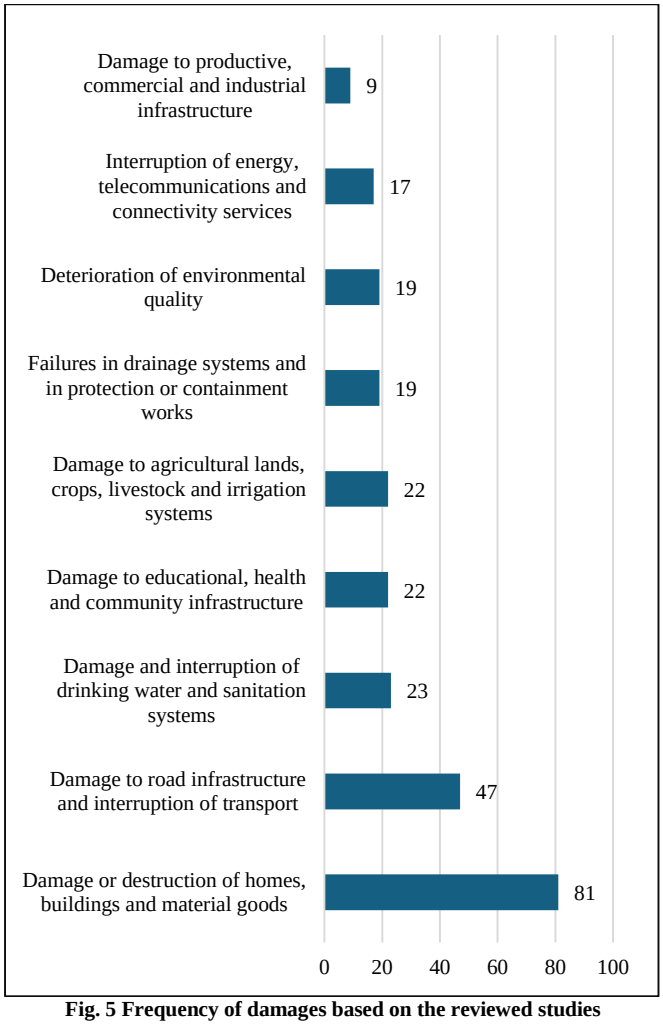


Fig. 5 Frequency of damages based on the reviewed studies

Although each hazard affects the territory differently, homes, roads, basic services, and productive spaces depend on one another, so the failure of one can restrict the functioning of the others. Blocked routes, for example, not only represent damaged infrastructure, but also a limitation on evacuation and access to assistance when they are most needed, while the loss of crops, businesses, and services extends the disaster beyond the event. Therefore, physical damage can become a new condition of vulnerability, since it reduces the resources available to the community to recover and face future events, which links these impacts to the factors analyzed in the following section.

3.3. Factors of Vulnerability and Risk Perception in Communities Exposed to Natural Disasters

3.3.1. Factors Associated with the Vulnerability of a Community

The studies reviewed for the different hazard conditions recognize a set of conditions that limit how well they can recognize the possibility of a natural disaster, take steps before it happens, and deal with its effects when it occurs. Among the conditions, factors based on the limitations of economic resources are mentioned, such as people's low income, indebtedness, scarce availability of resources, which makes it difficult to be able to take preparation or adaptation measures, according to what Tan et al. [26], Thiri [21], Rahman et al. [41] and Aosaf et al. [40] report.

Likewise, dependence on poorly diversified livelihoods, also influence economically in communities that depend particularly on agricultural, fishing activities or other sources of livelihood with few income alternatives, according to Tan et al. [26], Rahman et al. [42] and Aosaf et al. [40], since it could cause there to be a lower economic recovery capacity if their main activity is affected.

On the other hand, the conditions in which homes are found influence their capacity to protect people; in this way, fragile structures, low-quality materials, traditional or precarious constructions can reduce said protection capacity, according to what was mentioned by Thiri [21], Rahman et al. [41] and Aosaf et al. [40]. In the same way, deficiencies in water, sanitation and drainage systems affect the environmental and housing conditions, so according to Rahman et al. [42], housing conditions also depend on the prior availability of adequate basic services. Another set of factors was related to education, pointing out the low educational level, literacy difficulties, gaps in technology, limited opportunities to receive training and difficulties in finding information that helps people understand risks and prepare for disasters, this according to what Tan et al. [26], Reyes Suazo et al. [43], Rahman et al. [41], Zárate Torres [37] and Chen et al. [44] mention, likewise it is also related to factors linked with low perception and understanding of risk according to Liu and Sun [45], Moreschini et al. [19], Christia et al. [46] and Zárate Torres [37].

Likewise, certain territorial conditions make evacuation in the face of any event and access to health and emergency services difficult, which is evidenced in accessibility problems, greater distances or travel times and environmental conditions, thus restricting mobility during an emergency, according to Duan and Fei [33], Reyes Suazo et al. [43], Christian et al. [47] and Lin and Chen [48] agree. To this are added the deficiencies in institutional management and response, in relation to an insufficient availability of emergency resources, weaknesses in warning systems, lower response capacity and institutional difficulties to implement risk reduction measures, according to pointed out by Zhang et al. [49], Rahman et al. [42] and Goto et al. [24].

On the other hand, the composition and conditions of the household condition its response to some event, since cases with a high presence of children, older adults, people with disabilities or chronic diseases, members with reduced mobility, may occur, thus showing households with a greater presence of dependent relatives making them more prone to damage, this coincides according to what was reported by Tan et al. [26], Thiri [21], Rahman et al. [42], Lin and Chen [48], Chen et al. [44], Jasni and Majid [50] and Susilawati et al. [51]. In addition, at the level of actions of the community as a whole, the importance between social integration, support networks and community cohesion is also mentioned, since the absence of support links, isolation and low availability of collaboration networks can cause the possibilities of receiving guidance and assistance collectively to be reduced, this being interpreted according to the reports Christian et al. [47], Lin and Chen [48], Tan et al. [26] and Thiri [21].

