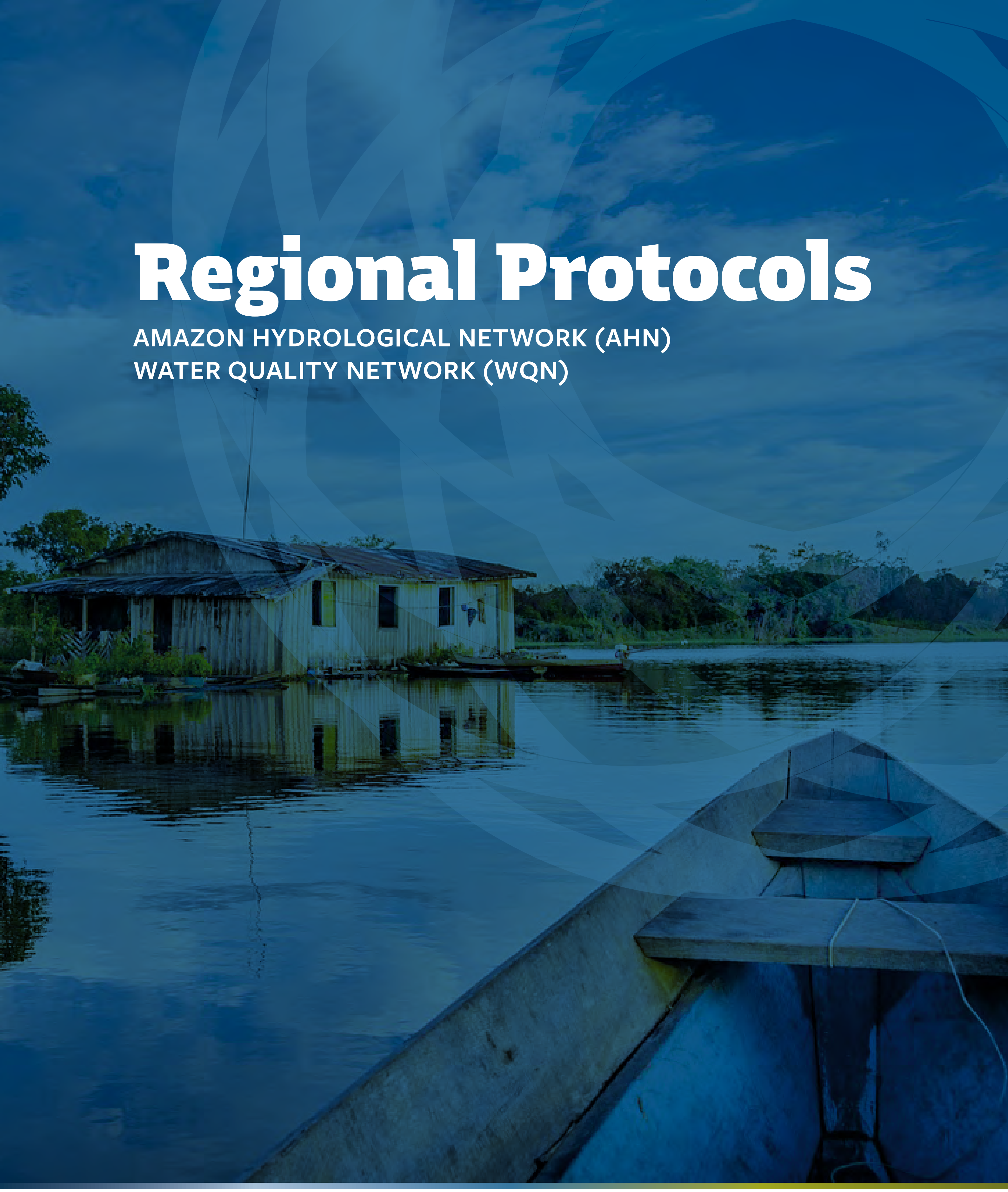
Regional Protocols

AMAZON HYDROLOGICAL NETWORK (AHN)
WATER QUALITY NETWORK (WQN)



ACTO Amazon Cooperation Treaty Organization
ANWA
ABC BRAZILIAN COOPERATION AGENCY MINISTRY OF FOREIGN AFFAIRS
ANA AGÊNCIA NACIONAL DE ÁGUAS E SANEAMENTO BÁSICO
AmazonBasin SAP IMPLEMENTATION gef
UN environment United Nations Environment Programme
gef

Regional Protocols for the Amazon Hydrological Network (AHN) and the Water Quality Network (WQN)

Amazon Cooperation Treaty Organization
2025

INDEX

Representatives of the Amazon Network of Water Authorities (ANWA - ACTO)

BOLIVIA

Daniel Rodríguez
Director General of Watersheds and Water Resources, Ministry of Environment and Water

BRAZIL

Veronica Sánchez da Cruz Rios
Director-President of the National Water and Basic Sanitation Agency (ANA)

COLOMBIA

Oscar Francisco Puerta Luchini
Director of Integrated Water Resource Management, Ministry of Environment and Sustainable Development

ECUADOR

María Luisa Cruz Riofrío
Minister of Environment, Water, and Ecological Transition

GUYANA

Garvin Cummings
Chief Hydrometeorological Officer, Ministry of Agriculture

PERU

José Genaro Musayón Ayala
Chief of the National Water Authority (ANA)

SURINAME

Iemdaad Nasser A. Rodjan
Permanent Secretary, General Management of the Ministry of Spatial Planning and Environment

VENEZUELA

Miguel Ángel Perozo Ynestroza
Deputy Minister of River Basin Management, Ministry of People's Power for Water

Specialized Technical Support Panel

BOLIVIA

Alejandra Guadalupe Marques Calderón
Strategic Monitoring Professional for IWRM, National Watershed Program, Ministry of Environment and Water

BRAZIL

Luciana Sarmento
Water Resources Regulation Specialist, National Water and Basic Sanitation Agency (ANA)

COLOMBIA

Elvia Johanna Gelvez Bernal
Specialized Professional, Directorate of Integrated Water Resources Management, Ministry of Environment and Sustainable Development

ECUADOR

Catalina Ortiz López
Territorial and Intersectoral Coordination Analyst, Directorate of Participation and Coordination of Water Resources, Ministry of Environment, Water, and Ecological Transition

