

Response to the referees and changes in the revised manuscript

Comments from referees	Author's response	Author's changes in manuscript
First Referee		
Overall, the manuscript is well written and pleasant to read. The work is extremely interesting in a region like West Africa, where there is relatively little documentation, as it involves compiling an inventory of existing databases on the locations and characteristics of dams and reservoirs, and attempting to validate this information in the field to verify that the databases are consistent. The results could be very useful for the hydrology community, particularly for feeding into regional hydrological, taking into account water storage and irrigation processes. The database is already available online with a corresponding DOI. One thing I'm not quite clear on is what criteria determine whether or not a database is included in the work. Do you simply use all existing data, or is there a preliminary filtering process? Similarly, I think the criteria for what is considered a large or small dam should be better defined. For example, what is the minimum reservoir size included in this new database? This is important because there is indeed a myriad of very small reservoirs, and I think it's a real challenge to try to inventory them all. On the other hand, it's important for database users to know what types and sizes of dams it contains. One point I think is worth elaborating on a bit more is this validation. It's clear that the database was validated using data from a single watershed. But I think there is a need to provide the reader with a bit more information to assess the reliability of this database, particularly in different hydroclimatic contexts. I fully understand that this type of field validation is a major work that requires significant effort at the local level and, of course, cannot be carried out on a regional scale. However, we need to provide context to help verify whether this validation is representative at the regional level.	Good points and thank you for these constructive comments. We will address them. 1. Criteria that determine whether or not a database is included in the work: We already indicated in the manuscript that based on this review, we selected datasets that are open-access with standardized file formats (CSV or XLS and SHP) for compilation (see Line 124-125). The list of datasets retained for the compilation is provided in the table 2 and Figure 2. 2. The minimum reservoir size included in this new database is already mentioned in the abstract: $57 \times 10^{-3} \text{ km}^2$ (see Lines 20-21)	3. We revised the method section and clearly defined what is called large or small reservoir and dam (see Lines 167-170). 4. We provided additional context for selecting the Upper Bandama watershed as the field-reference site used to validate the compiled dataset (see Lines 112-114). We also discussed the limitations and uncertainties associated with relying on a single watershed for validation across West Africa (see Lines 520-527).
Line 105: It would be helpful to explain why this basin was chosen for validation. Is it the only one with data, or is it representative of the area? In particular, we need to discuss how validation at a single site could be representative of the entire region, given that there are four very distinct climate zones.	The Upper Bandama watershed provides a valuable benchmark because it contains many small reservoirs and represents a data-scarce context where existing datasets often have limited coverage. We fully agree that this is only one watershed and does not capture the full diversity of environmental, hydrological, institutional, and data-availability conditions across West Africa, but it is currently the only validation data available to us for this assessment and thus of high value.	We explained why this basin was chosen for validation in the Study area section (see Lines 108-114). We also discussed the limitations and uncertainties associated with relying on a single watershed for validation across West Africa and provided recommendations for further validation across all West African climatic zones (see Lines 520-527).
Line 141. I don't quite understand this part. For example, the coordinates of the reservoirs were estimated using a statistical approach. That seems rather inappropriate to me. A reservoir can be observed, for example in satellite images, and its location is precise—not the	The geographical coordinates of dams and reservoirs were not estimated using a statistical approach. They were verified and harmonized using the spatial information provided in the source datasets, satellite imagery, and QGIS tools.	

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result of an average estimated from a statistical distribution.	In Line 141, we stated that: “<i>Finally, we assessed the differences between the newly compiled dataset and the original datasets (Sect. 2.2) at the West Africa scale by comparing the probability density distribution of attributes such as dam latitude, reservoir latitude, reservoir surface area, and reservoir volume.</i>” This analysis was not used to estimate the coordinates of reservoirs. Rather, it was used to compare the spatial and attribute distributions of the compiled dataset with those of the originate datasets, in order to assess differences and potential gaps between them.	
Line 286. I don't think this collection exceeds the number in previous studies; as its written it actually ranges from 1,415 to 1,429. So not a large difference. It would be interesting to state here which dataset reports 1415 dams, and the % in common with the current database. And it is not the same number reported line 488 (1141 records). Please revise.	In Line 286, we stated that: “<i>The dataset that we compiled based on the selected twelve datasets contains a total of 1,429 georeferenced dam points and 1,258 reservoir polygons ($\geq 0.57 \times 10^{-3} \text{ km}^2$ and $\geq 0.1 \text{ MCM}$). This number of entries clearly exceeds the count of dams and reservoirs in West Africa reported by any individual dataset, from 288 to 1,415 entries (Fig. 5).</i>” We would like to clarify that the range from 288 to 1,415 does not refer to the number of entries contained in the originate datasets. Rather, it refers to the additional number of entries in the compiled dataset compared with each individual source dataset. In other words, depending on the originate dataset considered, the compiled dataset contains between 288 and 1,415 more dam entries. This increase is explained by the fact that the original datasets do not contain exactly the same dams and reservoirs. Some infrastructures appear in more than one dataset, while others are unique to a specific dataset. By integrating the twelve selected datasets, removing duplicates, and adding reservoir polygons identified through satellite imagery, the compiled dataset includes more entries than any individual source dataset.	We have revised the sentence as follows (see Lines 318-323): “<i>The dataset compiled from the twelve selected datasets contains 1,429 georeferenced dam points and 1,258 reservoir polygons ($\geq 0.57 \times 10^{-3} \text{ km}^2$ and $\geq 0.1 \text{ MCM}$). Compared with the individual source datasets, the compiled dataset adds 1,088 to 1,415 dam entries and 117 to 1,119 reservoir entries, depending on the dataset considered (Fig. 5). Among the originate datasets, GLRSED contributed the largest share of reservoir records, accounting for 91% of the reservoir entries in the compiled dataset, whereas GDAT contributed the largest share of dam records, accounting for 24% of the dam entries.</i>” We also corrected the inconsistency in Line 488 (see Lines 553-554).
Figure 6: I see that the size of the catchment area is missing in many cases. However, it seems to me that this information is very easy to estimate: once you have the precise locations of the dams, you can delineate the catchment area using a digital elevation model (DEM).	We agree that watershed area can be estimated using dam locations and a digital elevation model (DEM). However, watershed-area delineation requires additional methodological choices, including DEM selection, flow-direction processing, treatment of flat areas, correction of dam-point locations relative to the drainage network, and validation of the derived catchments. These steps may introduce additional uncertainty and were therefore not included in the current version of the compiled dataset which focuses on harmonizing and documenting the attributes already provided by the selected source datasets rather than deriving new hydrological attributes for all dams and reservoirs.	In the revised manuscript, we clarify this point and mention watershed-area delineation with other missing attributes as a valuable next step for improving the compiled dataset, in the discussion section (see Lines 538-544).
Line 310. It should also be noted that these are climatologically very different regions, with a gradient of aridity from south to north.		We revised the text accordingly. In the revised version of the manuscript, this point is addressed in Lines 348-349.
Figure 12 can be misleading. At first glance, I thought it was a comparison of the same		We revised the caption of the Figure 12 as follows:

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dams—specifically, what was in the databases versus what was observed—but upon reading the text, one realizes that these are two different databases: on the one hand, what is observed in the field, and on the other hand, what is in the databases. Because otherwise, it would be very surprising that information such as the year of construction or the height of the dam—which are actually fairly easy to obtain—would differ so much. So I think the figure's caption should be rewritten slightly to explain that these are in fact two different sets of data.		<i>“Comparison of the density distribution of attributes from the compiled dataset and the field campaign dataset (ground truth data) at watershed scale (14,000 km²). This does not represent a one-to-one comparison of the same dams, but rather compares the overall attribute distributions in both datasets. The attributes shown are: (a) latitude, (b) year of completion, (c) reservoir volume, (d) reservoir surface area, (e) average reservoir depth, (f) dam height, and (g) average discharge.”</i>
Line 415: I think this paragraph should be expanded slightly to explain the link between the spatial distribution of dams and the climate. One might imagine that dams are unnecessary in humid regions but necessary in semi-arid regions. However, this is not explicitly discussed in the manuscript. However, given the number of dams analyzed, I believe this type of analysis would be very interesting.	In the line 415 of the preprint, we stated: <i>“The spatial pattern derived from the compiled dataset revealed a pronounced concentration of dams and reservoirs between 8° N and 14° N, corresponding to the Sudanian zone. This is consistent with previous studies (Cecchi et al., 2009b; Lèye et al., 2021; Fowé et al., 2023) and reflects long-term efforts to mitigate rainfall variability and sustain agricultural productivity in the savannah biome (Cecchi et al., 2009a; Lèye et al., 2021; Fowé et al., 2023; Peña-Angulo et al., 2025).”</i> The main purpose of this paragraph is to support the quality and consistency of the compiled dataset by showing that the spatial distribution of dams and reservoirs agrees with patterns already reported in previous studies. Additionally, the paragraph already addresses the climate link briefly. We agree that a detailed discussion of the necessity or role of dams across each climate zone would be interesting. However, it is beyond the main scope of this manuscript and does not directly address our research objectives.	
Line 496: I think we should clarify here what is meant by a “small reservoir.” Are we trying to detect pools a few meters in size? What is the average size? And, in fact, I feel that this definition is somewhat lacking in the manuscript; perhaps it should be clarified= what is the minimum dam size considered in the database	The dataset does not aim to systematically inventory very small pools or ponds of only a few meters in size.	In the revised manuscript, we defined reservoir classes according to the classification proposed by FAO (See Table 3 of the revised manuscript). We also defined “small-scale infrastructure” as referring to minor and small reservoirs, as specified in the Methods section (see Lines 170–171). We have ensured that the minimum reservoir size included in the compiled dataset is clearly stated where relevant in the revised manuscript, including in the Abstract (Line 21).
Second Referee		
The manuscript is generally well written and reads smoothly. It provides a clear overview of existing dam and reservoir datasets, identifies relevant scientific gaps, and presents a coherent methodology, results, and discussion. By integrating 12 existing datasets, the authors developed a harmonized database of dams and reservoirs in West Africa and evaluated it using field-survey data from the Upper Bandama watershed. The study has substantial regional relevance and potential practical value. In addition, the dataset has been made publicly available through a repository with a DOI, which is appropriate for an ESSD data description article. However, additional technical details are needed for several key procedures, including data harmonization, duplicate removal, dam–reservoir matching, and manual digitization. The authors should	We sincerely thank the reviewer for the careful reading of our manuscript and for the constructive and helpful comments. We are pleased that the reviewer found the manuscript generally well written and recognized the regional relevance and practical value of the harmonized dam and reservoir dataset. We also appreciate the specific suggestions regarding the need to provide more technical details on data harmonization, duplicate removal, dam–reservoir matching, manual digitization, temporal mismatches, and the non-independence of some source datasets. We agree that improving the transparency and reproducibility of these methodological steps will strengthen both the manuscript and the dataset. In the revised version, we will provide additional	

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also consider that the source datasets differ in feature type, size threshold, and temporal coverage. Moreover, several datasets inherit records from the same sources and therefore cannot be regarded as completely independent products. These dependencies should be explicitly considered during data integration and quality assessment. Overall, I consider this a meaningful study with considerable potential value. However, the manuscript would benefit from careful revision before publication. Improving the transparency and reproducibility of the methodology would substantially enhance the scientific value and practical usability of both the manuscript and the dataset. My specific comments are provided below.	details in the Methods and Discussion sections and add a dedicated limitations subsection. Please find below our preliminary responses to each comment.	
1. Abstract: Please define “small-scale infrastructure” and provide the corresponding area, storage-capacity, or dam-height threshold.	In our manuscript, “small-scale infrastructure” refers to minor and small reservoirs of the definitions proposed by FAO (Bernacsek, 1984), which ranges from 0.010 to 9.99 km ² surface area. We revised the manuscript to strictly follow the FAO classification, as shown below: Reservoir category Surface area range at USL (km ²) Major ≥ 1,000 Large 100–999 Medium 10.0–99.9 Small 1.00–9.99 Minor 0.010–0.999	We clarified in the abstract that large-scale reservoirs, classified as medium, large, or major, have surface areas greater than or equal to 10 km ² , whereas small-scale reservoirs, classified as minor or small, have surface areas below 10 km ² (see Line 25). We defined “small-scale infrastructure” and “large-scale infrastructure” in the revised manuscript (Lines 167–170) and updated Figure 7c to strictly follow the classification proposed by FAO (Bernacsek, 1984).
2. Introduction: The terms “large” and “small” dams and reservoirs should be precisely defined throughout the manuscript. If the classification is based on reservoir area, please provide the corresponding area ranges.		We clearly defined these categories, in the revised manuscript, based on the definitions proposed by FAO (Bernacsek, 1984).
3. Line 76: The research gap is described as the “underestimation” of West African dams and reservoirs in existing datasets. Does this refer to the number of dams, reservoir area, storage capacity, positional accuracy, attribute completeness, or a combination of these factors? Please define the specific dimensions of underestimation more clearly.	In the current version, the term “underestimation” refers to the number of dams and reservoirs reported in existing datasets.	We revised the manuscript as followed (see Lines 79-81): “ <i>One key gap is the inconsistency in the number of West African dam and reservoir entries across existing datasets (Zhang and Gu, 2023). This suggests that some datasets underestimate the number of dams and reservoirs, thereby limiting their completeness, accuracy, and reliability.</i> ”
4. Please explain how duplicate records were identified and removed, including the matching criteria, thresholds, and whether the process was automated or manual.	The harmonization was performed manually in QGIS after merging the selected source datasets. Separate harmonized attribute tables were created for dam points and reservoir polygons. Duplicate records were identified using a combination of spatial and attribute-based checks. First, records with identical or nearly identical geographic coordinates were flagged as potential duplicates. Second, overlapping or very closely located features were visually inspected in QGIS. Third, available attributes such as dam or reservoir name, country, river or basin name, reservoir area, storage capacity, construction year, and source dataset were compared to confirm whether the records referred to the same infrastructure. When duplicate records were confirmed, only one representative record was retained in the compiled dataset. Attribute information from the duplicate sources was not simply discarded; rather, consistent information was retained and used to improve the completeness of the final record. In cases where attributes differed across sources, priority was given to the most complete and plausible record. Ambiguous cases were checked manually before final inclusion.	We revised the method section accordingly (see Line 155-161).

