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# Strategies and Applicable Tools for Improving Greenhouse Gas Inventories in Southeast Asia

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A light blue map of Southeast Asia is visible in the background of the text box. It shows the outlines of Thailand, Cambodia, Laos, Vietnam, Malaysia, and Indonesia, with some major cities marked.

Mausami Desai  
Climate Change Division,  
Office of Atmospheric Programs  
U.S. EPA

Kuala Lumpur, Malaysia  
September 6, 2007

The logo of the United States Environmental Protection Agency (EPA) is located at the bottom center of the text box. It features a stylized green plant with a blue globe as its head, surrounded by the text 'UNITED STATES ENVIRONMENTAL PROTECTION AGENCY' in a circular arrangement.

# Purpose of Central America Project

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- Support implementation of CONCAUSA Action Plan on Climate Change (June 2001)
  - “Strengthen the Central American countries' capacity to adapt to climate change and to mitigate greenhouse gas emissions”
- Increase regional capacity to meet international obligations under the UNFCCC
- Increase regional capacity to develop national GHG inventories and improve data and methods



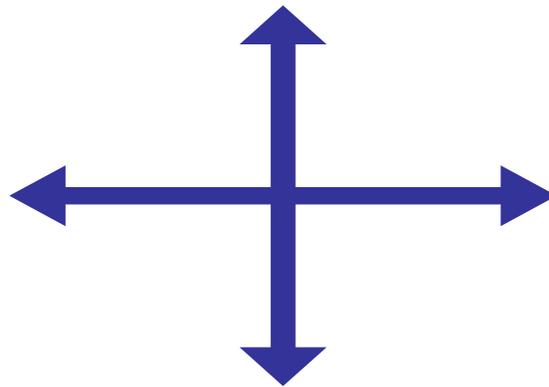
# USAID-EPA-NASA Work on GHG Inventory Capacity Building

Commitment from Central American governments



Overall Funding Support for Climate Change Expert

Greenhouse Gas Inventory Project



Remote Sensing Project

# Central America Inventory Project Components (2004-2007)

## Component I: *Build sustainable national inventory systems within each country*

- Inventory management focus areas:
  - Key source analyses
  - Description of institutional arrangements
  - Source-by-source background document
  - QA/QC & archiving system
  - Inventory improvement plan

## Component II: *Improve GHG estimates*

- Source/sink categories:
  - Forest C
  - Soil C
  - Soil N<sub>2</sub>O
  - Landfills
- Evaluate current methods and activity data
- Assist in applying the chosen methods

Goal: Build sustainable National GHG Inventory Management systems in Central America

**LOW TECH!  
IMPORTANT!**

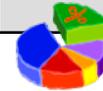
- A country can prepare a GHG inventory at regular intervals (annually, every 2 years etc.)
- All information used to prepare the inventory is archived
- Roles and responsibilities are understood
- Experts can come and go but the inventory does not suffer
- Inventory quality improves over time
- The GHG inventory meets the needs of policy-makers, researchers, and the public

Furthermore, the preparation of the report will be as useful as the report itself:

- Preparation of National Communication
- Background for future GHG inventories
- Priorities for future capacity building projects

 Inventory Coordinators use EPA Templates and Tools

1. Key Source Analysis Report



2. Description of Institutional Arrangements

3. Source by Source Documentation of Data and Methods for Key Sources

4. & 5. Description of Archiving Systems and QA/QC



6. National Inventory Improvement Plan ...Priorities and Projects for Improvements

Country Preliminary GHG Inventory System Report 2007



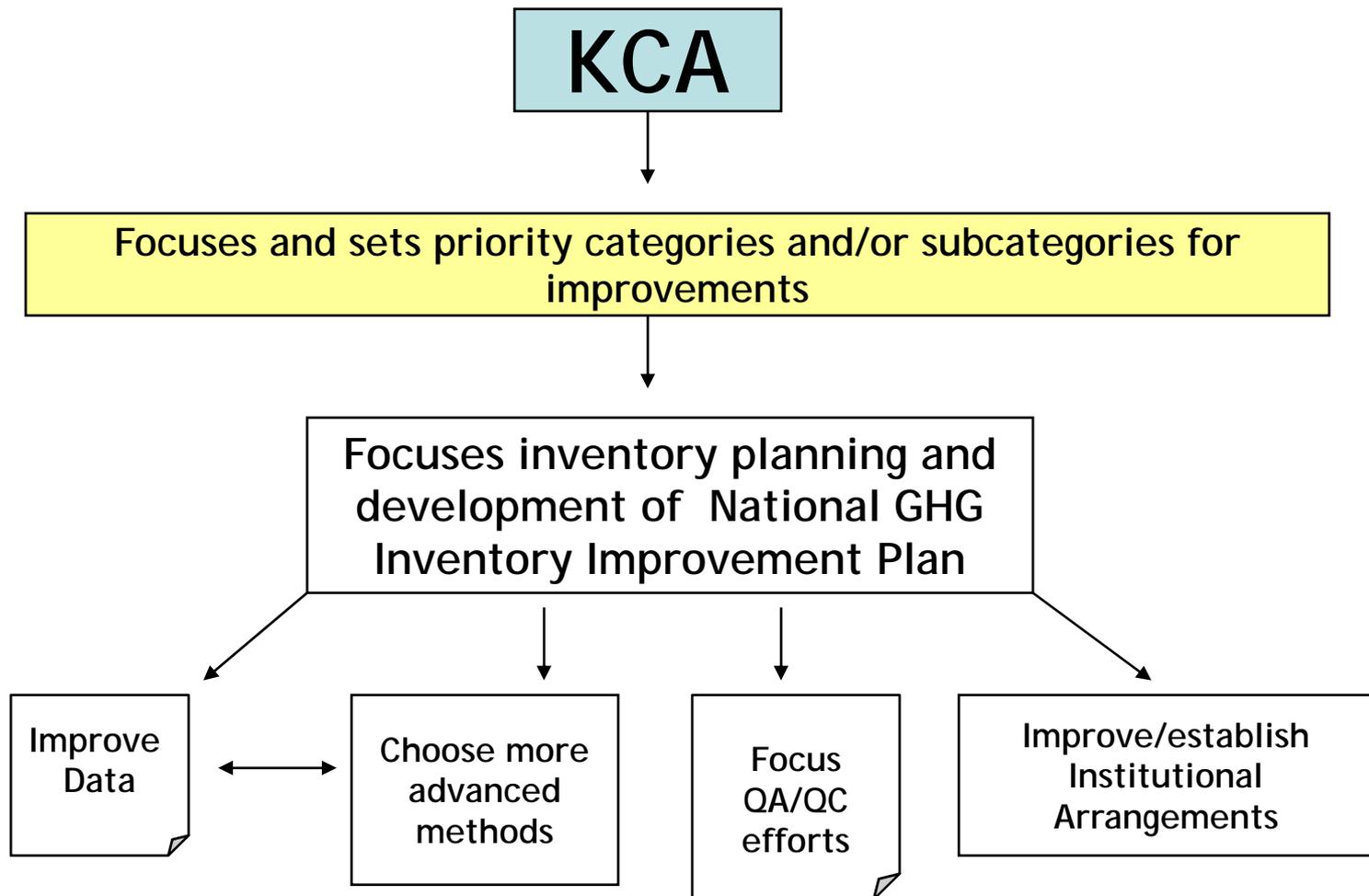
# Why use templates?

