Reviewer 1

Comments to the Author

This paper presents a river discharge dataset for Chinese rivers. Discharge is estimated by exploiting the correlation between river width as an observable variable from satellite EO and discharge. The predictive relationships (rating curves) are estimated using in-situ river discharge observations from a national database. These approaches are well known and have been used in many previous studies, both at regional and global scale. Authors argue that in earlier studies, only few estimation points (or gauges) have been included from China and that their dataset increases data availability for China significantly. However, I believe this is mainly a consequence of access restrictions for in-situ river gauging data that China imposes on both international and national researchers. For this reason, I see the in-situ dataset as the main contribution of this paper. Authors must ensure that this dataset is accessible for everyone in the public domain before this paper can be published. This is the only way to ensure that other people can benefit from this work and that the authors' work can be benchmarked and compared with alternative approaches.

Response: We sincerely appreciate the reviewer's valuable comments and constructive suggestions. We fully understand the reviewer's concern regarding the accessibility of in situ discharge observations and recognize their critical importance to the hydrologic community. We also appreciate the reviewer's acknowledgment of our work's contribution to improving the availability of runoff observations in China. Here, we would like to clarify the core scientific contributions of this study and their broader implications for the hydrologic community, while providing a formal explanation of the objective limitations on data sharing.

We would like to emphasize that the primary scientific contribution of this study is not merely the compilation of field-observed data, but the construction of the Chinese Daily River Discharge Record (CDR²) dataset through multi-source satellite-based reconstruction and physically constrained modeling. Although the compiled in situ dataset surpasses existing public databases (e.g., GRDC) in gauge density and temporal resolution, its temporal coverage spans only 2014–2024 and includes non-negligible data gaps (Fig. 2). The key advance lies in extending discharge records to 1990 for 301 gauges by combining multi-satellite-derived river width time series with gauge-specific hydraulic geometry relationships, under strict statistical testing (Spearman rank correlation ≥ 0.25) and physical constraints (hydraulic geometry width exponent between 0 and 0.59). Sacrificing a portion of potentially reconstructable gauges ensures the reliability of the reconstructed discharge records. CDR² achieves a median Kling–Gupta Efficiency (KGE) of 0.66 in validation, outperforming existing global satellite remote sensing products, while increasing the number of reconstructed and extended gauges in China by at least a factor of five compared to current global products (Elmi et al., 2024; Lin et al., 2023; Riggs et al., 2023; Saemian et al., 2024). The CDR² dataset, along with its complete quality assessment information, has been publicly released on Zenodo at https://doi.org/10.5281/zenodo.20152832 (Wang and Li, 2026). In addition to reconstructed discharge records for 310 gauges, the dataset includes metadata for 1,196 gauges, river width time series, hydraulic geometry parameters, and reconstruction accuracy metrics for each gauge. These data are freely accessible, independently verifiable, and reusable by the research community, ensuring transparency in data sources, reconstruction procedures, and the quality of results. Based on these openly available data, CDR² not only provides essential baseline data for cross-validation of satellite-derived discharge products and calibration of hydrological models over China, but also supports research on long-term discharge changes and their hydrological response mechanisms in the region.

Regarding the accessibility of in situ discharge data, we provide the following explanation. The observational data underlying this study were sourced from the National Hydrological and Rainfall Information System of the Ministry of Water Resources of China (http://xxfb.mwr.cn/). This platform provides a dynamic web interface for real-time discharge visualization but offers no download portal for historical archives. Consequently, our dataset was not extracted from an existing database; rather, it was compiled through continuous, long-term web scraping and rigorous cleaning of publicly displayed daily data via a custom automated retrieval program. Due to national data confidentiality policies and regulations, we regret that we are unable to directly release the original gauge records as an open-source dataset. This situation echoes the challenges faced by similar international datasets. For instance, the China Hydrological Project (CHP) dataset (Henck et al., 2010; Schmidt et al., 2011), although used in global river discharge compilations (Riggs et al., 2023) and publicly accessible via the RivRetrieve software package (Riggs et al., 2024), explicitly states that it does not include gauges within China due to the same data policy constraints. Nevertheless, we fully recognize the value of these fundamental observation data in advancing scientific progress and firmly uphold the principle of reproducibility in scientific research. To this end, we warmly welcome researchers who need access to these data to contact our team through collaborative research arrangements. At the same time, we will actively evaluate the possibility of publicly releasing the original observation data within the scope permitted by future policies.

