

# Pacific Islands National Forest Inventory for REDD+



## BOOKLET 2: GUIDANCE FOR PLANNERS & MANAGERS



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Pacific Islands National Forest Inventory for REDD+

- Booklet 1: Guidance for Policy Makers
- Booklet 2: Guidance for Planners and Managers
- Booklet 3: Field Operations
- Booklet 4: Data Analysis

# Pacific Islands National Forest Inventory for REDD+

## Guidance for Policy Makers

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Cover Photo: Participants to the Makira (Solomon Islands) NFI training, 2014. Photo by Loraini B. Kasainaseva.

# List of Abbreviations

FAO: Food and Agriculture Organization of the United Nations

FRA: Forest Resource Assessment

NFI: National Forest Inventory

NFMS: National Forest Monitoring System

PICs: Pacific Island Countries

REDD+: Reducing emissions from deforestation and forest degradation in developing countries; and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries

SPC: Secretariat of the Pacific Community

UNFCCC: United Nations Framework Convention on Climate Change





# Foreword

This booklet was designed for managers and planners who will design and manage a National Forest Inventory (NFI) to the standard required for REDD+ (Reducing emissions from deforestation and forest degradation). The booklet is a collaborative work between Pacific Island Countries (PICs), the Food and Agriculture Organization of the United Nations (UN-FAO) and the Secretariat of the Pacific Community (SPC). It provides an overview on guidelines and management procedures when creating and planning a National Forest Inventory.

This booklet is part of a series of four booklets to provide the appropriate guidance to policy makers, managers, technical and field personnel on the proper conduct of a national forest inventory, from planning to implementation.

The booklet series will ensure a common understanding that would help facilitate the regional sharing and mobilization of relevant expertise to support the conduct of national forest inventories in Pacific island countries. The aim is to foster a consistent approach to the planning and conducting of NFI within the Pacific communities, noting that the specific details may vary from country to country.

# Background

This second booklet was designed for Pacific Island Countries (PICs) through a collaborative work of the Food and Agriculture Organization of the United Nations (UN-FAO) and the Secretariat of the Pacific Community (SPC) that provides guidelines and strategies for Planners and Managers when implementing an NFI.

Developing a NFI that suits country circumstances is important but can be complex. This booklet aims to provide key considerations and recommendations for Managers at the planning stage.

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*Countries should adapt these  
guidelines to their country  
circumstances*

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# Mechanisms of the NFI Process

## Overview

These guidelines provide detail of the processes to consider by senior-level planners and managers. The following key elements are discussed in this section, and the decision outcomes will directly influence how the NFI is conducted. These key elements include:

- Identification and engagement of stakeholders;
- Articulation of clear objectives for the NFI;
- Sample design;
- Field plot survey design;
- Implementation of a pilot NFI;
- Review design for sampling, field plot and analysis;
- Implement the full NFI, including QA/QC;
- Reporting.

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*How an NFI is conducted depends on the details of planning*

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## Engaging Stakeholders

The NFI must meet the requirements of REDD+. Before deciding on additional objectives to the NFI, it is important to identify and consult the stakeholders during the planning phase. Stakeholder engagement initiates a dialogue to foster mutual understanding and to invite participation in seeking solutions to issues that may arise before and during the implementation stage of the NFI. In engaging these stakeholders, there are three key steps to follow- **Prepare Planning and Engagement.**

### Prepare

In this step, stakeholders must be identified and issues that need to be addressed in creating the NFI must be documented. In addition, a set of proposed objectives and approaches to the NFI must be prepared and presented to the various stakeholders during the engagement process.

It is important to identify the broadest group of stakeholders to ensure good participation, and that appropriate meetings or groups of stakeholders can be properly planned.

### Planning

This second step lists the various issues in order of priority. The prioritization of issues may depend on how the NFI would directly affect stakeholders and how much influence, credibility and legitimacy different stakeholders may have. This will help to identify the key stakeholders who are likely to have higher levels of engagement in the process. Following stakeholder meetings a priority list of objectives should have been formulated.

