

A Spatio-Temporal Dataset of Urban Water Distribution Schedules

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A Spatio-Temporal Dataset of Urban Water Distribution Schedules

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Abstract

Urban water supply in several rapidly growing cities in Latin America is managed through intermittent distribution schedules rather than continuous service, often in response to drought or water scarcity conditions. However, these practices are unevenly documented, and publicly available information is largely limited to cities where water authorities disclose distribution schedules. As a result, structured datasets suitable for systematic analysis remain scarce.

This study presents a reconstructed spatiotemporal dataset of municipal water distribution calendars for Tegucigalpa, Honduras. Historical schedules published by the municipal water authority (UMAPS) were systematically collected and transformed into a standardized dataset, capturing scheduled water availability across neighborhoods from 2016 to 2025. The reconstruction process involved extracting schedule information from heterogeneous source formats, harmonizing neighborhood identifiers, and linking distribution units to a consistent spatial neighborhood framework.

The resulting dataset provides quantitative indicators of scheduled water availability, including hours and days of supply per neighborhood and month. The full processing workflow, along with the open-source code used for data extraction, standardization, and aggregation, is publicly released to ensure transparency and reproducibility.

Background & Summary

Water scarcity remains a significant challenge in many urban areas, particularly in the Global South, where intermittent supply and unequal access to services are widespread. In cities such as Tegucigalpa, water availability varies due to topography, seasonal rainfall variability, infrastructure limitations, and rapid population growth. To manage these constraints, the Unidad Municipal de Agua Potable y Saneamiento (UMAPS, formerly SANAA) publishes Water Distribution Calendars (WDC), specifying scheduled water service across neighborhoods.

Intermittent water supply is not unique to Tegucigalpa¹. Cities such as Bogotá², Monterrey³, La Paz⁴, Quito⁵, Lima⁶, and Mexico City⁷ have implemented rationing schemes and, in some cases,

published water distribution schedules during periods of water stress. In these contexts, rotational distribution enables utilities to allocate limited water resources while maintaining service under constrained supply conditions.

Despite their operational importance, intermittent water supply is poorly represented in conventional water statistics. Existing national and international datasets primarily emphasize access rather than continuity, providing information on infrastructure and service coverage but rarely capturing the temporal reliability of water delivery. Although household surveys, administrative records, and global initiatives such as the WHO/UNICEF *Joint Monitoring Programme* (JMP)⁸ provide valuable information on water services, longitudinal operational datasets describing neighborhood-level distribution schedules remain scarce.

One reason for this scarcity is that Water Distribution Calendars are commonly disseminated as administrative notices, PDF documents, or public communications rather than as structured, machine-readable datasets. Historical records are frequently dispersed across institutional archives and, in many cities, are not accessible through APIs, bulk-download services, or centralized digital repositories. Consequently, researchers must first recover, archive, and harmonize the original records before they can be systematically analyzed.

To address this gap, this study reconstructs and harmonizes Water Distribution Calendars published between 2016 and 2025 into a standardized spatiotemporal dataset describing neighborhood-level water availability in Tegucigalpa. The reconstruction framework transforms heterogeneous operational records into a consistent, machine-readable format suitable for temporal and spatial analyses.

The resulting dataset provides a longitudinal record of urban water distribution that complements existing water-access, environmental, and socio-economic datasets while supporting analyses of service continuity, operational management, urban resilience, and Sustainable Development Goal (SDG) 6 monitoring⁹. More broadly, the framework provides a reproducible methodology that can be adapted by other cities facing similar data-access constraints.

Methods

Data Collection Overview

The original calendar documents (typically distributed as PDF files; see Figure 1) are not included in this dataset, as they remain official administrative publications of the municipal water utility. These documents can be requested through official government transparency channels, including the Honduran transparency portal managed by the *Instituto de Acceso a la Información Pública* (IAIP)¹⁰. A portion of the historical records used in this study was obtained through such formal information requests, while additional records were collected over time as new calendars were published.

The Water Distribution Calendars were obtained from the responsible utility through two streams. Calendars for the 2016-2020 period were obtained via a formal information request (No. SOL-

SANAA-271-2021), submitted in 2021 through the Honduran government's electronic information-access platform, SIELHO¹¹ administered by the IAIP; the request was directed to the utility then operating as SANAA, now the Unidad Municipal de Agua Potable y Saneamiento (UMAPS). To obtain the same records, a requester registers on SIELHO, submits a request in Spanish selecting UMAPS as the requested institution, and provides a national ID or passport number, an email address, and a telephone number.

Calendars published after 2020 were collected at the time of their publication from the utility's official announcements on social media, principally the official UMAPS accounts on Facebook¹², and Instagram¹³, and from local newspaper websites reproducing them. No public API, bulk-download facility, or centralized archive of these calendars existed at the time of collection; the original records as received cannot be redistributed by the authors but remain obtainable from the issuing institution via the route described above.

A Water Distribution Calendar was published for October 2022 but could not be obtained by the authors. Because post-2020 calendars were collected from official announcements at the time of publication and no centralized archive of historical calendars exists, this month could not be retrieved retrospectively. The gap is reported as missing and was neither interpolated nor inferred; October 2022 is therefore absent from Tables 1–3 and from all derived outputs.

For this study, the tabular information contained in the calendar documents was extracted from the original PDF files using iLovePDF¹⁴, a freely available document conversion tool. Several table-extraction tools were evaluated for this step, including pdfplumber, Camelot, and DocLing; iLovePDF was selected because it reproduced the calendar content reliably and is freely available. The resulting Excel files preserve the visual layout of the original PDF rather than a clean row-and-column structure and therefore require further processing before analysis. For small numbers of files the free service is sufficient, whereas large-scale batch conversion may benefit from a paid iLovePDF license, which removes the per-session file limits. Before entering the pipeline, these layout-preserving spreadsheet files are brought into a canonical form—a predefined column structure that the pipeline requires as its entry condition. This curation step involves a human-in-the-loop (HITL) stage, because some inconsistencies in the converted files cannot be resolved reliably by automated rules.

Neighborhood and group labels are proper names that may appear split across cells, broken into fragments, or otherwise garbled during conversion, and reconciling them to the correct entity requires human judgment. This step reorganizes the converted files into the expected schema and resolves such naming inconsistencies without altering the underlying schedule information.

The canonical-form files are then read by the first step of the pipeline, which converts them into a standardized tabular structure in which every record carries traceability fields identifying the source file, the processing date, and the pipeline version used to generate it, so that each output row can be traced back to the specific calendar and processing run it originated from. The pipeline begins from standardized spreadsheet files, which served as the input for subsequent harmonization, quality control, and spatiotemporal reconstruction procedures.



The software used to process the WDCs is publicly available through a GitHub repository archived on Zenodo¹⁵. The resulting derived dataset can be accessed from Zenodo¹⁶

After extracting the raw Excel files, two reference catalogs were created: one for distribution groups, based on *Barrios o Colonias*, and another for individual neighborhood names. Each entry was assigned a unique identifier to keep names consistent and allow records to be linked reliably over time.

The group catalog was then enriched with additional information from the original calendar documents, including the water sector, water source, and water distributor. These fields describe the operational hierarchy of the water system: distribution groups are organized within sectors, supplied by specific water sources, and served by assigned distributors.

Keeping this enrichment step separate from the initial parsing helped simplify the workflow. The core extraction focused on converting the calendars into structured records, while the hierarchy and metadata were added later in a controlled way. This made the dataset easier to validate and allowed the final outputs to support analysis of both scheduled water delivery and the organization of the water distribution system.

The reconstruction of the dataset followed a multi-stage processing workflow adapted to convert water distribution calendars (WDC) into standardized spatial and temporal records. The workflow is based on a generalizable reconstruction framework for transforming fragmented or semi-structured urban operational records into spatiotemporal datasets. While the present implementation is tailored to water distribution calendars, the underlying

approach—comprising structured standardization, identifier harmonization, validation, and aggregation—can be adapted to other urban data domains with similar characteristics.

The pipeline was implemented as a configuration-driven processing framework and executed through a series of sequential steps (Figure 2).

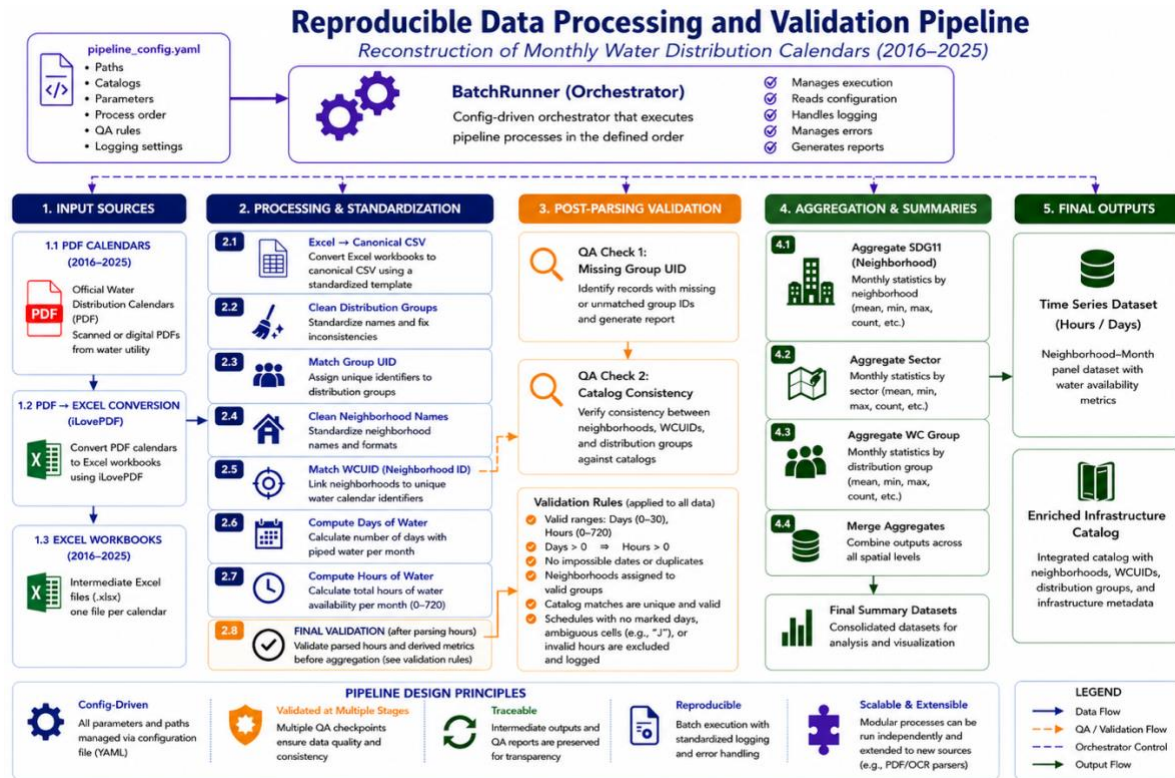


Figure 2 Pipeline, Graphic Representation

Raw Water Calendars

The dataset was reconstructed through a configuration-driven, multi-stage pipeline that transforms Water Distribution Calendars (WDCs) into standardized spatiotemporal records. A complete worked example of the processing pipeline is provided in Supplementary Material 1, where the transformation of a single neighborhood is documented step by step. The example follows the "28 de Marzo" neighborhood across its associated three distribution calendar groups, presenting the intermediate outputs generated at each processing stage, from the original Water Distribution Calendars through validation, harmonization, quality control, and the final standardized outputs.

