Proceedings of the 4th Workshop on Greenhouse Gas Inventories in Asia

14-15 February 2007, Jakarta, Indonesia

Center for Global Environmental Research

National Institute for Environmental Studies, Japan
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Foreword

The international community now recognizes increases in emissions of greenhouse gases (GHG) as the primary cause of climate change and its impacts. In this respect, GHG inventories, which provide information on these emissions and trends over time, play a critical role as a basis for decision makers to design and implement strategies to reduce emissions.

Parties to the UN Framework Convention on Climate Change (UNFCCC) which entered into force in March 1994 are required to develop and publish national GHG inventories. Almost all parties have submitted their first inventories in the initial national communications and are working on their second or subsequent communications.

The National Institute for Environmental Studies (NIES) has held the “Workshop on GHG Inventories in Asia” (WGIA) annually since November 2003 with the support of the Ministry of the Environment of Japan. The purpose of WGIA is to assist countries in Asia in developing and improving their inventories by promoting regional information exchange. The participants of this workshop have found that the information exchange that is made possible through WGIA and its resulting network has played a significant part in the enhancement of their inventories and their capacity to develop them.

The Center for Global Environmental Research (CGER) was established in 1996 at NIES to contribute to enhancing the scientific understanding of global environmental changes and to elucidate and provide solutions for environmental concerns. CGER has been actively working to achieve its goals by conducting global environmental research, providing the facilities to support research projects, and implementing global environmental monitoring.

This CGER report serves as the proceedings for the 4th WGIA, which was held on February 14-15, 2007, in Jakarta, Indonesia with more than 50 experts in attendance. It is our hope that this report proves useful to all those who work in the field of GHG inventory development and other areas of climate change research, and that it contributes to the progress of inventory development in the region.

March 2007

Yasuhiro Sasano
Director
Center for Global Environmental Research
National Institute for Environmental Studies
Preface

The Workshop on Greenhouse Gas Inventories in Asia, or WGIA, was first organised in 2003 by the Ministry of the Environment and the National Institute for Environmental Studies in Japan in order to assist Asian countries in developing and improving their GHG inventories by promoting regional information exchange. We are pleased to report that with the addition of two countries to our group this year, Myanmar and Singapore, we now have a total of fourteen participating countries.

Networking between the participants is gaining strength. Through this network, the people who develop inventories in this region have been able to establish communication by e-mail in order to give and receive advice about the technical issues involved with the development of GHG inventories. This kind of result is exactly what we were hoping to achieve from the very first WGIA and we hope to continue to foster this kind of exchange in all future WGIA events.

Moreover, last summer, through the collaboration of the participants of WGIA, we were able to publish the first WGIA Activity Report. This publication serves to link our activities with those that are taking place at the regional and international levels and has received good reviews from relevant communities outside WGIA.

We believe that the WGIA meetings and networks serve an important role in the development of inventories in this region. We look forward to the continued participation of our member countries, and hope to be able to include a larger range of participants from various sectors in the future.

Dr. Shuzo Nishioka
Executive Director
National Institute for Environmental Studies (NIES)

Mr. Hiroshi Fujita
Climate Change Policy Division
Global Environment Bureau
Ministry of the Environment of Japan
List of Acronyms and Abbreviations

AD          activity data
ALGAS       Asia Least-cost Greenhouse Gas Abatement Strategy
CGE         Consultative Group of Experts
CH₄         methane
CO₂         carbon dioxide
EF          emission factor
EFDB        Emission Factor Database
eq          equivalent
GHG         greenhouse gas
GIO         Greenhouse Gas Inventory Office of Japan
ICRAF       World Agroforestry Centre
IRRI        International Rice Research Institute
IPCC        Intergovernmental Panel on Climate Change
IPCC-NGGIP  IPCC National Greenhouse Gas Inventories Programme
LUCF        land-use change and forestry
LULUCF      land use, land-use change and forestry
MAI         mean annual increment of biomass of trees
MOEI        Ministry of Environment of the Republic of Indonesia
MOEJ        Ministry of the Environment of Japan
N           nitrogen
N₂O         nitrous oxide
NC          national communication
NIES        National Institute for Environmental Studies
QA          quality assurance
QC          quality control
UNFCCC      United Nations Framework Convention on Climate Change
WGIA        Workshop on Greenhouse Gas Inventories in Asia
Photos from the Workshop

Opening Speech

Dr. Shuzo Nishioka

Dr. Masnellyarti Hilman

Energy Working Group

Agriculture Working Group

Waste Working Group

Land-Use Change and Forestry Working Group
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Part 1

Summaries
Executive Summary

The 4th Workshop on Greenhouse Gas (GHG) Inventories in Asia (WGIA) was held in Jakarta, Indonesia on February 14 and 15, 2007. It was organized by the Ministry of the Environment of Japan (MOEJ) and the National Institute for Environmental Studies (NIES) of Japan and hosted by the Ministry of the Environment of Indonesia (MOEI). The workshop was attended by representatives of twelve countries (Cambodia, Indonesia, Japan, Lao PDR, Malaysia, Mongolia, Myanmar, Philippines, Republic of Korea, Singapore, Thailand, and Vietnam) in addition to members of the UN Framework Convention on Climate Change (UNFCCC) Secretariat, the Technical Support Unit of the IPCC National Greenhouse Gas Inventories Programme (IPCC-NGGIP), and the World Agroforestry Centre. The objectives of this meeting were (1) to identify ideas or requests for future activities in the region, (2) to establish collaborative relationships between the participants, (3) to find out practical information that can be directly applied in GHG inventory development, and (4) to learn about the latest inventory-related information at global and regional levels.

In the first session, the participants heard reports from Myanmar and Singapore, two new member countries, as well as updates from Japan and Mongolia. Myanmar is now working on its initial national communication and is experiencing certain problems that could benefit from capacity building in this area. Singapore submitted their initial national communication in 2000 and will submit their second national communication in 2009. Japan reported that its total GHG emissions in 2005 showed an 8.1% increase from emissions in the base year and that means that Japan needs to reduce its emissions by 14.1% in total in order to achieve its six percent reduction commitment under the Kyoto Protocol. Mongolia introduced short- and long-term strategies which they developed to improve their GHG inventories.

The first session closed with a summary of the survey on interests and needs of member nations. The survey identified the following areas of concern and interest in the four sectors:

- Energy: collection of activity data, calorific values, and carbon emission factors of fuels
- Agriculture: rice cultivation and livestock characteristics
- Land use change and forestry (LUCF): mean annual increment of aboveground biomass
- Waste: wastewater flow and sources, solid waste stream and composition

In Session 2, the participants were divided into four sectoral working groups (energy, agriculture, land use change and forestry, and waste) in order to discuss the issues that were highlighted in the survey mentioned above.

Energy: Many countries are using IPCC default values in their calculations, and that seems to serve their needs at this time. Some countries are using Energy Balances as a basis for developing inventories for the energy sector. Countries that do not already have Energy Balances do not necessarily have to start developing them, but if they do already exist, they can be a useful starting point. Another key point was that due to the costs involved with implementing the inventories, it is necessary to find other uses for the data.

Agriculture: Only India and Japan possess disaggregated activity data on water regime of rice cultivated areas, while the others have only aggregated information. To improve the availability of activity data, the institutionalization of the national data collection system in the agriculture sector needs to be improved. A number of countries in the region still do not have their own country-specific emission factors for rice cultivation. A number of future topics for discussion were identified, including organic carbon in soil, N₂O emissions from N inputs, CH₄ and N₂O emissions from residue burning, feed type and composition and its
relation to the CH\textsubscript{4} emissions from ruminants, and proper archiving of information regarding activity data and emission factors.

**Land Use Change and Forestry:** The group discussed methods for deriving mean annual increment of biomass of trees (MAI) and approaches to determining its uncertainty. The participants highlighted the fact that in Asia, although there exist methodologies for measuring MAI, and some have been put into practice in some countries, a critical concern is the uncertainty of the measured results. The group proposed that WGIA and its community play a role in linking relevant organisations and disseminating the outcomes of the workshops to a wider audience in order to increase awareness of the issues surrounding GHG inventory development in this sector.

**Waste:** The group discussed two themes: (1) wastewater treatment and discharge and (2) solid waste disposal on land. The reports from Indonesia, Japan, Lao PDR, Myanmar, Thailand, and Philippines identified four types of domestic wastewater flow in the region. In Asia, it is not common for domestic and industrial wastewater to be mixed for treatment. Comparison of solid waste streams among participating countries identified two types of recycling activities in the region: one is separation at source (e.g., at the home) and the other is material recovery at a recycling facility. The group highlighted the need to establish a database on the mass and composition of solid waste.

Session 3 dealt with the cross-cutting issues of Quality Control (QC) and Quality Assurance (QA). QC is performed by inventory personnel during the development of inventories and QA is performed on completed inventories by external evaluators following the implementation of QC procedures. QA/QC should be considered an integral part of the inventory process. Since there is a trade-off between QC requirements and timeliness/cost effectiveness, it is necessary to identify key areas on which to focus the QA/QC principles. The general discussion on QA/QC was followed by country reports from Mongolia and Japan.

The final session gave us a chance to hear from IPCC and UNFCCC representatives, summarize what we learned from the workshop, and discuss steps to improve GHG inventories in the region. Participants were informed of the differences between the Revised 1996 IPCC Guidelines and the 2006 Guidelines, with a note that the step between the two sets of guidelines is meant to be an evolutionary development. Participants were encouraged to make use of the latest version of UNFCCC software, especially because it offers non-Annex I Parties a way to archive their data, and to consult the GHG Inventory Experts Network.

During the final discussions, the participants discussed future activities that could be undertaken by the WGIA, including the development of a manual for inventory preparation in Asia, identifying possible regional projects, and linking to different organizations in order to enhance awareness. Participants also offered the idea of holding a workshop that involves policy makers from each country.

Three key concepts emerged from the discussions: (1) expertise, (2) dissemination of information, (3) and proposals for regional projects. The participants of WGIA should continue working together to improve GHG inventories in the region with these key concepts in mind.
Chairperson’s Summary

Background
1. The 4th Workshop on Greenhouse Gas (GHG) Inventories in Asia (WGIA) was held in Jakarta, Indonesia on February 14 and 15, 2007. It was organized by the Ministry of the Environment of Japan (MOEJ) and the National Institute for Environmental Studies (NIES) of Japan and hosted by the Ministry of the Environment of Indonesia (MOEI).
2. The workshop was attended by representatives of twelve countries (Cambodia, Indonesia, Japan, Lao PDR, Malaysia, Mongolia, Myanmar, Philippines, Republic of Korea, Singapore, Thailand, and Vietnam) in addition to members of the UN Framework Convention on Climate Change (UNFCCC) Secretariat, the Technical Support Unit of the IPCC National Greenhouse Gas Inventories Programme (IPCC-NGGIP), and the World Agroforestry Centre (ICRAF).

Opening Session
3. The opening session of the workshop was chaired by Ms. Sulistyowati Hanafi, Assistant Deputy Minister for Climate Change Impact Control of MOEI. Participants heard welcoming remarks from Dr. Shuzo Nishioka (NIES), who outlined the history of the workshop, including the first WGIA which took place in 2003. With the addition of Myanmar and Singapore from this year, we now have a total of fourteen countries participating in the network of WGIA. The network is continuing to gain momentum through the contact that is being made between members outside of the workshop. As a direct result of this momentum, in the summer of 2006, we were able to publish the first WGIA Activity Report, which has been presented at a number of international meetings and will serve to assist our member countries as they work on their respective national communications.
4. Dr. Nishioka’s remarks were followed by an address from the host country by Dr. Masnellyarti Hilman, Deputy Minister from Nature Conservation Enhancement and Environmental Destruction Control. Dr. Hilman mentioned that Indonesia has been very active in the field of GHG inventories, as it is currently preparing its second national communication. In addition, Indonesia is hosting this workshop and will host the Conference of the Parties to the UNFCCC (COP13) and the meeting of the Parties to the Kyoto Protocol (CMP3) later this year. The flooding that happened about one week before this workshop commenced served to underline the importance of climate change mitigation strategies and the inventories upon which such strategies can be based. The Indonesian team is working in close cooperation with their counterparts in Japan, and the country was very interested in working together to host the 4th WGIA, especially due to the potential for capacity building through the workshop. Dr. Hilman closed her speech by emphasizing the importance of local, regional, national, and international partnerships that can incorporate relevant expertise and stakeholders.
5. To close this session, Ms. Chisa Umemiya of the Greenhouse Gas Inventory Office of Japan (GIO) at NIES described the objectives of this workshop. She identified four areas that the participants should focus on during the following sessions:
   (1) identifying ideas or requests for future activities in the region,
   (2) establishing collaborative relationships between the participants,

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(3) finding out practical information that can be directly applied in GHG inventory development, and
(4) learning about the latest inventory-related information from global and regional levels.

Session 1: Updates on GHG Inventories in Asia
6. Session 1 was chaired by Mr. Kiyoto Tanabe of the Technical Support Unit of IPCC-NGGIP. In this session, we heard reports from Myanmar and Singapore, our two new member countries, as well as updates from Japan and Mongolia. The session closed with a summary of the survey on interests and needs of member nations.

- Mr. Ne Winn of the National Commission for Environmental Affairs reported that Myanmar participated in the “Asia Least-Cost Greenhouse Gas Abatement Strategy” (ALGAS), which included inventory development. They are now working on their initial national communication. They are experiencing problems including a lack of vulnerability/impact assessment and adaptation options, no national strategy and action plan, and the need for experts. The delegate underlined the need for capacity building in this area.

- For Singapore, Ms. Shu Yee Wong of the National Environment Agency reported that, as a highly industrialized, small city state with a high population, the country has unique issues in dealing with inventories. It is dependent on fossil fuels (99% fossil fuels, 1% renewables) and lacks natural resources. It has a 4-pronged national climate change strategy that includes public awareness, vulnerability and adaptation, mitigation, and competency building. The main mitigation strategies are energy efficiency and clean energy. They submitted their initial national communication in 2000 and will submit their second national communication in 2009.

- Mr. Hiroshi Fujita (MOEJ) reported that in Japan, MOEJ and GIO submit national GHG inventories to the UNFCCC in cooperation with relevant ministries and organizations. A 70-member committee checks the GHG emission estimation methods. In 2004, the total GHG emissions were about 1,355 million tons in CO₂ equivalents, which is a 7.4% increase from emissions in the base year under the Kyoto Protocol. As the total GHG emissions in 2005 showed an 8.1% increase over the base year, Japan needs to reduce its emissions by 14.1% in total in order to achieve its six percent reduction commitment under the Kyoto Protocol.

- Dr. Batimaa Punsalmaa of the Institute of Meteorology and Hydrology reported that Mongolia prepared its first GHG inventory in 1996, which was updated as a part of ALGAS in 1997, and again in 1998. Their initial communication was submitted in 2000 and they are now working on the second. Short and long term strategies have been developed to improve national GHG inventories. Their short-term strategy is to develop infrastructure by identifying data gaps, developing national procedures for collecting activity data, including the data in the statistical yearbook, and designing a database of activity data and emission factors. Their long-term strategy (2007-2010) focuses on bringing these concepts into practice by improving the database and developing national guidance.

7. Ms. Umemiya reported on the results of the preliminary survey on the interests and needs of WGIA member countries, which was conducted in October and November 2006 as part of the preparation for this workshop. The survey presented participants with a number of IPCC source/sink categories and asked them to select the levels (high, medium, low) of support needed for each of the categories. Areas that were identified as “high need”
could indicate problems with collecting activity data or setting country-specific values. Areas of “low need” may indicate that data and/or country-specific values already exist for that country. The survey identified the following areas of concern and interest in the four sectors:
- Energy: collection of activity data, calorific values, and carbon emission factors of fuels
- Agriculture: rice cultivation and livestock characteristics
- Land-use change and forestry (LUCF): mean annual increments of aboveground biomass
- Waste: wastewater flow and sources, solid waste stream and composition

Session 2: Sector-By-Sector GHG Inventory Development
8. In Session 2, the participants were divided into four sectoral working groups (energy, agriculture, land-use change and forestry, and waste) in order to discuss the issues that were highlighted in the survey mentioned above.

(a) Energy
- The energy working group session was chaired by Dr. Nishioka and reported on by Mr. Saleh Abdurrahman of the Ministry of Energy and Mineral Resources, Indonesia.
- The discussion started with reports from the participants on the issues surrounding the development of inventories in the energy sector for their respective countries. In general, it was found that many countries are using IPCC default values in their calculations, and that seems to serve their needs at this time. In some key instances where the energy sources and usage patterns are unique to the country, they may want to develop country-specific values, but the difference between the IPCC values and the country-specific values is not large in many cases, so it can be more cost-effective for certain countries to continue to use the IPCC values rather than spending a large amount of time and resources developing country-specific values. However, some countries that have already submitted one or two national communications might consider refining their results based on country-specific data.
- Some countries are using Energy Balances as a basis for developing inventories for the energy sector. Countries that do not already have Energy Balances do not necessarily have to start developing them, but if they do already exist, they can be a useful starting point. It is also important to try to find ways to collect the data for the inventories using, for example, estimates from supply side statistics.
- Another key point was that due to the costs involved with implementing the inventories, it is necessary to find other uses for the data. For some countries, it is difficult (i.e. too expensive) to ask for statistics to be prepared for the inventory alone. If the data can be used in other kinds of analyses, it will be easier to ask for it to be collected.
- The session closed with the suggestion that the countries in the energy section should come up with specific core activities to focus on before the 5th WGIA. For example, the group could study specific cases and see what can be done to improve upon them. The information exchange that takes place at WGIA is only the first step. It is important to set targets and work together to make improvements.

(b) Agriculture
- The agriculture working group session was chaired by Dr. Batimaa and reported on by Dr. Damasa Macandog of the University of the Philippines Los Banos.
- The agriculture group discussed the state of activity data and country-specific emission factors for rice cultivation in the region. One of the points that they discovered was that
only India and Japan possess disaggregated activity data on water regime of rice cultivated areas, while the others have only aggregated information. To improve the availability of activity data, the institutionalization of the national data collection system in the agriculture sector needs to be improved. Examples of research studies to develop country-specific emission factors by conducting field measurement in some countries were introduced, including those of the International Rice Research Institute (IRRI) and the National Institute for Agro-Environmental Sciences (NIAES) of Japan. However, a number of countries in the region still do not have their own country-specific emission factors for rice cultivation. These countries include Cambodia, Indonesia, Malaysia, and Vietnam. To help them develop their own country-specific emission factors, the group suggested that there was a need for more research and the use of the IPCC Emission Factor Database (EFDB)\(^2\) and that data from neighboring countries with similar conditions and practices could be used.

- Data availability and improvement for CH\(_4\) emissions from enteric fermentation was also discussed by the group and experiences were shared. The group identified that information on the number of heads of livestock is generally available, so that is what is used for estimation. The methodology that Japan uses to estimate country-specific emission factors from ruminants was introduced, but the group felt that while the methodology itself is quite useful, the cost for implementing this methodology was still too steep for most of the other nations.

- The group identified clear stages of development for the improvement of their activity data and emission factors in this sector. These stages are intended to help countries identify where they are in the spectrum of inventory development and where they might concentrate their energies on next.

- A number of future topics for discussion were identified, including organic carbon in soil, N\(_2\)O emissions from N inputs, CH\(_4\) and N\(_2\)O emissions from residue burning, feed type and composition and its relation to the CH\(_4\) emissions from ruminants, and proper archiving of information regarding activity data and emission factors.

During the discussion in the plenary session following the group report, a request arose to encourage countries to provide inputs for the IPCC EFDB and also to make better use of the database.

**(c) Land-Use Change and Forestry**

- The land-use change and forestry (LUCF) working group session was chaired by Dr. Rizaldi Boer of Bogor Agricultural University of Indonesia and reported on by Mr. Heng Chan Thoeun of the Ministry of Environment of Cambodia.

- The LUCF group discussed the following matters: (1) methods for deriving mean annual increment of biomass of trees (MAI), (2) approaches to determining uncertainty levels for the estimates of MAI and emissions and removals, (3) experiences in using the IPCC Good Practice Guidance for LULUCF (GPG for LULUCF)\(^3\) (i.e., stock change approach), and (4) proposals for improving national capacity to enhance GHG inventories in this sector.

- The country reports presented by the group members from Cambodia, Indonesia, and Malaysia on the measurement of MAI and the estimation of its uncertainty showed that,


although there are methodologies for measuring MAI, and some countries have already implemented them in order to develop their GHG inventories, the uncertainty of the results of the measurements has been a crucial concern for tropical countries in Asia. In tropical countries, MAI is different between natural and plantation forests, and among tree species. Also, the forests in these countries consist of a number of species and the countries contain a lot of natural and naturally-regenerated forests. As a result, the reliable estimation of MAI in tropical countries is a significant challenge compared to temperate and boreal zones. More research and support is therefore necessary for countries in the tropics. The expert report from ICRAF pointed out the difficulty in getting both accurate activity data and MAI. Whilst the broader land use categories are likely to reduce the uncertainty of activity data (i.e., land classification and area), obtaining reliable MAI under such broader categories seems not practically possible in a country like Indonesia where the ICRAF study was undertaken. Japan’s experience in using the IPCC GPG for LULUCF taught us that the stock change method of the guidance provides good estimation results only when accurate forest inventory data are available. The choice of the method should be left to expert judgment.

- The group then considered proposals for WGIA and its community to undertake in the future to improve national capacity for inventory development in this sector. One proposal was to suggest that the WGIA play a role in facilitating connections with national, regional, and international organizations that play some part in the inventory process, regardless of whether they are involved in producing the inventories themselves (e.g., organizations that develop satellite image databases). Another proposal was to disseminate the outcomes and products of the workshops to the wider climate-change community so that more experts and countries will be aware of the useful information accumulated by the WGIA network.

After the report from the LUCF group, a point was raised at the plenary session that there is a need for a regional project on collecting data for the development of inventories in this sector. In response to this point, it was suggested that the needs of each country in the region be clearly identified in order to make such a regional project happen. In addition, some participants pointed out the difficulty that they were experiencing in following the IPCC GPG for LULUCF for uncertainty assessment. In response, it was suggested that the UNFCCC “User Manual”\(^4\) and the CGE hands-on training materials on GHG inventories\(^5\) would be helpful in this respect.

