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Bibliometric mapping of the trends and contributions of scientific publications to risk and crisis communication regarding South America

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ABSTRACT

Risk and crisis communication (R&CC) are crucial elements of managing vulnerability to big threats. This paper aims to explore the trends and contributions of scientific publications to R&CC about South America. Through the examination of 330 papers listed in the Web of Science database, the current study conducted a thorough overview between 1998 (oldest study) and 2021 (cut-off date) of bibliometric networks (keyword co-occurrence map, co-authorship maps, and author co-citation map) and multivariate statistical models (principal component analysis, compositional linear model). We address main communication factors, links between communication factors and countries, main academic cooperation networks, determinants of publication trends, and most cited authors. 28 R&CC factors were mapped and their relative importance to various hazards was examined. Most of these factors were intended to strengthen the communication system and increase risk knowledge of vulnerable people. Chile, Colombia, and Ecuador were mostly focused on strengthening R&CC. Brazil and Argentina were best represented with health and exposure to pollutants communication. Publications on R&CC are determined by the level of wealth, tourist arrivals, and the number of people affected by disasters. The compositional analysis revealed that the behavior of publications determinants could have opposite tendencies depending on the threats’ multidimensionality. To the best of our knowledge, this is the first R&CC study on South America to use CoDA in a bibliometric analysis.

1. Introduction

At a conceptual level, risk is defined as ‘a situation or event in which something of human value (including humans themselves) has been put at stake and where the outcome is uncertain’ (Jaeger et al., 2001) and crisis as the manifestation of a risk (Heath & O’Hair, 2020). Despite the differences between risk and crisis, the language of both domains of knowledge is the same: managing discomfort, loss, damage, deficit, and negativity (Lavell & Maskrey, 2014).

Risk and crisis management is the responsibility of both: managers and actors (Garcia & Mendez-Fajury, 2018). Its management is considered a process that demands more collective than individual actions (Justo et al., 2020). In this process, communication is a key tool that helps to modify behaviors and attitudes in a crisis event (Alcantara & Ferreira, 2020; Diniz et al., 2021).

Risk and disaster management is a global priority well recognized by international frameworks such as the Sustainable Development Goals 2015–2030 (UN General Assembly, 2015; UNISDR, 2015). In the communication field, the Sendai Framework recognizes as important factors for good communication: a) the use of information on threats, b) the use of the media for risk management, c) communication between actors linked to the risk and disaster management system, d) the communication of risk management advances, e) the development of communication mechanisms for the disaster phase, and f) the strengthening of communication technologies oriented to social participation (UNISDR, 2015).

However, this contribution may be insufficient for the formation of a resilient society and the creation of public policies based on communication in the face of different threats (Khan & Mishra, 2022). One way to achieve greater communications impact on audiences lies in the scientific field (Weber & Schmidt, 2016).

Risk and crisis communication emerged as scientific fields in the 1970s and 1980s in response to the needs of industrialized nations to regulate technology and...
safeguard their population from technological, natural, and man-made hazards (Haupt, 2021; Heath & O’Hair, 2020; Krimskey & Golding, 1992). According to Leiss (1996), the term ‘risk communication’ was originally used in 1984 to address discrepancies between expert-assessed risks and public perceptions of such concerns. Whereas the study by Ware and Linkugel (1973), where communication was originally studied as a response strategy to preserve the corporate reputation from public attacks, is considered one of the earliest examples of crisis communication research (Heath & O’Hair, 2020).

Balog-Way et al. (2020); Fischhoff (1995) evidenced that risk communication as a scientific field has undergone continual evolution since its origins, establishing new practices and addressing new problems to solve as a result of an ongoing sequence of events and historical processes. Covello et al. (1986) showed that early risk communication was characterized by notable advancements in the field of psychological research on the public’s perception of risk and by significant gaps in knowledge of the most relevant risk communication issues. According to Gurabardhi et al. (2005); Gutteling (2016), until the year 2000, academics as P. Slovic, B. Fischhoff, and L. Frewer from the Western world (the United States and Western Europe) dominated the field of risk communication. ‘Today, the same authors are cited frequently and still rank highly on the list of most productive individuals’ (Gutteling, 2016).

V.M. Bier provided evidence that, up to the end of the 20th century, there was a dearth of empirical research on risk communication for decision-makers and a wide range of literature on risk communication for the public (Bier, 2001a, 2001b). The period 1988–2000 was marked by a gradual increase in studies related to two-way risk communication, whereas research about the one-way flow of risk communication decreased (Gurabardhi et al., 2005). According to McComas (2006) studies on social trust, social amplification of risk framework, affect heuristics and mental models occupied a prominent place in the period 1996–2005. According to Balog-Way et al. (2020) studies on public engagement, risk perception, framing, and trust are still relevant to today’s issues. Balog-Way et al. (2020) identified social network utilization, communication transparency, and the applicability of risk communication policies as critical opportunities and challenges in the contemporary world.

According to Krimskey (2007), the scientific field of risk communication has undergone three stages: stage one where communication was conceptualized as a linear process using primarily a top-down communication approach; stage two, based on scientific uncertainty, subjective and cultural aspects, and the role of the media; and stage three, based on a postmodernist and constructionist vision of risk.

The evolution of crisis communication is characterized mainly by the use of four theoretical approaches: a) the rhetorical approach, which emphasizes the cause, severity, and duration of a crisis while acknowledging that each is debatable; b) the organizational approach (predominant approach), which helps to determine what an organization should do in a crisis; c) the stakeholder approach, which takes into account that corporations affect stakeholders but that corporations are also affected by stakeholders; and d) the postmodernist approach, which critiques the current research on crisis planning and the recovery of order and control and seeks more humane ways of communicating that serve to alleviate the suffering of the interested parties (Coombs & Holladay, 2022; Heath & O’Hair, 2020).

Lundgren and McMakin (2018) grouped the theoretical approaches that have predominated in the scientific development of risk communication into four large groups: a) cross-cutting risk communication approaches, b) care communication approaches, c) consensus communication approach, and d) crisis communication approach. Figure 1 summarizes 16 influential approaches to risk communication collected by Lundgren and McMakin (2018), along with the names of some authors who have contributed to their development. This analysis shows traditional approaches like the communication process approach, through approaches that still draw on work in risk communication, like the hazard plus outrage approach (developed by B. Fischhoff and P. Slovic and popularized by P. Sandman) and the mental models approach (developed by B. Fischhoff, A. Bostrom, and associates), to the relational dialectics approach (developed by R. Littlefield, T. Sellnow, and associates), which seeks not only to understand the audience in crises situations but also to engage her fully in the communication process.

According to Covello (2022) the four dominant theories of risk communication are a) the trust determination theory, b) the negative dominance theory, c) the mental noise theory, and d) the risk perception theory.

Despite risk communication and crisis communication being two separate concepts, they share the practical value of developing public messages intended at enhancing the health, safety, and environment of the interested parties (Heath & O’Hair, 2020; Reynolds & Seeger, 2005). According to Lundgren (1994), crisis communication is part of a more constrained version of risk communication. Sandman (2006) suggested crisis communication as part of three distinct risk communication practices: preventive management, outrage management, and crisis communication.
Cross-cutting risk communication approaches

- Communication process approach
  Representations of Shannon’s traditional communication model
- National Research Council approach
- Hazard plus outrage approach
  Baruch Fischhoff, Paul Slovic, Peter Sandman
- Social amplification of risk approach
  Paul Slovic, Peter Sandman, Roger E. Kaspersion, Ortwin Rem, ...
- Social constructionist approach
  Craig Waddel
- CAUSE model approach
  Katherine E. Rowan, Carl H. Botan, Gary L. Kreps
- Mental Noise approach
  Vincent Covello
- Social network contagion approach
  Clifford W. Scherer; Hichang Cho
- Social trust approach
  Timothy C. Earle, George T. Cvetkovich, ...
- Evolutionary theory approach
  W. Troy Tucker, Scott Ferson

Consensus communication approach

Everett M. Rogers, D. Lawrence Kincaid

Care communications approaches

- Mental models approach
  M. Granger Morgan, Baruch Fischhoff, Ann Bostrom, Cynthia J. Atman, ...
- Extended parallel process model approach
  Kim Witte
- Description-experience gap approach
  Ralph Hertwig, Renato Frey
- Risk information seeking and processing
  Robert J. Griffin, Sharon Dunwoody, Kurt Nenwirth

Crisis communication approaches

- Original crisis communication approach
- Crisis and emergency risk communication approach
  Barbara Reynolds, Matthew W. Seeger
- Relational dialectics approach
  Robert Littlefield, Timothy Sellnow, ...

Seeger (2006) developed a best practice typology that develops risk and crisis communication as a continuous process.

According to Steelman and McCaffrey (2013), risk and crisis communication should be merged into a more holistic approach based on events that enable ongoing and participatory engagement with the public during all stages of the crisis. The approach developed by Reynolds et al. (2002), named crisis and emergency risk communication, stands out among those that combine risk and crisis communication in a specific field of study and practice. This approach combines the necessity of communicating risk with the urgency of conveying crisis, especially in response to global health threats (Heath & O’Hair, 2020).