The number of distribution groups per calendar remained relatively stable over time, generally ranging between 53 and 61 per month (Table 1). October 2022 is absent from Tables 1–3 because the corresponding calendar could not be obtained.

Number of Groups per Water Calendar										
Months/ Years	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
1	53	53	54	54	56	55	56	60	55	59
2	53	53	54	54	56	55	55	53	55	60
3	53	53	54	54	56	55	57	60	55	60
4	53	54	54	54	58	55	57	60	55	60
5	53	54	54	54	58	55	60	60	55	60
6	53	54	54	54	56	55	60	60	51	61
7	53	54	54	54	55	55	60	60	51	60
8	53	54	54	55	55	56	60	60	59	60
9	53	54	54	56	55	56	60	60	59	60
10	53	54	54	56	55	55		55	59	60
11	53	54	54	56	55	55	60	60	59	60
12	53	54	54	56	55	56	60	55	59	60

Table 1 WDC Number of Groups per Year/Month, no calendar was obtained for October 2022.

In contrast, the number of neighborhood schedules per calendar varied across months and years (Table 2), reflecting differences in calendar structure and group composition.

Quality control procedures were applied to validate identifier consistency and detect missing or inconsistent records. Schedule information was subsequently transformed into quantitative indicators of water availability, including days and hours with water. The resulting records were spatially linked to SDG11UID neighborhood polygons (a unique neighborhood identifier created from AMDC GIS¹⁷ data and adapted for consistent use across datasets) and aggregated using summary statistics to account for cases where multiple calendar units correspond to a single spatial neighborhood. Where a Water Distribution Calendar was unavailable, schedule attributes were recorded as missing (NaN) rather than as numeric zero; these incomplete records were removed during quality control and are not included in the released dataset, which therefore contains only records with an available official schedule.

Additional operational attributes (water sector, source, and distributor) were incorporated at the final stage, remaining constant within each distribution unit and reflecting the hierarchical structure of the water system. The pipeline produces standardized time-series

datasets and enriched infrastructure catalogs, enabling reproducible analysis of urban water distribution patterns.

Number of Neighborhood-Schedules /Year-Month Calendars

Month/ Year	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
1	672	694	695	709	1436	712	713	769	648	787
2	672	694	695	713	722	714	697	664	648	1574
3	670	694	695	1430	1448	712	715	769	652	1577
4	672	694	695	715	721	714	715	769	652	787
5	672	694	695	714	722	711	780	1538	652	788
6	682	694	696	712	714	711	768	1539	630	1575
7	682	694	697	714	713	711	768	1540	627	791
8	682	694	697	1425	714	709	767	770	784	798
9	697	694	699	1368	713	710	769	775	784	798
10	697	695	699	1268	712	713		650	784	796
11	697	697	699	1289	714	711	769	1431	784	795
12	694	695	699	1426	714	713	770	650	784	796

Table 2 Number of Neighborhood Schedules per Water Calendar (WDC) by month and year, no calendar was obtained for October 2022.

The resulting neighborhood records were linked to the GIS neighborhood polygons from the SDG 11 spatial dataset. Because multiple Water Distribution Calendar (WDC) neighborhoods may correspond to a single spatial neighborhood, water availability indicators were aggregated by wc_uid using summary statistics, including the mean, minimum, and maximum values, together with the number of contributing calendar units. Supplementary Material 1 provides a complete worked example of this aggregation process, illustrating how multiple Water Distribution Calendar groups associated with the same neighborhood are consolidated into a single standardized spatial record.

The pipeline produces multiple levels of aggregated outputs describing water availability patterns, including:

- Neighborhood-level indicators
- Water distribution group statistics
- Sector-level summaries
-

These outputs provide standardized datasets suitable for longitudinal analysis of urban water distribution patterns.

Georeferenced Neighborhoods

Spatial reference data consisted of neighborhood boundary geometries used for spatial harmonization and aggregation. Neighborhood polygons were obtained from an openly available administrative boundary dataset published by the Alcaldía Municipal del Distrito Central.

To ensure consistent spatial attribution across the Water Distribution Calendars, adjacent or overlapping administrative units were merged where calendar entries could not be reliably assigned to the most granular official boundary. Stable neighborhood identifiers (**wc_uid**) were generated and assigned to these harmonized spatial units. The resulting **wc_uid** values were then matched against a neighborhood reference catalog containing the corresponding SDG11UID for each spatial unit. Both identifiers were maintained consistently across all temporal snapshots and aggregated outputs, ensuring longitudinal comparability, reproducibility, and interoperability with other neighborhood-level datasets.

To provide additional spatial context for analyses of water distribution patterns, elevation statistics were calculated for each neighborhood polygon using the 1 arc-second (~30 m) NASADEM V001 digital elevation model (DEM)¹⁸. Minimum, maximum, and mean elevation values were extracted for each neighborhood and stored as attributes in the spatial reference layer. These variables were not used in the derivation of the published water distribution schedules; rather, they are provided as supplementary contextual information to facilitate future research on the relationship between topography and urban water distribution. The elevation attributes may support investigations of the operational challenges associated with supplying water across the steep and highly irregular terrain of Tegucigalpa, as well as integration of the dataset with future hydrological, infrastructure, and urban resilience studies.

Unmatched GIS Neighborhoods and Calendar Units

Not all neighborhood polygons in the GIS layer could be matched to entries in the historical WDC. These unmatched cases reflect differences between operational water distribution units and administrative spatial boundaries. In some instances, neighborhoods are not represented in the municipal distribution calendars, while in others, discrepancies arise from variations in naming conventions, boundary definitions, or changes in urban development over time.

Additionally, some WDC neighborhoods (**wc_uid**) represent areas that do not correspond exactly to the spatial boundaries of the GIS neighborhood polygons. As a result, certain **wc_uid** records cannot be confidently matched to a single polygon. These polygons are retained in the spatial layer but contain no associated calendar observations.

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Number of Water Calendars Neighborhoods without GIS Polygon Match											
Month /Year	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	
1	34	35	35	36	38	38	39	49	35	52	
2	34	35	35	36	38	38	36	42	35	52	
3	34	35	35	36	38	38	39	49	35	53	
4	34	35	35	36	42	38	39	49	35	52	
5	34	35	35	38	42	38	49	49	35	52	
6	35	35	35	38	38	38	49	49	32	52	
7	35	35	35	38	38	39	48	50	32	54	
8	35	35	35	38	38	39	47	50	52	55	
9	35	35	36	38	38	39	49	51	52	55	
10	35	35	36	35	38	38		35	52	55	
11	35	35	36	36	38	38	49	52	52	55	
12	35	35	36	38	38	39	49	34	52	55	

Table 3 Number of WDC neighborhoods without matching GIS, No calendar was obtained for October 2022.

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Table 3 summarizes the number of neighborhood schedule entries that could not be directly matched to a corresponding GIS neighborhood polygon for each year–month.

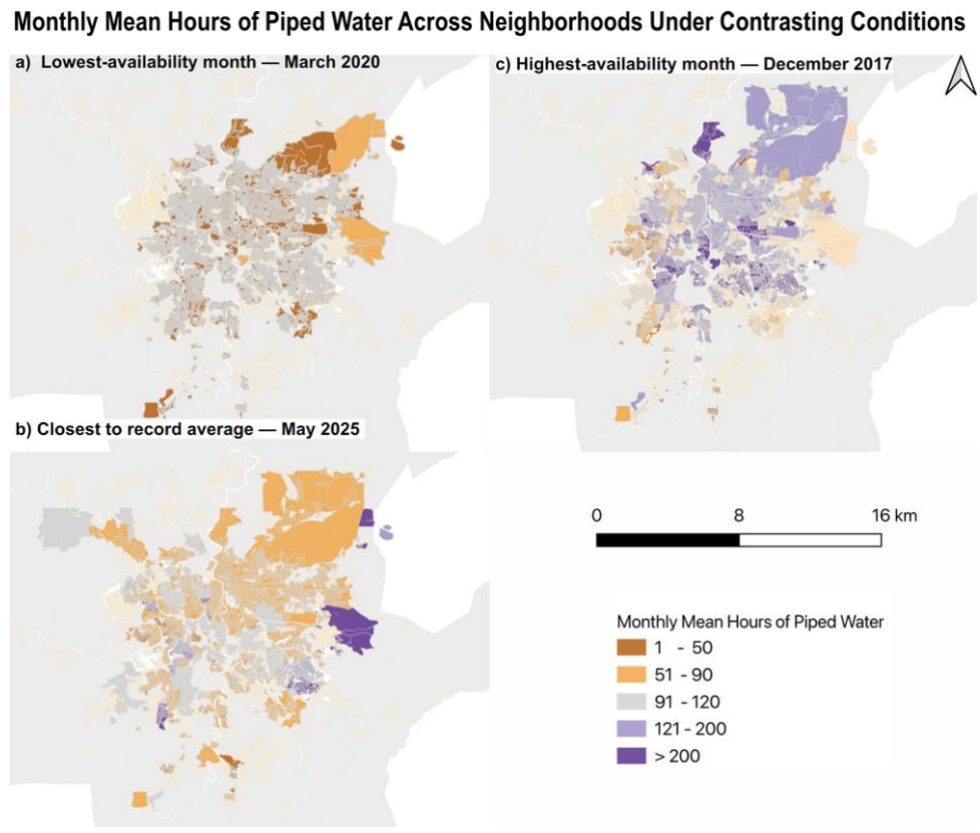
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Resolution of Duplicate Neighborhood Names

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A separate case arises when neighborhood names in the WDC correspond to multiple distinct geographic polygons in the GIS layer. This occurs because several neighborhoods share similar or identical names while representing different spatial areas within the city. In such cases, neighborhood assignments were resolved by considering co-occurring contextual information from the calendar: each neighborhood belongs to a sector and appears alongside a characteristic set of neighboring neighborhoods within the same distribution schedule. Same-named neighborhoods were therefore manually distinguished by their sector and by the co-occurring neighbors listed together in the calendar, allowing each entry to be matched to the correct geographic polygon.

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Figure 3 Monthly Mean Hours of Water Under Contrasting Conditions

301 The geographic coverage of the water calendars is illustrated in Figure 3 and 4, where
302 values represent the mean number of scheduled water supply hours/days per month for
303 each neighborhood across the full dataset period.

304
305 Figure 3 represent the spatial distribution of monthly hours of piped water across
306 neighborhoods under contrasting conditions. Panels represent (a) the month with the
307 lowest mean water availability in the record (March 2020), (b) a month with mean
308 availability closest to the record average (May 2025), and (c) the month with the highest
309 mean availability (December 2017). Colors indicate cumulative monthly hours of piped
310 water, with warmer tones representing drought conditions and cooler tones indicating
311 higher availability. Classes are centered on typical conditions (90–120 hours) to highlight
312 deviations in service levels across space. Months were classified by their monthly mean
313 of neighborhood-level hours of piped water relative to the overall mean $\pm$ one standard
314 deviation across all months in the record (consistent with the classification shown in
315 Figure 6): March 2020 has the lowest monthly mean in the dataset, December 2017 the

highest, and May 2025 lies within one standard deviation of the overall mean, reflecting average (typical) supply conditions.