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- Focus on documenting essential information in a concise format and avoids unnecessarily long written reports;
- Standardize tasks, allowing countries within regions to compare and contrast results;
- Accommodate varying levels of national capacity;
- Provide an objective and efficient system for identifying priorities for future improvements;
- Serve as instruction manuals for future inventory teams
- Create transparency in a country's national system
- Adapt to national, regional circumstances

# Key Source Category Analysis: Link to GHG Inventory Management

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# Key Source Template: Summarize and Document Results

- Companion software provides tool which facilitates key source category analysis to direct/prioritize inventory improvement efforts
- Report template provides documentation/archive of analysis
- Sample report: Nicaragua

## Nicaragua Key Source Category Analysis

### 1. Introduction

The concept of “Key Source Categories” was created by the IPCC as a tool to help countries prioritize resources for improving national greenhouse gas inventories. Key source categories have the greatest contribution to the overall level of national emissions. Key source categories can also be those categories that have a large influence on the trend of emissions over time.<sup>1</sup>

To improve the national greenhouse gas inventory, it may be necessary to consider more accurate methodologies, develop country-specific emission factors, or collect more detailed activity data. These activities all require additional resources, and it is not possible to make improvements for every source category. The primary purpose of this analysis is to provide a quantitative tool for the national greenhouse gas to use to develop an inventory improvement plan. A secondary purpose is to provide more complete and transparent information for the national communication.

This report presents the results of the IPCC Tier 1 methodology for determining key source categories. The Tier 1 methodology does not take into consideration uncertainty estimates for source categories.<sup>2</sup>

### 2. Summary of Results

#### 2.1 Key Categories – Level Analysis

Table 1 presents the results of the IPCC key source category level analysis for the year 1994. The key source categories are listed in order of decreasing magnitude, and when added to together, the emissions account for over 95% of total national emissions. In total there are 11 key source categories based on the level assessment.

Table 1 – Key Source Categories Based on the Contribution to the Overall Level

Source Category	Gas	Inventory Sector	Emission Level (Gg CO <sub>2</sub> Equivalent)	Cumulative Total (Gg CO <sub>2</sub> Equivalent)	Cumulative Percent of National Emissions
Enteric Fermentation in domestic Livestock	CH <sub>4</sub>	Agriculture	3224	3224	42%
Stationary combustion	CO <sub>2</sub>	Energy	903	4127	54%
Mobile Combustion, Road Vehicles	CO <sub>2</sub>	Energy	838	4965	65%
Agricultural Soils	N <sub>2</sub> O	Agriculture	674	5639	74%
Manufacturing Industries and Construction	CO <sub>2</sub>	Energy	369	6008	78%
Cement Production	CO <sub>2</sub>	Ind. Process	336	6344	83%

# WGIA Regional Key Source Category Analysis\*: Level Assessment Across Countries

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CO<sub>2</sub> Emissions from Changes in Forest and Other  
Woody Biomass Stocks

CO<sub>2</sub> Emissions from Stationary Combustion (Energy)

CH<sub>4</sub> Emissions from Rice Cultivation

CO<sub>2</sub> Emissions from Forest and Grassland Conversion

CO<sub>2</sub> Emissions from Manufacturing Industries and  
Construction

CO<sub>2</sub> Emissions from Mobile Combustion

CH<sub>4</sub> Emissions from Enteric Fermentation

CO<sub>2</sub> Emissions Abandonment of Managed Lands

# Institutional Arrangements Template

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- Address limitations countries have noted in prior National Communications
  - *“There are no institutional arrangements nor procedures to generate, manage, and analyze the information required to systematically prepare and update the inventory.”* - El Salvador First National Communications-Description of National Circumstances
- Helps inventory management teams focus systematically on institutional arrangements for the inventory process
  - Assess existing arrangements (esp. for key sources)
  - Identify and prioritize areas for improvement
  - Build continuity: provides document or “archive” of institutional history to pass on to future inventory teams

# Institutional Arrangements: Costa Rica

## DESCRIPCION GENERAL DEL EQUIPO QUE ACTUALMENTE GESTIONA EL INVENTARIO

**Cuadro 1.a Agencia Responsable del Inventario**

Agencia	Dirección
Ministerio del Ambiente y Energía (MINAE), Instituto Meteorológico Nacional (IMN)	Avenida 9 Calle 17 San José, Costa Rica

**Cuadro 1.b Equipo Gestor del Inventario Nacional**

Papel	Nombre	Organización	Datos de contacto	Comentarios
Director/Coordinador	Roberto Villalobos Flores	IMN	rvilla@imn.ac.cr	
Responsable del Sector Energía	Ana Rita Chacón	IMN	<a href="mailto:archacon@imn.ac.cr">archacon@imn.ac.cr</a>	
Responsable del Sector Procesos Industriales	Ana Rita Chacón	IMN	<a href="mailto:archacon@imn.ac.cr">archacon@imn.ac.cr</a>	
Responsable del Sector Agricultura	Ana Rita Chacón	IMN	<a href="mailto:archacon@imn.ac.cr">archacon@imn.ac.cr</a>	Temporal mientras la persona asignada se incorpora a las actividades
Responsable del Sector Residuos	Jihad Sasa Marín	Universidad Nacional	---	Contrato por tiempo limitado
Especialista en el Sector	Susana Rojas Piedra	Consultora	----	Contrato por tiempo limitado

**Cuadro 1.d Mejoras a la Gestión existente del Inventario Nacional**

1

En general la ampliación del grupo encargado de la elaboración del inventario es una mejora que se puede hacer al sistema del inventario.