GUYANA

Frank Grogan
Specialist Hydrologist, Ministry of Agriculture

PERU

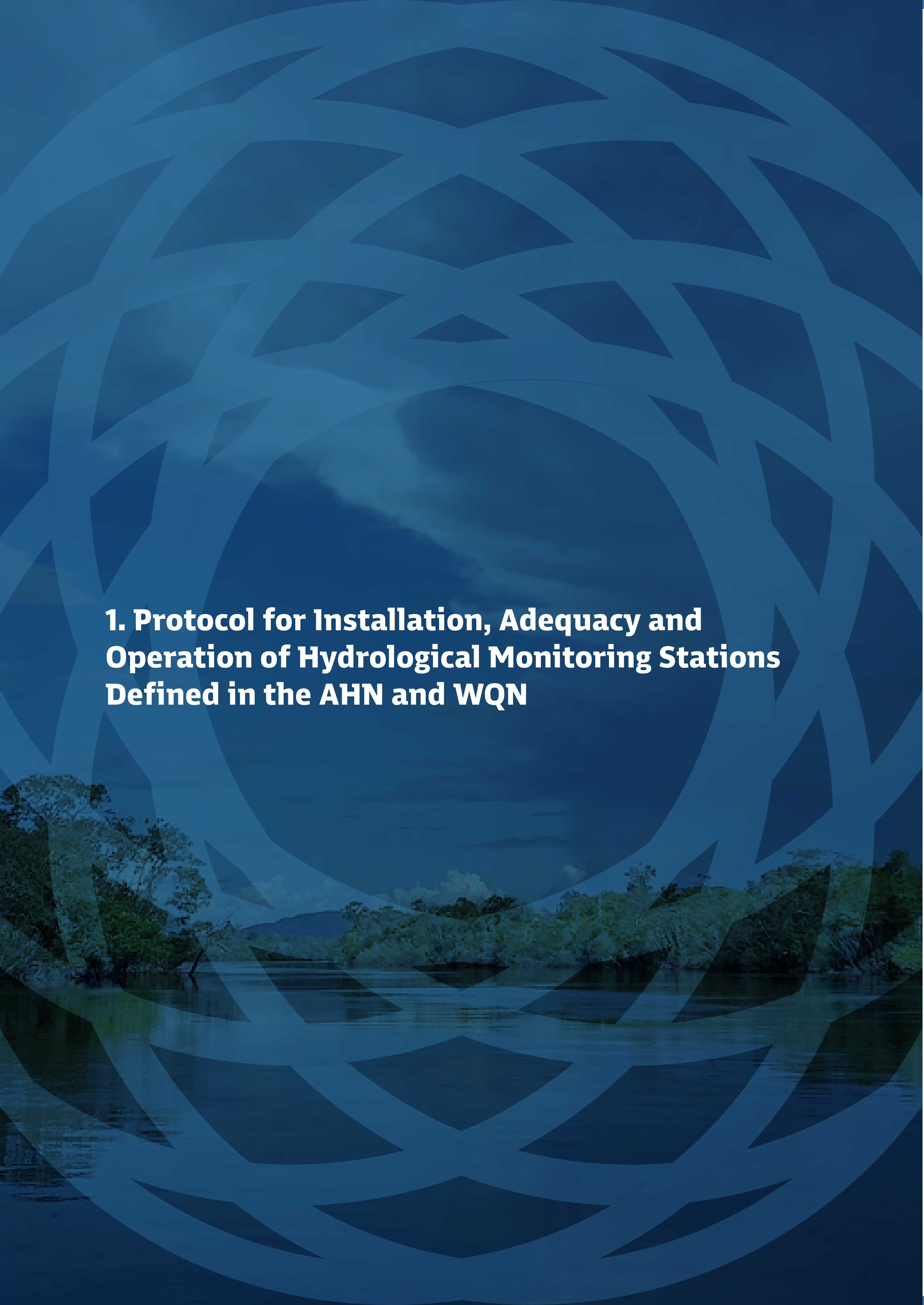
Hanny María Quispe Guzmán
Water Resources Management Specialist, National Water Authority (ANA)

SURINAME

Dewdath Bhaggoe
Deputy Permanent Secretary, Ministry of Public Works

VENEZUELA

Yesenia Carolina Moreno Gerde
Deputy Minister of Drinking Water and Sanitation Services, Ministry of People's Power for Water



1. Protocol for Installation, Adequacy and Operation of Hydrological Monitoring Stations Defined in the AHN and WQN

1.1 PLANNING THE ADAPTATION OF AHN AND WQN EXISTING STATIONS

1.1.1 ADAPTATION OF EXISTING STATIONS

During **Phase 1**, improvements must be implemented in existing stations to meet minimum monitoring standards, modernize equipment, and enhance operating methods according to protocols. This process is estimated to take between 5 to 10 years. **Phase 2** requires the addition of new stations and the expansion of monitoring over a period of 10 to 20 years, adapting to each country's conditions and investment capabilities or available external investments. The following activities must be considered:

- Carry out continuous and gradual actions respecting the sovereignty and differences between member countries to implement effective monitoring networks in the Amazon region. Initially, focus on the objectives of the Quantity and Quality Monitoring Networks for water resources management, as they are essential for understanding hydrometry. Expand the focus over time according to WQN plans to include water quality monitoring. The methodology should allow adding new stations with additional objectives, such as monitoring sediments or critical events.
- Select new stations based on detailed studies and the basic structure of the AHN and WQN. Given the constant changes in rivers due to variations in water, sediments, geomorphology, and geological deposits, continuous evaluation of morphology, river interactions, and impacted areas is required. Additionally, stations must monitor the environmental impact of projects under development, such as waterways and hydroelectric plants, both before, during, and after their execution. Extreme events and climate changes must also be recorded for a comprehensive view of the Amazon region.
- To establish adequate and safe monitoring stations within the complex river dynamics of the Amazon basin, local and regional geomorphological and hydrological information is needed. A workflow should include data download and processing, morphology characterization, and the definition of special zones. Consider access, observers, and logistics when selecting station locations. A reconnaissance visit is essential to evaluate logistics, hydrology, geomorphology, and accessibility.

1.1.2 WORKPLAN

1) Adjust the annual work plan for the monitoring stations in each Member Country to incorporate AHN and WQN stations, considering each country's specific characteristics, planning, and budgetary capacities. Initially, address networking, necessary adaptations, and establishing field objectives.
2) Generate a report with previous data and ACTO protocol guidelines, updating it with progress from surveys.
3) Design the monitoring plan, which should include: information on the study area, access, sampling location, sampling points, measurement capabilities, formats, materials, and logistics for transporting personnel, equipment, and samples.

4) Prepare the annual operation plan to manage teams and estimate monitoring activity costs, requiring a budget for logistics (vehicles, equipment, materials, personnel, observers, training, etc.). Effectively integrating this plan into regional or specific planning will be crucial, with technical details for each station in the AHN and WQN. Additionally, plan for resources, supplies, accessories, and spare parts for maintaining data collection platforms (DCPs).

1.1.3 NETWORK MODERNIZATION

Modernize the network by automating the capture, storage, and transmission of AHN parameters to improve temporal resolution and prevent issues such as failures in data collection or manual transmission. This requires implementing data collection platforms (DCPs) widely, the use of automatic level and precipitation sensors, as well as the installation of telemetry systems for data transmission in remote and hard-to-access areas.

