To

Conrad

Editor-in-Chief

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We hereby submit our revised manuscript, "**CAMELS-COL: A Large-Sample Hydrometeorological Dataset for Colombia,"** authored by David A. Jimenez, Julian E. Meneses, Pedro H. Bernardes Solha, Alvaro Avila Diaz, Benjamin Quesada, Bruno Melo Brentan, André Ferreira Rodrigues to be considered for publication in ***Earth System Science Data (ESSD).***

The authors express their sincere gratitude to the Editor-in-Chief for his valuable comments and feedback, which have greatly contributed to enhancing both the clarity of the text and the quality of the proposed analysis. We deeply appreciate the time and effort dedicated to reviewing the manuscript and addressing each comment in detail. The replies are highlighted in **blue.** The revised manuscript is attached.

Sincerely,

**Alvaro Avila-Diaz**
**Earth System Science Professor**
**Universidad del Rosario**
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# Reply to reviewer 1

**GENERAL COMMENTS:**

Jimenez et al. describe a new large-scale dataset of catchment attributes for Colombia, analyzing 347 catchments across different topographic and climatological gradients following the CAMELS initiative. CAMELS-COL is a very valuable dataset for both national and global hydrological studies, enhancing data availability across the tropics, where such datasets remain limited. However, the methods would benefit from further details to improve the clarity of the manuscript, as described below

**MAJOR COMMENTS:**

**1. Lines 129–133: I wonder if any quality control of the streamflow data was considered. There should be a careful explanation about this in the methods. If any quality control on the data was not made, please state why, explaining the limitations associated with the use of the resulting dataset.**

**Response 1:** To address this concern, we have expanded the Methods section to clarify the quality control procedures associated with the streamflow data. The hydrological data provided by the Instituto de Hidrología, Meteorología y Estudios Ambientales (IDEAM) undergo a structured, multi-stage quality control process prior to publication. This process includes: (i) field-level verification of water level readings and hydrometric measurements; (ii) primary data treatment to identify transcription errors, abrupt shifts, inconsistencies between manual and automatic sensors, and potential reference level (gauge zero) changes; and (iii) secondary validation involving cross-station balance analysis within the same basin, comparison with precipitation records, rating curve stability assessment (H–Q relationship), uncertainty checks in discharge measurements, and formal approval of time series before classification as “definitive” in the institutional database - DHIME (IDEAM, 2024).

Given that IDEAM applies standardized validation protocols aligned with international hydrological practices prior to public dissemination, no additional quality control was performed within this study. This decision was made to preserve the integrity and traceability of the officially validated observations. Our approach is consistent with the methodology adopted in other CAMELS datasets (e.g., CAMELS-CL, CAMELS-IND, and CAMELS-DE), which rely on the quality assurance procedures implemented by national hydrometeorological agencies.

We also explicitly acknowledge the limitations associated with this choice and clarify that, depending on the intended application of the dataset, additional quality control analyses may be required. In such cases, the responsibility for applying appropriate quality control tests lies with the user, particularly for applications with stricter data requirements. [line 140 - 148]

**REFERENCE:**


- IDEAM, 2024. Manual de Validación de la Información Hidrológica. https://www.ideam.gov.co/sites/default/files/mapa-de-procesos/gci-vh-m028_manual_de_validacion_de_la_informacion_hidrologica_1.pdf

**2. Line 137: Did you correct the gauge locations? This is a common issue identified in previous CAMELS studies. If so, please explain the process used to reduce this uncertainty/error. Also, what was the resolution and source of the stream network used to delineate the drainage areas?**

**Response 2:** Yes, gauge locations were systematically verified after completing the basin delineation in order to reduce uncertainties associated with potential gauge misplacement. This verification was conducted using Colombia's official national stream network dataset (Base de Datos Vectorial Básica de Colombia, scale 1:25,000; 2022 edition) and cross-validated against high-resolution satellite imagery (see Figure 1). (Base de datos vectorial básica de Colombia, scale 1:25,000, year 2022), validated through image-based cross-verification with high-resolution satellite data from Google Earth.

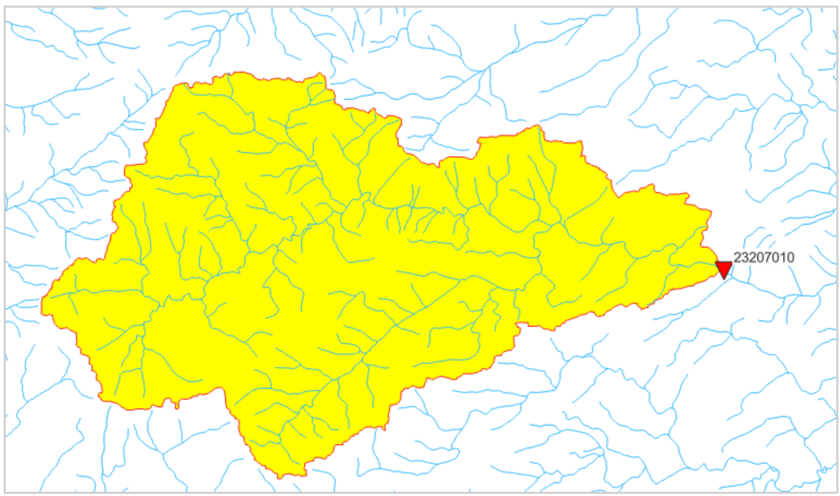


**Figure 1. Results of the watershed delineation for basin 23207070. The official national stream network of Colombia is shown in blue, and the watershed boundary obtained from the delineation process is shown in red.**

In addition, hydrological consistency was evaluated by analyzing drainage area continuity and mean discharge relative to neighboring upstream and downstream gauges along the same river system. When necessary, minor adjustments to the streamflow station location were applied to ensure consistency between gauge location, river topology, and observed streamflow characteristics [Lines 149 - 156].