La evaluación del Sector Uso de la Tierra y Silvicultura y manejo de desechos deben ser labores permanentes de las instituciones y no contrataciones, como se realiza actualmente.

# Institutional Arrangements: Strategy for Collecting Data

## Nicaragua

**Table 2.3 Industrial Processes Institutional Arrangements**

Data needs	Contacts	Organization	Contact Information (email, phone, etc.)	Comments
Industrial production statistics	Clifford Ramirez B.	Central Bank of Nicaragua (BCN)	Email: <a href="mailto:crb@bcn.gob.ni">crb@bcn.gob.ni</a> Phone: 505-2650500	
Industrial production statistics	Dulce Mayorga E.	National Institute of Statistic and Census (INEC)	Email: <a href="mailto:dulcem@inec.gob.ni">dulcem@inec.gob.ni</a> Phone: 505-2682160	

**Table 2.4 Industrial Processes Description of Institutional Arrangements**

Strategy and process used for collecting data
Check list preparation, Search for the contact key person within the key office in the Central Bank of Nicaragua (BCN) and the National Institute of Statistic and Census (INEC), meet the selected contact key person to discuss the check list and to know about the process to get the information, Motivation workshop, by sector GHG inventory presentation to key Staff, Official letter request to the office head, follow up meetings. Actually, there is no agreement.

# Institutional Arrangements: Strengths and Weaknesses

*[INSTRUCTIONS: Within each sector/source, list where institutional arrangements are well-established, where data are collected and managed adequately, and where strengthening is not needed. Given the key source analysis and existing institutional arrangements within each sector, identify what improvements are needed to improve the institutional arrangements for each specific sector (e.g., initiate collection of activity data, etc.)]*

**Table II.16: Identification of Improvements**

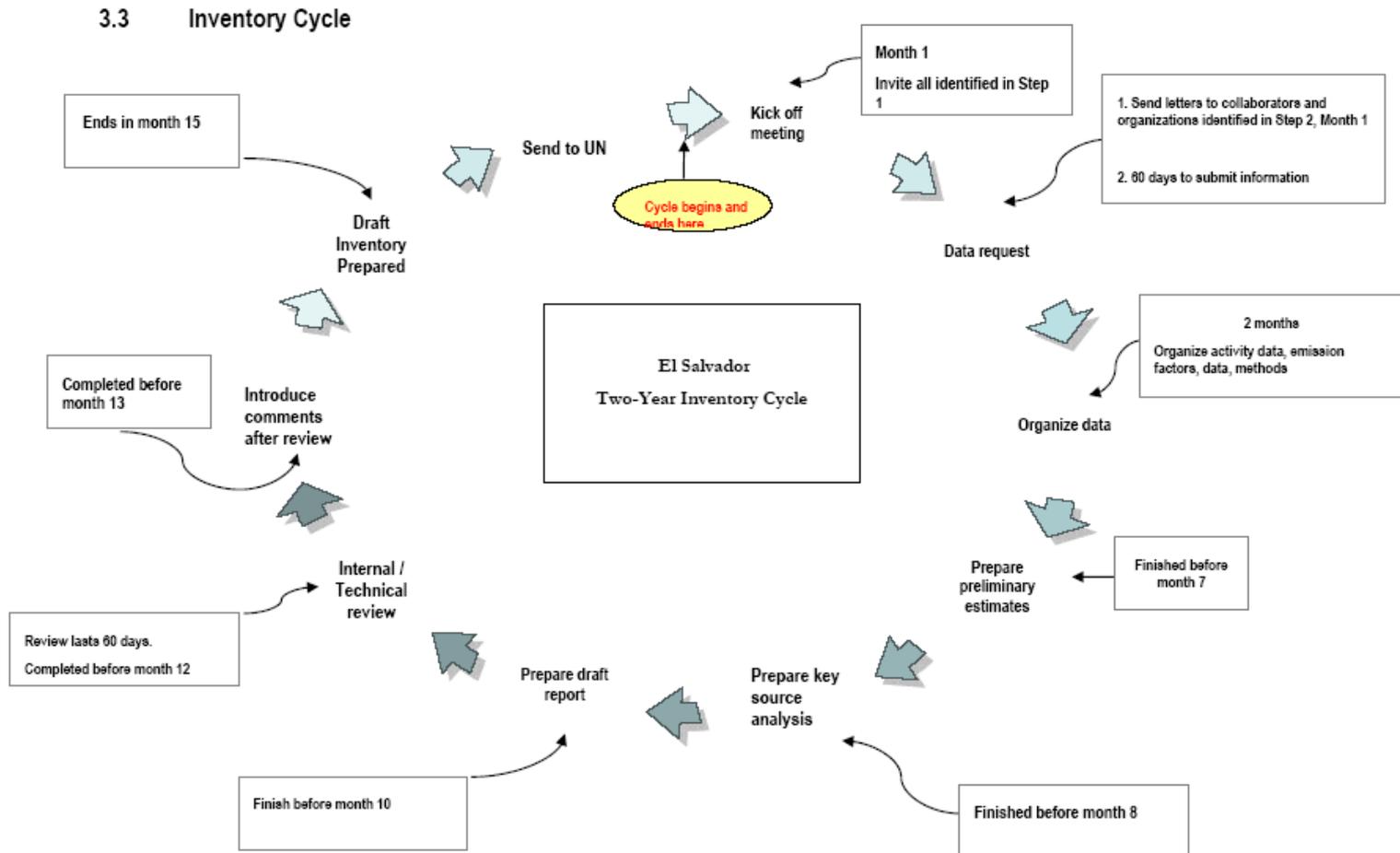
Sector	Strengths in Institutional Arrangements
Energy	The inventory is managed by the Ministry of Energy and Industry, and thus we have internal access to this data and are knowledgeable about compatibility with IPCC methods, etc.
Industrial Processes	
Agriculture	
Waste	
LUCF	
Other	
Sector	Weaknesses in Institutional Arrangements and Proposed Improvements
Energy	
Industrial Processes	Initiate collection of activity data from major cement manufacturer. Need to determine point of contact and availability of data.