1.1.4 MINIMUM PARAMETERS

At the AHN and WQN stations, it is recommended that at least the following parameters should be measured (accuracy indicated in parentheses):

- **AHN stations:** water surface level (0.01 m), precipitation (0.5 mm), channel morphology (1 cm) and banks (5 mm + 2ppm), and discharge (0.01 m^3/s).
- **WQN stations:**
  - *In situ variables*: pH, Electrical Conductivity (EC), Dissolved Oxygen (DO), Temperature (Ta), Turbidity (Tur).
  - *Physical parameters*: Total Dissolved Solids (TDS), Total Suspended Solids (TSS).
  - *Nutrients*: Ammoniacal Nitrogen ($N\text{-}NH_3/NH_4+$), Nitrate (NO_3-), Total Phosphorus (PT), and Orthophosphate Phosphorus or Soluble Reactive Phosphorus ($P\text{-}PO_4^3$), the latter under special conservation considerations.

1.1.5 TECHNICAL PERSONNEL

Form a multidisciplinary team of experts in areas such as hydrometry, hydrology, meteorology, topography, hydraulics, sedimentology, electronics, computer science, and chemistry, among others. This team must carry out various tasks, from planning to data collection and publication.

In the field, the required personnel will vary depending on factors such as the type of station, distance, parameters to be measured, and equipment to be used. However, at a minimum, two people are required: a hydrometry technician and an assistant. For conventional stations, an additional observer will be needed for daily precipitation and water level readings.

1.1.6 VEHICLE FLEET

Have own boats or ensure the rental of appropriate and properly identified water and land vehicles for personnel transport, equipment setup, instruments, tools, and sample collection during field visits. Perform regular maintenance and ensure proper functioning before each field deployment.

1.1.7 LOGISTICS OPTIMIZATION

Plan annual itineraries considering seasons, objectives, routes, and personnel. Coordinate logistics (accommodation, rest periods, sample shipments) based on the itineraries. Obtain permits for travel by land and waterways, especially in border areas.

Budget for the supply, inspection, and maintenance of vessels if necessary. Manage reservations and rentals in advance (accomodation, transportation) to ensure field support and efficiency. Maintain constant communication with the administrative area for support during field tasks.

1.1.8 COORDINATION WITH FIELD STAFF

Communicate with technical personnel and observers to initially inform them of required changes and adjustments in the AHN and WQN. Field technicians must prepare the adequate tools for measurement and sample collection and have spare parts available for both the adaptation and routine visits based on the information received from the observers.

1.1.9 DATA COLLECTION

Use appropriate equipment for data collection, ensuring the availability of suitable instruments (e.g., Ziploc bags, containers, buffer solutions), standardized data capture formats for MPs, unified parameterization of measurement units for water quantity and quality, and trained personnel to follow standardized techniques. Additionally, consider timing, duration, and access to monitoring points to prevent sample contamination, thereby guaranteeing the protection, accuracy, and quality of collected data.

The formats and parameters for data protection, accuracy, and quality are detailed in **Protocol 2**.

1.1.10 SAFETY PROGRAM

Create a personal and workplace safety program that describes task conditions, including itineraries and safety measures in the field and laboratory for personnel and equipment. Staff must receive occupational safety training and use protective equipment. Additionally, it is recommended to secure insurance for personnel, instruments, and land and water vehicles used in tasks.

Prioritize safety by implementing measures to protect equipment and prevent accidents. For instance, avoid sampling in turbulent areas or during heavy rainfall. Work in teams of at least two people, equipped with appropriate gear, communication devices (cell phone or radio), and an emergency first-aid kit.

1.1.11 OPERATION OF STATIONS IN BORDER AREAS

Promote integration and cooperation among Member Countries to operate stations in border areas, according to the AHN and WQN design, located in contiguous or transboundary rivers. This requires fostering information exchange, joint planning and ongoing dialogue to share experiences, as well as ensuring a legal team to gather the necessary documentation and facilitate the required authorizations for conducting measurements in border areas.

All Member Countries must garantee full access to the river's cross-section for monitoring purposes and establish these arrangements in advance. The possibility of jointly operating planned stations in border areas in the future should be considered, which will require specific agreements.

1.1.12 TRAINING ACTIVITIES

Conduct regular training for the technical team, including annual meetings to discuss improvements, updates and technical procedures. It is also recommended to provide training opportunities for students and professionals.

1.2 INSTALLATION OF AHN AND WQN STATIONS

1.2.1 RECONNAISSANCE VISITS

Conduct at least one reconnaissance visit to update information on the necessary adaptation (Phase 1) and installation (Phase 2) measures for the station. These visits should be carried out by technicians with expertise in hydrometry, topography, hydrology, electronics, telemetry, and water quality.

In addition to assessing the physical installations, the visit should confirm logistical aspects, the control section, hydrological and hydraulic conditions, security, and the presence of local observers. Subsequently, a preliminary topographic survey should be conducted, followed by the installation and verification of equipment and transmission systems.

If the measurement section does not match with the recorded water level data, a detailed site description must be identified and documented to ensure accurate station records.

1.2.2 CHARACTERISTICS OF MONITORING POINTS

For the selection of monitoring points at WQN stations, specific locations will be identified within each station, such as riverbanks or a set distance from the shore. It is recommended to use GNSS/GPS to determine the WGS84 coordinates, which should later be converted to UTM according to each country's parameters, with up to three decimal places.

Based on the AHN and WQN agreed among ACTO Member Countries, the choice of microlocation will be the responsibility of the Member Countries and should consider factors such as pollution sources, regional geology, water intake sources, quick and safe access, and the inclusion of points upstream of road crossings. Maintain the regional monitoring program requires clear objectives and scope.

The selected location should reflect the basin or area's characteristics and possible contamination sources. It is essential to avoid proximity to landfills, industries, or densely populated urban areas.

1.2.3 STATION LAYOUTS

Stations should preferably be equipped with automatic and telemetric systems for daily measurement of rainfall and water levels, in addition to conventional installations. The minimum required installations must include:

- **General**: A data collection platform and accessories that allow at least automatic recording and telemetry of rainfall and water level data.
- **Precipitation**: Automatic and conventional rain gauges.
- **Surface water levels**: A limnimetric ruler, at least three level reference points (protected from flooding), level sensors (pressure, radar, etc.), and/or a display.
- **Measurement section**: Preferably, georeferenced milestones at the initial and final points of the local network's cross-section to guide flow measurements and bathymetric surveys.

1.2.4 PREPARATION AND ADJUSTMENT OF EQUIPMENT AND INSTRUMENTS

Identify critical points and prepare the necessary tools for installation, maintenance, and measurement activities. Additionally, existing installations must be adjusted to meet established quality standards. Before deploying data collection equipment in the field, it is essential to thoroughly prepare and test them to prevent operational failures.

Calibrating field instruments is a critical step to ensure accurate measurements, and any damaged equipment must be immediately reported to the manufacturer for repair or replacement. When installing new stations, ensure the availability of required additional materials such as fences, poles, and smaller tools to guarantee a safe and efficient installation.

1.2.5 IDENTIFICATION AND PROTECTION OF STATIONS

Each station will have a unique nomenclature that includes its name, code, type, and geographic location to prevent errors and allow quick identification. If applicable, an existing Member Country code may be used. Identification plaques and protective fences should be installed at each station for official classification and recognition.

