Brief communication: Lessons Learned and Experiences Gained from Building Up a Global Survey on Societal Resilience to Changing Droughts

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Abstract. This paper presents the experiences during the process of creating a global survey with experts in drought resilience. The lessons learned include five main points: (1) the heterogeneity of the conceptual background should be minimized prior the construction of the survey; (2) large number of indicators decreases the engagement of respondents through the survey; (3) it is necessary to find a good survey design to balance response rate and accuracy, (4) the survey should be clean and fluid, (5) reaching diverse experts by knowledge areas, experience and regional representations is difficult, but crucial to minimize biased results.

Keywords: drought resilience, indicators, expert elicitation, global survey

1 Introduction

The formulation of a global survey is a complex process that poses several challenges both in its preparation (a priori), and evaluation of results (a posteriori) phases. In general, studies focusing on surveys and expert elicitation address a posteriori challenges, such as the data analysis tools used for samples of different sizes and compositions. However, a priori challenges are rarely addressed and represent an important and exhaustive step in the process. For example, Baker et al. (2014) state that “while there is a rich literature on expert elicitation approaches and protocols, there is less information available on the specifics of how an elicitation is carried out".

Harzing et al. (2013) have reviewed the issues faced in global surveys and identified cultural and language differences, which may lead to different interpretations of questions or loss of meaning, and varying response rates between countries as significant sources of bias in global surveys. ProductLab (2023) also discusses the difficulties of global surveys and provides best practices for their formulation. They also mention the challenges due to cultural and language differences and finally recommend appropriate survey timing for all countries. However, both studies have a focus on business and product development.

Therefore, our main motivation for writing this brief communication is due to the scarcity of papers or other materials discussing the challenges of creating global surveys in complex subjects where we face conceptual divergences - such as resilience. We believe that the challenges and problems faced during the survey-building process are often not discussed by the researchers, as doing so may weaken confidence in their final results. However, it is important to face this fear and openly share difficulties encountered, as this sharing of challenges can also lead to valuable new knowledge and insights gained. In this study, we have used a global survey to elicit experts' opinions on drought resilience indicators. These indicators have been increasingly used in Decision Support Systems (DSS) to reflect different socioeconomic, ecological, and technological conditions (WMO and GWP, 2016; Meza et al., 2019; Blauhut, 2020). Although numerous indicators for drought resilience are available in the literature, certain aspects may make them unfeasible for comparative analysis across global regions (Bachmair et al., 2016; Blauhut, 2020). The absence of spatial and temporal data, variability of measurements in different regions, and difficulty in understanding indicators can make it hard to select indicators to compose a global drought resilience index (Blauhut, 2020). However, these aspects are usually overlooked when rating the relevance of the indicators during the surveys. For example, Meza et al. (2019) have not incorporated these aspects in their global expert survey on drought vulnerability indicators. Therefore, there is a need for a more in-depth analysis of the drought resilience indicators to ensure their suitability for cross-regional comparisons.

Our focus was on the agricultural drought resilience of the food system linked to small farmers. By following the Sendai Framework for Disaster Risk Reduction (DRR) 2015-2030 (UNDRR, 2015), we listed and screened indicators proposed in the scientific literature for drought resilience focused on the food system. After, a global survey with experts was planned to assess the relevance, the data availability, and the shareholders' perception and understanding of these indicators in different contexts. Constructing the survey took about a year due to the challenges presented in this brief communication. We believe that it is important to discuss the process of formulating the survey to prevent other researchers from passing through the same problems and improving the use and interpretation of this method. The importance of preparing the survey itself for any generic field was also discussed by Elangovan and Sundaravel (2021). Here, we would like to complement the suggestions for the resilience field.

2 Methods for eliciting expert views and knowledge

Mukherjee et al. (2017) identify six strategies that are best suited to the various stages of the decision-making process and for eliciting different judgments: Interviews, Focus Group Discussion (FGD), Nominal Group Technique (NGT), Q methodology (Q), Delphi technique, and Multi-criteria Decision Analysis (MCDA). An interview consists of an information exchange between two or more individuals in which one of them aims to obtain information, opinions, or beliefs from the other person. The FGD is a technique in which a researcher gathers a group of people to discuss a given issue. Aside from the FGD, which aims to draw on participants' complex personal experiences and personal actions, beliefs, perceptions, and attitudes, the NGT is an interactive group decision-making process primarily focused on reaching a consensus. The Delphi technique traditionally aimed at reaching consensus, through a group-based, anonymous, and iterative technique. The Q, on the other hand, is a tool for understanding the primary viewpoints or opinions on an issue among a group of significant players, in which respondents are asked to rank a set of items. Finally, the MCDA assists decision-making by considering the benefits and disadvantages of several possibilities for achieving a certain objective.