## II.5 Inventory Priorities

*[INSTRUCTIONS: On the basis of Steps 1-4, list the most urgent improvements to your country's existing institutional arrangements required to help support a sustainable inventory management system.]*

Action Number	Priority Actions for [Country] National System
1	Establish arrangements with X University and Ag Center for collection of data, as several agricultural sector sources are key sources.
2	

# Institutional Arrangements and the Inventory Cycle



# Source-by-Source Documentation Template

- Apply to key source categories at minimum
- Provide information about each: key source category including
  - Relevance of emission source in the country
  - Methodology and EF for estimating emissions
  - Document QA/QC
  - Document data limitations
- Ensures reproducible and transparent estimates
- Reference/Archive for future teams, peer review

## Documentation and Source-by-Source Description (SBS)

### III.1 Source Category Information

*[INSTRUCTIONS: Provide information about each key source category, including the sector it belongs to, a description of the source, and details about emissions from this source in your country. A standard description from existing documents is sufficient to describe the source category. You will find descriptions of some relevant source categories from the 1996 IPCC Guidelines on page III-6.]*

*In the Country Detail field, describe the importance of emissions in your country from a particular source category. Provide the contribution to total emissions and the historical context for emissions in your country from this source (e.g., relative importance and trends).]*

<b>Sector</b>	Waste
<b>Key Source Category</b> (Note gas.)	CH <sub>4</sub> Emissions from Solid Waste Disposal Sites
<b>Source Description</b> (A standard description from existing documents is sufficient.)	Waste disposal sites consist of both managed sites (e.g., landfills) and unmanaged sites (e.g., open dumps). Disposal of solid wastes generates CH <sub>4</sub> as methanogenic bacteria break down organic matter in the waste. The most significant factors that affect CH <sub>4</sub> emissions are the disposal practice employed, composition of the waste, and such physical factors as moisture content.
<b>Country Detail</b> (Describe source as it relates to the country. Provide historical context for emissions from this source, such as relative importance and trends.)	CH <sub>4</sub> emissions from solid waste disposal are a key source by level and trend analysis. Such emissions represented around 2.8% of total GHG emissions by level analysis in the waste sector, and 76% of emissions from that sector. The average annual rate of increase of emissions from solid waste disposal for the period 1990-2003 is estimated at 3%. About half of the solid waste disposal sites in the country can be characterized as managed, and half as unmanaged. The estimated annual quantity of waste placed in solid waste disposal sites increased from about 2.8 Tg in 1990 to 4.6 Tg in 2003.  Over the next several years, the total amount of municipal solid waste generated is expected to increase as the population continues to grow. The percentage of waste landfilled will likely increase as the practice of managing solid wastes in landfills spreads throughout the country. However, recycling and composting practices are increasing as well and may lessen this increase. Overall, emissions from this source are expected to increase.

### III.3 Activity Data

*[INSTRUCTIONS: List each activity data point used to estimate emissions from this source, including the value, units, and year. Provide a citation for this data and other relevant information, such as the date the data were provided or obtained, and either the contact name (if the data were supplied by a person) or a full citation (if the data were collected from a published source). If completing this template for key sources in the current inventory cycle, identify the data likely to be used.]*

Type of Activity Data	Activity Data (Value and Units)	Year of Data	Reference	Other Information (e.g., Date obtained and data source or contact information)	Source QA/QC Procedure Adequate / Inadequate / Unknown	Are all data entered correctly into models, spreadsheets, etc.? Yes / No (List Corrective Action)	Checks with Comparable Data (e.g., At international level, IPCC defaults). Explain and show results.
Waste generation rate	1.0 kg/person/day	2003	Annual Waste Report, University of Southern Europe, 2004	<a href="http://www.uspu.edu/wwr2_04">www.uspu.edu/wwr2_04</a> , Dr. Ed Crane (Head Researcher) 1-504-253-3053	Adequate. Spoke with head researcher who explained that the document underwent extensive peer review.	No. 10.0 kg/person/day was entered. Changed to 1.0 kg/person/day in all models, spreadsheets, and text.	Checked with IPCC defaults. IPCC default value 0.38 tonnes/cap/year. The Emission Factor (EF) used, 1.0 kg/person/day, equals 0.365 tonnes/cap/year. Our EF is very similar to the default value, but slightly lower, which makes sense given that packaged foods and goods constitute a smaller fraction of our market than the regional average.  Other sources for data comparison not readily available.
Population	X persons	2003	Country Census Bureau	...	...	...	...

# Archive Procedures Template

- ◆ Archiving of all information used in inventory planning and preparation is essential
  - Information related to emission factors, activity data, key sources, QA/QC, uncertainty, methods used, technical review comments and response to comments should be archived
  - Archive may be electronic and/or hard copy
  - Should be located in single location
  - Need not be expensive: Simple but necessary!



Documentation and archiving is key!!

# Archive Procedures Template

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- Describe existing archive system (summarize notes from IA template)
  - Documentation checklist? Decentralized? Duplicate copies? Naming conventions? Location? Inventory archives manager?
- Develop proposed archive procedures
  - Describe roles and responsibilities
  - Overall checklist, source lead checklists (documentation requirements)
  - Archive schedule (i.e. when files must be given to archive manager)
  - Summarize storage mechanisms (i.e. location of hard and electronic file copies)

# QA/QC Measures Template

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- Important to ensure consistency, transparency, and integrity of inventory
- Describe existing procedures
- Develop a proposed QA/QC plan
  - Describe Roles and Responsibilities
  - Elaborate on procedures for communicating QA/QC Plan
  - List Minimal QC procedures that you will undertake
  - List additional (higher Tier) procedures that will be undertaken (determine criteria for use, i.e. key source)
  - Establish External Review or QA procedures (list institutions/individuals to be involved)
  - Overall Schedule (indicate more formal points for QC and QA)
- Much of the plan template is drafted - teams should customize the recommendations to their circumstances and needs

# National Inventory Improvement Plan (NIIP) Template: Objective

- Synthesize findings of previous templates
- Guide and inform future efforts and teams
- Propose projects for improvements
  - Can serve as a documented proposal for funding of further inventory improvement projects (e.g., World Bank, UNDP etc.)
- Consider also linkages to other development priorities

## VI.5 Prioritized List of Potential Improvements

*[INSTRUCTIONS: List up to 10 of the most important improvements identified in Steps according to how critical they are: "High," "Medium," or "Low." For example, improvements (High), while developing outreach materials may be a lower priority (Low). Insert a short (see additional instructions below).]*

This section prioritizes the most critical improvements needed, based on an assessment identified for key sources, additional sources, and institutional arrangements identified in issues, [Country] can move toward producing a more complete and higher-quality inventory and identifies the level of priority associated with each (High, Medium, or Low).