Monthly Mean Days of Piped Water Across Neighborhoods Under Contrasting Conditions

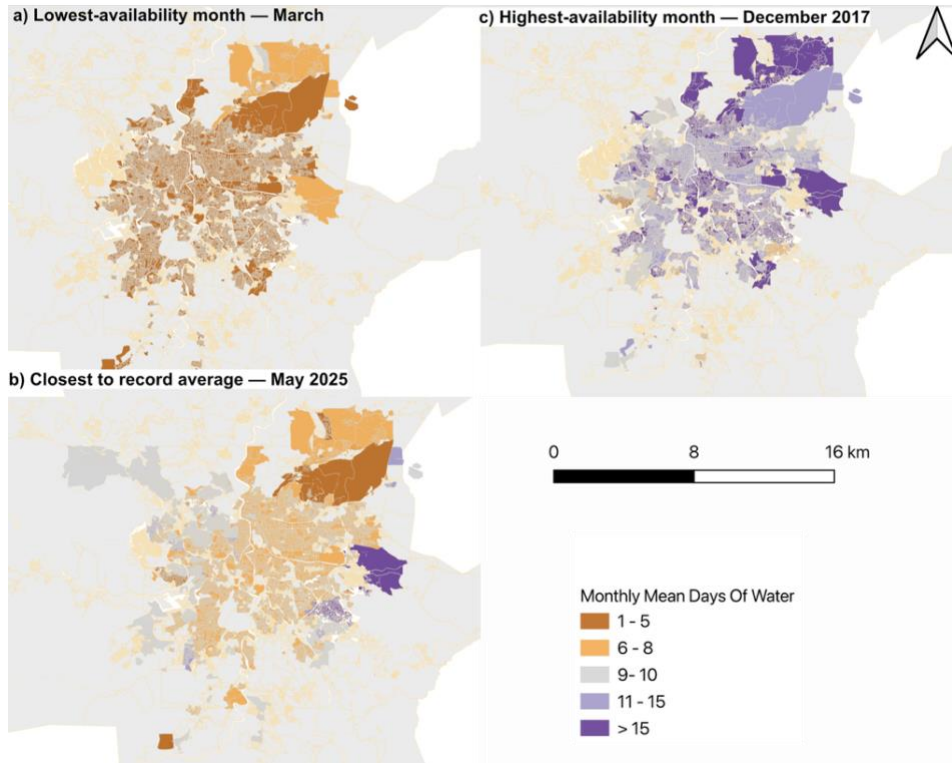


Figure 4 Monthly Mean Days of Water Under Contrasting Conditions

While Figure 4 shows monthly mean days of piped water under contrasting supply conditions: (a) the lowest-availability month (March 2020), (b) the month closest to the record average (May 2025), and (c) the highest-availability month (December 2017). Classes are centered around the average availability (~8.3 days per month). Warmer tones indicate lower availability (drought conditions), while cooler tones indicate higher availability. Persistent spatial inequalities are evident, with many neighborhoods remaining below the mean even during favorable conditions. The same three months as in Figure 3 are shown to allow direct comparison; selection was based on monthly hours of piped water (Figure 3), and the ordering of these months (lowest, closest to average, highest) is consistent for days with water (Figure 6b).

Data Record

All data produced in this study are openly available on Zenodo¹⁶, this dataset includes:

- Data format:** GeoPackage (GPKG)
- Spatial reference system:** Projected or geographic CRS defined at the layer level (EPSG code included in metadata)
- Spatial units:** Neighborhood-level polygon linkage with unique identifiers
- Temporal resolution:** Water Calendar aggregated by Year-Month
- Attributes:** Different aggregated files that includes Year, Month, neighborhood and distribution-group identifiers, and water-availability indicators (days and hours with water). The complete field list for each file is provided with the published dataset.
- Quality control:** Rule-based validation and statistical screening; anomalous records were removed
- Software environment:** Dataset generated using open-source Python and GIS tools; full processing pipeline is publicly available via the associated GitHub repository. Interactive HTML versions of the Figure 8 distribution panels (hours and days of piped water per month) are included with the dataset; these are self-contained files viewable in any web browser without additional software.
- File integrity:** UTF-8 encoding; consistent field naming; reproducible exports

Table 4 provides an overview of the layers included in the GeoPackage, detailing the data type, description, stratification method, inclusion criteria, and important notes regarding the dataset. The layers include neighborhood polygons, merged water calendars, and aggregated data by SDG11UID, water sector, and other relevant identifiers.

The dataset includes CSV files that contain the non-spatial attribute tables linked to the GeoPackage layers. These files are provided separately to accommodate researchers who prefer to work with the data outside of GIS software.

Layer Name	Data Type	Description	Inclusion Criteria	Notes
wcamdc20260228_finalv2	GeoJSON	Neighborhood polygons	Description of neighborhood boundaries and schedules	The spatial reference layer used for neighborhood boundaries and water distribution schedules.
all_hours	CSV	All calendar schedules merged	year, month, wc_uid, group_uid, SDG11UID, neighborhood, schedule, days_observed, days_with_water, conflict_days, etc.	Comprehensive look at both temporal and spatial data; includes conflict days, schedule crossing midnight, etc.
scheduled_errors.csv	CSV	All calendar errors	year, month, wc_uid, group_uid, SDG11UID, neighborhood, schedule, days_observed,	Records excluded during quality control: distribution groups whose monthly

Layer Name	Data Type	Description	Inclusion Criteria	Notes
			days_with_water, conflict days, etc.	aggregated hours totalled zero, indicating that delivery days could not be parsed from the source calendar, together with schedules that could not be parsed at all.
sdg11mean	CSV	All calendar schedules merged	SDG11UID, year_month, max_hours_with_water, mean_hours_with_water, pipeline_name, etc.	Aggregated data by SDG11UID and year_month; provides statistics on water supply availability for neighborhoods/areas.
merged_sector	CSV	All calendar schedules merged	water_sector, year_month, mean_hours_with_water, aggregation_level, pipeline_name, etc.	Aggregated data at the sector level; detailed analysis of water availability by sector.
merged_wcuid	CSV	All calendar schedules merged	water_sector, distribution_unit, water_source, group_uid, wc_uid, year_month, max_hours_with_water, count_sdg11uid, etc.	Detailed aggregation; includes distribution unit, water source, and multiple aggregation levels (sector, group, unit).

Table 4. Data Descriptor for Water Distribution Dataset

Technical Validation

To illustrate the reconstruction workflow, a supplementary workbook is provided with the dataset in which each worksheet corresponds to one stage of the pipeline for a single neighborhood, tracing it from the original Water Distribution Calendar through parsing, standardization, and aggregation to the final standardized record.

Water Piped Network Consistency

To assess the spatial consistency of the reconstructed water calendar dataset, a municipal water distribution pipe network dataset (Figure 5) was used as an independent infrastructure reference. This network represents the physical system supplying municipal water across the city. Neighborhood polygons intersecting the pipe network were therefore expected to be associated with at least one water calendar assignment (wc_uid) in the reconstructed dataset.

The municipal water pipe network dataset is not included in the published dataset but is publicly available through the AMDC open data portal¹⁷. It was used solely as an independent validation reference and not to generate the reconstructed water calendar records. Specifically, it was used to verify that neighborhoods intersecting the mapped pipe network were associated with at least one reconstructed calendar schedule. This validation is intentionally one-directional: it tests only whether neighborhoods with mapped pipe infrastructure have an associated schedule, not the accuracy or content of that schedule. The converse is not assumed. Some neighborhoods assigned a valid calendar schedule are absent from the 2019 pipe-network layer; the dataset does not infer

the reason, which may reflect mapping limitations, alternative service arrangements, or other discrepancies. These cases are reported without interpretation. Accordingly, the pipe network serves only as a lower-bound spatial consistency reference rather than a complete inventory of served neighborhoods.

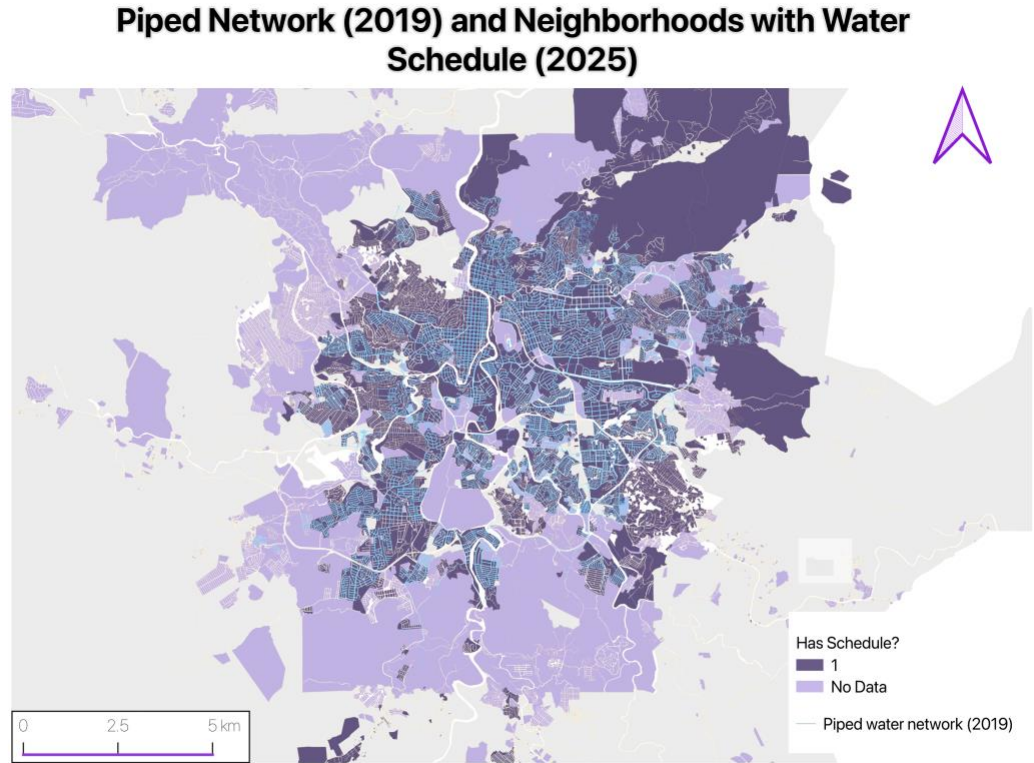


Figure 5 Piped water network (2019) and neighborhoods with water distribution schedules, illustrated for 2025. Dark polygons indicate neighborhoods with at least one schedule assignment in the 2025 Water Distribution Calendars; light polygons indicate neighborhoods without schedule data for that year. The network is used as an independent, one-directional consistency reference: neighborhoods intersecting it are expected to carry at least one schedule assignment in the reconstructed dataset.