In their application, all approaches have advantages and disadvantages. The interview, for example, may be difficult to perform due to the geographical proximity to the desired sample group (Mukherjee et al., 2017). Another example of a challenge is that FGD discussions are dependent on participant engagement, giving researchers less control. Furthermore, the Q and NGT may encounter time restrictions, one because participant interpretation might be difficult and time-consuming, and the other because there may be insufficient time to reach a consensus.

We chose the Delphi technique because it is a tool that can gather and assimilate a set of experts' opinions across geographically diverse time zones on potentially complex matters. Even though the reliance on expert opinions can pose obstacles to the use of the Delphi method in evaluating drought indices, this method has been applied to develop indices for desertification (Hai et al., 2016) and water supply (Crispim et al., 2022). Additionally, this methodology has been applied to global surveys (i.e., Rastandeh et al. (2018)); however, the process of conducting this research requires further discussion.

3 Challenges in the survey planning

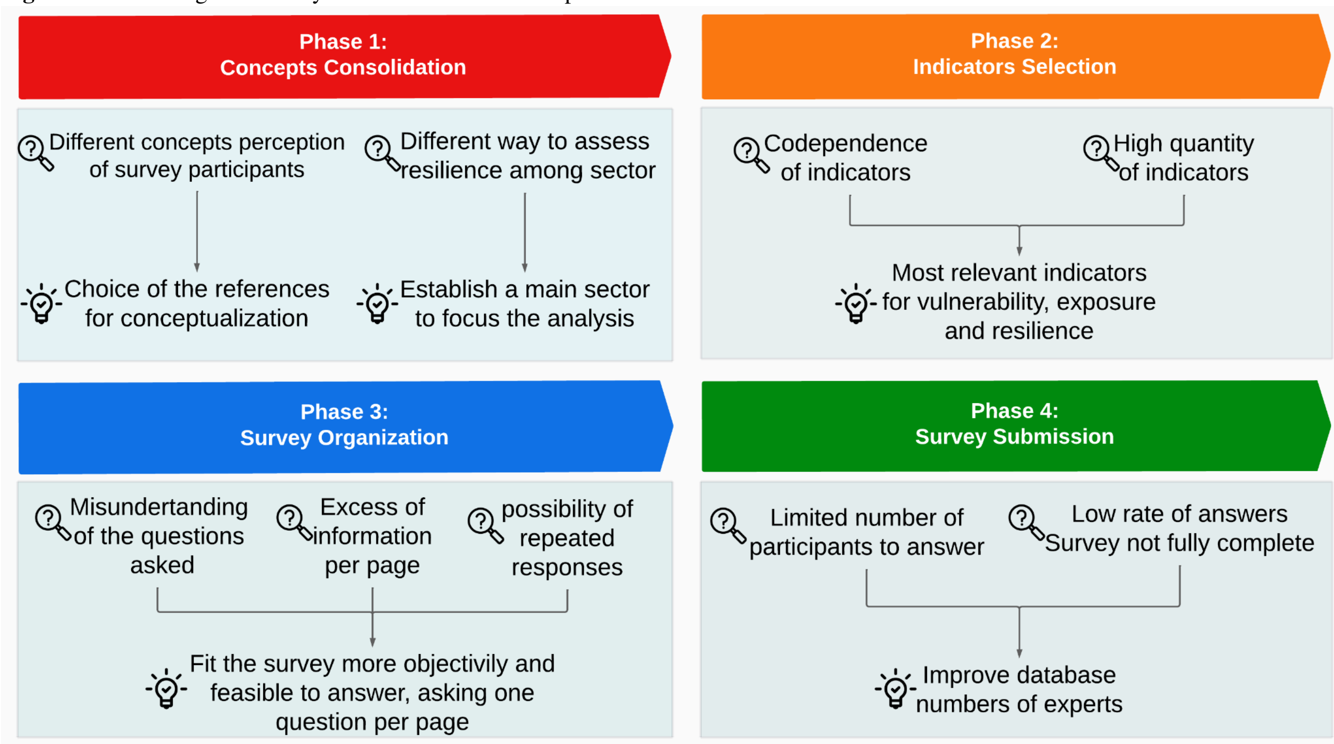
The elaboration and consolidation process of the global survey was carried out in four main phases: conceptualization (concept consolidation), indicators selection, survey layout organization, and distribution/data collection (Figure 1). This section discusses the challenges encountered in each phase and how the research team addressed them using a collaborative approach. The total survey construction process, in four phases, lasted 11 months, being the most time-consuming part of the research. Additionally, it was a crucial part since the quality of the research outcomes depended on the questions and the engagement of the responders.