**REFERENCE:**

Base de Datos Vectorial Básica de Colombia (scale 1:25,000), available at the official Colombia en Mapas geoportal: https://www.colombiaenmapas.gov.co/?u=0&t=23&servicio=206

**3. Line 139: "Basins with inconsistent delineations were excluded, particularly in cases where inconsistencies were attributed to limitations of the Digital Elevation Model (DEM) used." How was the delineation process evaluated? Please include supplementary figures to show the results. Did you compare the watershed delineations with IDEAM's official hydrological zonification or global datasets such as hydroSHEDS (https://www.hydrosheds.org/products)?**

**Please check the watershed delineation for streamflow gauge 13077030. I see some inconsistencies in the shapefile.**

**Please check overlapping inconsistencies between watershed limits in .shp files. For example, areas associated with streamflow gauges: e.g., 32157060 vs 32207010, 13017010 vs 13037010 or 29037020 vs 13067020**

**Response 3:** Regarding streamflow gauge 13077030, the watershed delineation was found to be inconsistent due to limitations of the Digital Elevation Model (DEM) used. As a result, this basin was excluded from the analysis to avoid introducing additional uncertainty (See Figure 2). Thank you for noticing this.

Additionally, the overlapping inconsistencies mentioned by the reviewer (e.g., 32157060 vs. 32207010, 13017010 vs. 13037010, and 29037020 vs. 13067020) were identified and corrected through manual revision of watershed boundaries and outlet points. After these adjustments, a comprehensive verification of the entire dataset was performed to ensure that no remaining overlaps or inconsistencies persisted among watershed polygons.

The delineated watersheds were compared with the main hydrographic units defined under IDEAM's official hydrological zonification. This comparison indicated a general spatial agreement between the derived basins and the national zonification framework. It is important to note that IDEAM adopts the official hydrographic zoning system based on the Pfafstetter methodology (IDEAM, 2013), implemented consistently at the national scale. This hierarchical and spatially standardized framework is independent of individual gauging station locations and supports water resources planning and management instruments, such as the *Planes de Ordenación y Manejo de Cuencas Hidrográficas (POMCA; IDEAM, 2023).* Therefore, the delineation of the basins included in CAMELS-COL was performed using the official DEM.

Most delineation issues were concentrated in low-relief and flat areas, where DEM-based flow direction algorithms are known to perform poorly. In particular, some basins located in flat regions exhibited an underestimation of upstream contributing areas, effectively excluding portions of the headwaters. This behavior was especially evident in the lower Magdalena–Cauca region, where minimal elevation gradients and complex drainage patterns increase the uncertainty of automatic watershed delineation [Line 166-177].

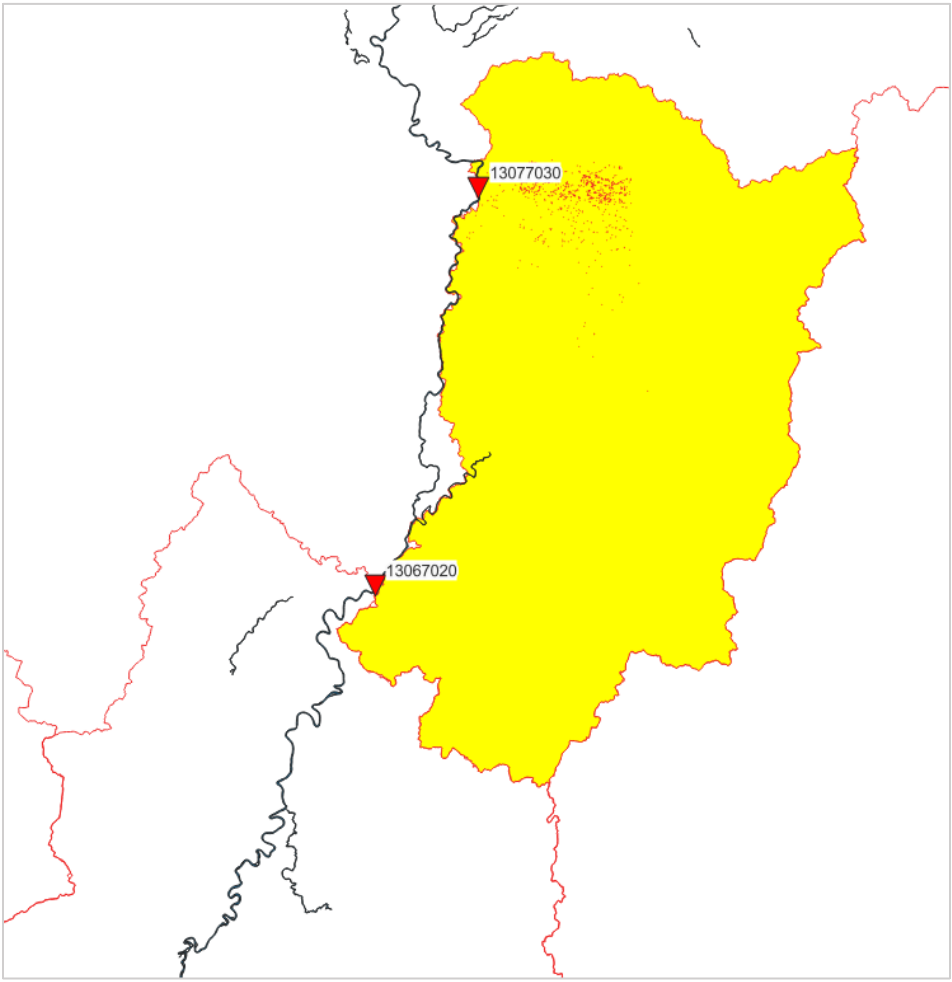


**Figure 2. The delineation of the 13077030 basin does not include the upstream area associated with gauge 13067020, which should be included. It is caused by a discontinuity in the streamflow network estimated from the DEM. This type of discontinuity was mainly observed in low-relief areas.**