These factors should not be interpreted as independent conditions, since they tend to accumulate in the same households. Several of them appear together in the same studies, suggesting that low incomes, precarious housing, limited education, and the presence of dependent members reinforce one another: a household with few resources may not only suffer greater damage, but also have fewer options to prepare, evacuate, or recover. Vulnerability also operates at different levels. Household limitations are aggravated when territorial access, institutional response, or support networks are weak, so vulnerability cannot be attributed solely to individual characteristics. Likewise, it is possible to distinguish between conditions that change slowly, such as income, housing, and location, and others that can be addressed in a shorter period, such as information, training, and community organization, a useful distinction for prioritizing interventions.

3.3.2. Factors Associated with the Risk Perception of a Community

The analyzed studies demonstrate that people measure danger according to a mixture of experiences, knowledge, personal traits and their social environment. Among these factors, having lived through a disaster is one of the most frequently reported. In fact, taking into account how often these events occur or having suffered losses provides concrete references to assess subsequent hazards. On the one hand, Askari et al. [52] affirms direct experiences with changes in perceived vulnerability and severity, while Ridzuan et al. [53] and Rana et al. [54] point out that previous experience acts as a stimulus that intervenes in the assessment of risk. Therefore, the memory of previous disasters functions as a basis from which people interpret the possibility and how serious their consequences would be.

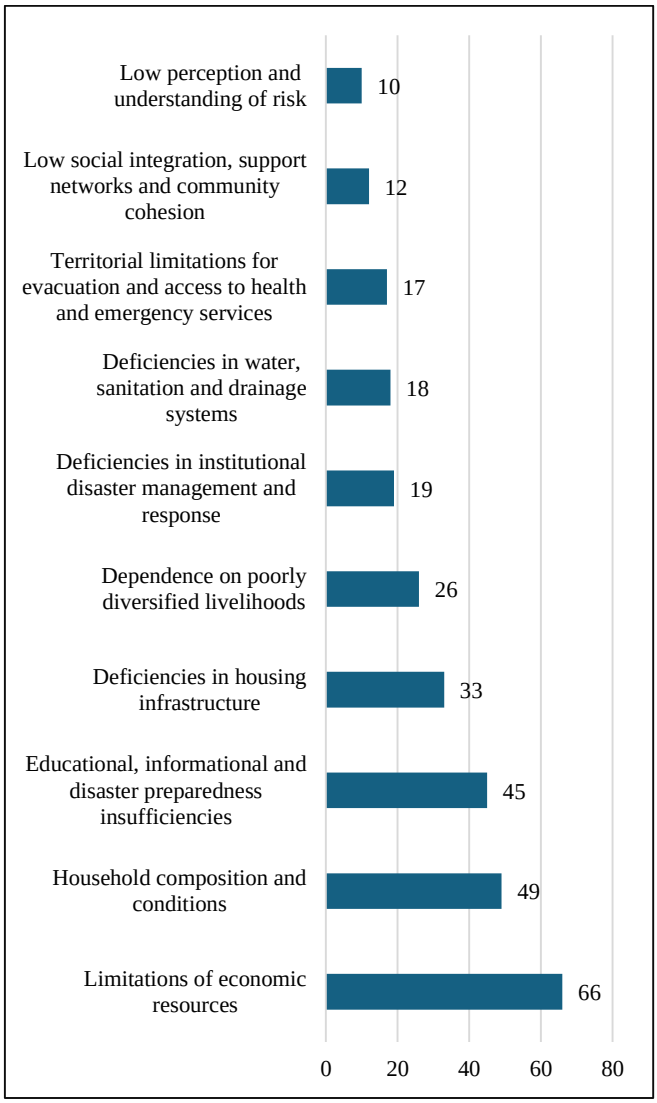


Fig. 6 Frequency of vulnerability based on the reviewed studies

In addition to previous experiences, knowledge and understanding of danger help interpret the causes, characteristics and possible effects of the hazard. On the one hand, Yuceturk [55] highlight the importance of experiences and observations of the environment to build a situated understanding of risk. Likewise, Cruz-Bello and Alfie-Cohen [56] and Suyuhan and Khoso [57] add that knowing how exposed one is to the hazard also influences. In this sense, the

way people interpret a danger depends on what they know about the phenomenon and their environment. On the other hand, access and exposure to information show another differentiated aspect according to Lin [58].

In fact, according to Hao et al. [59] highlight the role of digital capacities and online information channels and Hesti et al. [60] point out that both the frequency of use and consumption of digital content influence this process, while Leeffers [61] take into account exposure to informational videos and alerts. In general, these findings demonstrate that the channel and format of the message transform the perception of danger, especially if the information arrives on time, is easy to understand and comes from trusted sources.

Likewise, sociodemographic factors generate important differences in the way danger is perceived, for example, Shah et al. [62] point out variations related to age, educational level and family size; Mangansat [63] incorporate, among other aspects, gender, educational level, marital status and household composition; and finally, Scolozzi et al. [64] consider age, educational level and professional or social category; similarly, Grozdanić et al. [65] identify age, followed by education and gender, as predictors of earthquake risk awareness and preparedness.

Likewise, according to Askari et al. [66] identify psychological distance as an element that can reduce perception when danger is considered distant in geographic, temporal, social or hypothetical terms. In the same way, Han [67] incorporates place attachment and the feeling of helplessness, while Anwar et al. [68] show that the emotional bond with the territory and the consideration of situations as routine or manageable can intervene in the interpretation of risk. In a complementary way, sociocultural references also participate in this process. In this sense, Raza and Abu Hatab [69] highlight the presence of religious beliefs that attribute disasters to acts of God, which demonstrates that cultural and faith explanations modify the way of understanding and assessing a hazard.

Risk perception also depends in part on the trust placed in information sources, in authorities and in protection measures, in addition to the social environment in which people develop. On the one hand, Monteil et al. [70] link perception with trust in local authorities and with the security attributed to mitigation measures; for their part, Alves et al. [71] consider trust in institutional management important; and Dilshan et al. [72] incorporate trust in official alerts, media and social circles.