3.1 Phase 1: Concepts Consolidation

The first challenge was related to the consolidation of the concepts frequently associated with drought resilience. We targeted experts from different fields, such as geophysics, engineering, economics, and social sciences, who work and live in different countries. Thus, the concepts used in the Sendai Framework, such as drought, DRR, resilience, vulnerability, and adaptation, can be analyzed and perceived differently among participants.

Initially, we planned to ask experts to classify the selected indicators into vulnerability or resilience types, based on the component in which they had the highest representation. However, due to the heterogeneity of expertise, backgrounds, and contexts, we realized that leaving the classifications open for a later consolidation would only propagate conceptual confusion, instead of solving it. These conceptual divergences make it difficult to categorize indicators in the resilience components and may affect the perception of their relevance to the respondent. This task was difficult even for the research group itself, which

Figure 1. Phases of global survey elaboration and main steps



included researchers from different backgrounds and countries. Therefore, we realized the importance of having a clearly defined a priori resilience model to reduce conceptual confusion. For this purpose, we decided to adopt the Sendai Framework (UNDRR, 2015), due to its global significance in the development of public policies.

As part of the DRR approach, it is important to first understand the evolution of disaster response and decision-making from an international perspective. Past discussions attempting to reduce the impacts of disasters had a focus on disaster management, which does not necessarily aim at averting or eliminating threats, but decreasing the negative impacts resulting from the event and recovering as fast as possible to the original (or better) state of the system (UNDRR, 2015). In recent years, there has been a shift from the approach of disaster management to disaster risk management. The latter is defined as "the application of disaster risk reduction policies and strategies to prevent new disaster risk, reduce existing disaster risk, and manage residual risk, contributing to the strengthening of resilience and reduction of disaster losses" (UNDRR, 2015), aiming at actions on different timescales and with a focus on increasing the economic, social, health and environmental resilience. This new approach to managing disasters has been incorporated in the Sendai Framework report (UNDRR, 2015), which presents the importance of pre-disaster actions, such as prevention, mitigation, development, and implementation of appropriate actions for preparing and effectively responding to disasters. To this end, it emphasizes the importance of risk assessment and dissemination of location-based information, to support risk-informed decision-making.

As previously mentioned, the goal of disaster risk management is to increase and strengthen resilience. The UNDRR (2015) defines resilience as "the ability of a system or community to anticipate, resist, prepare, respond to and recover from an event with multiple risks, with the least possible harm to social, economic, and environmental well-being". Several indices have been proposed over the years to represent the level of resilience of a given system to a disruptive event. In general, resilience assessment requires the identification of the risks in the system due to disruptive events and the adoption of risk management policies to prevent their occurrence or reduce their impacts along the system's chain.

Risk can be represented by a function that correlates the probability of the occurrence of the disruptive event (H), the vulnerability of the system's different components (V), and their exposure to risk (E), so that vulnerability and exposure represent the potential impacts on the system (Merz et al., 2014). Within the disaster risk management and risk-oriented decision-making approach, the risk analysis stage is of fundamental importance and a precursor to the decision-making process.

To evaluate the risk management stage, it is important to understand the type of the proposed action, its temporal component, and the magnitude of the impacts if the proposed action fails. According to these components, the actions can be correlated with the different system capacities that help reduce the disaster risk and further impacts, therefore, improving resilience, such as adaptive capacity, coping capacity, and transformative capacity.