## REFERENCE:


- IDEAM, 2013. Zonificación y Codificación de Unidades Hidrográficas e Hidrogeológicas De Colombia. Available at: https://www.minambiente.gov.co/wp-content/uploads/2021/10/MEMORIAS-MAPA-ZONIFICACION-HIDROGRAFICA.pdf

- IDEAM, 2023. Estudio Nacional del Agua, Ministerio de Medio Ambiente. https://www.andi.com.co/Uploads/ENA%202022_compressed.pdf


**4. Line 141-144: Authors state that "Additionally, in line with the methodology used in CAMELS-DE, only basins containing at least one central pixel with available gridded weather data are considered. This decision ensures consistency with previous CAMELS-datasets, which included basins where gridded or satellite-based climate data could be reliably assigned within the basin boundaries." How many gauges were excluded based on this criterion? Also, would it be possible to extract climatic data from IDEAM gauges for those excluded basins?**

**Soil texture descriptors are important metrics for hydrological studies and are typically included in CAMELS datasets. Therefore, I suggest including sand, clay, and silt fractions, as well as soil density, using datasets such as SoilGrids (Poggio et al., 2021).**

**Although the Curve Number (CN) is a typical descriptor of precipitation partitioning between surface runoff and infiltration, its interpretation at an aggregated scale—particularly in large basins—may be unclear. I encourage the authors to provide further details about how CN contributes to the CAMELS project and discuss its limitations.**

**Response 4:** While in situ climatic data from IDEAM gauges are available for some basins lacking a central grid cell, these records often lack spatial and temporal continuity. Using them would make the data incomparable with the gridded datasets used throughout the CAMELS initiative.

Since our primary objective is to ensure consistency and comparability with existing CAMELS datasets (such as CAMELS-US, BR, and DE), we deliberately avoided IDEAM data to prevent introducing heterogeneity. Consequently, we excluded 22 streamflow gauges where basins did not intersect any valid pixels from our selected climate products.

Soil texture descriptors are indeed important variables for hydrological studies and are commonly included in CAMELS datasets. However, for CAMELS-COL, we deliberately chose not to include soil texture variables derived from global products such as SoilGrids (Poggio et al., 2021). As shown in Figure 4 of Poggio et al. (2021), the density of soil profile observations available for Colombia and South America is relatively low compared to other regions. Although SoilGrids relies on machine-learning approaches to extrapolate soil properties, the scarcity of in situ observations in this region introduces considerable uncertainty, particularly under complex topographic and heterogeneous soil conditions such as those found in Colombia. Tropical soils differ markedly from temperate ones and require context-specific characterization and parameterization (Sven and Fath, 2008). However, much of the training data and pedotransfer relationships supporting current machine-learning applications originate from temperate regions, where hydrological behavior is largely controlled by texture (Liu et al., 2022). In contrast, tropical soil hydrodynamics are strongly influenced by additional factors such as structure, aggregation, degree of weathering, iron and aluminum oxides, and mineralogical composition, which are often insufficiently represented. Incorporating these poorly constrained variables at the basin scale may therefore propagate additional and difficult-to-quantify uncertainty in simulated hydrological responses.

Instead, we chose Colombia's official land capability dataset (*Capacidad de uso de las tierras, Scale 1:100,000*). Based on national surveys by IGAC, this source provides spatially consistent data on drainage and soil textures (based on sand, silt, and clay proportions) according to international standards. By using this dataset, CAMELS-COL ensures that its soil information is both nationally representative and internally consistent. The classification comprises three major groups and eight classes and is summarized in Table 5.

Finally, the Curve Number (CN) was included in CAMELS-COL as a widely used engineering hydrology descriptor that summarizes runoff potential based on land cover and soil information. We acknowledge that, particularly in large and heterogeneous catchments, a single basin-averaged CN should not be interpreted as a physically explicit infiltration parameter. Accordingly, the manuscript has been revised to frame CN as a relative indicator and to clarify its limitations. CN was derived from national geospatial datasets (including soil information from IGAC). [line 261-266]

**REFERENCE:**


- Liu, Y., Wu, X., Wu, T., Zhao, L., Li, R., Li, W., Hu, G., Zou, D., Ni, J., Du, Y., Wang, M., Li, Z., Wei, X., Yan, X., 2022. Soil Texture and Its Relationship with Environmental Factors on the Qinghai–Tibet Plateau. Remote Sens. 14. https://doi.org/10.3390/rs14153797
- Poggio, L., de Sousa, L.M., Batjes, N.H., Heuvelink, G.B.M., Kempen, B., Ribeiro, E., Rossiter, D., 2021. SoilGrids 2.0: producing soil information for the globe with quantified spatial uncertainty. SOIL 7, 217–240. https://doi.org/10.5194/soil-7-217-2021
- Sven, E.J., Fath, B.D., 2008. Temperate Soils - an overview | ScienceDirect Topics, in: Encyclopedia of Ecology. Elsevier Science.