To this is added the influence of community relationships: Askari et al. [73] point out the role of social capital and community networks, Susilawati et al. [74] consider participation in organized groups, and Cruz-Bello and Alfie-Cohen [56] highlight the weight of support from family and neighbors.

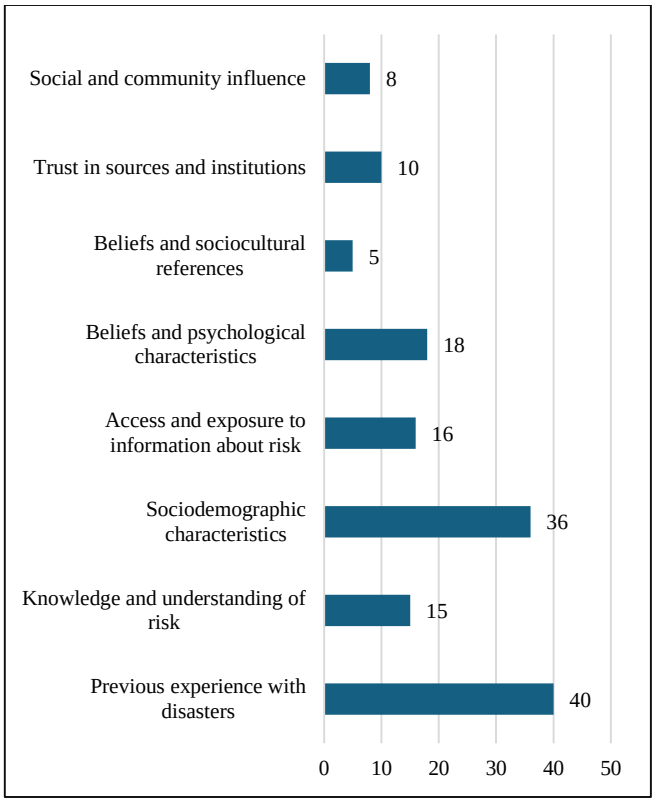


Fig. 7 Frequency of factors associated with risk perception

3.4. Manifestation of Community Resilience in Relation to Vulnerability and Risk Perception

In cases of conditions of socioeconomic and institutional vulnerability, community resilience can be reduced because the capacities and resources available to the population are limited, although said relationship can vary depending on the strength of existing social ties. In this way, Savari et al. [75], Gyan et al. [76] and Ekoh and Teron [77] mention that support networks, reciprocity and social cohesion can reduce part of those limitations. Therefore, despite having similar vulnerability conditions in a community, different levels of resilience can be shown depending on the solidity of their social relationships and the collective capacities they retain.

Furthermore, the relationship between risk perception and resilience is not direct either. Recognizing a hazard, considering it serious and feeling exposed to it can contribute to greater resilience, provided that this recognition is accompanied by the conditions needed to act on it. Iqbal and Nazir [78] and Aslam et al. [79] show that risk perception is itself shaped by awareness, fear, past experience and socioeconomic characteristics such as age, education and income, so it partly reflects the same conditions that shape vulnerability. Its effect on action also depends on other resources: Sawaneh et al. [80] found that the influence of risk perception on willingness to participate in flood prevention is reinforced by self-efficacy and bonding social capital, and Lin [58] reported that collective efficacy beliefs predicted

community action for flood risk management, although weakly. When these resources are lacking, perception and action can move apart. In Loja, the protective intentions reported against landslides exceeded the measures actually implemented by 40 to 60 percentage points [37], and in vulnerable Indonesian communities, greater flood awareness reduced preparedness when it was accompanied by excessive worry [46]. Perceiving more risk, therefore, does not necessarily mean being more resilient.

Previous experiences modify the way in which danger is interpreted, since they generate learning that remains within the community, according to what Iqbal and Nazir [78], Khadka et al. [81] and Kamarudin et al. [82] mention. To this is added the local and traditional knowledge identified by Kamarudin et al. [82] and Gutiérrez-Murillo et al. [25], through which risk awareness is formed based on coexistence with the environment, coming to strengthen resilience, since it reduces uncertainty about the hazard and broadens the understanding of one's own vulnerability conditions, especially when formal information or institutional support are limited. In contrast, Gade et al. [83] report major gaps in preparedness and limited early warning dissemination in island communities, where rehabilitation is hindered by resource constraints, weak coordination among agencies and inadequate infrastructure. These resources also shape how information becomes action, as Xu et al. [84] show that perceptions of available resources and of stakeholders, together with social support, mediate the effect of flood warnings on preparedness intention. When institutional support is limited, Georgiadou et al. [85] and Ekoh and Teron [77] point out that resilience depends to a large extent on ties and the community's own internal resources, whereas Robledo et al. [86] show that the participatory co-design of early warning systems builds trust between local actors and scientific institutions and connects scientific knowledge with concrete community actions.

