METHODOLOGICAL DOCUMENT

Sustainable Management and Conservation of Water Resources

BWS0002

Rainwater Harvesting Practices. Collection and Storage for Water Security

BIOCARBON CERT©

VERSION 1.0 | APRIL 30, 2026

BIOCARBON CERT
www.biocarbonstandard.com

BIOCARBON CERT®. 2026. Rainwater Harvesting Practices. Collection and Storage for Water Security. BWS0002. Version 1.0. April 30, 2026. 42 p. http://www.biocarbonstandard.com.

Credits

This document was developed by BioCarbon Cert as part of the BioCarbon Water Standard (BWS).

The technical development of this methodology was supported by the Asociación Cultural para el Desarrollo Integral (ACDI), whose expertise in climate resilience, sustainable water resources management, environmental conservation, and community development provided relevant technical insights for the construction of this framework.

The opinions and guidelines contained in this document correspond exclusively to the BioCarbon Water Standard.

Table of Contents

1 Introduction

Freshwater is an essential resource for human well-being, ecosystem functioning, and economic development. Although approximately 71% of the planet's surface is covered by water, only about 2.5% corresponds to freshwater, and less than 1% is available in rivers, lakes, and other surface bodies accessible for human and ecological use.

The availability of this resource is increasingly pressured by multiple factors, including population growth, the expansion of productive activities, the degradation of river basins, and the effects of climate change. In many regions of the world, these pressures manifest as seasonal or structural water stress, affecting the water security of rural and urban communities (UN-Water, 2015).

In this context, the implementation of decentralized solutions for sustainable water management has become a key strategy for strengthening water resilience. Among these solutions, rainwater harvesting systems allow the capture, storage, and use of rainfall to meet various domestic and productive needs (García-Ávila et al., 2023; Semaan et al., 2020), reducing dependence on conventional sources such as rivers, aquifers, or supply networks.

Rainwater harvesting is a widely used practice in different regions of the world to improve local water availability, reduce pressure on existing water sources, and increase adaptive capacity in the face of climate variability (Melville-Shreeve et al., 2016; Ursino, 2016). These systems allow water to be stored during rainy periods for later use during dry seasons, thereby contributing to the stability of the water supply.

Within the framework of current sustainable water management approaches, various international initiatives have promoted the quantification of hydrological benefits generated by water management interventions through volumetric water indicators, which allow for the consistent evaluation of results of such interventions in terms of water resource availability or use (World Resources Institute, 2019).

In this context, the present methodology establishes the technical guidelines for quantifying the volumetric benefits associated with the implementation of rainwater harvesting practices, through collection and storage systems that increase water availability for domestic and productive uses.

The methodology allows for the estimation of the additional volume of water captured, stored, and utilized as a result of the activities implemented within the project area, in comparison to a baseline scenario. These results are expressed in cubic meters of water per year (m^3/year) and constitute the basis for the issuance of Verified Water Credits (VWC) under the BioCarbon Water Standard.

In this way, the methodological approach seeks to facilitate the channeling of investments toward solutions based on sustainable water management, contributing to strengthening water security, climate resilience, and the sustainable management of water resources in different geographic contexts (Global Water Partnership, 2018).

2 Objectives

The objective of this methodology is to establish the technical guidelines for the quantification, monitoring, and verification of volumetric water benefits derived from the implementation of rainwater harvesting practices including systems for the catchment, storage, and use of water resources within the framework of the BioCarbon Water Standard.

In particular, this methodology establishes:

(a) the criteria for identifying the project area and characterizing the water regime of the territory;

(b) the eligibility and applicability conditions for rainwater harvesting activities;

(c) the procedures for establishing the baseline, including the collection of meteorological information, water demand analysis, and the characterization of existing rainwater collection systems;

(d) the equations and technical procedures for quantifying the additional volume of water collected, stored, and used as a result of project activities, expressed in cubic meters per year (m^3/year);

(e) the requirements for quantifying certifiable units as Verified Water Credits (VWC) under the BioCarbon Water Standard;

(f) the guidelines for monitoring, reporting, and verifying project results.

3 Terms and Definitions

For the purposes of this methodology, the following definitions are adopted:

Surface Water

Water present on the earth's surface, including rivers, lakes, streams, ponds, reservoirs, and other surface water bodies.

Water Storage

Accumulation of water in natural or artificial reservoirs, such as cisterns, tanks, dams, or ponds, intended for later use.

Project Area

Clearly delineated geographic area where rainwater harvesting activities are implemented and where the results associated with the project are quantified.

Water Balance of the Rainwater Harvesting System

Analytical framework that allows the quantification of inputs, outputs, storage, and water losses within a rainwater harvesting system over a defined period of time.

In this methodology, the water balance is used to estimate the effective volume of water collected, stored, and used by the system.

Storage Capacity

Maximum volume of water that can be stored in the rainwater harvesting system infrastructure, expressed in cubic meters (m^3).

Rainwater Harvesting

The practice of collecting, conveying, storing, and using rainfall through systems designed to collect water from catchment surfaces and store it for later use.

Rainwater Harvesting (RWH) is defined as the practice of collecting, storing, and using rainfall to meet water needs at the same site where the phenomenon occurs. This system fundamentally consists of collecting water from hard surfaces or rooftops, directing it through gutters and pipes, and storing it in a tank or cistern for later use.

Verified Water Credits (VWC)

Certified units representing the additional volume of water collected, stored, and used through rainwater harvesting systems, attributable to project activities, expressed in cubic meters per year (m^3/year).

VWCs reflect the verifiable increase in water availability generated by project activities compared to the without project situation.

Water Demand

Amount of water required by system users to meet domestic or productive needs over a given period.

