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Brief communication: lessons learnt and experienced gained from building up a global survey on societal resilience to droughts

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Abstract. Drought resilience indexes are essential tools for an evidence-based decision-making process. They can be constructed by enquiring experts about the most relevant indicators. This communication presents the challenges found *a priori* of creating a global survey with experts in drought. The lessons learned include: (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; (3) the format should balance response rate and accuracy, (4) raising diverse experts by knowledge areas, experience and regional representations is difficult, but crucial to minimize biased results.

1 Introduction

Drought is an omnipresent natural disaster on Earth and one of the biggest threats to water security, food, and energy production. Despite our limited short time window of meteorological observations, we have witnessed an increasing tendency in frequency and severity of droughts (IPCC, 2022). Society must adopt measures to mitigate these impacts and to adapt to reduce their consequences.

Drought resilience indicators are tools that are being increasingly used to support an evidence-based decision-making process since they can reflect different socioeconomic, ecological, and technological conditions. Although there are many indicators for drought resilience in the literature, several aspects can make them not feasible for analysis, in particular for comparison between global regions. The absence of spatial and temporal data, variability of measurements in different regions, and difficulty in understanding can be a hard challenge to select indicators to compose a drought resilience index. These difficulties are reflected in the use of these indicators as a support for public policies and decision-making processes.

A model for drought resilience quantification needs several indicators to integrate the magnitude and frequency, economic and social impact, and further analyse the capacity to overcome or minimize negative consequences in social and ecosystems under extreme events. There is a lack of clear consensus on which indicators should be selected to compose an index to

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assess exposure, vulnerability, and resilience concerning droughts. A conceptual hybrid approach considering stakeholder views on possible drought risk factors as well as quantitative measures of past impacts has not been implemented in a cross-country context. This encouraged us to seek the construction of an index, proposing connections between hazard, exposure, and vulnerability concepts, with an emphasis on infrastructure and institutional capacity indicators.

Our focus is on the drought resilience of the food system linked to small farmers. As drought, we are referring to the agricultural drought, which usually relates to a period with declining soil moisture and consequent crop failure without any reference to surface water resources (Mishra et al., 2010). A food system is “the networks that are needed to produce and transform food and ensure it reaches consumers” (WFP, 2023). The food system is also likely to be affected by extreme events, in particular droughts. Thus, we intend to contribute to the understanding of the risks related to drought this crucial sector can face.

By following the Sendai Framework for Disaster Risk Reduction 2015-2030, 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.

The process of formulating a global survey imposes several challenges *a priori* (in the process of preparing the survey itself) and *a posteriori* (in the process of evaluating the results). In general, studies with 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. In this sense, in this brief communication, we share the challenges faced in our study and the lessons learned that can help other research in global surveys.

2 Methods for eliciting expert views and knowledge

Global surveys are ambitious projects that require sufficient answers to attain statistical significance. The target group of the survey is the major determinant of the sample size and will define the amount of data to be collected to answer the research questions.

Mukherjee et al. (2017) identified 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 the 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

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players, in which respondents are asked to rank a set of items. Finally, the MCDA assists decision-making that considers the benefits and disadvantages of several possibilities for achieving a certain objective.

All approaches have advantages and disadvantages. The interview, for example, may be difficult to perform due to 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 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. We used it to create a sample of worldwide experts' opinions on the relevancy, understanding, accessibility, objectivity, and consistency of drought resilience indicators related to the food system. One of the main challenges of the Delphi technique is the low response rate, as well as the considerable planning and preparation time. In the next section, we discuss the main challenges we faced in this process.

3 Challenges in the survey planning

The elaboration and consolidation process of the global survey was carried out in four main phases: concepts consolidation, indicators selection, survey organization, and survey submission (Figure 1). The total survey construction process, in its 4 phases, lasted 11 months, being the most time-consuming part of the research. Additionally, it was a crucial part since depending on the questions and the engagement of the responders, the quality of the further steps of research is highly affected.

The first challenge was related to the consolidation of the concepts frequently associated with drought risks. We targeted experts from different fields, such as geophysics, engineering, economics, and social sciences that work and live in different countries. Thus, concepts such as droughts, disaster risk reduction, resilience, vulnerability, adaptation, and mitigation can be analysed and perceived differently among the participants. Thus, since the experts have different backgrounds, it was important to define all the relevant concepts.