**MINOR COMMENTS:**

**5. Line 13: Please add the range of areas for the 347 basins**

**Response 5:** The range of basin areas has been added to the abstract, as recommended by the reviewer. [Lines 13 and 14]

**6. Line 17-18: Consider including the characteristics of climatic (MAP ranging between X and X) and topography (e.g., 0 to X m.a.s.l.) gradients to provide a more detailed context for CAMELS-COL. This is particularly important due to the lack of hydrometeorological datasets for wetter tropical regions (e.g., Fig 1 in Kratzert et al., 2023)**

**Response 6:** We agree that providing explicit climatic and topographic ranges would offer valuable context. However, these details were not included in the abstract due to the journal's strict word limit; the abstract currently contains 250 words, which is the maximum permitted length.

Nevertheless, the limits of the climatic gradients, including the range of mean annual precipitation (MAP), as well as the topographic gradients (elevation in m a.s.l.), are clearly presented in the methodology section, specifically in section 3.1. We appreciate the reviewer's understanding.

**REFERENCE:**


- Kratzert, F., Nearing, G., Addor, N., Erickson, T., Gauch, M., Gilon, O., Gudmundsson, L.,


**7. Line 18: I suggest using the term "hydrological areas" instead of "basins", following the IDEAM classification. Please briefly describe how these "hydrological areas" were defined.**

**Response 7:** The text has been revised following the reviewer's recommendation, the term "hydrological areas" was adopted, and the sentence was adjusted. [Line 18]

**8. Line 19: 'low flood susceptibility" is a too general statement. Please specify the criteria used for this statement.**

**Response 8:** We agree that the statement "low flood susceptibility" was overly general and could introduce ambiguity in the absence of clearly defined criteria. Accordingly, this statement was removed from the abstract. Its removal enabled the inclusion of the range of basin areas, while remaining within the journal's abstract word limit.

**9. Lines 49-56: I recommend including a figure showing the relationship between two hydrometeorological features (e.g., Q/P vs P/PET) of Colombia in comparison to the rest of the**

**world (CAMELS studies). This would help to illustrate the hydrological characteristics of the country and the relevance of CAMELS-COL dataset.**

**Response 9:** We thank the reviewer for the valuable suggestion. However, we consider that the inclusion of such a figure is not appropriate for this stage of the manuscript. The purpose of the referenced lines is to describe the current state and limitations of hydrometeorological monitoring in Colombia, rather than to present comparative hydroclimatic analyses.

In addition, comparative diagnostic figures (e.g., Q/P vs. P/PET relationships) are not typically included in the core dataset description papers of other CAMELS initiatives, which primarily focus on data compilation, attribute derivation, and methodological transparency. Consistent with this established format, CAMELS-COL aims to document data sources, processing steps, and dataset structure, while leaving hydroclimatic comparative analyses to subsequent application-oriented studies.

**10. Line 88-89: Please add references of those datasets.**

**Response 10:** The references to these datasets were added. [line 89 -91]

**11. Lines 116-117 and Figures 1b-1d: I encourage the authors to use global datasets to describe the climatology of Colombia. Although IDEAM is the official national dataset, the temperature and precipitation data used in CAMELS-COL are derived from remote-sensing products. Additionally, I am curious about why the warmest areas are in the lowlands of the Magdalena and Orinoco regions rather than in the northern Caribbean region that is the driest area of the country– Please verify this.**

**Response 11:** Although CAMELS-COL forcing time series are derived from remote-sensing and reanalysis-based products to ensure spatially consistent coverage across all basins (CHIRPS for precipitation and MSWX for temperature and ETo-related variables), we used the official IDEAM 1981-2010 gridded climatologies exclusively for the national-scale descriptive context (Figures 1b-1d and related text). We keep the 1981-2010 reference period to maintain consistency with the climatological characterization presented in the initial manuscript development and to avoid mixing reference baselines across figures and narrative. Importantly, this choice does not affect the CAMELS-COL basin forcing time series, catchment attributes, or the derived hydrological signatures.

The gridded products of IDEAM are derived from long-term observational records and have undergone systematic verification and homogenization procedures, providing a more robust and representative description of Colombia's climatology than satellite-based products alone.

Remote-sensing products were used in the CAMELS-COL dataset because they provide complete spatial coverage and continuous time series without missing values, which is not the case for daily station-based IDEAM records. While satellite-based products are appropriate for ensuring spatially and temporally consistent data, IDEAM climatological normals are better suited to describe the characterization of Colombia's climatology.

Regarding the spatial distribution of the warmest areas, the observed pattern is physically consistent with the main climatic controls in Colombia. First, near-surface air temperature is strongly governed by altitude, with lowland regions being warmer than high-altitude areas. Second, although the Caribbean coastal zone represents the driest region of the country, it is influenced by coastal atmospheric and oceanic processes that can moderate mean air temperatures. These include persistent sea-breeze circulation and the influence of cold-water upwelling associated with the Guajira system (Navarro et al., 2025; Pérez R. et al., 2018).

In contrast, the lower Magdalena–Cauca valley is an interior lowland region bounded by the Central and Eastern Cordilleras. This orographic configuration limits the inland penetration of coastal cooling mechanisms, such as sea-breeze circulation and the thermal influence of Caribbean upwelling, thereby reducing ventilation and favoring enhanced heat accumulation within the valley (Navarro et al., 2025).