In the context of rainwater harvesting projects, the water mass balance is used to consistently, verifiably, and reproducibly estimate the effective volume of harvested water and the net water savings relative to a without project baseline.

Runoff Coefficient

Dimensionless coefficient representing the fraction of precipitation that can be captured from a given surface, considering losses due to evaporation, uncontrolled infiltration, splashing, and other system losses.

Baseline

Reference condition describing water use and availability in the without project scenario, used to evaluate the changes generated by the implementation of rainwater harvesting activities.

Precipitation

Amount of water that falls from the atmosphere to the earth's surface in liquid or solid form, generally expressed in millimeters (mm).

Effective Precipitation

Portion of total precipitation that can be captured by the rainwater harvesting system after deducting initial losses associated with the collection system.

Water Security

Condition in which there is sufficient, reliable, and sustainable availability of water of adequate quality to meet human, productive, and environmental needs.

Catchment Surface

Effective area from which rainwater is collected within the water harvesting system, expressed in square meters (m^2).

Water Harvesting System Unit

Minimum quantification unit within the project that includes at least one catchment area, a conveyance system, and a storage structure associated with the use of the collected water.

Effective Volume of Harvested Water

Amount of water that is actually collected, stored, and used by the rainwater harvesting system during a given period, considering storage limitations, operational losses, and demand patterns.

4 Applicability Conditions

The applicability conditions establish the minimum requirements that projects must meet in order to apply this methodology. These conditions ensure that rainwater harvesting activities generate measurable, verifiable, and attributable volumetric water benefits from the project's interventions.

Project proponents applying this methodology must comply with the following applicability conditions.

4.1 Water Security Context

Activities must be implemented in territories where there is evidence of current or seasonal water stress, limitations in water access, or vulnerability to climate variability (García-Ávila et al., 2023; Melville-Shreeve et al., 2016).

Evidence may be based on:

(a) regional hydrological or climatic analyses;

(b) historical records of precipitation and water availability;

(c) official diagnostics or watershed studies;

(d) analysis of seasonal dry periods;

(e) socioeconomic information on restricted water access.

The project proponent must demonstrate that the activities contribute to improving local water availability or to reducing pressure on existing water sources.

4.2 Dependence on Conventional Water Sources

The project area must exhibit dependence on existing water sources such as:

(a) surface waters (rivers, streams, lakes);

(b) groundwater;

(c) public supply networks;

(d) water transport by tankers or other means.

The project proponent must demonstrate that the harvested water totally or partially replaces the use of such sources.

4.3 Existence of Verifiable Catchment Surfaces

Rainwater harvesting systems must have clearly identifiable catchment surfaces, such as:

(a) building rooftops;

(b) impermeable surfaces;

(c) structures designed to channel runoff.

Surfaces must be measurable and verifiable through field surveys or geospatial tools.

4.4 Defined Storage Infrastructure

Collected water must be stored in infrastructure designed for this purpose, such as:

(a) tanks;

(b) cisterns;

(c) reservoirs;

(d) equivalent structures.

Storage capacity must be quantifiable and verifiable.

4.5 Identifiable Use of Harvested Water

The project proponent must identify the destination of the collected water, which may include:

(a) domestic consumption;

(b) productive use;

(c) agricultural or livestock use;

(d) other non-potable uses.

The volume used must be consistent with the demand patterns identified in the project area.

5 Typology of Rainwater Harvesting Systems

Rainwater harvesting systems included in this methodology must be designed to allow the collection, conveyance, storage, and use of rainwater safely and efficiently.

The main components of these systems include the catchment surface, the conveyance system (gutters and downpipes), first-flush or filtration devices, the storage system, and overflow mechanisms. These elements are consistent with the technical principles established in international standards for rainwater use systems (EN 16941-1:2024).

In general, rainwater harvesting systems can be classified into the following categories:

5.1 Rooftop Collection Systems (Roof Rainwater Harvesting)

Systems that collect rainwater from impermeable surfaces, such as rooftops of dwellings, buildings, or similar structures, and convey it to storage systems through gutters and pipes.

5.2 Surface Runoff Collection Systems

Systems that collect rainwater from impermeable or semi-permeable ground surfaces through channels, ditches, or other conveyance structures that direct water to storage structures.

5.3 Decentralized Storage Systems

Systems that store collected water in tanks, cisterns, reservoirs, or other storage structures designed to conserve water and allow for its later use.

5.4 Hybrid Collection and Storage Systems

Systems that combine different types of catchment surfaces and storage structures to maximize the volume of water collected and improve water availability in the project area.

These systems can be used for different purposes, including domestic consumption, productive activities, and agricultural or livestock uses, provided that the collected water contributes to improving local water availability or reducing pressure on existing water sources.

Rainwater harvesting systems must be designed and implemented in such a way as to minimize the risks of contamination of stored water. In particular, systems must consider basic control elements, such as protection of catchment surfaces, proper conveyance of water through gutters or pipes, initial removal of sediments through first-flush or filtration devices, and storage in structures protected against external contamination. These considerations are consistent with international recommendations for rainwater collection and storage systems (WHO, 2020).

6 Eligible Activities

Eligible activities under this methodology correspond to interventions aimed at collecting, conveying, storing, and using rainwater through systems designed to improve local water availability and reduce pressure on existing water sources.

Activities must generate a verifiable increase in the volume of water collected, stored, or used, compared to the without project situation.

Eligible activities under this methodology are limited to interventions for rainwater collection, storage, and use. Benefits associated with infiltration or aquifer recharge will be accounted for exclusively under the corresponding BioCarbon Water Standard methodologies.

The following activities may be eligible for the generation of Verified Water Credits (VWC) and are described below.