(d) Waste

- The waste working group session was chaired by Dr. Sirintornthep Towprayoon of King Mongkut’s University Technology Thonburi in Thailand and reported on by Dr. Masato Yamada (NIES).
- The group mainly discussed two themes: (1) wastewater treatment and discharge and (2) solid waste disposal on land. Each participating country gave a report in order to assess the similarities and disparities of the management of wastes in each country and their relationship with GHG emission estimates.
- To initiate the discussion, the methodology outlined in the 2006 IPCC Guidelines for


National Greenhouse Gas Inventories for estimating emissions from wastewater treatment was explained. The reports from Indonesia, Japan, Lao PDR, Myanmar, Thailand, and Philippines identified four types of domestic wastewater flow in the region: (1) untreated wastewater discharged to river/sea, (2) wastewater treated by septic tank and discharged to river/sea, (3) wastewater treated by septic tank via sewer collection and discharged to river/sea, and (4) wastewater treated by septic tank through sewer collection to central treatment plant before being discharged to river/sea. The industrial wastewater in the region is highly dependent on the nature of the industries in the area. In Asia, it is not common for domestic and industrial wastewater to be mixed for treatment. Comparison of solid waste streams among participating countries identified two types of recycling activities in the region: one is separation at source (e.g., at the home) and the other is material recovery at a recycling facility. The group highlighted the need to establish a database on the mass and composition of solid waste.

- With regard to the overall characteristics of the waste management situation in Asia, the group discovered that the situation differs considerably among large and small cities and rural areas in every country. In addition, it was found that, in Asia, recycling is important in the overall waste management flow and there is a need to collect and share more information on this topic.

Session 3: Cross-Cutting Issue- Quality Assurance and Quality Control (QA/QC)

9. Session 3 dealt with the cross-cutting issue of quality assurance and quality control (QA/QC). The session was chaired by Mr. Dominique Revet of the UNFCCC Secretariat.

- This session started with an overview of QA/QC principles by Mr. Tanabe. Quality Control (QC) is performed by inventory personnel during the development of inventories, whereas Quality Assurance (QA) is performed on completed inventories by external evaluators following the implementation of QC procedures. QA/QC should be considered an integral part of the inventory process. It serves to develop national GHG inventories which can be readily assessed in terms of quality and to drive the improvement of inventories. Countries that do not have the capacity to implement all parts of the QA/QC spectrum should consider using the minimum elements: defining roles and responsibilities and developing a QA/QC plan. Since there is a trade-off between QC requirements and timeliness/cost effectiveness, it is necessary to identify key areas on which to focus the QA/QC principles.

- Dr. Batimaa informed the group that Mongolia is currently using QA/QC to identify potential problems and make corrections to the inventories. They use it to check activity data, emissions factors, confirm the methodology and calculations, ensure completeness, provide documentation, and authenticate the report.

- Dr. Yukihiro Nojiri (GIO) explained that QA/QC principles are applied extensively to the GHG inventories in Japan. QC is undertaken by MOEJ, GIO, and related agencies and organizations. QA is done by a committee of 70 Japanese inventory experts organized into six subgroups. As an Annex I country, Japan is required to submit annual inventories. This means that they are working on the inventory for one year and the QA of the inventory for the previous year simultaneously. They have identified the need for

establishing a document archive system (e.g. similar to ISO) for the inventories.

Session 4: Toward Better GHG Inventory Development in Asia

10. Dr. Nishioka chaired the final session of the workshop, which gave us a chance to hear from IPCC and UNFCCC representatives, summarize what we learned from the workshop, and discuss steps to improve GHG inventories in the region.

11. Mr. Tanabe gave us a detailed description of the 2006 IPCC Guidelines for National Greenhouse Gas Inventories, including an overview of the differences between the Revised 1996 IPCC Guidelines and the 2006 Guidelines. He emphasized that the step between the two sets of guidelines is meant to be an evolutionary development. Key improvements include comprehensive coverage of emissions from CO₂ transport, injection and geological storage in the energy sector, new categories and new gases being included in the industrial processes and product use sector, the integration of agriculture and LULUCF sectors, and a revised methodology for CH₄ from landfills in the waste sector. It should be noted that the 2006 IPCC Guidelines have not yet been approved by the UNFCCC. Under the UNFCCC, Annex I Parties shall use the 1996 IPCC Guidelines and the Good Practice Guidance reports, and non-Annex I Parties should use the 1996 IPCC Guidelines and are encouraged to use the Good Practice Guidance reports. Nevertheless, the 2006 IPCC Guidelines may assist all Parties in fulfilling their inventory reporting requirements under the UNFCCC because individual methods in the 2006 IPCC Guidelines can be used in a consistent manner with the 1996 IPCC Guidelines and GPGs.

12. Mr. Tanabe’s speech was followed by Mr. Revet who gave us an outline of current and future greenhouse gas inventory development in non-Annex I Parties. A total of 134 non-Annex I Parties have submitted their initial national communications, and three have submitted their second, including the Republic of Korea. It is now possible for non-Annex I Parties to submit a project proposal in advance of completing previous NCs. This is to allow for continuity in project financing. However, Parties must then submit their subsequent NC within four years of the disbursement of financial resources. It is possible to obtain a one-year extension, but this does not imply additional financial support. Mr. Revet encouraged the members of the workshop to make use of the latest version of UNFCCC software, especially because it offers non-Annex I Parties a way to archive their data, and to consult the GHG Inventory Experts Network. The UNFCCC secretariat is interested in learning about the technical needs from the members of this region. It is also concerned with determining the effectiveness of CGE training materials and the inventory software.

13. Mr. Dadang Hilman of MOEI, rapporteur of the workshop, reported a summary of the key points from Sessions 1 to 3. During the final discussions, Ms. Umemiya outlined some suggestions that were offered during the workshop for future activities that could be undertaken by the WGIA, including developing a manual for inventory preparation in Asia, identifying needs to launch regional projects, and linking to different organizations in order to enhance awareness. Participants also expressed the idea of holding a workshop that involves policy makers from each country. It is expected that with the cooperation of policy makers in the region, inventory development would proceed more smoothly. Participants emphasized the need to increase the visibility of WGIA activities in the region, including targeting policy makers, as it is currently recognized only by

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7 http://unfccc.int/resource/cd_roms/na1/ghg_inventories/index.htm
8 http://www.ghgnetwork.org/
limited communities. One approach would be to disseminate the WGIA reports and publications to related experts in each country, including National Focal Points\(^9\) under UNFCCC. Participants also agreed on the importance of the effective use of GHG inventory experts in the region, including those who participate in WGIA.

14. Participants discussed how to approach the possible implementation of a regional project on GHG inventory development. One suggestion was to first call for a number of relevant experts in a country to clearly identify gaps which would then become the basis for a regional project proposal. Each sectoral working group highlighted potential topics for such regional projects: e.g., organic carbon in soil, \(\text{N}_2\text{O}\) emissions from N inputs in the agriculture sector; MAI in the LUCF sector; and waste recycling in the waste sector. Another proposal made by participants was to initiate an international journal in which the outcomes of inventory-related research (e.g., development of country-specific emission factors) can be presented as there is currently no such research journal available.

15. Dr. Nishioka highlighted three key concepts that emerged from our discussions: (1) expertise, (2) dissemination of information, (3) and proposals for regional projects. He indicated that we should continue working together to improve GHG inventories in the region with these key concepts in mind. This new focus should lead the WGIA to a new phase in its development, in which we apply the information and experiences that we have shared thus far to progress to a more dynamic level of cooperation at the regional level.

16. The meeting was closed with final remarks from Mr. Hilman of MOEI and Mr. Fujita of MOEJ. Mr. Fujita expressed the interest and willingness of MOEJ to hold the 5th WGIA in 2008 and the participants expressed appreciation to their Indonesian hosts for their warm hospitality in Jakarta.

\(^9\) http://maindb.unfccc.int/public/nfp.pl
Part 2

Reports from the Sectoral Working Groups
1 Energy Working Group

1 Introduction

There were 16 participants, with a mixture of people who were experts in the field and others who were here to learn more about the energy sector. Representatives from Indonesia, Japan, Korea, Lao, Myanmar, Singapore, Thailand, and Vietnam were present.

The objectives of the working group discussion were:

- To compare and discuss the collection of activity data in each country
- To compare and discuss the information of calorific values and carbon emission factors adopted by each country
- To learn existing practices of countries in Asia to estimate emissions more reliably

2 Results of the Discussion

2.1 Country Summaries

1 Indonesia

The Ministry of Energy and Mineral Resources publishes an energy balance table on a yearly basis. The data is obtained from energy producers and (large) consumers. The energy consumption from household, industry and transportation sectors is calculated using the intensity and activity data. Supply side data is used to measure greenhouse gas emissions especially carbon dioxide. This is done because the supply side data is more accurate and easier to obtain than demand/consumption data. Indonesia also uses the default IPCC emission factors. However, as Indonesian energy resources, including their calorific values, may vary from region to region, they are planning to develop their own emission factors.

2 Japan

Japan has a very long history of creating statistics for the energy sector as a part of its Energy Balance. The statistics are very detailed. This allows deep analysis, such as the situation in the transport sector where it has been noticed that emissions from trucks using diesel have decreased, while the number of cars has increased, with a resultant increase in emissions. In Japan, they have noticed a discrepancy between statistics that come from top-down sources and those that come from bottom-up sources, so they have worked to correct this gap. Japan gets 90 percent of its energy from external sources. Oil companies have to pay taxes on what they import, so records already exist about the supply. In Japan, various ministries produce their own data (METI supplies the Energy Balance, Ministry of Forestry gives stats for forestry), but the Ministry of the Environment is responsible for coordinating the inventories according to the Law Concerning the Promotion of Measures Concerning Global Warming. As an Annex I country, Japan is required to report its data annually, and this necessitates having an institutional structure in place for creating these reports. This results in a high level of coordination. Japan tends to use its own country-specific values and is capable of producing very detailed statistics in this sector. Japan had to create a national inventory as a part of its Kyoto Protocol commitments, so it has put a lot of time and energy into its inventory. Fortunately, there are very detailed statistics available for the energy sector, so this sector is not really causing concern in Japan right now.
3 Korea

Korea also imports 90% of its energy. In 2005, they took samples from various sectors to do bottom-up verification of activity data. Next year, they will focus on the transportation sector. Korea is still undergoing industrial restructuring, so it is important to refine the inventory now, while industries are in development. The Ministry of Commerce and Energy (equivalent to Japan’s METI) has been given the authority to collect activity data from other ministries (e.g. forestry) and other government entities (e.g. Korean gas and oil entities), and to improve upon and publish the data. The process they use is quite similar to that of Japan. However, the Ministry of Commerce and Energy is the one that coordinates data collection, not the Ministry of the Environment (which supports data collection). Korea is shifting to cleaner, more efficient energy, so it has become necessary to develop country-specific values rather than to continue using IPCC defaults. There is government-industry collaboration to work towards developing these country-specific values. Korea has a good amount of first rate data to work with, so they are now working on quality control and quality assurance. They are refining their inventories by focusing on the development of country-specific values, ensuring that the calculations are up-to-date and that they reflect the current pace of technological development, and reporting their results back to industries. They have reached the point where they feel that they can help other countries that require assistance.

4 Lao

The system in Lao for collecting data is not yet adequate. Many improvements are needed. Lao is currently working on its second communication and making efforts to improve their data collection methods.

5 Myanmar

Myanmar participated in the “Asia Least-cost Greenhouse Gas Abatement Strategy” (ALGAS) from 1995 to 1998. ALGAS was a study of national GHG emissions for 12 Asian countries. They mostly use supply-side figures in their inventories.

6 Singapore

Singapore has the advantage of being small, so its inventories can be simplified in some ways. They are currently working on creating an Energy Balance and trying to close their data gaps. They use IPCC default values and have no plans to develop country-specific values at this time.

7 Thailand

Thailand uses top down calculations as a basis for their inventories rather than bottom-up. There is enough activity data available to make estimates. The Ministry of Energy is responsible for supplying and coordinating the data. In general, Thailand uses IPCC defaults for emission factors and, at this stage, compared to other sectors, the energy sector is a relatively low priority for developing country-specific values. Inventories are basically only used for national communications at this point.

8 Vietnam

There are some main energy indicators in the national statistics, but the data is not adequate. They are trying to use the data from the energy sector, but it is very difficult and has been taking a long time. They are currently working on their second communication and
trying to update the data. The lack of activity data is causing problems. It is necessary to develop capacity for a national inventory group and policy-making.

2.2 Key Findings

Energy Balances can be used as a basis for developing inventories for the energy sector. However, countries that do not already have Energy Balances do not necessarily have to start developing them. It is more important to try to find ways to collect the data for the inventories using whatever means possible, for example, basing estimates on supply side statistics.

There are many categories, some of which are further differentiated into subcategories. Needs differ depending on the country, so this level of detail may not be necessary for every country. There should be a minimum set of broad categories for countries to focus on, especially when they are starting out. The categories can then be elaborated upon based on the needs of the country. These data from these categories can be used in the evaluation of countermeasures.

In order to gain support for inventory development in each country, it is important to recognize that the data used in the inventories can serve as valuable input for other analyses (CDM, assessment of mitigation strategies). It may be difficult (i.e. too expensive) to ask for statistics to be prepared only for the inventory. However, if the data can be used in other kinds of analyses, it will be easier to ask for it to be collected. It can also be used as feedback for the commercial sector so that industries can refine their emission strategies.

In Asian countries, which are experiencing rapid development, it is necessary to pay attention to new technologies that can enhance efficiency and decrease emissions. Certain industries should be examined on a regular basis (e.g. yearly, every five years) for new technologies that necessitate the recalculation of activity data and emission factors.

Many countries are using IPCC default values and that seems to serve their needs at this time. In some key instances where the energy sources and usage patterns are unique to the country, they may develop country-specific values. The difference between the IPCC values and the country-specific values is not large in many cases, so it can be more cost-effective for certain countries to continue to use the IPCC values rather than spending a large amount of time and resources developing country-specific values. However, countries that have already submitted one or two national communications may want to refine their results based on country-specific data. In addition, while it is natural to want to focus on finding ways to improve the accuracy of the estimates, it is also important to look for ways to gain institutional support for collecting and coordinating the data.

The session closed with the suggestion that the countries in the energy sector should come up with specific core activities to focus on in the energy sector before WGIA5. For example, the group could study specific cases and see what can be done to improve upon them. The information exchange that takes place at WGIA is only the first step. There is a need to set targets and work together to make improvements.
2 Agriculture Working Group

1 Objectives

The Agriculture Working Group Session focused on the following two categories:
- 4.C Rice Cultivation
- 4.A Enteric Fermentation

The Session discussed:
- Basic information on rice cultivation areas in each country and how the classification of those areas affects rice cultivation methane emissions (e.g., water regime, water regime prior to rice cultivation)
- Livestock characteristic in each country which affect methane emissions from enteric fermentation (e.g., weight, milk production)
- Existing practices of other countries to estimate emissions more reliably

2 Results of the Discussion

2.1 CH$_4$ Emissions from Rice Fields

1 Introduction

Rice ecosystems in the Asian region include upland rice, irrigated rice, rainfed rice and deep water rice ecosystems located at various positions in the landscape. A number of controlling factors affect the rate of CH$_4$ emissions from the various rice ecosystems. These factors include soil properties, temperature, cultural practices (water regime/drainage, fertilizer, seeding/transplanting, straw/residue management) and rice variety.

Cognizant of these varying factors, an Interregional Research Programme on Methane Emissions from Rice Fields was funded by the United Nations Development Program, Global Environmental Facility (UNDP/GEF GLO/91/G31) from 1993 to 1999. The program involved collaboration among international research organizations and national research institutes including the International Rice Research Institute, the Fraunhofer Institute for Atmospheric Environmental Research, and Agricultural Research Institutes of China, India, Indonesia, Philippines and Thailand.

Highlights of the results of this program showed that management practices can be modified to reduce CH$_4$ emissions without affecting rice yield:
- Intermittent drainage in irrigated systems reduces emissions and also saves water
- Improved crop residue management can reduce emissions
- Direct seeding results in less labor and water input and reduces methane emissions
- Plants grown under good nutritional conditions exhibit reduced methane emissions

2 Activity Data

With regard to the status of activity data for the calculation of CH$_4$ emissions from rice ecosystems, only 2 countries (India and Japan) reported the availability of disaggregated data for water regime management while the other countries (Cambodia, Philippines, Vietnam, Malaysia, Indonesia) reported the availability of only the aggregated data (Table 2.1). With regard to activity data on organic amendment, disaggregated data is not available for any
country represented in the Agriculture Working Group. Only two countries (Japan and Malaysia) reported aggregated data while the rest of the countries reported that this activity data was unavailable (Table 2.1).

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3 Emission Factors

Country-specific CH₄ emission factors are available for two countries (Japan and Philippines). There are many field measurements of CH₄ emissions from rice fields using the closed chamber method. Dr. Yagi of the National Institute for Agro-Environmental Sciences (NIAES), Japan analyzed 868 seasonal CH₄ emissions data from 103 study sites in the Asian region using a mixed linear model.

In the Philippines, the International Rice Research Institute measured CH₄ emissions from rainfed and irrigated rice fields and developed emission factors for these two rice ecosystems.

2.2 CH₄ Emissions from Enteric Fermentation

Activity Data for the number of heads of different ruminants are available from the National Statistics and Bureau of Animal Industry reports in all countries represented in the working group.

Dr. Enishii of Japan presented an analytical method to improve the determination of a CH₄ emission factor for ruminants based on Dry Matter Intake using Shibata’s equation. Dr. Enishii is also trying to develop and test simple measurement techniques to quantify CH₄ emissions from ruminants including the use of an open circuit respiration chamber, an in vitro gas production technique, a sulfur hexafluoride tracer technique and a semi-continuous system (Rusitec).

2.3 Further Improvements

Steps to improve activity data in the agriculture sector were identified as follows:
- Statistical Yearbooks
- Agricultural Statistics
- Seeking help for data gathering from National Ministries (Agriculture, Environment) and regional offices
- Experts’ opinions
- Documentation/Archiving (sources, comments)
- Sampling to obtain data
Steps to improve emission factors were identified as follows:

- Develop the technology needed to estimate CH\(_4\) emission accurately from ruminants
- For countries without country-specific emission factors, use emission factor values from other countries with similar climatic conditions and cultural practices
- Consult the IPCC Emission Factor Database
- Modeling, equations (Shibata’s equation)

Future directions for the improvement of GHG inventories in the agriculture sector will include:

- Organic C in soil
- N\(_2\)O emissions from N inputs (inorganic fertilizer, manure, crop residues)
- CH\(_4\) and N\(_2\)O emissions from residue burning
- Feed type and feed composition vs. CH\(_4\) emissions from ruminants
- Proper archiving of AD and EF (sources, notes, comments)
- Listing of activity data, emission factor, data gaps, institutionalization of data gathering, and compilation of activity data and emission factors for national GHG inventories
3 Land-Use Change and Forestry (LUCF) Working Group

1 Introduction

The LUCF Working Group session started with reports from four countries: Cambodia, Indonesia, Japan, and Malaysia. Following these reports, two experts presented the methodology from the IPCC Good Practice Guidance for Land Use, Land-Use Change, and Forestry (LULUCF) and discussed the uncertainty of C-stock estimates and its relation to sampling procedures. These presentations were made in order to help increase understanding of the issues and to develop possible strategies for developing better inventories. Finally, countries discussed ideas for developing and improving GHG inventories in the LUCF sector in Asia.

2 Objectives

The objectives of this discussion were:
- To compare and discuss the field measurement of and survey methods for mean annual increments (MAI) and the estimation of uncertainty
- To discuss existing practices for obtaining more reliable estimates of emissions and removals from the LUCF source/sink categories

The discussion covered four issues:
- Methods for deriving MAI
- Approaches to estimate the uncertainty of MAI
- The stock change methodology of the IPCC GPG for LULUCF
- Proposal for enhancing national capacity to improve GHG inventories in the LUCF sector

3 Results of the Discussion

3.1 Methods for Deriving MAI

- MAI can be derived from tree diameter increment data which are either reported by forest concession companies (e.g. Indonesia) or directly measured in the field. In addition, the difference in wood volume data between logged-over and virgin forests can be used for estimating MAI. Though these methodologies have been used to measure MAI in some countries in Asia, the critical concern with the results of estimated MAI is uncertainty.
- A case study in Cambodia showed how MAI, estimated from a field survey, could vary within the same national forest classification category, on which its first GHG inventories were based. The ecological condition of forests affects the values of MAI significantly; therefore, it is not appropriate if only national forest classification categories are taken into account.
- The analytical results of Indonesian inventory data highlighted the significant impact of the selection of MAI in certain forest categories, which are estimated to contribute to around 52% of total carbon removals in the country.
- Countries who have conducted regular forest inventories will have reliable estimates for the MAI. Full utilization of these forest inventory data and the MAI estimated from the data is desirable. In Malaysia, detailed forest inventories have been conducted every ten
years, therefore reliable estimation of MAI is possible.

3.2 Approaches to Estimating the Uncertainty of MAI

- The Monte Carlo analysis for uncertainty estimation requires a large number of data to be analysed in order to get objective results.
- A study by the World Agroforestry Centre showed that the uncertainty of activity data (i.e., land use classification and area) can be decreased if broad land use categories are adopted. However, if broad land use categories are selected, emission/removal factors (e.g., MAI) for such broad categories are needed. If obtaining reliable MAI in general is very difficult in tropical countries like Indonesia, getting good MAI under the broad categories would be a challenge.

3.3 The Stock Change Methodology of the IPCC GPG for LULUCF

- Japan’s experience in using the carbon stock change approach revealed that this approach generates accurate results when detailed forest inventory data are used (e.g., what is available in Japan). Hence, if detailed forest inventory data are not available, the default approach (biomass increment) is recommended.
- Tropical forests consist of various types of forests under various management systems and climate types. As a result, the measurement of MAI becomes a significant challenge for tropical countries as compared to boreal and temperate zones where the structure of forests is relatively simple.