3.2 Phase 2: Indicators selection

Droughts can have significant impacts on different economic and social sectors. However, assessing the drought resilience of each sector can be different. Initially, we focused on agriculture, but we realized that vulnerability and resilience to droughts can vary significantly within this sector. Therefore, we prioritized the selection of indicators related to small farms' drought resilience and vulnerability. Small farms produce a significant part of the world's food production (Lowder et al., 2021), and they are more susceptible to climate change and extreme events than commercial farms (Morton, 2007). We observed that prioritizing indicators specific to the resilience and vulnerability of small farmers to drought allows tailored insights and interventions to address their unique needs. However, such a specificity comes at the cost of broader applicability and requires more intensive data collection and analysis. These observations highlighted a trade-off between the effectiveness of the targeted application and the generalizability of a risk management index, which is overlooked in the literature.

The list of indicators to be evaluated in the global survey was compiled from a structured literature review. At the beginning of the process, we identified more than 136 indicators that are frequently used in the literature (Supplementary Material 1). From our literature review, we noticed that indicators related to the hazard component of the agricultural drought risk were already well established and could also be easily obtained from global open databases, or even remote sensing satellite data, through geoprocessing. For example, the Global Drought Observatory [1] already monitors hazard indicators globally. Therefore, our focus on this survey was to identify indicators related to risk impacts (vulnerability and exposure) and risk management actions to increase resilience (adaptive, coping, and transformative capacity).

There is a myriad of indicators for evaluating drought and its impact on agriculture. Two issues were raised from this initial list: (1) There were too many codependent indicators (e.g., Gini index and poverty rate). Including the codependent indicators

[1] https://edo.jrc.ec.europa.eu/gdo/php/index.php?id=2000

would affect the final index by unintentionally attributing a higher weight to this factor. (2) Including all the 136 indicators, the survey would become too extensive and exhaustive, which could affect the response rate.

To address the issues raised, the selection of the final list of indicators was made through three steps. The first step was to remove hazard indicators, as previously discussed. In this step, 31 indicators were removed. In the second step, we removed the codependent indicators from the list, keeping those with greater availability and easy-to-access data. For example, from the Gini index and the poverty rate, we opted for the poverty rate, since it is a more direct measurement and easier to get in different contexts. This process of eliminating codependent indicators was made interactively in group discussion sessions with members of our research team. A total of 28 indicators were removed from consideration through this process. The third step was reducing the total number of indicators to avoid the survey from becoming too extensive and exhaustive to answer. From this part, each participant in the group independently rated the relevance of the indicators, through a form available only to the group and based on the seven questions given by WMO and GWP (2016). From the answers, in a group discussion session, we selected the 33 indicators with the highest average rating.

In the next stage, we sought independent experts' opinions on the selected indicators and the overall structure of the survey. External experts recommended three additional indicators after the first pilot run of the survey. In the end, we had a list of 36 indicators (Table 1).

Additionally, during our internal group discussion sessions, one of the concerns was that some indicators are very interesting and relevant, but they are not easy to obtain. In this sense, we identified important complementary questions on data quality that are usually not asked in surveys (where all the relevant data are assumed to be equally easy to obtain and understand). We asked experts to rate the indicators' metrics: relevancy, ease of understanding, accessibility, and objectivity (we included a definition of each at the beginning of the formulary).

The choice of these specific metrics came from Sweya et al. (2021). They presented 5 complementary attributes for social resilience indicators of the water supply systems (which are: affordability, availability, reliability, simplicity, and transparency). As a result, they have obtained that data availability, reliability, and affordability were the most limiting factors for selecting indicators in Tanzania. In this sense, and with a focus on the Global South, the group selected the three metrics before mentioned to be complementary to relevancy and adapted from Sweya et al. (2021), where understanding was used to represent simplicity, accessibility was used as a single attribute to account for affordability and availability, and objectivity was an additional attribute that we chose to evaluate how objective the final measure is (since some of our social indicators are political measurements and may be subjective).

Table 1: List of indicators evaluated in the survey

Indicator	**Description**
1. Crop income dependence	Percentage of participation of crop and livestock .production in the income of smallholder farming

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Table 1: List of indicators evaluated in the survey (Continued)