Initially, we thought of asking the experts to classify the selected indicators concerning the component in which they had the greatest representation. However, due to the heterogeneity of specialties, backgrounds, and contexts, we realized that leaving the classifications open for a later consolidation would only propagate conceptual confusion, instead of solving it. This challenge was perceived even in the research group itself, which has people from different backgrounds and countries. Thus, the importance of having a well-defined *a priori* resilience model was perceived. In this sense, for this research, it was chosen to adopt the Sendai Framework for Disaster Risk Reduction due to its international importance in the formulation of public policies.

The next step was the most difficult one, the selection of indicators to be evaluated by the experts. Droughts can have significant impacts on different economic and social sectors, however, the way to assess the resilience of each of these sectors can differ. We first thought of focusing on agriculture, but we realized vulnerability and resilience to droughts can

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vary a lot inside this sector. So, we prioritized the selection of indicators of drought resilience and vulnerability related to medium and small farms. These farms respond to a significant part of the world's food production (Lowder et al., 2021) and are more susceptible to climate change and weather extreme events than commercial farms (Morton, 2007).

The list of indicators to be evaluated in the global survey was obtained from a compilation of indicators frequently used in the literature. At the beginning of the process, we compiled over 136 indicators. From this literature review, it was noticed that there was already a consolidation of indicators related to hazard, which can also be easily obtained from global open databases or even satellite information and geoprocessing. Therefore, we decided to reduce the survey on the exposure, vulnerability, and capacity indicators, since there is still a lot of context variation in terms of comprehension, data availability, and understanding, which still poses a challenge for constructing a global index for cross-country studies.

Two issues were raised from this first list: (1) There were too many codependent indicators (e.g., Gini index and poverty rate). Including the codependent indicators would affect the final index by unintentionally attributing a higher weight to this factor. (2) The survey would become too extensive and exhaustive to answer, which could affect the number of respondents. To solve this, we defined two selection criteria to reduce the number of indicators. First, we evaluated if the indicators can be classified into the dimensions of risk of the Sendai Framework (vulnerability, capacity, and exposure)). Then, we evaluated if the indicators are relevant in different local contexts, i.e., they should represent local risk and resilience. From a pre-selected list, the group independently evaluated the indicators, discussed their ratings and justifications in group discussions, and finally, we had a group consensus on which indicators to include. In the end, we had a list of 36 indicators (Table 1).

Another challenge was in the way of presenting the indicators to be answered. The layout of the survey was a theme of discussion, aiming at establishing the best way of viewing, understanding, and comparing them. We wanted the experts to rate the attributes: relevancy, ease of understanding, accessibility, objectivity, and consistency of the indicators (we included a definition of each one at the beginning of the formulary). As a group, we tested alternative layouts, but we also asked a small external group of experts for their opinion on which survey format to choose. We asked them to take the survey in different formats and give us feedback, which was incorporated into the final survey. In the selected layout, 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.

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 was consolidated after all members of the group and a small external group of experts answered the survey and did not make any new inputs and suggestions.

The last challenge was defining the experts to whom the survey should be sent. As the purpose was to obtain the opinion of people from different backgrounds and socio-economic contexts, a list of experts was made 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.

Due to the greater number of research conducted in countries and regions of the Global North, due to the economic bias of science, the use of scientific databases to list the names and contacts of experts reproduces this bias, so this must be addressed and equalized before sending the survey. Therefore, after this initial gathering, a distribution analysis on continents and countries was made to assess whether there was a need to complement any specific region.

Despite the attempt to assemble the greatest diversity of experts' background on drought risk and resilience analysis, the study had a limitation in relation to a large concentration of responses coming from academic experts (approximately 80%). This was due to the difficulty in listing the names of other practitioners and stakeholders, since there is no unified database, as is the case with Scopus and Web of Science for researchers.

The survey has been approved by the Institutional Review Board (IRB) of Penn State University for Human Subjects Protection (IRB # STUDY00021208) and an agreement term was provided for all the participants before starting the survey. After the survey concluded, we saw that 326 experts from 46 countries started answering and 120 finished it. The presentation and the analysis of the data from the survey will be the subject of a scientific paper (Sass et al., 2023).

4 Lessons learned and suggestions for further surveys

Constructing global surveys to classify indicators that allow comparison between contexts is a major challenge, as the concepts related to risk components, especially vulnerability and adaptation, have significant variations between regions. This variation can be attributed to the different impacts suffered by populations according to the social, economic and cultural characteristics of each location. In this sense, in this research a great effort was made on how to equalize regional issues in the identification of indicators from a global survey for the construction of a global index to evaluate resilience to agricultural droughts, focusing on the context medium and small farms.