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*Identify key stakeholders and issues*

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## **Engagement**

In this step, background information on the project should be presented in the appropriate format for the stakeholder group.

It is important to be prepared to collect information from the stakeholders that can help guide the NFI process, identify plans for the next course of action for the proposed NFI and evaluate the needs for further engagement.

Discussions should also stress that the NFI is a national exercise, and is not designed for project-level outcomes. As such, stakeholders should be made aware of the types of questions an NFI can answer.

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*Advisable to report the results of the  
NFI back to stakeholders*

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## Formulating Objectives

There are a few guidelines that should be considered when developing NFI objectives. The following are key questions to be discussed by leadership and management personnel to help narrow the scope, identify the authority, plan for resource requirements, and set goals to implement an NFI in a planned time frame. These questions include:

- Who has the authority to make decisions?
- What policy related issue(s) will be addressed?
- What national goals will be met and when?
- How are stakeholders engaged?
- What information needs to be gained?
- How are resources allocated to accomplish the objectives?

The objectives of the NFI for REDD+ are firstly to estimate carbon stock change that meets UNFCCC requirements. Other traditional objectives include providing data for country or regional level forest planning and management, environmental control and yield regulation.

## Sample Design Theory and Practice

Sample design is a framework for the selection of a survey sample. Before planning the sample design, it is advisable to conduct a reconnaissance to better understand the land use and land cover types to be considered, notable changes due to soils or elevation, different rainfall regimes that may affect vegetation, and gain an understanding of site access on the ground.

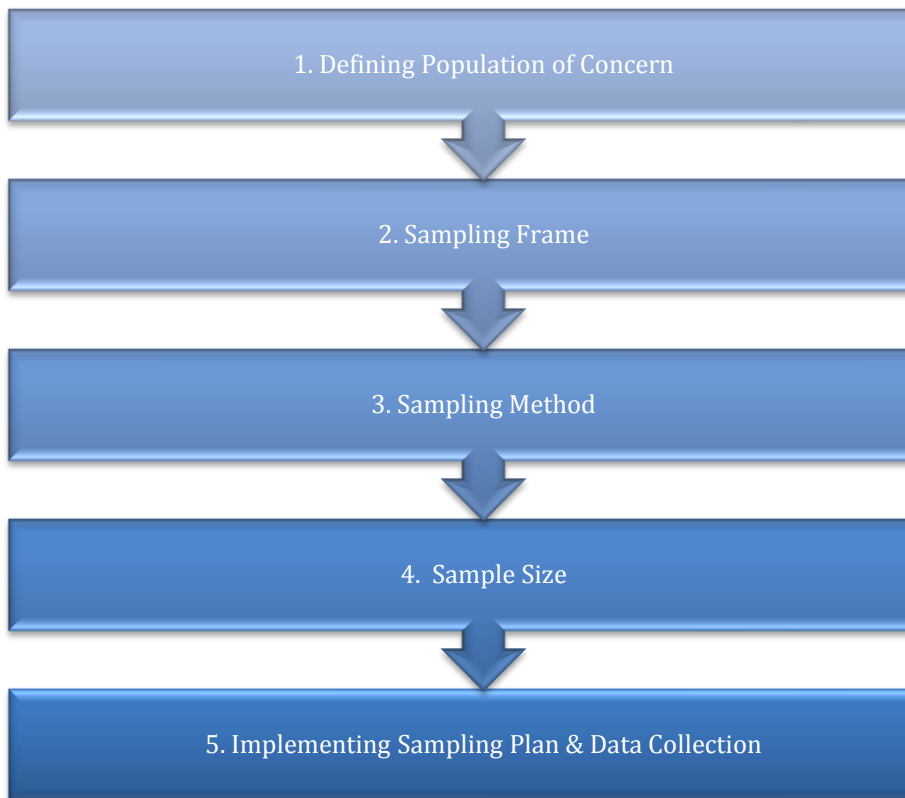
Once a proposed sample design has been agreed it is to be tested in a pilot NFI.

