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Handling Associate Editor, Biogeosciences  
European Geosciences Union

## Re: Manuscript EGUSPHERE-2026-1007, “Drivers of Ecosystem Stability Differ with the Intensity of Extreme Climatic Events” — response to minor revisions

Dear Dr. Fernández-Martínez,

Thank you for the editorial decision of 17 June 2026 recommending publication subject to minor revisions, and for forwarding the two referee reports. We are grateful to both referees for their continued careful reading and constructive comments. We are pleased to submit a further minor-revised version of the manuscript together with this expanded point-by-point response letter.

The referee in Report #1 requested no further textual changes. The referee in Report #2 recommended minor revision and raised three remaining points, all of which concern cautiousness, consistency, and precision of wording rather than the need for additional analyses. We have addressed these points by further clarifying that ASI, ASL, and ASR are modeled anthropogenic species-change proxies, by replacing causal or mechanistic wording with predictive wording, and by reinforcing that resistance and resilience are used here as NDVI-based, event-scale proximity indices.

In addition to the reviewer-related revisions, we made several technical and editorial corrections identified during the final consistency check. These include revisions to Fig. 1 and its caption, replacement of Table 2 grey shading with symbols and bold font, correction of the GIMMS NDVI3g citation, correction of the Yan et al. (2025) citation, updates to the Code and data availability section, and minor formatting and typographical corrections. The main changes are highlighted in yellow in the revised manuscript for ease of checking.

*Line numbers below refer to the clean minor-revised manuscript.*

## Point-by-point response to the referees

### Referee, Report #1

We thank the referee for the positive assessment. No specific revisions were requested in this report, so no point-by-point changes were required.

### Referee, Report #2

We thank the referee for recognizing the substantial improvements made in the previous revision and for clarifying that the remaining issues could be addressed through more cautious and consistent wording, without additional analyses. We responded to the three points as follows.

#### Comment 1. Maintain a cautious interpretation of ASI, ASL, and ASR throughout the manuscript.

*Comment.* The referee asked us to make clear that ASI, ASL, and ASR are modeled anthropogenic species-change proxies, not direct observations of local biodiversity change, and that the reported patterns should be interpreted as predictive associations within the LightGBM framework rather than clear causal biological mechanisms.

**Response.** We agree and revised the manuscript accordingly. Rather than presenting ASI, ASL, and ASR as direct measures of local biodiversity change, we now consistently describe them as modeled biodiversity-related or modeled

anthropogenic species-change proxy variables, and we describe their role as predictive associations within the model framework.

### **Abstract.**

We replaced broad statements referring simply to “biodiversity” with wording that distinguishes biodiversity-related predictors from the modeled proxy variables. The Abstract now refers to “modeled anthropogenic species-change proxies” and later to “these modeled proxies,” rather than implying direct biodiversity observations.

### **Introduction.**

We revised the framing of the predictor set to “modeled biodiversity-related metrics” and “modeled anthropogenic species-change proxies,” avoiding language that would imply direct observation of biodiversity change (approximately l. 80-94).

### **Methods and Table 1.**

We added an explicit cautionary sentence stating that “These variables are modeled biodiversity-related proxy variables and should not be interpreted as direct observations of local biodiversity change” (approximately l. 232–233). The Table 1 label was also revised from a direct species-richness framing to “Modeled biodiversity-related proxies,” and the explanatory note was kept consistent with the proxy-based interpretation (approximately l. 303–304).

### **Results and Discussion.**

Statements about ASI, ASL, and ASR were reworded as feature-importance patterns and associations with NDVI-based stability metrics, rather than direct mechanistic evidence. For example, the cropland result is now framed as an association between modeled anthropogenic species-increase proxies and NDVI-based stability (approximately l. 360–370 and l. 440–465).

### **Conclusions.**

The conclusion now refers to “modeled anthropogenic species-change proxies (ASL, ASI, and ASR)” and describes them as more frequently selected predictors under severe and extreme droughts, rather than as direct biotic drivers of ecosystem stability (approximately l. 512–532).

### **Comment 2. Temper the strongest conclusion about a shift from meteorological to non-meteorological drivers.**

*Comment.* The referee recommended replacing causal or mechanistic wording such as “controls” with “predictive contributors” or “dominant predictors,” because the analysis is based primarily on machine-learning feature importance and is subject to the limitations of NDVI, modeled biodiversity-related proxies, and spatially correlated predictors.

**Response.** We agree and revised the manuscript to avoid implying mechanistic causality. Throughout the manuscript, we now describe the results as patterns of predictive importance, leading predictors, or associations, rather than as direct evidence that particular variables control or regulate ecosystem stability.

### **Abstract.**

We replaced “dominant drivers,” “controls,” “regulation,” and “demonstrate/highlight” language with more cautious wording such as “dominant predictors,” “relative importance of leading predictors,” “suggesting context-dependent associations,” and “provide additional predictive information” (approximately l. 13–28).

### **Introduction.**

We replaced “dominant drivers” and “governed by climatic drivers” with “dominant predictors” and “evaluate whether the dominant predictors ... differ,” thereby presenting the study as a predictive comparison rather than a mechanistic test (approximately l. 56, 70–101).

### **Results.**

Sections 3.3 and 3.4 were revised to describe variables as “leading predictors” or variables with the “highest gain-based feature importance,” rather than causal controls. We also removed colour-based references such as “deep red cells” after revising Table 2 (approximately l. 347–369).