*[Insert a paragraph describing the highest priority items and the areas of priority that are estimates for new sources, enhancing current methodologies, obtaining more reliable data from other institutions.])*

Table VI.5: National Inventory Improvement Priorities

Priority Level	Improvement Needed
High	Develop emission estimates of CO <sub>2</sub> emissions from cement production. Coordinate with potential sources of activity data.
High	Develop a system for archiving inventory spreadsheets and documents.
Medium	Coordinate with the Ministry of Transport to identify alternative sources of fuel consumption.
Medium	Establish relationships with the National University and the National Center for Agricultural sources.

## VI.6 Communication, Outreach, and Training

*[INSTRUCTIONS: This is an optional section that should be included if there are current inventory efforts or for training staff on the inventory system or practices. These plans are]*

- Scheduling stakeholder meetings
- Raising awareness with government, academia, and the public
- Providing feedback to government and associated institutions
- Training or hiring inventory staff

# National Inventory Improvement Plan Priorities

## Nicaragua NIIP

**Table 5. National Inventory Improvement Priorities**

Priority Level	Improvement Needed
High	Establish relationships with Agrarian National University and the Center for Research and Environmental Studies to improve the emission estimates for agriculture and waste sectors
High	Develop an inventory archiving system
Medium	Coordinate with Ministry of Transport and National Police to include in their statistics data by type and age of road vehicles.
Medium	Develop a database platform to capture information from different sources

## Panama's NIIP

**Table 5. Potential Projects for Improving the National Inventory System**

#	Potential Project	Estimated Personnel Needed	Estimated Cost (\$)	Estimated Capital (equipment) Needed
1	Identify a key sub category source in LUCF sector and develop of the emission factor.	Need to hire 2 expert	\$20,000.00	\$20,000.00
2	Development of Institutional Arrangements memorandums.	None. Will be performed by current staff.	\$2000.00	Need a few staff members
3	Emissions Factors for N2O emissions from Agricultural Soils of Central America and the applicability for the Panama conditions.	Need to hire 1 expert	\$3,000.00	\$3,000.00
4	Emissions factors for CH <sub>4</sub> Emissions from	Need to hire	\$3,000.00	\$3,000.00

# National Inventory Improvement Plan Priorities

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## Costa Rica NIIP

Table 22: Priorities for Improvement of the National Inventories

Priority Level	Required improvement
High	Conduct soil carbon analysis
High	Conduct an actual survey to determine in-country emission factors
High	Conduct periodic studies on the composition of solid waste that is disposed of in landfills and follow up the emission analyses for methane in the landfills.
Medium	Develop information systems with less aggregated values in order to determine emissions by type of equipment
Medium	Evaluate possibility to improve emission factors taking into consideration national surveys, age of the fleet, type of vehicles.

# Central America Agriculture and Land-Use Tool (CAALU)

Welcome to the Central America Agriculture and Land Use Greenhouse Gas Inventory Tool (version 1.2.8)

The screenshot shows the CAALU software interface with the following components:

- Logos:** Colorado State University (Knowledge to Go Places), Natural Resource Ecology Laboratory, USAID (From the American People), and United States Environmental Protection Agency.
- Module I: Specify Activity Data**
  - Primary Data Specification: Land Use and Management Statistics, Livestock Statistics, N Fertilizer Statistics, Liming Statistics, Sewage Sludge Amendments, Finalize Primary Data.
  - Secondary Data Specification: Rice Management, Livestock and Manure Management, Crop Residue Management, Savanna/Grassland Burning, Woody Plant Removal, Finalize Secondary Data.
- Module II: Specify Emission/Stock Change Factors**
  - Biomass C Stocks
  - Soil C Stocks
  - Soil Nitrous Oxide
  - Manure Methane
  - Manure Nitrous Oxide
  - Biomass Burning Non-CO2 GHG
  - Rice Methane
  - Enteric Methane
- Module III: Inventory Calculations**
  - Biomass C Stocks
  - Soil C Stocks
  - Soil Nitrous Oxide
  - Manure Methane
  - Manure Nitrous Oxide
  - Biomass Burning Non-CO2 GHG
  - Rice Methane
  - Enteric Methane
- Module IV: Reporting and Documentation**
  - Biomass C Stocks
  - Soil C Stock Change
  - Soil Nitrous Oxide
  - Manure Methane
  - Manure Nitrous Oxide
  - Biomass Burning Non-CO2 GHG
  - Rice Methane
  - Enteric Methane
- Navigation:** Session Management, Quit.
- Footer:** © 2005-2006 Colorado State University. All Rights Reserved. Natural Resource Ecology Laboratory, Fort Collins, CO 80523 USA.
- Disclaimer:** This tool is for the exclusive use of Central American Countries (Belize, Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama) to estimate greenhouse gas fluxes associated with land use and management of agricultural land, and report those results to the United Nations Framework Convention on Climate Change. Any other use is strictly forbidden without permission from the developers. Colorado State University nor the developers guarantee the accuracy of flux estimates from this tool, and users are strongly encouraged to use Quality Control/Quality Assurance procedures to verify the results. This tool is based on methods elaborated in the revised 1996 Intergovernmental Panel on Climate Change Guidelines (1997), IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (2000) and the Intergovernmental Panel on Climate Change Good Practice Guidance for Land Use, Land-Use Change and Forestry (2004). If greenhouse gas inventory guidelines are modified in the future by the Intergovernmental Panel on Climate Change, this tool will need to be updated to reflect the new guidelines for reporting in national communications to the United Nations Framework Convention on Climate Change. This tool was developed through a project funded by the US Environmental Protection Agency and US Agency for International Development.