Distribution of Reconstructed Water Availability Indicators

Boxplots were used to visualize the neighborhood-level distribution of reconstructed water availability indicators (hours and days with water). Figure 6 comprises (a) the monthly distribution of total hours of piped water supply (1–720 hours) and (b) the monthly distribution of days with water access (1–30 days), aggregated at the neighborhood level; each overlaid point is one neighborhood schedule for that month. For each month, the box spans the interquartile range with the median marked, and the whiskers extend to the neighborhood minimum and maximum.

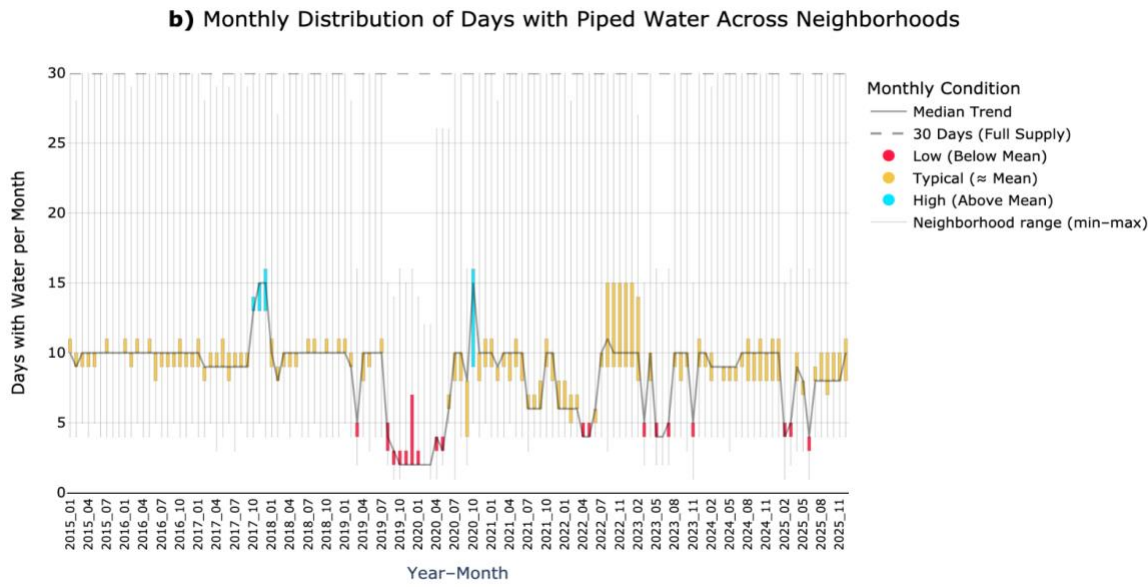
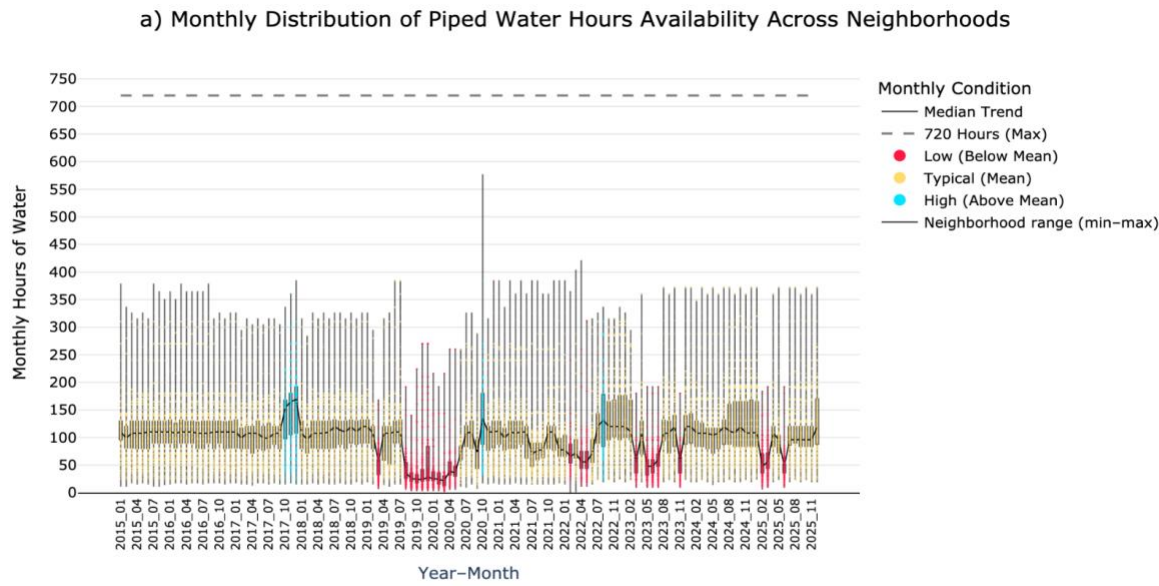


Figure 6 Monthly distribution of reconstructed water availability across neighborhoods, shown as per-month boxplots: (a) total hours of piped supply (1–720 h) and (b) days with water access (1–30 days)

The box color classifies that month's median relative to the overall mean $\pm$ one standard deviation across all months (low, typical, high), and the black line traces the median trend across months.

Dashed lines indicate full supply (720 hours per month in a 30 days per month in b). Together, the panels illustrate variation in both the intensity and frequency of water availability across the study period. Interactive HTML versions of both panels are included with the dataset on Zenodo.

Data Availability

The harmonized Water Distribution Calendar dataset, metadata, and supporting documentation are publicly available from the Zenodo¹⁶ repository under the Creative Commons Attribution 4.0 International (CC BY 4.0) license. Original Water Distribution Calendars are not redistributed because they remain the property of the issuing institution. Researchers wishing to reproduce or extend the dataset may obtain the original schedules through UMAPS' official public communication channels or by submitting requests through the Honduran transparency mechanisms administered by the Instituto de Acceso a la Información Pública (IAIP).

Code Availability

Custom scripts were developed to parse, clean, standardize, validate, and aggregate the water distribution calendars described in this study. The full processing pipeline—including schedule parsing, normalization routines, quality control procedures, neighborhood identifier matching, and temporal aggregation—is publicly available via Zenodo¹⁵.

The pipeline relies on deterministic, rule-based procedures rather than machine learning models. All transformation logic is explicitly encoded in the scripts, ensuring transparency, interpretability, and reproducibility of the dataset reconstruction process.

The workflow is tailored to the locally formatted government documents and the region-specific administrative units of the study area, and adapting it to another city would require adjustments concentrated in three components. The first is the initial parsing stage of the pipeline, which reads the converted calendar files and must accommodate the layout and conventions of a given municipality's published schedules. The second is the set of reference catalogs for distribution groups and neighborhoods: where a city does not organize service into groups, groups may be mapped one-to-one to neighborhoods, and attribute fields used here for water source and distributor may be repurposed to represent other locally relevant variables. The third is the matching of calendar neighborhoods to GIS neighborhood polygons; the granularity of this spatial matching is left to the data curator, and where multiple neighborhoods are associated with a single GIS unit their values are recorded as the mean, consistent with the aggregation procedure used in this dataset. Once a city's records are brought into the canonical form and processed by the first stage into the standardized tabular format, the remaining steps—harmonization, quality control, spatial linkage, and aggregation—operate on that common structure and are largely independent of the originating city, so the bulk of the pipeline can be reused without modification.

Code development was supported by AI-based code generation tools; however, all scripts were thoroughly reviewed, tested, and curated by the authors prior to release.

Declaration Of Competing Interests

The author declares no competing financial interests or personal relationships that could have influenced the work reported in this paper.

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References

1. Galaitsi, S. et al. Intermittent domestic water supply: A critical review and analysis of causal–consequential pathways. *Water* **8**, 274 (2016). <https://doi.org/10.3390/w8070274>
2. Bogotá.gov.co. *Consulta tu día y turno de racionamiento en la ciudad con mapas Bogotá* (2026). Available at: <https://bogota.gov.co/mi-ciudad/habitat/racionamiento-de-agua-en-bogota-consulta-tu-turno-con-mapas-bogota> (Accessed: 6 March 2026).
3. Servicios de Agua y Drenaje de Monterrey I.P.D. *Extensión horario suministro* (2022). Available at: https://www.sadm.gob.mx/SADM/Noticia.jsp?id_html=Extension_horario_suministro_5a12 (Accessed: 9 March 2026).
4. SAPA La Paz (2025). *Tandeo de agua*. Available at: <https://tandeo.sapalapaz.gob.mx> (Accessed: 6 March 2026).
5. Guerrero de la Cruz, H. *Quito enfrenta racionamiento de agua* (2024). Tiempo Real EC. Available at: <https://www.tiemporealec.com/quito-enfrenta-racionamiento-de-agua-potable-del-23-al-30-de-septiembre/> (Accessed: 6 March 2026).
6. Exitosa Noticias. *Anuncian corte de agua por 12 horas en Lima: ¿qué distritos tendrán servicio el 7 de marzo?* (2026). Available at: <https://www.exitosanoticias.pe/actualidad/anuncian-corte-agua-12-horas-lima-que-distritos-tendran-servicio-7-marzo-n170397> (Accessed: 6 March 2026).
7. Secretaría de Gestión Integral del Agua (SEGIAGUA). *Agua en tu colonia*. Gobierno de la Ciudad de México. Available at: <https://aguaentucoloniasacmex.cdmx.gob.mx/#/home> (Accessed: 6 March 2026).
8. WHO & UNICEF. *Joint Monitoring Programme (JMP) for Water Supply, Sanitation and Hygiene (WASH)*. Available at: <https://washdata.org> (Accessed: 28 April 2026).
9. UN Water. *SDG 6 Data Portal* (2026). Available at: <https://sdg6data.org/en> (Accessed: 28 April 2026).
10. Instituto de Acceso a la Información Pública (IAIP). *Portal Único de Transparencia*. Available at: <https://portalunico.iaip.gob.hn> (Accessed: 28 April 2026).
11. Sistema de Información Electrónico de Honduras (SIELHO) Available at: <https://sielho.iaip.gob.hn/inicio/> (Accessed: 28 April 2026).
12. UMAPS Facebook Available at: <https://www.facebook.com/umapsdc> (Accessed: 28 April 2026).
13. UMAPS Instagrams Available at: <https://www.instagram.com/umapsdc> (Accessed: 28 April 2026).
14. iLovePDF. *Online PDF tools*. Available at: <https://www.ilovepdf.com/> (Accessed: 13 July 2026).
15. Rivera, Y. *SDG-6 Water Distribution Pipeline (Tegucigalpa, 2016–2025), Version 1.2*. Zenodo (2026). <https://doi.org/10.5281/zenodo.21499633>
16. Rivera, Y. *Urban Water Distribution Schedules Dataset for Tegucigalpa, Honduras (2016–2025)*. Zenodo (2026). <https://doi.org/10.5281/zenodo.21499698>
17. Alcaldía Municipal del Distrito Central (AMDC). *ATLAS*. Tegucigalpa, Honduras (2025). Available at: <https://amdc.hn> (Accessed: 28 April 2025).
18. NASA JPL (2021). NASADEM Merged DEM Global 1 arc second V001. Distributed by Open Topography. (Accessed: 29 July 2025). Original data: NASA JPL, distributed by NASA EOSDIS LP DAAC, https://doi.org/10.5067/MEaSURES/NASADEM/NASADEM_HGT.001.