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5. Please clarify whether dam points and reservoir polygons have a one-to-one relationship in the compiled dataset. How were dam points linked to reservoir polygons?	Dam points and reservoir polygons do not always have a strict one-to-one relationship in the compiled dataset. This is because the selected source datasets differ in their feature types and purposes. Some datasets provide dam locations as points only, while others provide reservoir polygons without associated dam points. In addition, some large or complex reservoir systems may include more than one dam-related point, while some small dams may not have a clearly mapped reservoir polygon in the available products. Where possible, dam points were linked to reservoir polygons using spatial overlay and proximity analysis in QGIS. A dam point was associated with a reservoir polygon when it was located within, on the boundary of, or immediately downstream of the polygon. This spatial matching was supported by attribute information where available, including dam or reservoir name, country, river or basin, reservoir area, and source dataset. Ambiguous cases were manually inspected using the spatial layers and, where necessary, satellite imagery or base maps.	We clarified that in the method section of the revised manuscript (see Line 143-151).
6. Please clarify whether each record retains its original data source and indicates any modifications made during harmonization.	We agree that data provenance is essential for the transparency and reuse of the harmonized dataset. In the current version of the compiled dataset, each dam or reservoir record does not retain the full list of all original datasets in which the same infrastructure may have appeared. During harmonization, when duplicate or overlapping records were identified, we retained one representative record. The source indicated for each final entry corresponds to the dataset that provided the entry itself and/or the majority of the retained attribute information. Therefore, the source field should be interpreted as the main contributing source for the harmonized record, rather than as a complete record-level provenance history across all overlapping datasets. However, all original datasets used to build the harmonized database are cited throughout the manuscript and are also listed in the README file associated with the published dataset. In the revised manuscript, we will clarify this point to avoid any misunderstanding.	We clarified that when attribute values differed across sources, we retained the most complete and consistent record and identified the primary contributing dataset in the source field of the compiled dataset (See Line 160-163).
7. Please report the sample size and selection criteria for the surveyed dams and villages in the Methods and clarify whether the survey covered all known dams in the watershed.	We conducted the field campaign in the Upper Bandama watershed, which covers approximately 14,000 km². It is important to note that the survey focused on dams and reservoirs identified through consultations with institutions, local authorities, and community members, and that were accessible by vehicle or on foot and therefore verifiable during field visits. Some informal, inaccessible, or locally unreported dams may still be absent from the field data. Data from the field and institutional sources were combined to form a ground truth dataset for the Upper Bandama watershed. Therefore, the ground truth dataset contains all dams included in the lists of dams provided by the consulted institutions within the watershed but may still lack inaccessible or unreported dams.	These points are clarified in Lines 170–180 . We also discussed the limitations of this approach in the Discussion section (see Lines 525–526).
8. The field survey was conducted in 2024, whereas some source datasets are much older.	We conducted the field survey in 2024, while the most recently constructed dams	

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Please consider temporal mismatches when interpreting missing dams and assessing dataset accuracy.	recorded in the field dataset date from 2000. Among the original datasets used in the compilation, GLRSED is the most recent, having been developed and updated in 2024. In addition, FAO AQUASTAT, although the oldest source dataset used in this study, was first published in 1994 and has been updated regularly (FAO, 2021). Therefore, we do not consider temporal mismatch to be a major factor explaining the dams missing from the compiled dataset. Several source datasets were updated well after 2000, which corresponds to the construction year of the most recent dams identified in the reference field dataset (ground truth dataset).	
9. Figure 4: Please define the meaning of “lake control.”	The term “lake control” comes from the HydroLAKES database. It refers to a natural lake that is influenced or regulated by a control structure, such as a dam or outlet regulation structure.	We defined this term in the caption of Figure 4 .
10. Many of the selected datasets overlap or inherit information from other datasets. For example, some newer products incorporate records from GRanD, GLWD, HydroLAKES. Did the harmonization procedure account for this lack of independence?	We agree that the selected datasets cannot all be considered fully independent. Several dam and reservoir products share common source information or inherit records from earlier datasets such as GRanD, GLWD, and HydroLAKES. Our harmonization procedure accounted for this issue mainly through duplicate identification and data-source tracking. When the same dam or reservoir appeared in multiple datasets, it was treated as a duplicate record rather than as independent evidence of multiple infrastructures (dams and reservoirs). The final compiled dataset therefore aimed to retain one harmonized record per identified infrastructure while preserving source information for traceability.	We indicated that we accounted for this issue mainly through duplicate identification and data-source tracking in the revised manuscript (see Lines 154-157). We also discussed the limitation and uncertainties related to the non-independence of source datasets in discussion section (see Lines 529-535).
11. Table 4: The current comparison of attribute availability is rather coarse. Please consider listing the individual attributes provided by each dataset; this should not require excessive additional space and would substantially improve the usefulness of the comparison.	The existing datasets contain many individual attributes. For example, GRanD alone includes more than 45 attributes. Listing all attributes from each dataset in Table 4 would therefore make the table too large and difficult to read in the main manuscript. For this reason, we grouped the available attributes into four main categories and presented these categories in Table 4 to provide a concise overview of attribute availability across datasets.	
12. Lines 307–311: 148,671 MCM represents approximately 52.5%, rather than 55.61%, of 283,032 MCM.		We corrected the percentage in the revised manuscript and check all numbers (Line 344-346).
13. Lines 399–400: If the compiled dataset contains 32% of the dams observed during the field campaign, the gap should be approximately 68%, not 88%.		We corrected the statement in the revised manuscript in Line 440.
14. The field-based assessment was conducted in only one watershed. Please discuss more carefully whether its results can be generalized to the whole of West Africa.	The Upper Bandama watershed provides a valuable benchmark because it contains many small reservoirs and represents a data-scarce context where existing datasets often have limited coverage. We fully agree that this is only one watershed and does not capture the full diversity of environmental, hydrological, institutional, and data-availability conditions across West Africa, but it is currently the only validation data available to us for this assessment and thus of high value.	We discussed this limitation in the discussion section (see Lines 521-525).
15. I recommend adding a limitations subsection in discussion. This section should address the use of only one watershed for field	We agree and will add a dedicated limitations subsection to the discussion.	We added a limitations subsection to the discussion (see Lines 519-543).

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evaluation, the non-independence of source datasets, and potential uncertainty in the field-reference data itself.		

A Harmonized Dataset for Dams and Reservoirs in West Africa

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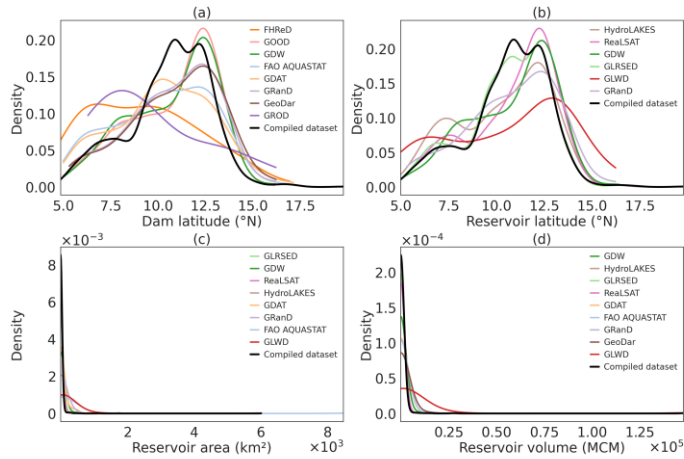
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Abstract. Most existing datasets that could support dam and reservoir management and assessments of their impacts in West Africa are limited by inaccurate georeferencing, inconsistent accessibility, heterogeneous data records, and a lack of validation against field observations. In this study, we review and assess existing datasets containing information on dams and reservoirs in West Africa and subsequently integrate them into a harmonized and consolidated regional dataset. We benchmarked the quality of the newly compiled dataset at watershed scale through an extended field study, and statistical analyses. The resulting dataset (<https://doi.org/10.60507/FK2/YLDK1Y>) includes 1,429 georeferenced dams and 1,258 reservoirs (with a minimum surface of $0.57 \times 10^{-3} \text{ km}^2$) exceeding the count of dams and reservoirs in West Africa reported by any available dataset. It contains 38 attributes and an estimated total reservoir surface area of $14,038 \text{ km}^2$ and a cumulative storage capacity of 283,032 million cubic meter (MCM), thereby enhancing data accessibility in West Africa. The regional compiled dataset contains fewer missing entries and exhibits lower bias compared to the originate datasets, advancing the existing efforts by explicitly integrating both large ($\geq 10 \text{ km}^2$) and small ($< 10 \text{ km}^2$)-scale reservoirs. The ground-based watershed scale assessment revealed strong spatial and temporal coherence for large scale reservoirs, but a systematic underrepresentation of small scale infrastructure in both the sources and thus also in the compiled dataset highlighting the importance of field validation. The field benchmarking advocates for collaborative research and data sharing initiatives among scientists and institutions across West Africa to improve the accuracy and completeness of dam and reservoir data, especially for small scale infrastructure.



Density distribution of compiled dataset compared to the selected datasets at regional scale (West Africa) for the following attributes: (a) latitude of dam entries, (b) latitude of reservoir entries, (c) reservoir surface area, and (d) reservoir volume.

1 Introduction

Unprecedented population growth, climate change, rapid urbanization, infrastructure expansion, and land-use conversion collectively alter the fluxes, pathways, and storage of water across multiple scales (Makarigakis and Jimenez-Cisneros, 2019). These components of global change increasingly affect water resources, pose substantial challenges to water security, and complicate the efforts of water managers and decision-makers to balance supply with growing demand (Klein and Kenney, 2009; Cosgrove and Loucks, 2015). Dams and their associated reservoirs, a longstanding element of water management in many regions, play a central role in tackling the growing challenges of climate change, population growth, urbanization, and hydrological extremes (Wheater and Gober, 2015; Zhang and Gu, 2023). These infrastructures are engineered to store and regulate water supply, mitigate floods, generate hydropower, and support irrigation, thereby ensuring the provision of essential water services during periods of both abundance and scarcity (Watts et al., 2011; Wheeler and Gober, 2015; Eslamian et al., 2018). Their multifunctional capabilities make dams and reservoirs a valuable tool for enhancing water security, especially in regions where climate variability and extreme hydrological events are increasingly common (Ehsani et al., 2017).

Estimates suggest there are around 58,000 large dams and more than 16 million smaller impoundments globally, collectively transforming terrestrial surface water dynamics and local climate (Li et al., 2023). This transformation is particularly evident in regions where water scarcity and variability of precipitation put agricultural productivity and socio-economic stability at risk (Yazdandoost, 2016; Mady et al., 2020). Across West Africa's semi-arid areas, governments and development agencies have constructed over 2000 small reservoirs to increase water storage capacity, thereby supporting irrigation, strengthening food security, and fostering income diversification (Cecchi et al., 2009a; Abobi and Wolff, 2020; Cecchi et al., 2020; Lèye et al., 2021; Owusu et al., 2022). Additionally, hydro-economic analyses have shown that multiple, smaller dams can generate substantial economic returns by optimizing water allocations for high-value irrigated crops while minimizing hydrological alterations (Ekka et al., 2024). Such findings highlight that artificial reservoirs function as dynamic systems that can improve livelihoods and strengthen resilience to climatic extremes in regions exposed to water security threats.

Despite their benefits, dams and their associated reservoirs are vulnerable to global change that threatens their operational reliability, safety, and functionality (Fluixá-Sanmartín et al., 2018; Ghimire and Schulenberg, 2022). Changes in precipitation patterns, increasing frequency of extreme weather events, and rising temperatures directly affect reservoir inflow volumes and timing, making it more difficult to predict and manage storage and release (Hou et al., 2022) and thus increasing the challenges of flood risk management. In addition, rising temperatures have been linked to increased evaporation rates from reservoir surfaces, which can significantly reduce stored water volumes, particularly in arid and semi-arid regions (Helfer et al., 2012). This is particularly true for West Africa, where already high interannual variability in the hydrological cycle is intensified by changing precipitation patterns, rising temperatures, and more frequent extreme weather events (Oyerinde et al., 2016; Chun et al., 2021). Besides their vulnerability to global change, dams and their associated reservoirs have increasingly become the focus of serious criticism due to their numerous social, environmental, and economic impacts (Kaup, 2015; Latrubesse et al., 2017). Multiple studies highlight the detrimental effects of dam construction on ecosystems and biodiversity, indicating a general consensus among scientists about the challenges posed by these infrastructures (Magilligan and Nislow, 2001; Ziv et al., 2012; Kaup, 2015; Latrubesse et al., 2017).