6.1 Implementation of New Rainwater Harvesting Systems

Includes the installation of infrastructure designed to collect and store rainwater, such as:

(a) rooftop or other impermeable surface collection systems;

(b) gutters, pipes, or other water conveyance systems;

(c) tanks, cisterns, reservoirs, or other storage structures;

(d) filtration or first-flush systems associated with collection;

(e) infrastructure associated with the distribution or use of collected water.

6.2 Improvement or Expansion of Existing Water Harvesting Systems

Includes interventions aimed at increasing the capacity or efficiency of existing systems, such as:

(a) expansion of the catchment surface;

(b) increase in storage capacity;

(c) improvement of conveyance or filtration systems;

(d) replacement of materials or infrastructure that increase system efficiency;

(e) incorporation of additional components that allow for an increase in the volume of usable water.

6.3 Optimization and Rehabilitation of Water Harvesting Systems

Includes activities aimed at recovering or improving the functioning of existing systems, such as:

(a) maintenance or repair of collection and storage infrastructure;

(b) improvement of the runoff coefficient through adaptation of catchment surfaces;

(c) rehabilitation of deteriorated systems;

(d) optimization of the use of collected water for domestic or productive purposes.

7 Prioritization of Areas for Intervention

This methodology is applicable in any country and to a wide variety of rainwater harvesting systems that comply with the guidelines established in this document and in the BioCarbon Water Standard.

However, its application is particularly relevant in territories that experience at least one dry season per year or where there is evidence of current or potential water stress, including contexts in which climatic or hydrological studies project a reduction in water availability due to climate variability or climate change.

In these contexts, the implementation of rainwater harvesting systems can significantly contribute to improving local water availability, strengthening water security, and reducing pressure on existing water sources.

8 Baseline Scenario and Additionality Demonstration

The project proponent must demonstrate that the additionality of the volumetric water benefits quantified using this methodology are a direct result of the activities implemented by the project and would not have occurred in its absence.

Project proponents must demonstrate that rainwater harvesting interventions generate a verifiable increase in the volume of water collected, stored, and used, compared to the baseline scenario.

The demonstration of additionality must be based on the comparison between:

1) Without project scenario (baseline): conditions of water collection, storage, and use in the absence of project activities;

2) With project scenario: conditions resulting from the implementation of rainwater harvesting systems.

The additional volume of water attributable to the project corresponds to the quantified difference between both scenarios.

8.1 Identification of the Baseline Scenario

The baseline scenario corresponds to the conditions of water availability and use in the absence of project activities and must be established based on information collected during the baseline assessment. In projects implementing new rainwater harvesting systems, the baseline scenario will correspond to the absence of such systems in the intervention area. In projects that contemplate improvements or expansions of existing systems, the baseline scenario will correspond to the functioning of the system prior to the project's intervention.

The characterization of the baseline scenario shall consider not only current water catchment and usage conditions, but also the hydrological context of the project area, including the precipitation regime, climate seasonality, existing supply sources, and the degree of pressure on local water resources. This approach is consistent with international water efficiency management frameworks that recommend assessing the context of water use and the conditions of water resources within the project environment (ISO 46001, 2019).

This analysis allows for an understanding of the conditions under which rainwater harvesting activities are implemented and constitutes the basis for evaluating the changes attributable to the project.

8.2 Baseline Assessment

Water consumption in the context of rainwater harvesting system projects is a fundamental input for estimating system water demand and quantifying the volume of water that can potentially be replaced through rainwater collection.

For demand estimation, the project's target population must be identified and water harvesting system units must be surveyed following the stratification established in this methodology.

Water consumption data per capita or by type of activity from internationally recognized sources such as FAO, WHO, or international research organizations must be considered. When possible, locally obtained consumption data should be prioritized.

8.2.1 Water Sources in the Without Project Situation

The project proponent must identify the origin of the water sources used by the population in the without project situation, which may include:

(a) surface waters;

(b) groundwater;

(c) existing supply networks;

(d) water transport by tanker;

(e) existing rainwater collection systems.

This information must be collected through surveys and assessments in the project area. Additionally, it must be identified whether these sources are subject to any type of use pressure or availability limitations.

8.2.2 Meteorological Data

For the establishment of the meteorological baseline, the project proponent must compile a catalog of representative climatic data for the project area.

These data must allow for the estimation of:

(a) precipitation availability;

(b) the precipitation that can be captured by the system;

(c) the relevant climatic losses of the system.

The project proponent must use records from meteorological stations located within the project's area of influence or in climatically comparable areas.

The historical precipitation series should preferably cover at least twenty (20) years prior to the project's start date, when such information is available.

When sufficient meteorological stations are not available, satellite data available on platforms such as Google Earth Engine (Funk et al., 2015) may be used.

8.2.3 Precipitation

Among the most widely used datasets for precipitation estimation are widely recognized and used satellite products in hydrological and climatic studies, such as GPM IMERG (Global Precipitation Measurement) developed by NASA, TRMM 3B42 (Tropical Rainfall Measuring Mission), CHIRPS - Climate Hazards Group InfraRed Precipitation with Station data (NASA; Funk et al., 2015), and PERSIANN-CDR (Precipitation Estimation from Remotely Sensed Information using Artificial Neural Networks – Climate Data Record).

These datasets can be particularly useful in contexts where local meteorological station coverage is limited or insufficient to adequately characterize the precipitation regime in the project area.

Records from national meteorological networks or direct measurements from rain gauges installed in the project area may also be used.

8.2.4 Complementary Meteorological Variables

Depending on the type of storage system and the intended use of the water, additional climatic variables may be incorporated to improve the characterization of hydrological conditions in the project area.