#### **Discussion.**

We replaced strong phrases such as “temperature primarily regulates,” “climatic controls weaken,” and “primary determinants” with “temperature-related variables were identified as leading predictors,” “the relative predictive importance of climatic variables decreased,” and “non-climatic variables showed increased predictive importance” (approximately l. 419–468).

#### **Conclusions.**

The conclusion now emphasizes “leading predictors,” “predictive importance,” and “approaches relying solely on climatic variables may be insufficient,” instead of stating that ecosystem stability is mechanistically controlled or governed by specific drivers (approximately l. 513–529).

### **Comment 3. Distinguish resistance/resilience from proximity-to-normal vegetation activity indices.**

*Comment.* The referee asked us to remind readers that the resistance and resilience metrics used here are NDVI-based, event-scale indices of proximity to normal vegetation activity levels, not comprehensive mechanistic measures of resistance and resilience in the broad ecological sense.

**Response.** We agree and further clarified the scope of the indices. The manuscript now explicitly states that resistance and resilience are used as NDVI-based, event-scale proximity indices, and the Results, Discussion, and Conclusions have been revised so that interpretations remain tied to this operational definition.

#### **Introduction.**

We added a reminder at the end of the Introduction: “Throughout this study, resistance and resilience refer to NDVI-based, event-scale indices of proximity to normal-year vegetation activity, rather than comprehensive mechanistic measures of ecosystem stability” (approximately l. 92–101).

#### **Results.**

We revised the interpretation of the temperature-related predictors to align with the temporal definitions of the two indices: resistance is calculated from event-year vegetation activity, whereas resilience is calculated from vegetation activity in the year following the event (approximately l. 350–369).

#### **Discussion and Conclusions.**

We revised broad stability wording to refer to “NDVI-based vegetation stability metrics,” “event-scale proximity indices,” and “vegetation stability under extreme conditions,” thereby avoiding the impression that the metrics capture all aspects of ecosystem resistance and resilience (approximately l. 419–532).

## **Editorial-office and technical corrections included in the highlighted revision**

In addition to the three referee comments, the yellow-highlighted manuscript includes the following technical and editorial corrections. These changes were made to address the editorial-office validation note and to improve consistency, readability, and citation accuracy.

**Table 2 formatting.** Following the editorial-office validation note that grey cell shading cannot be retained after HTML conversion, we removed the shading from Table 2. Values lower than 1 are now indicated by the dagger symbol (†), and values equal to or greater than 1 are shown in bold. The table note was revised accordingly (approximately l. 390 and Table 2 note).

**References to Table 2 in the Results.** Text referring to colour or shaded cells was revised so that the interpretation no longer depends on grey shading or coloured cells. This keeps the Results consistent with the revised table format (approximately l. 335).

**Figure 1 and caption.** Fig. 1 and its caption were revised for consistency and readability. The phrase “with using” was corrected to “using,” the duplicated “Resistance” label was corrected so that the workflow distinguishes resistance and resilience, and “Greek numerals” was corrected to “Roman numerals” in the caption (approximately l. 116–122 and Fig. 1).

**SPEI category wording.** The normal-condition boundary was made consistent with the SPEI categorization used in the figure and text (approximately l. 148).

**GIMMS NDVI3g citation.** The citation for the NDVI3g dataset was corrected from Mao and Yan (2019), which refers to an LAI climatology product, to Pinzon and Tucker (2014), the appropriate reference for the AVHRR NDVI3g time series (approximately l. 166 and References).

**Yan et al. (2025) citation.** The typographical error “Yan et a.” was corrected to “Yan et al.” in the Methods, and the full reference for Yan et al. (2025) was added to the reference list in the journal style (approximately l. 191 and References).

**Figure 6 caption.** The capitalization error “calculated Using” was corrected to “calculated using” in the caption (approximately l. 384).

**Table and supplement references.** Minor typographical issues such as “Table2” and “Tables. S4 and S5” were corrected to “Table 2” and “Tables S4 and S5” (approximately l. 339) where applicable.

**Code and data availability.** The section heading was revised to “Code and data availability.” Dataset descriptions were updated and made consistent with the terminology used in the manuscript, including the modeled biodiversity-related proxy variables and the updated Zenodo version 2.0 data set.

**Author contributions and competing interests.** The Author contributions and Competing interests sections were reformatted for clarity. The competing-interest statement now reads: “The authors declare that they have no competing interests.”

**Other minor language and formatting corrections.** We corrected minor capitalization, spacing, punctuation, and terminology issues, including the capitalization of “University of East Anglia,” (approximately l. 308) the definition of R as shortwave radiation (approximately l. 396), and other small typographical errors identified during the final check.

## Closing statement

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We believe that these revisions address all remaining concerns raised by the referee and the editorial-office validation note. The revised manuscript now uses consistent cautious terminology for modeled biodiversity-related proxies, describes the LightGBM results as predictive associations and feature-importance patterns, and clearly states the scope of the NDVI-based resistance and resilience indices.

We hope that the revised manuscript is now suitable for publication in Biogeosciences, and we remain happy to make any further minor adjustments if needed.

Sincerely,

**Aki Yanagawa**

on behalf of all co-authors

Corresponding author, EGUSPHERE-2026-1007