Given these intensifying pressures, there is a critical need to implement adaptive water resources management strategies that combine robust data, advanced observational technologies, predictive modelling, and comprehensive risk assessment (Boulange et al., 2021; Fluixá-Sanmartín et al., 2021). This is essential to safeguard the structural integrity of dams, the ecological and socio-economic systems they support while effectively managing their impacts (Boulange et al., 2021; Fluixá-Sanmartín et al., 2021). Makarigakis and Jimenez-Cisneros (2019) emphasized that improving data quality and ensuring data

accessibility is critical for the assessment, prediction, and mitigation of global change. Yet, access to hydrological data including information on dams and reservoirs remains limited in West Africa, due either to a considerable lack of data or to complex and time-consuming procedures that are required to obtain the data where it exists (Ndehedehe, 2019; Watermarq Limited, 2024). Consequently, researchers and practitioners frequently rely on global datasets. The emergence of comprehensive global geospatial databases has improved the quality, spatial coverage, and detail of available information on dams and reservoirs (Mu et al., 2020; Mulligan et al., 2020; Mulligan et al., 2021; Wang et al., 2022; ICOLD, 2024; Lehner et al., 2024).

Although these integrated datasets are critical for supporting cross-scale analyses, they still exhibit notable gaps that can limit the sustainable management of dams and their reservoirs. One key gap is the ~~inconsistency~~~~underestimation in the number of~~ West African dams and reservoirs ~~entries across~~~~among~~ existing datasets (Zhang and Gu, 2023). ~~This suggests that some datasets underestimate the number of dams and reservoirs, thereby limiting their completeness, accuracy, and reliability, which limit their accuracy and reliability.~~ Furthermore, the current datasets provide various attributes related to dams and reservoirs; however, many datasets exhibit disparities and missing records, thus challenging efforts to support robust and informed decision-making (Mirus et al., 2011; Zarfl et al., 2015; Zogheib et al., 2018; Zhang and Gu, 2023; Bai et al., 2025). These inconsistencies lead to incomplete assessments of dam effects on ecosystems and surrounding communities (Lehner et al., 2011; Lehner and Grill, 2013; Joseph et al., 2018; Dang et al., 2020), undermining the accuracy of environmental and social impact assessments. This issue is further exacerbated by the fact that the quality of most datasets has not yet been evaluated using field-observed data from the West African region (Du et al., 2022; Zhang and Gu, 2023; Bai et al., 2025). This lack of regional validation limits the ability to effectively assess the reliability and uncertainty of hydrological, climate, and land-surface models developed for the region based on these datasets (McManamay, 2014; Yassin et al., 2019).

Given these challenges, this study reviews and assesses existing datasets on dams and reservoirs in West Africa, integrates them into a harmonized and consolidated regional dataset, and benchmarks the resulting compiled dataset against field-campaign data at watershed scale to evaluate its quality.

The key contributions of this study include: i) a critical review and comparison of existing datasets containing information on West African dams and reservoirs; ii) the development of a new, region-specific dataset from the consolidation of multiple datasets; and iii) a watershed scale ground-truthing assessment of the quality of existing dam and reservoir data.

2 Methods

2.1 Study area

West Africa, lies between latitudes 0° N and 20° N and longitudes 20° W to 20° E (Fig. 1), and is home to approximately 456 million inhabitants (The United Nations - Department of Economic and Social Affairs, 2024). West Africa exhibits pronounced climatic variability on intra-seasonal to multidecadal timescales, with aridity increasing progressively inland. Three primary climatic zones are typically distinguished (Fink et al., 2017; Quenum et al., 2019; Ndao et al., 2020): (a) The Sahelian zone (~12.5° N), a semi-arid belt that transitions into the Sahara desert, with highly irregular rainfall ranging from approximately 150 to 600 mm year⁻¹, typically peaking in August; (b) the Sudanian (savannah) zone (9° N to 12.5° N), a sub-humid region influenced by the West African Monsoon, receiving around 200 to 1,000 mm year⁻¹, and (c) the Guinean coastal zone (4° N to 9° N), a humid tropical region characterized by a bimodal rainfall regime driven by the seasonal movement of the Inter-Tropical Discontinuity (ITD), with precipitation generally ranging from 1600 to 2000 mm year⁻¹.

The Upper Bandama (or Bandama Blanc) watershed, located in northern Côte d'Ivoire within the Sudanian climatic zone, was selected to evaluate the data quality. Covering approximately 14,500 km² between 8°40'-10°20' N and 5°00'-6°20' W, the

watershed is of key importance due to its position upstream of a major hydroelectric dam (Kossou dam). Moreover, small agricultural dams are prevalent in the area, and its rural population relies heavily on rain-fed agriculture for livelihoods and food security, making it particularly vulnerable to hydrological variability (Moussa Ouedraogo, 2016). The Upper Bandama watershed therefore provides a valuable benchmark and represents a data-scarce context where existing datasets often have limited coverage and is currently the only validation dataset available to us for this assessment.

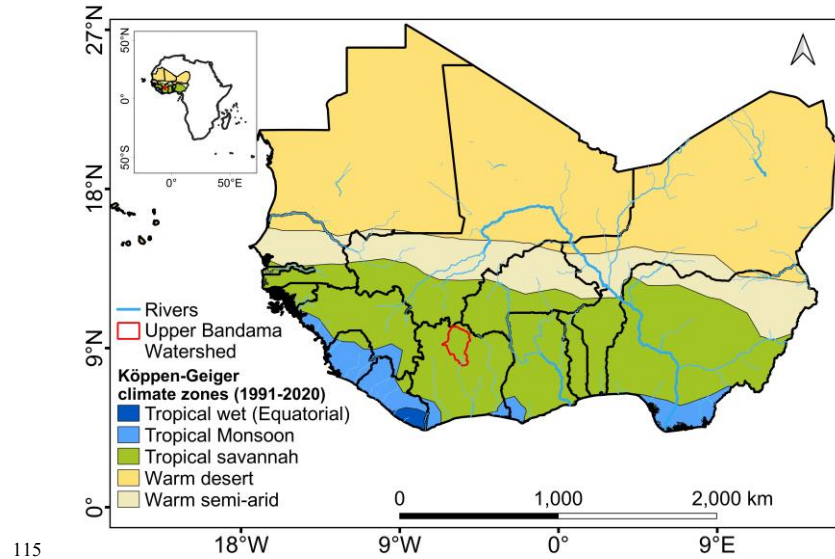


Figure 1: West Africa, its Köpen-Geiger climate zones (Beck et al., 2023), and the location of the Upper Bandama Watershed.

2.2 Literature review and selection of dam and reservoir datasets for compilation

We carried out a literature review to identify, inventory, and assess the current state of existing datasets containing information on dams and reservoirs in West Africa. We consulted online scholarly literature datasets of peer-reviewed journal articles, theses and dissertations, books, conference papers, and technical reports. The online scholarly literature datasets used were Google Scholar (<https://scholar.google.com/>) and SCOPUS (<https://www.scopus.com/>). Search strings were defined using the keywords of this study such as *dams*, *reservoirs*, *datasets*, *water management*, and *West Africa* along with their synonyms, and related words to ensure comprehensive coverage of pertinent literature (Table 1). Based on this review, we selected datasets that are open-access with standardized file formats (CSV or XLS and SHP) for compilation (Fig. 2, Table 2). For each dataset, we used the most recent dataset version available at the time of the study and combined the versions when they are complementary. For instance, we combined two versions of the Global Lakes and Wetlands Database (GLWD) into a unified dataset by merging them: GLWD Level 1 (GLWD-L1) including large waterbodies (≥ 50 km² for lakes and ≥ 0.5 km³ for reservoirs), and GLWD Level 2 (GLWD-L2), which includes smaller waterbodies.

Table 1: Search strings used to carry out the literature review, along with details on search language, year of publications and type of online scholarly literature datasets consulted.

Thematic	Search strings used
Dam and reservoir	Dam, Reservoir, Dams and their associated Reservoirs, Barrier, Small Dam, Large Dam, Artificial Reservoir, Waterbody, Enclosed Waterbody, Small Reservoir, Large Reservoir, Barrage, Impoundments

Thematic	Search strings used
Dataset	Database, Datasets, Global Dam Database, Regional Dam Dataset, Dam Dataset, Reservoir Dataset, West Africa Dataset, West Africa dam and reservoir datasets, Hydrological Dataset, West Africa Hydrological Dataset, Waterbody database
Study Area	West Africa, Countries of West Africa
Subject Area	Water Management, Hydrology, Climate Change, Irrigation, Hydropower
Year of publications	No specific date
Languages	English and French
Online scholarly literature databases	Google Scholar and SCOPUS

Table 2: List of datasets selected to compile the West Africa dam-reservoir dataset.

Dataset selected for compiled dataset		Accessibility	Coverage	Format	References
Global Information System on Water and Agriculture of the Food and Agriculture Organization	FAO AQUASTAT	Open access	Global	XLS	FAO (2021)
Global Lakes and Wetlands Database	GLWD-1 (Level 1) & GLWD-2 (Level 2)	Open access	Global	SHP	Lehner and Döll (2004)
-	HydroLAKES	Open access	Global	SHP	Messenger et al. (2016)
Global Georeferenced Database of Dams	GOODD	Open access	Global	SHP	Mulligan et al. (2020)
Future Hydropower Reservoirs and Dams Database	FHReD	Open access	Global	XLS	Zarfl et al. (2015)
Global Reservoirs and Dams version 1.3	Grand V1.3	Open access	Global	SHP	Lehner et al. (2011)
Global River Obstruction Database version 1.1	GROD v1.1	Open access	Global	SHP	Yang et al. (2022)
Reservoir and Lake Surface Area Timeseries	ReaLSAT	Open access	Global	SHP	Khandelwal et al. (2022)
Georeferenced global Dams And Reservoirs	GeoDAR	Open access	Global	SHP	Wang et al. (2022)
Global Dam Tracker	GDAT	Open access	Global	SHP	Zhang and Gu (2023)
Global Dam Watch	GDW database (V1)	Open access	Global	SHP	Lehner et al. (2024)
Global Lakes/Reservoirs Surface Extent Dataset	GLRSED	Open access	Global	SHP	Bai et al. (2025)

2.3 Compilation of selected datasets and quality control

We extracted the data related to West Africa from each dataset and compared their entry (feature) types (dams and/or closed waterbodies) and counts, the proportional (percentage) representation of West African entries, and their attribute types and records. We then merged dam point and waterbody polygon entries separately into unified shapefiles using the Quantum Geographic Information System software (QGIS version 3.28.3) (Moyroud and Portet, 2018).

We overlaid the two merged files (point and polygon files) on high-resolution satellite basemaps from ESRI Imagery and Google Earth. This was to verify and refine the spatial accuracy of dam and reservoir geographic coordinates and to digitize missing dam points or reservoir polygons as appropriate. ~~The satellite images also enabled us to visually identify natural waterbodies such as rivers and lakes that were subsequently removed manually from the data. We only retained man-made reservoirs with dams.~~ Dam points and reservoir polygons do not always have a strict one-to-one relationship in the compiled dataset as the selected source datasets differ in their feature types and purposes. Some datasets provide dam locations as points only, while others provide reservoir polygons without associated dam points. In addition, some large or complex reservoir systems may include more than one dam-related point, while some small dams may not have a clearly mapped reservoir polygon in the available products. Where possible, we linked dam points to reservoir polygons using spatial overlay and

proximity analysis in QGIS. A dam point was associated with a reservoir polygon when it was located within, on the boundary of, or immediately downstream of the polygon. This spatial matching was supported by attribute information where available, including dam or reservoir name, country, river or basin, reservoir area, and source dataset. We manually inspected ambiguous cases using the spatial layers and, where necessary, satellite imagery or base maps. The satellite images also enabled us to visually identify natural waterbodies such as rivers and lakes that were subsequently removed manually from the data. We only retained man-made reservoirs with dams.

Several original datasets may share common source information or inherit records from earlier datasets. We accounted for this issue mainly through duplicate identification and data-source tracking. We identified duplicate records using a combination of spatial and attribute-based checks. Records with identical or nearly identical geographic coordinates were flagged as potential duplicates. We visually inspected in QGIS, overlapping or very closely located features. Additionally, available attributes such as dam or reservoir name, country, river or basin name, reservoir area, storage capacity, construction year, and source dataset were compared to confirm whether the records referred to the same infrastructure. When duplicate records were confirmed, we retained only one representative record in the compiled dataset. Attribute information from the duplicate sources was not simply discarded; rather, consistent information was retained and used to improve the completeness of the final record. When attribute values differed across sources, we retained the most complete and consistent record and identified the primary contributing dataset in the source field of the compiled dataset.

Finally, we assessed the differences between the newly compiled dataset and the original datasets (sect. 2.2) at the West Africa scale by comparing the probability density distribution of attributes such as dam latitude, reservoir latitude, reservoir surface area, and reservoir volume. We estimated these distributions using Kernel Density Estimation (KDE), a widely used non-parametric method for probability density estimation (O'Brien et al., 2016). We defined the reservoir surface area classes based on the definition proposed by FAO (Table 3, Bernacsek, 1984). We classified minor and small reservoirs as “small-scale infrastructure” and medium, large, and major reservoirs as “large-scale infrastructure.” We further related dam size classes to the size class of their associated reservoirs. Accordingly, a small dam refers to a dam associated with a small reservoir.

Table 3: Reservoir categories ranked according to the surface area of reservoirs (Bernacsek, 1984).

Reservoir category	Surface area range (km ²)
Major	≥ 1,000
Large	100–999
Medium	10.0–99.9
Small	1.00–9.99
Minor	0.010–0.999

2.4 Assessment of data quality through a watershed scale ground truthing

The quality assessment of the dam and reservoir data at the watershed scale follows a structured, multi-step process designed to compare the compiled dataset with ground truth data. First, we consulted national institutions and agencies involved in studies related to dams and reservoirs in order to access their records. These institutions are the Geoscience & Environment Laboratory of Nangui Abrogoua University (UNA) in Côte d'Ivoire and the National Office of Technical Studies and Development (BNETD).