Communication research helps to provide reliable sources of information (Massarani et al., 2020), generate risk prevention in the community (Janes & Marques, 2013), to deal with infodemic (Mullo López et al., 2021), better communicate risks and crisis (Gwenzi & Rzymski, 2021; Litre et al., 2017), and the advancement of knowledge (Visschers & Siegrist, 2008; Visschers et al., 2009).

According to Steelman and McCaffrey (2013), the two most influential domains of research on extreme event communication are risk communication and crisis communication. ‘Risk communication seeks to inform people about a potential future harm and the associated dangers so that they might take action to mitigate the risk’ (Dufty, 2020). While crisis communication ‘relates to communication as an emergency or disaster event unfolds, and as part of recovery from that event’ (Dufty, 2020).

Effective threat management should employ risk communication and crisis communication to empower the response of diverse target audiences to emergencies and the mitigation of the repercussions of a risk event (Heath & O’Hair, 2020). The present study uses the term R&CC to refer to risk and crisis communication, this form emphasizes not only the characteristics of the crisis but also the communication requirements that emerge at its stages (Reynolds & Seeger, 2005; Reynolds et al., 2002).

In this line, bibliometric analysis is a popular research technique to provide an overview of the scientific output of R&CC (Asmi et al., 2019; de las Heras-Pedrosa et al., 2022). One of the main techniques that facilitate bibliometric analysis are maps based on scientific data networks, which allow the visualization of different parts of the publications through redundancy analysis (Van Eck & Waltman, 2010). In this study, we have referred to the bibliometric mapping applied to all published studies that allow a worldwide perspective of R&CC as ‘global bibliometric mapping’.

Within the fields of R&CC, there is evidence of global bibliometric mappings related to risk communication (Agyepong & Liang, 2022; Goerlandt et al., 2020), health communication (de las Heras-Pedrosa et al., 2022), environmental communication (Wu et al., 2021), and climate change communication (Agin & Karlsson, 2021; Asmi et al., 2019; Wu et al., 2022).

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**Figure 1.** Main approaches and authors linked to communicating risks. Sources of information (Heath & O’Hair, 2020; Lundgren & McMakin, 2018).
With this global approach, most scientific publications on R&CC bibliometric mappings focus on developed economies such as North America and Western Europe (Agin & Karlsson, 2021; Goerlandt et al., 2020). However, few scientific publications of global bibliometric maps of the R&CC enable to make the most vulnerable economies visible (Agin & Karlsson, 2021). Regions such as South America, Africa, Oceania, Asia, and Eastern Europe are underrepresented in global bibliometric mappings (Agin & Karlsson, 2021; Goerlandt et al., 2020). Agin and Karlsson (2021) revealed that generally 78.57% of the world’s countries (196 countries considered) are not represented in risk studies associated with this type of mapping. Overall, 0.7% of these studies are focused on South America (Agin & Karlsson, 2021) where Brazil is usually the only country visible (de las Heras-Pedrosa et al., 2022; Goerlandt et al., 2020).

Asmi et al. (2019); Che et al. (2022); Wu et al. (2021) have shown that the dominance of risk and crisis research by North American and Eastern European countries has been favored in large part by strong scientific collaboration networks between these countries. Wagner et al. (2015) showed that international co-authorship grew from 10% to 25% between 1990 and 2010, reshaping the scientific research landscape in favor of transnational networks. Lemarchand (2012); Mégignibêto (2013) have showed that international cooperation networks have also favored scientific capabilities in developing countries. On a broad scale, it has been demonstrated that Western Europe and the United States have a significant impact on scientific research in South America (Lemarchand, 2012).

South America is a region with a high ratio of natural hazards such as floods, earthquakes, and volcanic eruptions due to its geographical location in the Circum-Pacific belt (Marin et al., 2020).

The present study will contribute to i) raising awareness of risk and crisis communication research about South America; ii) to support for further studies in the field of risk and crisis communication about South America; iii) supporting the development of threat communication strategies in a comprehensively and continuously within risk and crisis management systems on South American countries; iv) strengthening R&CC knowledge and planning in most vulnerable economies; and v) to reduce the knowledge gap left by global bibliometric mappings. Thus, the present study aims to map the trends and contribution of scientific publications to risk and crisis communication regarding to South America. The specific objectives are:

- To map the factors associated with the improvement of R&CC in South America.
- To make comparative analysis on the development of scientific publications on R&CC in South America at country level.
- To map the most representative international cooperation links that favor hazard communication development in South America.
- To analyze the determining factors of the development of scientific publications on R&CC in South America.

2. Materials and Methods

2.1. Database and search definition

The unit of analysis is the risk and crisis communication publications on South America included in the Web of Sciences (WoS) database. The selection of this database is consistent with similar studies of R&CC (Asmi et al., 2019; Ying Chen et al., 2021; de las Heras-Pedrosa et al., 2022; Goerlandt et al., 2020). To address the comprehensiveness of R&CC in South America, general and specific search terms were used. In keeping with Agin and Karlsson (2021); Schäfer and Schlichting (2014), the search terms for risk and crisis communication used a general approach. Risk communication documents were searched for using the terms ‘risk’ and ‘communication’. Crisis communication documents were collected using the terms: ‘communication’ and ‘crisis’, ‘emergency’, and ‘disaster’. This definition of crisis communication is consistent with that of Duffy (2020), who covers communications during emergencies and disasters under the concept of crisis communication.

A broad search like the one above is adequate to give a comprehensive overview of the topic of R&CC (Asmi et al., 2019; Che et al., 2022). However, since the scope of the current study is restricted to South America (rather than the entire world), search terms related to the greatest impact threats were also considered to provide a stronger overview of the region. Table 1 provides an overview of the main statistics on natural events in the region by number of events, human losses, and affected people based on data from the Economic Commission for Latin America and the Caribbean (CEPAL, by its acronym in Spanish, 2022). According to this approach, the threats with the greatest negative impacts in South America are classified between threats associated with climate change and geophysical events. The most dangerous hazards related to climate change in South America are floods, droughts, storms, the movement of humid masses, and fires. The geophysical hazards that pose the greatest harm to the greatest number of
people are earthquakes, volcanic eruptions, and the movement of dry mass.

The current study used the hazards exposed in CEPAL database to define part of the research terms since they offer a picture of the most prevalent hazards affecting South American countries (CEPAL, 2022). Thus, in addition to general search terms like ‘natural hazard’, ‘extreme event’, and ‘man-made catastrophe’, this search option also included the specific search terms: ‘climate change’, ‘storm’, ‘cyclone’, ‘extreme temperature’, ‘flood’, ‘mass movement’, ‘droughts’, ‘fires’, ‘earthquake’, ‘volcanic’, and ‘landslides’. In addition, the terms ‘nin* event’, ‘nin* phenomenon’, ‘niño* event’, and ‘niño* phenomenon’ were added to refer to the phenomenon of ‘el Niño’ and ‘la Niña’ who are threats related to the Pacific Ocean.

Moreover, the terms ‘pandemic’, ‘covid’, ‘sars-cov’, and ‘coronavirus’ were considered to refer to pandemic crises, particularly COVID-19, a sickness that immobilized most of the world’s countries, including those in South America.

Furthermore, R&CC were focused on the 14 countries that make up South America by searching for the names of these countries (including the term ‘South America’) in title tags (TI), abstract (AB), author keywords (AK), or in the country/region (CU) reference field of WoS.

The search equation was defined by: (communication AND (risk terms OR crisis terms OR main hazards terms) AND South American countries). This search is based on the set theory concepts of union and intersection and seeks to include as many papers on risk and crisis communication as feasible (Aviv-Reuven & Rosenfeld, 2023). The search terms associated with R&CC considered the TI, KW, and AB fields, which is in line with Goerlandt et al. (2020). The term ‘communication’ was searched in the TI and AK fields to ensure more relevance. Terms related to risk, crisis, and hazards were searched in the fields TI, AK, and AB. And the names of South American countries were searched in the field tags TI, AB, AK, and CU.

To avoid the bias of frequent data renewal, the search and data download were completed in a single day, 2 December 2021 (Chen et al., 2021).

### 2.2. Study selection

A total of 641 publications were found in the WoS database. The analysis of the content of the publications provided by WoS (title, abstract, keywords) allowed us to determine that 330 publications were aligned with our analysis objective. This selection was made by consensus of three reviewers (Chen et al., 2021). It is noteworthy that the use of search terms associated with the communication of the main threats in South America contributed 25% of publications to the initial search and 37% of publications to the final selection of studies on R&CC.

In addition, there was no restriction on the language or category of the data. Most of the documents were written in English (63.64%), followed by Spanish (22.73%) and Portuguese (20.61%), noticed that there are documents written in more than one language. Articles made up 89.09% of the studies that were examined, while other sorts of documents (meetings, review articles, books) made up 10.91% of them. Although all papers are indexed at WoS, it is noteworthy to see that 31.52% of them are also included in Current Contents Connect, 21.21% in MEDLINE, and 10% in SciELO Citation Index. In addition, 55.46% of the selected data were classified as Open Access.