3.4 Proposal for Enhancing National Capacity to Improve GHG Inventories for the LUCF Sector

- The group concluded that although there are certain methodologies available for estimating MAI, the difficulty in getting reliable MAI is a critical concern for tropical countries in Asia, especially because the structure of tropical forests is more complex compared to boreal and temperate forests. Support for tropical countries to improve data availability and maintain datasets is needed.
- Participants discussed the difficulties they faced in getting access to information sources owned by different organisations. In order to improve data accessibility, it is necessary to have good coordination among all relevant organisations, including those which are directly and indirectly involved in inventory development. WGIA should play a role in facilitating such coordination in countries in Asia.
- WGIA should also make an effort to disseminate the work conducted by WGIA, including that of the LUCF group, as widely as possible, as this would help increase awareness among relevant personnel and organisations of the issues that are faced by countries and the resources that are currently in existence (e.g., pool of experts).
4 Waste Working Group

1 Overview

Discussion in the waste working group was focused on important activity data to improve GHG inventories; wastewater flow and solid waste streams in Asian countries. The discussion on wastewater began with Mr. Kiyoto Tanabe who reported on the 2006 IPCC Guidelines for National Greenhouse Gas Inventories on wastewater handling. Members from Lao PDR, Philippines, and Thailand reported on the situation of wastewater and solid waste in their countries. In addition members from Indonesia and Myanmar also shared experiences from their countries regarding these issues. Waste management in Japan, which was presented by Mr. Hiroshi Fujita, was used as a comparison case for Asian countries. As for solid waste, the presentations on recent study results on methane emission estimates by Ms. Sirintornthep Towprayoon and recent developments on Japan’s inventories with regard to solid waste disposal by Mr. Masato Yamada were used to discuss GHG estimation for solid waste.

2 Results of the Discussion

2.1 Comparison of Wastewater Flow and GHG Emissions in Asia: Similarities and Differences

Refer to country reports during the break out group discussion, wastewater flow in Asian countries depends on the condition of the individual cities and countries. In general, wastewater flow can be classified into at least four categories as follows:

- **Untreated wastewater with final flow to river or sea**: No preliminary treatment of wastewater from households, effluent is not collected, final discharge to the river or sea
- **Septic tank with final flow to river or sea**: Domestic wastewater from toilets partly treated by septic tank, the rest is not collected, final discharge to the river or sea
- **Septic tank and sewer collection**: Domestic wastewater from toilets partly treated by septic tank, the rest is collected using sewer systems and discharged to the river or sea.
- **Septic tank and sewer collection discharge to central treatment plant**: Domestic wastewater from toilets partly treated by septic tank, the rest is collected using sewer systems and treated at a central treatment plant

Types of wastewater flow are dependent on several factors such as size of city, nature of society, type of septic tank, etc.

Uncollected and untreated industrial wastewater originates from small factories and is often discharged directly to reservoirs. The food industry, paper and pulp industry, chemical industry and textile industry produce wastewater flow with high organic compounds. Sludge treatment is not well documented. Mixing of domestic and industrial wastewater is not common in Asian countries. Very little information on methane correction factors (MCF) is available in most countries. However members agree that the 2006 IPCC Guidelines benefit Asian countries.
2.2 Comparison of Solid Waste Streams in Asia and GHG Emissions: Similarities and Differences

Solid waste streams can be identified mainly by the recycling activities:
- Separation at source (household): recyclable waste is separated and sold to communities and un-recyclable waste is collected. Almost every country has this category. Collected waste can be treated at a central plant or go directly to the landfill.
- Separation at site (Material Recycling Facility: MRF): In Asia, it is more common for recycling and sorting activities to be implemented by hand sorting or mechanical sorting at the central treatment plant before final disposal.

Accessibility to recycling data in many countries is possible. Common pre-treatment (waste reduction) technologies in Asian countries are composting and incineration. The main solid waste disposal technology is landfill. Waste streams in each country are also affected by local municipalities, laws, society, and education. However, waste composition in developing countries in Asia does not differ much among the countries.

The improvement of waste management generates co-benefits such as waste recycling and energy recovery, but the type and extent of the co-benefits depends on the country’s situation.

2.3 Suggestions for Activities to Develop Improved Inventories, Including Potential Regional Cooperation

Many countries such as Thailand, Philippines, and Indonesia are now promoting waste recycling. Therefore, it is likely that waste composition in the future will change. The creation and maintenance of databases on mass and quality (composition) of waste would be very valuable. Such databases would be useful not only for improving GHG emission inventories but also for improving waste management in the future. Moreover, the application of technology that can produce energy, such as incineration, Refuse Derived Fuel (RDF), Waste to Energy, will be increased. Asian countries with advanced data on emission factors can step into using the Tier II methodology. However in case the technology changes, well defined activity data will be helpful for estimating emissions. Since the status of data acquisition is different among countries, guidelines on this issue would be useful for them.
Part 3

Presentations
Overview of WGIA4

WGIA Secretariat

Welcome Participants!

- 47 inventory-related government officials and researchers from 12 countries (including around 10 local participants from Indonesia)
- 3 representatives from international organisations
  - UNFCCC Secretariat
  - IPCC-NGGIP/TSU
  - World Agroforestry Centre

Joint Hosting Organisations

- Ministry of the Environment of Japan
- National Institute for Environmental Studies
- Ministry of Environment of Indonesia (Local host)

Please try to find out about:

- Ideas or requests for future activities in the region and your country, taking into account new inventories to be developed
- Collaborative relationships between participants
- Practical and useful information you can actually try to apply when you return home
- Latest inventory-related information at the global and regional level
The Status of GHG Inventories Preparation in Myanmar.

Presented by

Ne Winn
National Commission for Environmental Affairs (NCEA)
14-2-2007

The status of Myanmar to prepare GHG inventories-
- Also a party to several international and regional conventions and agreements relating to the environment, namely.
  (iii) London Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer, 1990.
  (iv) United Nations Framework Convention on Climate Change 1992, and

The ALGAS Project

- "Asia Least-cost Greenhouse Gas Abatement Strategy".
- a study by 12 Asian countries of national emissions of greenhouse gases (GHGs) in 1990.
- The Projections of GHGs emissions to 2020
- an analysis of GHGs abatement options in different economic sectors.
- also includes the formulation of national GHGs abatement strategies consistent with national development priorities.

NTE undertook the country study

- with the active involvement of Governments through a designated national counterpart agency (NCA).
- drawn from different institutions of the country
- assisted in their tasks by a team of international technical experts (ITEs).
- involved a number of regional capacity building activities including training workshop on
  - GHGs inventory preparation
  - analysis of GHGs mitigation options
  - empirical measurements of methane from rice paddies
  - analytical modeling of the energy and forestry sectors
  - preparation of project pre-feasibility report.

The outcomes of the ALGAS

- executed by ADB during 1995-1998 with funding of about $9.5 million from the GEF through the UNDP.
- Apart from Myanmar, the countries involved in the study are Bangladesh, People's Republic of China, India, Indonesia, Republic of Korea, Mongolia, Pakistan, Philippines, Thailand, Viet Nam and Democratic People's Republic of Korea (DPRK).
Situation on preparation of National Communication under UNFCCC
- has yet to submit Myanmar Initial National Communication.
- undertaking the Project on Preparation on Preparation on Initial National Communication under the UNFCCC.

Linkages with past and ongoing climate change activities
- very limited activities on climate change
- based on the ALGAS project
- regularly participated in subsidiary Bodies meetings and the conference of Parties of the UNFCCC.

Previous activities under ALGAS.
- has undertaken a national GHG Inventory for Carbon dioxide, methane (CH4) and nitrous oxide (N2O) for the base year 1990

Five source categories
- Energy [i.e. fuel combustion, energy industries, transport, commercial institution only (residential was not considered) and others].
- Industrial Processes.
- Agriculture [i.e. enteric fermentation from domestic livestock; manure management and rice cultivation (CH4 emission only); agricultural soils (N2O emission only; prescribed burning of savannas and field burning of agricultural residues (CH4 and N2O emissions only)].
- Land-Use change and forestry.
- Waste (CH4 emission only for solid waste disposal on land; wastewater treatment).

Gaps
The major gaps are
(i) CO2, CH4 and N2O data in the five source categories need to be updated and extended based on the COPB Guidelines.
(ii) Lack of data or reliable data in certain source categories (e.g. methane emission from agricultural soils).
(iii) Lack of country-specific emission factors.
(iv) Uncertainties for sources and sinks were not estimated.
(v) Capacity-building in IPCC methodologies for GHG Inventory is still very much needed.

Proposed activities
- Carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O).
- Carbon monoxide (CO), nitrogen oxides (NOX) and non-methane volatile organic compounds (NMVOC), as well as sulphur dioxide (SO2) will be undertaken for the year 2000.
- Five source categories.
- Energy (i.e. fuel combustion, energy industries; transport; commercial, residential; solid fuels).
- Industrial Processes.
- Agriculture (i.e. enteric fermentation from domestic livestock; manure management; rice cultivation, agricultural soils and field burning of agricultural residues).
- Land-Use Changes and Forestry.
- Waste.

Programmes containing measures to facilitate an Adequate Adaptation to Climate Change
- Previous activities.
- No previous studies on the vulnerability of Myanmar.
- Although eligible for funding for preparing NAPA.

Gaps
The Major gaps are-
(i) Lack of vulnerability assessment, including the integrated and quantitative vulnerability assessment.
(ii) Lack of cost-effective analysis of various adaptation options, including adaptation technologies.
(iii) Lack of national strategy and action plan for adaptation to climate change and its related disaster prevention, preparedness and management.
(iv) Lack of expertise in the field of vulnerability and adaptation (V&A) assessment integrated assessment.

(v) Lack of assessment of the impacts of climate variability and extreme weather events on key socio-economic sectors.

(vi) Capacity building is urgently needed in V & A assessment, including training on relevant methodologies.
Inventory Development in Singapore & National Climate Change Strategy

National Environment Agency
Singapore
4th Workshop on GHG Inventories in Asia
14-15 Feb 2007

Singapore’s Situation
- Small city-state
  - Land area of 680 km²
- High population density
  - Population of ~4 mil
- Highly industrialised economy
- Dependent on imported fossil fuels
- Lack of natural resources and renewable energy sources

Singapore’s Energy Resources

Energy Resources

- Fossil Fuels
  - Fuel Oil
  - Natural Gas (NG)
- Renewables
  - Biomass
  - Solar Thermal
  - Photovoltaic

National Climate Change Strategy

Public Awareness
Vulnerability and Adaptation
NATIONAL CLIMATE CHANGE STRATEGY
Mitigation
Competency Building

Key CO₂ contributors (2004)

<table>
<thead>
<tr>
<th>Category</th>
<th>Generation</th>
<th>Industry</th>
<th>Transport</th>
<th>Buildings</th>
<th>Household</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary Consumption</td>
<td>48%</td>
<td>33%</td>
<td>17%</td>
<td>1%</td>
<td>-1%</td>
<td></td>
</tr>
<tr>
<td>Secondary Consumption</td>
<td>44%</td>
<td>5%</td>
<td>30%</td>
<td>18%</td>
<td>3%</td>
<td></td>
</tr>
<tr>
<td>Overall</td>
<td>54%</td>
<td>19%</td>
<td>16%</td>
<td>10%</td>
<td>-1%</td>
<td></td>
</tr>
</tbody>
</table>

TOTAL CO₂ = 40,377 kilo tonnes

Main Mitigation Strategies

- Energy efficiency
- Clean, less carbon-intensive energy sources
Mitigation Efforts by Sector

Electricity Generation
Industry
Transport
Buildings
Consumer/Households

Improving Energy Efficiency in Electricity Generation

- New Energy Market introduced in Jan 2003
  - Promotes competition and expected to continue to drive improvements in generation efficiency
- Gencos switching to NG and adopting combined cycle generation technologies (CCGT)
- Cogeneration
  - 815 MW CCGT cogeneration plant
  - >30% energy savings and emissions reduction when compared to separate power and heat generation
- Trigeneration and multigeneration have potential to further improve efficiency

Using Cleaner Fuels & Renewables

- Promoting cogeneration will increase the adoption of NG in industry
- Test-bedding and demonstration of innovative clean energy technologies will help Singapore become an early adopter when these technologies are commercially viable
  - Solar photovoltaics (PV)
  - Hydrogen fuel cells

Promoting Greater Energy Efficiency

- Energy Efficiency Improvement Assistance Scheme (EASE)
  - Introduced in Apr 2005
  - $10 million incentive scheme
  - Fund limit - 50% of the cost of engaging ESCOs
  - Manufacturing companies and building owners/operators
- Energy Audit Scheme for large energy consumers
  - Launched in Jul 2002
  - Encourage very large emitters of CO₂ to improve their energy efficiency and energy management systems and practices
  - Measures implemented:
    - Improvement of furnace efficiencies
    - Optimisation of heat recovery, heat integration

Promoting Greater Energy Efficiency

- Accelerated Depreciation Allowance Scheme
  - Introduced in Jan 1996
  - Allows companies to depreciate qualifying capital equipment in one year instead of three

Promoting Energy Efficiency

- Promote public transportation
- Promote green vehicles
  - Hybrid, fuel cell cars
  - Natural gas for taxis and buses
- Green vehicle tax rebates
  - 40% of O&M for electric, hybrid, and CNG cars
  - 5% of O&M for CNG buses
  - Valid until 31 Dec 2007
- Fuel Economy Labelling Scheme
  - Launched in Jun 2003 on Green Transport Day
  - Green Transport Guide
Promoting Energy Efficiency

- Regulations and standards
  - BCA’s Building Control Regulation for air-con bldgs (revised in Jun 2004)
  - EnerTrust’s Energy Efficiency Rating (ETTV) and Roof TYV (RTYV)
  - Minimum efficiency requirements for air-con systems exceeding 30 kW
  - Maximum lighting power budget
  - Code of Practice 24 under SPRING Singapore’s standards
  - Technical workgroup led by NEA

- Energy Efficiency Improvement Assistance Scheme (EAE5)
  - Energy conservation projects
    - Energy audit of common area services in 40 blocks of Aljunied Town Council
    - 145 - 185 potential energy savings uncovered
    - Results and recommendations were shared with Town Councils and HDB

Public Sector to Lead

- Energy efficiency improvement of public sector buildings under Economy Drive Initiative
  - 8 public agencies participating
  - Standard performance contracting documents developed
  - Two models: Shared savings & Guaranteed savings

- Energy Smart Building Labelling Scheme to raise awareness
  - Accord recognition for buildings with good energy performance, while maintaining a healthy and productive indoor environment

Raising Awareness

- Energy labelling of household appliances
  - Launched in Apr 2002
  - To-date, about 20% of air-cons and refrigerators in the market are energy labelled
  - Mandatory labelling to be introduced by mid-2007

- Green corners
  - Launched in Mar 2003
  - Showcase energy labelled products
  - 8 green corners island-wide

- Associate Green Corners
  - Launched in Jul 2005
  - At least 33% of displayed models are energy labelled
  - 17 associate green corners

- Energy efficiency display at HDB showflats

Vulnerability and Adaptation

- As a low-lying island state in tropics, Singapore is vulnerable to climate change

- Areas of vulnerability include:
  - Coastal land loss and flooding
  - Water resource impacts
  - Higher energy demand and heat stress, higher ambient temperature
  - Rise in vector populations and impact on public health

- Study on the effects and impacts of climate change on Singapore is being commissioned
**Competency Building**

- Promote demonstration projects and R&D in low-carbon technology through innovation for Environmental Sustainability (IES) Fund and joint research with tertiary institutions
  - E.g. solar, fuel-cells

- Govt agencies jointly promote sustainable energy industry and build competency to support local and regional CDM projects
  - E.g. ESCO services, solar industry, distributed power generation
  - E.g. carbon trading

**Public Awareness**

- Climate Change Awareness Programme (CCAP) aims to:
  - Raise awareness among households and motorists about climate change
  - Encourage the public to reduce GHG emissions through simple changes in lifestyles and habits that would reduce their energy consumption

- CCAP (focusing on consumers) launched on 22 Apr 2006
  - "Everyday Superhero"
  - www.everydaysuperhero.com.sg

- Habits for motorists launched during Green Transport Week in Aug 2006

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**Thank you**
Updates on GHG Inventories in Japan

Hiroshi Fujita
Climate Change Policy Division
Global Environment Bureau
Ministry of the Environment

February 14, 2007
The 4th Workshop on GHG Inventories in Asia (WGIA4)

Current Institutional Arrangement

- “the Committee for the GHGs Emissions Estimation Methods”, since 1999,
- Members: external experts, approximately 60
- The committee is in charge of methodological development of the inventory

Committee for the GHGs Emissions Estimation Methods

Inventory Working Group
(crosscutting issues)

6 subgroups (for each sector): Energy and Industrial Processes, Transportation, Agriculture, Waste, F-gas, LULUCF

Report on Japan’s Assigned Amount

para 7 Part One
para 7 (a) I. Complete inventories of anthropogenic emissions by sectors and removals by sinks of greenhouse gases and controlled by the Montreal Protocol for all years from 1990
(para-1) page 1
para 7 (b) II. Selected base year for HFCs, PFCs and SF6 in accordance with Article 3, paragraph 5
(para-1) page 8
para 7 (c) III. The agreement under Article 4
(para-1) page 1
para 7 (d) IV. Calculation of allowed amount pursuant to Article 3, paragraph 7 and 8
(para-1) page 8

para 8 Part Two
para 8 (a) I. Calculation of its commitment period reserve in accordance with decision 1/CP.1 (Article 17 of the Kyoto Protocol)
(para-2) page 1
para 8 (b), (c), (d) II. Activities under Article 3, paragraph 3 and 4 of the Kyoto Protocol
(para-2) page 2
para 8 (e) III. State of Development of a National System Based on Article 3, paragraph 1 of the Kyoto Protocol
(para-2) page 6
para 8 (f) IV. National Registry in accordance with Decision 13/CP.17
(para-2) page 29

Trends in overall emissions and removals

CO₂ (direct)

- Other
- Non-
- Commercial Activities
- Agriculture
- LULUCF

- Other
- Non-
- Commercial Activities
- Agriculture
- LULUCF
The Aims of the Kyoto Target Achievement Plan
(Cabinet Decision on April 28, 2005)

1. Ensure achievement of 6% reduction commitment under the Protocol
2. Steady implementation of a continuous as well as long-term GHG emissions reduction on a global scale

21st Century is a century of the environment. Climate change is a common issue to all humans.

The government of Japan, as one of the most advanced countries across the globe in implementing measures on climate change, is aspiring to take a leading role in the international community.
Introduction

- Mongolia has prepared its first greenhouse gases (GHG) inventory in 1996 for the base year 1990 under the US Country Studies Programme
- The inventory has been updated within the Asia Least-Cost Greenhouse Gas Abatement Strategy (ALGAS) in 1997.
- Initial National Communication (GEF/ UNEP), the GHG inventories were updated to 1998 with base year 1994.
- Capacity Building for Improving GHG Inventories

Short term inventory strategy

Data collection and archiving

- prepare a list of identified data gaps
- develop a national procedures of Activity data (AD) collection
- include necessary data for GHG inventories in Statistical Yearbook
- design of the database structure of national AD and Emission factors (EFs)
- establish National AD and EFs Database
Data and EF assessment

<table>
<thead>
<tr>
<th>Sector</th>
<th>Activity data assimilation (AD)</th>
<th>Reporting</th>
<th>National</th>
<th>Uncertainty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Climate</td>
<td>AD data assimilation</td>
<td>Reporting</td>
<td>National</td>
<td>Uncertainty</td>
</tr>
<tr>
<td>GHG</td>
<td>AD data assimilation</td>
<td>Reporting</td>
<td>National</td>
<td>Uncertainty</td>
</tr>
<tr>
<td>Inventory</td>
<td>AD data assimilation</td>
<td>Reporting</td>
<td>National</td>
<td>Uncertainty</td>
</tr>
</tbody>
</table>

Solid waste

Short term inventory strategy

Improvement of Emission Factors:
- develop a list of emission factors used in GHG inventories
- check reliability of EFs used
- prepare a list of local emission factors to be estimated in the specific local conditions
- estimate local EFs

Completeness:
- identify missing sub-sectors and emission gases in the GHG inventories
- develop a work plan for national inventory by using IPCC Good Practice Guidance

Long Term strategy (2007-2010)

Data:
- To improve the design of the database structure of national AD and EFs
- To develop a national guidance for updating national and/or activity data of sectors
- To establish database of National AD and EFs

Methodological issues:
- prepare national manual for preparation of national GHG inventories
- learn IPCC Good Practice and Uncertainty Management in National GHG Inventories
- prepare quality assurance and quality control (QA/QC) plan in the development of national GHG inventories
- assess uncertainties

Reporting and Documentation:
- create reporting and documentation system for national GHG inventory
Long Term strategy (2007-2010)

Emission factors

- To check reliability of EFs used
- To check estimated local EFs

Long Term strategy (2007-2010)

Completeness

- To conduct key source analysis of the GHG inventories
- To identify missing sub-sectors and activities in the GHG inventories
- To estimate emissions of missed gases

Long Term strategy (2007-2010)

Institutional and procedural arrangements

- To establish a legal instrument on data issuing for GHG
- To establish an institutional structure for preparation of national GHG inventories
- To develop a capacity building program
- To establish a permanent center/laboratory/team of experts responsible for preparation of national GHG inventories

Long Term strategy (2007-2010)

Inventory quality and uncertainty assessment

- To establish an official technical peer review process
- To conduct inventories QA/QC

Long Term strategy (2007-2010)

Reporting and Documentation

- To create inventory documentation system
- To complete documentation of activity data, EFs, methods
- To conduct trend analyses
- To conduct recalculations

Thank you
The WGIA4 Preliminary Survey conducted in Oct.-Nov. 2006

- **Objective:**
  To identify the current situations and the levels of the need for improvement

- **Survey Method:**
  Requested participants to select the levels of the need for each of IPCC source/sink categories as "High", "Medium", or "Low"
Guidance for the Next Session (1) Approach:
Focusing on the significant categories identified, each WG will compare and discuss.
- The characteristics of the activities emitting/absorbing GHGs
- The measurement/survey methodology for obtaining fundamental data necessary for calculation

Guidance for the Next Session (2) Energy -
- Collection of AD
- Carbon Values and Carbon EF of Fuels
- Agriculture -
- Rice Cultivation Area
- Livestock Characteristics
- LUCF -
- Mean Annual Increments of Aboveground Biomass
- Waste -
- Wastewater Flow and Sources
- Solid Waste Stream and Composition

Points of Discussion!
- Comparison of the characteristics of an activity: Similar or different?
- Application of one country’s method to the other(s)
- Necessary steps to be taken for improvements
- More and more...