Next, we conducted field surveys during the dry season (December 2024) across the Upper Bandama watershed, which covers approximately 14,000 km². Using a structured questionnaire (Appendix A, Fig. A1), we carried out group interviews with local communities in each village that hosts a dam, covering ten villages and four districts (county) in total: Niakaramandougou, Dikodougou, Korhogo, M'Bengué. Interview questions were focused on dam and reservoir characteristics (e.g. year of construction, main uses, existence or not of maintenance plan, reservoir surface and volume, potential number of users).

Participants included traditional authorities, local dam management bodies, user cooperatives, women's and youth associations, and smallholder farmers (Appendix B, Table B1). This participatory approach ensures that the data reflects both technical accuracy and socio-environmental realities (Quimby and Beresford, 2023). Additionally, we recorded ground truth geographic coordinates of dams and their reservoirs using a GPS-enabled handheld device. It is important to note that the survey focused on dams and reservoirs identified through consultations with institutions, local authorities, and community members, and that were accessible by vehicle or on foot and therefore verifiable during field visits.

Data from the field and institutional sources were combined to form a ground truth dataset for the Upper Bandama watershed. This field campaign data (ground truth data) was then compared with the compiled dataset (sect. 2.3) to evaluate how accurately the compiled dataset represents the spatial representation and the characteristics of constructed dams and their reservoirs. The comparison involved the probability of density distribution of attributes including latitude of dams, year of completion, reservoir volume, reservoir surface area, average reservoir depth, dam height, and average discharge (outflow). In addition, we determined the descriptive statistics (mean, median, root mean square error (RMSE), and interquartile range (IQR)) for each attribute to quantify the differences between the compiled dataset (sect. 2.3) and the field campaign data for the Upper Bandama watershed.

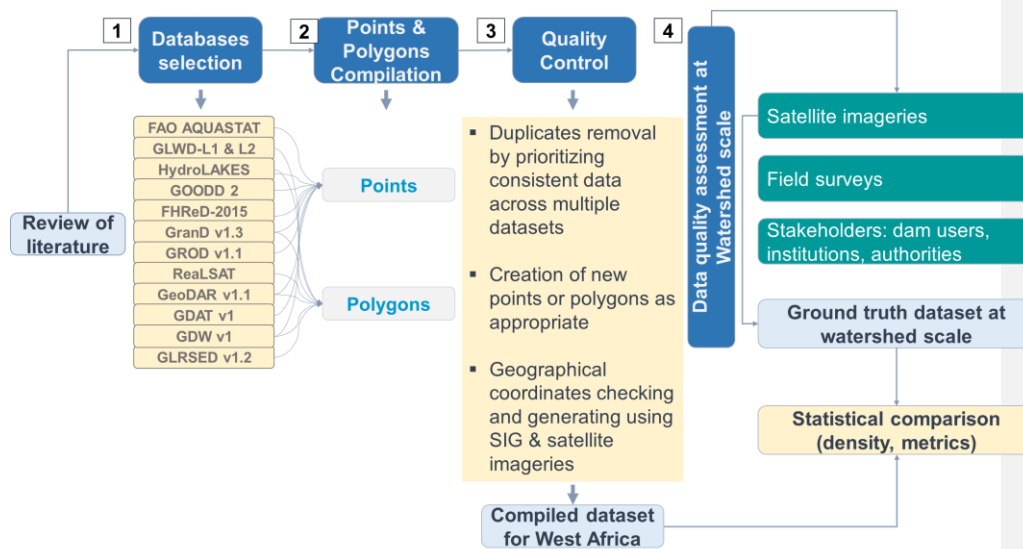


Figure 2: Flowchart describing the methodological approach applied to develop the West Africa dam and reservoir dataset: 1) datasets selection through literature review, 2) compilation of point and polygon shapefiles from the selected datasets, 3) quality control of the compiled dataset, and 4) data quality assessment at watershed scale.

3 Results

3.1 Existing databases containing West African dam and reservoir data and their characteristics

The International Commission on Large Dams (ICOLD) has maintained and regularly updated the World Register of Dams (WRD) since 1958. The WRD is a comprehensive inventory of over 62,000 large dams (≥ 15 m in height or ≥ 3 million m^3 in storage capacity) across 166 countries, of which two-thirds are georeferenced (ICOLD, 2024). The WRD has informed the development of several major global datasets, including the Global Lakes and Wetlands Database (GLWD) (Lehner and Döll, 2004). GLWD provides a global raster map with a 30-second resolution structured in three tiers: (1) 3,067 large lakes (≥ 50

km²) and 654 large reservoirs (≥ 0.5 km³), (2) approximately 250,000 smaller waterbodies (≥ 0.1 km²), and (3) a classification of wetland type.

The Food and Agriculture Organization (FAO) incorporated data from the WRD and other sources, including national surveys and literature reviews, into the Global Information System on Water and Agriculture (AQUASTAT) (FAO, 2007, 2021). AQUASTAT provides detailed information on approximately 14,500 dams and their reservoirs, covering the geographic location, dam height, reservoir capacity, surface area, and primary purpose. This dataset contributed to the Global Reservoirs and Dams (GRanD) database, which supports integrated assessments of the environmental and socio-economic impacts of dams (Lehner et al., 2011). GRanD v1.1 contains 6,862 records with a combined storage capacity of 6,197 km³. In 2019, GRanD v1.3 added 458 additional reservoirs, bringing the total to 7,320, and the earlier v1.2 which was not produced as a standalone product was integrated into the HydroLAKES v1.0 database (Lehner et al., 2011). These updates reflect the continued global growth of reservoir capacity, especially from projects completed between 2000 and 2016. Other relevant databases include the Future Hydropower Reservoirs and Dams (FHReD) database (Zarfl et al., 2015), which contains over 3,700 planned or under-construction dams exceeding 1 MW in capacity. Mulligan et al. (2020) introduced the GLObal GeOreferenced Database of Dams (GOODD), which is containing over 38,000 dams identified through high-resolution satellite imagery, although with limited attribute information. The version 1.1 of the Global River Obstruction Database (GROD v1.1) by Yang et al. (2022) maps 30,549 artificial structures across 2.1 million km of large rivers using Google Earth Engine. Each structure is categorized into one of six types of flow barriers. Wang et al. (2022) developed the Georeferenced global Dams And Reservoirs (GeoDAR) dataset using Google Maps and other inventories including ICOLD WRD, GRanD v1.3, and HydroLAKES v1.0. GeoDAR v1.1 includes, in all continents except Antarctica, over 24,000 dam points and 21,500 reservoir polygons linked to high-resolution water masks. Zhang and Gu (2023) relied on AQUASTAT, GRanD, and the World Resources Institute (WRI) database to build the Global Dam Tracker (GDAT), which includes over 35,000 geocoded dams, suitable for temporal analysis. A recent consolidation effort by Lehner et al. (2024) harmonized datasets by releasing the Global Dam Watch (GDW v1), integrating GRanD, GOODD, and FHReD, and complemented by GROD and the EC Joint Research Centre's Global Surface Water dataset. GDW v1 contains 41,145 dam and barrier locations, and 35,295 reservoir polygons, with a total storage of 7,405 km³.

In parallel, recent initiatives focused on global monitoring of waterbody surface dynamics and morphology which contain data about reservoirs in all continents (except Antarctica). Khandelwal et al. (2022) developed the ReaLSAT dataset using machine learning applied to Earth Observation data and compiled surface area variations of over 681,000 waterbodies (≥ 0.1 km²) from 1984 to 2015. Donchyts et al. (2022) monitored 71,208 small to medium-sized reservoirs globally using multi-sensor satellite data. Khazaei et al. (2022) introduced a novel GLObal Bathymetric (GLOBathy) dataset, which estimates bathymetry for over 1.4 million waterbodies using a GIS-based framework. Bai et al. (2025) produced the GLRSED, combining data from HydroLAKES and OpenStreetMap to provide detailed spatial and physical attributes for 2.17 million entries (features). We provided a summary of existing global databases containing data for West African dams and reservoirs in the following table (Table 34).

Table 43: List of some existing databases containing West African dam and reservoir related data and their characteristics.

Database	Scale	Size of dams and related reservoirs included	Number of dams and reservoirs	Dam and related reservoir attributes	Geospatially referenced	Source of data & methods used	Date of dataset creation	Last updated	Accessibility	Data format	Link for accessing	Reference
ICOLD - WRD	Global	Dams > 3 Million Cubic Meters (MCM)	62,339 dams	Country, name of dam, year of commissioning, dams & reservoirs' characteristics (height, length, volume, area, etc.) purposes, owners, etc.	Yes (only 2/3)	National inventories from member countries	1958	2024	Subscription-based access	-	https://www.icold-cigh.org/GB/world_register/world_register_of_dams.asp	ICOLD (2024)
FAO AQUASTAT	Global	Dams ≥ 0.001 MCM	14,500 dams	Location, height, reservoir capacity, surface, and main purpose	Yes	National reports, country surveys, ICOLD (WRD), OMS, Wikipedia, etc. Combination of seven digital maps and attribute data sets (WRD, ArcWorld, GLCC in 'Global Ecosystem' classification)	1994	Regular updates	Open access	CSV	https://www.fao.org/aquastat/en/databases/dams	FAO (2021)
GLWD-1 (Level 1)	Global	Lakes ≥ 50 km ² Reservoirs ≥ 0.5 km ³	3,067 lakes 654 reservoirs	Includes extensive attribute data	Yes		2004	-	Open access	SHP	https://www.worldwildlife.org/publications/global-lakes-and-wetlands-database-lake-polygons-level-1	Lehner and Döll (2004)
GLWD-2 (Level 2)	Global	Water bodies ≥ 0.1 km ²	250,000 smaller lakes, reservoirs and rivers	Includes extensive attribute data	Yes	-	2004	-	Open access	SHP	https://www.worldwildlife.org/publications/global-lakes-and-wetlands-database-small-lake-polygons-level-2	Lehner and Döll (2004)
GLWD-3 (Level 3)	Global	-	All water bodies of levels 1 and 2	Global raster map at 30-second resolution	Yes	-	2004	-	Open access	Raster	https://www.worldwildlife.org/publications/global-lakes-and-wetlands-database-lakes-and-wetlands-grid-level-3	Lehner and Döll (2004)
HydroLAKES	Global	Lakes ≥ 10 ha	1.4 million lakes or reservoirs	Mostly geometric attribute (surface area, shoreline length, average depth, water volume, etc.)	Yes	Use of auxiliary data sources of lake polygons and gridded lake surface areas	2006	Regular updates	Open access	SHP	https://www.hydro-lakes.org/projects/hydro-lakes	Messager et al. (2016)
GOOOD	Global	Dam wall length ≥ 150 m	38,667 dams	Location and associated watershed	Yes	Visible dams digitized using Google Earth's satellite imagery	2009	2020	Open access	SHP	https://docs.google.com/forms/d/e/1FAIpQLSID8vAIBds75gFcLOxy0CQeJbO6z0s66RgcIe110z750Q/view/form?fbzx=8791344801892727584	Mulligan et al. (2020)
Grand V1.1	Global	Dams ≥ 0.1 km ³	6,862 dams	Location, name, dams/reservoirs' characteristics, purpose, year, etc.	Yes	Datasets from institution, statistics approaches, HydroSHEDS, AQUASTAT, etc.	2011	2019	Open access	SHP	https://in.sync.com/dl/eb25b8d9df4e4e45apc4m-kgr84bu-uf6da7q5/view/default/447817190013	Lehner et al. (2011)
FHRcD	Global	Dams ≥ 1 MW	3,700 dams	Project name, location, river basin, hydroelectric capacity, and construction timeline	Yes	Peer-reviewed literature, existing databases, contribution from NGOs	2015	-	Open access	CSV	https://in.sync.com/dl/b984e6802eupdfce7maza9m-n8d7znk-kumz28k/view/default/447830420013	Zarfl et al. (2015)
Global Surface Water	Global	All size included	-	Surface water occurrence, change, seasonality, recurrence, transitions and maximum extent	Yes	Three million Landsat satellite images used to quantify changes in global surface water over the past 32 years at 30-metre resolution.	2016	-	Open access	Raster	https://global-surface-water.appspot.com/download	Pekel et al. (2016)
Grand V1.3	Global	Dams ≥ 0.1 km ³	7,320 dams	Location, name, dams/reservoirs' characteristics, purpose, year, etc.	Yes	Datasets from institution, statistics approaches,	2019	-	Open access	SHP	https://in.sync.com/dl/bd47ab6b90anhxakr-c6bmrgqk-44x84fz	Lehner et al. (2011)