### 2.3. Analysis of bibliometric maps

The bibliometric analysis was performed using the freely available software: VOSviewer (Van Eck & Waltman, 2010). The analysis of the key factors of risk and crisis management-oriented communication was carried out on the basis of a co-occurrences map constructed with all keywords (author keywords and keywords plus) (Van Eck & Waltman, 2010). In addition, similar terms were standardized using the thesaurus option of VOSviewer (Van Eck & Waltman, 2010). For the interpretation of the keywords, we proceeded to review the publications around the keywords that made up the bibliometric map. The library ‘bibliometric’ of R software (Aria et al., 2020) was used to deal with the content review and the bibliographic management of the analyzed papers.

Additionally, two co-authorship maps (by authors and countries) and a co-citation map (by authors) were made, which allowed us to study the main
academic cooperation networks and the most referenced authors in South American publications.

A critical stage in the elaboration of bibliometric maps is the selection of the thresholds for objects to be represented. The default parameters of the VOSviewer program were applied to visualize the map of co-authorship by nations and the map of co-occurrences of keywords. However, more flexible thresholds were used for the representation of the co-citation map by cited authors and the co-authorship map by authors due to the smaller number of items they represented. The co-citation map by cited authors used a minimum of eight citations per author as the threshold, which is in line with Asmi et al. (2019); Wu et al. (2022). Meanwhile, the threshold for the author co-authorship map included authors with a minimum of two publications, which is consistent with Fu et al. (2022) to depict this kind of mapping.

Furthermore, three bibliometric measures related to the citation level were used in the analysis: a) times cited, b) the average of citations per publication, and c) the H-index. The H-index refers to ‘h papers published in the journal have been cited at least h times’ (Fu et al., 2022). The three metrics were built from the ‘Times Cited, All Databases’ measure that is included in the WoS database.

2.4. Dimension Reduction Analysis

Multivariate methods were also used in this study to analyze the strengths and weaknesses of communication development because of their potential to compare at the regional level (Marcillo-Delgado et al., 2022). In this sense, two estimations of dimension reduction were conducted. The first model compares the factors of R&CC (rows) to the most cited authors (columns). Since the statistical model considered requires that the input data have more rows than columns (Reusch et al., 2005), only human authors were considered and institutional authors were excluded. The second model examines the research related to the South American countries (rows) in comparison to the factors of R&CC and different threats (columns). It is important to emphasize that the second model is conditioned by writers from different countries of the world, in line with the co-occurrence analysis in section 3.4.1.

The variables linked to the factors of R&CC and hazards were derived from the keyword co-occurrence map (section 3.2). The variables referring to the most cited authors are based on the co-citation map (section 3.3). The variable referred to the countries of the region was considered as described in section 2.1. The analysis was conducted through Principal Components Analysis (PCA) using the function ‘princomp’ of R (Jolliffe, 2006; R Core Team, 2021).

2.5. Determinants of risk and crisis communication

One of the particularities of global bibliometric mappings is the trend analysis using univariate approaches (Goerlandt et al., 2020; Wu et al., 2021, 2022). However, Goerlandt et al. (2020) argue that in regions with a relative scarcity of publications on R&CC, such as South America, it is advisable to delve into the factors determining these trends. As a consequence, the publication curve was analyzed under a multivariate approach that allows for analyzing the determinants of scientific production on R&CC in South America.

2.5.1. Dependent variable

Looking at the structure of the articles under analysis, it was noted that many of them were related to COVID-19. In addition, the previous analysis of the determinants of R&CC showed that COVID-19 exerts an influence over the indicators associated with the rest of the threats. In light of this, we considered a dependent variable that discounts the COVID-19 effect when analyzing the factors that influence R&CC without losing sight of the whole picture. In this way, a structure made up of two parts was considered as the dependent variable: publications unrelated to COVID-19 ($X_1$) and publications connected to COVID-19 ($X_2$). Where $X_1 + X_2 = \text{Total publications}$.

2.5.2. Explanatory variables

The occurrence of an extreme event constitutes a threat for some sectors and, at the same time, an opportunity for others (Lavell & Maskrey, 2014). Research on R&CC is largely influenced by perceived risk and the incidence of extreme events. The development of an anti-nuclear movement in the 1970s helped highlight interest in risk communication (Heath & O’Hair, 2020). Crisis communication began as a result of a Johnson & Johnson communication strategy employed to refute the idea that Tylenol usage was connected to fatalities in the city of Chicago (Coombs & Holladay, 2022; Heath & O’Hair, 2020).

The global COVID-19 pandemic outbreak in 2020 significantly boosted scientific output across a variety of sectors, including R&CC (Bauwens et al., 2022; Mohadab et al., 2020). Based on the above, the current analysis implies that the factors connected to the materialization of hazards contribute to the explanation of the volume of scientific output on R&CC.

Developed Western countries—particularly United States, United Kingdom, Germany, Netherlands, and Canada—dominate scientific production on risk communication (Agin & Karlsson, 2021; Goerlandt et al.,
On this basis, economic development is proposed as a determining factor to estimate the growth of publications on R&CC. Evidence reveals that during the COVID-19 pandemic, nations with better values for Gross Domestic Product (GDP), tourism, security, innovation, and competitiveness made greater investments in health management (Santos et al., 2021).

Samimi (2011) showed that the link between GDP and scientific productivity is positive and bidirectional. The arrival of tourists is an economic component that is sensitive to the release of announcements regarding the existence of probable natural hazards, so it is important to use communication efforts targeted at mitigating unfavorable perceptions (Buhalıs & Costa, 2006). Oh and Reuveny (2010) showed that the occurrence of disasters linked to climate change has a detrimental impact on import and export trade relations.

This study contends that disaster characteristics and economic development (with a focus on GDP, tourist arrivals, and trade in goods and services) are determinants to explain scientific production on R&CC (Goerlandt et al., 2020; Heath & O’Hair, 2020; Oh & Reuveny, 2010; Samimi, 2011; Santos et al., 2021).

The R test function, which is based on the Akaike Information Criterion (AIC) and a stepwise method was used in the process of choosing the best model (Wickham et al., 2022). The ANOVA test was used to compare various explanatory models and assess the significance of the exploratory variables. Additionally, the ANOVA test was complemented with the AIC to select the model that best explains the scientific output on R&CC, this selection approach is in line with Lander (2014); Lazor (2008); Motulsky and Christopoulos (2004).

The indicators detailed in Table 2 were considered explanatory variables after analyzing the level of significance of the coefficients (P-value < 0.05) and the different assumptions of the model: the absence of multicollinearity, the absence of heteroskedasticity, the presence of residual normality, and the good specification of the model (Baum, 2006; Faraway, 2016). All variables were gathered for 2020 or the nearest year to that date.

### 2.5.3. Statistical modeling technique

Compositional Data Analysis (CoDA) was employed to deal with the particularities of the proposed model since the dependent variable belongs to a vector space called simplex (Filzmoser et al., 2021). CoDA is a field of statistics that permits managing compositions, i.e. strictly positive vectors that characterize the components of a whole (van den Boogaart & Tolosana-Delgado, 2013). Compositions cannot be modeled directly in Euclidean space due to the possibility of spurious estimates (van den Boogaart & Tolosana-Delgado, 2013). In this sense, CoDA enables a composition to be converted from simplex to real space (and vice versa) while maintaining the geometric features of the data (van den Boogaart & Tolosana-Delgado, 2013).

In this line, the dependent variable was modeled by ordinary least squares using a transformation known as the additive log-ratio (alr) (Filzmoser et al., 2021). Taking $X_1$ and $X_2$ as the components of the total number of publications, the alr representation is given by:

$$\text{alr}(X) = \ln\left(\frac{X_1}{X_2}\right)$$

A common issue when applying logarithmic transforms is the presence of zeros. In the current study, there were certain countries where there were no publications related to COVID-19 communication as of the analysis date. The model-based ordinary and robust expectation-maximization algorithms was used to impute zeroes using the R function lrEM (Palarea-Albaladejo et al., 2022; Quispe-Coica & Pérez-Foguet, 2020).

### 3. Results

#### 3.1. Descriptive analysis

Figure 2 shows the evolution of research on R&CC in South America. The curve referring to cited publications shows the interest these publications have received in

<table>
<thead>
<tr>
<th>Table 2. Explanation of the independent variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Variables</td>
</tr>
<tr>
<td>Disaster characteristics</td>
</tr>
<tr>
<td>Number of people affected</td>
</tr>
<tr>
<td>Number of confirmed cases (COVID-19)</td>
</tr>
<tr>
<td>Economic development</td>
</tr>
<tr>
<td>GDP per capita (Current US$)</td>
</tr>
<tr>
<td>International tourism, number of arrivals</td>
</tr>
<tr>
<td>Net trade in goods and services (BoP, current US$)</td>
</tr>
</tbody>
</table>
the research context from 1998 (oldest study analyzed) to 2021 (cut-off date). Additionally, it shows that R&CC started to receive attention from 2010 onwards. It is noteworthy that the number of publications increased in the period 2020–2021 as a result of COVID-19.