These variables include air temperature, reference evapotranspiration (ET_0) or evaporation, solar radiation, relative humidity, and wind speed. These variables allow for a more precise estimation of potential system losses and the climatic conditions influencing the availability and use of collected water. The corresponding information may be obtained from official meteorological networks or recognized global climatic products provided that the data source and its representativeness for the project area are adequately documented.

8.3 Baseline Analysis

The objective of the baseline analysis is to characterize the existing conditions of water availability, collection, and use in the project area, so that a robust baseline scenario can be established for the quantification of volumetric water benefits. This analysis must integrate information collected during the baseline assessment, including climatic data, water consumption patterns, and characteristics of existing rainwater harvesting systems. As a first step in this analysis, a stratification of the project area must be carried out, enabling the system units to be organized into sets of comparable conditions for subsequent analysis and quantification.

8.3.1 Project Area Stratification

As part of the baseline analysis, the project proponent must establish a stratification of the project area in order to group rainwater harvesting system units into sets of relatively homogeneous conditions.

This stratification ensures that measurements, sampling, and calculations associated with water collection, storage, and use are representative, comparable, and technically consistent throughout the project scope.

The definition of strata must consider, among others, the following factors:

(a) geographic location and water regime of the project area;

(b) type of rainwater harvesting system;

(c) catchment surface;

(d) system storage capacity;

(e) destination of the water used, distinguishing between domestic and productive use.

The defined strata must allow for:

(a) representative estimation of rainwater collection and harvested water consumption; and

(b) analysis of the changes generated by project activities over time.

The number of strata must be defined based on the diversity of water harvesting systems present, the planned uses of the water, and the conditions of the water regime in the project area.

8.3.2 Water Stress Analysis

The project proponent must conduct an analysis of the monthly precipitation behavior in the project area, with the objective of identifying the months of highest precipitation and the dry periods of the local climatic regime.

This analysis must be carried out for each of the strata defined in the project area, in order to characterize the water regime of the territory and determine the periods in which water availability is limited. The identification of these periods will allow for an evaluation of the extent to which the implementation of rainwater harvesting systems can contribute to improving water availability and reducing pressure on existing water sources.

8.3.3 Water Demand Analysis

For each project stratum, the annual water consumption must be estimated, differentiating between the different types of use identified in the project area, including at least:

(a) domestic consumption;

(b) productive consumption.

Demand estimation may be based on data from recognized sources (e.g., international organizations or technical studies) or from consumption surveys conducted in the project area, provided these are representative of local conditions (WHO, 2017).

Additionally, for each stratum, the primary water supply source used by the population must be identified. Where multiple supply sources exist, the relative proportion of use of each source must be estimated, in order to adequately characterize the baseline scenario and evaluate the substitution potential through rainwater harvesting systems.

8.3.4 Analysis of the Without Project Status of Water Harvesting Systems

When the project contemplates the implementation of new rainwater harvesting systems, water collection through these systems in the baseline scenario will be considered equal to zero.

When the project contemplates improvements, expansions, or rehabilitation of existing rainwater harvesting systems, a detailed survey of the systems present in the project area must be conducted, in order to characterize their functioning in the without project scenario.

For each stratum defined in the project area, the water balance of existing systems must be estimated, considering at least the following parameters:

(a) catchment surface;

(b) material of the catchment surface;

(c) system runoff coefficient;

(d) storage capacity;

(e) water demand associated with the system;

(f) percentage of water demand that is supplied through rainwater collection.

This information will allow for the adequate characterization of the performance of existing systems in the baseline scenario and the establishment of the reference point for quantifying the additional volume of water attributable to the project.

8.4 Additionality Demonstration

The project proponent must demonstrate that the rainwater harvesting activities implemented generate a verifiable increase in the volume of water collected, stored, and used compared to the without project scenario. This increase corresponds to the additional volume of water available as a result of the implementation of the rainwater harvesting system.

Additionality must be demonstrated through the application of the following criteria:

(a) Demonstration of Change from Baseline

The demonstration of additionality will be carried out through the comparison between the water balance of the system in the with-project scenario and the water balance corresponding to the baseline (without project) scenario.

In the case of new installations, the baseline scenario corresponds to the absence of rainwater harvesting systems in the intervention area.

In the case of improvements or expansions of existing systems, additionality must be demonstrated by quantifying the increase in the volume of water collected, stored, or used relative to the system prior to the project's intervention.

(b) Non-Regulatory Obligation

Project activities must not correspond to measures required by legislation, environmental regulation, or administrative provisions in force in the territory where the project is implemented.

8.5 Common Practice Analysis

The rainwater harvesting interventions implemented by the project must not constitute the predominant or widely adopted practice in the project area.

The project proponent must justify that the implemented activities represent an additional intervention beyond the customary practices of the territory.

8.6 Additionality Confirmation

Only the additional volume of water collected, stored, and used that meets the additionality criteria established in this section may be considered for the quantification of Verified Water Credits (VWC) under this methodology.

8.7 Exclusions

The following activities will not be considered additional:

(a) practices already widely implemented in the project area or that constitute common practice in the sector or territory;

(b) legally mandatory activities or those required by current regulations;

(c) interventions that do not generate a quantifiable change in the collection, storage, or use of rainwater;

(d) improvements that do not produce a verifiable increase in the effective volume of water available to system users.

9 Quantification of Volumetric Water Benefits

The quantification of volumetric water benefits under this methodology is based on the estimation of the additional volume of water collected, stored, and used through rainwater harvesting systems, compared to the baseline (without project) scenario. This approach is consistent with international frameworks that promote the measurement of water management interventions through volumetric water benefits (World Resources Institute, 2019).

The additional volume of water attributable to the project is determined through the comparison between:

1) the with-project scenario, which corresponds to the functioning of the water harvesting system implemented or improved by the project; and

2) the without project scenario, which represents the conditions of water collection and use in the absence of such interventions.