In papers on surveys and experts' 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 and discussed, despite being a great challenge and crucial for the quality of the data obtained and the later stages of the researchHere we highlight the main ones and suggestions to work around them:

(1) Different concepts related to the components of risk and resilience, especially about 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, we chose the Sendai Framework, due to its relevance in public policies), rigidly adopting the presented settings. Moreover, to equalize the importance of the indicators due to the different local contexts, in addition to the relevance of each indicator, complementary attributes were listed, such as ease of understanding, accessibility, objectivity, and temporal consistency.

(2) Large number of indicators present in the literature. Surveys containing all the indicators become tiresome to answer, decreasing the engagement in the total of complete answers and the consistency of the answers obtained.

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

(3) Identify better formats that clarify in questions and definitions, to reduce misunderstanding and divergent answers.

Before the open it to the general public and experts, the survey must be validated by an external and smaller group of experts, to reduce poorly prepared questions and poorly defined concepts.

(4) Clean and fluid survey format

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. Response time should preferably not exceed 15 min.

(5) Difficulty in listing participants from different areas of knowledge, professional experience and regions/countries. The small number of respondents for each area affects the significance of the analyses *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 the decision-making process. 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, requesting the linkage of research in institutional communication to the agencies involved in dealing with the risk of disasters, especially droughts. Moreover, even in academic databases, there is still a great bias for international research to be centred on countries of the Global North, so that the listing of names through these databases without prior treatment to ensure greater isonomy between regions can reproduce this bias in the results obtained by the survey. 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 fail to pay attention to such representativeness.

Lessons learned can be addressed from the own experience and sentiment of the survey itself, as well as from a global perspective around climate justice. On the one hand, by sharing our experience in the process of constructing a global survey, we expect to help other researchers by pointing out the main difficulties and presenting our solution.

5 Conflict of Interest

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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6 Author Contributions

All authors contributed to the development and execution of the global survey which is part of the Management of Disaster Risk and Societal Resilience (MADIS) project, funded by the Belmont Forum . MM, MB, KS, and AN contributed to this manuscript by writing, reading, and reviewing. AK, NO, EM, GS, PS, and MJ contributed to the manuscript revision and reading.

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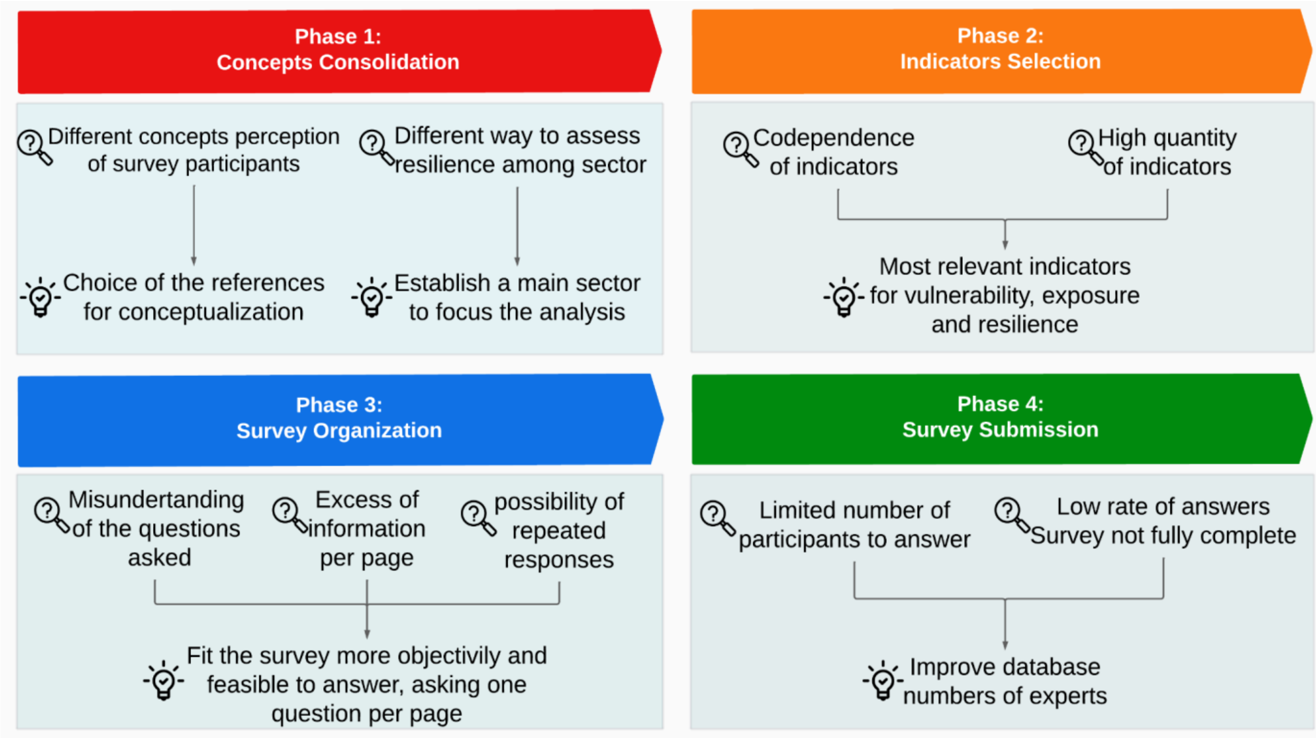