A Spatiotemporal Dataset of Urban Water Distribution Schedules

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Abstract

Urban water supply in several rapidly growing cities in Latin America is managed through intermittent distribution schedules rather than continuous service, often in response to drought or water scarcity conditions. However, these practices are unevenly documented, and publicly available information is largely limited to cities where water authorities disclose distribution schedules. As a result, structured datasets suitable for systematic analysis remain scarce.

This study presents a reconstructed spatiotemporal dataset of municipal water distribution calendars for Tegucigalpa, Honduras. Historical schedules published by the municipal water authority (UMAPS) were systematically collected and transformed into a standardized dataset, capturing scheduled water availability across neighborhoods from 2016 to 2025. The reconstruction process involved extracting schedule information from heterogeneous source formats, harmonizing neighborhood identifiers, and linking distribution units to a consistent spatial neighborhood framework.

The resulting dataset provides quantitative indicators of scheduled water availability, including hours and days of supply per neighborhood and month. The full processing workflow, along with the open-source code used for data extraction, standardization, and aggregation, is publicly released to ensure transparency and reproducibility.

Background & Summary

Water scarcity remains a significant challenge in many urban areas, particularly in the Global South, where intermittent supply and unequal access to services are widespread. In cities such as Tegucigalpa, water availability varies due to topography, seasonal rainfall variability, infrastructure limitations, and rapid population growth. To manage these constraints, the Unidad Municipal de Agua Potable y Saneamiento (UMAPS, formerly SANAA) publishes Water Distribution Calendars (WDC), specifying scheduled water service across neighborhoods.

Intermittent water supply is not unique to Tegucigalpa¹. Cities such as Bogotá², Monterrey³, La Paz⁴, Quito⁵, Lima⁶, and Mexico City⁷ have implemented rationing schemes and, in some cases,

published water distribution schedules during periods of water stress. In these contexts, rotational distribution enables utilities to allocate limited water resources while maintaining service under constrained supply conditions.

Despite their operational importance, intermittent water supply is poorly represented in conventional water statistics. Existing national and international datasets primarily emphasize access rather than continuity, providing information on infrastructure and service coverage but rarely capturing the temporal reliability of water delivery. Although household surveys, administrative records, and global initiatives such as the WHO/UNICEF *Joint Monitoring Programme* (JMP)⁸ provide valuable information on water services, longitudinal operational datasets describing neighborhood-level distribution schedules remain scarce.

One reason for this scarcity is that Water Distribution Calendars are commonly disseminated as administrative notices, PDF documents, or public communications rather than as structured, machine-readable datasets. Historical records are frequently dispersed across institutional archives and, in many cities, are not accessible through APIs, bulk-download services, or centralized digital repositories. Consequently, researchers must first recover, archive, and harmonize the original records before they can be systematically analyzed.

To address this gap, this study reconstructs and harmonizes Water Distribution Calendars published between 2016 and 2025 into a standardized spatiotemporal dataset describing neighborhood-level water availability in Tegucigalpa. The reconstruction framework transforms heterogeneous operational records into a consistent, machine-readable format suitable for temporal and spatial analyses.

The resulting dataset provides a longitudinal record of urban water distribution that complements existing water-access, environmental, and socio-economic datasets while supporting analyses of service continuity, operational management, urban resilience, and Sustainable Development Goal (SDG) 6 monitoring⁹. More broadly, the framework provides a reproducible methodology that can be adapted by other cities facing similar data-access constraints.

Methods

Data Collection Overview

The original calendar documents (typically distributed as PDF files; see Figure 1) are not included in this dataset, as they remain official administrative publications of the municipal water utility. These documents can be requested through official government transparency channels, including the Honduran transparency portal managed by the *Instituto de Acceso a la Información Pública* (IAIP)¹⁰. A portion of the historical records used in this study was obtained through such formal information requests, while additional records were collected over time as new calendars were published.

The Water Distribution Calendars were obtained from the responsible utility through two streams. Calendars for the 2016-2020 period were obtained via a formal information request (No. SOL-

SANAA-271-2021), submitted in 2021 through the Honduran government's electronic information-access platform, SIELHO¹¹ administered by the IAIP; the request was directed to the utility then operating as SANAA, now the Unidad Municipal de Agua Potable y Saneamiento (UMAPS). To obtain the same records, a requester registers on SIELHO, submits a request in Spanish selecting UMAPS as the requested institution, and provides a national ID or passport number, an email address, and a telephone number.

Calendars published after 2020 were collected at the time of their publication from the utility's official announcements on social media, principally the official UMAPS accounts on Facebook¹², and Instagram¹³, and from local newspaper websites reproducing them. No public API, bulk-download facility, or centralized archive of these calendars existed at the time of collection; the original records as received cannot be redistributed by the authors but remain obtainable from the issuing institution via the route described above.

A Water Distribution Calendar was published for October 2022 but could not be obtained by the authors. Because post-2020 calendars were collected from official announcements at the time of publication and no centralized archive of historical calendars exists, this month could not be retrieved retrospectively. The gap is reported as missing and was neither interpolated nor inferred; October 2022 is therefore absent from Tables 1–3 and from all derived outputs.

For this study, the tabular information contained in the calendar documents was extracted from the original PDF files using iLovePDF¹⁴, a freely available document conversion tool. Several table-extraction tools were evaluated for this step, including pdfplumber, Camelot, and DocLing; iLovePDF was selected because it reproduced the calendar content reliably and is freely available. The resulting Excel files preserve the visual layout of the original PDF rather than a clean row-and-column structure and therefore require further processing before analysis. For small numbers of files the free service is sufficient, whereas large-scale batch conversion may benefit from a paid iLovePDF license, which removes the per-session file limits. Before entering the pipeline, these layout-preserving spreadsheet files are brought into a canonical form—a predefined column structure that the pipeline requires as its entry condition. This curation step involves a human-in-the-loop (HITL) stage, because some inconsistencies in the converted files cannot be resolved reliably by automated rules.

Neighborhood and group labels are proper names that may appear split across cells, broken into fragments, or otherwise garbled during conversion, and reconciling them to the correct entity requires human judgment. This step reorganizes the converted files into the expected schema and resolves such naming inconsistencies without altering the underlying schedule information.

The canonical-form files are then read by the first step of the pipeline, which converts them into a standardized tabular structure in which every record carries traceability fields identifying the source file, the processing date, and the pipeline version used to generate it, so that each output row can be traced back to the specific calendar and processing run it originated from. The pipeline begins from standardized spreadsheet files, which served as the input for subsequent harmonization, quality control, and spatiotemporal reconstruction procedures.



Figure 1 Water Distribution Calendar (WDC) PDF

Data Processing

The software used to process the WDCs is publicly available through a GitHub repository archived on Zenodo¹⁵. The resulting derived dataset can be accessed from Zenodo¹⁶

Catalog creation

After extracting the raw Excel files, two reference catalogs were created: one for distribution groups, based on *Barrios o Colonias*, and another for individual neighborhood names. Each entry was assigned a unique identifier to keep names consistent and allow records to be linked reliably over time.

The group catalog was then enriched with additional information from the original calendar documents, including the water sector, water source, and water distributor. These fields describe the operational hierarchy of the water system: distribution groups are organized within sectors, supplied by specific water sources, and served by assigned distributors.

Keeping this enrichment step separate from the initial parsing helped simplify the workflow. The core extraction focused on converting the calendars into structured records, while the hierarchy and metadata were added later in a controlled way. This made the dataset easier to validate and allowed the final outputs to support analysis of both scheduled water delivery and the organization of the water distribution system.

Brief Description of the Data Processing Pipeline

The reconstruction of the dataset followed a multi-stage processing workflow adapted to convert water distribution calendars (WDC) into standardized spatial and temporal records. The workflow is based on a generalizable reconstruction framework for transforming fragmented or semi-structured urban operational records into spatiotemporal datasets. While the present implementation is tailored to water distribution calendars, the underlying

approach—comprising structured standardization, identifier harmonization, validation, and aggregation—can be adapted to other urban data domains with similar characteristics.

The pipeline was implemented as a configuration-driven processing framework and executed through a series of sequential steps (Figure 2).

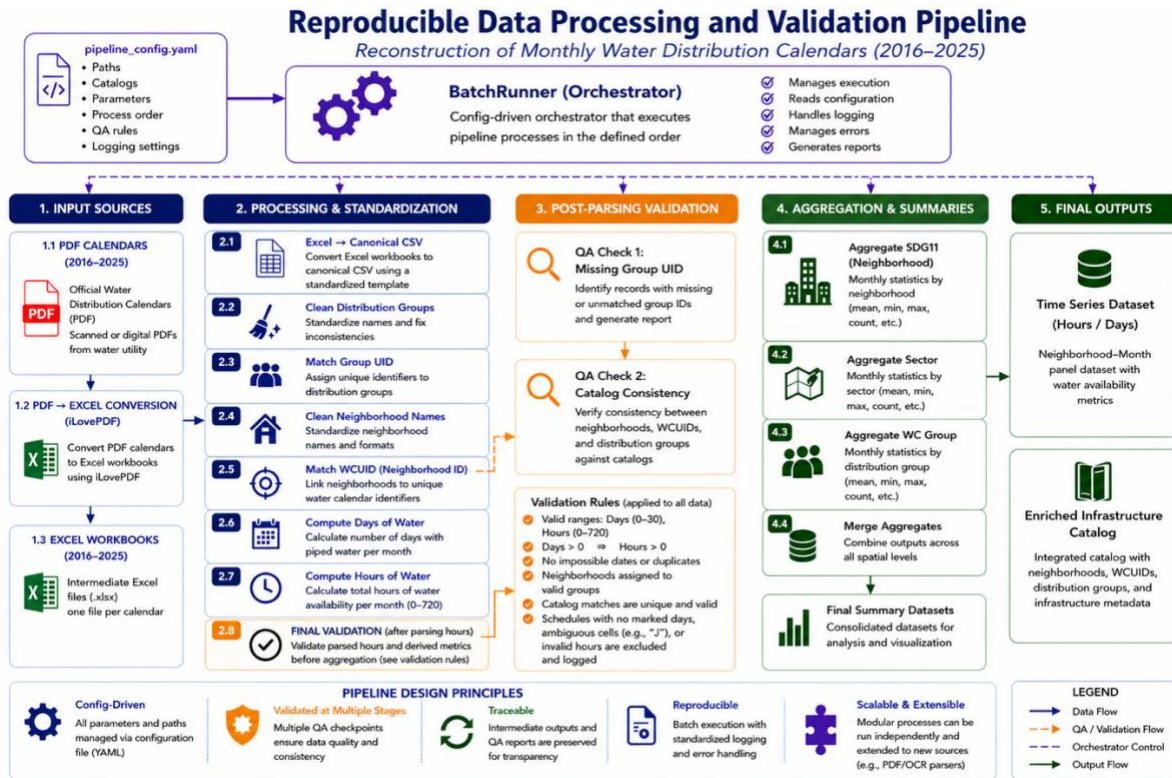


Figure 2 Pipeline, Graphic Representation

Raw Water Calendars

The dataset was reconstructed through a configuration-driven, multi-stage pipeline that transforms Water Distribution Calendars (WDCs) into standardized spatiotemporal records. A complete worked example of the processing pipeline is provided in Supplementary Material 1, where the transformation of a single neighborhood is documented step by step. The example follows the "28 de Marzo" neighborhood across its associated three distribution calendar groups, presenting the intermediate outputs generated at each processing stage, from the original Water Distribution Calendars through validation, harmonization, quality control, and the final standardized outputs.