Table 3 shows the percentage of studies carried out on R&CC about South American countries, together with the number of citations associated with these publications. Brazil stood out as the country with the most publications, with 50.61% of the total number of publications. On the opposite side were: Paraguay, Guyana, and Suriname as the countries with the least representation in terms of research on R&CC. The number of citations behaves directly proportional to the total number of publications (correlation = 0.99).

Through the analysis of the publications by hazard type (see Table 4) it was found that most of the studies analyzed were oriented towards the communication of diseases where 21% were associated with COVID-19; in second place human activities, in third place climate change and fourth place natural extremes. According to this viewpoint, the number of citations and the H-index behave proportionally to the percentage of publications by hazard type. While studies that focus on threats derived from human activity (agriculture, mining, and industry) get more citations per publication.

### 3.2. Key factors of risk and crisis communication

The co-occurrence analysis of the keywords using the VOSviewer software made it possible to differentiate 83 keywords, 1,141 links, and five clusters associated with R&CC. Through the literature review for each of the 83 keywords, we determined that the five clusters shown in Figure 3 referred to: i) factors for risk communication in vulnerable areas (red cluster), ii) factors for health and crisis communication (green cluster), iii) communication of human and environmental exposure to

![Figure 2. Publications published and cited on South America in WoS as of December 2, 2021.](image)

### Table 3. Percentage of scientific publications (N = 330), times cited, the average of citations per item, and H-index related to risk and crisis communication regarding South America

<table>
<thead>
<tr>
<th>ID</th>
<th>Country Name*</th>
<th>% of publications</th>
<th>Times cited</th>
<th>Average per item</th>
<th>H-index</th>
</tr>
</thead>
<tbody>
<tr>
<td>BR</td>
<td>Brazil</td>
<td>50.61</td>
<td>1029</td>
<td>6.16</td>
<td>18</td>
</tr>
<tr>
<td>CL</td>
<td>Chile</td>
<td>16.06</td>
<td>441</td>
<td>8.32</td>
<td>12</td>
</tr>
<tr>
<td>AR</td>
<td>Argentina</td>
<td>11.82</td>
<td>248</td>
<td>6.36</td>
<td>8</td>
</tr>
<tr>
<td>CO</td>
<td>Colombia</td>
<td>11.21</td>
<td>158</td>
<td>4.27</td>
<td>7</td>
</tr>
<tr>
<td>EC</td>
<td>Ecuador</td>
<td>9.39</td>
<td>135</td>
<td>4.35</td>
<td>5</td>
</tr>
<tr>
<td>PE</td>
<td>Peru</td>
<td>7.58</td>
<td>131</td>
<td>5.24</td>
<td>6</td>
</tr>
<tr>
<td>VE</td>
<td>Venezuela</td>
<td>2.73</td>
<td>80</td>
<td>8.89</td>
<td>2</td>
</tr>
<tr>
<td>TT</td>
<td>Trinidad and Tobago</td>
<td>1.52</td>
<td>32</td>
<td>6.4</td>
<td>2</td>
</tr>
<tr>
<td>BO</td>
<td>Bolivia</td>
<td>1.21</td>
<td>55</td>
<td>13.75</td>
<td>2</td>
</tr>
<tr>
<td>UY</td>
<td>Uruguay</td>
<td>1.21</td>
<td>29</td>
<td>7.25</td>
<td>3</td>
</tr>
<tr>
<td>PY</td>
<td>Paraguay</td>
<td>0.61</td>
<td>90</td>
<td>45</td>
<td>2</td>
</tr>
<tr>
<td>GY</td>
<td>Guyana</td>
<td>0.61</td>
<td>18</td>
<td>9</td>
<td>1</td>
</tr>
<tr>
<td>SR</td>
<td>Suriname</td>
<td>0.30</td>
<td>20</td>
<td>20</td>
<td>1</td>
</tr>
</tbody>
</table>

*No publications related to French Guiana were detected.
pollutants (blue cluster); iv) management of continuity and communication quality (yellow cluster) and v) enhancers for environmental and climate communication (purple cluster). Based on the meaning and associations of the keywords the clusters were divided into 28 factors. The most relevant aspects of each cluster are described below.

3.2.1. Risk communication in vulnerable areas (red cluster)
In this cluster 38.8% of the publications were identified with cluster risk communication in vulnerable zones. This cluster is directly associated with the communication of natural hazards such as volcanic eruptions, earthquakes, and floods.

The keywords vulnerability, vulnerable zones, and environmental refer to the central element of communication. It deals with terms associated with risk perception management such as risks, risk communication, and risk perception. The keywords cooperation, framework, governance, knowledge, management, model, networks, and system are associated with the instruments of communication management. The words behavior, challenges, disaster risk reduction, resilience, and trust refer to the benefits of good communication.

Table 5 shows the most relevant factors of the R&CC that were derived from the review of the publications around the keywords of the red cluster. The most researched factors of this cluster were risk communication and risk perception management (1.1) and risk communication tools (1.2).

3.2.2. Health and crisis communication (green cluster)
In this cluster 66.4% of the publications were identified with the cluster health and crisis communication. This cluster is mostly associated with the communication of crisis care related to illnesses. Studies associated with COVID-19 were largely identified with this cluster.

Table 4. Percentage of publications by hazard type. The hazards type was examined using the keyword co-occurrence map (section 3.2): diseases = covid-19, disease, pandemic; human activities = agricultural, mining, industry; climate change = climate change, climate change communication; and natural extremes = volcanoes, earthquake, flood

<table>
<thead>
<tr>
<th>Extreme Events</th>
<th>Percentage of publications</th>
<th>Times cited</th>
<th>Average of citations per item</th>
<th>H-Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diseases</td>
<td>30.91%</td>
<td>704</td>
<td>6.9</td>
<td>13</td>
</tr>
<tr>
<td>Human activities</td>
<td>8.48%</td>
<td>338</td>
<td>12.07</td>
<td>9</td>
</tr>
<tr>
<td>Climate change</td>
<td>7.58%</td>
<td>223</td>
<td>8.92</td>
<td>7</td>
</tr>
<tr>
<td>Natural extremes</td>
<td>4.55%</td>
<td>72</td>
<td>4.87</td>
<td>5</td>
</tr>
</tbody>
</table>
3.2.3. Communication of human and environmental exposure to pollutants (blue cluster)

The blue cluster is associated with the communication of human and environmental exposure to pollutants. This cluster is primarily linked to the communication of hazards resulting from land exploitation such as agriculture and mining. The keywords Amazon and environment allude to the spaces most prone to contamination in the region.

The terms: exposure, pesticides, and pollution are directly related to exposure to contaminants. The word ‘children’ refers to a vulnerable group during such events. The keywords monitoring, environment, and wireless are related to tools to generate knowledge of the environment. The keywords: leadership and health system are associated with health management. The phrase ‘science communication’ has to do with the set of scientific tools to communicate better in a crisis situation.

In this cluster 20.9% of the publications were associated with the communication of human exposure to contaminants. The key factors are listed in Table 7. These factors are rarely researched in the context of South America, as evidenced by the column relating to the percentage of publications.

3.2.4. Management of continuity and communication quality (yellow cluster)

In the yellow cluster 23.60% of the publications were associated with ‘inalienable rights of the audience during a crisis’. This cluster is primarily tied to the communications of hazards linked to the development of industries.

The keyword ‘impact’ which refers to the consequences of a crisis event is directly related to this cluster. The keywords ‘rights’ and ‘political’ refer to the political environment and the right to information. The keywords ‘education’, ‘school’, and ‘teaching’ refer to the importance of the continuity of communication in the education sector during a crisis event. The words ‘social’

Table 5. Factors for risk communication in vulnerable areas (red cluster)

<table>
<thead>
<tr>
<th>ID</th>
<th>Explanation</th>
<th>Publications (%)</th>
<th>Average per item</th>
<th>H-index</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1</td>
<td>Risk communication and risk perception management (Zinn, 2021)</td>
<td>23.24</td>
<td>10.76</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>KW: risks, risk communication, perception, risk perception</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td>Empowerment of risk communication management instruments (Viteri &amp; Takahashi, 2020)</td>
<td>22.18</td>
<td>9.1</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>KW: cooperation, framework, governance, knowledge, management, model, networks, system</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3</td>
<td>Recognition of vulnerability to different threats (Coates, 2021)</td>
<td>11.97</td>
<td>13.41</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>KW: vulnerability, vulnerable zones, environmental</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.4</td>
<td>Management of the expected goals of risk communication (Vallejos Romero, 2012).</td>
<td>9.86</td>
<td>10.93</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>KW: behavior, challenges, disaster risk reduction, resilience, trust</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 6. Factors for health and crisis communication (green cluster)

