

Manuscript title: Lessons Learned in Institutional Preparedness and Response
During the 2022 European Drought

Authors: Biella et al.

Dear Editor and Reviewers,

We sincerely thank you for your time and thoughtful feedback, which has helped us improve the clarity and quality of our manuscript. Below we provide a detailed, point-by-point response to all reviewer comments. Reviewer comments are listed in *italic*, followed by our responses in plain text. Line numbers refer to the revised manuscript with tracked changes.

Before addressing the reviewers' comments, we would like to point out that the title of the manuscript was changed. This was due to feedbacks from readers of the preprint who found confusing the original title being similar to that of the companion paper.

Reviewer 1

We thank Reviewer 1 for their careful and thoughtful review. We appreciate the concern raised regarding the sampling strategy, and we have revised the manuscript to clarify the nature and limitations of our data collection. However, we also take this opportunity to underscore the unique value of the dataset and the relevance of the analysis conducted.

Comment – Generalizability and Sampling Limitations:

The study's statistical methods assume representativeness, but the sample is not probability-based. The authors should avoid generalizations to the broader population and reframe the analysis accordingly.

Response:

We have clarified that our sampling strategy was not entirely snowballing but rather a combination of systematic targeted sampling and snowballing. In countries where it was feasible, such as Sweden, Italy, and Spain, the survey was also disseminated to specific networks of water managers. However, in countries where this was not possible, a combination of web searches and snowballing through key contacts was used. This was clarified in the Methods (Section 2.1.1, lines 257-264). Furthermore, the use of only countries with more than 10 responses when doing country-level comparisons was also devised to increase the representativity of the sample. This was clarified in Section 2.3 (lines 357-359).

Still, we agree that our sampling strategy does not entirely support population-level generalizations and have revised the manuscript to more clearly frame the analysis as descriptive and exploratory. Explicit statements to this effect have been added in the limitation (Section 2.1.3, lines 306-311).

That said, we are confident in the value of the dataset and the robustness of our analytical approach. The survey offers a rare and timely snapshot of professional drought management responses during the 2022 European drought, and its design involved substantial effort in outreach, translation, and expert targeting across 30 countries. While not a probability sample, the dataset reflects a broad and diverse institutional landscape and provides valuable insights into real-world preparedness and response, particularly in the absence of comparable continental-scale data for such events.

Reviewer 2

We thank Reviewer 2 for the positive evaluation of our study's scope and contributions, and for the constructive comments that helped strengthen the manuscript's conceptual clarity and methodological transparency. Below we respond to each of the main points, followed by a brief note addressing the minor issues raised.

Comment – Clarify sampling limitations and avoid overgeneralization

In my view, some of the hypotheses may not be fully or precisely tested with the available data, and this should be considered when interpreting and discussing the results.

We have added a dedicated paragraph in the Limitation (Section 2.1.3, lines 299, 306-311, and Section 2.3 lines 357-359), and Discussion (Section 4.4, lines 831-842), as well as throughout the manuscript to reinforce that the analysis is descriptive in nature and that generalizations beyond the sample should be made with caution.

Comment – Add numerical examples to the abstract

The abstract could bring one or two numerical examples to exemplify their findings.

Numerical examples were added to the Abstract to better illustrate our key findings (lines 54-55, and 59).

Comment – Structure the introduction more clearly

I suggest structuring it into subsections to better guide the reader, as follows: (a) Contextualize the 2022 European drought; (b) Define drought risk assessment and indices; (c) Outline drought risk governance frameworks in the EU; (d) Present the novelty and main contributions of the study for the European context.

The Introduction has been restructured with clear subsections as suggested by the reviewer.

Comment – Address limitations of using SPEI-6 for regional comparisons

This approach may introduce bias, as droughts vary significantly in timing, duration, and severity across Europe.

We added a brief note in Section 2.2 (lines 329-333) explaining the use of a single time window across diverse European regions with variable drought patterns and clarifying its limitations.

Comment – Clarify how preparedness, awareness, and effectiveness were assessed

It is unclear which questions or items were used to evaluate each of these aspects.