Database	Scale	Size of dams and related reservoirs included	Number of dams and reservoirs	Dam and related reservoir attributes	Geospatially referenced	Source of data & methods used	Date of dataset creation	Last updated	Accessibility	Data format	Link for accessing	Reference
GRDD v1.1	Global	Barriers on rivers ≥ 30 m	30,549 barriers	Barrier class, incl. dam, lock, low-head dam	Yes	HydroSHEDS, AQUASTAT, etc. Manually identified on Google Earth Engine satellite map	2021	-	Open access	SHP	https://zenodo.org/records/5793918	Yang et al. (2022)
RealSAT	Global	Lakes and reservoirs $> 0.1 \text{ km}^2$	681,137 lakes and reservoirs	Location and surface area variations from 1984 to 2015	Yes	Measurement and unsupervised machine learning on satellite derived data	2021	2023	Open access	SHP and Raster	https://zenodo.org/records/7614815	Khandelwal et al. (2022)
GeoDAR v1.1	Global	Dams $> 3 \text{ MCM}$	24,783 dams and 21,515 reservoirs	Multiple attributes including location and storage capacity.	Yes	Google Maps geocoding - API and multi-source inventory (WRD, GRand v1.3, HydroLAKES, etc.)	2022	-	Open access	SHP	https://zenodo.org/records/6163413	Wang et al. (2022)
Global Water Watch	Global	$0.01 \text{ km}^2 \leq \text{Reservoirs} \leq 100 \text{ km}^2$	71,208 reservoirs	Reservoir water area time series (m^2), reservoir water storage time series (m^3)	Yes	Multi-satellite data	2022	-	Open access	Satellite images and CSV of time series	https://globalwaterwatch.earth	Donchits et al. (2022)
GLOBathy	Global	Lakes $\geq 10 \text{ ha}$ (HydroLAKES water bodies)	1.4+ million waterbodies	Lake depth, reservoir depth, bathymetry, Head-Area-Volume relationship	Yes	Machine learning, Geographic Information System, bathymetry data processing	2022	-	Open access	Raster	https://doi.org/10.6084/m9.figshare.c.5243309.v1	Khazaei et al. (2022)
GDAT	Global	All size included	$> 35,000$ dams	Location, completion year, purpose, height, length, and installed capacity, etc.	Yes	AQUASTAT, GRand and the World Resources Institute (WRI) database) and other sources	2023	-	Open access	SHP	https://zenodo.org/records/7616852	Zhang and Gu (2023)
GDW database (V1)	Global	All size included	41,145 barriers 35,295 reservoirs	> 50 attributes, incl. height, purpose, year, volume, discharge	Yes	Existing databases (GOODD, Grand V1.3, FHRED, etc.)	2024	Regular updates	Open access	SHP	https://figshare.com/articles/data/set/Global_Dam_Watch_database_v1.0/25988293	Lehner et al. (2024)
GLRSED	Global	All size included	2.17 million lakes / reservoirs	Spatial extent and basic attributes (e.g., name, area, source, depth and type)	Yes	Existing database (HydroLAKES, OSM, GRand, GOODD, GeoDAR)	2024	2024	Open access	SHP	https://zenodo.org/records/14190225	Bai et al. (2025)
<i>Databases are listed in order of their creation date</i>												

245 **3.2 Comparison of data on West African dams and reservoirs from selected datasets**

3.2.1 Type of entries and their proportional representation for West Africa in selected datasets

The number of entries (dams, other barriers and any closed waterbodies) contained in the datasets varies between datasets. This also applies to the extent and detail of West African related entries (Fig. 3). The total entries counted in the selected datasets varies from 3700 to 2.17 million with FHRed containing the fewest records and GLRSED v1.2 holding the highest number of entries. The proportion of West African entries within the selected datasets is relatively low ranging from 0.19% to 4.26%. Despite the extensive global coverage of GLRSED, only 0.26% of its entries correspond to West Africa. These clearly reflect the differences between the existing datasets regarding the total number of entries recorded for West Africa (Fig. 4). These differences are also observable at the level of the entry types in selected datasets. According to the type of their entries, the datasets can be grouped into four categories:

- Dam-only datasets, including various barrier types (e.g., FAO AQUASTAT, GOODD 2, FHRed, GROD v1.1, GDAT);
- Integrated dam-reservoir datasets providing information on both infrastructure and associated waterbodies (e.g., Grand v1.3, GeoDAR v1.1, GDW v1);
- Combined lakes and reservoirs datasets (e.g., GLWD-L1 & L2, HydroLAKES, GLRSED v1.2);
- Unspecified waterbody datasets where natural lakes, artificial reservoirs, and other surface waters are grouped without classification (e.g., RealSAT).

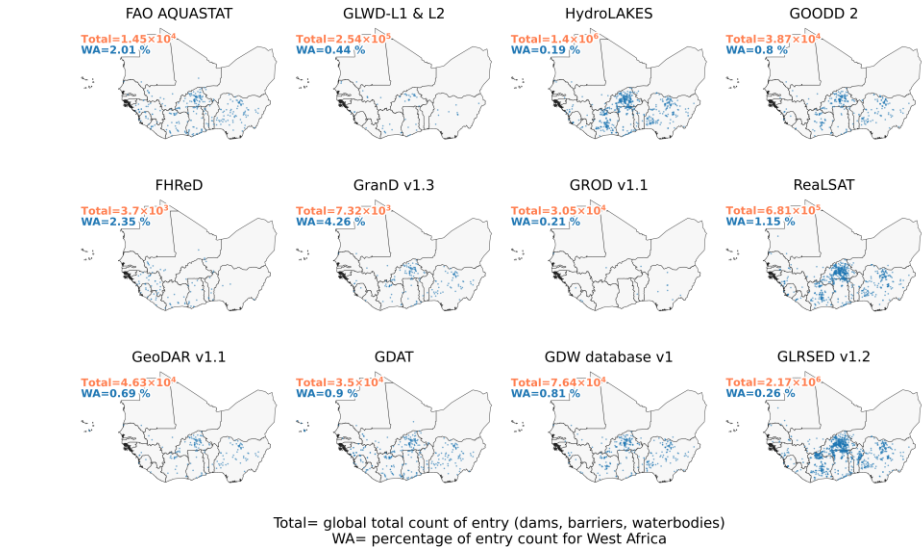


Figure 3: Comparison of global total count of entry (dams, other barriers, and closed waterbodies) and the corresponding proportion (percentage) of West African entries in selected datasets.

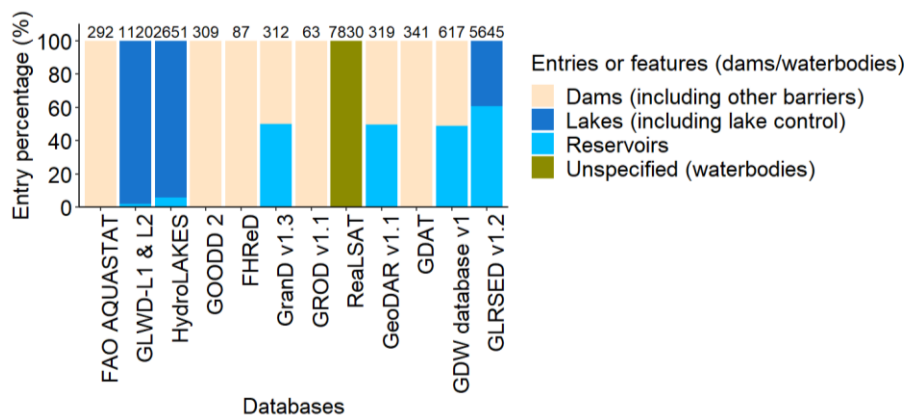


Figure 4: Entry types, total counts, and proportion (%) of each entry for West Africa in selected datasets. The term “lake control” refers to a natural lake that is influenced or regulated by a control structure, such as a dam or outlet regulation structure.

3.2.2 Type of available attributes for the selected datasets

A wide range of attributes for West African dams and reservoirs is included in the available datasets and varies across the datasets (Table 5). This encompasses:

- Identification data: Name of dam or reservoir, geographic coordinates, country, continent, administrative unit, and year of construction;
- Geometric data: Dam or barrier height and length, reservoir surface area, storage volume, and average depth;
- Purpose-related data: Designated uses such as irrigation, hydroelectric power generation, livestock watering, and flood control;
- Hydraulic and hydrological data: Inflow, discharge (outflow), water residence time, and sedimentation characteristics.

Although some attributes appear to be common across the datasets, clear differences exist in the number of information recorded. We outlined these differences by providing a comparative overview of attribute types and completeness across selected datasets for West Africa (Table 56). FAO AQUASTAT dataset reports the largest total surface area of reservoirs and the highest number of dams categorized by use. HydroLAKES covers the most West African countries and reports the highest total storage capacity. ReaLSAT contains the largest number of entries and is unique in providing data on the dynamics of water surface bodies and GDAT includes the highest number of entries with names and years of completion.

Table 54: Attribute types (identification, geometry, purpose, and hydraulic and hydrological data) available in selected dam and reservoir datasets. The cross in the cells indicates the availability of the attribute type in the dataset.

Dataset	Attribute types available in selected datasets				Reference
	Identification data	Geometric data	Purpose-related data	Hydraulic and hydrological data	
FAO AQUASTAT	x	x	x		FAO (2021)
GLWD-L1 & L2	x	x	x		Lehner and Döll (2004)
HydroLAKES	x	x		x	Messenger et al. (2016)
GOODD 2	x				Mulligan et al. (2020)
FHReD	x		x		Zarfl et al. (2015)
GranD v1.3	x	x	x	x	Lehner et al. (2011)
GROD v1.1	x				Yang et al. (2022)
ReaLSAT	x	x			Khandelwal et al. (2022)
GeoDAR v1.1	x	x			Wang et al. (2022)
GDAT	x	x	x		Zhang and Gu (2023)
GDW dataset v1	x	x	x	x	Lehner et al. (2024)
GLRSED v1.2	x	x			Bai et al. (2025)

Table 65. Comparison of attribute type details and data completeness in selected dam and reservoir datasets for West Africa. Bold values represent the highest column values.

Datasets	Identification data				Geometric data				Purpose-related data				Hydraulic and hydrological data			
	292	292	14	179	106	106	106	106	123	110	114	66	2	3	0	-
FAO AQUASTAT	292	292	14	179	106	106	106	106	123	110	114	66	2	3	0	-
GLWD-L1 & L2	1120	29	13	11	11	-	-	444200	5	1	8	-	2	-	-	-
HydroLAKES	2651	16	16	-	-	2651	-	35100	-	-	-	-	-	-	-	-
GOODD 2	309	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
FHReD	87	87	12	4	-	-	-	-	-	-	87	-	-	-	-	-
Grand v1.3	312	156	12	156	156	156	12400	260	101	81	27	47	2	4	0	-
GROD v1.1	63	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
RealSAT	7830	-	-	-	-	-	42000	-	-	-	-	-	-	-	-	7830
GeoDAR v1.1	319	-	-	-	-	-	-	258	-	-	-	-	-	-	-	-
GDAT	341	341	17	200	64	4	1	7770	8	-	-	-	-	-	-	-
GDW database v1	617	158	13	188	95	10	301	11300	101	82	29	47	2	5	27	-
GLRSED v1.2	5645	15	-	-	-	-	37500	28.9	-	-	-	-	-	-	-	-

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3.2.3 Methodological differences and limitations in existing dam and reservoir datasets

Selected datasets can be grouped into three categories based on the methods applied to collect data on dams and reservoirs: remote-sensing driven datasets, curated inventory datasets and hybrid datasets.

Remote-sensing driven datasets (e.g., GLRSED v1.2, ReaLSAT, GROD v1.1) are collected in real-time or near-real-time using optical or radar satellite imagery (e.g., Landsat, Sentinel-1/2, MODIS), automated classification, and time-series water detection algorithms (Khandelwal et al., 2022; Bai et al., 2025). These datasets can provide detailed measurements of parameters of dam and reservoir entries such as water levels and flow rates at a high spatial and temporal resolution and can track small, ephemeral, or seasonally variable waterbodies. They are particularly useful for monitoring and managing dynamic systems, allowing for timely responses to changes (Donchyts et al., 2022; Kachoue et al., 2025). Limitations are that accuracy can be affected when high-resolution imagery is not available or when distinguishing between man-made and natural waterbodies (Khandelwal et al., 2022; Bai et al., 2025).

Curated inventory datasets (e.g., GLWD, FAO AQUASTAT, GeoDAR v1.1, GDAT, FHReD, GDW Database v1) are typically more static datasets that compile information from multiple sources, focusing on larger-scale entries and providing broad coverage of dam and reservoir attributes (Zarfl et al., 2015; FAO, 2021; ICOLD, 2024). These datasets standardize attributes, enhance accessibility and usability, and support decision-making for water management across larger spatial and temporal scales (Lehner et al., 2024). Meanwhile they may lag in representing newly constructed dams or recent environmental changes if not regularly maintained (Zarfl et al., 2015; FAO, 2021; Wang et al., 2025). In addition, small reservoirs and informal structure can sometimes be overlooked or inaccurately georeferenced due to the methods of data collection used, such as manual georeferencing or inconsistencies in attribute reporting (Paredes-Beltran et al., 2021; Minocha and Hossain, 2025).

Hybrid datasets (e.g., HydroLAKES, GOODD 2, GRanD v1.3) combine remote-sensing data for mapping with curated inventory data for metadata, leveraging the strengths of each to enhance the overall quality and comprehensiveness of dam and reservoir information (Lehner et al., 2011; Messenger et al., 2016; Mulligan et al., 2020). However, hybrid datasets may be limited by inherent variability in data quality originating from the different sources involved in their compilation. The complexity of merging static data from curated inventory with dynamic datasets derived from remote sensing associated to mismatches in format, scale, and temporal resolution can lead to additional errors in analyses or even misinterpretations (Lehner et al., 2011; Song et al., 2022).