The result of this comparison constitutes the additional volume of water attributable to the project, expressed in cubic meters per year (m^3/year).

To estimate this volume, the equations described below are applied, which represent the main components of the water balance of the rainwater harvesting system.

9.1 Rainwater Collection

The first step of the quantification consists of estimating the volume of rainwater that can be collected by the system during a given period. This volume depends on the precipitation recorded in the project area, the available catchment surface, and the efficiency of the collection system (Martin et al., 2015).

The volume of water collected during period t is calculated using the following equation:

$$Q_t = \frac{P_t}{1000} \times S_c \times F_c \qquad \text{Equation 1}$$

Where:

Q_t	=	Volume of water collected in period t; m^3
P_t	=	Precipitation in period t; mm
S_c	=	Catchment Surface; m^2
F_c	=	Runoff Coefficient; adimensional

The runoff coefficient represents the fraction of precipitation that can be effectively captured by the considered surface, deducting losses associated with evaporation, uncontrolled infiltration, and first flush.

9.2 Water Demand

The system water demand represents the volume of water required by the users of the rainwater harvesting system during the analysis period. This demand may be associated with domestic, productive, or other uses defined within the project.

The total water demand of the system is estimated as the sum of the demands corresponding to each type of use.

$$D_t = D_h + D_p \qquad \text{Equation 2}$$

Where:

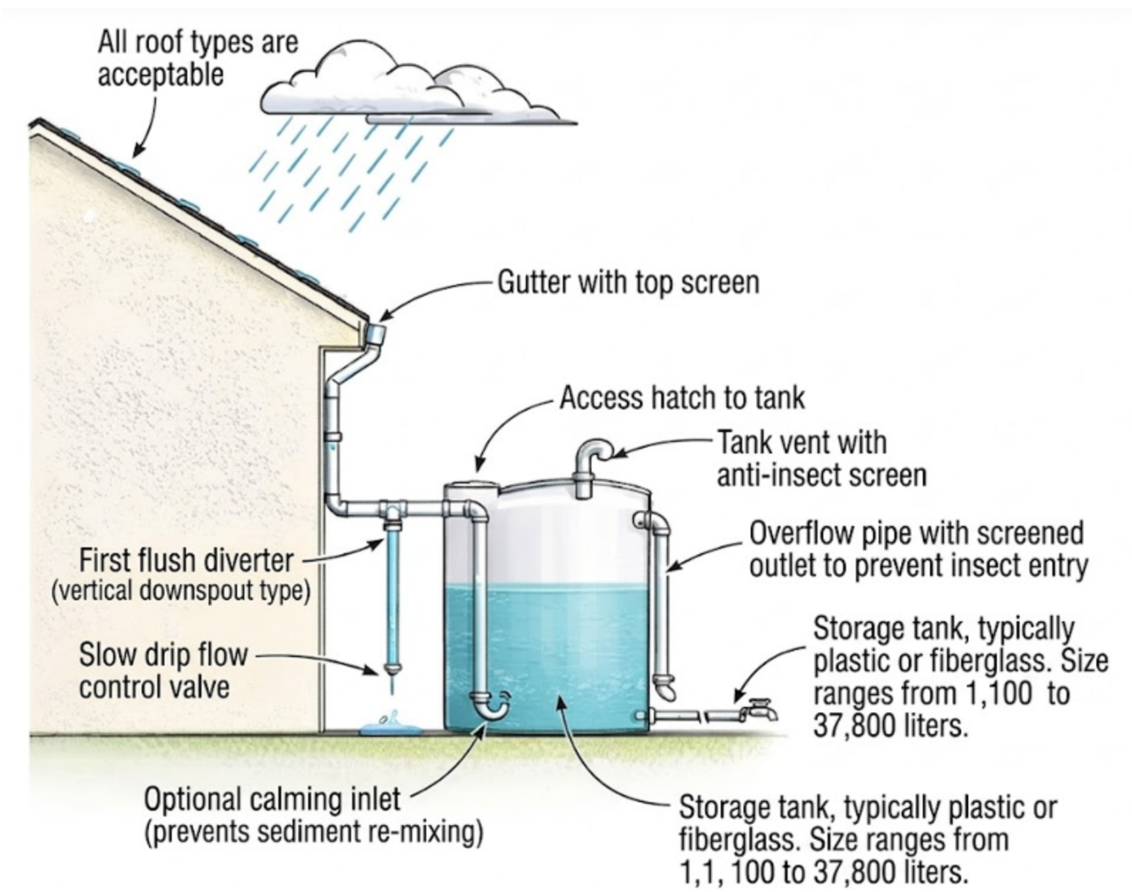
D_t	=	Total water demand in period t; m^3
D_h	=	Domestic demand in period t; m^3
D_p	=	Productive demand in period t; m^3

9.3 System Water Balance

This balance allows for the evaluation of the dynamics of the volume stored in the system, considering the water collected, the water used by users, and the losses due to overflow when the storage capacity is exceeded.

The behavior of the rainwater harvesting system is represented by a water balance that allows for the estimation of water inputs, outputs, and storage in the system during a given period (Figure 1).

Figure 1. Conceptual Diagram of a Rainwater Harvesting System



Source: Adapted from Roof Rainwater Harvesting System, Watercache[1]

The diagram shows the main inputs, outputs, and storage of the system considered in the quantification of volumetric water benefits, including precipitation, collection, system storage, water use, and overflow.