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*There are five steps in planning a sampling design for an NFI*

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*Figure 1: Sampling Design Process*

### **Defining Population of Concern**

The population of concern is the collection of units about which the survey is going to be conducted (e.g. forested lands). While some countries develop NFI for all land use types, others may only wish to consider forested lands. Most countries are adopting the FAO Forest Resource Assessment (FRA) definition of forests and other wooded land to classify their land cover types (Table 1) for common standards of reporting. To conform to IPCC, member countries may define a forest within wider limits than in table 1, in order to establish

a NFI that best suits their country circumstances. It is crucial for government agencies to identify one national forest definition and make it transparently available.

*Table 1: Terms and Definitions for Forests and Other Wooded Land used in FRA 2010. Source: FAO.*

<b>Category</b>	<b>Definition</b>
<b>Forest</b>	Land spanning more than 0.5 ha with trees higher than 5m and a canopy cover of more than 10%, or trees able to reach these thresholds <i>in situ</i> . It does not include land that is predominantly under agricultural or urban land use.
<b>Other Wooded Land</b>	Land not classified as “Forest”, spanning more than 0.5 ha, with trees higher than 5m and a canopy cover of 5-10%, or trees able to reach these thresholds <i>in situ</i> ; or with a combined cover of shrubs, bushes and trees above 10%.It does not include land that is predominantly under agricultural or urban land use.
<b>Other Land</b>	All land that is not classified as “Forest” or “Other wooded Land”
<b>Other land with tree cover (sub-category of “Other Land”</b>	Orchards and trees in urban areas are part of land classified as “Other land”. They should span more than 0.5ha with a canopy cover of more than 10% of trees able to reach a height of 5m at maturity.

## Sampling Frame

A sampling frame is a list of all units from which samples are taken, also referred to as the ‘statistical universe’. The sample frame regulates how well the target population is surveyed and determines the choice of the data collection method.

In a NFI, the sampling frame is established by subdividing the total land area of the population of concern into mutually exclusive sub-populations (normally administrative areas) and the sub-populations are systematically divided into sample units.

## Sampling Method

The next phase of sampling design is to determine the sampling methods. It is important that the sampling frame contains supporting information on the units to ensure that an efficient sample plan can be developed.

Accuracy is a relative measure of the exactness of the value of an inferred variable for a population, or how close the estimates are to be the true values.

Precision indicates the closeness of agreement among independent measurements obtained under stipulated conditions. It is the inverse of uncertainty in the sense that the more precise something is, the less uncertain it is (Figure 2).

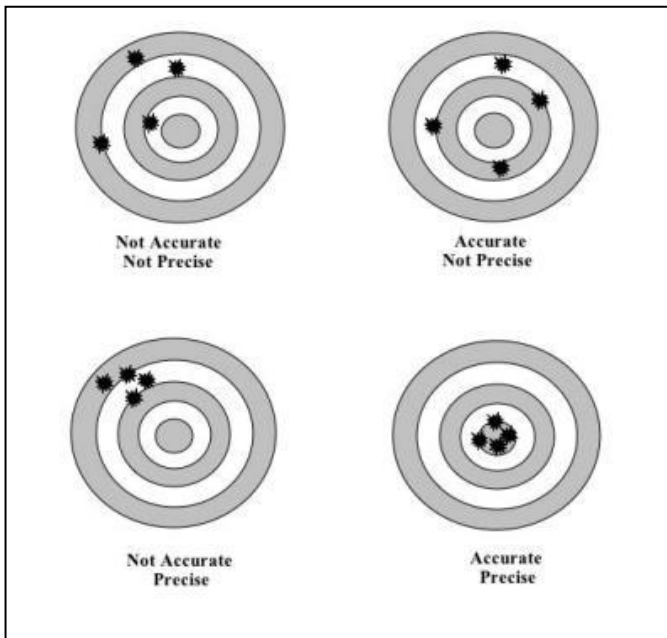


Figure 2: Balancing Accuracy and Precision. Source NOAA, 2012.

It is important to ‘minimize bias’ and ‘maximize efficiency’.