We look forward to 10-min. presentations from each of the groups tomorrow!!

WG Information

<table>
<thead>
<tr>
<th>Energy</th>
<th>Dr. Shuzo Nishioka</th>
<th>Mr. Saleh Abdurrahman</th>
<th>Diponegoro</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>Dr. Baima Punsalmaa</td>
<td>Dr. Damaso Macandog</td>
<td>Tanjung</td>
</tr>
<tr>
<td>LUCF</td>
<td>Dr. Rizalidi Boer</td>
<td>Mr. Heng Chan Theun</td>
<td>Teratai</td>
</tr>
<tr>
<td>Waste</td>
<td>Dr. Shinornthep Towprayoon</td>
<td>Dr. Masato Yamada</td>
<td>Rasamala</td>
</tr>
</tbody>
</table>
Methane Emissions from Major Rice Ecosystems in Asia

International Rice Research Institute

Dennis B. Magandao

Methane in a paddy field

The Interregional Research Programme on Methane Emissions from Rice Fields

- International Rice Research Institute, Fraunhofer Institute for Atmospheric Environmental Research, Agricultural Research Institutes of China, India, Indonesia, Philippines and Thailand
- Funded by United Nations Development Program, Global Environmental Facility (UNDP/GEF GLO/91/G31)
- 1993-1999

<table>
<thead>
<tr>
<th>Sources/Sinks</th>
<th>IPCC Emission average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural</td>
<td>115</td>
</tr>
<tr>
<td>Wetlands</td>
<td>25</td>
</tr>
<tr>
<td>Termites</td>
<td>15</td>
</tr>
<tr>
<td>Oceans, fresh waters</td>
<td>15</td>
</tr>
<tr>
<td>Others</td>
<td>15</td>
</tr>
<tr>
<td>Anthropogenic</td>
<td>100</td>
</tr>
<tr>
<td>Fossil fuel (coal, gas products)</td>
<td>75</td>
</tr>
<tr>
<td>Cattle</td>
<td>85</td>
</tr>
<tr>
<td>Rice paddies</td>
<td>40</td>
</tr>
<tr>
<td>Other soils</td>
<td>25</td>
</tr>
<tr>
<td>Biomass burning</td>
<td>25</td>
</tr>
<tr>
<td>Landfills</td>
<td>25</td>
</tr>
<tr>
<td>Animal waste</td>
<td>25</td>
</tr>
<tr>
<td>Domestic sewage</td>
<td>25</td>
</tr>
<tr>
<td>Total identified sources</td>
<td>535</td>
</tr>
<tr>
<td>Total direct</td>
<td>515</td>
</tr>
<tr>
<td>Atmospheric increase</td>
<td>17</td>
</tr>
</tbody>
</table>
Irrigated rice ecosystem

Irrigated rice: heavy water consumer

Methane emissions from rice fields:
Controlling factors:
- Soil properties
- Temperature
- Cultural practices (water regime/drainage, fertilizer, seeding/transplanting, straw/residue management)
- Rice variety

Methane emissions: field measuring system
Seasonal CH$_4$ emissions from reference treatment (continuous flooding, pure mineral fertilizer, cultivar IR72)

Seasonal CH$_4$ emissions from irrigated and rainfed rice in Jakenan and Los Baños, and irrigated and deepwater rice in Prachinburi.

Effect of water regime on methane emission from ricefield grown to IR72 at Jakenan, Indonesia during the 1994 dry season.

Methane emission rates in rainfed (white) and irrigated (maroon) rice, Los Baños, Philippines.

Effect of temperature on methane emission Beijing, China.

Site-specific CH$_4$ emissions in response to organic amendments.
Methane emissions from urea, rice straw and organic manure

Los Baños Philippines

Conventional, improved high yielding, and new plant type

Effect of cultivar, 1995 DS

Transplanting

Direct (dry) seeding

Direct (wet) seeding

Variations in CH₄ emissions as affected by different cultural practices in Southeastern Korea

Harvesting rice
Residue management

- Eliminate straw burning
- Incorporate rice straw
  - Maintain soil fertility in the long term
  - Sustain increased yield
  - Increase in organic C, N, available P, K and Si
  - Yield advantage of straw incorporation over straw burning is 0.4 t ha\(^{-1}\) season\(^{-1}\)

Nutrient content of straw

<table>
<thead>
<tr>
<th>Element</th>
<th>Content, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nitrogen</td>
<td>0.6</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>0.1</td>
</tr>
<tr>
<td>Sulfur</td>
<td>0.1</td>
</tr>
<tr>
<td>Potassium</td>
<td>1.5</td>
</tr>
<tr>
<td>Silica</td>
<td>5.0</td>
</tr>
<tr>
<td>Carbon</td>
<td>40.0</td>
</tr>
</tbody>
</table>

Burning rice straw in China

Field burning of crop residues

Trace gases emitted

- Methane
- Carbon monoxide
- Non methane volatile organic compound
- Nitrous oxide
- Nitrogen oxides

Alternate residue management

Incorporation into the soil
  - rice-rice system: incorporate previous residue soon after harvest
  - rice-upland crop: use straw as upland crop mulch
Rice production and methane emissions

Management practices can be modified to reduce emissions without affecting yield

- Intermittent drainage in irrigated systems reduces emissions and also saves water
- Improved crop residue management can reduce emissions
- Direct seeding results in less labor and water input and reduce methane emissions
- Plants grown under good nutrition exhibit reduced methane emissions

<table>
<thead>
<tr>
<th>Year</th>
<th>Total</th>
<th>Irrigated</th>
<th>Rainfed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1983</td>
<td>3141</td>
<td>1688</td>
<td>1473</td>
</tr>
<tr>
<td>1984</td>
<td>3222</td>
<td>1755</td>
<td>1467</td>
</tr>
<tr>
<td>1985</td>
<td>3403</td>
<td>1838</td>
<td>1565</td>
</tr>
<tr>
<td>1986</td>
<td>3403</td>
<td>1878</td>
<td>1525</td>
</tr>
<tr>
<td>1987</td>
<td>3256</td>
<td>1852</td>
<td>1404</td>
</tr>
<tr>
<td>1988</td>
<td>3393</td>
<td>1956</td>
<td>1437</td>
</tr>
<tr>
<td>1989</td>
<td>3497</td>
<td>2064</td>
<td>1433</td>
</tr>
<tr>
<td>1990</td>
<td>3319</td>
<td>2010</td>
<td>1309</td>
</tr>
<tr>
<td>1991</td>
<td>3425</td>
<td>2060</td>
<td>1365</td>
</tr>
<tr>
<td>1992</td>
<td>3398</td>
<td>1980</td>
<td>1218</td>
</tr>
<tr>
<td>1993</td>
<td>3450</td>
<td>2017</td>
<td>1433</td>
</tr>
<tr>
<td>Mean</td>
<td>3337</td>
<td>1916</td>
<td>1421</td>
</tr>
</tbody>
</table>

Methane emission factors from rice fields in the Philippines.

<table>
<thead>
<tr>
<th>Ecosystem</th>
<th>Mean emission (mg/m²/day) from Sites</th>
<th>Emission Factor (kg/ha/day)</th>
<th>Derived IPCC default (T=27°C)</th>
<th>% Decrease from IPCC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Los Banos Maligaya Mean Derived IPCC</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irrigated</td>
<td>233.1</td>
<td>229.3</td>
<td>2.3</td>
<td>5.9</td>
</tr>
<tr>
<td>Rainfed</td>
<td>40.3</td>
<td>40.3</td>
<td>0.4</td>
<td>3.54</td>
</tr>
</tbody>
</table>

Global rice ecosystems, area and methane emissions

<table>
<thead>
<tr>
<th>Ecosystem</th>
<th>Area (ha x 10^6)</th>
<th>Methane emission (kg ha⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Irrigated</td>
<td>79</td>
<td>21</td>
</tr>
<tr>
<td>Rainfed</td>
<td>36</td>
<td>10</td>
</tr>
<tr>
<td>Upland</td>
<td>19</td>
<td>0</td>
</tr>
<tr>
<td>Deepwater and tidal wetlands</td>
<td>12</td>
<td>16</td>
</tr>
</tbody>
</table>

Methane emission from rice fields:

Mitigation options in irrigated ecosystem

- Water management
- Management of organic amendments
- Alternate cultural practices
- Rice cultivar selection

Mitigation options in rainfed ecosystem

- Suitable water management
- Management of organic amendment
- Use of nitrification inhibitors

Methane emission from rice fields:

Mitigation options in deepwater ecosystem

- Proper straw management

Acknowledgment

- Mrs. Rhoda Lantin, retired Research Scientist of the International Rice Research Institute provided all the slides, materials and data for this presentation.

THANK YOU!
Revised 2006 IPCC Guidelines

Methodology for CH$_4$ Emissions from Rice Cultivation

Basic Equations

\[
\text{Emissions} \ (\text{Gg yr}^{-1}) = \sum_{i,j,k} \left( \text{EF}_i \cdot \text{SFW} \cdot \text{SFp} \cdot \text{SFO} \cdot \text{SFj} \right) \cdot 10^6
\]  
Eq. (1)

\[
\text{EF}_i = \text{EFc} \cdot \text{SFW} \cdot \text{SFp} \cdot \text{SFO} \cdot \text{SFj}
\]  
Eq. (2)

Here:
- \(\text{EF}_i\) = a daily emission factor for \(i, j, k\) conditions, kg CH$_4$ ha$^{-1}$ day$^{-1}$
- \(\text{EFc}\) = baseline emission factor, kg CH$_4$ ha$^{-1}$ day$^{-1}$
- \(\text{SFW}\) = scaling factor for water regime during the cultivation period
- \(\text{SFp}\) = scaling factor for water regime in the pre-season
- \(\text{SFO}\) = scaling factor for organic amendment applied
- \(\text{SFj}\) = scaling factor for soil type, rice cultivar, etc., if available

2006 IPCC Guidelines

Methodology for CH$_4$ Emissions from Rice Cultivation

Baseline Emission Factor (EFc)

<table>
<thead>
<tr>
<th>CH$_4$ emission (kg CH$_4$ ha$^{-1}$ day$^{-1}$)</th>
<th>Emission factor</th>
<th>Error range</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.30</td>
<td>0.80-2.20</td>
<td></td>
</tr>
</tbody>
</table>

Table 3.2

A baseline emission factor for:
- no flooded fields for less than 180 days prior to rice cultivation
- continuously flooded during the rice cultivation period
- without organic amendments

EFc in the 1996 Guidelines & 2000 GPG = 200 kg ha$^{-1}$ season$^{-1}$
- Without statistical analysis
- Regardless of the length of the cultivation period

Field measurements in Asia

CH$_4$ & N$_2$O Source Database for Rice Fields

Publishing data at web sites
- CH$_4$ from rice → JAMSTEC web
- N$_2$O from rice → NIAES web (under construction)

Analysis by a mixed linear model
- Baseline emission factors
- Various scaling factors
- Uncertainty analysis
**2006 IPCC Guidelines**

**Methodology for CH₄ Emissions from Rice Cultivation**

**Scaling Factors for Water Regime during the Cultivation Period (SFₚ)**

<table>
<thead>
<tr>
<th>Water Regime</th>
<th>Aggregated case</th>
<th>Disaggregated case</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Scaling Factor (SFₚ)</td>
<td>Error Range</td>
</tr>
<tr>
<td>Upland</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Irrigated</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuously flooded</td>
<td>0.78</td>
<td>0.62-0.98</td>
</tr>
<tr>
<td>Intermittently flooded</td>
<td>0.66</td>
<td>0.46-0.80</td>
</tr>
<tr>
<td>Regular rainfed</td>
<td>0.52</td>
<td>0.41-0.66</td>
</tr>
<tr>
<td>Rainfed and deep water</td>
<td>0.27</td>
<td>0.21-0.34</td>
</tr>
<tr>
<td>Drought prone</td>
<td>0.23</td>
<td>0.18-0.36</td>
</tr>
<tr>
<td>Deep water</td>
<td>0.31</td>
<td>ND</td>
</tr>
</tbody>
</table>

**Scaling Factors for Organic Amendment applied (SFₒ)**

\[ SFₒ = (1 + ROA ⋅ CFₒA)^{0.26} \]  

**Relationship between application rate of organic amendment in fresh weight and CH₄ emissions**

**2006 IPCC Guidelines**

**Methodology for CH₄ Emissions from Rice Cultivation**

**Major Revisions**

- Baseline emission factor (EFc) has been revised to the daily rate, on the basis of statistical analysis of monitoring data.
- New scaling factor for water regime in the pre-season (SFₚ) has been incorporated.
- Other scaling factors have been revised on the basis of statistical analysis of monitoring data.

**2006 IPCC Guidelines**

**Methodology for CH₄ Emissions from Rice Cultivation**

**Implementation**

- Reliable and universal emission and scaling factors, on the basis of statistical analysis of monitoring data, have provided.
- As a result, priority for developing country-specific factors became lower.
- More importance to collect reliable activity data in each country for developing better emission inventory.

**National Inventory for Japan**

**Anthropogenic Sources for CH₄ and N₂O**

<table>
<thead>
<tr>
<th>Source</th>
<th>CH₄</th>
<th>N₂O</th>
</tr>
</thead>
<tbody>
<tr>
<td>paddy fields</td>
<td>9.2 Mt (193 Mt CO₂ equivalent)</td>
<td>0.72 Mt N (346 Mt CO₂ equivalent)</td>
</tr>
</tbody>
</table>

Inventory in 2005 (Colored parts indicate agricultural sources)
National Inventory for Japan
CH$_4$ Emissions from Rice Cultivation

Methodology

- Tier 2 methodology
- Country-specific emission factors for 5 soil types, which are based on seasonal field monitoring at 35 sites over the country during 1992-94
- Country-specific scaling factors for 3 organic amendment
- Water management was assumed to be homogeneous intermittent-irrigation for 98% of the rice fields

<table>
<thead>
<tr>
<th>Type of soil</th>
<th>No. of data</th>
<th>Straw amendment</th>
<th>Various compost amendment</th>
<th>No-amendment</th>
<th>Proportion of area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andosol</td>
<td>2</td>
<td>8.50</td>
<td>7.59</td>
<td>6.07</td>
<td>11.9</td>
</tr>
<tr>
<td>Yellow soil</td>
<td>4</td>
<td>21.4</td>
<td>14.6</td>
<td>11.7</td>
<td>9.4</td>
</tr>
<tr>
<td>Lowland soil</td>
<td>21</td>
<td>19.1</td>
<td>15.3</td>
<td>12.2</td>
<td>41.5</td>
</tr>
<tr>
<td>Grey soil</td>
<td>6</td>
<td>17.8</td>
<td>13.8</td>
<td>11.0</td>
<td>30.8</td>
</tr>
<tr>
<td>Peat soil</td>
<td>2</td>
<td>26.8</td>
<td>20.5</td>
<td>10.4</td>
<td>6.4</td>
</tr>
</tbody>
</table>

- Based on field monitoring campaign during 1992-1994 at 35 sites over Japan
- Measured by conventional water management with mid-season drainage followed by intermittent flooding

National Inventory for Japan
CH$_4$ Emissions from Rice Cultivation
Calculation for Organic Amendment Applied

- Activity data based on interview with ca. 2,000 farmers by MAFF

<table>
<thead>
<tr>
<th>CH$_4$ emission from the plot with no rice straw (g/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CH$_4$ emission from the plot with rice straw (g/ha)</td>
</tr>
</tbody>
</table>

- SFo for straw: 1.68
- SFo for various compost: 1.25

- Grey lines: Andosols
- Yellow lines: Yellow soils
- Grey lines: Grey lowland soils
- Grey lines: Grey soils
- Grey lines: Peat soils

National Inventory for Japan
CH$_4$ Emissions from Rice Cultivation
Water Management Categorization

- Water management was assumed to be homogeneous intermittent-irrigation for 98% of the rice fields

- A scaling factor of 1.77 is applied for continuous flooding fields which accounted for 2% of the area
- No consideration for water regime in the pre-season

National Inventory for Japan
CH$_4$ Emissions from Rice Cultivation
Trend of CH$_4$ Emission

- CH$_4$ emission (g/ha)
- Area planted (ha)

Estimation of GHG Emissions by a Process-Based Model

- DNDC model
- Simulation and validation
- GIS data for parameters
- Regional estimation
**Direct N₂O Emissions from Chemical Fertilizer and Organic Matter Application**

**Emission Factors for N₂O from Rice**

- **Direct N₂O:** Mineral fertilizer/Animal manure
  - Paddy rice: 0.31% (from global data analysis)
  - Tea: 2.9% (from national data analysis)
  - Other crops: 0.62% (from national data analysis)
- **Direct N₂O:** Crop residues/Legumes
  - IPCC default values
- **Direct N₂O:** Organic soils
  - IPCC default values
- **Indirect N₂O**
  - Atmospheric deposition (IPCC default values)
  - Leaching and run-off: 1.24% (from global data analysis)

**Greenhouse Gas Studies in the Agricultural Sector Research Tasks**

- Mechanism
- Quantification of controlling factors
- Modeling
- Estimation
- National and global inventories
- Scaling up
- Minimizing uncertainties
- Mitigation
- Technology development and extension
- Demonstration
- Quantification of options
- Determination of trade-off
- Scaling-up
- Extension at local level

**MAGES-Workshop**

*International Workshop on Monsoon Asia Agricultural Greenhouse Gas Emission Study*

December 13-14, 2006
Tsukuba, Japan

**An International Research Project**

*MAGES Monsoon Asia Agricultural Greenhouse Gas Emission Studies*

**Targets**

- More accurate regional estimation of Agricultural GHG emissions
- Provide feasible mitigation options and their potentials
- Assess the influences of changing GHG emissions due to changes of management on regional land ecosystems and the atmosphere

**Plans in 2007**

- MAGES web-site will be open soon.
- MAGES Research Plan will be completed by summer.
- Selected papers in 2006 Workshop will be published as a special section of Soil Sci. Plant Nutr.
- Next Workshop will be held in late 2007 or 2008.
Greenhouse gas emissions caused from Livestock in Japan

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enishu@affrc.go.jp

In this presentation.....
1. Animal production in Japan
2. Major source of GHG in this section
3. CH4 caused from ruminant
4. What research are need for next step?

Main Livestock in Japan

Holstein
Japanese black cattle
Jersey
Japanese Brown cattle
Japanese shorthorn

Minor livestock in Japan

Corriedale
Suffolk
Saanen
Japanese native goat

Livestock population in Japan

GRAPH
Methane estimated source in Japan
(Ministry of the Environment, Japan 2006)

National Total CH4 Emissions in FY2004 24.4Mt (CO2eq)

<table>
<thead>
<tr>
<th>Component</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ruminant</td>
<td>34.0%</td>
</tr>
<tr>
<td>Others (Cattle, sheep, goat)</td>
<td>6.2%</td>
</tr>
<tr>
<td>Air conditioner</td>
<td>5%</td>
</tr>
<tr>
<td>Other sources</td>
<td>20%</td>
</tr>
</tbody>
</table>

GHG from Ruminant

- Ruminant (Cattle, sheep, goat) emit methane as a part of their normal digestive processes.

CH4 production represents a loss of 3 to 13% of dietary energy.

Measurement of methane production from ruminant
(Open circuit respiration apparatus)

This apparatus is used to research and analyze energy metabolism and use by gathering and analyzing the gases produced, particularly by respiration and other such operation, by domestic animals.

Method for Estimation Current Methane Emission

Dividing animals into animal group

Collecting dry matter intake (DMI) of each animal group

Estimate methane emission by Shibata's equation

\[ \text{Methane production} = 0.849 \times \text{DMI}^2 + 42.793 \times \text{DMI} - 17.766 \]

Multiplying the population by estimate methane emission for each animal group

Summing emissions across animal group

Prediction of methane emission from enteric fermentation in Japan

Average dry matter intake of cattle

(Ministry of the Environment, Japan 2006)
CH₄ emissions from enteric fermentation (kgCH₄/year/head)

<table>
<thead>
<tr>
<th>Year</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Silage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peas</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rapeseed meal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cottonseed meal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Peas meal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fishmeal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sunflower meal</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Waste</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Factors affecting methane emission from ruminant

- Feed intake level
- Digestibility of feeds
- Feed processing
- Addition of lipid (unsaturated fatty acid), and so on

"Methane emission is influenced by many factors"

To take an accurate measurement of methane in various conditions

It is need to develop simple measurement techniques of quantity of methane emission

A trial of simple measurement technique of quantity of methane emission

The research that we have to do

1. It is important to develop the technology needed to estimate CH₄ emission accurately from ruminant and practically method to reduce the amounts of CH₄.
2. Evaluation and a prediction of global warming impact on animal production.
3. We have to develop the feeding technology of livestock for warming.

Future study

*In vitro* gas production technique (Menke's method) appears to have the capacity to determine the CH₄ production potential of ruminant diets. Further studies are needed to evaluate *in vitro* technique to reflect the treatment difference among the feed.

We found that condensed tannins (CT) compounds reduced the methane emissions from goat. Therefore, it is need to study about methane reduction using cattle.
Factors affecting methane emission from ruminant

Improving animal productivity decreases methane emissions per unit of product.