Stations should preferably be located in areas protected from vandalism and flooding. Rain gauges must be positioned to ensure unobstructed rainfall collection, free from interference by buildings or vegetation.

Maintenance routines for the stations will be the responsibility of the institutions managing their operation. Additionally, a preventive and corrective maintenance schedule must be included in the strategic action plan of the responsible institution in the Member Country.

1.2.6 WARRANTY DURING INSTALLATION AND OPERATION

Acquired equipment must have a Calibration Certificate and comply with the warranty period, ensuring at least one hydrological year of installation and proper station operation.

1.3 OPERATION OF AHN AND WQN STATIONS

1.3.1 MEASUREMENT EQUIPMENT

Use the following minimum equipment for on-site parameter measurement, aiming to follow best practices and optimize procedures:

- **Bathymetric Survey**: Use Acoustic Doppler Current Profilers (ADCP) to capture the cross-sectional profile during discharge measurements. Alternatively, employ single or dual-frequency echo sounders (33 and 12 Hz for fine substrates and 200 kHz for coarse materials such as sand); in particular, multibeam echo sounders are ideal for scanning the riverbed with higher spatial resolution. For riverbank studies, use total stations. Alternatively, drones with altimetric correction can be employed.
- **Liquid Flow**: The use of ADCP with operational frequencies that vary according to the river section characteristics is recommended, such as 600 kHz for depths of 1.8–70 m, 1200 kHz for 1.2–20 m, and 3000 kHz for 0.06–5 m. Additionally, consider conventional or acoustic current meters as backup equipment for specific conditions.
- **Water Quality**: Field parameter measurements (pH, dissolved oxygen, electrical conductivity, turbidity, temperature, and total dissolved solids) should be conducted using portable equipment such as multiparameter probes, pH meters, and conductivity meters. For samples sent to the laboratory (TSS, N-NH_3/NH_4+, NO_3-, TP, Orthophosphate Phosphorus), it is essential to preserve them and coordinate transportation following the corresponding laboratory instructions.
- **Sediments**: To measure suspended sediments in large river systems, equipment such as US P-61 and US D-96 is recommended for collecting point or integrated samples at different depths. In certain situations, Van Dorn or Niskin samplers can also be used. The main parameters analyzed in the laboratory include the granulometric distribution of suspended material and concentrations of suspended and dissolved solids. For bottom sediment sampling, it is recommended to conduct it twice a year in different hydrological periods. Equipment such as the Van Veen Grab or Ekman Grab is suggested to avoid sample washing. Collected material should be properly stored in labeled bags. In the laboratory, granulometric analysis of the collected material should be performed.

1.3.2 MEASUREMENT FREQUENCY

Field campaigns for measuring water quantity and quality, as well as sediments, should be conducted at least twice a year and preferably four times a year (high flow, low flow, and two transitional campaigns), in conjunction with station maintenance. Measurements should ideally be carried out jointly.

- **Precipitation and Levels**: In Data Collection Platforms (DCPs), a minimum data storage interval of 30 minutes should be configured. However, parameter variability should be assessed to better define intervals. For conventional stations, water level readings should be taken at least twice a day. Conventional rain gauges should have their data recorded at least once a day.
- **Water Quality**: Samples can be simple or composite, as agreed upon by those responsible for monitoring. For parameters measurable with multiparameter probes, four measurements per year are suggested.
- **Sediments**: Sediment samples should be collected at the same flow measurement sections to obtain the corresponding calibration curves.

1.3.3 DATA TRANSMISSION INTERVALS IN DCPS

Data should be transmitted every hour and, in some cases, every 30 minutes, depending on capture frequency and network availability. The minimum information to be transmitted includes time, date, station code, parameters (precipitation and/or level), and battery voltage. Data should be sent reliably and in real-time using systems such as radio, satellite, GSM, or the internet, depending on available infrastructure.

1.3.4 REGULAR MAINTENANCE

Conduct maintenance and operation visits to stations at least every three months. Stations require regular maintenance to ensure accurate measurements. This involves cleaning, sensor calibration, equipment verification, and replacement of defective or worn-out parts. The purpose of these visits is to inspect and repair the station as needed, collect measured data, and perform liquid flow and suspended solids measurements when relevant, distributing these visits throughout the hydrological year.

Maintenance routines should be managed by the institutions responsible for station operation. Preventive and corrective maintenance routines should also be included in the strategic action plan of the responsible institution of the Member Country.

1.3.5 OPERATIONAL CENTER, LOGISTICS, AND INFORMATION PROCESSING

Each country is recommended to establish at least one physical center to perform various tasks related to station operation, such as administration, planning, calibration, equipment testing, training courses, and data post-processing. The center may also include computer, electronics, and sedimentology laboratories for processing information, repairing equipment, and conducting sediment analyses.

The center can store equipment and vehicles needed for field visits. Preferably, these centers should be near the monitoring region and may be located in government facilities of ACTO Member Countries.

1.3.6 EQUIPMENT REVIEW AND CALIBRATION

Before field deployment, it is essential to verify that all equipment is in optimal condition. This includes conducting a general inspection, calibrating equipment correctly to ensure accurate measurements during monitoring, and preparing a checklist of required instruments and materials. If calibration is performed in a laboratory, the corresponding manuals must be followed. For field calibration, reviewing the manuals in advance to identify necessary reagents and standards is important. Additionally, before beginning activities, all equipment should be inspected to ensure proper operation, with clean sensors configured according to manufacturer instructions (refer to chapter 2.1).

A regional calibration reference manual will be developed as an annex to the protocol, created by a regional expert group.

1.3.7 PRECAUTIONS DURING WATER QUALITY MONITORING

Precautions should be taken during field monitoring to avoid personal injury and material damage. Safety recommendations include planning itineraries considering access points and sample collection and preservation times; ensuring samples are representative and easy to transport; following laboratory instructions for preserving samples so they remain unaltered; using clean and appropriate materials for each sample type; and providing complete information in the custody chain, including climatic conditions and other safety measures.

Field data should be recorded in specific formats according to the water bodies. Parameters must be recorded immediately after measurement, and point samples should be taken to maintain representativity.

1.3.8 PROCEDURES FOR COLLECTING WATER QUALITY SAMPLES

Preferably, collect an integrated sample from the middle or across the entire width of the river at an average depth. Sampling should be performed using appropriate preservation and conditioning materials to prevent contamination. The technical team must review and complete data forms to ensure quality control and coordinate sample shipment to the laboratory when necessary.

Detailed observations of any abnormalities in samples, such as color, odor, presence of foreign matter, algae, or dead aquatic species, should be recorded to minimize uncertainties. When collecting river or stream samples, specify the sampling depth, flow, and distance from the bank, as these factors affect results. Avoid sediments and handling sample bottles. Clean and dry instruments between sampling points, perform calibrations, and ensure equipment functions properly. Verify measurements by comparing equipment readings, using reference samples, and maintaining accurate records.

Laboratory procedures for field sample collection should be followed, along with sample preservation and transportation coordination per laboratory instructions. Accredited laboratories and accredited testing methods are recommended. The Expert Group will develop data collection formats.