**REFERENCE:**


- Navarro, J., Lonin, S., Linero-Cueto, J., Romero-Balcucho, C., 2025. Hydrodynamic Modelling of the Guajira Upwelling System (Colombia). Appl. Sci. 15. https://doi.org/10.3390/app152011000
- Pérez R., A., Ortiz R., J.C., Bejarano A., L.F., Otero D., L., Restrepo L., J.C., Franco H., A., 2018. Sea breeze in the Colombian Caribbean coast. ATMÓSFERA 31, 389–406. https://doi.org/10.20937/ATM.2018.31.04.06


**12. Line 124: Please clarify which MapBiomas classification level was used, and including its reference Table 1. Based on a review of previous CAMELS studies, I suggest adding the following attributes to enhance the CAMELS-COL dataset:**

**Gauge_record_start, gauge_record_end, and gauge_n_obs (as used in CAMELS-CL) Percentage of missing values in streamflow observations. Catchments mean slope (e.g., CAMELS-BR) Elev_med, elev_max, elev_min (CAMELS-CL) Water table depth from (from Fan et al., 2013) Please provide gauge_lat and gauge_long in WGS84 system Please provide final datasets in .txt or .csv format. Additionally, I encourage authors to merge in one single dataset the .xlsx files (catchment information, geologic_characteristics, land_cover, soil, among others). This would make the work of future CAMELS-COL users easier.**

**Please include the streamflow network and locations of streamflow gauges in the catchment boundaries data (.shp files).**

**Figure 1. Please use color-blind friendly palette. There seems to be an inconsistency: the figure shows 347 selected gauges, but only 346 basins are reported. Please clarify. Consider adding the streamflow network and watersheds delineation.**

**Response 12:**

- MapBiomas **Collection 2** was used in this study, as it was the most recent and consolidated version available at the time of the analysis (up to 2024). In response to the reviewer's suggestion, this information has now been explicitly included in **Table 1** and clarified in **lines 87 and 331** of the manuscript.

- Following the reviewer's suggestion, additional attributes have been incorporated into Catchment information_R2 table of CAMELS-COL: *gauge_record_start*, *gauge_record_end*, and *gauge_n_obs*, the percentage of missing values in streamflow observations and elev_min, elev_med, and elev_max.

- We agree that groundwater-related information can be highly informative for hydrological interpretation. We assessed the global water table depth product of Fan et al. (2013); however, we decided not to include it in the current CAMELS-COL release to avoid adding a single global, model-based layer with heterogeneous uncertainties and limited validation across Colombia, which could be misinterpreted as an 'observational' national reference. Instead, we have expanded the manuscript discussion to explicitly acknowledge the relevance of groundwater controls and to frame groundwater depth as a priority for future CAMELS-COL updates, particularly if/when nationally consistent groundwater datasets become available. [743-749]

- The gauge_lat and gauge_long coordinates are provided in the WGS84 reference system, using EPSG:3395 (World Mercator), which ensures metric units in the International System (SI). All spatial datasets were consistently maintained in this datum and projection to guarantee coherence and avoid inconsistencies across derived spatial attributes. In addition, the final datasets are supplied in CSV format, as suggested by the reviewer, ensuring compatibility and ease of use across different platforms and software.

- The streamflow network has been included in **.shp** format, as requested.

- We carefully considered the reviewer's suggestion to merge all attributes into a single file. However, because each file contains multiple variables associated with distinct thematic domains (e.g., catchment information, geological characteristics, land cover, and soil properties), we chose to keep this information in separate files. This structure facilitates clearer interpretation, targeted analyses, and greater flexibility for users interested in specific groups of attributes. Merging all variables into a single file would substantially increase dataset complexity and could hinder data handling and interpretation. Nevertheless, all datasets share a consistent catchment identifier, allowing users to easily combine them when needed.

- The color palette used in Figure 1 was carefully reviewed to ensure accessibility. The figure was evaluated under different color-vision conditions, including trichromatic view, anomalous trichromacy, dichromatic view, and monochromatic view, confirming that the selected color tones remain distinguishable across these scenarios.

- Regarding the inconsistency in the number of gauges reported in Figure 1, the manuscript has been revised accordingly. The reference to 347 gauges has been corrected, and the final number of selected stations is now consistently reported as 346 basins throughout the text and figures.

- The inclusion of the streamflow network and watershed delineations in Figure 1 was considered; however, these elements were intentionally not added in order to avoid overloading the figure and compromising its readability at the national scale. These components are instead provided within the dataset itself.

**13. Line 129: Did the analysis include any transboundary basins? Please clarify.**

**Response 13:** No, the analysis did not include any transboundary basins. Due to the geographical location of Colombia, the watersheds considered in this study originate and are fully contained within national territory. No basins with transnational extent were included. This was verified through a detailed inspection of the watershed boundaries, confirming that all selected basins are entirely located within Colombia. [line 182-184]

**14. Line 136. I am curious if there are changes in watersheds delineation using a DEM with a 90 m spatial resolution.**

**Response 14:** To address this question, a randomly selected watershed was used for comparison (Basin: 23067060 of CAMELS-COL). The watershed was first delineated using the Copernicus Digital Elevation Model (DEM) with 90 m spatial resolution and then compared with a watershed delineation obtained from a 30 m resolution DEM provided by the Instituto Geográfico Agustín Codazzi (IGAC), which is used in CAMELS-COL.

The results indicate that no significant differences were observed between the two delineations. Although minor differences may exist in flat or low-relief areas, the watershed boundaries are highly consistent overall, as shown in Figure 3.