Correlation methane production and liveweight gain

Methane reduction by calcium fatty acid

Emission Reduction

- Unsaturated fatty acids
- Fat rich by-products
- Ionophore
- Removing ciliate protozoa from rumen
Country Report of Cambodia: Efforts to Estimate Country-Specific Mean Annual Biomass Increment and Its Uncertainty

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National Institute for Environmental Studies  
Heng Chan Thoeun & Sum Thy  
Ministry of Environment of Cambodia

* umemiya.chisa@niees.go.jp  
February 14-15, 2007, Jakarta, Indonesia

Outline
- Overview
- Review of 1994 LUCF Inventories in NC1
- Methodology and Results of the Pilot Study
- Summary

Overview
- 3-year pilot study (completed in Mar. 2006) implemented jointly by MoEC and NIES with the financial assistance from the Asia-Pacific Network for Global Change Research CAPABLE Programme
- Lack of country-specific MAI for the top key categories of the LUCF sector
- Conducted plot-based field measurement to estimate MAI of 3 major forest types
- Estimated the uncertainty of MAI for evaluation of the measurement
- Lessons learned

1994 Inventories in NC1
- Total national uptake is bigger than total emissions by around 5,000 Gg of CO2-eq.


1994 Inventories in NC1

<table>
<thead>
<tr>
<th>Results of Key Category Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAI (Gg CO2-eq)</td>
</tr>
<tr>
<td>Category</td>
</tr>
<tr>
<td>Deciduous</td>
</tr>
<tr>
<td>-----------------</td>
</tr>
<tr>
<td>Forest &amp; Forest Plantations</td>
</tr>
<tr>
<td>Natural Forest</td>
</tr>
<tr>
<td>Other Forests</td>
</tr>
<tr>
<td>Non-forest Land</td>
</tr>
</tbody>
</table>

Methodology

Step 1: Established sample plots in 3 major forest types designated by national forest definition

- Deciduous
- Evergreen
- Secondary

2 plots for one site
Methodology

Step 2: Conducted field measurement once a year for two years
- Feb.-Apr. 2005 (1st time)
- Jan.-Feb. 2006 (2nd time)

1 year gap

- 2 separate sites for each forest type with 2 plots in each site
- Size of plots (m)
  - 20x100 (bigger plots)
  - 5x40 (sub-plot within a bigger plot)

- Items
  - Diameter (DBH), height, species of each tree


Methodology and Results

Step 3: Estimated aboveground biomass by applying a biomass regression equation

\[ Y = 42.69 - 12.800(D) + 1.242(D^2) \]

Where: \( D \) = DBH in cm


Step 4: Subtracted year 1 values from year 2 values to obtain annual increments

<table>
<thead>
<tr>
<th>Year</th>
<th>EF</th>
<th>SF</th>
<th>EF- SF</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>298.36</td>
<td>238.73</td>
<td>59.63</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>293.33</td>
<td>238.73</td>
<td>54.60</td>
<td>0.4</td>
</tr>
</tbody>
</table>

Results

Average Number of Trees within Different DBH Ranges (cm)

<table>
<thead>
<tr>
<th>DBH Range (cm)</th>
<th>EF</th>
<th>SF</th>
<th>EF-SF</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-10</td>
<td>30</td>
<td>20</td>
<td>10</td>
<td>100%</td>
</tr>
<tr>
<td>11-20</td>
<td>25</td>
<td>20</td>
<td>5</td>
<td>100%</td>
</tr>
<tr>
<td>21-30</td>
<td>20</td>
<td>20</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>31-40</td>
<td>15</td>
<td>15</td>
<td>0</td>
<td>0%</td>
</tr>
<tr>
<td>41-50</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>0%</td>
</tr>
</tbody>
</table>

Summary

- Efforts to develop country-specific MAI are encouraged as the categories are key
- AGB of forest is influenced mainly by the living condition and not necessarily by the national forest definition
- Nation-wide information of forests' living condition is desired

- Is such a map available or can be developed?
- How about the consistency with the activity data (i.e. forest area) used?

Thank You!
Estimating Mean Annual Increments of Aboveground Living Biomass and Uncertainty Analysis

Rizaldi Boer
Laboratorium of Climatology
Department of Geophysics and Meteorology
Faculty of Mathematics and Natural Sciences
Bogor Agricultural University
WGIA4, 14-15 February 2007, Jakarta

Background

- All Parties to the UNFCCC are required to report national GHG inventories
- GHG inventory reports the estimate of GHG emission and uptake, therefore country should be able to assess the long-term impacts of different land development and land-use management practices on GHG emissions and removals.
- Quality of activity data and emission factor from LULUCF is quite poor. In Indonesia, the estimates of carbon emission and uptake from this sector varied considerably from study to study due to change in assumption, activity data, emission factor and methodology.
- There is need to improve quality of activity data and emission factor as well as methodology.

GHG Inventory: Forestry Sector

Data that need to be improved

<table>
<thead>
<tr>
<th>Priority data domains</th>
<th>Importance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Converted forest area per forest type</td>
<td>6</td>
</tr>
<tr>
<td>Growth rate of forest and vegetation types (including plantations)</td>
<td>9</td>
</tr>
<tr>
<td>Forest typology (biomass-based, forest type, climatic, administrative)</td>
<td>7</td>
</tr>
<tr>
<td>Wood harvest (legal + illegal, half-life time by use)</td>
<td>2</td>
</tr>
<tr>
<td>Biomass of each forest and vegetation type</td>
<td>3</td>
</tr>
<tr>
<td>Root biomass per vegetation land use land cover type</td>
<td>2</td>
</tr>
<tr>
<td>Wood to biomass expansion factor, allometric</td>
<td>4</td>
</tr>
<tr>
<td>Abandoned land area + growth rate (increment)</td>
<td>1.7</td>
</tr>
<tr>
<td>Soil C stock (including organic soils + LU impacts)</td>
<td>1.3</td>
</tr>
<tr>
<td>On-site (in situ) burning</td>
<td>0.5</td>
</tr>
</tbody>
</table>

Source: Murdiyarso (2002)

Approach to Estimate MAI

- Estimated from common available data such as
  - mean annual diameter increment collected by forest concession companies
  - yield table or wood volume data from plantation companies or from result of forest inventory conducted by the Ministry of Forestry etc.

Approaches to Estimate Above ground Biomass and MAI of logged over forests using diameter increment data

<table>
<thead>
<tr>
<th>Diameter/Mean class (cm)</th>
<th>Volume of stems (V in m³)</th>
<th>Total Volume of stems (V in m³)</th>
<th>Diameter after growing (D in cm²)</th>
<th>Volume of stems after growing (V in m³)</th>
<th>Total Volume of stems after growing (V in m³)</th>
<th>Total Volume of stems (V in m³)</th>
<th>Total Volume of stems (V in m³)</th>
<th>Total Volume of stems (V in m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
<td>(5)</td>
<td>(6)</td>
<td>(7)</td>
<td>(8)</td>
<td>(9)</td>
</tr>
<tr>
<td>14.50</td>
<td>241.4</td>
<td>102.5</td>
<td>14.52</td>
<td>21.8</td>
<td>14.62</td>
<td>0.909</td>
<td>33.1</td>
<td></td>
</tr>
<tr>
<td>24.50</td>
<td>241.4</td>
<td>102.5</td>
<td>14.52</td>
<td>21.8</td>
<td>14.62</td>
<td>0.909</td>
<td>33.1</td>
<td></td>
</tr>
<tr>
<td>44.50</td>
<td>241.4</td>
<td>102.5</td>
<td>14.52</td>
<td>21.8</td>
<td>14.62</td>
<td>0.909</td>
<td>33.1</td>
<td></td>
</tr>
<tr>
<td>64.50</td>
<td>241.4</td>
<td>102.5</td>
<td>14.52</td>
<td>21.8</td>
<td>14.62</td>
<td>0.909</td>
<td>33.1</td>
<td></td>
</tr>
<tr>
<td>84.50</td>
<td>241.4</td>
<td>102.5</td>
<td>14.52</td>
<td>21.8</td>
<td>14.62</td>
<td>0.909</td>
<td>33.1</td>
<td></td>
</tr>
<tr>
<td>104.50</td>
<td>241.4</td>
<td>102.5</td>
<td>14.52</td>
<td>21.8</td>
<td>14.62</td>
<td>0.909</td>
<td>33.1</td>
<td></td>
</tr>
</tbody>
</table>

1. Allometric equation for estimating volume of wood is $V = 0.0000777D^{1.5}$ and
2. $D = 0.00001D^{2} - 0.00001D + 0.001B$ (B = 80-40%).
Another approaches using wood volume data

- $MAI = \frac{(WV_{vir} - WV_{log})}{Rotation} \times WD \times BEF$
  - wood volume of virgin ($WV_{vir}$) and logged-over ($WV_{log}$) forests
  - WD wood density and BEF Biomass expansion factor (1.5 for natural forest: Rahiyat, 1995)
- $MAI = \frac{(SY \times CF \times BEF)}{(Age \ of \ stand)}$
  - $SY$ stand yield in $m^3$
  - $CF$ correction factor: ratio between stand yield table and observed data collected through forest inventory

Uncertainty Analysis Using Monte Carlo Simulation

- AD = Forest/land use
category: Satellite
- $x$ = Emission
- EF = From Sampling

Approach to estimate uncertainty when the total area of an inventory region is generally known (Source: IPCC-GFG2000):

Table 9.1.1 provides an example of this procedure. The standard error of an area estimate is obtained as $SE_{Area} = \sqrt{n \times \frac{\sigma^2}{A}}$, where $n$ is the proportion of points in the particular land-use class, $A$ the base area, and $\sigma$ the total number of sample points. The 95% confidence interval for $A$, the estimated area of land use class, is given by approximately 1.64 times the standard error.

Source: IPCC-GFG (Chapter 5)
Level of uncertainty would depend on
- the complexity of LULUCF (number of land use categories)
- Size of area under study
- Resolution of images ~ area estimates of LULUCF
- Method of averaging MAI, Biomass density (non-weighted or weighted mean)

Future Works
- Assessing the impact of changing resolution of satellite image on:
  - area estimates
  - above ground biomass estimates ~ allometric equations, expansion factor (rules: as simple as possible)
  - Level of uncertainty of C-emission and C-uptake estimates ~ cost effectiveness
- Development of model for estimating MAI
- Development of more effective and efficient procedures for estimating AD and EF
Green House Gas Inventory in Malaysia

Presentation for the WGA 4
Jakarta 13-14 February 2007

By Samsudin Musa
Forest Research Institute Malaysia

Malaysia: National Communication

- National Initial National Communication 1994
- Second National Communication 2000 - on-going

Second National Communication

- FRIM appointed leading LULUCF sector - March 2004
- Working closely with several relevant departments
  - Ministry of Natural Resources & Environment (MNR)
  - Forest Department: Peninsular Malaysia, Sabah & Sarawak
  - Department of Agriculture (DOA)
  - Universiti Putra Malaysia (UPM)
  - Malaysian Palm Oil Board (MPOB)
  - Malaysian Rubber Board

Forestry in Malaysia

- Forest sector is an important economic sector
- Contributed about US$5.7 billion in 2005
- Major income earner for some State Governments
- About 60% of land covered by natural tropical forest
- Malaysia recognise the protective role of forest - environment, climate, soil, water, biodiversity, etc.
- Conserving and Managing forest on sustainable basis accorded a high priority

Forest Lands in Malaysia

- Forested lands in Malaysia categorised:
  - Permanent Reserved Forests
  - National/State Parks, Wildlife Sanc. Etc
  - Stateland Forests
- Permanent Reserved Forest categorised
  - Production Forest
  - Protection Forest

Malaysia: Distribution and Extent of Major Forest Type, 2000 (Million Hectares)

<table>
<thead>
<tr>
<th>Region</th>
<th>Inland</th>
<th>Swamp</th>
<th>Mangrove</th>
<th>Others</th>
<th>Total Forested Land</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peninsular Malaysia</td>
<td>5.500</td>
<td>0.200</td>
<td>0.100</td>
<td>0.100</td>
<td>5.900</td>
</tr>
<tr>
<td>Sabah</td>
<td>3.810</td>
<td>0.120</td>
<td>0.340</td>
<td>0.340</td>
<td>4.420</td>
</tr>
<tr>
<td>Sarawak</td>
<td>8.640</td>
<td>1.040</td>
<td>0.130</td>
<td>0.130</td>
<td>9.940</td>
</tr>
<tr>
<td>Total</td>
<td>17.950</td>
<td>1.360</td>
<td>0.670</td>
<td>0.284</td>
<td>20.160</td>
</tr>
</tbody>
</table>

Source: FOPM, FO Sabah & Sarawak
Malaysia: Forested Area By Region, 2000 & 2004 (Million Hectares)

<table>
<thead>
<tr>
<th>Region</th>
<th>2000</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peninsular Malaysia</td>
<td>5.94</td>
<td>5.90</td>
</tr>
<tr>
<td>Sabah</td>
<td>4.42</td>
<td>4.38</td>
</tr>
<tr>
<td>Sarawak</td>
<td>9.84</td>
<td>9.24</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>20.20</strong></td>
<td><strong>19.52</strong></td>
</tr>
</tbody>
</table>

Source: FOPM, FD-Sabah & Sarawak

Changes in Forested Area (Pen. M’sia)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest Reserve</td>
<td>8.00</td>
<td>7.00</td>
<td>6.00</td>
<td>5.00</td>
<td>4.00</td>
</tr>
<tr>
<td>State Land</td>
<td>6.00</td>
<td>5.00</td>
<td>4.00</td>
<td>3.00</td>
<td>2.00</td>
</tr>
<tr>
<td>Wildlife Reserve</td>
<td>2.00</td>
<td>1.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>16.00</strong></td>
<td><strong>13.00</strong></td>
<td><strong>10.00</strong></td>
<td><strong>8.00</strong></td>
<td><strong>6.00</strong></td>
</tr>
</tbody>
</table>

Selective Management System (SMS)

- Initial stocking
  - Pre-F. inv.
- Harvesting regime
  - Cutting limit
- Tagging
- Standards/Basis in SMS:
  - Diameter: 32 trees/ha (10-45 cm)
  - Volumetric: 40 - 50 m³/ha (excl. cut)
  - Ratio of Dpt. to Non-dpt
  - 50cm-D & 45cm-ND
- 25-30 years

Net Changes in CO₂ in forest and other woody Biomass stocks

<table>
<thead>
<tr>
<th>Region</th>
<th>Annual Carbon Release (Kt C)</th>
<th>Net Annual Carbon Intake (kt C)</th>
<th>Annual CO₂ Removals (Gg CO₂)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pen. Malaysia</td>
<td>4,765</td>
<td>32,744</td>
<td>120,061</td>
</tr>
<tr>
<td>Sarawak</td>
<td>17,728</td>
<td>31,684</td>
<td>116,174</td>
</tr>
<tr>
<td>Sabah</td>
<td>3,218</td>
<td>18,272</td>
<td>66,996</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>25,711</strong></td>
<td><strong>82,699</strong></td>
<td><strong>303,231</strong></td>
</tr>
</tbody>
</table>

Improvements Since the last presentation

- Key categories
  - Only managed forest is considered
  - Totally protected area not included
- Forest Conversion
  - Real 10-year average used
  - Based on FD annual reports
- Current and future work
  - Country specific increment data
  - Soil data

Data Accuracy

- Malaysia has relatively good estimates on forest extent
  - Based on periodic national inventories
  - Accepted sampling procedures and analysis
- Growth data for carbon — still using many default IPCC values
  - Plans to improve further using local growth estimates
Estimate of Extent - Inventories

- Macro Level
  - National Forest Inventory
    - ten year intervals
    - cluster plot
    - 95% confidence level
    - ± 1% sampling intensity
  - Operational Level
    - Pre-F & Post-F Inventory
      - areas open for logging
      - systematic line plot
      - 10% at 95% confidence level
  - Different in terms of sampling design, information collected and accuracy.

The National Forest Inventory has the following objectives:

- To determine the extent location of forest areas by forest types;
- To assess changes in forest resources with respect to distribution, composition, forest stocking, forest stand and total tree volume according to its quality and productivity;
- To determine the standing volume of forest areas in accordance with the forest type stratification;
- To estimate the net and gross standing volumes of specific diameter classes according to species groups/types and areas with potentials for exploitation; and
- To determine the location and assess both the quality and quantity of rattan, bamboo, palm and pandanus.

NFI method

PHASE 1
The use of satellite imagery (LANDSAT TM) for the establishment of a fixed grid of monitoring points over the entire forest area.

PHASE 2
The establishment of GIS to describe the forest situation at these grid points.

PHASE 3
Field sampling of all forest types on a random selected number of grid points according to predetermined accuracy standards.

Layout of the National Forest Inventory Plot

Minimum Sample Inventory Unit

<table>
<thead>
<tr>
<th>Forest type/Strata</th>
<th>Strata Code</th>
<th>Estimated CV (%)*</th>
<th>SE (%)</th>
<th>Min. sample unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Superior Nat. For.</td>
<td>11</td>
<td>30</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>Good Nat. For.</td>
<td>12</td>
<td>30</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>Moderate Nat. For.</td>
<td>13</td>
<td>30</td>
<td>15</td>
<td>20</td>
</tr>
<tr>
<td>Poor Nat. For.</td>
<td>14</td>
<td>55</td>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>Logged For. 11-20 yrs.</td>
<td>23</td>
<td>45</td>
<td>15</td>
<td>35</td>
</tr>
<tr>
<td>Logged For. 21-30 yrs.</td>
<td>24</td>
<td>40</td>
<td>10</td>
<td>60</td>
</tr>
<tr>
<td>Logged For. 31+ yrs.</td>
<td>25</td>
<td>35</td>
<td>10</td>
<td>50</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td></td>
<td></td>
<td>225</td>
</tr>
</tbody>
</table>

* 95% probability level
Biomass Increments

- Under National Communication estimates of forest extent, stocking (volume and density estimates) and species composition is reliable based periodical inventory—country specific data
- However, above ground biomass increments and carbon stocks are still based on default factors by IPCC

<table>
<thead>
<tr>
<th>Forest Type</th>
<th>Forest Categories</th>
<th>Area of Forest Biomass Stocks (ha)</th>
<th>Annual Growth Rate (m³/ha/yr)</th>
<th>Annual Biomass Increment (tC/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Island</td>
<td>Virgin Forest Good</td>
<td>837.63</td>
<td>5.9</td>
<td>4,938.48</td>
</tr>
<tr>
<td></td>
<td>Virgin Forest Moderate</td>
<td>723.31</td>
<td>5.9</td>
<td>4,267.55</td>
</tr>
<tr>
<td></td>
<td>Logged-over 1-10 yrs (exclude enrichment planting)</td>
<td>563.13</td>
<td>9.16</td>
<td>5,158.31</td>
</tr>
<tr>
<td></td>
<td>Logged-over 11-20 yrs</td>
<td>1,014.56</td>
<td>6.93</td>
<td>7,030.89</td>
</tr>
<tr>
<td></td>
<td>Logged-over 21-30 yrs</td>
<td>705.94</td>
<td>4.63</td>
<td>3,254.36</td>
</tr>
<tr>
<td></td>
<td>Logged-over 31+ years</td>
<td>620.32</td>
<td>4.17</td>
<td>2,586.73</td>
</tr>
<tr>
<td>PEAT swamp</td>
<td>Virgin Peat Swamp Forest</td>
<td>100.56</td>
<td>2.22</td>
<td>223.23</td>
</tr>
<tr>
<td></td>
<td>Logged-over Peat Swamp Forest</td>
<td>138.196</td>
<td>11.11</td>
<td>1,535.36</td>
</tr>
<tr>
<td>Mangrove</td>
<td></td>
<td>87.021</td>
<td>12.47</td>
<td>1,085.15</td>
</tr>
</tbody>
</table>

Mean Annual Increments

- Plans to use more country specific increment data
- Mean Annual Volume Increments has been determined under SMS to be between 2.0-2.5 m³/ha/yr
- Mean diameter increments 0.8-1.0 cm/yr
- Based on studies by Forestry Department and FAO in 1970's
- Current new data on MAI available from growth studies

Growth and Yield Studies

- Many PSP's have been established over the years for various objectives, have different plot layouts and measurement protocol
- Currently 13 growth studies located in different parts of the country being used for estimating increments
- 5 plot layouts and some differences in measurements protocols
- Studies generally indicate and volume and diameter increments are lower than that estimated under current management practice (SMS)

Biomass estimation

Estimation of forest biomass was carried out using allometric relationships obtained in this forest during IFM. This section summarizes the process work on allometric relations in Plot 1 of the Forest Reserve (Kato et al. 1978). The height (H) of a given tree can be estimated from its diameter (D) by the following formula:

\[
H_{est} = \frac{1}{1.6} \times \sqrt[1.6]{D^4}
\]

From the values of D and H, the dry mass of stems, branches, and leaves of the tree are estimated as:

\[
M_{s} = 0.03134D^{2.738}\ (\text{kg})
\]

\[
M_{b} = 0.136D^{0.715}\ (\text{kg})
\]

where \(M_{s}\) and \(M_{b}\) are the dry mass of stems, branches, and leaves, respectively. These equations were determined using the whole range of tree diameters from samples taken in regard of species in Plot 1 (Kato et al. 1978). The total above-ground biomass (TAG-B) was computed by summing the above-ground biomass of individual trees (\(M_{a} + M_{b} + M_{s}\)).
Increment Data

- From biomass estimate we can use default data to calculate carbon fraction
- These proposal are options that can be explored further to improve estimates compared to IPCC and other default values
- Constraints that there may not be applicable across the 3 regions in Malaysia
- Future – we are looking into soil estimates

Thank you
Terima Kasih
Evaluation Procedure for Carbon Stock Changes in Japanese Forest Sectors

Masahiro Amano
Waseda University

Forest land remaining forest land

- 1995 Report adopted IPCC Default Method
  \[ \Delta \text{CFFLB} = (\Delta \text{CFFG} - \Delta \text{CFFL}) \]

\( \Delta \text{CFFLB} \) = annual change in carbon stocks in living biomass
\( \Delta \text{CFFG} \) = annual increase in carbon stocks due to biomass growth
\( \Delta \text{CFFL} \) = annual decrease in carbon stocks due to biomass loss.

Forest land remaining forest land

- 2005 Report adopted Stock Change Method
  \[ \Delta \text{CFFLB} = (C_{t2} - C_{t1}) / (t2 - t1) \]

\( \Delta \text{CFFLB} \) = annual change in carbon stocks in living biomass
\( C_{t2} \) = total carbon in biomass calculated at time \( t2 \)
\( C_{t1} \) = total carbon in biomass calculated at time \( t1 \)

Japanese Inventory System focuses on Kyoto Protocol

Monitoring ARD
Preparation of orthophotos around 1990 to define forest area in 1989/12/31

Location of an ARD test area by RS

Images used in ARD monitoring test case
Identification of FM lands

- Narrow and broad interpretation of the definition of FM
  - (LULUCF GPG) ... A party could interpret the definition of forest management in terms of specific forest management practices, such as fire suppression, harvesting or thinning, undertaken since 1990. Alternatively, a country could interpret the definition of forest management in terms of a broad classification of land subject to a system of forest management practices, without the requirement that a specified forest management practice has occurred on each land.