3.3 Compiled dataset for dams and reservoirs in West Africa

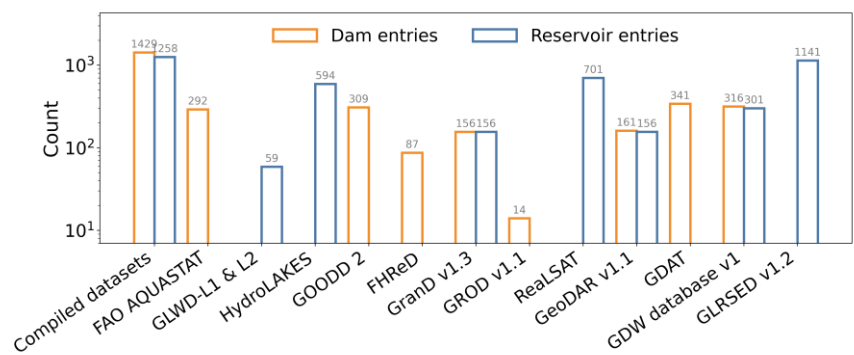
3.3.1 Description of the compiled dataset and data characteristics

The dataset that we compiled based on the selected twelve datasets contains a total of georeferenced 1,429 dam points and 1,258 reservoir polygons ($\geq 0.57 \times 10^{-3} \text{ km}^2$ and $\geq 0.1 \text{ MCM}$). Compared with the individual source datasets, the compiled dataset adds 1,088 to 1,415 dam entries and 117 to 1,119 reservoir entries, depending on the dataset considered. This number of entries

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clearly exceeds the count of dams and reservoirs in West Africa reported by any individual dataset from 288 to 1,415 entries (Fig. 5). Among the originate datasets, GLRSED contributed the largest share of reservoir records, accounting for 91% of the reservoir entries in the compiled dataset, whereas GDAT contributed the largest share of dam records, accounting for 24% of the dam entries. In terms of attribute completeness, the compiled dataset provides thirty-eight attributes. All dam entries have known geographic coordinates and country identifiers. Approximately 88 % of dam entries are linked to a delineated reservoir polygon, and 80 % contain information on the estimated reservoir surface areas. Furthermore, around 40 % of dam entries provide additional physical characteristics such as reservoir average discharge, reservoir storage capacity, mean depth, average slope, and watershed area. In contrast, metadata attributes including dam names, year of construction, major river basin, primary use, and river name are less consistently available, occurring in fewer than 20 % of dam entries (Fig. 6).



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Figure 5: Comparison of dam and reservoir (without any other type of barrier and closed waterbody) entry count between the compiled dataset and selected datasets.

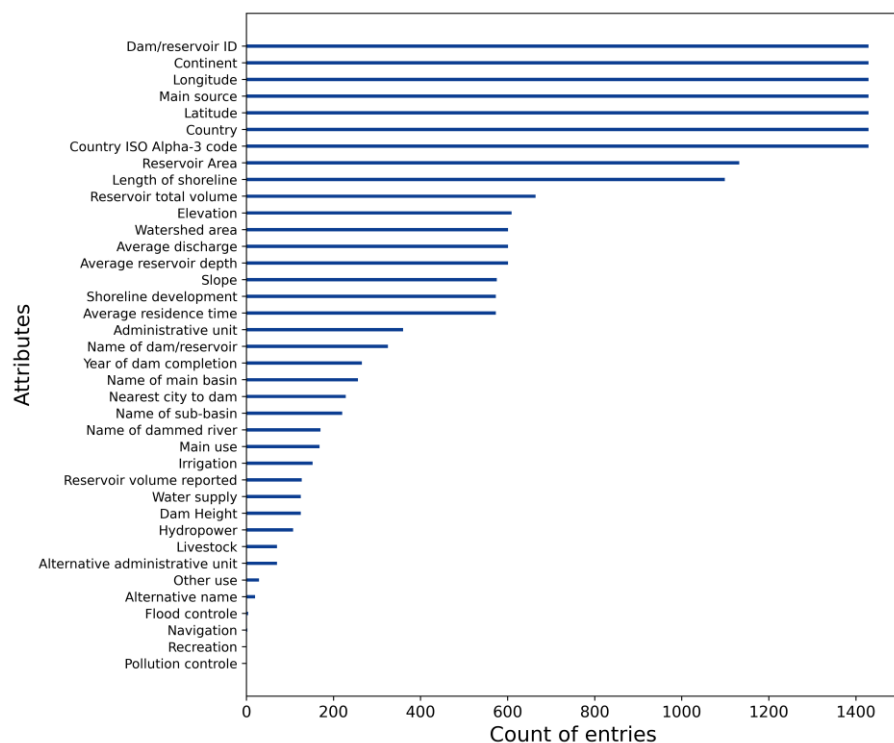


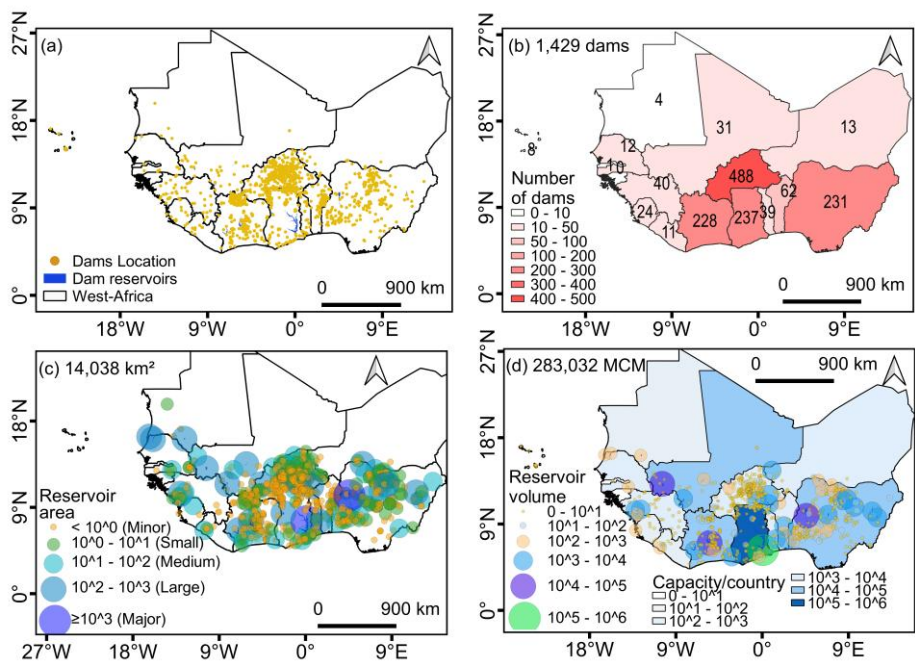
Figure 6: Attribute completeness for the 1,429 dams and their reservoirs from the compiled dataset for West Africa.

3.3.2 Spatial distribution of dams and associated reservoirs over West Africa

The spatial distribution of dams and reservoirs reported from the compiled dataset, is highly uneven across West Africa. A notable concentration is observed in Burkina Faso with 489 recorded dams (Fig. 7a). Ghana follows with 236 dams, while Guinea-Bissau stands out as the only country with no recorded dam and reservoir (Fig. 7b). Overall, the total surface area of artificial reservoirs reported from the compiled dataset is estimated at 14,038 km² (Fig. 7c). The two largest reservoirs by surface area are located in Ghana and Nigeria, namely, the Akosombo Reservoir (6,019.49 km²) and the Kainji Reservoir (1,034.85 km²). Medium-sized reservoirs are more evenly distributed across the climatic zones of West Africa, whereas small-scale infrastructure composed by minor and small ~~smaller~~ reservoirs are more commonly found in the Sudanian savannah (northern of Côte d'Ivoire, Ghana, Togo, Benin, and Nigeria) and in the semi-arid zone of Burkina Faso. In terms of water volume, the storage capacity totalled approximately 283,032 million cubic meters (MCM) for all dam reservoirs from the

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compiled dataset (Fig. 7d). However, this storage capacity is far from evenly distributed. Ghana alone accounts for 148,671 MCM, representing 52.53 % of the region’s total. Nigeria follows with 41,658.4 MCM (14.72 %), Côte d’Ivoire with 38,209.1 MCM (13.5 %), and Mali with 13,615.2 MCM (4.81 %). Interestingly, although Burkina Faso has the highest number of dams, it represents only 2.4 % of the total regional storage capacity reported from the dataset. This contrast highlights the difference between the abundance of dam infrastructure and the relatively limited water storage volume these structures represent, which is influenced by the south-north aridity gradient across West Africa.



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Figure 7: Spatial distribution and summary characteristics of 1,429 dams and their reservoirs in West Africa. (a) Locations of dams and mapped reservoirs, (b) number of dams per country, (c) reservoir surface area (totalling 14,038 km²) classified based on the definitions proposed by FAO (Bernacsek, 1984), and (d) estimated storage capacity by reservoir and aggregated per country (totalling 283,032 MCM).

3.3.3 Temporal changes in dam numbers and latitudinal distribution

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The temporal distribution of dam construction reported from the compiled dataset shows that the annual number of constructed dams peaked in 1985 in West Africa, with the oldest constructed dam dating back to 1881 (the Kpong dam in Ghana) (Fig. 8a). Spatially, the distribution of dams and their associated reservoir reflects distinct climatic gradients across the region and can be divided into three main zones (Fig. 8b). In the southernmost zone (6–8° N), corresponding to the humid tropical Guinean

coastal region, the number of dams is relatively low, yet the reservoirs are generally associated with large reservoir surface areas. Further north, between 8° and 14° N, encompassing the sub-humid Sudanian savannah and the semi-arid Sahelian zones, dam density increases markedly, with most reservoirs exhibiting small to medium surface areas. North of 14° N, the northern limit of the Sahelian zone, the number of dams declines sharply, with only a few isolated structures recorded.

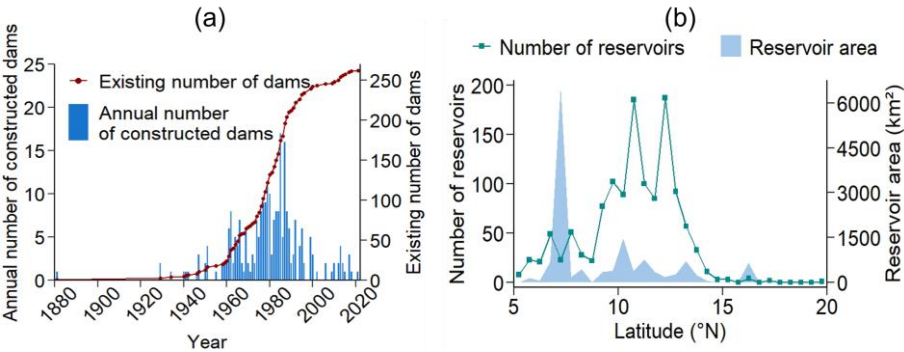


Figure 8: Temporal and spatial distribution of constructed dams and their reservoirs in West Africa. (a) Temporal changes in dam construction reported from the compiled dataset, (b) latitudinal distribution of reservoirs showing the number of reservoirs and their corresponding surface area per latitude.

3.4 Comparing spatial and size-class densities in compiled and selected datasets in West Africa

Across the existing datasets and the compiled dataset, dam and reservoir locations exhibit consistent latitudinal modes between approximately 9–13°N. The long right tails for the reservoir surface area and volume appearing in most datasets, reveals a consistent representation of large infrastructure (Fig. 9). However, density peaks at the very small entries vary widely across datasets reflecting strong differences in counts and distributions of small infrastructure (Fig. 9c, d). Additionally, differences in reservoir size distributions, including surface area and volume, indicate contrasting dataset biases. Remote sensing driven and hybrid datasets (e.g., GLRSED v1.2, ReaLSAT, HydroLAKES) predominantly capture smaller scale infrastructure. In contrast, curated inventory datasets (e.g., GLWD L1 and L2, FAO AQUASTAT, GeoDAR v1.1, GDAT) are biased toward larger dams and reservoirs. Broader or shifted latitudinal tails and variations in density magnitude, represented by line heights, across datasets imply strong differences in regional completeness and geolocation practices. As a result, even when the main spatial patterns are consistent, the number of reservoirs detected, particularly at the northern and southern edges, differs substantially between datasets (Fig. 9c, d). Compared to existing datasets, the compiled dataset integrates both large- and small-scale reservoirs. It includes a higher number of small-scale entries while preserving the central latitude mode observed in the selected datasets. This suggests better spatial completeness and scale coverage compared to individual datasets, although residual biases from the sources remain in the compiled dataset.

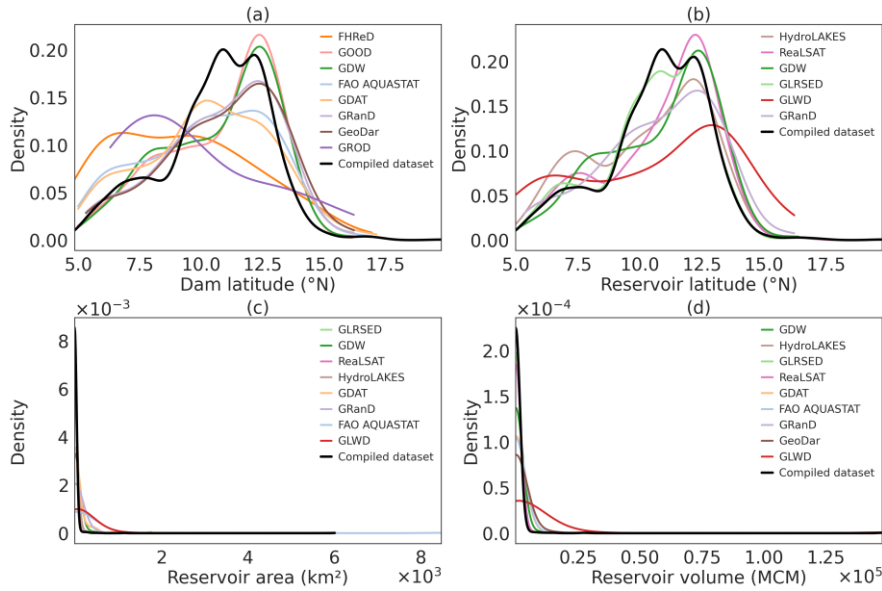


Figure 9: Density distribution of compiled dataset compared to the selected datasets at regional scale (West Africa) for the following attributes: (a) latitude of dam entries, (b) latitude of reservoir entries, (c) reservoir surface area, and (d) reservoir volume.