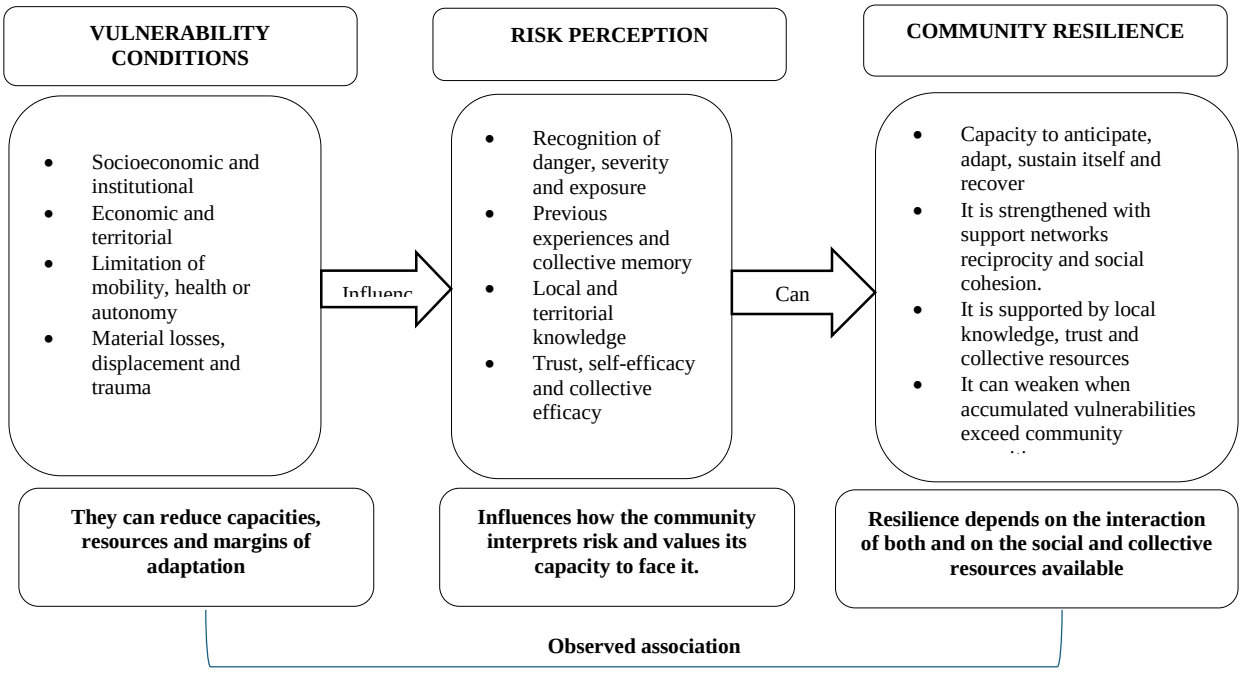


Fig. 8 Interaction between vulnerability, risk perception and community resilience

Economic and territorial conditions show that vulnerability can limit the level of resilience of a community according to Kalita et al. [87], Shahzad et al. [88] and Mohammed and Favretto [89]. Similarly, Jiang et al. [90], Muroi et al. [91] and Gangwal et al. [92] show that isolation, mobility difficulties and environmental limitations can reduce the possibilities of adaptation; in this way, the greater the vulnerability conditions, can condition resilience, since the resources and alternatives available to sustain community capacity in adverse situations decrease. This interaction is also not homogeneous within the same community. Ohtsu et al. [93], Coutureau et al. [94] and Gutiérrez-Murillo et al. [25] show that mobility, health or autonomy limitations increase the vulnerability of certain groups and, with it, their dependence on the social capacities of the environment. On the other hand, according to Ullah et al. [95], Song et al. [96] and Datta et al. [97] show that material losses, displacement, trauma and the breaking of social networks have the possibility increase vulnerabilities that already exist and thus weaken the community capacities already available. In turn, the preservation or reconstruction of social ties can recover resilience and even strengthen itself. In this context, although resilience can be strengthened, it can also be weakened or become more fragile as social conditions and collective resources change after the disaster.

The relationships represented in Figure 8 should be understood as observed associations rather than demonstrated causal influences. The arrows in the model indicate the direction of the relationships consistently suggested by the evidence, for example, that vulnerability limits resilience or that social capital strengthens it. However, many of the studies supporting these relationships use cross-sectional, qualitative, or modeling designs, which allow associations to be identified without establishing causality. Even quantitative studies that estimated mediation effects, such as those by Sawaneh et al. [80] and Xu et al. [84], or the explained variance in resilience, such as the study by Savari et al. [75], assume a direction between variables based on data collected at a single point in time. Therefore, their findings are consistent with that direction but do not prove it. Among the reviewed studies, only the randomized experiment by Leeffers [61] allows a causal effect to be attributed, in this case, the effect of information on flood preparedness, whereas the single-group pretest–posttest design by Asih et al. [98] provides more limited causal evidence because it lacks a comparison group. Consequently, Figure 8 represents an interpretive model constructed from the synthesis of the evidence, whose directional relationships will need to be tested using longitudinal or experimental designs.

3.5. Risk Management Measures for the Improvement of Resilience in the Face of Vulnerability Conditions, and Low Risk Perception

The measures reported in the reviewed studies respond not only to low risk perception, but also to situations in which risk is recognized, and material constraints prevent communities from acting on it. The reviewed studies show some measures for reduction of vulnerability, for example, for the case of homes, they focus on the structural strengthening and elevation of homes, as mentioned by Tharziansyah and Rahman [99] and Han et al. [100], while Peiris et al. [101] observe that household physical mitigation measures allowed residents to cope with past floods. Regarding protection of the environment, the construction of drainage, dikes, reforestation and green infrastructure are mentioned, as pointed out by Uwayisenga et al. [102], Lopa et al. [35] and Rajaperumal et al. [103]. In matters of community organization, Klimeš et al. [104] and Alvalá et al. [105] mention zoning measures, land-use regulation and relocation of population or infrastructure that are located in areas where the greatest hazard is concentrated. In the same way, they could also be reinforced with prior evaluation and be able to recognize the existing conditions present around them, so according to Anthwal et al. [38], Rajaperumal et al. [103] and Shrestha et al. [106] report the use of vulnerability and hazard maps, geographic information systems, monitoring and analysis of the territory to identify areas and groups that require greater attention.

On the other hand, early warning systems and timely risk communication are also pointed out to improve or correct existing deficiencies and reinforce safety conditions, through the use of alerts through sirens, local networks, digital media and official channels to inform the population in advance, according to what Ringo et al. [107], Intaramuean et al. [108], Pamungkas et al. [109] and Askari et al. [110] report. Likewise, evacuation and shelter planning systems must be counted with in order to identify the safest routes for evacuation, safe areas, shelter centers and transfer procedures, especially in places where there are access or mobility difficulties, as mentioned by Yazdani and Haghani [111], Shrestha et al. [106] and Klimeš et al. [104].