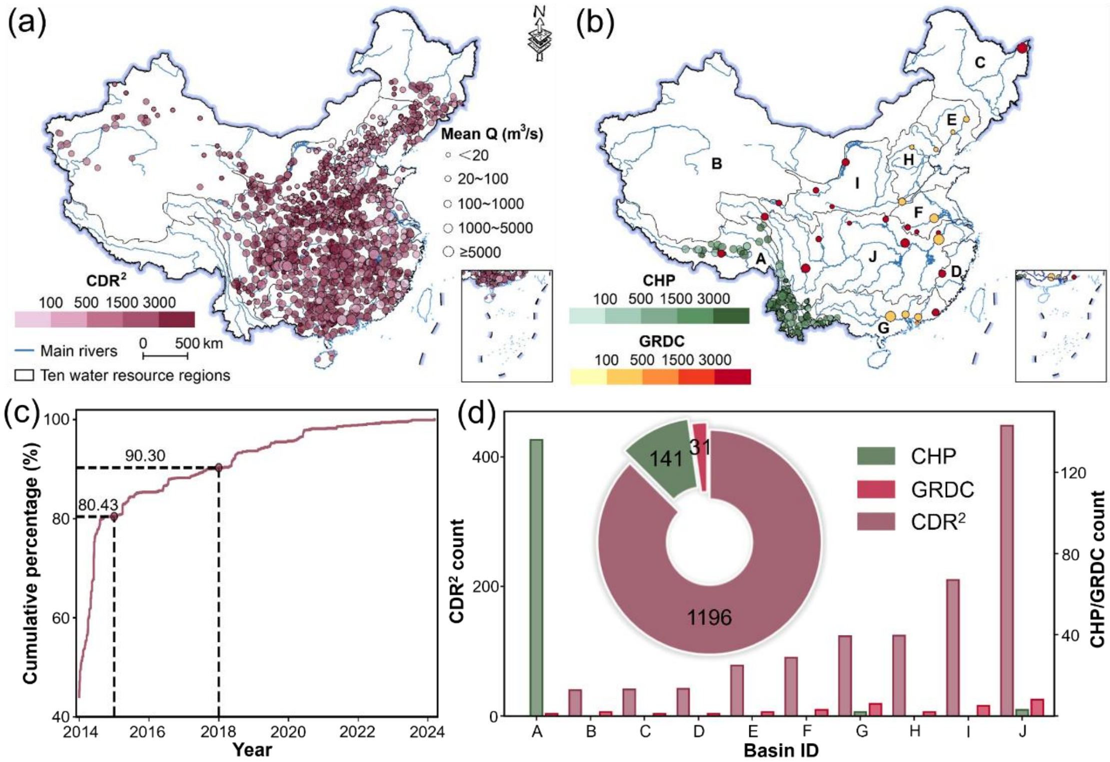

Figure 2. Spatial distribution and temporal coverage of in situ river discharge observations across China (2014–2024). (**a**) Spatial distribution of the 1,196 gauges included in the China Daily River Discharge Records (CDR^2) dataset, with symbol size representing mean discharge (Q, m³/s). (**b**) Spatial distribution of river gauges available from the Chinese Hydrology Project (CHP) and the Global Runoff Data Centre (GRDC) within China. The labeled regions (A–J) denote the ten major basins: Southwest Rivers (A), Northwest Rivers (B), Songhua River (C), Southeast Rivers (D), Liao River (E), Hai River (F), Pearl River (G), Huai River (H), Yellow River (I), and Yangtze River (J). (**c**) Cumulative probability distribution of gauge observation start years in the CDR^2, indicating that over 80% of gauges contain records beginning in or before 2015, while more than 90% begin in or before 2018. (**d**) Comparison of the number of gauges included in the CDR^2, CHP, and GRDC datasets across China. (Page 7, Lines 154–165)

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1. Authors have decided to use river width as the observable satellite EO proxy for river discharge. However, several other proxies have been used in the literature, most importantly water surface elevation from satellite altimetry. Can authors discuss the pros and cons of using river width as compared to the other proxies individually or combined in a data fusion approach, and motivate/justify their choice?