<table>
<thead>
<tr>
<th>ID</th>
<th>Explanation</th>
<th>Publications (%)</th>
<th>Average per item</th>
<th>H-index</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>Communication and information (Villela &amp; Almeida, 2013)</td>
<td>38.38</td>
<td>6.74</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>KW: communication, information</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.2</td>
<td>Health communication and prevention management (Cezar-Vaz et al., 2015)</td>
<td>17.61</td>
<td>5.55</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>KW: prevention, health, health communication</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.3</td>
<td>Articulation of the media and journalism(Miranda Costa, 2016)</td>
<td>15.14</td>
<td>4.26</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>KW: media, journalism</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.4</td>
<td>The use of technology for communication (Tejedor et al., 2020)</td>
<td>12.68</td>
<td>5.5</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>KW: internet, web, social network, mobile application, technology</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.5</td>
<td>Managing the negative effects of misinformation (Mullo López et al., 2021)</td>
<td>4.58</td>
<td>3.85</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>KW: fake news, ethics</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.6</td>
<td>Crisis communication (Gomez-Zapata et al., 2021)</td>
<td>3.17</td>
<td>1.89</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>KW: crisis communication</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 7. Factors associated with the communication of human and environmental exposure to pollutants (blue cluster)

<table>
<thead>
<tr>
<th>ID</th>
<th>Explanation</th>
<th>Publications (%)</th>
<th>Average per item</th>
<th>H-index</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Integration of scientific communication in risk policy (Dada et al., 2021)</td>
<td>5.99</td>
<td>6.24</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>KW: science communication, policy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.2</td>
<td>Recognition of human and environmental exposure to contaminants (Cubillas-Tejeda et al., 2018)</td>
<td>5.28</td>
<td>16.73</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>KW: exposure, pesticides, pollution</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.3</td>
<td>Articulation of the health system to the risk management system (Pingel et al., 2021)</td>
<td>5.28</td>
<td>7.4</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>KW: health system</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.4</td>
<td>Monitoring of spaces subject to contamination (Cama et al., 2013)</td>
<td>4.58</td>
<td>9.08</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>KW: monitoring, wireless, environment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.5</td>
<td>The importance of leadership in R&amp;CM (Coates, 2021)</td>
<td>2.46</td>
<td>8.14</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>KW: leadership</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.6</td>
<td>Management of children’s perception and disasters (Ottenbros et al., 2019)</td>
<td>2.11</td>
<td>18</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>KW: children</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

and ‘social minorities’ refer to vulnerable groups during a crisis event. The keywords ‘information and communication technologies’ and ‘resources’ refer to tools for good communication.

Table 8 provides a breakdown of the R&CC’s primary factors that relate to continuity and communication quality. Where the factor ‘managing the continuity of information and communication technologies’ during crisis events (4.1) has attracted the most focus from researchers.

3.2.5. Enhancers for good communication (purple cluster)

In the purple cluster 25.5% of the publications were related to enhancers for environmental and climate change communication. The terms coverage, framing, and discourse denote three key elements of the communications. The keywords strategies, adaptation, and legitimacy indicate important aspects to manage the quality of communication. The keyword ‘community’ refers to a sector of the population that is part of the problem. The keyword ‘sciences’ refers to a support tool for good communication. Whereas the terms ‘environmental communication’ and ‘climate change communication’ refer to two communication-related fields that enable handling risks and crises.

The factors derived from the review of the keywords of this cluster are detailed in Table 9. Studies on this region rarely cover these factors, according to the examination of the percentage of publications.

Finally, the H-index and the average citation per publication were correlated with the percentage of publications for the 28 communication factors listed in Tables 5–9. The findings showed that the H-index and the percentage of publications had a positive correlation of 0.83, meaning that the factors with the largest number of publications also have the best productivity and citation impact.

While the correlation between the number of publications of the 28 factors presented and the average of publications per item was not significant. Despite this finding, certain factors were found to have low levels of scientific production but a high rate of citations (in comparison to the most representative factors), such as the management of children’s perception (ID = 3.6) and the recognition of human and environmental exposure to contaminants (ID = 3.2), which had an average of citations per item of 18 and 16.73, respectively.

3.3. Co-citation analysis

The co-citation analysis showed 9,847 authors whose scholarly work has contributed to the R&CC research.

Table 8. Management of continuity and communication quality (yellow cluster)

<table>
<thead>
<tr>
<th>ID</th>
<th>Explanation</th>
<th>Publications (%)</th>
<th>Average per item</th>
<th>H-index</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.1</td>
<td>Continuity of information and communication technologies (Loza et al., 2021)</td>
<td>10.21</td>
<td>2.62</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>KW: information and communication technologies, resources</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.2</td>
<td>The right to education during crisis events (Pascual et al., 2016)</td>
<td>8.45</td>
<td>5.04</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>KW: education, school, teaching</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.3</td>
<td>Political environment and right to information (Ribeiro et al., 2020)</td>
<td>5.28</td>
<td>3.93</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>KW: rights, political</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.4</td>
<td>Consideration of cultural diversity and social vulnerability (Zinn, 2021)</td>
<td>4.58</td>
<td>4.77</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>KW: social, social minorities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.5</td>
<td>Digital communication (Tejedor et al., 2020)</td>
<td>3.87</td>
<td>6.55</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>KW: digital communication</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.6</td>
<td>Disaster impact communication (Miranda Costa, 2017)</td>
<td>2.82</td>
<td>6.88</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>KW: impact</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
on South America. The map of co-citations detailed in Figure 4 allowed us to visualize 26 representative authors (philosophers, thinkers, and scientists) whose works served as the foundation for the advancement of the state of the art, the different research methodologies, discussions, and conclusions of the various publications examined in this study.

Along these lines, the orange cluster highlights the theorists and researchers B. Fischhoff and P. Slovic. Both authors have worked collaboratively on research in the areas of decision-making and risk perception with contributions to the affect heuristic, the psychometric paradigm, and the psychic numbing theory (Slovic, 1987; Slovic et al., 1980). The joint work of B. Fischhoff and A. Bostrom contributed to the advancement of knowledge on risk perception by introducing the concept of mental models, which is ‘... often applied to intuitive theories that are elaborated well enough to generate predictions in diverse circumstances’ (Fischhoff et al., 1993; Greenberg & Lowrie, 2022).

The pink cluster features M. Douglas, an author whose research is renowned for advancing cultural risk theory (Heath & O’Hair, 2020). The cultural risk theory emphasizes the relationship between the things that a culture views as risks and the things that it treats as bad considering sociocultural needs (Jaeger et al., 2001). According to Heath and O’Hair (2020), two of the most important currents in environmental risk

Table 9. Enhancers for environmental and climate change communication (purple cluster)

<table>
<thead>
<tr>
<th>ID</th>
<th>Explanation</th>
<th>Publications (%)</th>
<th>Average per item</th>
<th>H-index</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1</td>
<td>Management of coverage, framing and discourse (Orlove et al., 2019)</td>
<td>6.69</td>
<td>5.11</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>KW: coverage, framing, discourse</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.2</td>
<td>Recognition of the transdisciplinary nature of R&amp;CM (Wilmshurst, 2018)</td>
<td>6.69</td>
<td>9.5</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>KW: sciences</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.3</td>
<td>Management of the quality and legitimacy of communication (Kouloukou et al., 2019)</td>
<td>6.34</td>
<td>9.28</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>KW: strategies, adaptation, legitimacy</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.4</td>
<td>Management of community participation in R&amp;CM (Pascual et al., 2016)</td>
<td>3.87</td>
<td>7.64</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>KW: community</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.5</td>
<td>Environmental communication (Castello, 2021)</td>
<td>2.46</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>KW: environmental communication</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.6</td>
<td>Climate change communication (Paerregaard, 2020)</td>
<td>1.76</td>
<td>6.6</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>KW: climate change communication</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 4. Co-citation map. Minimum of eight citations of an author.
communication were born from the work done by P. Slovic (and associates) and M. Douglas (and associates).

The red cluster enabled R.E. Kasp­erson and O. Renn, whose work on the Social Amplification of Risk Framework (SARF) contributed to the understanding of risk perception (Kasp­erson et al., 2022). The SARF goal is to assess the technical aspects of risk and their interaction with psychological, sociological, and cultural views on risk perception and risk-related behavior (Kasp­erson et al., 2022). O. Renn has contributed to the expansion of the idea of ‘systemic risk’, which originated in the field of finance, to a wider variety of areas, such as climate change, pandemics, or cyber security (Wong, 2021).

The gray cluster highlights U. Beck, who has contributed to the advancement of risk knowledge in modern societies (Beck et al., 2019). Risk society theory argues that the social environment has turned into one of risk and that a ‘reflexive modernization’ would serve to develop checks and balances inside the modernization process itself (Beck & Ritter, 1995; Jaeger et al., 2001).

The light blue cluster makes visible the authors N. Luhmann and M. Castells who have contributed to the understanding of modern societies from a communicational viewpoint (Castells, 2010; Urteaga, 2010). According to the systems theory of N. Luhmann, contemporary society may be thought of as a communication system composed of subsystems that are focused on political, economic, scientific, religious, artistic, media, educational, and legal issues (Urteaga, 2010). M. Castells examines the influence and primacy of information and communication technologies in contemporary societies (Castells, 2010; Kirtiklis, 2017). His theoretical work on the network society aids in understanding how structured mass communication networks and networks of power and counterpower affect the human mind (Castells, 2010).