The monthly water balance of the system is expressed by the following equation:

$$V_t = V_{t-1} + Q_t - Y_t - O_t \quad \text{Equation 3}$$

Where:

V_t	=	Volume of water stored at the end of period t. Storage at the end of the month (or defined period); m^3
V_{t-1}	=	Volume stored at the beginning of the period. Storage at the beginning of the month (or defined period); m^3
Q_t	=	Volume of water collected during the period. System input, from captured precipitation; m^3
Y_t	=	Volume of water used during the period. Output due to use/consumption (household and/or productive); m^3
O_t	=	Volume of water lost due to system overflow; m^3

The performance of rainwater harvesting systems can be represented through water balances that describe the system's inputs, storage, and outputs (Semaan et al., 2020; Ursino, 2016).

9.3.1 System Overflow

When the stored water volume exceeds the maximum capacity of the storage system, the excess water is released outside the system as overflow. This process is incorporated into the water balance to ensure that the stored volume does not exceed the physical capacity of the tank or reservoir.

[1] Available in https://watercache.com/rainwater/residential

System overflow is calculated using the following equation:

$$O_t = max(V_{t-1} + Q_t - Y_t - S, 0) \quad \text{Equation 4}$$

Where:

S	=	Maximum tank capacity; m^3

This calculation prevents storage from exceeding the system's capacity.

9.4 Determination of the Effective Volume of Harvested Water

The volume of water collected by the system does not necessarily correspond to the volume that is effectively used by users. To avoid overestimations, the effective volume of harvested water is defined as the volume of water that is actually used within the system.

Therefore, the effective volume is determined as the lesser value between the volume collected and the volume of water used.

$$V_{ef} = min(Q_t, Y_t) \quad \text{Equation 5}$$

Where:

V_{ef}	=	Effective Volume of Harvested Water; m^3
Q_t	=	Volume of water collected; m^3
Y_t	=	Volume of water used or demanded; m^3

The system water balance is calculated with monthly temporal resolution. The annual effective volume of harvested water is obtained by summing the monthly effective volumes calculated for each period t.

$$V_{ef,anual} = \sum_{t=1}^{12} V_{ef,t} \quad \text{Equation 6}$$

Where:

$V_{ef,annual}$ = Annual effective volume of harvested water; m^3/year

$V_{ef,t}$ = Effective volume of harvested water in period t; m^3

9.5 Quantification of the Additional Volume of Water (Attributable to the Project)

The additional volume of water attributable to the project is calculated as the difference between the effective volume of harvested water in the with-project scenario and the effective volume corresponding to the baseline scenario.

$$V_{add} = V_{e.f.,annual,project} - V_{e.f,annual,baseline} \qquad \text{Equation 7}$$

Where:

V_{add} = Additional volume of water attributable to the project; m^3

$V_{e.f,project}$ = Effective volume of water harvested with the project; m^3

$V_{e.f,baseline}$ = Effective volume of water harvested in the baseline; m^3

9.6 Difference Between New Installations and Existing Improvements

The quantification of the additional volume of water attributable to the project will depend on the type of intervention implemented.

In the case of new rainwater harvesting system installations, the baseline scenario is considered equal to zero, given that there was no prior rainwater collection through such systems in the intervention area. In this case, the additional volume of water corresponds directly to the effective volume of water collected and used by the implemented system.

In the case of projects that contemplate improvements, expansions, or rehabilitation of existing rainwater harvesting systems, the additional volume of water will be determined as the difference between the effective volume of water harvested in the with-project scenario and the effective volume corresponding to the system in the without project situation.

9.7 Conversion to Verified Water Credits (VWC)

Verified Water Credits (VWC) correspond to the additional annual volume of water collected, stored, and used as a result of project activities.

VWCs are expressed in cubic meters per year (m^3/year).

$$VWC = V_{add} \qquad \text{Equation 8}$$

The sum of the additional water volumes obtained in all system units within the project area constitutes the basis for the issuance of VWCs.

The volume of water considered for the generation of Verified Water Credits corresponds exclusively to the effective volume of water collected and used by the system.

10 Permanence and Continuity of Water Benefits

The volumetric water benefits generated by rainwater harvesting systems depend on the continuous operation and adequate maintenance of the implemented systems. Therefore, the permanence of the benefits associated with the project will be linked to the proper functioning of the collection, conveyance, storage, and use infrastructure for rainwater.

The project proponent must ensure that rainwater harvesting systems are maintained in operational conditions during the project's credit period. This includes periodic inspection of system components, maintenance of catchment surfaces, cleaning of gutters and filters, and verification of the structural condition of storage systems.

When failures or deterioration in the systems are identified that may affect rainwater collection or storage, the project proponent must implement the necessary corrective actions to restore system functioning.

The operational continuity of the systems will be verified through the monitoring activities established in this methodology, which will allow confirmation that the rainwater harvesting units continue to generate the volumetric water benefits associated with the project.

11 Monitoring of Project Activities

The monitoring of project activities aims to verify the effective implementation of rainwater harvesting systems and to gather the information necessary for the periodic quantification of the volumetric water benefits generated by the project.

Monitoring will allow for:

(a) verification of the installation and operation of rainwater harvesting systems;

(b) recording of the data necessary for the calculation of the system water balance;

(c) evaluation of the evolution of the volume of water collected, stored, and used;

(d) supporting the quantification of the Verified Water Credits (VWC).

11.1 Monitoring Method

The monitoring plan must be structured based on the stratification of the project area, so that measurements and estimations are representative of system conditions in each stratum.

For each stratum, representative data must be collected on:

(a) precipitation;

(b) catchment surface;

(c) storage capacity;

(d) user water consumption;

(e) operational status of the water harvesting systems.

These data will allow for the periodic updating of the parameters used in the system water balance.

11.2 Components of the Monitoring Plan

The monitoring plan must include, at a minimum, the following components.