The number of distribution groups per calendar remained relatively stable over time, generally ranging between 53 and 61 per month (Table 1). October 2022 is absent from Tables 1–3 because the corresponding calendar could not be obtained.

Number of Groups per Water Calendar										
Months/ Years	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
1	53	53	54	54	56	55	56	60	55	59
2	53	53	54	54	56	55	55	53	55	60
3	53	53	54	54	56	55	57	60	55	60
4	53	54	54	54	58	55	57	60	55	60
5	53	54	54	54	58	55	60	60	55	60
6	53	54	54	54	56	55	60	60	51	61
7	53	54	54	54	55	55	60	60	51	60
8	53	54	54	55	55	56	60	60	59	60
9	53	54	54	56	55	56	60	60	59	60
10	53	54	54	56	55	55		55	59	60
11	53	54	54	56	55	55	60	60	59	60
12	53	54	54	56	55	56	60	55	59	60

Table 1 WDC Number of Groups per Year/Month, no calendar was obtained for October 2022.

In contrast, the number of neighborhood schedules per calendar varied across months and years (Table 2), reflecting differences in calendar structure and group composition.

Quality control procedures were applied to validate identifier consistency and detect missing or inconsistent records. Schedule information was subsequently transformed into quantitative indicators of water availability, including days and hours with water. The resulting records were spatially linked to SDG11UID neighborhood polygons (a unique neighborhood identifier created from AMDC GIS¹⁷ data and adapted for consistent use across datasets) and aggregated using summary statistics to account for cases where multiple calendar units correspond to a single spatial neighborhood. Where a Water Distribution Calendar was unavailable, schedule attributes were recorded as missing (NaN) rather than as numeric zero; these incomplete records were removed during quality control and are not included in the released dataset, which therefore contains only records with an available official schedule.

Additional operational attributes (water sector, source, and distributor) were incorporated at the final stage, remaining constant within each distribution unit and reflecting the hierarchical structure of the water system. The pipeline produces standardized time-series

datasets and enriched infrastructure catalogs, enabling reproducible analysis of urban water distribution patterns.

Number of Neighborhood-Schedules /Year-Month Calendars

Month/ Year	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
1	672	694	695	709	1436	712	713	769	648	787
2	672	694	695	713	722	714	697	664	648	1574
3	670	694	695	1430	1448	712	715	769	652	1577
4	672	694	695	715	721	714	715	769	652	787
5	672	694	695	714	722	711	780	1538	652	788
6	682	694	696	712	714	711	768	1539	630	1575
7	682	694	697	714	713	711	768	1540	627	791
8	682	694	697	1425	714	709	767	770	784	798
9	697	694	699	1368	713	710	769	775	784	798
10	697	695	699	1268	712	713		650	784	796
11	697	697	699	1289	714	711	769	1431	784	795
12	694	695	699	1426	714	713	770	650	784	796

Table 2 Number of Neighborhood Schedules per Water Calendar (WDC) by month and year, no calendar was obtained for October 2022.

The resulting neighborhood records were linked to the GIS neighborhood polygons from the SDG 11 spatial dataset. Because multiple Water Distribution Calendar (WDC) neighborhoods may correspond to a single spatial neighborhood, water availability indicators were aggregated by `wc_uid` using summary statistics, including the mean, minimum, and maximum values, together with the number of contributing calendar units. Supplementary Material 1 provides a complete worked example of this aggregation process, illustrating how multiple Water Distribution Calendar groups associated with the same neighborhood are consolidated into a single standardized spatial record.

The pipeline produces multiple levels of aggregated outputs describing water availability patterns, including:

- Neighborhood-level indicators
- Water distribution group statistics
- Sector-level summaries
-

These outputs provide standardized datasets suitable for longitudinal analysis of urban water distribution patterns.

Georeferenced Neighborhoods

Spatial reference data consisted of neighborhood boundary geometries used for spatial harmonization and aggregation. Neighborhood polygons were obtained from an openly available administrative boundary dataset published by the Alcaldía Municipal del Distrito Central.

To ensure consistent spatial attribution across the Water Distribution Calendars, adjacent or overlapping administrative units were merged where calendar entries could not be reliably assigned to the most granular official boundary. Stable neighborhood identifiers (**wc_uid**) were generated and assigned to these harmonized spatial units. The resulting **wc_uid** values were then matched against a neighborhood reference catalog containing the corresponding SDG11UID for each spatial unit. Both identifiers were maintained consistently across all temporal snapshots and aggregated outputs, ensuring longitudinal comparability, reproducibility, and interoperability with other neighborhood-level datasets.

To provide additional spatial context for analyses of water distribution patterns, elevation statistics were calculated for each neighborhood polygon using the 1 arc-second (~30 m) NASADEM V001 digital elevation model (DEM)¹⁸. Minimum, maximum, and mean elevation values were extracted for each neighborhood and stored as attributes in the spatial reference layer. These variables were not used in the derivation of the published water distribution schedules; rather, they are provided as supplementary contextual information to facilitate future research on the relationship between topography and urban water distribution. The elevation attributes may support investigations of the operational challenges associated with supplying water across the steep and highly irregular terrain of Tegucigalpa, as well as integration of the dataset with future hydrological, infrastructure, and urban resilience studies.

Unmatched GIS Neighborhoods and Calendar Units

Not all neighborhood polygons in the GIS layer could be matched to entries in the historical WDC. These unmatched cases reflect differences between operational water distribution units and administrative spatial boundaries. In some instances, neighborhoods are not represented in the municipal distribution calendars, while in others, discrepancies arise from variations in naming conventions, boundary definitions, or changes in urban development over time.

Additionally, some WDC neighborhoods (**wc_uid**) represent areas that do not correspond exactly to the spatial boundaries of the GIS neighborhood polygons. As a result, certain **wc_uid** records cannot be confidently matched to a single polygon. These polygons are retained in the spatial layer but contain no associated calendar observations.

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Number of Water Calendars Neighborhoods without GIS Polygon Match											
Month /Year	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	
1	34	35	35	36	38	38	39	49	35	52	
2	34	35	35	36	38	38	36	42	35	52	
3	34	35	35	36	38	38	39	49	35	53	
4	34	35	35	36	42	38	39	49	35	52	
5	34	35	35	38	42	38	49	49	35	52	
6	35	35	35	38	38	38	49	49	32	52	
7	35	35	35	38	38	39	48	50	32	54	
8	35	35	35	38	38	39	47	50	52	55	
9	35	35	36	38	38	39	49	51	52	55	
10	35	35	36	35	38	38		35	52	55	
11	35	35	36	36	38	38	49	52	52	55	
12	35	35	36	38	38	39	49	34	52	55	

Table 3 Number of WDC neighborhoods without matching GIS, No calendar was obtained for October 2022.

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Table 3 summarizes the number of neighborhood schedule entries that could not be directly matched to a corresponding GIS neighborhood polygon for each year–month.

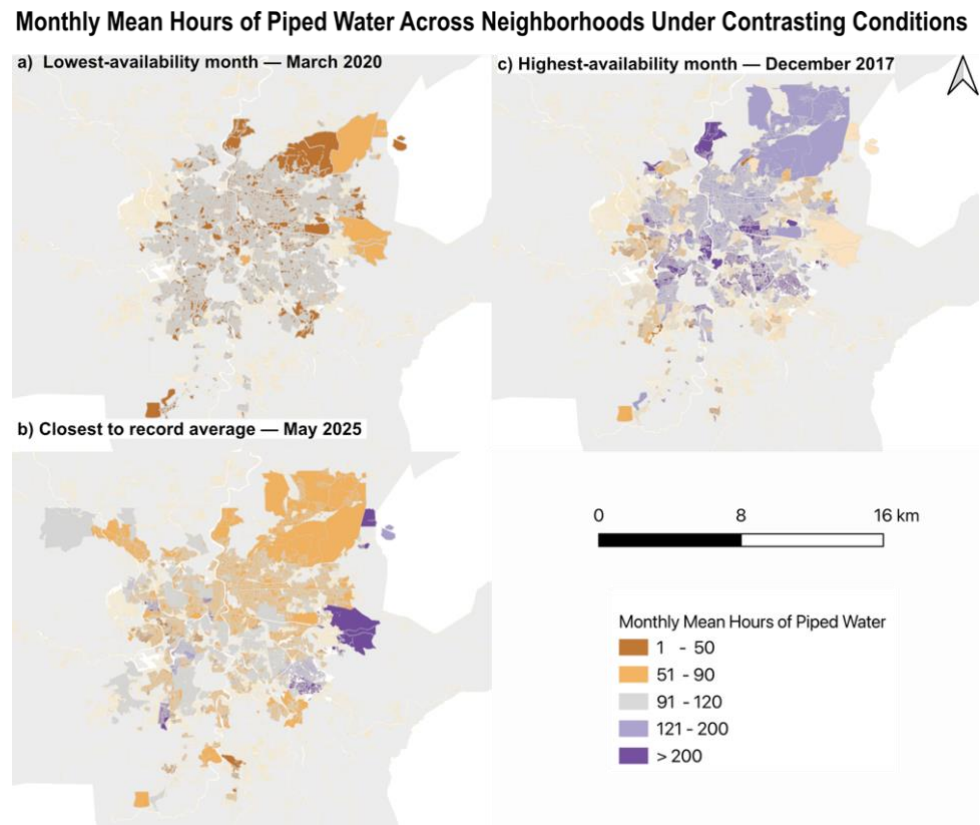
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Resolution of Duplicate Neighborhood Names

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A separate case arises when neighborhood names in the WDC correspond to multiple distinct geographic polygons in the GIS layer. This occurs because several neighborhoods share similar or identical names while representing different spatial areas within the city. In such cases, neighborhood assignments were resolved by considering co-occurring contextual information from the calendar: each neighborhood belongs to a sector and appears alongside a characteristic set of neighboring neighborhoods within the same distribution schedule. Same-named neighborhoods were therefore manually distinguished by their sector and by the co-occurring neighbors listed together in the calendar, allowing each entry to be matched to the correct geographic polygon.

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Figure 3 Monthly Mean Hours of Water Under Contrasting Conditions

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The geographic coverage of the water calendars is illustrated in Figure 3 and 4, where values represent the mean number of scheduled water supply hours/days per month for each neighborhood across the full dataset period.

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Figure 3 represent the spatial distribution of monthly hours of piped water across neighborhoods under contrasting conditions. Panels represent (a) the month with the lowest mean water availability in the record (March 2020), (b) a month with mean availability closest to the record average (May 2025), and (c) the month with the highest mean availability (December 2017). Colors indicate cumulative monthly hours of piped water, with warmer tones representing drought conditions and cooler tones indicating higher availability. Classes are centered on typical conditions (90–120 hours) to highlight deviations in service levels across space. Months were classified by their monthly mean of neighborhood-level hours of piped water relative to the overall mean $\pm$ one standard deviation across all months in the record (consistent with the classification shown in Figure 6): March 2020 has the lowest monthly mean in the dataset, December 2017 the

highest, and May 2025 lies within one standard deviation of the overall mean, reflecting average (typical) supply conditions.