Response 1: We sincerely thank the reviewer for this thoughtful comment, which prompts us to provide a more explicit justification for our choice of river width as the primary satellite proxy. We fully agree that the relative merits of different hydraulic observables—particularly river width versus water surface elevation—deserve clear articulation in the manuscript. In response, we have added the following text to the Introduction: "River width and water surface elevation are complementary hydraulic observables for satellite-based river discharge estimation. Unlike satellite altimetry, which samples rivers only along discrete ground tracks and provides conventional one-dimensional profile data, optical remote sensing, via wide-swath imaging, offers continuous two-dimensional swath measurements, thereby substantially enhancing spatial coverage of river networks (Alsdorf et al., 2007; Lettenmaier et al., 2015; Tourian et al., 2022). Moreover, the long-term archival continuity of optical satellite imagery provides a viable means to reconstruct historical discharge records over multi-decadal timescales. Therefore, when aiming to maximize both the spatial density of reconstructible gauges and the temporal coverage of discharge estimates at fine temporal resolution, river width emerges as a more suitable remote sensing proxy." (Page 3, Lines 64–73)

Beyond the discussion presented in the manuscript, we further clarify the practical considerations behind this methodological choice. Based on our experience processing satellite altimetry data over inland waters, we find that the effective record length of high-quality water-level observations remains relatively limited. Although earlier altimetry missions, such as Jason-1, provide longer temporal coverage dating back to 2001, their measurement accuracy over inland waters is generally insufficient for reliable discharge reconstruction. More recent missions, such as CryoSat-2, SARAL/AltiKa, and Sentinel-3, have adopted improved inland-dedicated retracking algorithms that substantially enhance measurement quality. However, according to our experience, observations suitable for reliable reconstruction are primarily available from 2016 onward, resulting in a relatively short record length. In contrast, the Landsat archive has provided continuous optical observations since 1984, enabling reconstructions spanning multiple decades. Furthermore, the river sampling frequency of nadir altimeters poses another critical constraint. This study requires a minimum of ten same-day concurrent satellite observations and in situ discharge measurements to establish reliable cross-sectional stage–discharge relationships. However, satellite altimeter revisit intervals substantially exceed those of optical missions. Radar altimeters typically cycle every 10–369 days; similarly, ICESat/ICESat-2 laser altimeters—despite their exceptional along-track spatial resolution (17–70 m footprints and a 0.7 m along-track sampling interval)—operate on an approximate 91-day revisit period. Such infrequent observation severely restricts the acquisition of valid synchronous samples. Consequently, given our objective of reconstructing the maximum number of gauges over the longest possible time span, river width is a more suitable proxy for this study.

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2. The entire workflow hinges on the availability of in-situ discharge at stations. What authors present is not a truly contactless "satellite-only" approach. It is thus essential to share the dataset of in-situ discharge in the public domain to ensure that others can reproduce the work and benchmark it against their own approaches. Given the access limitations for Chinese in-situ discharge, publishing the in-situ data in itself has significant value. Authors refer to a website in the manuscript where the in-situ data supposedly can be downloaded. I made a few checks and tried to navigate this Chinese page, but was unable to actually access in-situ river discharge time series. Authors should either provide detailed guidance as to how the data can be accessed from the website or re-publish it in an open archive using science-friendly data formats (e.g. netcdf).