11.2.1 Field Monitoring

Field monitoring comprises the direct collection of information on the functioning of rainwater harvesting systems.

Among the aspects that must be recorded are:

(a) identification of water harvesting system units;

(b) number of users associated with each system;

(c) system catchment surface;

(d) storage capacity;

(e) system conservation and operation status;

(f) uses of the collected water;

(g) water consumption for domestic and productive uses.

Additionally, the validity of the runoff coefficient used in the calculations must be periodically verified, based on the conditions of the catchment surface.

11.2.2 Geospatial Monitoring

Geospatial monitoring comprises the identification and georeferencing of all rainwater harvesting system units within the project area.

Geospatial information will allow for:

(a) verification of the location of collection systems;

(b) ensuring the spatial traceability of the project;

(c) supporting the representativeness analysis of the defined strata.

11.3 Monitoring Points

The project proponent must select monitoring points through stratified random sampling, in which a representative number of water harvesting system units will be selected within each project stratum.

The distribution of monitoring points must ensure that the selected units are representative of the conditions of water collection, storage, and use within the project area.

11.4 Sample Size

The sample size must be determined in a manner that ensures statistical representativeness within each project stratum. These methods allow the monitoring effort to be distributed according to the variability observed among the different project strata.

For the estimation of the initial sample size, Cochran's formula may be used (Cochran, 1977):

$$T_m = \frac{Z^2 \times p(1-p)}{e^2} \qquad \text{Equation 9}$$

Where:

T_m	=	Initial sample size
Z	=	Critical value of the normal distribution (for a 95% confidence level, Z=1.96)
p	=	Estimated proportion of the characteristic of interest. When no prior information is available, p=0.5 is used, which maximizes variability.

e	=	Maximum permissible sampling error (e.g., 0.05 for a 5% error)

11.4.1 Proportional Allocation by Strata

In the case of projects with multiple strata, the total sample size n may be distributed among the different strata using Neyman's proportional allocation (Neyman, 1934), which allows the monitoring effort to be adjusted according to the relative size of each stratum.

The formula for proportional allocation is:

$$T_h = n \times \frac{N_h}{\mathrm{N}} \quad \text{Equation 10}$$

Where:

T_h	=	Sample size allocated to stratum h
N_h	=	Population size of stratum h
N	=	Total population size (sum of all strata)
n	=	Total sample size

11.4.2 Neyman's Optimal Allocation

When information on the internal variability of the strata is available, Neyman's optimal allocation (Neyman, 1934) may be applied. This method distributes the total sample size in proportion to the product of the size and standard deviation of each stratum, prioritizing those with greater variability.

The formula is as follows:

$$n_h = \frac{N_h S_h}{\sum_{h=1}^{L} N_h S_h} \quad \text{Equation 11}$$

Where:

n_h	=	Sample size allocated to stratum h
N_h	=	Population size of stratum h
S_h	=	Standard deviation of stratum h
n	=	Total sample size
L	=	Number of strata

This approach allows for the optimization of monitoring effort, improving the statistical precision of estimates based on the heterogeneity observed among the different project strata.

11.5 Monitoring Frequency

Monitoring of the parameters relevant to the quantification of volumetric water benefits must be conducted with a minimum annual frequency, unless the project proponent has information with greater temporal resolution.

When possible, it is recommended that information be collected with monthly resolution, in order to adequately represent the dynamics of the water balance of the rainwater harvesting system.

Monitoring planning must consider the predominant precipitation regime in the project area, including its seasonality (e.g., unimodal or bimodal regimes), in order to ensure that measurements adequately reflect the hydrological conditions of the territory and the periods of water collection and use.

11.6 Data Verification and Quality Control

Data obtained during monitoring activities, including information on precipitation, water demand, storage, and system overflow, must undergo quality control and assurance procedures to ensure their consistency, traceability, and reliability.

These procedures must be applied both to field measurements and to data from satellite sources or climatic databases.

Quality control must include, at a minimum:

(a) verification of consistency among the different data sets used in the analysis;

(b) identification and review of outlier values that may generate biases in the quantification;

(c) documentation of the criteria used for data cleansing.

When outlier values are identified, the project proponent must apply appropriate statistical methods for their evaluation and treatment. Under no circumstances should data be eliminated without documented technical justification.

Additionally, it must be verified that the error associated with the estimates used in the quantification remains within acceptable ranges to ensure the reliability of the project's results.

12 Methodology Assumptions and Limitations

This methodology is based on a series of technical and operational assumptions that allow for the standardized application of the quantification procedures.

In particular, it is assumed that:

(a) the precipitation climatic data used are representative of the conditions of the project area;

(b) the monthly water balance of the rainwater harvesting system adequately represents the dynamics of water collection, storage, and use;

(c) the water demand estimates are representative of the consumption patterns of the population or productive activities considered in the project;

(d) the rainwater harvesting system units included in the project exhibit sufficiently homogeneous characteristics within the defined strata.

However, the application of this methodology may present limitations in contexts where there is a scarcity of local information, high spatial heterogeneity not captured by available data, or difficult-access conditions that limit information collection.

In such cases, the use of regional assumptions, multi-year averages, or secondary data must be duly documented and justified by the project proponent.

13 Project Document Management

13.1 Project Database Management

The implementation of the procedures established in this methodology must be supported by an information management system that allows for the storage, organization, and updating of the technical information generated during the project cycle.

The use of Geographic Information Systems (GIS) is essential for the organization and analysis of the spatial data associated with the project.

It is recommended that databases be structured on robust platforms that allow for the integration of geospatial layers, attributes, and metadata associated with rainwater harvesting system units.

Among the tools that may be used are:

(a) commercial GIS platforms, such as ArcGIS;

(b) free software-based solutions, such as QGIS, which allow for the management of geospatial databases and integration with various information sources.