Monthly Mean Days of Piped Water Across Neighborhoods Under Contrasting Conditions

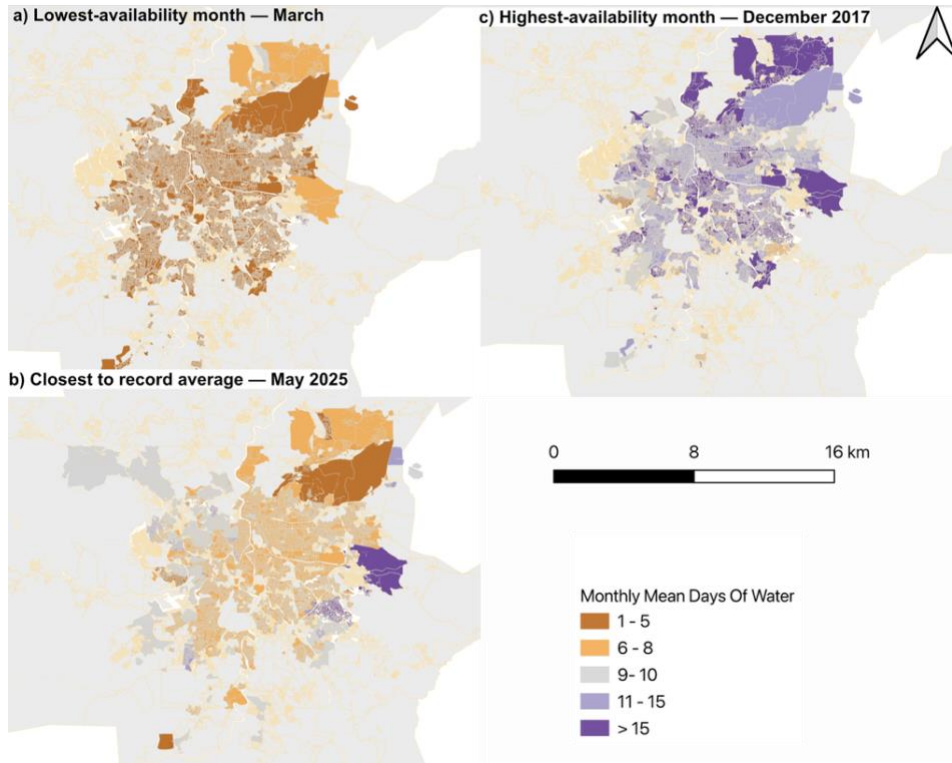


Figure 4 Monthly Mean Days of Water Under Contrasting Conditions

While Figure 4 shows monthly mean days of piped water under contrasting supply conditions: (a) the lowest-availability month (March 2020), (b) the month closest to the record average (May 2025), and (c) the highest-availability month (December 2017). Classes are centered around the average availability (~8.3 days per month). Warmer tones indicate lower availability (drought conditions), while cooler tones indicate higher availability. Persistent spatial inequalities are evident, with many neighborhoods remaining below the mean even during favorable conditions. The same three months as in Figure 3 are shown to allow direct comparison; selection was based on monthly hours of piped water (Figure 3), and the ordering of these months (lowest, closest to average, highest) is consistent for days with water (Figure 6b).

Data Record

All data produced in this study are openly available on Zenodo¹⁶, this dataset includes:

- Data format:** GeoPackage (GPKG)
- Spatial reference system:** Projected or geographic CRS defined at the layer level (EPSG code included in metadata)
- Spatial units:** Neighborhood-level polygon linkage with unique identifiers
- Temporal resolution:** Water Calendar aggregated by Year-Month
- Attributes:** Different aggregated files that includes Year, Month, neighborhood and distribution-group identifiers, and water-availability indicators (days and hours with water). The complete field list for each file is provided with the published dataset.
- Quality control:** Rule-based validation and statistical screening; anomalous records were removed
- Software environment:** Dataset generated using open-source Python and GIS tools; full processing pipeline is publicly available via the associated GitHub repository. Interactive HTML versions of the Figure 8 distribution panels (hours and days of piped water per month) are included with the dataset; these are self-contained files viewable in any web browser without additional software.
- File integrity:** UTF-8 encoding; consistent field naming; reproducible exports

Table 4 provides an overview of the layers included in the GeoPackage, detailing the data type, description, stratification method, inclusion criteria, and important notes regarding the dataset. The layers include neighborhood polygons, merged water calendars, and aggregated data by SDG11UID, water sector, and other relevant identifiers.

The dataset includes CSV files that contain the non-spatial attribute tables linked to the GeoPackage layers. These files are provided separately to accommodate researchers who prefer to work with the data outside of GIS software.

Layer Name	Data Type	Description	Inclusion Criteria	Notes
wcamdc20260228_finalv2	GeoJSON	Neighborhood polygons	Description of neighborhood boundaries and schedules	The spatial reference layer used for neighborhood boundaries and water distribution schedules.
all_hours	CSV	All calendar schedules merged	year, month, wc_uid, group_uid, SDG11UID, neighborhood, schedule, days_observed, days_with_water, conflict_days, etc.	Comprehensive look at both temporal and spatial data; includes conflict days, schedule crossing midnight, etc.
scheduled_errors.csv	CSV	All calendar errors	year, month, wc_uid, group_uid, SDG11UID, neighborhood, schedule, days_observed,	Records excluded during quality control: distribution groups whose monthly

Layer Name	Data Type	Description	Inclusion Criteria	Notes
			days_with_water, conflict days, etc.	aggregated hours totalled zero, indicating that delivery days could not be parsed from the source calendar, together with schedules that could not be parsed at all.
sdg11mean	CSV	All calendar schedules merged	SDG11UID, year_month, max_hours_with_water, mean_hours_with_water, pipeline_name, etc.	Aggregated data by SDG11UID and year_month; provides statistics on water supply availability for neighborhoods/areas.
merged_sector	CSV	All calendar schedules merged	water_sector, year_month, mean_hours_with_water, aggregation_level, pipeline_name, etc.	Aggregated data at the sector level; detailed analysis of water availability by sector.
merged_wcuid	CSV	All calendar schedules merged	water_sector, distribution_unit, water_source, group_uid, wc_uid, year_month, max_hours_with_water, count_sdg11uid, etc.	Detailed aggregation; includes distribution unit, water source, and multiple aggregation levels (sector, group, unit).

Table 4. Data Descriptor for Water Distribution Dataset

Technical Validation

To illustrate the reconstruction workflow, a supplementary workbook is provided with the dataset in which each worksheet corresponds to one stage of the pipeline for a single neighborhood, tracing it from the original Water Distribution Calendar through parsing, standardization, and aggregation to the final standardized record.

Water Piped Network Consistency

To assess the spatial consistency of the reconstructed water calendar dataset, a municipal water distribution pipe network dataset (Figure 5) was used as an independent infrastructure reference. This network represents the physical system supplying municipal water across the city. Neighborhood polygons intersecting the pipe network were therefore expected to be associated with at least one water calendar assignment (wc_uid) in the reconstructed dataset.

The municipal water pipe network dataset is not included in the published dataset but is publicly available through the AMDC open data portal¹⁷. It was used solely as an independent validation reference and not to generate the reconstructed water calendar records. Specifically, it was used to verify that neighborhoods intersecting the mapped pipe network were associated with at least one reconstructed calendar schedule. This validation is intentionally one-directional: it tests only whether neighborhoods with mapped pipe infrastructure have an associated schedule, not the accuracy or content of that schedule. The converse is not assumed. Some neighborhoods assigned a valid calendar schedule are absent from the 2019 pipe-network layer; the dataset does not infer

the reason, which may reflect mapping limitations, alternative service arrangements, or other discrepancies. These cases are reported without interpretation. Accordingly, the pipe network serves only as a lower-bound spatial consistency reference rather than a complete inventory of served neighborhoods.

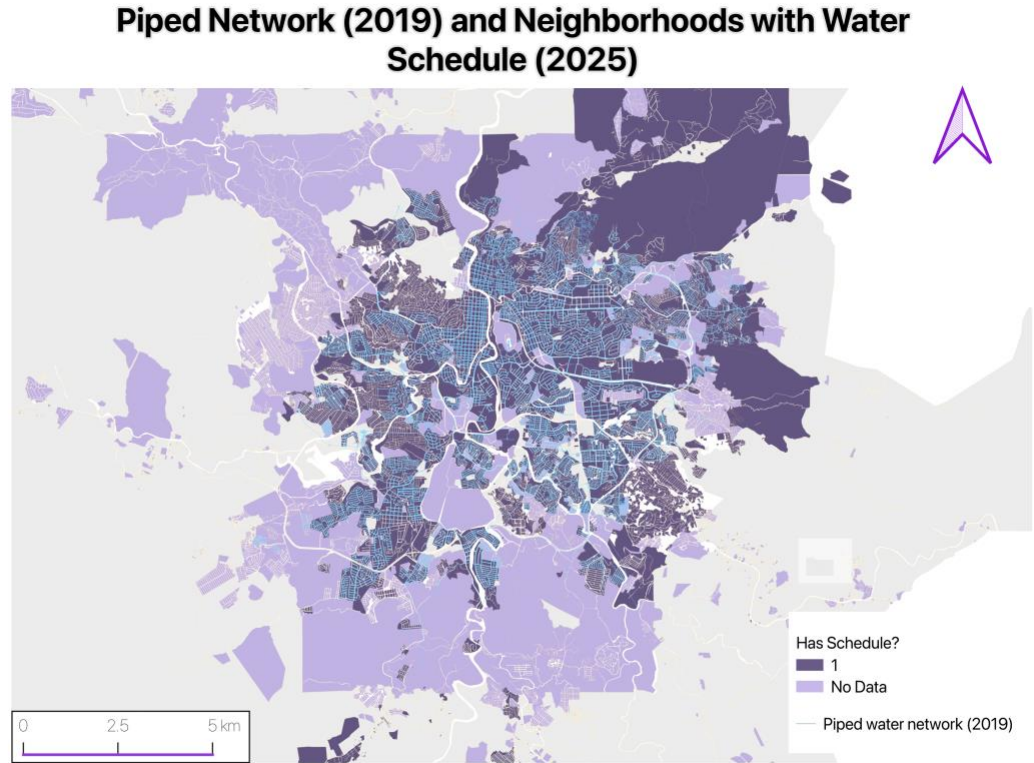


Figure 5 Piped water network (2019) and neighborhoods with water distribution schedules, illustrated for 2025. Dark polygons indicate neighborhoods with at least one schedule assignment in the 2025 Water Distribution Calendars; light polygons indicate neighborhoods without schedule data for that year. The network is used as an independent, one-directional consistency reference: neighborhoods intersecting it are expected to carry at least one schedule assignment in the reconstructed dataset.