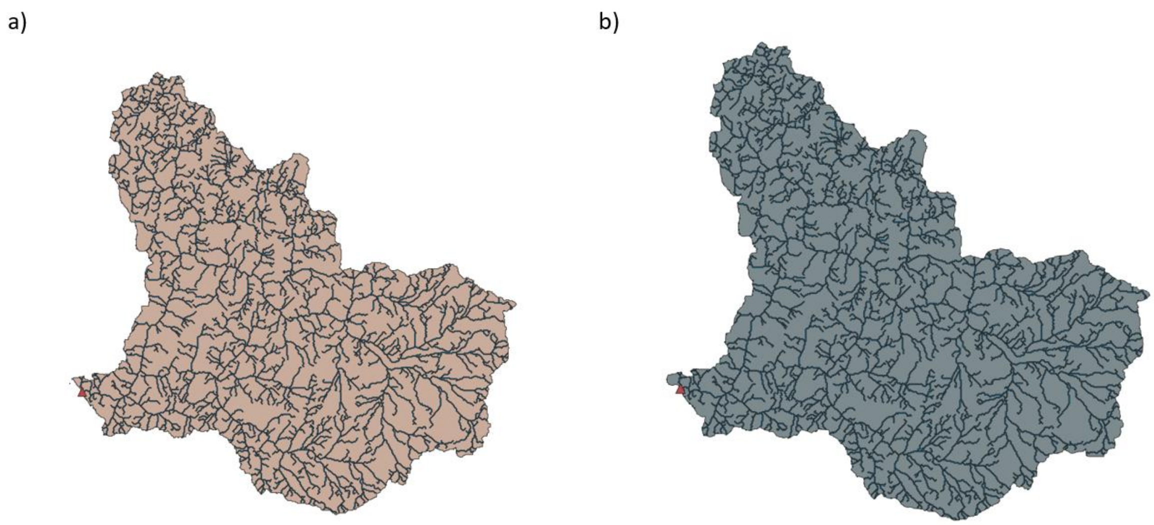


**Figure 3.** Watershed delineation. A) boundary estimated from the 90 m DEM resolution (1115,25 $km^2$). B) boundary estimated from the 30 m DEM resolution (1114,66 $km^2$)

**15. Line 145: Please remove the extra period "."**

**Response 15:** The extra period was removed. [line 178]

**16. Line 158. Why was MSWX selected to obtain temperature data?**

**Response 16:** MSWX was selected as the primary source of temperature data because recent evaluations conducted in Colombia have demonstrated that MSWX adequately represents temperature patterns, showing improved performance compared to ERA5-Land (Blanco et al., 2023), furthermore, MSWX integrates ERA5 reanalysis fields with observational corrections, providing spatially consistent and bias-adjusted temperature estimates suitable for large-sample hydrological applications. [line 191-194]

**REFERENCES:**

Blanco, K., Villamizar, S.R., Avila-Diaz, A., Marceló-Díaz, C., Santamaría, E., Lesmes, M.C., 2023. Daily dataset of precipitation and temperature in the Department of Cauca, Colombia. Data Brief 50, 109542. https://doi.org/10.1016/j.dib.2023.109542

**17. Line 161: Why did you choose to calculate evapotranspiration (ET) based on Tmax and Tmin rather than using a remote-sensing-derived ET product? Consider using different methods.**

**Response 17:** Evapotranspiration (ET) was estimated using methods derived from daily maximum and minimum temperatures rather than remote sensing-based products for several reasons. First, to date, there have been no identified studies evaluating the performance and uncertainty of remote sensing ET datasets across Colombia, a country characterized by highly diverse climatic and topographic regions.

Consequently, there was insufficient evidence to select a representative and well-validated ET dataset. Furthermore, previous assessments have demonstrated that MSWX provides a robust representation of temperature patterns, showing strong agreement with in-situ observations. Given that temperature is the primary driver in the selected ET formulation, we opted to estimate ET using MSWX-derived temperature variables.

This approach ensures methodological consistency, transparency, and reproducibility while avoiding uncertainty and maintaining coherence with the CAMELS framework, which prioritizes standardized and well-characterized input datasets.

**18. Line 167: Why did you compute Tmean as the average of Tmax and Tmin when MSWX provides data every 3 hours?**

**Response 18:** The daily mean temperature was computed as the average of daily maximum and minimum temperatures to ensure methodological consistency with the original formulation of the Hargreaves–Samani method (Hargreaves and Samani, 1985), in which $T_{\text{mean}}$is explicitly defined as $(T_{\text{max}} + T_{\text{min}})/2$ (Droogers and Allen, 2002).

**REFERENCES:**

Droogers, P., Allen, R.G., 2002. Estimating Reference Evapotranspiration Under Inaccurate Data Conditions. Irrig. Drain. Syst. 33–45.