Adequate document management will ensure the traceability, transparency, and verifiability of the information used in monitoring and quantification processes.

14 Quality Control and Quality Assurance

The results obtained through the application of this methodology will be subject to independent validation and verification processes, in accordance with the requirements established by the BioCarbon Water Standard.

In order to ensure the traceability and integrity of the Verified Water Credits (VWC), the following conditions must be met:

(a) all information used in the calculations must be duly documented, georeferenced, and available for review;

(b) data collection, analysis, and modeling procedures must be consistent with the provisions of this methodology;

(c) field measurements and climatic data used must be traceable to their original sources and supported by technical documentation demonstrating their representativeness;

(d) consistency between baseline data, with-project scenarios, and quantified results will be subject to review during the verification process.

Failure to comply with these conditions may affect the approval of the project and the issuance of the corresponding credits.

The project proponent will be responsible for maintaining an updated, complete, and verifiable information system, as an integral part of the project's monitoring and document management plan.

15 References

Banco Mundial. (2014). Water storage: Analysis and design. https://openknowledge.worldbank.org/bitstream/handle/10986/21042/Water-Storage-Analysis-and-Design.pdf

Cochran, W. G. (1977). Sampling techniques (3rd ed.). John Wiley & Sons.

European Committee for Standardization (CEN). (2024). EN 16941-1: On-site non-potable water systems – Part 1: Systems for the use of rainwater. Brussels: CEN.

FAO. (2011). The state of the world's water resources. https://www.fao.org/3/a-i2917e.pdf

FAO. (2013). Conservation and rehabilitation of soils in Latin America and the Caribbean. https://www.fao.org/3/i3340s/i3340s.pdf

Fariz-Salinas, E. A., Acuña-Bedoya, J. D., Fonseca Rodríguez, R. I., Turrén-Cruz, T., & López Zavala, M. Á. (2025). Definition of potential sites to implement urban rainwater harvesting systems in water-stressed cities by integrating GIS and AHP tools. Urban Climate, 64, 102639.

García-Ávila, F., Guanoquiza-Suárez, M., Guzmán-Galarza, J., Cabello-Torres, R., & Valdiviezo-Gonzales, L. (2023). Rainwater harvesting and storage systems for domestic supply: An overview of research for water scarcity management in rural areas. Results in Engineering, 18, 101153.

Global Water Partnership. (2018). Water governance: Strategies and challenges for sustainable water management. https://www.gwp.org

Hoekstra, A. Y., & Chapagain, A. K. (2008). Globalization of water: Sharing the planet's freshwater resources. IWA Publishing.

ISO. (2019). ISO 46001: Water efficiency management systems — Requirements with guidance for use. International Organization for Standardization.

Magdy, A., Elsaiad, A., Ramadan, E. M., Kuriqi, A., Ahmed, A. A., & Abd-Elaty, I. (2025). Targeting runoff hotspots for sustainable rainwater harvesting in arid regions. Cleaner Water, 4, 100166.

Martin, E. A., Buchberger, S. G., & Chakraborty, D. (2015). Reliability of harvested rainfall as an auxiliary source of non-potable water. Procedia Engineering, 119, 1119–1128.

Melville-Shreeve, P., Ward, S., & Butler, D. (2016). Rainwater harvesting typologies for UK houses: A multi-criteria analysis of system configurations. Water, 8(4), 129.

Neyman, J. (1934). On the two different aspects of the representative method. Journal of the Royal Statistical Society, 97(4), 558–625.

World Health Organization (WHO). (2017). Guidelines for drinking-water quality. https://www.who.int/water_sanitation_health

Puppala, H., Ahuja, J., Tamvada, J. P., & Peddinti, P. R. T. (2023). New technology adoption in rural areas of emerging economies: The case of rainwater harvesting systems in India. Technological Forecasting and Social Change, 196, 122832.

Rovira, C., Sánchez-Masferrer, M., & Rovira, M. D. (2020). Is rainwater harvesting a solution for water access in Latin America and the Caribbean? IDB Technical Note, IDB-TN-1679.

Semaan, M., Day, S. D., Garvin, M., Ramakrishnan, N., & Pearce, A. (2020). Optimal sizing of rainwater harvesting systems for domestic water usages: A systematic literature review. Resources, Conservation and Recycling: X, 6, 100033.

Shefaei, A., Maleki, A., van der Hoek, J. P., van de Giesen, N., & Abraham, E. (2025). Optimising rainwater harvesting systems under uncertainty. Resources, Conservation and Recycling Advances, 26, 200254.

UN-Water. (2015). Water security and the sustainable development goals. https://www.unwater.org/publications/water-security-and-sdgs.pdf

Ursino, N. (2016). Risk analysis approach to rainwater harvesting systems. Water, 8(8), 337.

Wang, J., Jiang, E., Wang, J., Zhang, S., Guo, Y., Yu, L., Pan, X., Jun, C., & Sivakumar, B. (2025). Parsimonious analytical modelling of rainwater harvesting systems' performance under climate change. Journal of Hydrology: Regional Studies, 62, 102924.

World Health Organization (WHO). (2020). Rainwater collection and storage: Technical fact sheet. Geneva: WHO.

World Resources Institute (WRI). (2019). Volumetric Water Benefit Accounting (VWBA): A Method for Implementing Corporate Water Stewardship. World Resources Institute. https://www.wri.org/research/volumetric-water-benefit-accounting

Document History

Document Type. Methodological document.

Version	Date	Description
Version 1.0 for Public Consultation	March 22, 2026	Initial version – Public consultation
Version 1.0	April 30, 2026	Final version issued following internal review and consolidation of feedback.