Forest Inventory Data 1

- Forest registers
  - Attribute information
    - Area, Species, Age, DBH, Volume, Ownership
  - Number of Compartment and Sub-compartment of all private and national forests
    - Compartments: 370,000 records
    - Sub-compartments: 31,000,000 records
  - Renewal every five years
  - Linkage to boundaries in forest maps

Forest Registers Database

- Historical records of forest management
- Linkage by key code
- Linkage by polygon ID
- GIS boundaries

Forest Inventory Data 2

- Forest maps
  - 1/5000 scale maps
  - Boundaries of forest compartments and sub-compartments
  - Around 40% of the boundaries were digitized for GIS so far

Geographic Units

Identification of FM Lands by Database Linking
Forest Inventory Data 3
Forest Resource Monitoring System

Definition of Forest
Minimum Crown cover 10-30%:
A minimum height 2-5m
A minimum area 0.05-1.0ha(0.3ha)

Collection of data
(above ground biomass)

Biomass Expansion Factor (BEF$_2$) of Sugi Cedar

BEF$_2$ of Boreal Conifer
Biomass Expansion Factors of Some Typical Species in Japan

<table>
<thead>
<tr>
<th>Stand Age</th>
<th>Tree Species</th>
<th>Previous Literature</th>
<th>by added data of research project FY1988-2003</th>
<th>Estimate value by added data of forest agency project FY1997-2003</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Number r of</td>
<td>Mean ± RSE</td>
<td>Mean ± RSE</td>
</tr>
<tr>
<td>5-20</td>
<td>Cryptomeria japonica</td>
<td>118.0 ± 0.00</td>
<td>193.0 ± 0.08</td>
<td>193.0 ± 0.08</td>
</tr>
<tr>
<td></td>
<td>Abies sachalinensis</td>
<td>120.0 ± 0.00</td>
<td>193.0 ± 0.08</td>
<td>193.0 ± 0.08</td>
</tr>
<tr>
<td></td>
<td>All of broadleaf</td>
<td>120.0 ± 0.00</td>
<td>193.0 ± 0.08</td>
<td>193.0 ± 0.08</td>
</tr>
</tbody>
</table>

By T. Ishino

Belowground to Aboveground Biomass Ratio (Root-Shoot Ratio, R)

<table>
<thead>
<tr>
<th>Stand Age</th>
<th>Tree Species</th>
<th>Previous Literature</th>
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<td>193.0 ± 0.08</td>
<td>193.0 ± 0.08</td>
</tr>
<tr>
<td></td>
<td>All of broadleaf</td>
<td>120.0 ± 0.00</td>
<td>193.0 ± 0.08</td>
<td>193.0 ± 0.08</td>
</tr>
</tbody>
</table>

Forest GHG Accounting System

<table>
<thead>
<tr>
<th>Stand Age</th>
<th>Tree Species</th>
<th>Previous Literature</th>
<th>by added data of research project FY1988-2003</th>
<th>Estimate value by added data of forest agency project FY1997-2003</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Number r of</td>
<td>Mean ± RSE</td>
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<tr>
<td>5-20</td>
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<td>193.0 ± 0.08</td>
</tr>
</tbody>
</table>

By M. Matsunaga
Methodology in IPCC's GPG-LULUCF

Masahiro Amano
Waseda University

Reference Manual, Chapter 5: Land-use Change & Forestry

• page 3.17
• Changes in forest and other woody biomass stocks may be either a source or a sink for carbon dioxide for a given year and country or region. The simplest way to determine which, is by comparing the annual biomass growth versus annual harvest, including the decay of forest products and slash left during harvest. Decay of biomass damaged or killed during logging results in short-term release of CO2. For the purposes of the basic calculations, the recommended default assumption is that all carbon removed in wood and other biomass from forests is oxidized in the year of removal. This is clearly not strictly accurate in the case of some forest products, but is considered a legitimate, conservative assumption for initial calculations. Box 5 provides some further discussion of this issue.

Age distribution of forest resources
(Even-aged high forest available for wood supply)

Age distribution of Japanese forest resources
(Even-aged high forest available for wood supply)
Growth Pattern of Forests

**Equation 3.2.4**

Annual increase in carbon stocks due to biomass increment in forest land remaining forest land

\[ \Delta C_{\text{bio}} = \sum (A_b + G_{\text{bio}}) \times CF \]

- \( \Delta C_{\text{bio}} \): annual increase in carbon stocks due to biomass increment in forest land
- \( A_b \): area of forest land remaining forest land, ha
- \( G_{\text{bio}} \): average annual increment rate in total biomass in units of dry matter, by forest type (1 to 5) and climatic zone (1 to 6), ha
- \( CF \): carbon fraction of dry matter (default = 0.5), tonne C (tonne d.m.)^-1

**Equation 3.2.6**

Annual decrease in carbon stocks due to biomass loss in forest land remaining forest land

\[ \Delta C_{\text{loss}} = L_{\text{bio}} + L_{\text{other}} \]

- \( \Delta C_{\text{loss}} \): annual decrease in carbon stocks due to biomass loss in forest land
- \( L_{\text{bio}} \): annual carbon loss due to commercial felling, tonne C yr^-1
- \( L_{\text{other}} \): annual other loss of carbon, tonne C yr^-1

**Default method <<<<< Stock change method**

- In general the stock change method will provide good results relatively where very accurate forest inventories are carried out.
- The stock change method has a risk of the inventory error.
- Under some conditions incremental data may give better results.
- The choice of using default or stock change method at the appropriate tier level will therefore be a matter for expert judgment, taking the national inventory systems and forest properties into account.

**Carbon pools defined by IPCC**

- Branches & Leaves
- Trunk
- Below-ground biomass
- Dead wood
- Litter
- Soil organic carbon

**Carbon pools defined by IPCC**

- Above-ground biomass
- Below-ground biomass
- Dead wood
- Litter
- Soil organic carbon

**Table:**

<table>
<thead>
<tr>
<th>Carbon pools</th>
<th>Method for measurement</th>
<th>Feasibility y/n (only)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Above</td>
<td>Branc h &amp; Leaf, Trunk</td>
<td>y</td>
</tr>
<tr>
<td>Below</td>
<td>Sampling survey &amp; model</td>
<td>n</td>
</tr>
<tr>
<td>Litter</td>
<td>Sampling survey &amp; model</td>
<td>n</td>
</tr>
<tr>
<td>Dead wood</td>
<td>Sampling survey &amp; model</td>
<td>n</td>
</tr>
<tr>
<td>Soil organic</td>
<td>Sampling survey &amp; model</td>
<td>n</td>
</tr>
</tbody>
</table>

*Projects participants shall account for all changes in the following carbon pools: above-ground biomass, below-ground biomass, litter, dead wood, and soil organic carbon.*

*Projects participants may choose not to account for a given pool in a commitment period.*

*Transparent and verifiable information is provided that the pool is not a source.*
Conclusion

- Boreal and temperate zone
  - There are small differences of MAI between natural/plantation and among species.
  - Many stands have been composed of one or a few species.
  - There are a lot of man-made forests

- Tropical zone
  - There are big differences of MAI between natural/plantation and among species generally.
  - Many stands have been composed of various species.
  - There are a lot of natural regenerated forests and natural forests.

Forest Inventory in tropical zone requires more task than Temporal and boreal zone.
Estimating the uncertainty of C stock estimates: its implication for sampling procedures

Betha Lusiana, Melina van Noordwijk, Subekti Rahayu and Andree Ekadinata

The 4th Workshop on GHG Inventories in Asia, Jakarta - Indonesia
February 14 - 15, 2007

The IPCC Good Practice Guideline (2004) sets requirements to assess uncertainty of the national GHG inventories including for Land Use, Land Use Change and Forestry (LULUCF) sector.

Table 1. Estimated uncertainty values for CO2

<table>
<thead>
<tr>
<th>Source category</th>
<th>Emission Factor $U_e$</th>
<th>Activity Data $U_a$</th>
<th>Overall uncertainty $U_o$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy</td>
<td>7%</td>
<td>7%</td>
<td>10%</td>
</tr>
<tr>
<td>Industrial Processes</td>
<td>7%</td>
<td>7%</td>
<td>10%</td>
</tr>
<tr>
<td>Land Use Change and Forestry</td>
<td>13%</td>
<td>50%</td>
<td>60%</td>
</tr>
</tbody>
</table>

Source: Revised 1996 IPCC Guidelines for National GHG Inventories: Reporting Instruction

With the LULUCF sector responsible for about 20% of global emissions, the uncertainty in this term is unacceptably high...

Relationships between the errors in 'emission factor' and 'activity data'?

In estimating net C emissions due to land cover change 'emission factor': difference in C stock of the previous and new land cover type (the difference between two C stock estimates), 'activity data': the area where changes occurred.
If the land cover classification is very coarse (forest $\Leftrightarrow$ non-forest), the uncertainty in 'emission factor' will be large, 'activity data' are relatively easy to obtain.
If the land cover classification includes many nuances, the 'emission factors' will be well-defined, 'activity data' will have high uncertainty due to misclassification of points.

Is there an intermediate ground of 'optimal' land cover classification with minimal uncertainty in net C emissions?

AN EXAMPLE

Estimating uncertainty of C stocks: Sumberjaya catchment

Table 2. Classification error matrix

<table>
<thead>
<tr>
<th>Classified Land Use</th>
<th>Reference Land Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest</td>
<td>Multi-strata coffee</td>
</tr>
<tr>
<td>Forest</td>
<td>45</td>
</tr>
<tr>
<td>Multi-strata coffee</td>
<td>92</td>
</tr>
<tr>
<td>Simple shade coffee</td>
<td>42</td>
</tr>
<tr>
<td>Sun coffee</td>
<td>1</td>
</tr>
<tr>
<td>Rice field</td>
<td>1</td>
</tr>
<tr>
<td>Shrub</td>
<td>4</td>
</tr>
<tr>
<td>Horticulture</td>
<td>1</td>
</tr>
<tr>
<td>Others</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
</tr>
</tbody>
</table>

Source: Ekadinata (2002)

Table 3. Estimated error in land use classification

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Estimated error in land use classification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest</td>
<td>10%</td>
</tr>
<tr>
<td>Multi-strata coffee</td>
<td>32%</td>
</tr>
<tr>
<td>Simple shade coffee</td>
<td>46%</td>
</tr>
<tr>
<td>Sun coffee</td>
<td>31%</td>
</tr>
<tr>
<td>Ricefield</td>
<td>11%</td>
</tr>
<tr>
<td>Horticulture</td>
<td>60%</td>
</tr>
<tr>
<td>Shrub</td>
<td>14%</td>
</tr>
<tr>
<td>ALL</td>
<td>26%</td>
</tr>
</tbody>
</table>

Source: Ekadinata (2002)

based on 48 groundtruth points
Uncertainty: Emission factor

Carbon stock estimates and its error

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Carbon stock estimate (Mg ha⁻¹)</th>
<th>Standard deviation</th>
<th>Mean standard error σ²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest</td>
<td>232.0</td>
<td>133.5</td>
<td>29.1</td>
</tr>
<tr>
<td>Multistrata coffee</td>
<td>44.8</td>
<td>34.0</td>
<td>7.2</td>
</tr>
<tr>
<td>Simple shade coffee</td>
<td>23.5</td>
<td>12.0</td>
<td>2.9</td>
</tr>
<tr>
<td>Sun coffee</td>
<td>16.3</td>
<td>20.8</td>
<td>4.0</td>
</tr>
<tr>
<td>Rice field</td>
<td>3.0</td>
<td>1.4</td>
<td>0.6</td>
</tr>
<tr>
<td>Horticulture</td>
<td>1.9</td>
<td>1.2</td>
<td>0.5</td>
</tr>
<tr>
<td>Shrub</td>
<td>82.0</td>
<td>84.3</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Source: based on 110 sample plots from ASB (1998) and Berlton (2002)

What happened to the error if we make the land use category coarser?

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Multi-strata coffee</th>
<th>Simple shade coffee</th>
<th>Sun coffee</th>
<th>Shrub</th>
<th>Rice field</th>
<th>Horticulture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean standard error σ²</td>
<td>29.1</td>
<td>2.9</td>
<td>4.0</td>
<td>2.0</td>
<td>0.5</td>
<td>0.6</td>
</tr>
</tbody>
</table>

Calculation is based on aggregation of the original land use categories.

The error slightly decreased

Estimating landscape carbon stocks: combining both errors

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Area (km²)</th>
<th>Plot level C-stock estimate (Mg ha⁻¹)</th>
<th>Landscape level C-stock estimate (Mg ha⁻¹)</th>
<th>Incorporating classification error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forest</td>
<td>47.8</td>
<td>232.0</td>
<td>223.6</td>
<td>0.03</td>
</tr>
<tr>
<td>Multistrata coffee</td>
<td>212.7</td>
<td>44.8</td>
<td>38.7</td>
<td>0.13</td>
</tr>
<tr>
<td>Simple shade coffee</td>
<td>57.1</td>
<td>23.5</td>
<td>31.7</td>
<td>0.18</td>
</tr>
<tr>
<td>Sun coffee</td>
<td>39.4</td>
<td>16.3</td>
<td>20.6</td>
<td>0.1</td>
</tr>
<tr>
<td>Rice field</td>
<td>41.1</td>
<td>3.0</td>
<td>5.4</td>
<td>0.02</td>
</tr>
<tr>
<td>Horticulture</td>
<td>10.7</td>
<td>1.9</td>
<td>3.1</td>
<td>0.002</td>
</tr>
<tr>
<td>Shrub</td>
<td>19.6</td>
<td>82.0</td>
<td>95.4</td>
<td>0.19</td>
</tr>
<tr>
<td>Others</td>
<td>11.9</td>
<td></td>
<td></td>
<td>0.03</td>
</tr>
<tr>
<td>TOTAL</td>
<td>475.7</td>
<td>2,44</td>
<td>2,4</td>
<td>0.04</td>
</tr>
</tbody>
</table>

Results from example

- In this particular case, no tradeoff of error:
  - Optimal land use categories in this case 5 (Forest, AF coffee, Sun (mono) coffee, agriculture, bush)
- More sample plots for C stock should be taken for land use category with higher variation → FOREST
- More points for ground truth should be taken for land use category with higher uncertainty → SUN COFFEE
Is there an ‘optimal’ land cover classification?

C-Stock live tree (Mg/ha)

NDVI conceptually useful for C-stock estimation. But, shows no clear relationship. Reflectance is not enough. Thus, prior land use categories is still needed.

Next steps: estimating uncertainty in carbon stock changes

- To estimate C-stock changes, similar approach can be used.
  \[ U_k = U_{k,year1} \times U_{k,year2} \]
  \[ U_t = U_{t,year1} \times U_{t,year2} \]
- For efficiency, Year-1 C-stock estimates can still be used in Year-2. Thus efforts can be focused on reducing classification error (‘Activity’ data)
- To reduce geo-referenced error and increase the ability in detecting spatial changes, sample plots for C-stock should not be taken in edges

Next steps: estimating uncertainty in carbon stock changes

- Broad land use categories are desirable to reduce classification error. E.g., Forest, Tree-based, non-tree-based, non-vegetation, settlement. Nevertheless, C-stocks sample plots should be in finer categories structured in a hierarchy that allows grouping into the broad categories used in image classification.

Thank You

Disclaimer: This is an early version of the calculation. For more information, please contact Betha Lusiana (b.lusiana@cgiar.org)
How to estimate emissions from Wastewater Handling

Kyoto Tanabe
Technical Support Unit, IPCC NCGIP
The 4th Workshop on GHG Inventories in Asia (WGA)
14-15 February 2007, Jakarta, Indonesia

Methods for emission estimation

- Under the UNCC, Non-Annex I Parties should use 1996GLs, and are encouraged to apply GPG2000.
- However, for this category, the 2006GLs can be used to estimate emissions, because the methods are essentially the same as, and better than, the 1996GLs.
  - Reasonably simplified (e.g., distinction between wastewater and sludge has been removed [following GPG2000])
  - Wider coverage (e.g., CH₄ from uncollected wastewater)
  - Up-to-date information and data available
- Therefore, let’s see 2006GLs methods here.
- Attention!
  - Spreadsheets in the UNFCCC Inventory Software are not entirely compatible with 2006GLs calculation procedure.
  - Worksheets in Vol.5 can be used instead.

Overview of this category

- Gases to be estimated and reported
  - CH₄ and N₂O
  - CO₂ emissions are not considered because these are of biogenic origin
- Sources by type
  - Domestic (including commercial) wastewater / Industrial wastewater
  - Collected / Uncollected
  - Treated / Untreated

Important factors for CH₄ production

- Wastewater and sludge can produce CH₄ if it degrades anaerobically.
- CH₄ production depends primarily on
  - Quantity of degradable organic material
    - BOD (BOD₅) for domestic wastewater
    - COD (by dichromate method) for industrial wastewater
  - Temperature
    - Below 15 °C, significant production is unlikely
  - Type of treatment system
    - Degree to which the system is anaerobic - MCF
Estimation of CH₄ emissions

- Three tiers according to data availability
  - Tier 1: Default values for EFs and activity parameters
  - Tier 2: Same method as Tier 1 with country-specific EFs and activity parameters
  - Tier 3: Advanced country-specific method (based on plant-specific data from large wastewater treatment facilities)
- Determine the tier to use following the decision trees
- If this is a key category, Tier 2 or 3 should be used.

CH₄ from domestic wastewater treatment and discharge (Tiers 1 & 2)

- Step 1: Estimate total organically degradable carbon in wastewater (TOW) [kg BOD/yr]
  \[ TOW = P \times BOD \times 0.001 \times 1 \times 365 \]
  \[ P = \text{country population} \times \text{per capita BOD} \times \text{days/year} \]
  \[ \text{BOD} = \text{BOD per person} \times \text{population} \]
  \[ i = \text{correction factor for additional industrial wastewater discharged into sewers} \]
- Step 2: Obtain emission factors (EF) [kg CH₄/kg BOD]
  - Select the pathways and systems
  - Obtain EFs for each pathway or system
  \[ EF_j = B_j \times MCF_j \]
  \[ B_j = \text{maximum CH₄ producing capacity} \]
  \[ MCF_j = \text{methane correction factor} \]

CH₄ from industrial wastewater treatment and discharge (Tiers 1 & 2)

- Step 1: Estimate total organically degradable carbon in wastewater for industrial sector \( i \) (TOW) [kg COD/yr]
  \[ TOW = P \times W \times COD_i \]
  \[ P = \text{total industrial product for sector} \]
  \[ W = \text{wastewater generated in sector} \]
  \[ COD_i = \text{chemical oxygen demand} \]
- Step 2: Obtain emission factors (EF) [kg CH₄/kg COD]
  \[ EF = B \times MCF \] (similarly to domestic WW)

CH₄ from domestic wastewater treatment and discharge (Tiers 1 & 2)

- Step 3: Calculate emissions from TOW and EF, and adjust for possible sludge removal and/or CH₄ recovery
  \[ CH_4 \text{ emissions} = \sum \left( \frac{U_i \times T_i \times EF_j}{TOW - S} - R \right) \]
  \[ U_i = \text{fraction of population in income group} \]
  \[ T_i = \text{degree of utilisation of treatment/discharge pathway} \]
  \[ S = \text{organic component removed as sludge} \]
  \[ R = \text{amount of CH}_4 \text{ recovered} \]
- Default values for S and R = 0
**Issues on sludge**

- CH$_4$ emissions from sludge sent to landfills, incinerated or used in agriculture should not be included in this category.
- The amount of organic component removed as sludge ("S" in the equations) should be equal to the sum of:
  - amount of sludge disposed at SWDS
  - amount of sludge applied to agricultural land
  - amount of sludge incinerated or used elsewhere
- Wastewater and sludge that is applied on agricultural land should be considered in Agriculture (or AFOLU) Sector.