Indicator	**Description**
2. Crop loss	Crop Damage & Sensitivity (Crop Loss)
3. Drought resistant crops	Cultivation of drought-resistant crops (%)
4. Crop varieties	Farmers use different crop varieties (%)
5. Protected area	Area protected and designated for the conservation of biodiversity (%)
6. Use of agricultural inputs	Use of Insecticides and pesticides (Use of agricultural inputs)
7. WUE	Crop water use efficiency (WUE)
8. Land degradation	Degree of land degradation and desertification*
9. Land rights	Land rights clearly defined (yes/no)
10. Drought management policies	Existence of drought management policies
11. Technical assistance	Technical assistance from local entities
12. Drought insurance	Farmers with crop, livestock, or drought insurance (%)
13. Water use rights	Water use rights are clearly defined
14. Prediction system	Availability of drought prediction and warning systems or climatic predictions
15. Transportation network	Transportation network
16. Electricity	Access to electricity (Access to energy)
17. Conflict	Prevalence of conflict/insecurity
18. Sanitation condition	Population without access to (improved) sanitation (%)
19. Gender inequality	Gender inequality (categorical)
20. Rural population	Rural population (% of the total population)
21. Unemployment	Unemployment rate (and/or proportion of formal work)

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Table 1: List of indicators evaluated in the survey (Continued)

Indicator	Description
22. Working-age population	Population ages 15-64 (% of the total population)
23. Displaced population	Percentage of the population displaced internally or transboundary
24. Drivers of migration	Presence of drivers of migration and displacement
25. Poverty	Poverty Rate
26. Food source reliability	Food source reliability and diversity
27. Participation in local policy	Public participation in local policy
28. Cooperatives or associations	Participation in farming cooperatives or associations
29. Employment in small farms	% of the population employed in small farms
30. Financing and credit	Access to financing and credit
31. Water stress	Baseline water stress (ratio of withdrawals to renewable supply)
32. Water quality	Water quality (categorical)
33. Groundwater level	Groundwater level/sources
34. Integrated policies	Integrated land and water management policies
35. Retained renewable water	Percentage of retained renewable water
36. Dam capacity	Total dam capacity

* The reference to each indicator is provided in Supplementary Material 1

3.3 Phase 3: Survey Organization

Another challenge was presenting the indicators and relevant information effectively during the survey to make viewing, understanding, and comparing the indicators as straightforward as possible. The survey design was made based on guidelines for operationalizing the Delphi method (Hasson et al., 2000) and the suggestions made by Elangovan and Sundaravel (2021). The last provided a template to validate the survey instrument. However, they present a generic form of document, in which we still experienced difficulties related to the resilience field study. Therefore, we have improved our survey design based on the evaluation of different literature that used the Delphi method to access resilience indicators (e.g., Alshehri et al. (2015); Ogah et al. (2021)).

Over a year, our team worked on constructing a survey. During the process, we tested different designs within the group. We created several prototype surveys that varied in terms of question layout, types of questions (such as Likert scales versus ranking), number of scales, and how the definition of concepts was presented. To evaluate each prototype, the research team members considered the ease of understanding, cognitive load, and the time required to complete the survey. These survey prototypes were modified and combined based on the user experience. After the first consolidation of the survey design to be used, a pilot test was done with a small external group of experts who were asked for their opinions on the final design and indicators. We used the same process to design the second stage of the survey, according to the Delphi method, which was more difficult because the results of the first stage of the survey were expected to be provided to the respondents.

In the final selected design, each page of the survey refers to one specific attribute, and rates of importance should be given to each indicator. This format was chosen because it allows a comparison between the indicators when answering, reducing the possibility of repeated responses for all indicators, and allowing a hierarchy between them and greater fluidity in conducting the survey. Each indicator could be rated on a three-point scale: "Low", "Medium", and "High". The definition of this point scale changes according to the metric that is being evaluated. The category "Don't know" was included to filter pseudo-opinions. On the last page of the survey, we asked for some demographic information, like area of expertise, years of experience, region of analysis, etc. The final format of the survey (Supplementary Material 2) was consolidated after all members of the group and the piloting phase group answered the survey and did not make any new inputs and suggestions. For the second stage of the survey, the same format was used, but we included the percentage of responders at each level of the scale, for each indicator and each metric.

3.4 Phase 4: Survey Distribution/Data Collection

The last challenge was defining the experts to whom the survey should be sent. As the purpose was to obtain the opinions of experts from different backgrounds and socio-economic contexts, a list of experts was created from recently published papers on droughts in the Web of Science and Scopus databases. The members of the group also shared the survey in their networks.

As a result of the disproportionate amount of research conducted in countries and regions in the Global North due to economic factors, scientific databases have a bias toward the Global North. Therefore, it is important to address and remedy this issue in the recruitment process. After this initial data collection, a distribution analysis was carried out about continents and countries to assess whether there was a need to complement any specific region.