1.3.9 FIELD DATA SHEETS

It is essential to preserve the original data for all measured parameters during visits without any post-processing. Data can be stored in various formats depending on technology and parameters, but structuring them in text files such as CSV or TXT is recommended to facilitate analysis.

Field notes should be digitized, along with any complementary visit annotations. Procedures should be established for recording and verifying data, including date, time, and consistency checks against previous measurements and known meteorological conditions.

2. Regional Protocol for Field Analysis and Sample Collection

2.1 PRE-MONITORING PROCEDURES

All sampling equipment, instruments, and supplies must be operational. The following aspects should be observed:

- **Physical Condition**: Visually check the general condition of equipment and instruments. Look for signs of damage, corrosion, wear, or any other issues that may affect their operation, in addition to checking the integrity of cables and connectors.
- **Functionality**: Perform tests to ensure that the equipment operates correctly, including turning on the devices, testing buttons and controls, verifying that readings are consistent, and checking battery status.
- **Preventive Maintenance**: Carry out necessary preventive maintenance, such as cleaning, lubrication, or replacing worn parts, following the manufacturer's recommendations.
- **Supplies and Spare Parts**: Ensure the availability of sampling supplies such as batteries, filters, and chemical reagents, as well as spare parts if needed.
- **Team Training**: Ensure that the sampling team is trained in the proper use of the equipment. Provide additional training if necessary.

2.1.1 EQUIPMENT CALIBRATION

Equipment must be calibrated according to the procedure described in the manufacturer's manual. Calibration frequency should be determined based on manufacturer recommendations, measurement accuracy, and equipment stability over time. It is essential to follow a regular calibration schedule to ensure precise and consistent measurements.

Before starting measurements, verify the equipment using standard solutions. If results fall outside the acceptable range, calibrate according to the manufacturer's manual.

2.1.2 FIELD QUALITY CONTROL

Quality control must be performed before starting monitoring. Verify equipment calibration; uncalibrated equipment should not be used.

In addition to laboratory quality controls, duplicate samples, blank samples, temperature witnesses, and field additions must be collected to verify the purity of chemical preservatives and detect possible contamination in containers, paper filters, and handling equipment. Replicated samples should also be collected to assess sampling reproducibility.

2.2 FIELDWORK EXECUTION

2.2.1 PRELIMINARY OBSERVATION

Fieldwork begins with a preliminary observation to select the appropriate sampling point in the water body. Measurements of pH, conductivity, dissolved oxygen, temperature, and turbidity must be taken at the same point and depth.

2.2.2 FIELDWORK PROCEDURE AND SAMPLE COLLECTION RECORD

Record water conditions, prepare bottles according to the parameters to be evaluated, collect and preserve samples, take in situ measurements, complete the chain of custody (as per the established format), and record the millimetric level if applicable to an RHA station. The objective is to optimize the correlation between hydrological and water quality measurements in the RHA and RCA to calculate flow using the river calibration curve.

During collection, the technician must record details of the sampling environment, such as water color, transparency, temperature, flow velocity, presence of suspended materials, odor, and any observed anomalies. Environmental conditions, such as wind direction and speed, ambient temperature, and recent precipitation, should also be recorded. This level of detail contributes to better result interpretation.

2.2.3 CONSIDERATIONS DURING SAMPLE COLLECTION

Readings should be taken immediately after collection, as values may change during storage. If this is not possible due to safety reasons or flow variations (such as turbulence patterns and instability), a representative sample should be collected in a clean, wide-mouthed container, rinsed two or three times with the sampling water, and then measured. For turbidity, the required volume should be collected in the cell and measured.

2.3 SAMPLE COLLECTION, PRESERVATION, AND TRANSPORT

2.3.1 SAMPLE COLLECTION

The goal of sampling is to obtain a representative water sample with an adequate volume for parameter analysis. Samples should be collected in plastic or glass bottles, depending on the parameter to be analyzed.

Sampling in rivers should avoid areas of excessive turbulence, considering depth, current speed, and river width. Collection should be conducted against the water flow direction.

It is essential to record information such as the exact sampling location, date and time of collection, environmental conditions, and other relevant data for analysis.

2.3.2 SAMPLE FILTRATION AND PRESERVATION

Filtration should be performed during or immediately after collection, depending on the parameter being analyzed. This process separates dissolved matter from particles and is preferably carried out using a centrifuge. After filtration, preservatives should be added according to reference methods to ensure sample quality and prevent physical, chemical, and biochemical changes.

For organic component analysis, glass fiber or metal membrane filters should be used. Follow OMM (2008) and Standard Methods recommendations for preservation, such as keeping samples in the dark, reducing temperature, freezing, or using specific solvents as needed.

2.3.3 CHAIN OF CUSTODY, LABELING, AND SAMPLE IDENTIFICATION

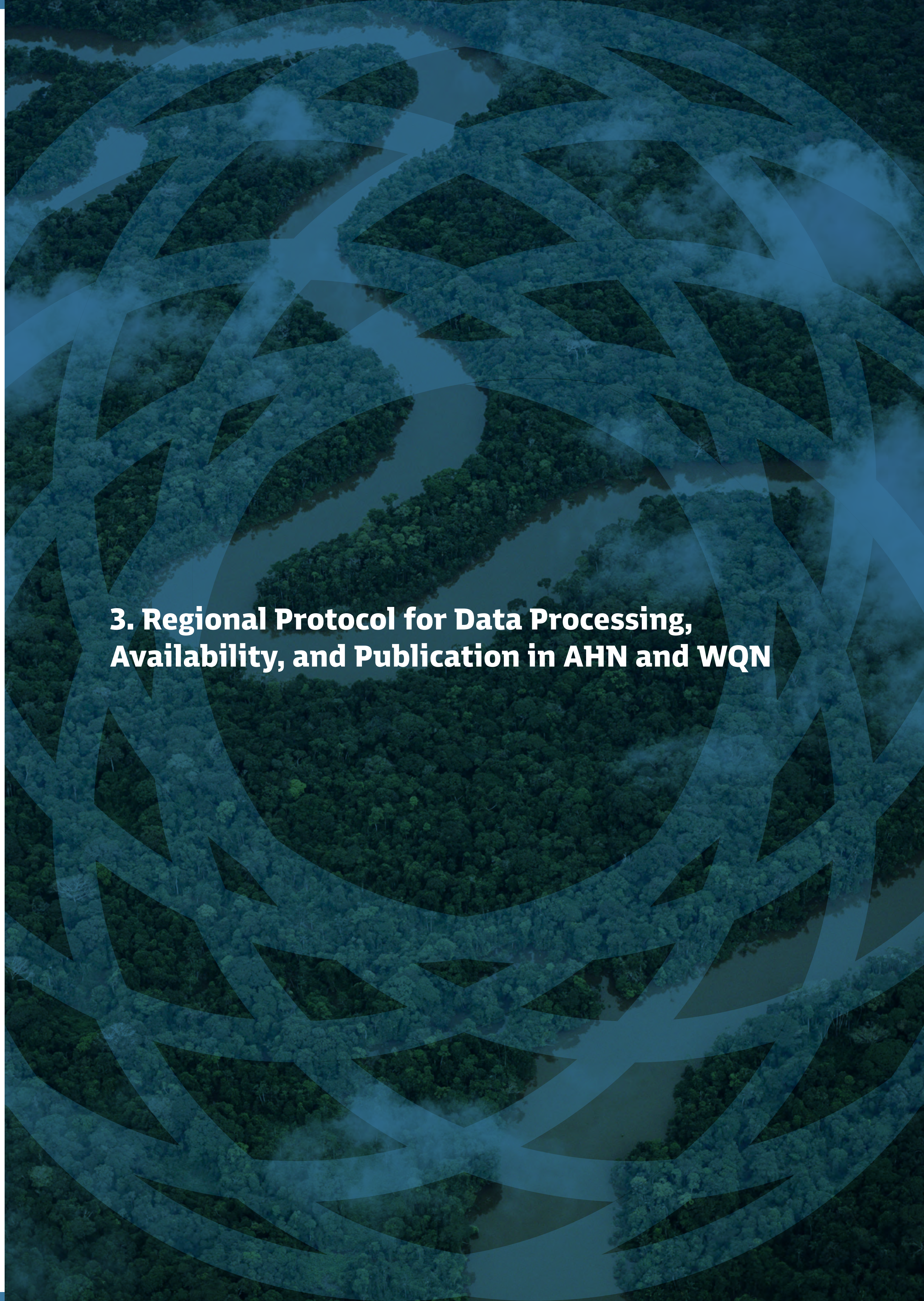
Each sample must be accompanied by a chain of custody, stored in an envelope or plastic folder to prevent damage. The chain of custody must include:

- Unique identification of the sample with a number or unique code that is not repeated in other samples.
- Data of the entity conducting the monitoring.
- Contact information of the personnel responsible for sample collection (name, email, phone number).
- Name of the monitoring campaign.
- Name of the monitoring area (e.g., basin or region).
- Code of the monitoring point or sample.
- Type of water body (e.g., river).
- Date and time of sampling.
- Quantity and type of containers per sampling point.
- Sample preservation method used.
- List of parameters to be analyzed for each sample.
- Signature of the personnel responsible for sample collection.
- Field observations, such as environmental conditions, organoleptic anomalies in the water, and unusual conditions at the sampling site.
- Detailed description of the sample, including type, collected volume, and other relevant physical characteristics.

2.3.4 SAMPLE STORAGE AND TRANSPORT

After preservation and labeling, samples must be stored in insulated boxes or hermetic coolers, in an upright position, at a temperature of 4°C ± 2°C, protected from direct light. Freezing should be avoided.

Transport to the laboratory must comply with the recommended preservation time and be accompanied by the chain of custody.



3. Regional Protocol for Data Processing, Availability, and Publication in AHN and WQN

3.1 FIELD DATA VERIFICATION

Identify obvious measurement errors, which may occur due to incorrect data capture by technicians or equipment failures. For each RHA and RCA measurement or sampling point, a range of expected values for measured variables (such as flow rate, water temperature, etc.) should be established whenever possible, defining maximum and minimum reference values. This facilitates the preliminary detection of erroneous values.

Systematic Errors: Check the transcription of original data and reassess any field information of questionable reliability. Before making any corrections, archive the original data and record the corrected measurements with appropriate context. Corrections often depend on external factors or other error components. The following aspects should be reviewed: periods without measurements, extreme high or low values, evident or out-of-context errors, consecutive days with identical values, decimal point errors, frequently repeated values, and assignment of station-related keys.

If the technical team identifies a data issue, it must decide whether to correct the error or omit the recorded information. Additionally, an explanatory note about the decision must be included. Field personnel must also record the time of data collection.

3.1.1 DATA RECEPTION BY MEMBER COUNTRIES

ANH and WQN networks data are time series, recorded periodically with an associated date and time. In addition to the temporal factor, measurements are also linked to a geographic location (where stations are situated or measurements are taken) and other identifiers such as a unique key and the site's physical characteristics (metadata).

3.2 DATA PROCESSING

3.2.1 DATA ANALYSIS METHODS

Data processing methods must be objective, clear, and traceable. Data analysis activities conducted by accredited, certified, and/or authorized laboratories must be standardized and properly documented to ensure reliability. Each product generated at each stage of data processing must be subject to review and supervision. Any modifications made to the data, from their receipt at the laboratory to the final product, must be traceable. This ensures the validation of results and the identification of possible errors at different stages of the process.

3.2.2 PRIMARY PROCESSING

At this stage, data undergo a quality control process. Time series from each station must be reviewed to identify absolute values that cannot be exceeded. This requires statistical analysis of the station's historical data, comparing them with the maximum recorded values.

Additionally, relative checks must be performed, comparing expected maximum variations between successive observations. An additional verification involves comparing maximum differences between adjacent stations in rainfall areas or between stations located in the same stream.

It is recommended to create graphs of the time series. If errors or inconsistencies are detected in these graphs, a detailed description of the identified errors, the corrections made, and the calculation of statistical uncertainty must be included.

It is also necessary to verify the flow rate measured by the ADCP against the discharge curve. For water quality data, the coherence of the information provided by the laboratory must be checked, measurement units must be standardized, and, whenever possible, values must be corrected to align with a reference standard—such as adjusting dissolved oxygen and conductivity values to a standard temperature of 20 °C.

3.2.3 SECONDARY PROCESSING

Secondary processing involves data correction when necessary. This includes identifying missing data, converting data into secondary intervals (such as series of average or total values), constructing discharge curves, or transforming unprocessed water level data into flow rate values, among other actions.

At this stage, corrected data must be stored in an accessible and secure manner, properly documented with metadata, and correctly indexed. If data gaps are detected, missing information must be inserted cautiously to ensure data integrity is not compromised. When applicable, data from other stations may be used to fill in gaps.

Additionally, for hydrometric data processing, it is essential to preserve historical discharge curves, as they allow for flow recalculations and ensure continuity and reliability of information.

3.3 DATA STORAGE BY EACH MEMBER COUNTRY

Raw and processed data (both primary and secondary) must be stored separately to ensure the integrity and organization of information. Each set of data measured at the stations must be associated with metadata, allowing for its identification and traceability.

Processed data can be integrated into a Geographic Information System (GIS) platform for user visualization. For digital storage, data may be stored in plain text files (.txt), spreadsheets (.csv or *.xlsx), or structured databases with tables. It is recommended to use a centralized database to store and manage hydrological data from the Amazon Hydrological Network (RHA) and water quality data from the RQA. This can be implemented through database management systems (DBMS) such as MySQL, PostgreSQL, or Microsoft SQL Server.

Files should be managed in the WHOS format, organized in folders or directories according to their category and generation date, facilitating access and management. The choice of storage technology must be discussed jointly with the Information Technology (IT) team and the technicians responsible for data operations to ensure the most convenient and efficient solution for the project's needs.