Response 2: We sincerely thank the reviewer for this constructive comment and for carefully testing the data access pathway described in our manuscript. First, we fully acknowledge the reviewer's perspective that the in situ dataset used in this study is of significant value. However, as we emphasized in our previous response, the core scientific contribution of this study is the construction of the Chinese Daily River Discharge Record (CDR^2)—a satellite-reconstructed and physically constrained discharge dataset—rather than the original gauge observations alone. The CDR^2 dataset (including reconstructed daily discharge records for 310 gauges, river width time series, hydraulic geometry parameters, and reconstruction accuracy metrics) has been publicly released on Zenodo (https://doi.org/10.5281/zenodo.20152832) to ensure full reproducibility and independent verification. We believe this openly available dataset already serves the scientific community's need to benchmark and compare our results with alternative approaches.

Second, the inability to retrieve historical in situ river discharge time series from the National Hydrological and Rainfall Information System (http://xxfb.mwr.cn/) is inherent to the platform's operational design. Serving strictly as a real-time operational monitoring terminal with a Chinese-only interface, the platform provides dynamic visualization of daily hydrological updates but lacks public interfaces for historical data retrieval, retrospective querying, or bulk downloading (Fig. R1). Notably, the website underwent a redesign in July 2024, after which it ceased providing real-time river discharge data and now displays only water level data. This explains why checking the platform would only reveal water-level dynamics, not discharge. Given these constraints, the long-term historical dataset used in this study was not obtained through direct download but was compiled by running custom web-scraping scripts daily over multiple years, followed by automated quality control and cleaning of the instantaneous real-time data. Regarding data sharing, as we have noted, national data confidentiality policies and regulations preclude the direct release of raw in situ measurements as an open-source dataset. Nevertheless, we fully endorse the principle of scientific reproducibility. Researchers seeking access to these raw data are warmly welcome to contact our group through collaborative research arrangements. We will also actively evaluate the possibility of making the observational data publicly available as future policies permit. In addition, we have explicitly clarified this in the Data Availability section of the manuscript: "The in situ daily river discharge observations were sourced from the National Hydrological and Rainfall Information System of the Ministry of Water Resources of China (http://xxfb.mwr.cn/), a platform exclusively available in China that provided river discharge visualization until July 2024, after which it only shows water level data, and does not support historical data download." (Page 31, Lines 678–682)

Station 站名	River 河名	Basin 流域	Stage (m) 水位（m）	Time 时间	超警戒水位 (m)
民和	湟水	黄河	1761.76	07-03 08:00	--
泉眼山(二)	清水河	黄河	1204.63	07-03 08:00	--
赵城	汾河	黄河	472.92	07-03 08:00	--
河津	汾河	黄河	371.44	07-03 08:00	--
北道	渭河	黄河	1073.51	07-03 08:00	--
魏家堡	渭河	黄河	486.54	07-03 08:00	--
咸阳	渭河	黄河	373.77	07-03 08:00	--
临潼	渭河	黄河	350.59	07-03 08:00	--
华县	渭河	黄河	338.25	07-03 08:00	--
张家山	泾河	黄河	419.53	07-03 08:00	--
状头	北洛河	黄河	361.19	07-03 08:00	--
戴村坝	大汶河	黄河	40.64	07-03 08:00	--
黑石关	伊洛河	黄河	108.13	07-03 08:00	--
龙门镇	伊河	黄河	146.99	07-03 08:00	--
白马寺	洛河	黄河	112.63	07-03 08:00	--

Figure R1. Interface of the real-time visualization terminal from the National Hydrological and Rainfall Information System. The screenshot demonstrates the platform's core functionality, which is restricted to displaying single-day, transient hydrological dynamics for national key river stations. Red text has been overlaid on the original Chinese-only interface for description.

3. The authors' river discharge reconstruction resulted in a median KGE of 0.66. While this is useful, it is not stellar for a rating-curve based approach using in-situ data, especially for rivers with a highly seasonal flow regime such as in China. It would thus be interesting to benchmark the authors' results using other discharge retrieval techniques developed by other groups.

Response 3: We sincerely thank the reviewer for this constructive suggestion. We fully agree that benchmarking our results against other discharge retrieval techniques is an essential step to contextualize the performance of CDR^2. In fact, this is exactly what we have already done in Section "4.1 Comparison of reconstructed discharge records with existing datasets" of the manuscript (Page 24, Line 526). We compared CDR^2 with four global satellite-derived river discharge products that employ different methodologies—height-based, width-based, and hybrid approaches. These include RSEG by Elmi et al. (2024), SAEM by Saemian et al. (2024), as well as the products by Lin et al. (2023) and Riggs et al. (2023). The comparison shows that CDR^2 achieves the highest median KGE (0.66) among these products, which exhibit a global median range of 0.33–0.48.