Despite the attempts to assemble the greatest diversity of experts' backgrounds on drought resilience analysis, the study had a limitation about a large concentration of responses coming from academic experts (approximately 80%). This was due to the difficulty in accessing the information of other practitioners and stakeholders, since there is no unified database, as is the case with Scopus and Web of Science for researchers. For future surveys, we recommend trying to reach out to existing policy networks around drought to reach other types of stakeholders.

The survey has been approved by the Institutional Review Board (IRB) of Penn State University for Human Subjects Protection (IRB # STUDY00021208) and a consent form was provided for all the participants before starting the survey. We customized the research consent form to align with the legal and ethical standards of the participant's country as much as possible. For example, the survey presented a different consent form that accurately reflects the customized considerations of the European Union. After the survey concluded, we saw that 326 experts from 46 countries started answering and 120 finished it. The presentation of the data obtained from the survey and their a posteriori analysis are presented in Sass et al.. For the second stage of the survey, we obtained 32 respondents from 21 countries.

4 Lessons Learned and Recommendations

In this study, great effort was made to understand how to equalize regional issues during the construction of a global survey aiming at identifying indicators to compose a global index to evaluate resilience to agricultural droughts in the context of small farms for food production. In articles on surveys and expert elicitation, the challenges encountered a priori in the application of the method (e.g. construction of questions and engagement of participants in the process) are not explained or discussed, despite being crucial for the quality of the data obtained. In this paper, we summarize our processes of designing such a survey, highlight the main challenges, and present suggestions to work around them:

(1) There are different concepts related to resilience, especially vulnerability and adaptation, which can be very context-dependent.

To deal with this challenge in the construction of a global indicator, we suggest choosing an internationally relevant and well-consolidated resilience framework (in this case, the Sendai Framework due to its relevance in public policies), rigidly adopting the presented settings. Additionally, to account for differences in local contexts, in addition to the relevance of each indicator, we utilized complementary attributes, such as ease of understanding, accessibility, objectivity, and temporal consistency.

(2) There are many indicators in the literature. Surveys containing all the indicators become tiresome to answer, decreasing engagement, response rate, and quality of the answers obtained.

In our experience, including more than 40 indicators already significantly reduced engagement and consistency in responses. Therefore, the choice of the final and reduced list of indicators should be based on the objective of the research, and the system evaluated, with only the priority indicators chosen for representativeness in different local contexts of risks.

(3) It is important to identify the best survey design that clarifies questions and definitions to reduce misunderstanding and divergent answers across different contexts (expertise and region-wise).

Before making the survey available to the general public and experts, it was essential to study its face validity and conceptual validity by our internal research team and externally by a smaller group of experts during a pilot phase. Face validation refers to whether participants can interpret the survey items according to their intended meaning. The conceptual validity ensures that the survey items accurately represent the theoretical concept that they are intended to represent. These validation processes will help identify and correct poorly prepared items and ill-defined concepts to ensure the quality of the survey responses. Providing the conceptual definitions of the scales can improve the face validity of surveys.

(4) The survey design must be clean and fluid.

The engagement of respondents from the beginning to the end of the survey is of great importance to maintain consistent results for all questions. Therefore, the format of the applied survey is important. The survey should allow quick and explicit comparison between the main components evaluated (in our case the indicators) and questions about different attributes should be separated into different sections. The response time should preferably not exceed 15 min.

(5) It can be difficult to list participants from different areas of knowledge, professional experience, and regions/countries. The small number of respondents for each area affects the significance of the analysis a posteriori.

There is a lack of databases for practitioners and stakeholders other than academics, which makes it difficult to gather names of other actors usually involved in decision-making processes. Suggestions to obtain a more diverse base with more actors from the public and private sectors and international organizations include seeking alternative sources of contacts and requesting the linkage of research in institutional communication to the agencies involved in dealing with disasters, especially droughts (e.g. IDMP, UNCCD, WMO, FAO). Moreover, even in academic databases, there is still a great bias for international research to be centered on countries of the Global North. Since the countries of the Global South are generally the ones with the greatest difficulty in coping with the risks of droughts, studies of indicators cannot ignore this representativeness. By sharing our experience in the process of building a global survey, we expect to help other researchers by pointing out the main difficulties and presenting our solution.

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Competing interests. The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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