Hargreaves, H.G., Samani, A.Z., 1985. Reference Crop Evapotranspiration from Temperature. Appl. Eng. Agric. 1, 96–99. https://doi.org/10.13031/2013.26773

**19. Lines 177-178: This sentence is unclear. Please revise for clarity.**

**Response 19:** The sentence in lines 201-203 has been revised for clarity. The revised text reads as follows:

> *"The average climatic conditions for each basin are estimated by computing the arithmetic mean of all CHIRPS and MSWX grid cells whose centroids fall within the basin boundaries. No spatial interpolation or resampling is applied; instead, the original CHIRPS and MSWX pixel values are used directly in order to preserve the native spatial resolution and characteristics of the datasets" [Line 202-205]*

**20. Line 182 and 188: What is "GSC"? GSC or GCS?**

**Response 20:** "GSC" refers to the Geological Colombian Service (GCS). The acronym has been corrected and clearly defined in the revised manuscript to avoid any ambiguity. [Line 318 and 324]

**21. Lines 228–231: Why was the aridity index selected to describe the climatology of Colombia? I also wonder why it was computed as PET/MAP instead of the more typical formulation MAP/PET. This index can be extracted directly from Zomer et al. (2022). Also, please correct the typo in "Ponce."**

**Response 21:** In this study, the aridity index is defined as PET/MAP, following the conceptual framework described by Arora (2002) and commonly adopted in Budyko-type analyses, in which climatic regimes are interpreted along a normalized gradient relating potential evapotranspiration to precipitation. This formulation is mathematically equivalent to the inverse of the more commonly reported MAP/PET index.

The use of PET/MAP facilitates interpretation within a process-based hydrological context, as increasing values indicate a transition from energy-limited to water-limited conditions. This interpretation is consistent with classical climatic spectrum and drought characterization frameworks (e.g., (Ponce et al., 2000)), even though those studies often express the relationship in an inverse or conceptual form.

A clarification regarding the definition and interpretation of the aridity index has been added in lines 293 to 304.

**REFERENCES:**

- Arora, V.K., 2002. The use of the aridity index to assess climate change effect on annual runoff. J. Hydrol. 265, 164–177. https://doi.org/10.1016/S0022-1694(02)00101-4
- Ponce, V.M., Pandey, R.P., Ercan, S., 2000. Characterization of Drought across Climatic Spectrum. J. Hydrol. Eng. 5, 222–224. https://doi.org/10.1061/(ASCE)1084-0699(2000)5:2(222)

**22. Line 251: Please include a reference for the Whitebox tool. What was the software used to run this tool? R, Python, GRASS?**

**Response 22:** A reference to the WhiteboxTools library has been added to the manuscript. The physiographic characteristics were derived using WhiteboxTools, which was executed in R (v4.4.3) via RStudio [Line 221-222].

**23. Table 3: Please extend the table description. I guess "S" means slope.**

**Response 23:** We thank the reviewer for the suggestion. However, S does not represent the mean basin slope. Instead, S corresponds to the equivalent slope of the main channel, derived from the longitudinal segmentation of the channel. This distinction has now been explicitly clarified in Table 2 to avoid any ambiguity. [Line 240]

**24. Lines 269-278: What are the limitations of concentration times for large basins?**

**Response 24:** The limitations of applying a single time of concentration to large basins are now explicitly discussed in the revised manuscript. As basin size increases, hydrological responses become spatially heterogeneous, involving multiple flow paths, storage components, and non-uniform rainfall patterns. Therefore, the estimated concentration times should be interpreted as indicative measures of basin response rather than exact physical quantities, particularly for large catchments. This clarification has been added in lines 249-253 of the revised manuscript.

**25. Line 260 and 317-324: While compactness indices are commonly used to indicate watershed's response, categorizing basins as having "low," "medium," or "high" flood risk requires integrating additional factors such as soil properties, land cover, and precipitation patterns, and socio-economic features. I encourage the authors to clarify the basis for this classification or reconsider the wording to avoid oversimplification.**

**Response 25:** We agree with the reviewer that compactness-based indices alone are insufficient to classify basins in terms of "low," "medium," or "high" flood risk, since flood hazard assessment requires the integration of additional factors such as soil properties, land cover, precipitation characteristics, and socio-economic conditions. Accordingly, the text in lines 226-234 and 396-399 has been revised to avoid oversimplification. All terminology directly associated with flood risk has been removed, and the discussion is now framed exclusively in terms of hydrological response capacity.

**26. Line 317-340: I suggest presenting your results in the same order as the data and methods sections.**

**Response 26:** The text has been revised as suggested. The results section is now presented following the same order as the data and methods sections to improve clarity and consistency.

**27. Figures 3–7 Please add streamflow network. Please use color-blind friendly palette In the legend, all circles appear to be the same size—please correct or clarify this if circle size is intended to represent a variable. Please consider removing the background DEM to enhance the clarity of the figures.**

**Response 27:** The circle size is scaled by contributing area to reflect differences in basin size; this has been explicitly clarified in the figure captions. As suggested, the DEM background was removed to improve clarity and reduce visual complexity.

The river network was intentionally omitted, as its inclusion hindered the identification of individual points rather than aiding interpretation. Priority was therefore given to point visibility and spatial distinction.

The color scheme was also reviewed, and in the absence of the DEM background, the selected colors remain clearly distinguishable and accessible across different types of color vision, ensuring broad interpretability.