Education and capacity strengthening, such as awareness programs, practical training, first aid, peer education, help guide knowledge about the risk that a hazard can have on their community, as mentioned by Asih et al. [98], Fazeli et al. [112] and Pamungkas et al. [109]. For their part, Lundgren and Strandh [113], Li and Lin [114] and Singh and Bhagwan [34] guide measures such as the participation of local committees, community organizations and support networks that may allow incorporating the population in preparation and response processes; in addition, within that context, Yazdani and Haghani [111] emphasize considering specific measures for older adults, people with mobility difficulties and other groups that require differentiated support, Iqbal et al. [115] stress gender-sensitive preparedness and response because social norms and mobility restrictions increase women's vulnerability, and Islam et al. [116] show that limited access to relief, healthcare services and WASH infrastructure increases public health vulnerability, and that NGO interventions that improved adaptation and relief distribution reduced it in the most flood-affected area. In addition, in relation to limited economic capacities, Nasta et al. [117], Dinh et al. [118] and Phuong et al. [119] mention the possibility of seeking income alternatives, support for alternative livelihoods, insurance and other forms of economic protection.

As a whole of the community, according to Lundgren and Strandh [113], Li and Lin [114], Singh and Bhagwan [34] and Danraka et al. [120] suggest the organization and spaces for joint communication through workshops, meetings and exchange spaces where people participate and share information about the risks of their environment, or also that they can share topics related to previous experiences, according to Kamarudin et al. [82], Raška et al. [32] and Askari et al. [73]. Another measure is the use of maps, signage and graphic representations to show areas of greater susceptibility, but above all that they are easy to understand, measures that coincide Anthwal et al. [38], Rajaperumal et al. [103] and Truong et al. [121]. On the other hand, transparency, clarity of messages and credibility of authorities and technical sources have to be oriented toward favoring a better understanding of risk according to Xu et al. [84], Alves et al. [71] and Monteil et al. [70]. In this way, according to Rasool et al. [122], Fazeli et al. [112] and Liu and Sun [45], guide interventions in correcting ideas that can distort the

assessment of danger, such as fatalism, the false sense of security or psychological distancing. At the institutional level, Alvalá et al. [105], Lopa et al. [35] and Elum and Lawal [123] should consider focusing on strengthening in coordination between authorities, local organizations and community, in addition to improving standards, responsibilities and planning mechanisms. In turn, according to Nasta et al. [117] and Bhusal et al. [20], interventions in rehabilitation, reconstruction of homes and infrastructure and recovery of livelihoods should also be prioritized to avoid or mitigate the prior conditions of vulnerability are maintained or deepened.

Not all the measures in Figure 9 have the same level of empirical support, so it is useful to distinguish between those with documented outcomes and those proposed as recommendations. Only a small group of studies evaluated the effects of a measure. Using an experimental design, Leeffers [61] showed that providing information on flood risk, even through text messages, increased the implementation of mitigation measures in urban communities in Mozambique. Using a single-group pretest–posttest design, Asih et al. [98] observed improvements in students' knowledge and attitudes following a peer education program. Other studies documented outcomes observed or perceived by the population. Ringo et al. [107] found that responses to early warnings reduced deaths, injuries, and material losses, and that this reduction was associated with family discussions about preparedness and evacuation. In the study by Bhusal et al. [20], 96% of households attributed the acceleration of housing reconstruction to sociotechnical assistance. Islam et al. [116] observed lower health vulnerability in the area where NGO interventions improved adaptation and aid distribution, and the modeling by Han et al. [100] estimated that community-level damage decreases when households become aware of the risk. The evidence also shows that some measures failed to achieve their objectives or had unintended effects. Post-disaster resettlement in Salgar did not reduce the vulnerability of the relocated population [29], and reconstruction plans following the 2011 tsunami, focused on risk reduction, contributed to displacement and the disruption of social ties [21]. The remaining measures in the figure come from recommendations derived from diagnostic studies; therefore, their effectiveness has yet to be demonstrated and should be interpreted with caution