The yellow cluster presents two important exponents of contemporary sociological theory such as A. Giddens and J. Habermas (Bialakowsky, 2010). The structuring theory of A. Giddens focuses on establishing the connection between people and the social factors that influence us (Lamsal, 2012). According to this theory, the ordered networks of language are part of the substructure of meaning and allow useful social behavior as well as the understanding of events (Lamsal, 2012; Ortiz Palacios, 1999). The development of J. Habermas theories, which include the theories of communicative action, discourse ethics, and deliberative democracy, heavily relies on language (Gómez, 2003; Vergara, 2011). His theory of deliberative democracy offers a set of discursive and analytical tools to support citizen involvement and ensure social inclusion within the framework of a democratic state (Domínguez, 2013).

The purple cluster shows the author S. Moscovici who contributed to the understanding of the social representation theory (Wagner et al., 1999). The theory of social representation offers a specific method for describing how society constructs reality, including how people develop in both the physical and social spheres and how communication takes place among the members of the community (Umaña, 2002; Wagner et al., 1999).

The green cluster enabled us to draw attention to W. T. Coombs, who developed the Situational Crisis Communication Theory (SCCT) and has contributed to discussions on issues like strategic communication, communication management, and social media crisis (Coombs et al., 2017). The SCCT theory evaluates the reputational threat caused by a crisis scenario and then suggests crisis response tactics based on the amount of reputational threat (Heath & O’Hair, 2020).

The blue cluster highlights the authors P. Bourdieu, P. Charaudeau, and E. Veron whose research adds to reflection on discourses and politics (Maestri et al., 2014). The research of P. Bourdieu gave rise to the theory of structuralist constructivism which holds that people are active social agents in social structures with the ability to negotiate and modify the social reality in which their communicative interactions take place (Bourdieu & Clough, 1998). P. Charaudeau was one of the primary referents in the discourse analysis study area (Soulages, 2015). The dictionnaire d’analyse du discours (Charaudeau et al., 2002) constitutes a valuable theoretical contribution that aids in illustrating the many discourse study areas (Pastene, 2006). The theory of social discourses developed by E. Verón in his book La Semiosis Social enables us to examine the description of the traces of the productive conditions in the discourses, whether they are those of their generation or those that account for their effects (Jofré, 2007; Retamozo & Fernández, 2010).

The wine cluster, on the other hand, highlights climate change communication specialists M.C. Nisbet, S. C. Moser, and K. Paerregaard (Moser et al., 2007; Nisbet, 2009; Paerregaard, 2020). M.C. Nisbet is a specialist in communication and public policy and is considered one of the most influential researchers of his time (Nisbet, 2009; NU, 2023). S.C. Moser is a researcher whose work focuses on practical, cooperative, problem-oriented, and ethical work (Moser, 2023). In contrast, K. Paerregaard is a researcher who has devoted most of his work to investigating how climate change is affecting rural and urban population of Peru (GU, 2023).
Additionally, the co-citation map highlighted W.N. Adger and K.C. Haynes, who have significantly advanced the fields of risk and crisis communication as well as climate change adaptation. The scientific work of W.N. Adger is focused in the areas of environmental geography, institutional economics, and global environmental change (Adger et al., 2009; EXON, 2023). Geographer K. Haynes has a focus on risk communication, disaster risk reduction, and climate change adaptation (García & Mendez-Fajury, 2018; MU, 2023).

Furthermore, the co-citation analysis identifies a group of authors, including I.S. Araujo, A. Donovan, H.B. Nicoll, M.M.B. Paoliello, F. Peres, and M. Petracci, who have contributed to the understanding of risk and risk communication in the context of South America (Figueiredo et al., 2010; Gallant et al., 2021; Nicoll et al., 1989; ORCID, 2023; Peres & Moreira, 2003; Petracci & Waisbord, 2011). The research of I.S. Araujo, M.M.B. Paoliello, and M. Petracci contributes to the field of communication and health in Argentina and Brazil (Figueiredo et al., 2010; ORCID, 2023; Petracci & Waisbord, 2011). The studies of A. Donovan have helped to better understand how volcanic risks in nations like Chile, Argentina, and Ecuador interact with their physical and human environments (Gallant et al., 2021; UC, 2023). The contributions made by H.B. Nicoll are mostly concerned with the presence of arsenic in the water in the Chaco-Pampeana plain (Nicoll et al., 1989). Moreover, F. Peres is an expert in public health with a focus on occupational health, environmental health, pesticides, risk perception and communication, health literacy, and scientific communication (Peres & Moreira, 2003; UNL, 2023).

In a complementary way, this analysis enabled identifying governmental and non-governmental institutions that actively participate in risk and crisis management (R&CM), including the World Health Organization, the United Nations, the United Nations International Strategy for Disaster Reduction (UNISDR), the Intergovernmental Panel on Climate Change (IPCC), the Centers for Disease Control and Prevention, and the Brazilian Ministry of Health.

3.3.1. Cross-analysis between the most cited authors and key factors of risk and crisis communication

The most cited authors (Figure 4) and the communication factors (Tables 5–9) were compared using Principal Component Analysis. This analysis revealed two well-defined groups: (1) one that focuses on the health and safety of individuals, and (2) another that examines the effectiveness and reliability of the communication system.

The group depicted in the lower part of Figure 5 (group 1) was focused on improving risk perception and communication (ID = 1.1), risk communication management instruments (ID = 1.2), vulnerability recognition (ID = 1.3), public trust, resilience, and behavior (ID = 1.4), and human and environmental exposure to contaminants (ID = 3.2). Among other authors, these research fields were connected to the scientific work of B. Fischhoff, P. Slovic, O. Renn, R.E. Kasperson, and M. Douglas.

The upper part of Figure 5 (group 2) is mainly associated with communication and information management (ID = 2.1), improving the quality and legitimacy of communications (ID = 5.3), journalism and media management (ID = 2.3), the improvement of coverage, discourse, and framing (ID = 5.1), and health communication (ID = 2.2). Among other authors, these areas of study were linked to the scientific work of M. Castells, N. Luhmann, J. Habermas, A. Giddens, U. Beck, S. Moscovici, and W.T. Coombs. The work of the authors P. Bourdieu, P. Charadeau, E. Veron, and M. Castells was closer to studies about journalism and media (ID = 2.3).

3.4. Academic cooperation networks to strengthen risk and crisis communication

3.4.1. Analysis of co-authorship by country

Figure 6 illustrates a bibliometric map of co-authorship by country. The most prominent cooperation links that advance scientific output in the area of R&CC are depicted on this map. The red cluster emphasizes the value of language in forging connections with academic goals in the region. It indicates the cooperation network between six South American countries with the official Spanish language: Argentina, Chile, Colombia, Ecuador, Peru, and Venezuela. In addition, it shows relations with other countries outside the region such as Spain, Italy, and Mexico.

The green cluster demonstrates that Brazil’s primary international academic partners include countries of other regions like France, Portugal, China, England, and the United States.

The geographical factor plays an important role when conducting network research on R&CC. In North America, the network of the United States and Canada is highlighted by the yellow cluster, whereas in Europe, the network of Germany, Switzerland, and the Netherlands is highlighted by the blue cluster. This finding also demonstrates the concern that academics from outside the region have for the issues of South America. The linkage strengths indicate that the strongest cooperative relationships are between (Chile, Spain,
Ecuador), (Chile, USA), and (Germany, Brazil, and England).

The publications of the countries that have been published through collaboration networks are presented in Figure 7. In terms of production, South American countries that have worked together in a network have a higher level of productivity than non-South American countries because their production curve is situated further to the right on the horizontal axis of the cartesian plane than that of non-South American countries.
However, the production and impact curve of non-South American countries is higher up on the vertical axis than the South American curve, meaning that their contribution to science is of a higher quality (measured by the H-index). In addition, non-South American countries have higher average citation rates per publication (represented by the size of the circles in Figure 7), suggesting that non-South American publications typically have a bigger influence than those from the region. The United States, Spain, and England are the non-South American nations that contribute the most in terms of productivity and impact on citation (H-index). Australia, England, and China are the non-South American nations that contribute the most in terms of the average citations per item.

3.4.2. Analysis of co-authorship by authors

The co-authorship analysis showed 1,189 authors who have published on R&CC topics in South America. Figure 8 shows a co-authorship map with 48 authors having two or more publications published on R&CC. According to the co-authorship map, the cooperation networks to publish about R&CC at the author level are minimal in the region. The clusters with the greatest author interaction are denoted by the colors green, blue, red, and yellow. They are mostly related to the fields of public environmental occupational health (red, green, and yellow clusters) and computer science and engineering (cluster blue).

Figure 9 depicts the distribution of publications by research field from two viewpoints: a) authors with the most publications (55 studies) and b) the total number of publications (330). The horizontal axis demonstrates that studies by authors with two or more publications are primarily related to the scientific fields of computer science, communication, and public environmental occupational health. Then with engineering, psychology, environmental sciences, ecology, and telecommunications.

It is noteworthy that the analysis of authors with more publications correlates with the overall number of publications of 0.71. Thus, the vertical axis of Figure 9 demonstrates that most of the scientific contribution of all the publications analyzed on R&CC about South America originates from the research fields connected to communication, public environmental occupational health, and environmental sciences ecology.