3.4 DATA AVAILABILITY AND PUBLICATION

Data may be published through yearbooks, bulletins, or directly in the database using web-based systems that allow access via direct downloads or similar procedures. Publication must be done in a standardized format, easily accessible and usable by users.

Access to information must comply with confidentiality agreements of each country. Users should be able to identify which data are available and how they are organized. Metadata navigation should allow searches by stations and measurement points with historical data, using geographic and temporal filters.

The system should also provide access to complementary data, such as notes recorded by field technicians or data processors. Users should have the option to download data in different formats, such as .csv, .xlsx, or other standard formats, enabling them to apply the data to subsequent analyses or external applications.

3.5 CENTRALIZED DATA PLATFORMS

A data storage platform managed by the technical team is necessary to organize the collected information. It must offer different levels of access: one for technical personnel and, optionally, another for the general public, who will only be able to download data. Regular training sessions and internal reviews should be conducted to improve the platform. The use of web technologies for its development is recommended. Additionally, regular tests must be performed to ensure the correct transmission of data from RHA stations to storage centers, verifying connectivity and data integrity.

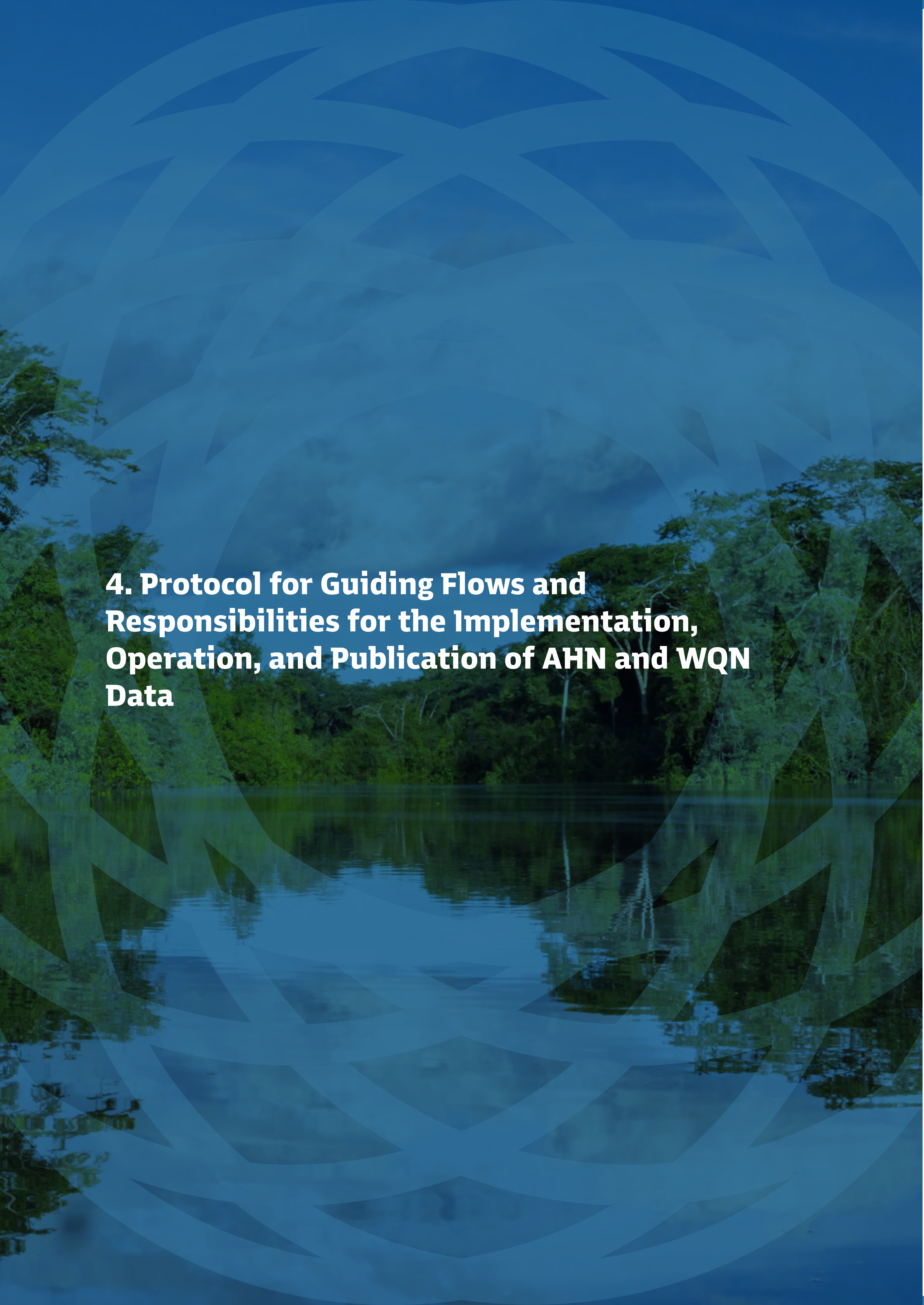
3.6 DATA SECURITY SYSTEMS

It is essential to implement backup and data storage systems to ensure the integrity and availability of information from RHA and RQA stations. This may involve the use of cloud storage, regular backups, and protective measures against data loss.

3.7 DATA ACCESS MANAGEMENT AND OTHER PRODUCTS GENERATED BY AHN AND WQN

The entities managing the AHN and WQN in each Member Country must require users, at the time of request through the website, to complete an electronic form with the following information:

- Date and origin (location) of the request;
- Personal and institutional data of the requester;
- Email;
- Type of product/data requested;
- Intended use of the data;
- Brief evaluation of the quality of the data service provided by the user;
- Acceptance of terms and conditions: the user must accept the terms and conditions established by the managing entity for accessing and using the data and products. This may include aspects such as data confidentiality, proper attribution when using the data, prohibition of commercial use without authorization, among others.



4. Protocol for Guiding Flows and Responsibilities for the Implementation, Operation, and Publication of AHN and WQN Data

4.1 TIME SCALES FOR DATA GENERATION

The Member Countries and the ACTO/ARO will work together on two time scales (monthly and annual) for data processing and publication, as well as the different processes to ensure data quality. The monthly and annual time scales indicate that, at the end of each month, data is compiled by the designated agencies in each Member Country, and primary processing, validation, raw data storage with corrections, and secondary processing—including monthly calculations—are carried out. In addition to the measured data, it must be verified whether the data falls within the range of the historical series. At the end of the year, annual data processing is performed.

4.2 ASSIGNMENT OF RESPONSIBILITIES

The Member Countries will be responsible for receiving incoming data from observers, automatic equipment, and field teams. Subsequently, the Member Countries will handle data processing (primary, validation, and secondary). This information will be stored with proper classification (compatible with WMO standards until the regional technical team agrees on a regional standard) to distinguish raw data, corrected data, and data that has undergone primary and secondary processing. The Member Countries will be responsible for publishing this information within their respective countries. Finally, the ACTO/ARO will be responsible for consolidating, storing, organizing, and disseminating the data from the Member Countries. An additional task of ACTO is to provide feedback to the Member Countries on data quality.