**Estimation of N$_2$O emissions**

- N$_2$O emissions can occur as:
  - direct emissions from treatment plants, or
  - indirect emissions from wastewater after disposal of effluent into waterways, lakes or the sea
- Typically, direct emissions are much smaller than indirect emissions.
- Except for countries that predominantly have advanced centralized wastewater treatment plants with nitrification and denitrification steps
- Industrial sources are believed to be insignificant.
- Only one tier for indirect emissions from domestic wastewater:
  - No higher tiers, no decision tree
  - Industrial wastewater co-discharged with domestic wastewater into the sewer system is included

**N$_2$O from domestic wastewater treatment effluent (indirect emissions)**

**Step 1:** Estimate total nitrogen in the effluent ($N_{EFFLUENT}$) [kg N/yr]

\[
N_{EFFLUENT} = (P \times \text{Protein} \times F_{NPR} \times F_{NON-CON} \times F_{IND-COM}) - N_{SLUDGE}
\]

- $P$ = human population [person]
- Protein = annual per capita protein consumption [kg/person/yr]
- $F_{NPR}$ = fraction of nitrogen in protein [kg N/kg protein]
- (default = 0.16)
- $F_{NON-CON}$ = fraction for non-consumed protein added to the wastewater [fraction]
- $F_{IND-COM}$ = fraction for industrial and commercial co-discharged protein into the sewer system [fraction]
- $N_{SLUDGE}$ = nitrogen removed with sludge [kg N/yr]

**N$_2$O from domestic wastewater treatment effluent (indirect emissions)**

**Step 2:** Calculate emissions by multiplying an emission factor to $N_{EFFLUENT}$

\[
N_2O \text{ emissions} [kg N_2O/yr]
= N_{EFFLUENT} \times EF_{EFFLUENT} \times 44/28
\]

- $EF_{EFFLUENT}$ = emission factor for N2O emissions from wastewater effluent discharged into aquatic environments
  [kg N$_2$O-N/kg N]$\ (N_2O-N$ is consistent with the EF for indirect N$_2$O in AFOLU$)$
- Default value is 0.005 (0.0005-0.25) [kg N$_2$O-N/kg N]
- 44/28 = factor for conversion of kg N$_2$O-N into kg N$_2$O

**For more details...**

- Default values for EFs and other various parameters can be found in Chapter 6 of Vol.5 of 2006GLs.
- Worksheets – See Annex 1 of Vol.5.
- Any questions?
SOLID WASTE DISPOSAL on LAND in INDONESIA

The 4th Workshop on Greenhouse Gas (GHG) Inventories in ASIA

by

HB Henky Sutanto – BPPT – Indonesia

Jakarta, 14-15 February 2007

FD-OD Cilowong, Serang 2004

THE MAIN PROBLEMS

460 Location of Final Disposal - Open Dumping in Indonesia

460 Unit Emitter of Green House Gas (CH4 & CO2)

21 x CO2 = CH4 (Landfill Gas & GreenHouseGas)

Time Frame of Production of CH4-Gas in SW-Landfill-Sites

Timeframe & Amount of LFG-Production from SW-Landfill
ANOTHER PROBLEMS

- How to fulfill the MDG-Targets & to eradicate:
  - Poverty
  - Illiteracy
  - Hunger
  - Unsafe & unsustainable water supply
  - Disease
  - Urban & environmental degradation

- Energy supply shortages

- Sustainability of available Airspace for the Solid Waste -Temporary & -Final Disposal.
SOLID WASTE STREAM, FROM GENERATION TO DISPOSAL
The Prediction of Solid Waste Production Growth in Indonesia

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Sumatra</td>
<td>0.10</td>
<td>1.05</td>
<td>1.43</td>
<td>2.17</td>
<td>2.44</td>
<td>2.51</td>
</tr>
<tr>
<td>Java</td>
<td>4.48</td>
<td>4.57</td>
<td>7.20</td>
<td>12.53</td>
<td>15.92</td>
<td>18.29</td>
</tr>
<tr>
<td>Kalimantan</td>
<td>0.03</td>
<td>0.32</td>
<td>0.57</td>
<td>1.04</td>
<td>1.36</td>
<td>1.62</td>
</tr>
<tr>
<td>Sulawesi</td>
<td>0.03</td>
<td>0.37</td>
<td>0.60</td>
<td>1.07</td>
<td>1.37</td>
<td>1.59</td>
</tr>
<tr>
<td>Nusa Tenggara</td>
<td>0.03</td>
<td>0.35</td>
<td>0.65</td>
<td>1.29</td>
<td>1.89</td>
<td>2.53</td>
</tr>
<tr>
<td>Maluku</td>
<td>0.01</td>
<td>0.09</td>
<td>0.18</td>
<td>0.39</td>
<td>0.63</td>
<td>1.01</td>
</tr>
<tr>
<td>Indonesia</td>
<td>0.70</td>
<td>1.80</td>
<td>3.60</td>
<td>7.00</td>
<td>10.80</td>
<td>14.80</td>
</tr>
<tr>
<td>Indonesia (Total)</td>
<td>1.70</td>
<td>5.30</td>
<td>9.30</td>
<td>19.00</td>
<td>36.40</td>
<td>56.30</td>
</tr>
</tbody>
</table>


Sources of Solid Wastes & Volume (m3/day) in Bandung – West Java Province

<table>
<thead>
<tr>
<th>Nr.</th>
<th>Source</th>
<th>Volume (m3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Housing Area</td>
<td>3.978</td>
</tr>
<tr>
<td>2</td>
<td>Market</td>
<td>613</td>
</tr>
<tr>
<td>3</td>
<td>Street</td>
<td>449</td>
</tr>
<tr>
<td>4</td>
<td>Industry</td>
<td>787</td>
</tr>
<tr>
<td>5</td>
<td>Commercial</td>
<td>312</td>
</tr>
<tr>
<td>6</td>
<td>Public Facility</td>
<td>561</td>
</tr>
</tbody>
</table>


Composition of Solid Wastes & Volume (m3/day) in Magetan – East Java Province

<table>
<thead>
<tr>
<th>Nr.</th>
<th>Art of Waste</th>
<th>Volume (m3)</th>
<th>(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Organic Materials</td>
<td>93.18</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Paper</td>
<td>3.87</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Plastics</td>
<td>3.97</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Metal</td>
<td>1.54</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Glass/Porcelain</td>
<td>0.52</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Natural Rubber</td>
<td>0.63</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Textile</td>
<td>1.72</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Others</td>
<td>1.84</td>
<td></td>
</tr>
</tbody>
</table>


POSSIBLE SOLUTIONS

- CH4 Recovery from existing SW-Final Disposal Open Dumping
- Landfill-Mining after CH4-Recovery activity
- Use of LM-Compost for erosion control activity
- Plantation of Jatropha Curcas in terraced area
- Use the Jatropha Tree as a hedge in the rural area
- Jatropha Seed processing for Non-Edible BioDiesel Oil (Liquid)
- Conversion of SWFD from existing FD Open Dumping to FD RSL I
- Development of 2nd FD RSL in New Locations
- Integrate two FD Locations in the IC-2FD RSL Spatial concept.
- CH4 Gas Recovery in every FD REUSABLE SANITARY LANDFILL (Gas)
- Landfill-Mining in FD RSL after CH4-Recovery activity, preparation works before the next filling cycle (Reuse of FD Reusable Sanitary Landfill)

SW-Final Disposal, a spatial problems

<table>
<thead>
<tr>
<th>Scenario</th>
<th>I</th>
<th>II</th>
<th>III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Heavy Equipment</td>
<td>Cat-D8</td>
<td>Cat-D8 / Cat-MC 60AC</td>
<td>Cat-MC 628B</td>
</tr>
<tr>
<td>Standard Spaces FD-RSL Mobile BPT</td>
<td>Hs.</td>
<td>2361</td>
<td>1865</td>
</tr>
<tr>
<td>Indonesia 2000</td>
<td>Hs.</td>
<td>5360</td>
<td>4280</td>
</tr>
<tr>
<td>Indonesia 2010</td>
<td>Hs.</td>
<td>6470</td>
<td>5170</td>
</tr>
<tr>
<td>Indonesia 2020</td>
<td>Hs.</td>
<td>7560</td>
<td>6032</td>
</tr>
</tbody>
</table>


METHODOLOGY OF SITE SELECTION FOR SWFD-REUSABLE SANITARY LAND DEVELOPED DURING THE WORLD-BANK PROJECT WJEMP-SERANG 3-1, Kabupaten Serang, Provinsi Banten 2003 "ONE TIME SITE SELECTION, USE IT FOREVER"
FD, SL...or...FD RSL?

SL 1 - 2005 >= 2025
SL 2 - 2025 >= 2045
SL 3 - 2045 >= 2065

TPSA.RSL 1 - 2005 >> 20xx

REUSABLE SANITARY LANDFILL, LANDFILL MINING COMPOST, SOIL CONSERVATION AND JATROPHA CURCAS L. PLANTATION

An Automotive Non Edible Bio-Diesel Oil (ANE-BDO)
& CH4-Landfillgas sustainable producer

Integrated System of Solid Waste Management to Dual Renewable Energy Generation, Catchment Area Land Conservation & Poverty Alleviation

Integrated System of Solid Waste Management to Dual Renewable Energy Generation, Catchment Area Land Conservation & Poverty Alleviation

REUSABLE SANITARY LANDFILL TECHNOLOGY
Investment Rp. 3 Million/Hektor
CH4-Power Plant, Recycling Plant, Anaerobic Compost Producer after 10 tahun Fix location, everlasting FD plant (reusable)
1 Operational-Cycle takes about 15 tahun
No need new FD location seeking, because Followed by application of Reusable Sanitary Landfill Technology

PELOT PLANT OF REUSABLE SANITARY LANDFILL
TPSA-SDL Bejiing -Ker. Purwakarta - kab. Serang Province Budget Actual: 119.5 Hektar Carrying Capacity for 1 Cycle: 100,000 kg LP/FE: 1 week 25 MWh
Total Cost: 3,000 Ton/day Investment : USD 90 Juta
(Exchange Rate USD-Rp 9,000.00 ) REUSABLE - x-Cycles
Lao People's Democratic Republic
Peace Independence Democracy Unity Prosperity

Country Report on Waste Working Group Session at WGIA 4
14 - 15 Feb 2007, Jakarta, INDONESIA.
By Khamphone KEODALAVONG
Deputy Chief of Industrial Environment Division Department of Industry (MIC).

Strengthening solid waste management

Government Policy:
- Promote the integration and development national policy, strategy, legislation and framework
- Increase institutional capacity in planning and monitoring and management
- Improve human resources and building awareness of government staff and publics
- Increase the coordination between line agencies
- Seeking technical cooperation and fund Establishing network and database system

Applicable Laws
- The Land Law - 1997
- Industrial Manufacturing Law-1999
- Decree of the Council of Minister on the Management of the City and Public Places, 1991
- The Minister's Agreement on the Rules and Regulation for Town Planing, 1996
- Prime Minister's Decree on the Organization of Urban Development and Administration Authorities, 1997

Ministries Concerned to Environmental (Wastewater and Solid Waste) Management such as:
- Ministry of Agriculture and Forestry (MAF).
- Ministry of Health.
- Ministry of Communication, Transportation; Post and Construction (MCTPC).
- Science Technology and Environment Agency (STEA)
- Ministry of Electricity and Mine
- Ministry of Industry and Commerce (MIC).

Number of Industrial Manufacturing Sector

The statistic show in 1994 to 2004:
- In 1994 : 5,946 units.
- In 2000 : 21,000 units.
- In 2004 : 26,200 units.
Capital and Industrial Wastewater

- Every industry should have wastewater treatment systems before discharge to the river.
- Total of industrial wastewater in Vientiane capital in 2002 about 8,224,000 m³/y
- Composition (sources) of wastewater

<table>
<thead>
<tr>
<th>Sources</th>
<th>Mass</th>
<th>% Share</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pulp and paper manufacturing</td>
<td>201,932</td>
<td>2.46</td>
</tr>
<tr>
<td>Meat processing</td>
<td>116,640</td>
<td>1.42</td>
</tr>
<tr>
<td>Alcohol, beer production</td>
<td>461,209</td>
<td>5.69</td>
</tr>
<tr>
<td>Textiles</td>
<td>7,444,221</td>
<td>90.52</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>8,224,000</td>
<td><strong>100 %</strong></td>
</tr>
</tbody>
</table>

Industrial Wastewater Flow

- Factory Screeniung Equalizatio
- Aeration tank
- Polishing pond
- Sedimentatio
- Fertilizer
- Belt press
- Filter

Capital and Industrial Waste

- Only 5 major towns have waste collection systems
- Disposal Methods:
  - Disposal at the landfill sites
  - Burning in open areas
  - Dumping on selected spots or water bodies
- Waste Production in urban areas 0.75 kg per capita per day.
- Composition of Solid Waste:
  - Organic Material (Compost) - 60 %
  - Reuse waste (Glass, cans) - 10-15 %
  - Recycle Waste (Plastic, Paper, Steel) - 10-15 %
  - Hazardous Waste - 10 %
  (Urban and commercial waste has the same composition)

Capital and Industrial Waste Flow

- Household and Commercial
- **Collected**
- **Factor**
- Landfill

Case Study on Solid Waste in Vientiane Capital (2002)

- In Vientiane capital has 9 districts
- The population is 636,493 belonging to 108,083 families
- The amount of solid waste about 400-500 tons/day
- Solid waste collection and disposal ability to landfill is about 50% from 4 districts and amount 120-130 tons/day and the rest 50% has been separated for recycling: Paper, Bottles, Metal, Iron, Plastic and etc

Key Issues and Barriers
- Lack of capacity in planning and management
- In sufficient technical knowledge, fund and equipment
- Low awareness of public on the impact of solid waste

The Pupils and waste economic in the future

At the present many primary and lower secondary schools in Vientiane municipality have the waste bank mean that:
Teachers in every school urged their students bring the waste that could recycle especially the paper, the waste papers and others… to sell at their school. 30% of the profit is put into the fund of school administration and 70% of the rest if used in capital to by waste from pupils. Now a day comprise of four Schools that involved the project and in the future will have 15 Schools.
With good methodology positive impact are as followed:
- The pupils learn about the value of the waste.
- The pupils learn about making income for the, decreased their parents’ payment.
- Country will be cleaned.
- The pupils will spend with great economy because they know they find it hard to earn money.

Thank you very much for your attention

E-mail: kdlvng@yahoo.com
WASTEWATER HANDLING

Reported by:

RAQUEL FERRAZ VILLANUEVA
PHILIPPINES

COMPOSITION/SOURCES OF DOMESTIC WASTEWATER

Domestic Wastewater is composed of:

- Human Waste
- Urine
- Water from Washings
- Water from Bathing

WASTEWATER FLOW FOR INDUSTRIAL WASTEWATER

For Beer Manufacturing: Weight in kgs./year = 3,456 kgs./yr.

- Domestic Wastewater - 10%
- Wash Water from equipments, tanks, etc. - 30%
- Process Wastewater - 60%

For Desiccated Coconut Manufacturing:
Weight in kgs./yr. = 2,448 kgs./yr

- Domestic Wastewater = 4.5%
- Wash Water from equipments = 4.5%
- Process Wastewater = 72%
- Wash water from the floor = 19%
SOLID WASTE DISPOSAL ON LAND

Reported by:
RAQUEL FERRAZ VILLANUEVA
PHILIPPINES

BACKGROUND PROFILE:
The Municipality of Sto. Tomas in Davao del Norte was created on August 14, 1959 through Executive Order No. 352. It has a land area of 32,641 hectares composed of 19 barangays with a total population of 84,367 with a total households of 16,810.

Solid Waste Management in the municipality started in 1994 as The Clean and Green Program, up to 2004. In order that this program will succeed two (2) Municipal Ordinances and three (3) Resolutions were passed by the municipal council.

A Solid Waste Management Board was organized to oversee the effective solid waste management of their municipality.

This municipality is one of the model sites being assisted by the Environmental Management Bureau, DENR in Region XI and is a recipient of several awards because of its successful implementation of its solid waste disposal.

SOLID WASTE COMPOSITION OF THE MUNICIPALITY OF STO. TOMAS, DAVAO DEL NORTE

SOLID WASTE STREAM FROM GENERATION TO DISPOSAL

SOLID WASTE COMPOSITION/SOURCES

Residual
- Tin Foil
- Rubber Tires
- Broken Ceramics
- Broken Bottles
- Broken Glasses
- Cigarette Filters
- Hair
- Straws
- Diapers

Weight in kilograms = 10.45 kgs.
Percentage = 52%

Biodegradable
- Food Leftovers
- Leaves
- Vegetable Peplings
- Flowers
- Roots of Plants
- Egg Shells
- Banana Stalk
- Paper
- Kitchen Waste
- Barbeque
- Animal Waste
- Sticks

Weight in kilograms = 10.45 kgs.
Percentage = 52%
### COMPOSITION/SOURCES OF SOLID WASTE

<table>
<thead>
<tr>
<th>Special Wastes</th>
<th>Recyclables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Styrofoam</td>
<td>Metal Bottles</td>
</tr>
<tr>
<td>Chemical Bottles</td>
<td>Paper Cellophane Tetra Packs</td>
</tr>
<tr>
<td>Used Batteries</td>
<td>Plastic Caps/Cover Cartons</td>
</tr>
<tr>
<td>Used Oil</td>
<td>Soft Drink Crowns Plastics</td>
</tr>
<tr>
<td>Fluorescent Bulbs, Paints</td>
<td>PET Bottles</td>
</tr>
<tr>
<td>Funeral Waste, Thinners</td>
<td>Tin Cans</td>
</tr>
<tr>
<td>Chemical Waste, Hospital Waste</td>
<td>Weight in kilograms = 1.50 kgs.</td>
</tr>
<tr>
<td></td>
<td>Percentage = 5%</td>
</tr>
<tr>
<td>Spray Canisters</td>
<td>Weight in kilograms = 5.05 kgs.</td>
</tr>
<tr>
<td></td>
<td>Percentage = 29%</td>
</tr>
</tbody>
</table>

---

**Thank You!**
Wastewater flow and solid waste stream in Thailand

Sirintornthep Towprayoon
Joint Graduate School of Energy and Environment, King Mongkut’s University of Technology Thonburi

Presented at The 4th Workshop on GHG Inventories in Asia (WGI4) 14-15 February 2007, Jakarta, Indonesia

General description of Thailand
Location: latitude 5°40’ N to 20°30’ N
longitude 97°30’ E to 105°45’ E
Area: 513,114.6 square kilometers
27% remains under forest
Climate: wet and dry seasons
annual mean temperature 27°C
Population: approx. 64 Million

Wastewater Flow
- Location of Source
  - Metropolitan
  - Municipalities
  - Cities
- Type of Source
  - Household
  - Building
  - Restaurant
  - Industry
  - Agricultural farm
- Activity data
  - Wastewater generation rate
  - Amount of wastewater
  - BOD per head

Domestic Wastewater

Domestic Wastewater Generation

<table>
<thead>
<tr>
<th>Region</th>
<th>Wastewater generation (l/capita/day)</th>
<th>1993</th>
<th>1997</th>
<th>2002</th>
<th>2007</th>
<th>2012</th>
<th>2027</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central</td>
<td></td>
<td>160-214</td>
<td>165-242</td>
<td>170-288</td>
<td>176-342</td>
<td>183-406</td>
<td>189-482</td>
</tr>
<tr>
<td>North</td>
<td></td>
<td>183</td>
<td>200</td>
<td>225</td>
<td>252</td>
<td>282</td>
<td>316</td>
</tr>
<tr>
<td>South</td>
<td></td>
<td>171</td>
<td>195</td>
<td>204</td>
<td>226</td>
<td>249</td>
<td>275</td>
</tr>
</tbody>
</table>

Source: OEPP 1995

Domestic Wastewater

<table>
<thead>
<tr>
<th>Region</th>
<th>(gm BOD/capita/day)</th>
<th>1997</th>
<th>2002</th>
<th>2007</th>
<th>2012</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central</td>
<td></td>
<td>30</td>
<td>34</td>
<td>36</td>
<td>38</td>
<td>40</td>
</tr>
<tr>
<td>North</td>
<td></td>
<td>30</td>
<td>34</td>
<td>36</td>
<td>38</td>
<td>40</td>
</tr>
<tr>
<td>Northeast</td>
<td></td>
<td>35</td>
<td>40</td>
<td>43</td>
<td>47</td>
<td>50</td>
</tr>
<tr>
<td>South</td>
<td></td>
<td>35</td>
<td>38</td>
<td>42</td>
<td>46</td>
<td>50</td>
</tr>
</tbody>
</table>

Source: OEPP 1995

On site Wastewater Treatment
Domestic Wastewater Treatment in Bangkok

Ongoing Wastewater Treatment Projects Status in 2002

<table>
<thead>
<tr>
<th>Wastewater Treatment Project</th>
<th>Service Area (ha)</th>
<th>Capacity (m³/day)</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. S. Hana</td>
<td>1.3</td>
<td>17,000</td>
<td>Operation</td>
</tr>
<tr>
<td>2. Don Muang</td>
<td>4.2</td>
<td>86,000</td>
<td>Operation</td>
</tr>
<tr>
<td>3. Rayong</td>
<td>1.1</td>
<td>32,000</td>
<td>Underconstr.</td>
</tr>
<tr>
<td>4. Chachoengsao</td>
<td>28.3</td>
<td>360,000</td>
<td>Operation</td>
</tr>
<tr>
<td>5. Rayong Oriental-Phraekarn</td>
<td>4.3</td>
<td>35,000</td>
<td>Operation</td>
</tr>
<tr>
<td>6. Phatthalung</td>
<td>33.2</td>
<td>160,000</td>
<td>Operation</td>
</tr>
<tr>
<td>7. Poon-Thong</td>
<td>55.2</td>
<td>40,000</td>
<td>Operation</td>
</tr>
<tr>
<td>8. Bang Ladla</td>
<td>36.0</td>
<td>160,000</td>
<td>Operation</td>
</tr>
<tr>
<td>9. Phra Nakhon</td>
<td>27.0</td>
<td>160,000</td>
<td>Operation</td>
</tr>
<tr>
<td>10. Nakhon</td>
<td>157.8</td>
<td>360,000</td>
<td>Operation</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>315.7</strong></td>
<td><strong>955,000</strong></td>
<td></td>
</tr>
</tbody>
</table>

Listing of the Future Wastewater Treatment Project

<table>
<thead>
<tr>
<th>Wastewater Treatment Project</th>
<th>Service Area (ha)</th>
<th>Capacity (m³/day)</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Phahurat</td>
<td>95</td>
<td>550,000</td>
<td>Preparation for the Feasibility Study</td>
</tr>
<tr>
<td>2. Watthana - Wang Tai</td>
<td>75</td>
<td>100,000</td>
<td>Construction of Feasibility Study</td>
</tr>
<tr>
<td>3. Nong Bua</td>
<td>69</td>
<td>300,000</td>
<td>within the 5th SME Plan</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>169</strong></td>
<td><strong>900,000</strong></td>
<td></td>
</tr>
</tbody>
</table>

Source: Department of Drainage and Sewerage, DSA, 2003

Solid Waste Stream

- Waste generation rate
- Waste composition
- Waste recycle

Wastewater Central Treatment Plant in Thailand

<table>
<thead>
<tr>
<th>Location</th>
<th>Number of Plants</th>
<th>Status of treatment plants</th>
<th>Capacity (m³/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Number</td>
<td>Under operation</td>
<td>Under Repair</td>
</tr>
<tr>
<td>Bangkok</td>
<td>7</td>
<td>7</td>
<td>-</td>
</tr>
<tr>
<td>1,000</td>
<td>992.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Central region</td>
<td>21</td>
<td>15</td>
<td>5</td>
</tr>
<tr>
<td>1,000</td>
<td>812.100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eastern region</td>
<td>15</td>
<td>11</td>
<td>3</td>
</tr>
<tr>
<td>1,000</td>
<td>293.900</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northern region</td>
<td>17</td>
<td>9</td>
<td>5</td>
</tr>
<tr>
<td>1,000</td>
<td>236.088</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Northwestern region</td>
<td>18</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td>1,000</td>
<td>277.082</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Southern region</td>
<td>17</td>
<td>8</td>
<td>4</td>
</tr>
<tr>
<td>1,000</td>
<td>358.320</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>95</td>
<td>59</td>
<td>20</td>
</tr>
<tr>
<td>1,000</td>
<td>2,969.40</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Waste generation and waste generation rate

<table>
<thead>
<tr>
<th>Area</th>
<th>Population</th>
<th>Waste generation (tons/day)</th>
<th>Waste generation rate (kg/cap/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Bangkok</td>
<td>5,844,607</td>
<td>9,350</td>
<td>1.6</td>
</tr>
<tr>
<td>2. City and Pattaya</td>
<td>12,203,425</td>
<td>14,661</td>
<td>1.2</td>
</tr>
<tr>
<td>2.1 Central Western region</td>
<td>3,585,595</td>
<td>4,650</td>
<td>1.3</td>
</tr>
<tr>
<td>2.2 Northern region</td>
<td>2,264,406</td>
<td>2,825</td>
<td>1.25</td>
</tr>
<tr>
<td>2.3 North-east region</td>
<td>3,239,281</td>
<td>3,134</td>
<td>0.97</td>
</tr>
<tr>
<td>2.4 Eastern region</td>
<td>1,246,151</td>
<td>1,901</td>
<td>1.53</td>
</tr>
<tr>
<td>2.4 Southern region</td>
<td>1,867,992</td>
<td>2,151</td>
<td>1.15</td>
</tr>
<tr>
<td>3. Outside City</td>
<td>44,871,653</td>
<td>17,930</td>
<td>0.4</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>63,655,458</strong></td>
<td>41,941</td>
<td>0.66</td>
</tr>
</tbody>
</table>

Waste generation in Thailand
Solid waste treatment in Thailand 2003

Treatment Technology
- Bangkok:
  - Landfill at Kampangsan, Rachadhewa,
- City and Pattaya:
  - Sanitary landfill 104 sites,
  - Incinerators 3 sites,
  - Combined technology 10 sites

Waste to Energy
- Incineration:
  - Phuket 2.5 MW
- Landfill:
  - Kampangsan 870 kW
  - Rachadhewa 935 kW
- Anaerobic Digestion:
  - Rayong 625 kW
  - Chonburi 1MW

Thank you for your attention
And
Sawasdee Ka
Country Report of Japan Management of Wastewater

Hiroshi Fujita
Climate Change Policy Division
Global Environment Bureau
Ministry of the Environment

February 14, 2007
Waste Working Group Session
The 4th Workshop on GHG Inventories in Asia (WGI-A4)

Waste in Japan
- Waste are classified into "municipal waste" and "industrial waste," in accordance to Japanese regulations.
- Industrial waste is categorized into 18 types of waste from various industries.
- Municipal waste is other wastes to be treated by municipalities and is classified into "municipal solid waste," such as garbage from households, and "hazardous waste.
- Wastewater and solid waste are treated separately.