Minimize bias means to:

- Avoid systematically distorting an estimate, as distinct from a random error which may distort on any one occasion but balances out on the average;
- Avoid over- or under-emphasizing particular aspects or forest types in the population, avoiding a biased sampling process, that is to say, a process which incorporates a systematic component of error;
- Not selecting sites due to a particular location or attribute, for example sites nearest to roads, or tall forests on productive soils.

Maximize efficiency means to:

- Achieve the best possible estimate of carbon stocks (or other forest attribute);
- Achieve a known level of uncertainty (precision) that meets the objectives, acceptable for the resources available;
- Employ affordable and cost-effective methods ;
- One sampling design is more efficient than another if it secures the same precision with less expenditure of money or resources.

## Sampling Methods

There are various sampling methods that may be adopted for an NFI sampling (Shiver and Borders.1995) but the most commonly used methods are:

- Simple Random Sampling

Sample units (inventory field plots) are located randomly across the forested landscapes. It ensures that there is no bias, as all forest areas have an equal chance of being sampled. In practice, this method can be difficult and expensive to execute in areas other than in small, homogeneous forest areas with low variation in environmental characteristics.

- Systematic Sampling

Plots are located at predictable, regularly spaced intervals in a grid or transect.

- Stratified Sampling

Stratified sampling divides the forest land into homogeneous strata to form groups with common characteristics. Examples include stratification based on geographic or environmental characteristics, forest type, land use or all of the above. Stratified sampling generally provides a more precise estimate of average carbon stocks for a given amount of effort and cost.

- Cluster Sampling

This method is useful when plots are difficult to access or require long travel times. Plots within a cluster are close to each other but capture a larger “footprint” than a single plot of the same area, to ensure the variation is captured at that site. The cluster patterns

need to be pre-defined (e.g. subplots in cardinal directions). The statistics for the site are assessed on the cluster as a whole.

- Multi-Phased Sampling

Using this method, sampling is done in various stages. Sampling occurs in *stages*, the *sampling* units at each *stage* being sub-sampled from the (larger) units chosen at the previous *stage*. This method is helpful for sampling large areas, as it reduces costs in identifying areas of interest and deploys resources in a targeted manner.

## Sample Size

The next step of sampling design is determining the sample size that provides the necessary precision specified in the objectives of the inventory. The desired precision combined with the prescribed sampling method will determine the number of sample units (plots or plot clusters). The more variable the plot clusters are within a stratum (for stratified random sampling using clusters, for example) the more plots will be required for a given level of precision.

To determine the sample size needed, forest types can be initially sampled with a few number of plots (e.g. 15 plots for a single stratum), to quickly provide an estimate of the mean and between plot standard deviation associated with that stratum. Statistical formulae can then estimate the number of plots needed for the desired confidence interval at the 95% probability.

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*Advisable to engage a sampling specialist to assist with statistical aspects of sampling design*

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## **Sampling and Data Collection**

This set of booklets is aimed at implementing a pilot NFI. Following the pilot phase, the methodologies are reviewed and adapted where needed to ensure all of the appropriate information is gained, the assumptions are correct and the objectives are met. Then resources can be planned well for full implementation.

## Sample Design Considerations

### Vegetation Types

Vegetation is generally defined as the grouping of plant species and the ground cover they provide. These plant species are then categorized into different vegetation types such as tropical forest, shrub lands, grasslands and so forth. In planning an NFI, a country needs to be familiar and have a land classification system to better stratify their vegetation types. In doing so, one must also know how to differentiate land cover from land use. Land cover is the vegetation or other material covering the land surface and land use is the human activity that is usually or not always related to land cover. Every country has its own land cover classification system unique to their national vegetation types.

### Species Composition

Plant species composition is important within the NFI. Although there are over 500 tree species, expertise in tree species identification (tree spotting) expertise is often present at least at the local level. For other plant species, this may require additional knowledge of up to 1,500 species and expertise at this level is not generally available for forestry field crews. An understanding of tree species composition is helpful for improving carbon estimates using species-specific wood density values. It is also useful for the identification of merchantable timber resources and species diversity and forest type.