4.3 ACTIVITIES UNDER THE RESPONSIBILITY OF THE MEMBER COUNTRIES

4.3.1 DATA COLLECTION AND PERFORMANCE EVALUATION

At this stage, the monitoring plan is developed and executed, indicating the frequency and timing of measurements. This is the phase where the performance of stations, installed sensors, observers, and field operation teams must be verified. The data collected at this stage is maintained as raw data.

4.3.2 PRIMARY PROCESSING

Field-collected data will be transcribed into appropriate digital formats and organized in a centralized database. It will be ensured that the data is complete and correctly recorded, including date, time, location, and other relevant parameters. Data units and formats will be converted as necessary to ensure consistency and compatibility among different measurement parameters and systems. Additionally, an initial consistency check of the collected data will be conducted. Recorded values will be compared with acceptable ranges or expected values, identifying potential errors or discrepancies to allow corrections or, if necessary, request a new measurement.

4.3.3 SECONDARY PROCESSING

At this stage, more advanced data analysis and processing techniques will be applied to obtain more detailed and meaningful information, also referred to as advanced data analysis and processing. This may include trend analysis, correlations, modeling, spatial interpolation, among others.

4.3.4 DATA REVIEW FOR STORAGE AND PUBLICATION

This phase will be carried out if, after consistency checks, the need for changes due to detected revisions at the end of the entire process is identified. A new compilation of daily, monthly, and annual frequencies will be performed, along with their respective basic statistics (maximum, average, minimum, and median values). Additionally, metadata will be generated.

4.4 ACTIVITIES UNDER THE RESPONSIBILITY OF ACTO/ARO

4.4.1 RECEPTION OF DATA BY ACTO/ARO

Data is received in monthly batches from each Member Country once processing has been completed. Before this, ACTO/ARO must have identified the measurement stations or points in each Member Country.

4.4.2 CONTINUITY ANALYSIS IN DATA TRANSMISSION

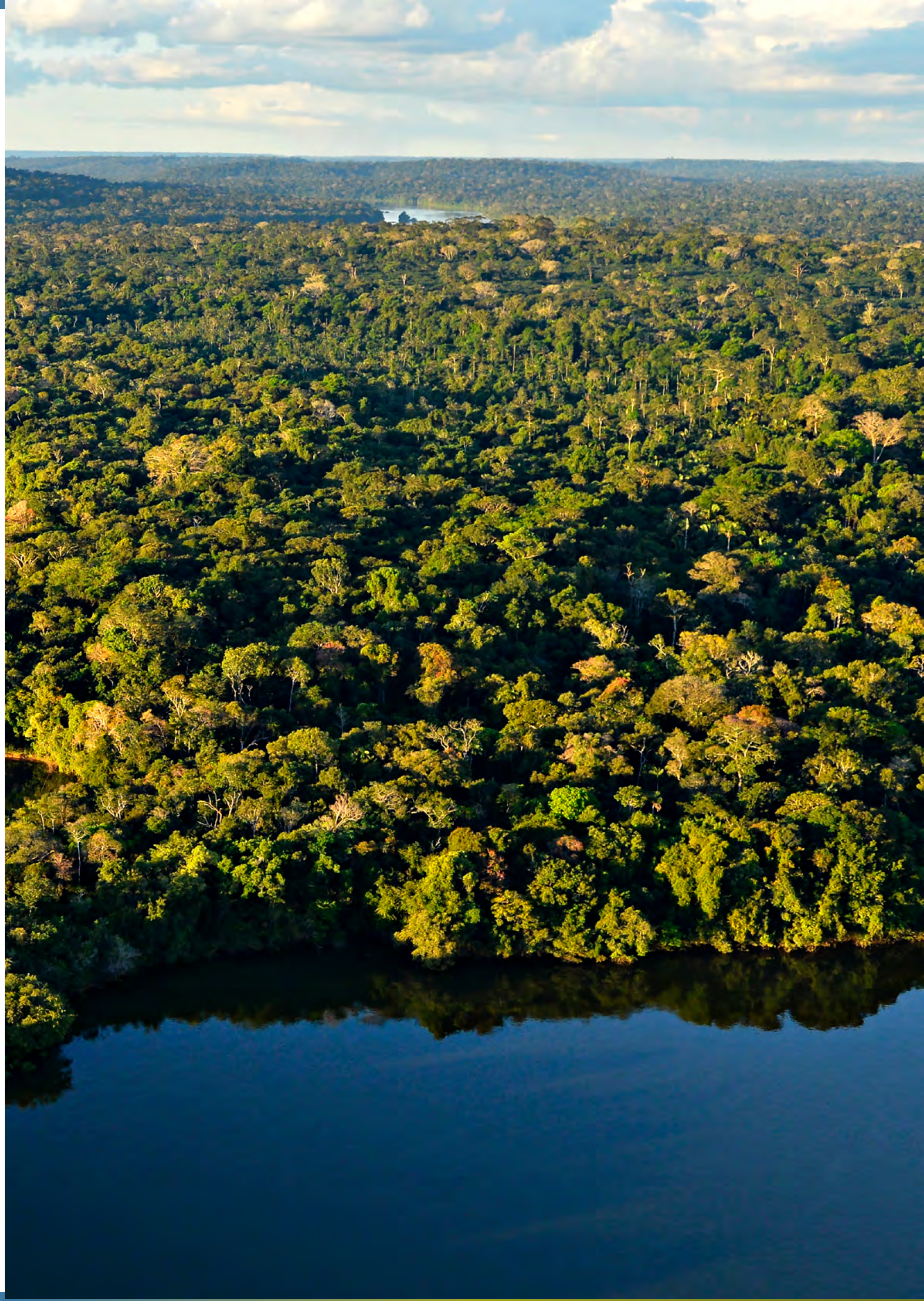
Ensure the continuity of data received from Member Countries. Verify information received from active measurement stations or points in each Member Country. If missing information is detected, contact must be made with the corresponding Member Country's managing body.

4.4.3 REGIONAL ANALYSIS AND DATA STORAGE

Integrate measurements to create a regional characterization. Generate regional statistics whenever monthly data batches are received. It is recommended to store not only raw and processed data but also the calculated monthly statistics.

4.4.4 REPORT GENERATION AND DISSEMINATION

ACTO/ARO must generate periodic reports and derivative products from water quantity and quality data. These reports may include analyses of the status and trends in water quantity and quality in the Amazon region, recommendations for water resource management and conservation, among others. Access to water quantity and quality information will follow the continuous and permanent operation of RHA and RQA and the policies established by each country for information sharing.



Find out more about ANWA:

ACTO Amazon Cooperation Treaty Organization

ANWA

ABC BRAZILIAN COOPERATION AGENCY MINISTRY OF FOREIGN AFFAIRS

ANA AGÊNCIA NACIONAL DE ÁGUAS E SANEAMENTO BÁSICO

AmazonBasin SAP IMPLEMENTATION

UN environment United Nations Environment Programme

gef