3.5 Benchmarking of the compiled dataset at a watershed-scale for quality assessment

The field campaign dataset (ground truth dataset) obtained at watershed scale (the Upper Bandama watershed) contains 192 dam entries with each dam entry corresponding to a matching reservoir entry. The compiled dataset contains 62 dams with associated reservoirs in the Upper Bandama watershed, all confirmed by the field campaign data, accounting for 32 % of the dams documented during field campaign (Fig 10). In addition, the compiled dataset records a total maximum reservoir area of approximately 31 km² and a total storage volume of 207 MCM for the Upper Bandama watershed, compared with 50 km² and 352 MCM, in the field campaign dataset. The compiled dataset therefore captures about 62 % of the total reservoir area and 59 % of the total storage volume reported from field campaign. After the field campaign, more detailed data was available for the different attributes relative to the available data from the compiled dataset (Fig. 11). The analysis of the density distribution (KDE) of the attributes for both datasets indicates reduced outliers and a concentration of values within more plausible ranges in the field campaign data (Fig. 12). While the number of dams is different between both datasets, the latitudinal distribution of dams is consistent and peaks around 9.50° N (Fig. 12a). The low root mean square error value (RMSE= 0.53) of the compiled latitudes indicates a very low deviation in the geographical information of the compiled dataset (Table 67). The different distribution of the year of dam completion clearly shows that current available datasets have a bias towards older dams, while

the field campaign also accounted for newer infrastructure (Fig. 12b, Table 67). Overall, the current available datasets may underrepresent newer infrastructure by approximately 8 years on average. Additionally, the field data clearly deviated from the compiled dataset in terms of reservoir surface area and storage volume (Fig. 12c, d), with the existing datasets strongly underrepresenting small- and med-sized reservoirs. These differences are associated with high RMSE values (2.79 km² and 17.44 MCM) reflecting high deviation in reservoir surface area and storage volume of the compiled dataset (Table 67). Differences in average depth and discharge were much less pronounced between what the compiled dataset showed for the Upper Bandama and what the field campaign and data collection revealed (Fig. 12e, g). However, the few samples on larger streams might have biased the tailing, which may have resulted in higher errors in the discharge values (RMSE= 15.85 m³ s⁻¹). Consistent with the revealed smaller reservoir area and storage sizes, the field-based survey revealed much smaller dams (in terms of height) compared to the data compiled from existing datasets (Fig. 12f).

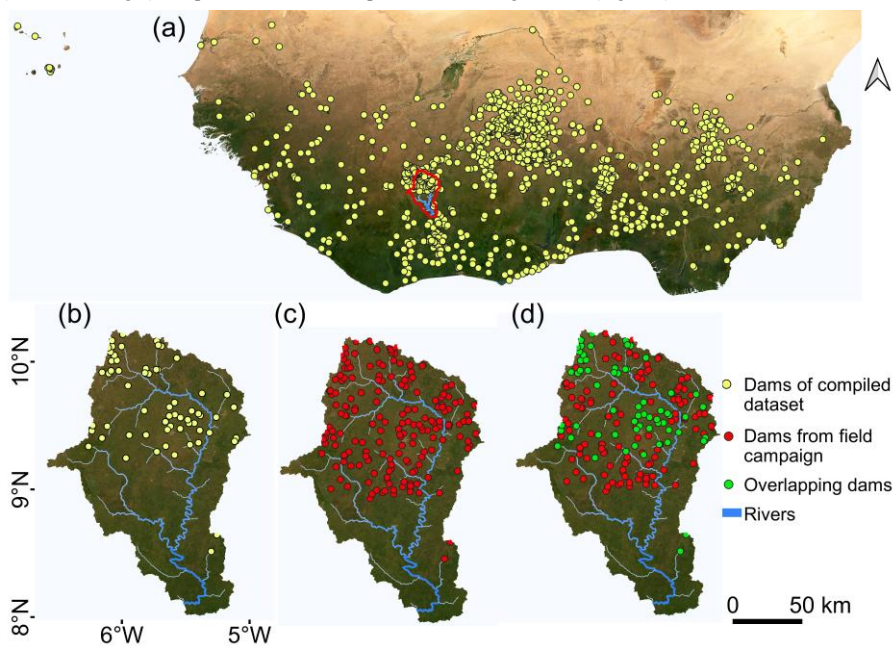


Figure 10: Comparison of dam distributions from the compiled dataset and field campaign at watershed scale. (a) Spatial distribution of dams across West Africa from the compiled dataset. (b) Map of the 62 dams contained in the compiled dataset for the Upper Bandama watershed (14,000 km²). (c) 192 dams documented during the field campaign (ground-truth data). (d) Spatial overlap between dams in the compiled dataset and those documented during field campaign. Background image source: Esri imagery base map.

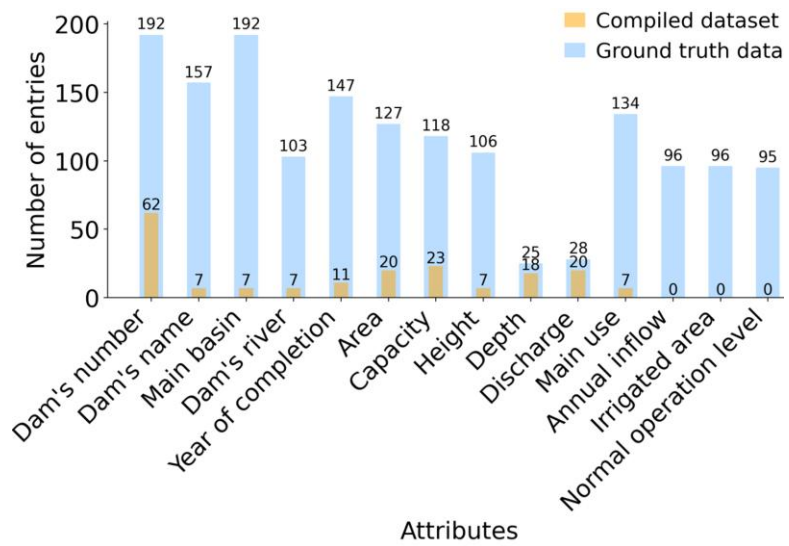


Figure 11: Comparison of the number of entries for different attributes reported from the compiled dataset and the field campaign data (ground truth data) at watershed scale.

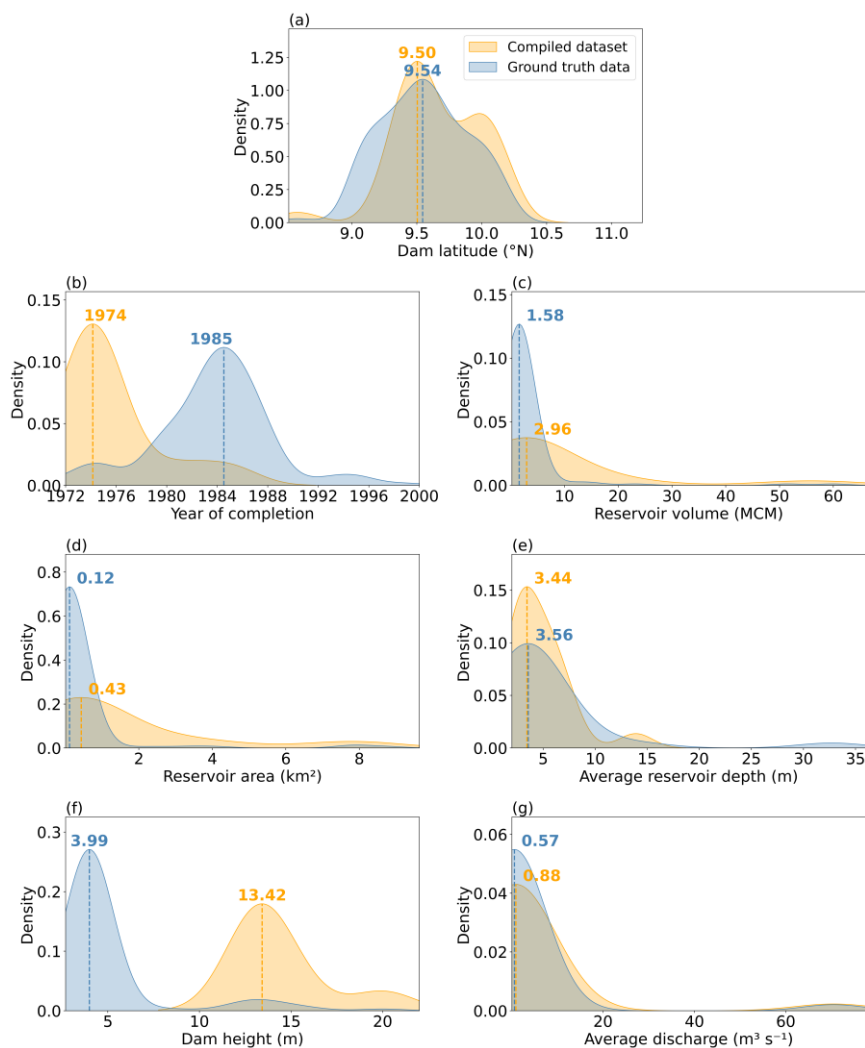


Figure 12: Comparison of the density distribution of attributes from the compiled dataset and the field campaign dataset (ground truth data) at watershed scale (14,000 km²). This does not represent a one-to-one comparison of the same dams, but rather compares the overall attribute distributions in both datasets. The attributes shown are: (a) latitude, (b) year of completion, (c) reservoir volume, (d) reservoir surface area, (e) average reservoir depth, (f) dam height, and (g) average discharge. Density distribution of the

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compiled dataset compared to the ground truth data for the following attributes: (a) latitude (° N), (b) year of completion, (c) reservoir volume, (d) reservoir surface area, (e) average reservoir depth, (f) dam height, (g) average discharge.

Table 76: Statistical comparison of compiled and field campaign (ground-truth) data for dam latitude, year of completion, reservoir volume, reservoir area, average reservoir depth, dam height and average discharge at watershed scale.

Variable	Latitude (° N)	Year	Volume (MCM)	Area (Km ²)	Depth (m)	Height (m)	Discharge (m ³ s ⁻¹)
Mean of compiled	9.66	1975	9.02	1.53	4.74	14.43	4.46
Mean of compiled dataset - RMSE	9.13	1972	-8.42	-1.25	2.11	2.83	-11.39
Mean of compiled dataset + RMSE	10.19	1979	26.45	4.32	7.38	26.03	20.31
Median of compiled dataset	9.59	1974	3.10	0.51	3.60	13.00	0.11
IQR of compiled dataset	0.48	1.50	5.39	0.92	2.78	1.50	1.10
RMSE	0.53	3.40	17.44	2.79	2.63	11.60	15.85
Mean of ground truth data	9.55	1984	2.99	0.39	5.34	5.00	3.22
Median of ground truth data	9.56	1984	1.50	0.08	3.20	4.00	0.10
IQR of ground truth data	0.51	4	0.90	0.08	3.10	0.45	0.22

RMSE: Root mean square error, IQR: Interquartile range

4 Discussion

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4.1 Differences between existing datasets and quality of compiled dataset for West Africa

The comparison among existing dam and reservoir datasets highlighted substantial differences, particularly in spatial resolution, entry types (dams and/or reservoirs), and attribute completeness. These differences reflect to the heterogeneity of data sources, reporting standards, geographical focus, the dynamic nature of dam and reservoir operations, and variation in data collection approach and dataset objectives (Zarfl et al., 2015; Zhang and Gu, 2023; Bai et al., 2025). Such discrepancies have critical implications for future mapping efforts and research in Earth system sciences, including hydrology, climatology, and land-surface processes. In particular, they can lead to substantial uncertainty in estimates of surface water storage, flow regulation, evaporation losses, and human water use, especially in data sparse regions such as West Africa, highlighting the urgent need for standardized, high-resolution, and systematically validated datasets.

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The ground truthing assessment showed that only 32 % of the field observed dams (with their associated reservoirs) were contained in the compiled dataset for the Upper Bandama watershed corresponding to a gap of 68 %. This result support the findings in Zhang and Gu (2023) that revealed a low proportion of West African dams in existing datasets and emphasized that publicly available dam-related data for much of Africa (except South Africa) remain limited due to restricted access and scarce reporting from national institutions. Complementary findings by Cecchi et al. (2020) suggest that water infrastructure development in the region has largely focused on small scale systems, such as minor earth dams and farm reservoirs. These

445 small scale structures are often constructed informally or at the community level (e.g., for community irrigation or livestock)
without official documentation limiting their inventory (Brewitt and Colwyn, 2020; Hennig et al., 2023; Umukiza et al., 2023).
The bias of the compiled dataset toward large scale dams and reservoirs is inherited from source datasets that primarily capture
well-documented, officially reported, or remotely detectable large dams, which typically have long operational histories and
broader geopolitical or hydrological significance (Biswas and Tortajada, 2001; Lehner et al., 2011; Schulz and Adams, 2019;
450 Hennig et al., 2023; ICOLD, 2024). In addition, the use of moderate-resolution satellite imagery (e.g., 30 m) in most datasets
limits the detection of small dams and their reservoirs (Pekel et al., 2016; Mulligan et al., 2020; Yang et al., 2022).
Consequently, the combined limitations of documentation and detection technologies result in the underestimation of small
dams and reservoirs in remote sensing-driven, curated inventory and hybrid datasets.