Species composition requires extensive in-field training and local knowledge by forestry professionals, specifically the need for trained tree spotters and botanists to identify unknown species.



## **Developing a Stratification Scheme for a country**

Stratification means to divide a heterogeneous population into more homogeneous strata. Different forest types have different carbon stocks and carbon stock dynamics. A stratification scheme is helpful as it should improve the precision of the estimates of volume and carbon stock change.

# Pilot NFI

## Pilot Inventory Plan

Prior to the full NFI, a pilot NFI is carried out to test the methods, the sampling design and plot layout. The plan for the pilot contains all of the relevant information needed to test the NFI. It should include the work flow, resources required, Quality Assurance / Quality Control (QA/QC) procedures, outreach with traditional owners, and other elements required. Generally the Pilot Inventory Plan will contain:

- The decision-making authority;
- Policies that will be supported;
- Budget requirements;
- Goals of the NFI;
- Traditional owner outreach procedures;
- Responsibilities and resources required;
- Sample design;
- Variables to measure or observe;
- Field instructions;
- Schedules;
- Data chain of custody;
- Analysis procedures;
- Quality Assurance/ Quality Control procedures;

- Defined terminologies and reference information.

## Implementing the Pilot Plan

The field work needs to be planned following the development of the sample and field survey designs.

### **Field Crew Formation, Preparation and Implementation of Field Work.**

These stages outline the components for developing and implementing a field production team.

1. The initial steps involve the development of maps; contact information, field training, and data capture (forms or handheld computers).
2. Following the initial steps, there are requirements for consultation of traditional owners, and the procurement of local field guides to assist the teams with access and logistical support.
3. Field training is very important and should be carried out prior to implementation. It should involve management staff, field crew and any separate QA/QC personnel.
4. The measurements and data collection is carried out following protocols and procedures listed in the inventory plan. QA/QC procedures should also be trialed at this point
5. Data analysis should began as soon as possible once the first plots have been measured, to ensure that volumes, other forest parameters and carbon

stocks can be readily calculated. Data and sample storage, error checking, data processing and data retrieval / querying procedures should all be validated.

6. The format of reporting should be established and reports distributed.

## Organization Guidance

This section identifies two different teams: the **Management** (planning team) and the **Operational Team** (field technicians) and their roles in carrying out a successful NFI, following the construction of the NFI. It is highly desirable that staffs in the Management Team are fully familiar with field practice and periodically join the Operational Teams in the bush.

### Management

The key roles are:

- Manager of the NFI;
- Field operation supervisor; and
- The data base administrator/analyst.

The Management Team will take the lead in organizing and approving the final stages of NFI planning by putting in place a system for the field technicians to implement the NFI field inventory. To do this, they will have to:

- Carry out analysis and adaptation, if needed, of sampling design, inventoried variables and definitions;
- Setting up field crews;

- Conducting training for field crews;
- Organizing and planning fieldwork, in particular mobilization and preparation of necessary resources and equipment, such as vehicles, and allocation of areas to field crews;
- Monitoring and backstopping fieldwork, including technical and logistic support to field crews, in order to ensure data quality and consistency among field crews;
- Validating field forms;
- Controlling data and evaluating its quality;
- Administrating databases;
- Reporting and disseminating results;
- Proper workplace health and safety equipment and procedures are in place.

### **Operations**

The Operations Team carries out the field work. Important points to take into consideration include:

- They are responsible for the data/information collected from the field;
- Must evaluate and ensure quality of data during and after the field work;
- Ensure that the team is well versed with the proposed method and techniques of data collection from the field. All team members must be skilled and have bush experience;
- Workplace health and safety procedures are followed at all times.

## Guidelines in Field Crew Composition

The field crew will each have to play a role in making sure that field work preparation is up to par to allow flow of work in the field.

Field inventory crew should at a minimum consist of four members i.e. a team leader, Forestry technician/forester, tree spotter/botanist and a local guide.

Field crew should have good bush skills and be physically fit. They should be capable of navigating through difficult forest conditions in adverse weather. They should be capable of consistent careful measurement. Responsibilities of each crew member must be clearly laid out before the field work to avoid mishaps in the field (Table 2).