4.1 Comparison of reconstructed discharge records with existing datasets

To better contextualize the contribution of the CDR^2 dataset, we conducted a comparative assessment against several representative global remotely sensed river discharge products, including the Remote Sensing-based Extension for the GRDC (RSEG) (Elmi et al., 2024), the Satellite Altimetry-based Extension of global in situ river discharge Measurements (SAEM) (Saemian et al., 2024), and the datasets developed by Lin et al. (2023) and Riggs et al. (2023). Although these datasets have substantially expanded the spatial coverage of global river discharge observations, their representation within China remains extremely limited (Fig. 10 and Table 2). Specifically, the number of gauges in China ranges from only one in Riggs et al. (2023) to 62 in SAEM. In all cases, Chinese gauges account for less than 1% of the total stations included in these global products, reflecting both the scarcity of publicly accessible in situ discharge observations and the challenges of satellite-based discharge retrieval in this region. In contrast, CDR^2 increases the number of gauge-constrained discharge records within China by approximately 5–300 times relative to existing global datasets, providing daily-scale discharge estimates at 310 gauges distributed across diverse hydroclimatic and geomorphological settings (Fig. 10). The dataset encompasses rivers spanning a wide range of discharge magnitudes and channel sizes, thereby substantially improving the representation of China within global river discharge archives.

Beyond its improved spatial coverage, CDR^2 also demonstrates clear advantages in temporal resolution and predictive performance. While RSEG and Lin et al. (2023) provide monthly discharge estimates, CDR^2, SAEM, and Riggs et al. (2023) operate at daily time scales. Notably, CDR^2 achieves a median KGE of 0.66, exceeding the reported global median range of 0.33–0.48 among existing products (Table 2), although these comparisons should be interpreted considering differences in gauge selection criteria and river characteristics. Consistent improvements are also evident in other performance metrics, including a lower median NRMSE (12.7%) and a higher median CC (0.80), indicating enhanced capability in reproducing both the magnitude and temporal variability of observed discharge.

These improvements are partly attributed to the rigorous screening strategy adopted in this study, whereby only gauges exhibiting stable width–discharge relationships and physically consistent hydraulic behavior were retained (Fig. 5). In contrast, global-scale products often face an inherent trade-off between maximizing spatial coverage and maintaining retrieval quality, frequently incorporating gauges with weaker hydraulic relationships or unstable channel responses that introduce additional uncertainty. Moreover, by integrating observations from both Landsat and Sentinel-2 imagery, CDR^2 achieves a substantially higher effective sampling frequency than single-sensor approaches. This enhanced temporal sampling improves detection of short-term discharge fluctuations and mitigates the smoothing effects of monthly aggregation, as observed in RSEG and Lin et al. (2023), thereby enabling a more realistic reconstruction of discharge dynamics at daily timescales. Overall, CDR^2 provides an expanded and higher-resolution characterization of river discharge across China, a hydrologically critical yet globally underrepresented region. Through its greatly expanded gauge density, daily-scale discharge estimates, and enhanced predictive performance, the dataset fills a major geographic gap in existing global river discharge products.