Distribution of Reconstructed Water Availability Indicators

Boxplots were used to visualize the neighborhood-level distribution of reconstructed water availability indicators (hours and days with water). Figure 6 comprises (a) the monthly distribution of total hours of piped water supply (1–720 hours) and (b) the monthly distribution of days with water access (1–30 days), aggregated at the neighborhood level; each overlaid point is one neighborhood schedule for that month. For each month, the box spans the interquartile range with the median marked, and the whiskers extend to the neighborhood minimum and maximum.

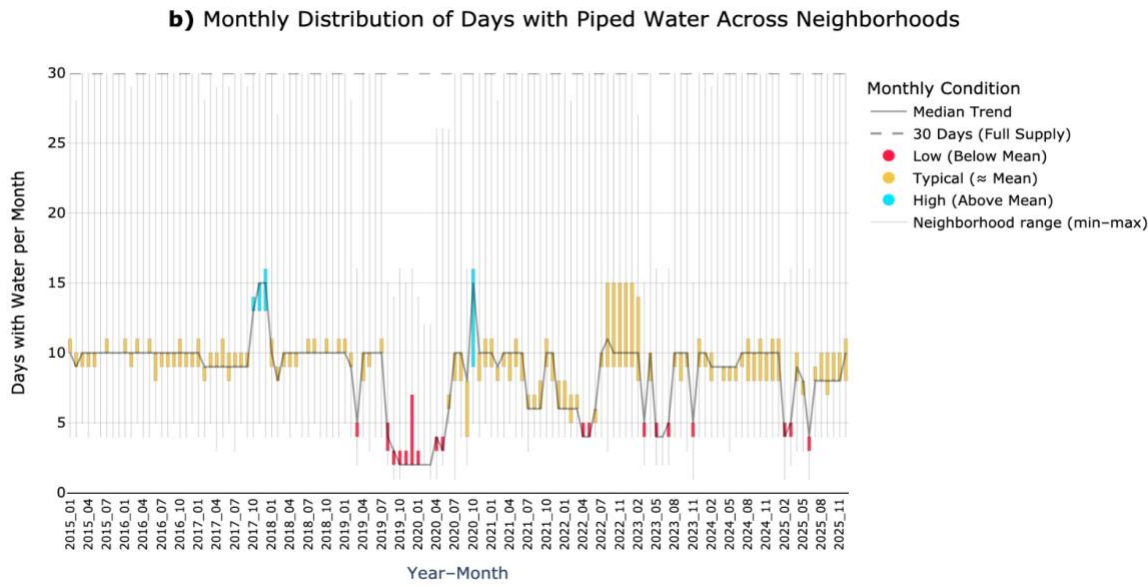
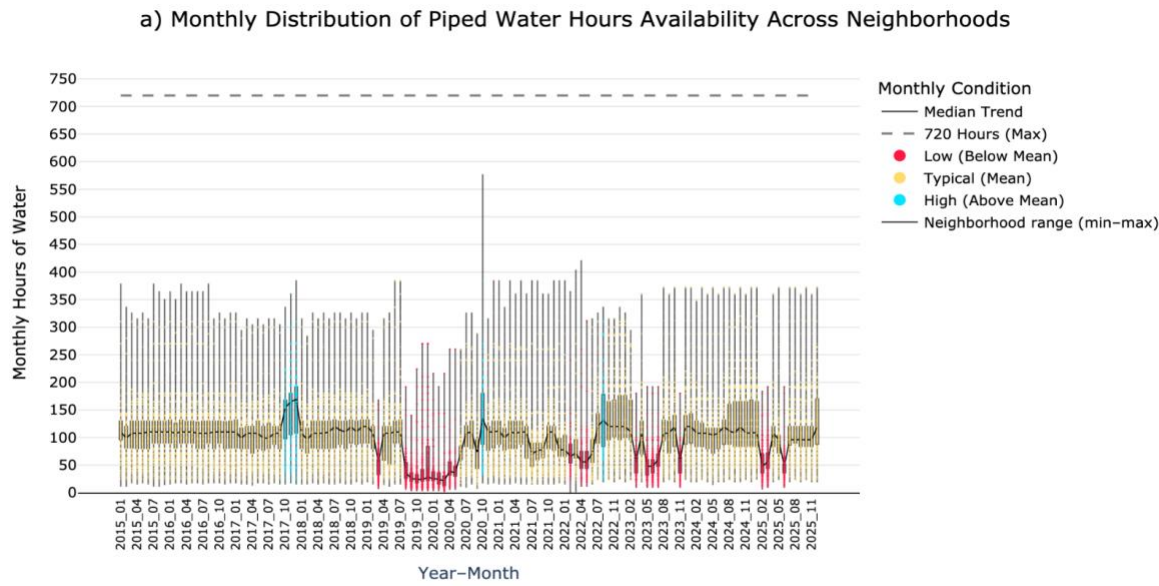


Figure 6 Monthly distribution of reconstructed water availability across neighborhoods, shown as per-month boxplots: (a) total hours of piped supply (1–720 h) and (b) days with water access (1–30 days)

The box color classifies that month's median relative to the overall mean $\pm$ one standard deviation across all months (low, typical, high), and the black line traces the median trend across months.

Dashed lines indicate full supply (720 hours per month in a 30 days per month in b). Together, the panels illustrate variation in both the intensity and frequency of water availability across the study period. Interactive HTML versions of both panels are included with the dataset on Zenodo.

Data Availability

The harmonized Water Distribution Calendar dataset, metadata, and supporting documentation are publicly available from the Zenodo¹⁶ repository under the Creative Commons Attribution 4.0 International (CC BY 4.0) license. Original Water Distribution Calendars are not redistributed because they remain the property of the issuing institution. Researchers wishing to reproduce or extend the dataset may obtain the original schedules through UMAPS' official public communication channels or by submitting requests through the Honduran transparency mechanisms administered by the Instituto de Acceso a la Información Pública (IAIP).

Code Availability

Custom scripts were developed to parse, clean, standardize, validate, and aggregate the water distribution calendars described in this study. The full processing pipeline—including schedule parsing, normalization routines, quality control procedures, neighborhood identifier matching, and temporal aggregation—is publicly available via Zenodo¹⁵.

The pipeline relies on deterministic, rule-based procedures rather than machine learning models. All transformation logic is explicitly encoded in the scripts, ensuring transparency, interpretability, and reproducibility of the dataset reconstruction process.

The workflow is tailored to the locally formatted government documents and the region-specific administrative units of the study area, and adapting it to another city would require adjustments concentrated in three components. The first is the initial parsing stage of the pipeline, which reads the converted calendar files and must accommodate the layout and conventions of a given municipality's published schedules. The second is the set of reference catalogs for distribution groups and neighborhoods: where a city does not organize service into groups, groups may be mapped one-to-one to neighborhoods, and attribute fields used here for water source and distributor may be repurposed to represent other locally relevant variables. The third is the matching of calendar neighborhoods to GIS neighborhood polygons; the granularity of this spatial matching is left to the data curator, and where multiple neighborhoods are associated with a single GIS unit their values are recorded as the mean, consistent with the aggregation procedure used in this dataset. Once a city's records are brought into the canonical form and processed by the first stage into the standardized tabular format, the remaining steps—harmonization, quality control, spatial linkage, and aggregation—operate on that common structure and are largely independent of the originating city, so the bulk of the pipeline can be reused without modification.

Code development was supported by AI-based code generation tools; however, all scripts were thoroughly reviewed, tested, and curated by the authors prior to release.

Declaration Of Competing Interests

The author declares no competing financial interests or personal relationships that could have influenced the work reported in this paper.

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References

1. Galaitsi, S. et al. Intermittent domestic water supply: A critical review and analysis of causal–consequential pathways. *Water* **8**, 274 (2016). <https://doi.org/10.3390/w8070274>
2. Bogotá.gov.co. *Consulta tu día y turno de racionamiento en la ciudad con mapas Bogotá* (2026). Available at: <https://bogota.gov.co/mi-ciudad/habitat/racionamiento-de-agua-en-bogota-consulta-tu-turno-con-mapas-bogota> (Accessed: 6 March 2026).
3. Servicios de Agua y Drenaje de Monterrey I.P.D. *Extensión horario suministro* (2022). Available at: https://www.sadm.gob.mx/SADM/Noticia.jsp?id_html=Extension_horario_suministro_5a12 (Accessed: 9 March 2026).
4. SAPA La Paz (2025). *Tandeo de agua*. Available at: <https://tandeo.sapalapaz.gob.mx> (Accessed: 6 March 2026).
5. Guerrero de la Cruz, H. *Quito enfrenta racionamiento de agua* (2024). Tiempo Real EC. Available at: <https://www.tiemporealec.com/quito-enfrenta-racionamiento-de-agua-potable-del-23-al-30-de-septiembre/> (Accessed: 6 March 2026).
6. Exitosa Noticias. *Anuncian corte de agua por 12 horas en Lima: ¿qué distritos tendrán servicio el 7 de marzo?* (2026). Available at: <https://www.exitosanoticias.pe/actualidad/anuncian-corte-agua-12-horas-lima-que-distritos-tendran-servicio-7-marzo-n170397> (Accessed: 6 March 2026).
7. Secretaría de Gestión Integral del Agua (SEGIAGUA). *Agua en tu colonia*. Gobierno de la Ciudad de México. Available at: <https://aguaentucoloniasacmex.cdmx.gob.mx/#/home> (Accessed: 6 March 2026).
8. WHO & UNICEF. *Joint Monitoring Programme (JMP) for Water Supply, Sanitation and Hygiene (WASH)*. Available at: <https://washdata.org> (Accessed: 28 April 2026).
9. UN Water. *SDG 6 Data Portal* (2026). Available at: <https://sdg6data.org/en> (Accessed: 28 April 2026).
10. Instituto de Acceso a la Información Pública (IAIP). *Portal Único de Transparencia*. Available at: <https://portalunico.iaip.gob.hn> (Accessed: 28 April 2026).
11. Sistema de Información Electrónico de Honduras (SIELHO) Available at: <https://sielho.iaip.gob.hn/inicio/> (Accessed: 28 April 2026).
12. UMAPS Facebook Available at: <https://www.facebook.com/umapsdc> (Accessed: 28 April 2026).
13. UMAPS Instagrams Available at: <https://www.instagram.com/umapsdc> (Accessed: 28 April 2026).
14. iLovePDF. *Online PDF tools*. Available at: <https://www.ilovepdf.com/> (Accessed: 13 July 2026).
15. Rivera, Y. *SDG-6 Water Distribution Pipeline (Tegucigalpa, 2016–2025), Version 1.2*. Zenodo (2026). <https://doi.org/10.5281/zenodo.21499633>
16. Rivera, Y. *Urban Water Distribution Schedules Dataset for Tegucigalpa, Honduras (2016–2025)*. Zenodo (2026). <https://doi.org/10.5281/zenodo.21499698>
17. Alcaldía Municipal del Distrito Central (AMDC). *ATLAS*. Tegucigalpa, Honduras (2025). Available at: <https://amdc.hn> (Accessed: 28 April 2025).
18. NASA JPL (2021). NASADEM Merged DEM Global 1 arc second V001. Distributed by Open Topography. (Accessed: 29 July 2025). Original data: NASA JPL, distributed by NASA EOSDIS LP DAAC, https://doi.org/10.5067/MEaSURES/NASADEM/NASADEM_HGT.001.