Table 10 shows the top eight authors by the number of publications. Due to the vast number of writers who had two publications, we only display the top eight. The author with the greatest number of publications in this study was Ochoa (six publications). Regarding the top eight, Ochoa’s research has the highest number of times cited (114 citations) and the most average citations per publication (19 citations). It should be noted that the paper with the most citations (95 citations) belongs to Viviana Waichman et al. (2007) with a publication on pesticide exposure and risk of poisoning in the Brazilian Amazon.

![Figure 7](image-url) Relationship between total publications and H-index of the countries that have published through cooperation networks. The size of the circles indicates the average number of citations per article.
Figure 8. Map of co-authorship by authors with two or more publications (48 authors out of a total of 1,189). The size of the circle refers to the number of publications.

Figure 9. Classification of publications on R&CC according to the research area proposed by web of science.

Table 10. Authors with three or more publications

<table>
<thead>
<tr>
<th>Author</th>
<th>Publications</th>
<th>Times cited</th>
<th>Average citations per publication</th>
<th>H-index</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ochoa</td>
<td>6</td>
<td>114</td>
<td>19</td>
<td>4</td>
</tr>
<tr>
<td>Di Giulio/Figueiredo</td>
<td>4</td>
<td>21</td>
<td>5.25</td>
<td>3</td>
</tr>
<tr>
<td>Bonow/Cezar-Vaz</td>
<td>4</td>
<td>25</td>
<td>6.25</td>
<td>3</td>
</tr>
<tr>
<td>Santos</td>
<td>3</td>
<td>32</td>
<td>10.67</td>
<td>3</td>
</tr>
<tr>
<td>Dos Anjos</td>
<td>3</td>
<td>15</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Massarani</td>
<td>3</td>
<td>5</td>
<td>1.67</td>
<td>1</td>
</tr>
</tbody>
</table>
3.5. Mapping of risk and crisis communication factors regarding South America

In order to have a better grasp of the five R&C factors detailed in section 3.2, a PCA was conducted at the country level. The model estimated with two PCA factors explained 98.7% of the variance of the data. The study of the biplot correlations revealed the preexisting connections between the distribution of studies by country and the communication clusters.

First quadrant of Figure 10 shows the interdependence between risk communication, climate change communication, and environmental communication. This quadrant represents research on natural extremes (keywords: volcanoes, earthquakes, and floods). Chile (CL), Colombia (CO), and Ecuador (EC) were closely related to these communication factors.

Quadrant four in Figure 10 is associated with health communication, crisis communication, and communication of human exposure to pollutants. This quadrant was associated with threats from illnesses (keywords: diseases, COVID-19, pandemic) and human activities (keywords: mining, agriculture, and industry). These communication factors are mostly associated with Brazil and Argentina (BR).

The importance of continuity and communication quality as well as digital communication was depicted as transversal axes that complemented risk communication and health communication. Other countries such as Bolivia (BO), Guyana (GY), and Venezuela (VE) are minimally represented in the analysis.

3.6. Analysis of determinants of risk and crisis communication

Table 11 displays the estimation of the factors influencing the development of risk and crisis communication in South America. Three statistical models were estimated to better understand the findings: (1) an overall model that considered all publications in the dependent variable, (2) a discount model that excluded publications related to COVID-19, and (3) a compositional model that considered the total number of publications into two parts ($X_1, X_2$).

The overall model showed that the outbreak of COVID-19, measured by the number of positive cases, had a positive influence on the number of publications. The estimate associated with economic development suggested that countries with a higher level of net exports of goods and services tend to publish more. It is noteworthy that in this preliminary analysis, the variables related to other hazards (geophysical and resulting from climate change) were not significant.

A second model was fitted where publications related to COVID-19 were discounted (discount model) since COVID-19 was a determining variable in risk and crisis communication.

![PCA - Biplot](image)

**Figure 10.** Principal component analysis of the factors of risk and crisis communication regarding South America.
communication research. The discount model showed that the damage level of disasters measured by human losses positively influences the development of publications. Whereas, the countries with the highest number of affected people generally made fewer publications. The estimate associated with economic development suggested that in countries where tourism was greater, there was a greater development of communication. It is interesting to point out that the discounted model is incomplete because it lacks information about COVID-19 publications.

The third model shows the compositional estimate associated with publications unrelated to COVID-19 ($X_1$) and those connected with COVID-19 ($X_2$). The variables that explain this model are the total number of people affected, tourist arrivals, and GDP per capita. The relationships between the explanatory variable and the dependent variable were visually evaluated to interpret the model, while maintaining the other variables with constant values (ceteris paribus).

Figure 11 demonstrates that the development of R&CC in the context of COVID-19 ($X_2$) followed a completely different trend from the development of publications on the other threats ($X_i$). The left side of Figure 11 illustrates that the percentage of publications unrelated to COVID-19 increases as the country’s wealth (as determined by GDP per capita) increases. While publications connected to COVID-19 behaved in the other direction, with a higher concentration of publications in the poorest countries.

On the other hand, the right and center sides of Figure 11 evidence that the effect of the level of affectation of disasters and the tourism component act quite similarly regarding the percentage of R&CC publications. In the context of non-COVID-19-related publications, the trend suggests that countries with higher levels of tourism or higher numbers of people affected by disasters generally have fewer R&CC topics published. On the opposite side, the R&CC studies linked to COVID-19 were more prevalent in countries with higher rates of tourist entrance and affected people by disasters.

### 4. Discussion

The mapping of the co-occurrences allowed the visualization of five clusters related to the R&CC, which were
further divided into 28 factors. Figure 12 depicts the arrangement of the aforementioned factors (specified by their ID) within a communication process approach adapted to the R&CM system. This analysis is founded on the fundamental elements of communication, including sender, message, channel, receiver, effects, and feedback (Narula, 2006). The size of the circles in Figure 12 shows the relevance of each communication factor measured by the percentage of publications and labeled with a letter from A to I.

According to Figure 12, the most common communication components at the investigative level are communication system (B), receiver (G), communication channels (F), and communication effects (H). Firstly, most of the R&CC publications were focused on enhancing the communication systems (B) through proposals and contributions that aim to include scientific communication into risk policies and assist the management of R&CC. Second, a significant portion of publications on R&CC about South America was focused on identifying vulnerabilities, improving perception, and preserving people’s health, with a particular focus on vulnerable groups (G). Third, focused on the enhancement of the communication channel (F), with emphasis on the continuity of ongoing communication technologies and the integration of media with the R&CM system. Fourth, focused on the enhancement of the R&CC (H) expected goals, including the management of the trust, resilience, prevention, risk reduction, crisis impact, and the reduction of misinformation.

Risk and crisis management are frequently portrayed as a conflict between political and scientific rationality (Vallejos Romero, 2012). Scientific research helps to understand vulnerability, while political action helps to establish risk and disaster management measures (da Mata Martins et al., 2016; Severo et al., 2014). In this context, it is critical to create policies that include scientific communication in R&CM initiatives and enable the community to access the many sciences’ scientific repertoires (Janes & Marques, 2013; Massarani et al., 2020; Weber & Schmidt, 2016).

One of the primary goals of the R&CC is to assure the health, safety, and collective participation of people (Lavell & Maskrey, 2014). To achieve greater empowerment and participation of audiences in risk issues (ID = 1.2), the literature recommends aspects such as i) improving the interaction of risk managers with the local community (ID = 5.4) (Marin et al., 2020); ii) respecting the vulnerabilities, ways of life and identities of the community (Voos & Marques, 2020); iii) recognize local perspectives and traditional knowledge for the development of communication strategies (Figueiredo et al., 2010; Mullo López et al., 2021); and iv) include social minorities (ID = 4.4) such as indigenous groups, pregnant women, children and elderly in educational strategies to reduce their vulnerability to risks and crisis (Diniz et al., 2021; Loza et al., 2021).

Another factor that has drawn the most attention from academics is the improvement of communication channels. An important input to face the challenges of a communication channel during a crisis is technology (de França Bail et al., 2021; Figueiredo et al., 2010). In this regard, the expected characteristics of technologies (ID = 2.4) for good communication during a crisis are solidity (Pascual et al., 2016), fail-safe (Severo et al., 2014), flexibility (Severo et al., 2014), easy to use (Scavarda et al., 2021), open source and low cost (Figueiredo et al., 2010). In addition, journalists (ID = 2.3) are a crucial sector that needs to be articulated and included in the network of stakeholders and decision-making, since they have a significant impact on public opinion as members of the media (Miranda Costa, 2016; Roncallo-Dow et al., 2021).

The assurance of ongoing, high-quality information is a crucial factor of R&CC during the different phases of the crisis. This aspect allows to recognize the

**Figure 12.** The value of scientific research in the context of R&CC systems.
vulnerability generated by hazards to different groups in a specific environment (Berardo, 2014; Marin et al., 2020). To ensure that the information reaches everyone equally, the information right of affected and unaffected people must be guaranteed (Alves et al., 2016). Guaranteeing this right (ID = 4.3) provides the means of social protection to consolidate the right to health in law and practice (Paerregaard, 2020; Voos & Marques, 2020). Also, the crisis is often seen as a problem of conflict of interests (Lima, 2017; McKeever, 2021). R&CC discourses are frequently employed and exploited by many actors for goals that go beyond R&CM, thus invalidating the right to information (Alves et al., 2016; Coronel et al., 2018). Aspects such as the political environment, political inclination, and politically sensitive issues are variables to be considered in order to guarantee the right to information (Coates, 2021; Zinn, 2021).