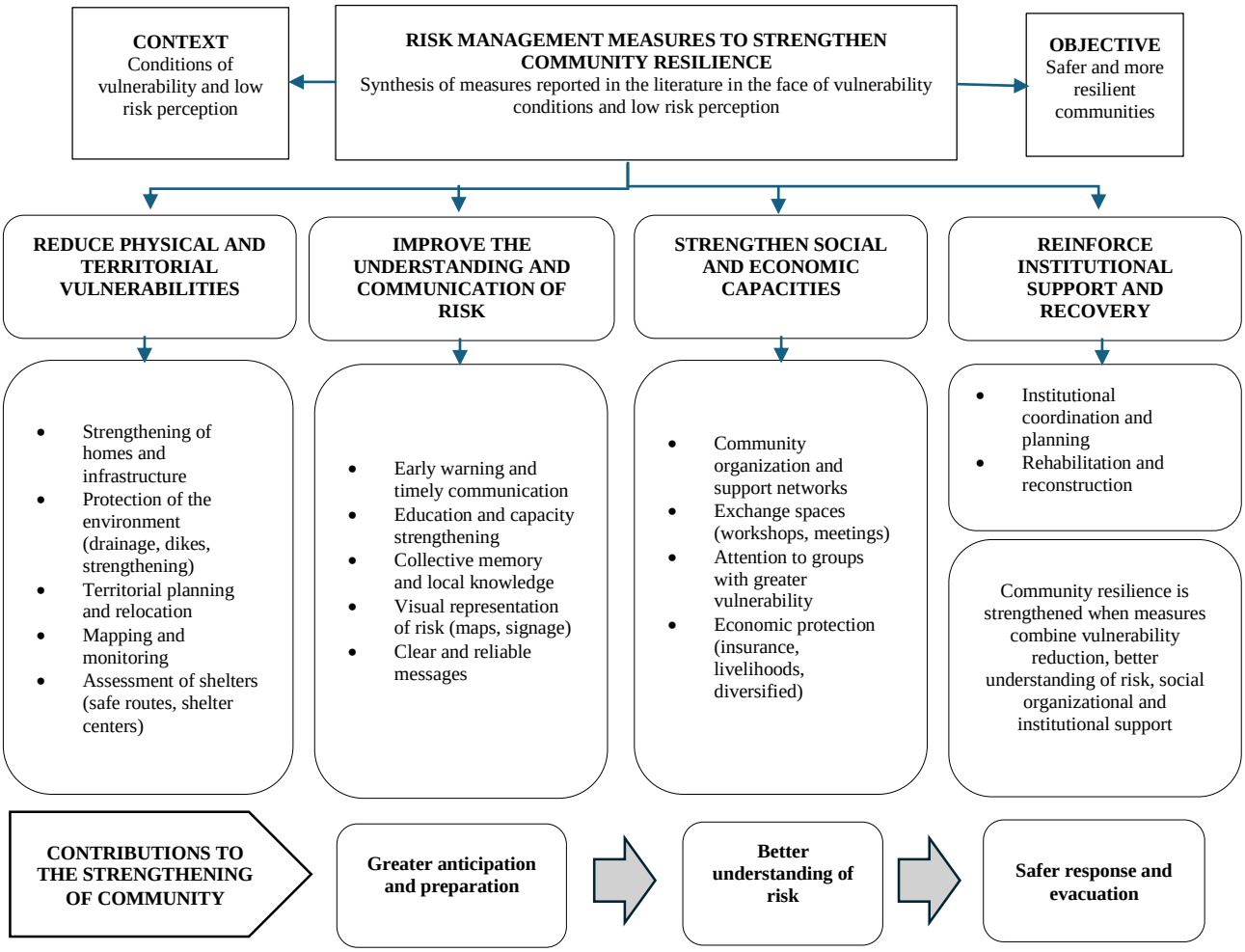


Fig. 9 Risk management measures for the improvement of community resilience in the face of vulnerability and risk perception conditions.

4. Discussions

The reviewed studies agree that the effects of disasters extend far beyond material damage. Along with the loss of lives and homes, disasters affect physical and mental health, basic services, mobility, and livelihoods, and many of these consequences persist long after the event. As shown in Figure 5, damage to housing and material assets was the most frequently reported impact, followed by disruptions to roads and transportation. These frequencies, however, should be interpreted with caution. As shown in Figure 4, most of the evidence comes from studies on floods, meaning that the ranking of impacts largely reflects what occurs with this hazard and not necessarily the relative importance of each impact in earthquakes, tsunamis, landslides, or debris flows. It is also worth examining how these impacts are documented. In several of the reviewed studies, damage is presented as a description of the event or the study area rather than as systematically measured results, making comparisons across hazards and contexts difficult. This is consistent with Zaman and Raihan [13], who found that research on community resilience rarely covers all phases of a disaster: in this review, the studies either described the damage of a single event or, in the case of less frequent hazards, focused on preparedness, and few followed the same communities over time. The work of Tan et al. [26] shows the benefits of tracking impacts over time: four years after the 2015 Nepal earthquake, households that already had insufficient income or were in debt before the event were approximately twice as likely to report poorer health. Furthermore, the official assessment conducted after the disaster, which focused on housing and income, considered neither health nor households in debt. The impact, therefore, is not evenly distributed: it follows patterns of pre-existing vulnerability, and an assessment that only accounts for physical losses may overlook precisely those who will face the greatest difficulties in recovering. Moreover, as described in Section 3.2.2, these impacts are interconnected, so physical damage ultimately becomes a new condition of vulnerability by reducing the resources available to the community to face the next event. This idea is consistent with the shift from a static to a dynamic view of vulnerability described by Armaș and Albulescu [5], and the reviewed studies provide evidence of this dynamic nature at the community level.

As shown in Figure 6, economic constraints were the most frequently reported vulnerability condition, followed by household composition, educational and informational gaps, and housing deficiencies. As noted in Section 3.3.1, these conditions tend to accumulate within the same households and worsen when territorial access, institutional response or support networks are weak, so distinguishing between those that change slowly and those that can be addressed in the short term helps to prioritize interventions. Progress can also be observed compared with the earlier literature: gender, which Zaman and Raihan [13] identified as an understudied dimension between 2010 and 2021, is now explicitly addressed in some of the reviewed studies [55, 89, 115], although these remain few. Regarding risk perception, Figure 7 shows that previous experience and sociodemographic characteristics were the most frequently reported factors. The prominence of previous experience is partly explained by the predominance of floods, whose recurrence allows communities to accumulate experiences that serve as a reference for assessing the hazard. This finding is only partially consistent with the meta-analysis by Theodorou et al. [9], based on 127 studies. In that analysis, previous experience, knowledge, and trust in authorities were associated with higher risk perception, but with small effects ($r = 0.16$, 0.19, and 0.20), whereas negative emotions ($r = 0.46$) and social norms ($r = 0.36$) showed the strongest effects. Age, education, and income could not even be analyzed because their effects were not normally distributed. In other words, the most frequently studied variables are not necessarily the most influential, and emotional and normative factors deserve greater attention in community-level research.

The comparison also reveals an apparent contradiction. Place attachment, psychological distance, and religiosity had no significant effects on average in the meta-analysis [9], yet they exerted an influence in specific contexts within the reviewed studies. Place attachment enhanced household adaptation when combined with high risk perception [67], and communities that remained in flood-prone areas had normalized flooding [68]. In Iran, psychological distance and place attachment were associated with the adoption of protective measures [73], while in Pakistan, the belief that floods are an act of God received the highest scores within psychological resilience [69]. Both sets of findings are compatible: Theodorou et al. [9] report high heterogeneity and suggest that place attachment may guide protective behaviors rather than risk perception itself. In fact, several of the reviewed studies measured these factors in relation to adaptation, protective measures or resilience rather than risk perception [67, 69, 73]. All indications suggest that the effects of these factors depend on the context, something that averages obscure and that, according to Zaman and Raihan [13], qualitative approaches capture more effectively. As these findings come from studies on floods, their applicability to other hazards remains to be established. Finally, vulnerability and risk perception are not independent. Educational and informational gaps appear in both: they increase vulnerability while limiting the ability to understand the hazard and assess its consequences. Therefore, information and training can address both components, although they are insufficient on their own when constraints are structural.