We now clearly specify the questionnaire items used to derive these variables in Section 2.1.1, making the link between survey items and analytical variables explicit. This was briefly repeated in the Results (Section 3.4.1, line 630).

Comment – Justify how Hypothesis 3 is tested and interpreted

I'm not fully convinced that the authors are effectively testing Hypothesis 3. Could the authors further elaborate or clarify their reasoning behind this assessment?

We agree that the analysis would have been more robust with additional data on perceptions, particularly from "non-drought" years. However, the primary aim of this test is to explore whether perceptions of effectiveness are shaped by long-term memory (that is, whether there is a lasting influence from earlier events such as the 2018 drought) or whether they are more influenced by recent experiences and short-term memory, such as the severity of the 2022 drought. Our working assumption is that perceived effectiveness should primarily reflect levels of preparedness, including factors such as water governance, management plans, and available financial resources, rather than the severity of individual drought events. However, the strong correlation we observe between 2022 drought severity and perceived effectiveness in 2022 suggests that recent events exert a dominant influence on managers' perception. This indicates that short-term memory may introduce a bias in how effectiveness is evaluated. We briefly clarified this in Section 2.3 (lines 357-359).

Minor Comments:

We have corrected typographical errors, clarified percentage inconsistencies, fixed figure captions, and adjusted the introduction for flow. We thank the reviewer for spotting these errors.

Reviewer 3

We thank Reviewer 3 for their positive evaluation of the manuscript and for recognizing its clarity and organization. We also appreciate the thoughtful comments and suggestions, which have helped us improve the precision and transparency of key methodological aspects. Below, we respond to each point in detail and indicate how the manuscript was revised accordingly.

Comment – Consider categorizing responses by mission (responsive vs. strategic)

Responses to the survey are categorised according to state, type of structure... but not according to mission (responsive versus strategic). We can expect real differences. Why didn't you make this distinction in the analyses?

We appreciate this suggestion. In the revised manuscript, we clarify in Section 2.1.1 (lines 274-279) that drought management plans (DMPs) were classified as either responsive (short-term) or strategic (long-term). This was also more clearly described when presenting the structure of the survey (Section 2.1.1, lines 223-224, and lines 232-235). While both plan types were included in our analysis, we now also acknowledge in the Discussion (Section 4.4, lines 836-839) that many organizations reported having both types of plans and forecast type, which limited our ability to disaggregate their individual effects on preparedness and effectiveness.

Comment – Discuss variability in national forecasting systems

Do all states have a national forecasting system? These aspects must be discussed in a more developed section on the limits of this work.

We have added a sentence to the Discussion (Section 4.4, lines 839-843) acknowledging that forecasting systems vary across countries, and that the absence or presence of a national forecasting system could influence how organizations perceive and implement preparedness measures.

Comment – Address possible outlier status of Sweden (SE)

The answers for SE seem very particular (e.g. F3). How can you explain it? They may influence correlation (e.g. Fig. 7b, Fig. 10c-d).

Sweden stands out in the dataset, as Swedish respondents rated the effectiveness of drought measures significantly higher than most other countries. While the exact reasons for this perception are not fully clear, several plausible explanations exist: (1) Milder drought conditions: In 2022, drought impacts in Sweden were generally less severe than in many other parts of Europe and were largely confined to the southern regions. This may have influenced the overall perception of response effectiveness. (2) Increased preparedness following past events: Sweden has faced several droughts since 2015, with the severe 2018 drought serving as a key turning point. In its aftermath, substantial investments were made to improve drought preparedness, particularly at the municipal level. These included hiring climate and water strategists, raising public awareness, building system redundancies, and establishing backup water reserves. As shown in other studies as well, such efforts have demonstrably improved drought preparedness, which likely contributes to the more favourable evaluations of effectiveness.

Despite Sweden's relatively high ratings, there is no statistical justification to treat it as an outlier. Its values remain within the commonly accepted range for identifying outliers (i.e. within 1.5 times the interquartile range above the 75th percentile). Therefore, excluding Sweden from comparative analysis or discussing it as a "special case" is not appropriate, as natural variation across countries is to be expected. Moreover, Sweden had a relatively high number of respondents, which adds to the reliability and stability of its ratings.