Figure 1: Phases of global survey elaboration and main steps.

255 **Table 1: List of indicators evaluated in the survey**

Indicator	Description	Reference
1. Crop income dependence	Percentage of participation of crop and livestock production in the income of smallholder farming	(Lindoso et al. 2011)
2. Crop loss	Crop Damage & Sensitivity (Crop Loss)	(Hao et al. 2012; Antwi-Agyei et al. 2012; Simelton et al. 2009; Epule 2021)
3. Drought resistant crops	Cultivation of drought-resistant crops (%)	(Meza et al. 2019)
4. Crop varieties	Farmers use different crop varieties (%)	(Meza et al. 2019)
5. Protected area	Area protected and designated for the conservation of biodiversity (%)	(Meza et al. 2019)

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Indicator	Description	Reference
6. Use of agricultural inputs	Use of Insecticides and pesticides (Use of agricultural inputs)	(Meza et al. 2019)
7. WUE	Crop water use efficiency (WUE)	(Meza et al. 2019)
8. Land degradation	Degree of land degradation and desertification*	(Meza et al. 2019)
9. Land rights	Land rights clearly defined (yes/no)	(Lindoso et al. 2011; Leguizamo et al. 2020)
10.Drought management policies	Existence of drought management policies	(Kampragou et al. 2015)
11.Technical assistance	Technical assistance from local entities	(Leguizamo et al. 2020)
12.Drought insurance	Farmers with crop, livestock, or drought insurance (%)	(Meza et al. 2019)
13.Water use rights	Water use rights are clearly defined	(Kampragou et al. 2015)
14.Prediction system	Availability of drought prediction and warning systems or climatic predictions	(Lee and Yoo 2021; Xu et al. 2021; Leguizamo et al. 2020)
15.Transportation network	Transportation network	(Simelton et al. 2009)
16.Electricity	Access to electricity (Access to energy)	(Meza et al. 2019)
17.Conflict	Prevalence of conflict/insecurity	(Meza et al. 2019)
18.Sanitation condition	Population without access to (improved) sanitation (%)	(Meza et al. 2019)
19.Gender inequality	Gender inequality (categorical)	(Meza et al. 2019)
20.Rural population	Rural population (% of the total population)	(Meza et al. 2019)
21.Unemployment	Unemployment rate (and/or proportion of formal work)	(Meza et al. 2019)
22.Working-age population	Population ages 15-64 (% of the total population)	(Meza et al. 2019)
23.Displaced population	Percentage of the population	(Meza et al. 2019)

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Indicator	Description	Reference
	displaced internally or transboundary	
24.Drivers of migration	Presence of drivers of migration and displacement	(Meza et al. 2019)
25.Poverty	Poverty Rate	(Epule 2021)
26.Food source reliability	Food source reliability and diversity	(Luetkemeier and Liehr 2018)
27.Participation in local policy	Public participation in local policy	(Meza et al. 2019)
28.Cooperatives or associations	Participation in farming cooperatives or associations	(Lindoso et al. 2011)
29.Employment in small farms	% of the population employed in small farms	(Lindoso et al. 2011; Kampragou et al. 2015)
30.Financing and credit	Access to financing and credit	(Leguizamo et al. 2020)
31.Water stress	Baseline water stress (ratio of withdrawals to renewable supply)	(Meza et al. 2019)
32.Water quality	Water quality (categorical)	(Meza et al. 2019)
33.Groundwater level	Groundwater level/sources	(Kampragou et al. 2015; Wu et al. 2013; Alonso et al. 2019; Murthy et al. 2015)
34.Integrated policies	Integrated land and water management policies	(Lerner et al. 2018)
35.Retained renewable water	Percentage of retained renewable water	(Meza et al. 2019)
36.Dam capacity	Total dam capacity	(Meza et al. 2019)