**28. Lines 354-355: Natural non-forest formations such as wetlands or paramo vegetation play a large role in hydrological dynamics. Please check this statement "Additionally, 86% of the catchments have less than 20% of their area associated with natural non-forest formations, indicating that these landscapes have a minimal role in the general hydrological dynamics."**

**Response 28:** The text was carefully reviewed and adjusted. The original statement was revised to avoid an overinterpretation of the hydrological role of natural non-forest formations. The sentence was modified to emphasize their areal proportion rather than their hydrological relevance, as follows:

> *"Additionally, 86% of the catchments have less than 20% of their area associated with natural non-forest formations, indicating that these landscapes cover a low proportion of the basin's area."* [Line 598]

**29. Line 449. Previously you described that the highest temperatures are observed in the Magdalena region. Please check.**

**Response 29:** We thank the reviewer for the observation. The text has been revised to clarify that the highest temperatures occur in both the Orinoco lowlands and the northern of the Magdalena–Cauca region, ensuring consistency in the climatic description. [Line 425-427]

**30. Line 513-516: How did you compute the Base Flow Index (BFI)? Clarify the method used for obtaining those values. For example, if a Recursive Digital Filter was implemented, please state the empirical equation and the parameter's values used. This statement "In Colombia, 76% of river basins have a Base Flow Index (BFI) between 0.6 and 0.8, suggesting that groundwater resources play a crucial role in the stability, availability, and regulation of surface water sources" requires further analysis, as temporal dynamics (daily or seasonal variations) are not examined. Additionally, what does the correlation between forest cover and BFI suggest in hydrological terms? I guess that the Amazon forest in Colombia is within regions with shallow water table depth.**

**Response 30:** We thank the reviewer for this valuable comment. The manuscript has been revised to clarify the computation of the Base Flow Index (BFI). [Line 322-327]

In addition, the discussion of BFI values has been moderated to avoid overly strong interpretations. The relationship between forest cover and BFI is now discussed with greater caution. For the Amazon region, we incorporated findings from Satizábal-Alarcón et al. (2024), who report positive trends in groundwater storage across the central and western Amazon, suggesting that enhanced aquifer recharge helps sustain baseflow during subsequent dry periods. In this context, higher BFI values may reflect favorable groundwater storage and recharge conditions. However, for other regions of Colombia, further region-specific analyses are needed to assess whether similar relationships apply [Lines 500-510].

**REFERENCES:**


- Satizábal-Alarcón, D.A., Suhogusoff, A., Ferrari, L.C., 2024. Characterization of groundwater storage changes in the Amazon River Basin based on downscaling of GRACE/GRACE-FO data with machine learning models. Sci. Total Environ. 912, 168958. https://doi.org/10.1016/j.scitotenv.2023.168958


**31. Lines 546-448: These statements require more extensive analysis than those conducted in this study.**

**Response 31:** We thank the reviewer for this comment. The statements in the indicated lines were removed, as they went beyond the scope of the analyses conducted in this study.

**32. Line 556 – Section "Water Resources and Climate Change in Colombia": While the topic is important, this section feels somewhat disconnected from the rest of the manuscript. Consider strengthening the link between climate change and the purpose or future application of CAMELS-COL. I recommend adding a section discussing study limitations and potential future developments or updates for CAMELS-COL.**

**Response 32:** To strengthen the connection between the section *"Water Resources and Climate Change in Colombia"* and the other sections of the manuscript, an introductory paragraph was added to explicitly describe how the hydroclimatic variables, hydrological signatures, and catchment attributes compiled in CAMELS-COL can be used to assess watershed sensitivity to climate variability and climate change. [Line 65-70 and lines 683-689]

In addition, a new section entitled "5. Limitations and Future Developments of CAMELS-COL" has been incorporated according to the review recommendation. [line 737-749]

**33. Line 604: The conclusion section is currently too long and reiterates several points already covered in the results. Please re-structure and highlight the main results and implications of the manuscript.**

**Response 33:** The Conclusions section was restructured to reduce repetition of descriptive results and to emphasize the main findings and their broader hydrological and practical implications. [Line 751-775]

# Reply to reviewer 2

**GENERAL COMMENTS:**

My main point of criticism is the CHIRPS and MSWEP gridded products that are presented here and nothing against such products, they are tremendously useful, but no assessment of how good or not these products represent measured precipitation and temperature is shown apart from a couple of citations. If the purpose of these data sets is hydrological modelling, then it should be clear how much uncertainty is introduced with the input data. I therefore suggest to present such a comparison between CHIRPS and measured station observations (the data is also open access by IDEAM, I would guess), how many stations are included in the calibration of CHIRPS and a discussion on why a gridded product based only on measured data is not feasible even if that reduces the number of catchments.
I would have appreciated to get catchment information on the topographical wetness index and leaf area index for modelling purposes, but this is more of a personal note.

The figures (e.g. Fig. 8) often show little color variation and some dots disappear, so maybe the classes could be adjusted and the panel size increased to make differences more visible?

**Response 1:** We thank the reviewer for this constructive and important comment regarding the use of gridded precipitation and climate products for hydrological applications.

We agree that the suitability of gridded climate datasets for hydrological modelling depends on their ability to represent in-situ observations. In response, we have added text justifying the selection of these datasets and presented previous studies that evaluated the performance of CHIRPS v2 and MSWX against station observations in Colombia (lines 178–181 and 198–200).

We did not reproduce local validation analyses in this study in order to avoid duplication of well-established evaluations and to maintain the focus on the development of a consistent, spatially complete hydroclimatic dataset. The exclusive use of in-situ observations was not considered feasible because station data are not spatially continuous and contain temporal gaps, which would substantially reduce the number of usable records and catchments. In addition, we opted not to mix climate data sources and to preserve consistency with the framework adopted by previous CAMELS datasets.

Concerning catchment descriptors, the Topographic Wetness Index (TWI) was computed during dataset development. While it is not included in the core CAMELS-COL attribute table, we have now added the spatial TWI layer(s) to the repository and explicitly documented them as an auxiliary product to support hydrological modelling applications.

Finally, the figures (including Fig. 8) have been revised following this and other reviewers' comments. Color classes and panel sizes were adjusted to improve contrast and readability, ensuring that spatial patterns and differences are more clearly visible.