Comment – Clarify timeliness calculation and use of median

How was timeliness computed? How are answers 'Before March' considered in the calculation? The mean cannot be calculated using truncated samples; in this case, using the median is more appropriate.

In response, we revised the Methods Section to explain how categorical responses (e.g., “Before March” or “After September”) were numerically approximated to enable analysis. This certainly poses a limitation to the analysis, and we have more explicitly acknowledged that (Section 2.3, lines 340-346).

Following the reviewer’s suggestion, we also replaced to mean timeliness with median. This meant replacing the values throughout the text and figures where appropriate (Figures 6, 7 and 8), as well as all references to the values of timeliness of in Section 3.3.4.

Despite changing from mean to median, no significant changes in the main analysis occurred. This is mainly due to the main analysis being carried out using the unpaired Wilcoxon test, which does not depend on the value of the mean. Only two minor differences occurred. First, the median difference in response timeliness went from 1 month when using the mean, to 2 months when using the median (as stated in the Abstract, line 54, and Results, lines 603-604). Second, the significance of the link between SPEI6 and Timeliness decreased for the 2018 drought, and increased for the 2022 drought. Consequently, the relation between the SPEI6 of the 2022 drought and the Timeliness is now significant. This was clarified in the Results (Section 3.3.3, lines 593-594), and Discussion (Section 4.3, lines 795-801).

Comment – Typographical and formatting issues

We have carefully reviewed and corrected all typographical and formatting issues noted, including removing or correcting the incorrect section reference, and fixing punctuation and spacing errors.

Revisions due to Overlap with Biella et al. (2025)

As requested by the editor, we reviewed the manuscript to avoid undue textual or content overlap with the companion paper (Biella et al., 2025), published in the same issue. Plagiarism issues were identified using the Inspira Originality software (<https://inspera.com/inspera-originality/>). The revised document was deemed “*low likelihood*” of plagiarism according to the software used. Below we outline the changes made to ensure clear distinction between the two contributions:

- Sections 2.1.2 and 2.1.3 were revised to condense dataset descriptions and refer readers to the companion paper for methodological detail. Figure 1 was moved to the Supplement and is now explicitly referenced as originating from Biella et al. (2025).
- Section 3.2.1 was shortened by removing overlapping statistics. It now highlights only results novel to this paper (i.e., mean effectiveness measures), with a citation to Biella et al. (2025) for the full breakdown.

- Captions for Figures 2 and 8 now state “Adapted from Biella et al. (2025)” to acknowledge the reused data visualizations with minor modifications.
- Section 3.4.4 (lines 605–610) was rewritten to avoid repeating detailed statistics from the companion paper. The revised text emphasizes broader findings and cites the Supplement (S6.3) and Biella et al. (2025) to contextualize results.
- All references to the preprint version of the companion paper (Biella et al., 2024) were updated to cite the final published version (Biella et al., 2025).
- The following sentences were modified, removed, or rephrased in order to avoid overlapping with the companion paper:
 - Abstract, line 46-49 and 51-53.
 - Section 1.1 line 68-71, and line 92-94
 - Section 1.2 line 103-105.
 - Section 1.4, line 194-199.
 - Section 2.1.1, line 203-208, and line 248-249.
 - Section 4.5, line 850-851.
 - A sentence present in several figure captions describing European regional acronyms was reworded to avoid duplication of phrasing found in the companion paper.
 - Section 5 was revised to avoid repeating the policy call found in Biella et al. (2025). While supporting the companion paper’s conclusion regarding the need for a European drought directive, our version expands the argument by identifying specific principles to guide drought risk preparedness.
 - Titles of Sections 3.2, 3.4, and 5 were modified to better reflect their specific focus in this manuscript and to reduce similarity with the companion paper.

We trust these changes sufficiently address the concerns about potential overlap and maintain the integrity and independence of both contributions.

Final Statement

We thank the reviewers and the editor for their valuable and constructive feedback. The manuscript has been significantly improved as a result. We hope that the revised version meets your expectations and look forward to your final decision.

With kind regards,
Riccardo Biella
On behalf of all co-authors