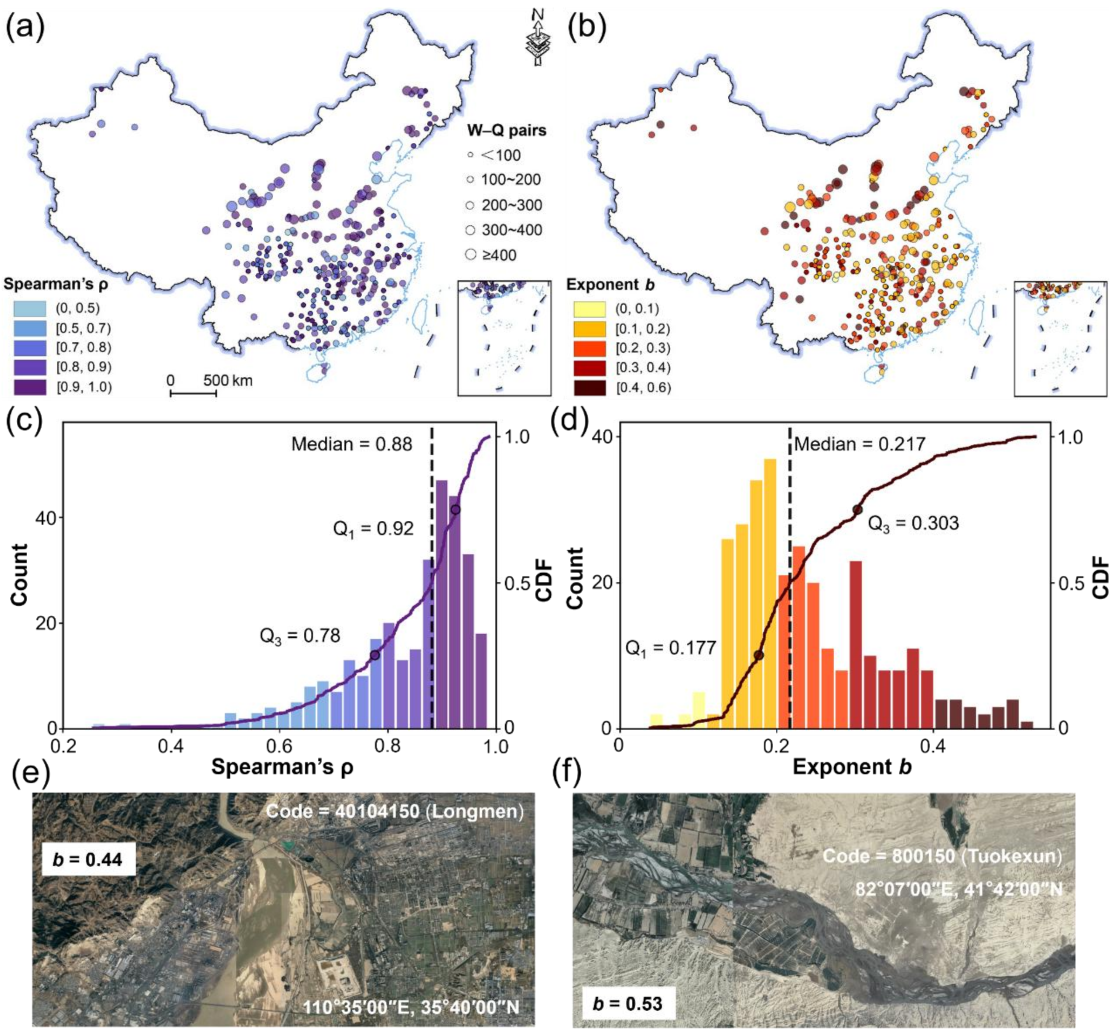

Figure 5. Spatial distribution and statistical characteristics of width–discharge relationships across the 310 selected gauges. (**a**) Spatial distribution of the Spearman rank correlation coefficient (ρ) between river width and discharge, with symbol size

representing the number of width–discharge (W–Q) observation pairs at each gauge. (**b**) Spatial distribution of the power-law exponent (*b*) derived from the at-a-station hydraulic geometry (AHG) relationship. (**c–d**) Frequency histograms and cumulative distribution functions (CDF) of *ρ* and *b*, respectively, with median values and interquartile ranges indicated. (**e–f**) High-resolution satellite imagery of representative river reaches exhibiting high *b* values and morphologically dynamic channel patterns. Source of the underlying image: © Google Earth. (Page 16, Lines 349–358)