A key factor of the communication process is the message. In the context of crisis, discourses (ID = 5.1) are a means of constructing or obstructing R&CM legality (ID = 5.3) (Zinn, 2021). Mismanagement of discourse legality could generate tensions that result in new crises (Cardoso & Silva, 2020; Roncallo-Dow et al., 2021; Zinn, 2021). Therefore, it is important to ensure the legitimacy of information sources and communiqué (Tejedor et al., 2020) and that the legal terminologies used are adapted to the local language (Viviana Waichman et al., 2007). Crisis communication represents an ethical context that is often tainted by situations such as the transmission of optimistic messages about the termination of a crisis that has just begun (Contreras-Pacheco, 2018).

Finally, it is emphasized that the strengthening of communication in the R&CM system is only possible with the commitment of their leaders (ID = 3.5). Communication policies require leaders who interact, coordinate, distribute responsibilities, and promote collective participation with decision-makers and actors (Berardo, 2014). This leadership must be inclusive, distributed, and communitarian that empowers the most relevant actors (Boyer-Villemaire et al., 2014; Coates, 2021; Pascual et al., 2016). The political representative is a leader who reinforces public opinion (Manfredi-Sánchez et al., 2021; Mullo López et al., 2021). As far as possible, leaders should have sufficient power to exert political pressure (Berardo, 2014), since power conflicts underlie intervention processes (Alcantara & Ferreira, 2020; Voos & Marques, 2020).

5. Conclusions

Five clusters of risk and crisis communication have been identified on mapping a keyword co-occurrence network: i) risk communication in vulnerable areas, ii) health and crisis communication, iii) communication of human and environmental exposure to pollutants, iv) management of continuity and communication quality, and v) enhancers for environmental and climate communication. Each of these five clusters deserves special attention when reporting hazards derived from: i) natural extremes, ii) human health issues, iii) land exploitation (agricultural, mining), iv) industry, and v) climate change respectively.

The in-depth review of the corpus associated with the keywords within the analyzed publications allowed us to disaggregate the five clusters into 28 key factors for a more effective R&CC. Most studies focused on the factors related to communication and information (ID 2.1 = 38.38%) and risk communication and perception management (ID 1.1 = 23.24%). The cross-analysis between the most cited authors and key factors of R&CC helped to understand these two factors (See Figure 5). As a result, the factor related to information and communication (ID = 2.1) is connected to the management of communication systems’ quality and the legitimacy of their messages. While the factor associated with risk communication and perception (ID = 1.1) is related to ensuring the health and safety of people and their surroundings.

Complementarily, it was shown (Figure 12) that many of these factors were intended to strengthen the communication system, to increase the risk knowledge of the population of interest, to improve the communication channels, and to a lesser extent, to enhance the aspects related to the communication effect.

Regarding R&CC trends most of the publications were related to issues in Brazil and Chile. The estimated PCA model evidenced that the publications associated with Chile, Colombia, and Ecuador were mostly focused on strengthening risk communication, climate change communication, and environmental communication. Health communication and the communication of human and environmental exposure to pollutants were main topics in Brazil and Argentina. Considerations on communication quality and continuity, together with digital communication were shown to be transversal to risk, health, and crisis communication.

The authors who received the most citations while developing the body of scientific research on R&CC about South America were highlight and classify through the creation of a map of co-citations: a) authors with expertise on risk, risk governance, and risk perception in modern societies (e.g. B. Fischhoff, P. Slovic, R.E. Kasperson, O. Renn, M. Douglas); b) authors that emphasize the value of language and communication in society’s development (e.g. N. Luhmann, M. Castells,
A. Giddens, J. Habermas); c) authors with expertise in crisis communication (e.g. W.T. Coombs); d) authors with expertise in discourse analysis (e.g. P. Bourdieu, P. Charaudeau, and E. Verón); and e) authors with expertise in climate change-related issues (e.g. M.C. Nisbet, S.C. Moser, W.N. Adger, K. Haynes). In addition, this analysis allowed for the visualization of authors who are actively involved in the research of R&CC about South America such as K. Paerregaard, A. Donovan, H.B. Nicoll, and F. Peres. These findings make it possible to connect decision-makers and scientists with relevant authors of R&CC.

Additionally, the analysis of co-authorship by country of origin led to the most significant cooperation links that favor the development of the R&CC. With the use of this analysis, it was feasible to show that the language and geographical proximity of the countries influence the development of cooperation linkages. South America has robust scientific cooperations, particularly among nations that speak the Spanish language, such as Chile, Colombia, Argentina, Ecuador, Peru, and Venezuela. In addition, the linkage strengths revealed that Chile and Brazil have the strongest international partnerships for the growth of R&CC in the region.

A significant finding of this study was the recognition of the contribution made by researchers from non-South American countries to the growth of R&CC science in the region (see section 3.4.1). According to this viewpoint, non-South American countries contributed to productivity and impact in citations (measured by the H-index). Considering the average of citations per item, our results suggested that publications from non-South American countries often tended to have a higher citation influence than regional research. According to the H-index, higher quality publications were provided by United States, Spain, and England. Likewise, the publications from non-South American countries with the greatest citation average come from Australia, England, and China. Additionally, non-South American countries contribute with theories and frameworks that help to understand R&CC (see section 3.3.1). Most of these approaches come from authors from North America and Western Europe such as P. Slovic, B. Fischhoff, W.T. Coombs, M. Douglas, J. Habermas, M. Castells, among others.

Unquestionably, the growth of R&CC publications regarding South America has been influenced favorably by COVID-19 (de las Heras-Pedrosa et al., 2022). The abrupt generation of publications on COVID-19 in 2020 evidenced the importance of addressing the determinants of R&CC publications from the standpoint of the multidimensionality of hazards. To the best of our knowledge, this is the first study to address the compositional approach through CoDA in the bibliometric analysis regarding South America. The use of CoDA through an air transformation allowed us to draw the conclusion that the studies connected to COVID-19 acted differently from those related to other types of threats. This finding provides evidence that the development of articles on R&CC might act in completely distinct ways depending on the sort of threat.

A compositional approach that controlled for COVID-19 publications led to the conclusion that the level of wealth, the capacity for tourism, and the number of people affected by a disaster all influence the growth of publications about South America. In the context of COVID-19, publications from countries with lower GDP per capita, more inflows of tourists, and more disaster victims were more prevalent. While in the absence of COVID-19, the countries that produced the most publications tended to be wealthier, less reliant on tourism, and more resilient to disasters.

One of the factors that influenced the trend of R&CC publications related to COVID-19 in South America to be opposite to those unrelated to COVID-19 was the general open access policy (de las Heras-Pedrosa et al., 2022) promoted by scientific journals during the pandemic. As a result, we believe that the contribution of scientific journals is essential to improve knowledge of R&CC in the most vulnerable areas of the world in the face of different threats.

The analysis of publications by research area (see Figure 9) showed that most articles on R&CC are related to the fields of communication, public environmental occupational health, and environmental science ecology. However, one of the limitations of this analysis is that it does not delve into the sub-branches of communication that contribute to R&CC. The keywords co-occurrence analysis showed that R&CC makes use of specific communication subfields such as digital communication, science communication, climate change communication, environmental communication, and health communication. Further research needs to emphasize the communication subfields that contribute to R&CC. It would also be interesting to examine whether what is published fits the needs of the crisis-affected population.

Finally, this study provides a thorough review of R&CC publications on South America and serves as support those who are interested in both developing policies and conducting research in this area by providing information that will help them move more quickly and effectively. The proposed methodology was
primarily based on the application of bibliometric mapping techniques and multivariate statistical models that were customized to the unique characteristics of each phenomenon under study. We recognize that R&CC knowledge of South America is underrepresented in global bibliometric maps and rarely included in R&CM systems, thus it is crucial to keep researching communication focused on South America in the presence of high-impact hazards and to incorporate this knowledge into the R&CM systems of the various countries.

**Disclosure statement**

No potential conflict of interest was reported by the authors.

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**Public interest statement**

This study provides a thorough review of risk and crisis communication regarding South America and serves as support those who are interested in both developing policies and conducting research in this area by providing information that will help them move more quickly and effectively. The present study aims to map the trends and contribution of scientific publications to risk and crisis communication regarding to South America. This research assesses the main factors of risk and crisis communication, visualize notable authors in conducting studies, and analyzes the main areas of research that contribute to risk and crisis communication in this subcontinent. In addition, it emphasizes the importance of non-South American countries in the scientific production of risk and crisis communication about South America and values the role of the economic aspect and disasters characteristics as deciding variables of scientific production.

**Data availability statement**

The paper is based on the Web of Sciences (WoS) online scientific information service.

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