- State of the art database software developed by Colorado State University (CSU)
- Designers also wrote IPCC Guidelines
- Greatly simplifies task of completing a GHG inventory, but including:
  - QA/QC checks
  - Consistent use of data
  - Hard-wired for IPCC defaults
  - Options to use country-specific data
- Can handle large datasets such as satellite maps

Panama



# Conclusions: EPA's experience

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- A cooperative project where Central American and US experts worked together together on improving inventories
  - Each country prepared a draft National GHG Systems Report identifying priorities for the future
  - The inventory management template approach does not solve the problem of resources but can help address lack of staff continuity
  - EPA project components have enhanced institutional and technical capacity to develop accurate, consistent, and transparent inventories now and in the future
  - Central Americans have strong networks that can be further developed for more formal information sharing
  - EPA has also learned about potential improvements for the U.S. inventory through interaction with Central American experts
- Tools and lessons from Central America can be applied to improve GHG inventories in other regions

# For more information

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Template Workbook for  
Developing a National Greenhouse  
Gas Inventory System



Mausami Desai

Climate Change Division

U.S. Environmental Protection Agency

[desai.mausami@epa.gov](mailto:desai.mausami@epa.gov) or

[GHGInventory@epa.gov](mailto:GHGInventory@epa.gov)

## Online Resources:

- Climate Change Site - <http://www.epa.gov/climatechange>
- U.S. GHG Inventory - <http://www.epa.gov/climatechange/emissions/>
- GHG Inventory Capacity Building Tools - <http://www.epa.gov/climatechange/emissions/ghginventorycapacitybuilding/>



# Climate Change - Greenhouse Gas Emissions

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- Carbon Dioxide
- Methane
- Nitrous Oxide
- Fluorinated Gases
- Greenhouse Gas Inventories
- U.S. Inventory
- Other Countries
- Global Emissions
- States
- Corporate Inventories
- Individual Emissions
- Projections

## Greenhouse Gas Emissions

[Greenhouse Gas Emissions Overview](#) | [Inventories](#) | [Projections](#)



### 2007 Inventory of Greenhouse Gas Emissions and Sinks

Prepared annually by EPA, the national greenhouse gas inventory report presents estimates of U.S. greenhouse gas emissions and sinks for the years 1990 through 2005. This report also discusses the methods and data used to calculate the emission estimates.

### Greenhouse Gas Overview

Gases that trap heat in the atmosphere are often called greenhouse gases. This section of the EPA Climate Change Site provides information and data on emissions of greenhouse gases to Earth's atmosphere, and also the removal of greenhouse gases from the atmosphere. For more information on the science of climate change, please visit EPA's [climate change science home page](#).

Some greenhouse gases such as carbon dioxide occur naturally and are emitted to the atmosphere through natural processes and human activities. Other greenhouse gases (e.g., fluorinated gases) are created and emitted solely through human activities. The principal greenhouse gases that enter the atmosphere because of human activities are:

- **Carbon Dioxide (CO<sub>2</sub>):** Carbon dioxide enters the atmosphere through the burning of fossil fuels (oil, natural gas, and coal), solid waste, trees and wood products, and also as a result of other chemical reactions (e.g., manufacture of cement). Carbon dioxide is also removed from the atmosphere (or "sequestered") when it is absorbed by plants as part of the biological carbon cycle.
- **Methane (CH<sub>4</sub>):** Methane is emitted during the production and transport of coal, natural gas, and oil. Methane emissions also result from livestock and other agricultural practices and by the decay of organic waste in municipal solid waste landfills.
- **Nitrous Oxide (N<sub>2</sub>O):** Nitrous oxide is emitted during agricultural and industrial activities, as well as during combustion of fossil fuels and solid waste.
- **Fluorinated Gases:** Hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride are synthetic, powerful greenhouse gases that are emitted from a variety of industrial processes. Fluorinated gases are sometimes used as substitutes for [ozone-depleting substances](#) (i.e., CFCs, HCFCs, and halons). These gases are typically emitted in smaller quantities, but because they are potent greenhouse gases, they are sometimes referred to as High Global Warming Potential gases ("High GWP gases").

### Greenhouse Gas Inventories

A greenhouse gas inventory is an accounting of the amount of greenhouse gases emitted to or removed from the atmosphere over a specific period of time (e.g., one year). A greenhouse gas inventory also provides information on the activities that cause emissions and removals, as well as background on the methods used to make the calculations. Policy makers use greenhouse gas inventories to track emission trends, develop strategies and policies and assess progress. Scientists use greenhouse gas inventories as inputs to atmospheric and economic models.

To track the national trend in emissions and removals since 1990, EPA develops the official [U.S. greenhouse gas inventory](#) each year. The national greenhouse gas inventory is submitted to the United Nations in accordance with the [Framework Convention on Climate Change](#) [EXIT Disclaimer].

In addition to the U.S. inventory, greenhouse gas emissions can be tracked at the global, state and local levels as well as by companies and individuals:

- Many [other countries](#) also develop national greenhouse gas inventories, which can be compiled into [global inventories](#). EPA works with developing and transition countries to improve the accuracy and sustainability of their greenhouse gas inventories. EPA has developed [Greenhouse Gas Inventory Capacity Building](#) templates and software tools targeting key sources, emissions factors, good practices, institutional infrastructure and use of the latest IPCC guidelines on greenhouse gas inventories.
- Many [states](#) prepare greenhouse gas inventories, and EPA provides guidance and tools to assist them in their efforts.
- [Corporate greenhouse gas inventories](#) provide information on the emissions associated with the operations of a company.
- [Individuals](#) produce greenhouse gas emissions through everyday activities such as driving and using air conditioning or heating. EPA provides an [online calculator for estimating personal emissions](#).

**Related Links**

**EPA**

- [U.S. Greenhouse Gas Inventories](#)
- [Methane to Markets](#)
- [Personal Greenhouse Gas Emissions Calculator](#)

[Greenhouse Gas Equivalencies Calculator](#) [EXIT Disclaimer]

[IPCC's National Greenhouse Gas Inventories Programme](#) [EXIT Disclaimer]

**UNFCCC**

- [Greenhouse Gases Database](#) [EXIT Disclaimer]
- [National Inventory Submissions 2006](#) [EXIT Disclaimer]

The [Intergovernmental Panel on Climate Change \(IPCC\)](#) [EXIT Disclaimer] publishes internationally accepted inventory methodologies that serve as a basis for all greenhouse gas inventories, ensuring that they are comparable and understandable. The [2006 IPCC Guidelines](#) were completed and accepted by the IPCC in May



# Climate Change - Greenhouse Gas Emissions

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## GHG Inventory Capacity Building

Developing greenhouse gas inventories is an important first step to managing emissions. U.S. EPA's approach for building capacity to develop GHG inventories is based on the following lessons learned from working alongside developing country experts:

- Technical expertise for GHG inventories already exists in developing countries.
- Nevertheless, developing country climate change teams face other significant challenges:
  - Small teams with multiple responsibilities and limited resources;
  - Incomplete or non-existent data;
  - Lack of country-specific emission factors;
  - Insufficient documentation of methods and data sources used in previous inventories; and
  - Difficulties retaining capacity and expertise developed during the preparation of the first National Communications.
- Priorities should be determined by developing countries rather than donors.