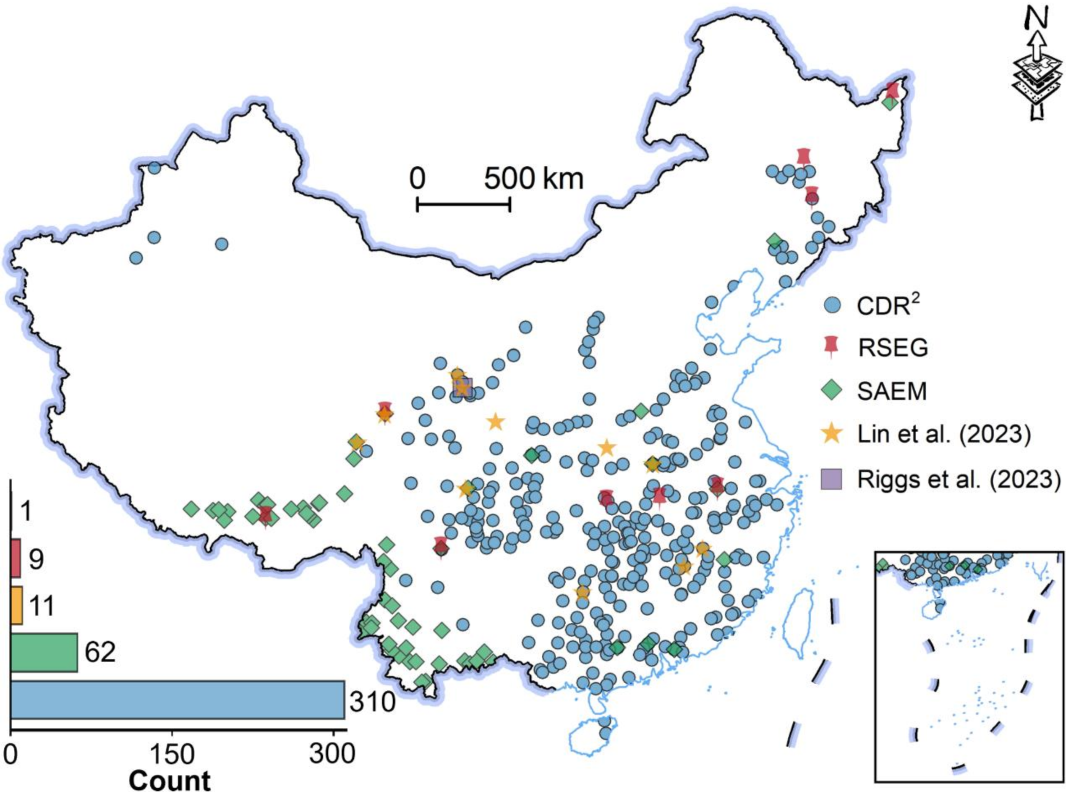

Figure 10. Spatial distribution of river discharge gauges included in CDR^2, compared with gauges from RSEG (Elmi et al., 2024), SAEM (Saemian et al., 2024), Lin et al. (2023), and Riggs et al. (2023). The inset summarizes the number of gauges contained in each dataset within China. (Page 26, Lines 567–570)

Table 2. Comparison of CDR^2 with existing satellite-extended river discharge datasets. (Page 26, Line 571)

Dataset	Hydraulic variables	Data source	Global gauge	China gauge	Temporal resolution	Validation results
Elmi et al., 2024 (RSEG)	River width/ stage	Landsat/Satellite altimetry	3377	9	Monthly	All gauges (mean): KGE = 0.35, rRMSE = 21.8%, CC = 0.43
Saemian et al., 2024 (SAEM)	River stage	Satellite altimetry	8730	62	Daily	All gauges (median): KGE = 0.48, nRMSE = 18%, CC = 0.64
Lin et al., 2023	River width	Landsat	3078	11	Monthly	>600 gauges (median): KGE = 0.33

Riggs et al., 2023	River width	Landsat/Sentinel	2168	1	Daily	All gauges (median): KGE = 0.46, rRMSE = 83%, rBias = 1.4%
CDR[2]	River width	Landsat/Sentinel	310	310	Daily	All gauges (median): KGE = 0.66, nRMSE = 12.7%, rBias = 6.6%, CC = 0.8

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