As shown in Figure 8, the relationship of vulnerability and risk perception with resilience is neither direct nor proportional but is influenced by other factors. Vulnerability restricts resilience by reducing the available resources, but this relationship can be modified. In communities with similar conditions, support networks, reciprocity, and cohesion compensated for some of these limitations [75-77], as did local

and traditional knowledge when formal information or institutional support was limited [25, 82]. These findings provide empirical support for the conceptual shift described by Graveline and Germain [14]: resilience, long considered the opposite of vulnerability, is now understood as a set of capacities. The reviewed evidence shows that the two are not simply opposed but interact through the social, cognitive, and institutional resources of each community. This role of social capital is consistent with the findings of Zhao et al. [15], who identified five mechanisms through which it strengthens resilience: social learning, collective action, preparedness, information communication, and civic responsibility. However, that review did not examine vulnerability, and therein lies one of the contributions of this synthesis: social capital can compensate for vulnerability, although not always. Displacement, losses, and trauma can disrupt the very networks on which the community relies [95-97], and groups with limitations in mobility, health, or autonomy depend more heavily on them [93, 94]. This nuance is consistent with the warning by Zaman and Raihan [13] that social capital can also become dysfunctional and exclude certain groups. Resilience therefore appears as a dynamic condition that can strengthen or weaken over time, rather than a fixed attribute of the community. The mediated nature of these relationships, in turn, is supported by studies that quantitatively examined some of them. The components of social capital explained 68.1% of the variance in the resilience of rural households to floods [75], and self-efficacy and bonding social capital mediated the relationship between risk perception and participation in prevention [80]. Similarly, perceptions of resources and institutional actors mediated the effect of warnings on preparedness intentions [84], and place attachment enhanced adaptation only when combined with high risk perception [67]. Other studies showed that the effects of the factors vary according to the level of household preparedness [18] and that risk awareness, by generating excessive concern, can reduce preparedness, a relationship that the authors explicitly describe as nonlinear [46]. However, these studies analyzed pairs of components rather than all three within a single model. Therefore, the joint relationship proposed in this review should be understood as a synthesis of converging evidence rather than as a statistically estimated relationship. Testing this relationship will require studies that simultaneously measure vulnerability, risk perception, and resilience within the same communities, using models that allow mediation and moderation effects to be tested.Risk perception does not automatically translate into resilience either. Ribeiro et al. [8] found that high risk awareness rarely translates into preventive measures because of trust-related, communication, and socioeconomic barriers. The reviewed studies confirm this gap. In Loja, trust in authorities and early warning systems was the main predictor of protective behaviors against landslides, while reported intentions exceeded implemented measures by 40 to 60 percentage points [37]. In Indonesia, greater awareness reduced preparedness when it generated excessive concern [46], and in the United States, Nkouaga [18] found lower earthquake preparedness among higher-income and long-term residents, a possible effect of complacency. Neither perceiving greater risk nor having more resources guarantees a better response on its own; what is decisive is their combination with institutional trust and collective capacities. When material constraints are severe, a community may clearly recognize the hazard and still have limited capacity to respond and recover.

As shown in Table 3 and Figure 4, the evidence is highly uneven: 80 studies addressed floods, 13 earthquakes, 9 landslides, 4 tsunamis, and 2 debris flows. In the case of floods, the recurrence of events allows communities to accumulate experience and local knowledge, and the evidence encompasses social capital, livelihoods, and gender. For earthquakes, studies focus more on preparedness than on resilience, and risk perception depends on digital media [60], fatalism and optimism [45], community participation [18], and sociodemographic factors [65]. When past earthquakes were analyzed, their effects persisted for years among previously vulnerable groups [26, 27]. For tsunamis, none of the four studies empirically examines the relationship between risk perception and resilience, although they do show the disruption of social ties during reconstruction [21], the concentration of vulnerable or aging populations in exposed coastal areas [43, 91], and, given the short warning time, the risk posed by limited knowledge among transient populations, such as tourists [19]. In landslides, impacts persist over time [32, 38, 40], vulnerability is concentrated among older adults and low-income households [50], institutional trust plays a greater role than perceived severity [37], and social networks support recovery [48]. For debris flows, the two available studies highlight institutional vulnerability [24] and lower risk knowledge among ethnic minorities and older adults [44], but neither was conducted in the Andean region; therefore, their findings cannot be extrapolated to Andean debris flows.

These contrasts suggest that, for recurrent hazards, risk perception is shaped primarily by experience, whereas for sudden and less frequent hazards in a given locality (earthquakes, tsunamis, and debris flows), it depends more on information, communication, and institutional trust, a pattern also observed in landslides, where institutional trust outweighed perceived severity [37]. This could explain the emphasis of these studies on preparedness and early warning. Nevertheless, some findings recur across hazards: pre-existing vulnerability influenced recovery after an earthquake [26] and a tsunami [21], and the gap between perception or resources and action emerged in landslides [37] and earthquakes [18]. The identified relationships are therefore not exclusive to floods, but their confirmation in the context of tsunamis and debris flows requires studies that examine resilience, rather than preparedness alone, in exposed communities, particularly in the Andes.