U.S. EPA's capacity building activities focus on specific measurable and realistic outcomes. The keys to this approach are the two complementary sets of tools to assist Non-Annex I (NAI) Parties with GHG inventories:

- [National System Templates](#) to document and institutionalize the inventory management process.
- [Targeted data collection strategies and software tools](#) to assist developing countries in moving to higher Tier IPCC methods.

These tools, developed in conjunction with the U.S. Agency for International Development, are consistent with UNFCCC reporting guidelines. These tools are available through the links above. If you have additional questions regarding these tools, please contact U.S. EPA's Climate Change Division by sending an email to [GHGInventory@epa.gov](mailto:GHGInventory@epa.gov).

### Related Links

#### EPA

- [U.S. Greenhouse Gas Inventory](#)
- [EPA's Landfill Methane Outreach Program \(LMOP\) International Activities](#)

#### NCSP

- [UNDP-UNEP-GEF National Communication Support Programme \(NCSP\)](#) [\[EXIT Disclaimer\]](#)
- [NCSP Manual on Managing the Greenhouse Gas Inventory Process](#) [\[EXIT Disclaimer\]](#)

#### IPCC

- [IPCC National Greenhouse Gas Inventory Program \(NGGIP\)](#) [\[EXIT Disclaimer\]](#)
- [IPCC Emission Factor Database](#) [\[EXIT Disclaimer\]](#)

#### UNFCCC

- [UNFCCC Greenhouse Gas Inventory](#) [\[EXIT Disclaimer\]](#)
- [UNFCCC Greenhouse Gas Inventory Review Training Program](#) [\[EXIT Disclaimer\]](#)

#### USAID

- [USAID's Global Climate Change Program](#)

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<http://www.epa.gov/climatechange/emissions/ghginventorycapacitybuilding/index.html>  
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## National System Templates: Building Sustainable National Inventory Management Systems

U.S. EPA's approach builds a national inventory management system from a set of building blocks, which developing countries can construct using pre-defined "templates." The advantages of the templates are that they:

- Focus on documenting essential information in a concise format and avoid unnecessarily long written reports;
- Standardize tasks, allowing countries within regions to compare and contrast results;
- Accommodate varying levels of national capacity;
- Provide an objective and efficient system for identifying priorities for future improvements;
- Serve as instruction manuals for future inventory teams; and
- Create transparency in a country's national system.

The six National System Templates can be compiled into a single National Inventory System Report of typically less than fifty pages, which provides comprehensive documentation of each of the critical national system building blocks.

**Note:** You will need the free Adobe Reader to view some of the files on this page. See [EPA's PDF page](#) to learn more. In addition, if you do not have access to a copy of Microsoft Word you may [download a free viewer application](#) from Microsoft, which will allow you to view and print Microsoft Word documents.

Name and Description	Example Template	Blank Template
<p><b>Key Source Category Analysis (KCA)</b></p> <p>The first step in documenting a country's national inventory management system, KCA provides information, according to IPCC criteria, on which sources are the most important and should be the focus of improvement efforts.</p>	<a href="#">Download</a> (PDF, 11pp., 59 KB)	<a href="#">Download</a> (MS Word, 139 KB)
<p><b>Institutional Arrangements for National Inventory Systems (IA)</b></p> <p>Assists inventory teams in assessing and documenting the strengths and weaknesses of existing institutional arrangements for inventory development to ensure continuity and integrity of the inventory, promote institutionalization of the inventory process, and facilitate prioritization of future improvements.</p>	<a href="#">Download</a> (PDF, 10pp., 58 KB)	<a href="#">Download</a> (MS Word, 178 KB)
<p><b>Documentation and Source-by-Source Description (SBS)</b></p> <p>Assists inventory teams in documenting and reporting the origin of methodologies, activity datasets, and emission factors used to estimate emissions from each key source. Future inventory teams can refer to the completed template for each source to determine what information was collected, how the data was obtained, and what methods were used.</p>	<a href="#">Download</a> (PDF, 7pp., 44 KB)	<a href="#">Download</a> (MS Word, 102 KB)
<p><b>Quality Assurance and Quality Control Measures (QA/QC)</b></p> <p>Guides countries through the establishment of a cost-effective QA/QC program to improve transparency, consistency, comparability, completeness, and confidence in national greenhouse gas emission inventories.</p>	<a href="#">Download</a> (PDF, 8pp., 56 KB)	<a href="#">Download</a> (MS Word, 147 KB)
<p><b>Inventory Archive System</b></p>	<a href="#">Download</a> (PDF, 7pp., 59 KB)	<a href="#">Download</a> (MS Word, 140 KB)

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### Targeted Data Collection Strategies and Software Tools

U.S. EPA's approach is to assist countries in identifying priority sectors and sources, and in developing strategies for moving to higher tier methods. There are two general parts to this approach:

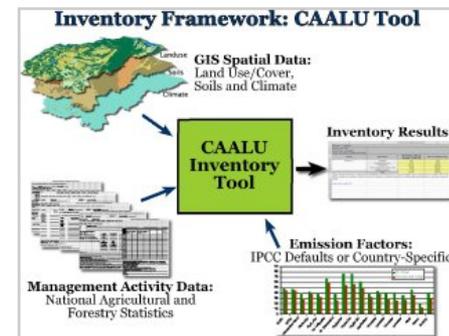
- Identification of data needs and strategies: U.S. EPA has worked with national experts to identify critical data needs for higher Tier IPCC methods, and to prioritize these needs to recognize available resources.
- Software tools: U.S. EPA has prepared software tools for the Agriculture, Land-Use Change and Forestry, and Solid Waste sectors that simplify the task of completing a GHG inventory.

The software tools below have been developed for the Central American region in conjunction with the U.S. Agency for International Development. Both of these software tools can be adapted to other countries or regions.