*Table 2: Team Responsibilities*

<b>Crew</b>	<b>Responsibilities</b>
<b>Team Leader</b>	Is responsible for organizing the fieldwork from preparation phase to the data collection. Has to plan the work for the field crew and ensure that all forms are verified by management, maps are authentic, correct and ready, equipment is available and in working order and logistical requirements are addressed. The Team Leader will also be supervising the field work in progress.
<b>Forestry technicians/foresters</b>	Assist the team leader in carrying out the tasks. Take the lead in field measurements.
<b>Tree spotter or botanist</b>	Specialize in tree identification for the local forest type.
<b>Local Guide</b>	Knowledgeable of the local area, access routes and customary protocols.

# Resource Considerations

## Staffing and Training

It is important to allocate a team specifically tasked with implementing an NFI. A successful and long-term approach includes linking the NFI program with an institution that will ensure the long term availability of data and expertise to manage information to inform decision-makers. An institutional arrangement also increases the capacity to train, review, monitor, and verify the work conducted.

Training of staff must cover various aspects of NFI and can be considered in two ways:

- Internally, where training is carried out within a ministry, proposals could be put forward to the governing body on budget allocation to cover costs of training and hiring experts to conduct training;
- For training where internal capacity does not exist, external partner organizations such as the SPC Regional Support Facility, FAO and other external parties that have direct links to NFI and NFMS can be consulted.

One member of each team should have basic knowledge in Excel to better understand, proof, and analyze their data. Resources should be allocated to boost their capacity by providing basic training, sending crew members for organized training by regional or global organizations and institutes.

Most importantly, a country must have access to a permanent sample plot and carbon database that can securely host all their NFI datasets. Physical samples must be securely stored. In the case where a country cannot develop or administrate this database, assistance can be sought from SPC NFI Support Facility or other International organisations that offer a bureau service.

## **Travel, Outreach & Logistics**

Efficient allocation of both financial and staff, is necessary to cover travel, outreach and logistics during an NFI Project.

When carrying out community outreach, the team should first approach communities within the areas that fall within the grid of measurement for inventory and bring awareness to the community on the purpose and aim of their visit and briefly give an overview on the inventory project being carried out.

It is also important to take note of traditional local protocols before entering the communities, and the team leader should ensure that all team members are aware of this. This will assist in the dialogue process and help to ensure that local communities are not reluctant to support the work and allow access to their lands. Team should also provide inventory maps with the grid system (aerial maps) to the people to better visualize the places that the team would be visiting. With this approach, locals could also identify places that have restricted access (e.g. Taboo sites) and provide to the team alternative solutions.



# Reporting

In principal, the greenhouse gas inventory reporting follow these guidelines “TACCC” (IPCC, 2006).

- *Transparency*-Assumptions/methods are clear; inventory can be replicated;
- *Accuracy*-Reflects actual emissions and removals;
- *Consistency*-Differences in results reflect real emissions differences;
- *Completeness*-All relevant sources, sinks and geographical areas;
- *Comparability*-Methodologies and the reporting approach allow comparisons.

For PICs, there are challenges encountered in attempts to establishing NFI. These challenges include the limited human resources available to carry out multiple responsibilities, the insufficient documentation from previous inventories and the difficulties of retaining expertise.

Nevertheless for any reporting country, the general guidelines are set out in the IPCC Guidelines (2006). In general it is *good practice* to archive and document all data and information such as figures, statistics, sources of assumptions, modeling approaches, uncertainty analyses, validation studies, inventory methods, research experiments, measurements arising from field site studies, associated protocols, and other basic data.

Elaborations on carbon pool definitions should be reported, and definitions relevant to determining the extent of the managed land

included in the inventory, together with evidence that these definitions have been applied consistently over time provided.

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*Meeting the international standard of reporting and documentation is critical for REDD+ countries*

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Documentation is needed for demonstrating completeness, consistency of time series data and methods for interpolating between samples, methods and years, and for recalculating and avoidance of double counting as well as for performing QA/QC (IPCC, 2006).

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