The spatial pattern derived from the compiled dataset revealed a pronounced concentration of dams and reservoirs between 8°
455 N and 14° N, corresponding to the Sudanian zone. This is consistent with previous studies (Cecchi et al., 2009b; Lèye et al.,
2021; Fowé et al., 2023) and reflects long-term efforts to mitigate rainfall variability and sustain agricultural productivity in
the savannah biome (Cecchi et al., 2009a; Lèye et al., 2021; Fowé et al., 2023; Peña-Angulo et al., 2025).

Similar to other regional compilations (Paredes-Beltran et al., 2021; Song et al., 2022) the compiled dataset for West Africa
contains fewer missing entries and exhibits lower bias compared to the originate datasets. This advances the existing efforts
460 by explicitly integrating both large and small scale reservoirs. The compiled dataset reduces spatial and attribute biases
observed in individual datasets and improves the characterization of cumulative reservoir presence and distribution. This
improvement is critical for regional hydrological modeling, water balance assessments, and climate land surface interactions
analyses. In addition, a more balanced representation across latitudinal gradients further enhances the suitability of the
compiled dataset for basin scale and regional analyses. By filling the gap between global scale inventories, this dataset provides
465 a regionally optimized foundation for future mapping and model calibration. It also supports scenario-based assessments of
dam and reservoir impacts in West Africa. However, the gaps between the compiled dataset and the ground truthing data may
still have important implications for water management and Earth system science research.

4.2 What do the gaps between the compiled dataset and ground truthing data imply for research and water management?

470 The limited representation of smaller and recently constructed infrastructure, as well as gaps in associated attributes at the
watershed scale, reflects structural limitations in existing dam and reservoir datasets when applied to the West African region.
Further, numerous studies reported the existence of several thousand dams and reservoirs in West Africa (Cecchi et al., 2009b;
Jeppe Kolding, 2016; Abobi and Wolff, 2020; Lèye et al., 2021). Yet, there is still no consensus on their total number which
underscores a need for additional surveys ground-based or remotely to supplement the existing data.

475 Reservoirs play a crucial role in shaping hydrological processes by regulating runoff, energy balance, and water availability (Eslamian et al., 2018; Hou et al., 2022). Through their alteration of natural river flows, they exert important influence on surrounding ecosystems, agricultural productivity, and water management strategies (Kaup, 2015; Latrubesse et al., 2017). The compiled dataset accounts for 62 % of the total reservoir area and 59 % of the total storage volume reported from field campaign at watershed scale (Upper Bandama watershed). Such data gaps in dam and reservoir inventories can introduce
480 considerable bias into hydrological and land surface analyses, resulting in misestimation of key parameters such as runoff, water storage capacity, and evapotranspiration, energy and ultimately affecting water availability estimates (Lehner et al., 2011; Helfer et al., 2012; Lehner and Grill, 2013; McManamay, 2014; Joseph et al., 2018). Dang et al. (2020) showed that models excluding reservoirs can reproduce observed streamflow by compensating through parameter adjustments, resulting in biased representations of key hydrological processes such as surface runoff, infiltration, and baseflow. These structural
485 deficiencies may remain hidden during model calibration. However, they become evident when the models are applied to climate change impact assessments. In such cases, projections of low, mean, and high flows differ substantially from those produced by models that explicitly represent reservoirs. Such discrepancies highlight the importance of incorporating a better representation of dams and reservoirs to ensure physically realistic simulations and robust future water resource and fluxes assessments.

490 In semi-arid regions where communities depend heavily on reservoirs for water supply, inaccuracies in estimating storage capacity or spatial distribution can misguide water allocation decisions and undermine policy planning (Zogheib et al., 2018; Ekka et al., 2024). For instance, in the Volta Basin, mismanagement and incorrect estimation of available water resources have hindered equitable allocation among stakeholders (Youkhana and Laube, 2009). The competing demands for water between agricultural, domestic, and industrial uses have led to conflicts among different water users when actual water availability does
495 not meet anticipated allocations (Youkhana and Laube, 2009). Therefore, in data-scarce regions such as West Africa, the use of these datasets requires balancing trade-offs between spatial resolution, completeness, accessibility, uncertainty in available water, and reliability.

Users of the compiled dataset should be cautious of not only the inherited errors from sources but also the potential errors stemming from the compilation process such as human errors and bias-trade-off decisions when resolving conflicting attribute
500 values (Kopperud et al., 2019; Song et al., 2022; Wang et al., 2022; Ye et al., 2023). These issues can amplify uncertainty in available water estimates in model predictions and other downstream applications, underscoring the importance of transparent error reporting and continuous data validation.

4.3 So what could we do to capture small scale and new dams and reservoirs more effectively?

Enhancing the quality and completeness of data on small sacle and recently constructed dam and reservoir in West Africa
505 requires coordinated efforts that combine field validation, participatory approaches, and technological innovation. The ground-

truthing of dam and reservoir data at watershed scale in this study revealed a much higher number of small infrastructures than recorded in the compiled data. This outcome highlights the importance of participatory mapping in identifying informal or community-built reservoirs that are often absent from official records. Expanding such participatory approaches to a regional level would improve data coverage and consistency (Rahman et al., 2025). This could be achieved by promoting open data policies across West African countries, ensuring the official publication of national inventories, and strengthening regional collaboration through basin organizations and water management authorities. Incorporating data-sharing requirements into donor-funded water projects would encourage regular updates and reduce data fragmentation. Moreover, establishing formal mechanisms for continuous dataset updates, supported by transparent exchange among national agencies and research institutions, would also help ensure that newly constructed or modified reservoirs are promptly included. Lastly, future research should focus on integrating field-based and participatory data with high-resolution satellite imagery, drone surveys, and machine-learning-based detection methods (Jing et al., 2021; Utama et al., 2024; Wang et al., 2025). Such a combination would enhance the detection and documentation of small and newly constructed dams and reservoirs, contributing to a more complete and up-to-date representation of water infrastructure across West Africa.

4.4 Limitations of the compiled dataset and future improvements

Despite the harmonization of dam and reservoir data in West Africa, the compiled dataset remains subject to several limitations. The quality assessment relied on field observations from a single watershed. Although this watershed scale comparison represents an important step toward validating existing datasets against locally observed information, the Upper Bandama watershed cannot capture the full diversity of environmental, hydrological, institutional, and data-availability conditions across West Africa. The performance of the compiled dataset may therefore differ in other climatic regions, river basins, and administrative contexts. Moreover, the field-reference dataset may itself be incomplete because some informal, inaccessible, recently constructed, or locally unreported dams could not be identified during the survey. These limitations introduce uncertainty into estimates of omission and dataset accuracy. Future assessments should include additional watersheds across the Guinean, Sudanian, and Sahelian climatic zones.

It is also important to note that the original datasets used in the compilation are not fully independent. Many of these datasets overlap, incorporate information from earlier inventories, or use similar remote-sensing products and mapping procedures. Consequently, agreement among multiple sources does not necessarily represent independent confirmation of a record. Additionally, the source field in the compiled dataset should be interpreted cautiously. It identifies the primary contributing source retained during harmonization rather than providing a complete record-level provenance history of all datasets that contributed information to a given dam or reservoir. Future versions could strengthen data traceability by recording all contributing sources, documenting attribute-level provenance, and assigning confidence scores based on source agreement, spatial accuracy, and attribute completeness.

Several attributes remain incomplete or uncertain. Reservoir surface area, storage capacity, watershed area, construction year, dam height, and other management-related characteristics are unavailable for some records. Missing values limit regional comparisons and may introduce bias because larger and formally managed infrastructure is generally better documented than small or informal structures. Differences in measurement methods, observation dates, spatial resolution, and definitions across the original datasets may also reduce the comparability of attribute values. Future work should establish standardized procedures for estimating missing reservoir areas and volumes, delineating upstream watersheds, and quantifying the uncertainty associated with derived attributes.

5 Conclusion

This study provides insights into currently available datasets for dam and reservoir management in West Africa while presenting a new, region-specific dataset from the consolidation of existing sources. We identified nineteen datasets containing West African dam and reservoir information and which are widely reported in the literature. These datasets depict differences and limitations in terms of entry types (dams, other barriers and closed waterbodies), spatial resolution, percentage of West African data, attribute types and completeness, and data sources (remote sensing-driven, curated inventory and hybrid data).

From these, we integrated twelve datasets to improve access to data in West Africa, resulting in a more comprehensive and unified regional dataset with enhanced representation of the infrastructure. The compiled dataset includes thirty-eight attributes, and 1,429 dam points and 1,258 reservoir polygons. Compared with the original datasets considered individually, the compiled dataset adds between 1,088 and 1,415 dam entries and between 117 and 1,119 reservoir entries for West Africa.

We assessed the quality of the compiled dataset against field campaign data at watershed scale (14,500 km², in the Sudanian savannah) and validated through stakeholder engagement. The compiled dataset showed strong spatial and temporal consistency while counting for 32 % of field observed dams, 62 % of the total reservoir area and 59 % of the total storage volume reported from field campaign. This is primarily due to the underestimation of smaller and recently constructed dams and reservoirs highlighting persistent biases inherited from the source datasets.

By integrating both large and small scale infrastructure and reducing spatial and attribute biases observed in individual datasets, the compiled dataset enhances data accessibility for hydrological research and water management in West Africa.

However, further efforts are needed to improve the accuracy and completeness of dam and reservoir data, especially for small scale infrastructure, through collaborative research and data sharing initiatives among scientists and institutions across West Africa. Promoting open data policies, ensuring the official publication of national inventories, and strengthening regional collaboration through basin and water management authorities are critical steps toward this goal. These measures will not only improve data accessibility and transparency but also support more robust, evidence-based water resource planning and management across West Africa and beyond.

6 Appendices

6.1 Appendix A

The structured questionnaire (Fig. A1), used to collect data on dams and reservoirs during the field survey for watershed-scale ground-truthing and quality assessment of the compiled dataset, primarily focused on the characteristics, uses, and management strategies of the infrastructures.



Group Interview Questionnaire: Data Collection on Dams and Reservoirs

Date:...../2024	Questionnaire n°:
Country/District/Department/Village:	
Participant's names/Entities or Institutions/ Contact:	

1. Dam and reservoirs characteristics:

1.1. What are the technical characteristics of the dam(s) (name, size, volume, height, years of construction, etc.) in your area?

1.2. Is the dam connected to other infrastructure (e.g., canals, irrigation networks)? If yes, what is the total irrigated area?

1.3. Who are the different users of the dam or reservoir?

2. Main purpose or uses of dams

2.1. What are the main uses of the reservoir?

☐ Irrigation,

☐ energy production,

☐ Breeding

☐ Aquaculture

☐ Domestic consumption

☐ Other (specify)

3. Dam and reservoir management

3.1. Do you have a maintenance plan for the dam or reservoir? If yes, please describe the plan

3.2. Is there a local management committee? If yes, how does the committee operate?

3.3. What are the main challenges or problems related to the operation of the dam?
(e.g., sedimentation, water quality degradation, conflicts among users, maintenance issues, floods, droughts)

Figure A1: Structured questionnaire used to collect data on dams and reservoirs during the field survey in the Upper Bandama Watershed (Sudanian savannah, Côte d'Ivoire).

Table B1 Distribution of Group Interview Sizes Across Districts and Villages Surveyed in the Upper Bandama Watershed for the field campaign at watershed scale.

District	Village	Type of interview	Number of attendances	Entity attended
Niakaramadougou	Kafiné	Group interview	10	Village authorities Agricultural cooperative's members Women's representant Young's President
		Interview		Administrative authority (prefect)
	Niakaramadougou	Interview	1	User (famer)
	Nogotaha	Group interview	4	Administrative authority (prefect)
Dikodougou		Group interview	2	Village authorities
				Village authorities
	Noufré	Group interview	4	Young's President Agricultural cooperative's representants
Korhogo	Solomougou	Interview	1	Administrative authority (prefect) Agricultural cooperative's president
				Agricultural cooperative's representant
	Sologo	Group interview	3	(president & secretary) Young's president
	Koko	Group interview	2	Agricultural cooperative's representants
M'Bengué	Kaloa	Group interview	5	Agricultural cooperative's representants
	Kanoufa	Group interview	3	Village authorities
	M'Bengué	Interview	3	Users (1 farmer and 2 road construction workers)

Data availability

The Harmonized Dataset for Dams and Reservoirs in West Africa also called West Africa Dam and Reservoir Dataset (Kouassi et al., 2026) is freely accessible in CSV files and shapefiles (dam points and reservoir polygons) for download and updates via <https://doi.org/10.60507/FK2/YLDK1Y> under the <https://creativecommons.org/licenses/by/4.0/> license.

Author contribution

All authors contributed to the study's conception and design. Valery Bessely Stanislas Kouassi, Blé Anouma Florest Yao, and Gneneyougo Emile Soro were responsible for data collection and the execution of field surveys. Valery Bessely Stanislas Kouassi carried out the data analysis and drafted the initial version of the manuscript. Gneneyougo Emile Soro, Albert Bi Tié Goula, Nelly Carine Kelome-Ahouangnivo, and Julian Klaus provided critical feedback on earlier versions of the manuscript. All authors reviewed and approved the final version of the manuscript.

Competing interests

The authors declare that they have no conflict of interest.

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Review statement

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