#### Agriculture, Land-Use Change and Forestry

These sectors are important for most developing countries, but managing the large amount of data and cross-linkages can be an overwhelming task. To assist the seven Central American countries in this task, U.S. EPA developed the [CAALU](#) [\[EXIT Disclaimer\]](#) (Central American Agriculture and Land-Use) software tool. CAALU enables countries to estimate emissions and removals from all agricultural and land-use source categories, using both IPCC Tier 1 and Tier 2 methods. CAALU also has the following features:

- Data are entered once into input modules and stored for multiple uses, ensuring consistent use of data across multiple IPCC categories;
- Built-in documentation and QC features serve as an electronic archive of data inputs and calculations and minimize errors;
- Drop-down menus with IPCC defaults, and options to use country-specific data;
- Capacity to upload remote sensing data (GIS data) for LUCF for categorization of unique soil, climate and land use categories; and
- Allows for mitigation scenario analysis by changing input variables as compared to a baseline case.



#### Solid Waste Disposal

As more developing countries begin to manage wastes in sanitary landfills, methane emissions from solid waste disposal become more important in those countries. U.S. EPA has worked with countries to collect data on waste composition and disposal practices. The data were used to develop an Excel-based spreadsheet model containing default values for each country in Central America.

The [Central America Landfill Gas Model](#) estimates:

- Landfill gas generation from landfills;
- Potential landfill gas recovery; and
- Methane emission reductions.

Inputs to the model include the year the landfill opened, estimated annual growth in disposal, average precipitation, average landfill depth, and site management practices. Data collected will also improve national GHG inventories. The data can be input into the [2006 IPCC Waste Model](#) [\[EXIT Disclaimer\]](#) and shared with other regions through the [Emissions Factor Database](#) [\[EXIT Disclaimer\]](#).

# Central American countries reported problems with their first GHG inventories

Costa Rica	X			<b>Improvements:</b> Need for a more disaggregated set of data.
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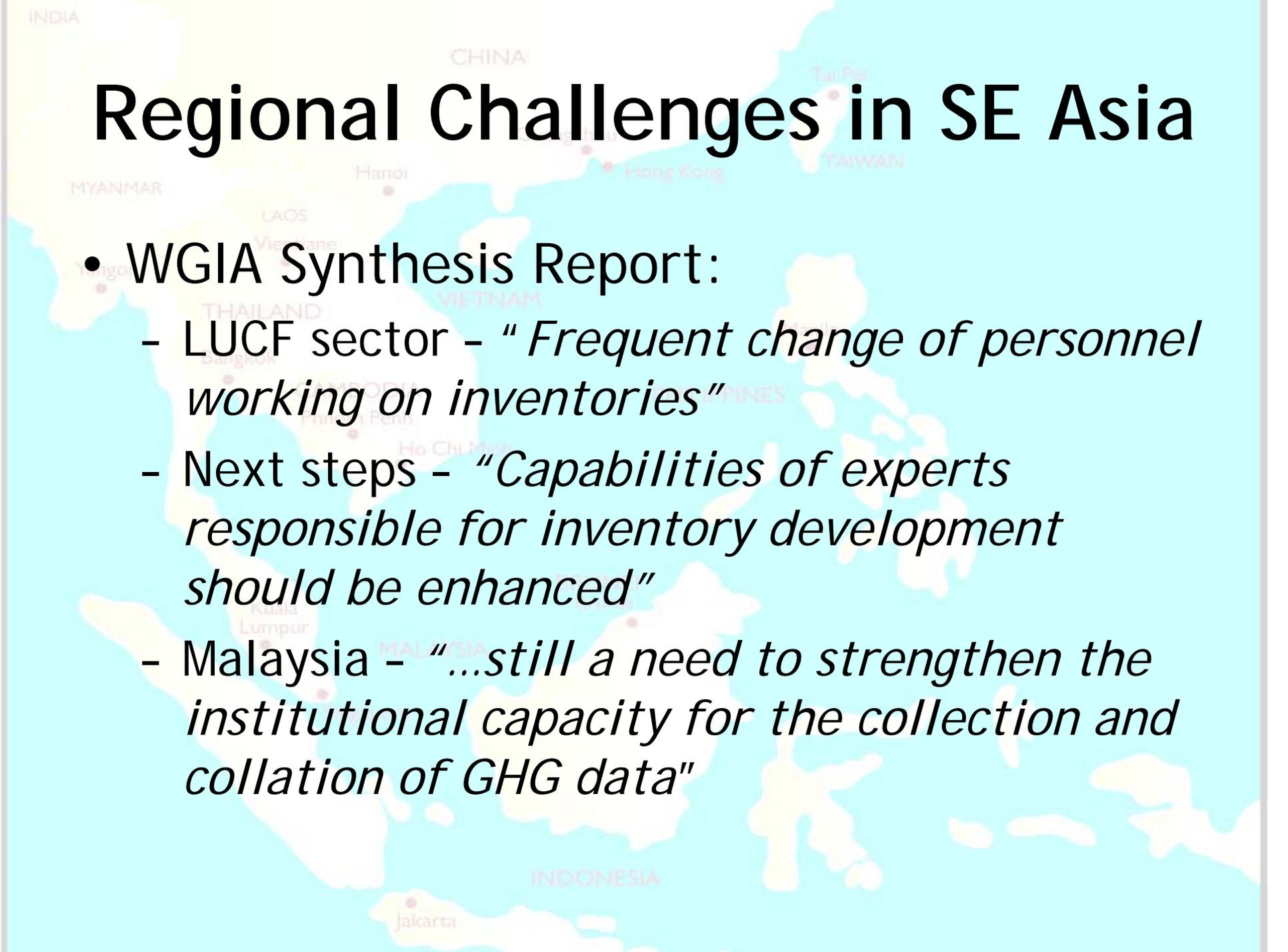
Data availability problems

El Salvador	X	X		<b>Problems:</b> Activity data for LUCF not reliable. Method for LUCF was found to be very complex.
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Problems Applying IPCC Methods

Institutional problems:

- Ad hoc inventory teams disbanded after first inventory
- Experience and capacity was built and then lost
- Starting from scratch to produce the 2<sup>nd</sup> GHG inventory

A light blue map of Southeast Asia is visible in the background. It shows the outlines of countries including India, China, Myanmar, Laos, Thailand, Vietnam, Malaysia, and Indonesia. Major cities like Hanoi, Ho Chi Minh, Jakarta, and Singapore are marked with red dots. The map is semi-transparent, allowing the text to be overlaid.

# Regional Challenges in SE Asia

- WGIA Synthesis Report:
  - LUCF sector - *"Frequent change of personnel working on inventories"*
  - Next steps - *"Capabilities of experts responsible for inventory development should be enhanced"*
  - Malaysia - *"...still a need to strengthen the institutional capacity for the collection and collation of GHG data"*