As summarized in Figure 9, the reported measures encompass the reduction of physical and territorial vulnerability, economic support, early warning systems and risk communication, education, community participation, and targeted support for the most vulnerable groups. Although these measures predominantly come from flood contexts, they were also reported for other hazards, such as reconstruction with sociotechnical assistance after an earthquake [20], tsunami evacuation routes [43], and housing relocation in landslide-prone areas [104]. However, many of these measures emerged as recommendations from diagnostic studies, and only a few studies evaluated interventions. Among them, Leeffers [61] stands out, whose randomized experiment in Mozambique showed that text messages were as effective as more costly visits or videos in promoting preparedness. In contrast, Asih et al. [98] reported improvements following a peer education program, but without a comparison group. This scarcity of evaluations is one of the main gaps in the evidence, particularly for less studied hazards, because it prevents determining what works, for whom, and in what context. The identified measures are consistent with the recommendations of Zhao et al. [15] on communication, social learning, and collective action, but the findings add a nuance: as Ribeiro et al. [8] warn, it is necessary to address the barriers that separate perception from action, and the reviewed evidence shows that these barriers are often material. Therefore, information and communication will have a limited reach unless accompanied by livelihood support [117-119] and targeted support for older adults, women, and people with mobility or health limitations [111, 115, 116]. The way these measures are designed also matters: the participatory design of early warning systems builds trust between local actors and scientific institutions [86], confirming that risk management should integrate vulnerability reduction, communication, and the strengthening of community capacities rather than rely on isolated interventions.

The evidence is also geographically concentrated. Nearly two-thirds of the studies (64) were conducted in Asia, primarily in Pakistan (11), Indonesia (10), China (7), Iran (6), and Bangladesh (5). Another 15 were conducted in Africa, 16 in the Americas, 8 in Europe, 2 in Oceania, and 1 covered multiple continents. In Latin America, there are only 9 studies, and just 3 in Andean countries (Colombia, Ecuador, and Peru). Furthermore, fewer than one-fifth of the studies were conducted in high-income countries. This concentration limits the scope of the findings because institutional and socioeconomic conditions influence how the components relate to one another. Where institutional support is limited, as in informal settlements in South Africa or Lagos, resilience depends primarily on the community's internal networks and resources [77, 85]. In contexts with greater state capacity, however, the emphasis shifts to the quality of institutional management. In Montecito, despite being a high-income community, institutional vulnerability influenced the impact of debris flows, and the county's timely response helped reduce this vulnerability [24]. In Nîmes, France, an inconsistency was identified between the centralized approach to risk management and the authorities' call for individual preparedness [70]. Top-down approaches without community participation do not guarantee lower vulnerability either, as demonstrated by the resettlement in Salgar [29]. Socioeconomic differences also operate within each community. In Iran, higher-income households showed greater resilience [75], and in Nepal, households in debt experienced poorer recovery [26], although having more resources does not always translate into greater preparedness [18]. Consequently, the findings of this review are more representative of flood-exposed communities in low- and middle-income countries in Asia and Africa, and their transferability to high-income contexts or Andean communities should be approached with caution and validated through local studies.

5. Conclusion

Natural disasters generate effects that transcend immediate physical damage and can extend to different dimensions of community life. Among the identified impacts stand out the loss of human lives, injuries and effects on physical and psychological health, damage to homes and property, interruption of water, sanitation, energy and telecommunications services, transport and evacuation difficulties, as well as losses in agricultural, productive and commercial activities.

Among the most recurrent vulnerability conditions were economic limitations, the presence of dependent members in the household, dependence on poorly diversified livelihoods, deficiencies of homes and basic services, educational and informational gaps, mobility and access difficulties, institutional weaknesses and the limited availability of support networks. Regarding risk perception, the studies identified as relevant elements previous experience with disasters, knowledge and understanding of the hazard, sociodemographic characteristics, access to information, beliefs, trust in institutions and the influence of the social environment. The coincidence of educational and informational factors between both components allows recognizing points of connection between vulnerability conditions and the way in which people interpret risk, without this implying that both concepts are equivalent.

The reviewed evidence shows that greater vulnerability can restrict resilience when it reduces the material, economic, institutional or territorial resources available to respond and recover. However, this relationship can be modified by the existence of social capital, cohesion, reciprocity, support networks, local knowledge and collective efficacy. In the same way, greater risk perception can favor preparation and certain preventive actions, but it does not guarantee by itself greater resilience. When a community recognizes risk, but lacks

resources or capacities to act, a high perception accompanied by a limited response capacity may persist. Therefore, resilience does not depend only on how much risk is perceived nor on how much vulnerability exists, but on how these conditions interact with the resources and capacities available in each context.

The measures identified in the literature suggest that strengthening resilience requires articulated interventions and not isolated actions. The reduction of vulnerability can be supported by the improvement of homes and infrastructure, protection of the environment, territorial planning, attention to economic conditions and consideration of groups that require differentiated support. In a complementary way, early warning systems, clear and timely communication, education, training, community participation and strengthening of support networks can contribute to improving the understanding of risk and response capacity.

Overall, the findings indicate that understanding community resilience to disasters requires overcoming a vision centered exclusively on the event and considering the prior conditions of populations, the way in which they construct their risk perception and the social, material and institutional capacities that they can mobilize in the face of adverse situations. Unlike previous reviews, which examined vulnerability, risk perception or resilience separately, this synthesis brings together evidence showing that the three components interact at the community level and that this interaction depends on the social, institutional and material resources available. On the other hand, one of the main limitations was the diversity of the reviewed studies, because they were developed with different approaches and methodologies. In addition, not all analyzed vulnerability, risk perception and resilience jointly, so some relationships were interpreted from results. The evidence is also concentrated in floods and in low- and middle-income countries in Asia and Africa, many of the studies used designs that identify associations rather than causal effects, and few evaluated the effectiveness of the measures, so the findings should be transferred to other hazards and contexts with caution. Future research requires empirical studies on community responses to huaicos conducted in Andean communities, as well as an analysis of tsunamis. On the other hand, it is necessary to directly measure the relationship between risk perception and resilience in earthquakes and tsunamis, since the available evidence is mainly focused on preparedness, and to verify whether social capital and local knowledge compensate for vulnerability in sudden-onset hazards. In addition, models are needed to quantify the benefits of early warning systems, reported mainly as communication measures, in terms of protected lives, evacuation time, and damage avoided to homes and infrastructure. Finally, longitudinal studies using comparable instruments are recommended, following the same community before and after a disaster, to distinguish associations from the actual effects of risk management measures.

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