Source of Waste
- Municipal wastewater
- Industrial wastewater
- Domestic wastewater
- Hazardous waste

Type of Waste
- Municipal solid waste
- Industrial solid waste
- Domestic wastewater
- Hazardous waste

Water Pollution Control Law

Water Quality Conservation Law
Factory Wastewater Regulation Law

These laws (1950) were limited to those situations in which damage from water quality degradation had already occurred, and did not preventively prevent degradation of water quality. Consequently, the laws were unable to provide sufficient coverage with regard to environmental conservation.

Water Pollution Control Law (1979)
1. Measures to overcome "catch-up" administrative attitude
   - Shift from specified-area regulation to national regulation
   - Uniform wastewater standards + more stringent prefectoral effluent standards
2. Regulations tightened to ensure strict compliance with standards
3. Direct penalties for violations
4. Unification of the legal system in principle

Sewerage Law

Under the Sewerage Law enacted in 1961, local government is to conduct sewage works but financial measures were lacking. For this reason, although local governments began sewage works, they were faced by financial difficulties.

- Although construction of sewers and treatment facilities was implemented by local government, house connection and conversion to flush toilets for households were left to residents. When sewage works were started, such financial burdens held back the development of house connection and flush toilets.
- When hazardous wastewater is discharged from factories into the sewerage system, it could damage sewerage facilities and harm treatment capacity of treatment facilities.
- The installation, maintenance and management of individual treatment tanks were completely left to residents.

Johkassou Law

Gappei shori johkassou
- Both miscellaneous drainage and feces and urine are treated
- Only gaspel shori johkassou has been permitted to be newly established after April 2001.

In 1983, the Johkassou Law was established to regulate the manufacture, establishment, inspection, and clearing of individual treatment tanks. Also, in 1984, regulations established localities as the basic regulating body for the installation and management of Johkassous.

Subject of Estimation

6.A Solid Waste Disposal on Land
   - 6.A.1 Controlled Landfill Sites
   - 6.A.3 Other Controlled Landfill Sites

6.B Wastewater Handling
   - 6.B.1 Industrial Wastewater
   - 6.B.2 Domestic/commercial wastewater

6.C Waste Incineration
   - Incineration
   - Used as raw materials or fuels

6.D Other
   - Decomposition of Petroleum-Derived Surfactants
Emissions estimate and trends

- Emissions from the waste in FY2004 increased by 28.7% compared to FY1990, representing 2.8% of total GHGs emissions in FY2004.
- The main reason for emission increasing is due to an increment of incinerated waste. Though the total amount of waste has been almost stable.

Management flow of Wastewater

6.B Wastewater handling

- CH₄ and N₂O emissions from '6.B Wastewater handling in 2004-FY' were 2,686 Gg CO₂eq, which have decreased by 21.2% since 1990-FY.
Recent development on Japan’s inventories with regard to solid waste disposal

Masato Yamada
National Institute for Environmental Studies, JAPAN
MSW Stream (FY2004)

Composition of MSW (for combustible waste)

MSW Statistics
- Data is obtained by measurement of every load. Municipalities, who are responsible to disposal, measure waste, recovered materials and its treated residues at the gate of plants and disposal sites.
- This statistical survey is yearly.
- The national government request for this data to prefectures.
- Waste composition data is not demanded for national statistics. However, municipalities occasionally estimate this for operation of plants and planning of waste management.

Industrial Waste Stream (FY2004)

Industrial Waste Statistics
- Data is obtained by the sample method. Prefectures send questionnaires to generators who are responsible to disposal.
- This statistical survey is usually quinquennial. Timings of survey are different for prefectures.
- The national government request for summery of this data to prefectures.
- Betweenness is interpolated using generation units of 66 industrial sectors, which denominators are economic drivers, such as shipment value, number of employees, headdress, etc.
- More detail mass flow of industrial waste streams is complemented by additional inquiry surveys and statistics from industries.

Sub Categories for SWDS
**Method for Estimation**

- First Order Decay (FOD) Model with Domestic Parameters (Tier. 3)

\[ E = \{ \sum (EF_{i,j} \times A_{i,j}) - R \} \times (1 - OX) \]

- CH4 emissions from managed disposal sites (kg-CH4)
- EF\(_{i,j}\): Emission factor of degradable waste, i disposed to site with structure, j without incineration (kg-CH4/t)
- A\(_{i,j}\): Degraded waste of degradable waste, i degradable waste disposed to site with structure, j without incineration in a inventory year (t-dry)
- R: CH4 recovery (t)
- OX: Fraction of CH4 oxidation in cover soil (-)

**Emission Factor**

- EF=[Carbon Content] x [Fraction of Gasification] x [Methane Correction Factor] x [CH4 Fraction in Landfill Gas]
  - Carbon Content
  - Fraction of Gasification (DOC): 50%
  - MCF: anaerobic=1.0, semi-aerobic=0.5
  - CH4 Fraction: 50%

**Carbon Content**

- Set by the 9 types of waste
- Kitchen garbage, Waste paper, Waste Woods
- Data sources: Result of analyses for MSW conducted by 5 cities in Japan
- Data sources: Result of analyses for MSW conducted by 5 cities in Japan
- Set by averaging all data between 1990-2004
- MSW data have been used for also ISW
- Waste natural fiber textile
  - Data sources: Carbon content of each natural fiber product data and domestic demand of each fiber
  - Set by averaging carbon content in each year from 1990 to 2004
- Sewage sludge
  - Use the upper limit of default value presented in GPG2000 on ground of Japan's domestic research results
- Human waste sludge, Livestock waste
  - Use the sewage sludge's value in consideration with properties of waste
- Waterworks sludge
  - Intermediate results of measurements at several water purification plants in Japan has been used
- Organic sludge from manufacturing industries
  - Use papermaking industry's value in view of data limitation
- Paper sludge is the main organic sludge under papermaking industry and the carbon content were calculated by the cellulose's carbon content

**Landfill Types in Japan**

- Emissions from SWDS have been calculated under two types of landfill: semi-aerobic landfill and anaerobic landfill.

  **Semi-aerobic landfill**
  - Regarding as semi-aerobic those sites which have leachate treatment facilities and subsurface containment structures.

  **Anaerobic landfill**
  - Disposal sites where landfilling started before the 1977 joint order, and all coastal and inland water landfills are treated as anaerobic disposal sites.

**Landfill types in IPCC GL**

- The "managed" landfill in Guidelines is classified to the "anaerobic landfill".

  - Traditional Sanitary Landfill
  - Western Landfill

- No or Incomplete Leachate Drain
- Minimize amount of Leachate

Emission of polluted leachate will be extend over a long period of time.

**Semi-Aerobic Landfill**

- Natural (passive) ventilation will be occurred by temperature difference between waste layer and outside air.
- Aerobic decomposition of waste can improve quality of leachate and LPG emission.
### Fraction of DOC that can decompose

- Lignin: Undegradable under anaerobic condition
- Flow out as leachate
- Gasification

Generally, the amounts of DOC lost with the leachate are low (less than 1%) and can be neglected in the calculations. (2006 IPCC Guideline)

**Is this explanation realistic in Asian Countries?**

### Activity

- Degradable waste disposed
  - Accounting amount of disposal waste other than flowing stream with incineration

\[
W_i(T) = W_i(T-1) \times e^{-kT} + w_i(T)
\]

\[
A_i(T) = W_i(T-1) \times (1 - e^{-kT})
\]

\[
k = \ln(2) / T
\]

- Degradation rate (1/yr)
- Half life of waste, T

\[
w_i = \text{[Degradable waste disposed]} \times \text{[Fraction of waste disposed to site with different structures]} \times \text{[Fraction of dry matter in waste, i]}
\]

### Activity

- Fraction of dry matter in waste

<table>
<thead>
<tr>
<th>Item</th>
<th>Dry matter content %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>10</td>
</tr>
<tr>
<td>Paper</td>
<td>20</td>
</tr>
<tr>
<td>Textile (Natural)</td>
<td>30</td>
</tr>
<tr>
<td>Sludge</td>
<td>50</td>
</tr>
<tr>
<td>Cattle Manure</td>
<td>70</td>
</tr>
<tr>
<td>Manufacture</td>
<td>50</td>
</tr>
</tbody>
</table>

### Activity

- Fraction of waste disposed to site with different structures

<table>
<thead>
<tr>
<th>Category</th>
<th>Structure</th>
<th>% dry matter</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSW</td>
<td>incombustible</td>
<td>90%</td>
</tr>
<tr>
<td></td>
<td>compostable</td>
<td>10%</td>
</tr>
<tr>
<td>Wood</td>
<td>incombustible</td>
<td>90%</td>
</tr>
<tr>
<td></td>
<td>compostable</td>
<td>10%</td>
</tr>
</tbody>
</table>

**Half Life**
- Food: 3 years
- Paper: 7 years
- Textile (natural): 7 years
- Wood: 36 years
- Sludge: 3.6 years (default)

**Delay Time**
- 6 month

### Activity

- Activity for Emission from managed SWDS

<table>
<thead>
<tr>
<th>Item</th>
<th>Degradable waste in a inventory year - 1,000 tonnes/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food</td>
<td>517 511 484 135</td>
</tr>
<tr>
<td>Paper</td>
<td>314 314 259 86</td>
</tr>
<tr>
<td>Textile (natural)</td>
<td>27 65 56 47</td>
</tr>
<tr>
<td>Wood</td>
<td>345 345 238 139</td>
</tr>
<tr>
<td>Sludge</td>
<td>397 397 273 138</td>
</tr>
<tr>
<td>Manufacture</td>
<td>52 52 52 52</td>
</tr>
<tr>
<td>Animal Nature</td>
<td>35 35 35 35</td>
</tr>
<tr>
<td>Total</td>
<td>3391 3379 2653 2259</td>
</tr>
</tbody>
</table>
Other

- CH₄ Recovery
  - For one site
  - CH₄ Usage
    - Unit: 1990 1995 2000 2004
    - Unit: 1990 1995 2000 2004
    - CH₄ Usage
    - 1990: 1.1 2.2 3.3 4.4
    - 1991: 2.2 3.3 4.4 5.5
    - 1992: 3.3 4.4 5.5 6.6
    - 1993: 4.4 5.5 6.6 7.7
  - Fraction of CH₄ oxidation in cover soil
    - 0

Structures of MSW Stream

Western Countries
- Waste Collection
- Mechanical Separation
- Anaerobic Treatment
- Landfill
- UNG recovery
- Pioneering emission of CH₄
- “Mechanical Separation” should be applicable to waste with low water content.

Japan
- Waste Source Separation
- Communities
- Collection
- Incineration
- Landfill
- New CH₄ emissions
- “Incineration” has been selected due to sanitation of waste with high water content.

Asian Countries
- Waste Collection
- Resource
- Un(aa)lements
- “Resource” includes organic materials with high water contents for composting.

Issues on Estimation of MSW stream

- Waste mass data on authorized management stream can be estimated from account (monetary) data.
  - Uncertainty will be depended on conversion from truck road to weight.
  - Installation of treatment and resource recovery facilities before disposal will improve quality of SWDS and waste statistics.
  - 3R activities including unauthorized resource recovery can significantly be change mass and composition of MSW.
    - “How to estimate the unauthorized stream” is important research issue.
    - “How to incorporate unauthorized activity to waste management” is important political issue.
- Better waste management will lead to better estimation and environment.

Co-benefit in Waste Stream Management

Future economic development will change the level of applicable technologies.

Final Disposal Technology

- Appropriate Treatment Technology
  - Source Separation
  - Resource Recovery Plant.
  - GHG Emission
  - Base Line
  - Final Disposal Technology
  - Sustainablility of System

Thank you for your attention.
Country Report of Thailand: Evolution of SWDS methane emission estimate

Siritornthep Towprayoon

Joint Graduate School of Energy and Environment
King Mongkut’s University of Technology Thonburi

Content

- Historical record of GHG emission from SWDS
- Improving of activity data
- Improving of emission factor
- Study of k value

Comparison of methane emission from SWDS using IPCC tier 1

Report in Algas Project and first NC

Methane emission from SWDS using USEPA model

Comparison of Methane emission from SWDS using Tier 1 and FOD method

Emission from FOD method

1 Masriyoom and Towprayoon 1996, 2 Komboonnaka et al 2004
Comparison of Methane emission from SWDS Using FOD method with local value (Gg/yr)

<table>
<thead>
<tr>
<th>Method</th>
<th>2004</th>
<th>2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>US EPA with default value ¹</td>
<td></td>
<td>138.5</td>
</tr>
<tr>
<td>USEPA with local Le and k value ²</td>
<td></td>
<td>97.3</td>
</tr>
<tr>
<td>Land GEM ¹</td>
<td></td>
<td>114.3</td>
</tr>
<tr>
<td>FOD with value from field measurement (close flux chamber) ³</td>
<td></td>
<td>103.1</td>
</tr>
<tr>
<td>IPCC method (Tier 1) ²</td>
<td></td>
<td>366.0</td>
</tr>
</tbody>
</table>

¹ Mastryoom and Towprayoon 1996, 2 Komboonraksa et al. 2004

Range of different emission

Improving activity data acquisitions

- More data details are studied and collected
- Increase numbers of landfill sites and basic data achieved
- Waste generation and waste generation rates are more precise at sub-district level
- More accuracy estimation is expected

Location of waste disposal site in Thailand

Waste generation and waste generation rate

<table>
<thead>
<tr>
<th>Area</th>
<th>Population</th>
<th>Waste generation (tons/day)</th>
<th>Waste generation rate (kg/cap/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Bangkok</td>
<td>5,844,607</td>
<td>9,350</td>
<td>1.6</td>
</tr>
<tr>
<td>2. City and Pattaya</td>
<td>12,203,425</td>
<td>14,661</td>
<td>1.2</td>
</tr>
<tr>
<td>2.1 Central Western region</td>
<td>3,585,595</td>
<td>4,650</td>
<td>1.3</td>
</tr>
<tr>
<td>2.2 Northern region</td>
<td>2,264,406</td>
<td>2,825</td>
<td>1.25</td>
</tr>
<tr>
<td>2.3 North-east region</td>
<td>3,239,281</td>
<td>3,134</td>
<td>0.97</td>
</tr>
<tr>
<td>2.4 Eastern region</td>
<td>1,246,151</td>
<td>1,901</td>
<td>1.53</td>
</tr>
<tr>
<td>2.4 Southern region</td>
<td>1,867,992</td>
<td>2,151</td>
<td>1.15</td>
</tr>
<tr>
<td>3. Outside City</td>
<td>44,871,653</td>
<td>17,930</td>
<td>0.4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>63,655,458</td>
<td>41,941</td>
<td>0.66</td>
</tr>
</tbody>
</table>

Improving Emission Factor

- Waste composition has been investigated and archived as database at sub-district level
- DOC by each site is available
- Study of k value has been done
- More accuracy estimation is expected
K value by type of Landfill

<table>
<thead>
<tr>
<th>Type of Landfill</th>
<th>Site</th>
<th>Year</th>
<th>Age (yr)</th>
<th>Clogging (vol)</th>
<th>WOF</th>
<th>DOC</th>
<th>Lo</th>
<th>K</th>
</tr>
</thead>
<tbody>
<tr>
<td>Managed - Deep</td>
<td>Pete</td>
<td>2002</td>
<td>3</td>
<td>219.63</td>
<td>1</td>
<td>0.1487</td>
<td>106.96</td>
<td>0.273</td>
</tr>
<tr>
<td></td>
<td>Hua-He</td>
<td>1996</td>
<td>9</td>
<td>45.51</td>
<td>1</td>
<td>0.2126</td>
<td>181.90</td>
<td>0.263</td>
</tr>
<tr>
<td></td>
<td>Leninc</td>
<td>1999</td>
<td>6</td>
<td>120.20</td>
<td>1</td>
<td>0.2097</td>
<td>146.64</td>
<td>0.21</td>
</tr>
<tr>
<td></td>
<td>Male</td>
<td>2001</td>
<td>4</td>
<td>60.40</td>
<td>1</td>
<td>0.1274</td>
<td>124.60</td>
<td>0.216</td>
</tr>
<tr>
<td></td>
<td>Recl</td>
<td>2002</td>
<td>4</td>
<td>3,350.30</td>
<td>1</td>
<td>107.97</td>
<td>107.97</td>
<td>0.102</td>
</tr>
<tr>
<td>Managed - Shallow</td>
<td>Cha-</td>
<td>2000</td>
<td>5</td>
<td>26.30</td>
<td>1</td>
<td>0.1482</td>
<td>120.90</td>
<td>0.218</td>
</tr>
<tr>
<td></td>
<td>Noro</td>
<td>1987</td>
<td>8</td>
<td>160.20</td>
<td>0.8</td>
<td>0.1809</td>
<td>109.21</td>
<td>0.0924</td>
</tr>
<tr>
<td></td>
<td>Norok</td>
<td>1985</td>
<td>20</td>
<td>80.50</td>
<td>0.8</td>
<td>0.1541</td>
<td>88.64</td>
<td>0.302</td>
</tr>
<tr>
<td></td>
<td>Sand</td>
<td>1989</td>
<td>6</td>
<td>80.00</td>
<td>0.8</td>
<td>0.2135</td>
<td>122.85</td>
<td>0.0569</td>
</tr>
<tr>
<td>Unmanaged - Shallow</td>
<td>Lorn</td>
<td>1993</td>
<td>12</td>
<td>3.50</td>
<td>0.4</td>
<td>0.1760</td>
<td>50.63</td>
<td>ND</td>
</tr>
<tr>
<td></td>
<td>Raye</td>
<td>2001</td>
<td>4</td>
<td>69.11</td>
<td>0.4</td>
<td>0.1688</td>
<td>45.11</td>
<td>0.007</td>
</tr>
</tbody>
</table>

Managed-Deep 0.016-0.21  Managed-Shallow 0.018
Unmanaged ND - 0.007

K value and site age

Thank you for your attention
And
Sawasdee Ka
Session II
GHG Inventory Report by Sector

Energy Sector

Participants
- 16 participants, 8 countries
- mixture of people who were experts in the field and others who were here to learn more about the energy sector
- Mr. Saleh Abdurrahman (Indonesia), Ms. Lili Handayaningrum (Indonesia), Mr. Haneda Sri Mulyanto (Indonesia), Dr. Agus Nurrohim (Indonesia), Mr. Amin Suwanto (Indonesia)
- Dr. Shuho Nishio (Japan), Dr. Yukhiro Nojiri (Japan)
- Mr. Young Yoon Kim (Korea), Mr. Yong Gi Lim (Korea), Mr. Donghoon Yoo (Korea), Mr. Chan-Gyu Kim (Korea)
- Mr. Imnai Inhaboavaly (Lao)
- Mr. Thein Tun (Myanmar)
- Ms. Shu Yee Wong (Singapore)
- Dr. Yute Wangwacharakul (Thailand)
- Dr. Huy Phuong Bui (Vietnam)

Key Points
- Find other uses for the data so it is easier to ask for it to be produced
- Pay attention to new technologies and adapt calculations accordingly
- Decide whether to use IPCC defaults or develop country-specific values based on need
- Need to determine targets for WGIA5

Indonesia
- uses a combination of reported figures and calculated figures
- for energy sector, tends to use supply side figures as there is more accurate data available for the supply side than for the consumption side
- fuel is subsidized rather than taxed, so not easy to use government records in the calculations
- generally makes rough estimates from their Energy Balance

Japan
- uses country-specific values, capable of producing very detailed statistics in this sector
- very long history of creating statistics for the energy sector as a part of its Energy Balance
- various ministries produce their own data (METI supplies the Energy Balance, Ministry of Forestry gives stats for forestry), but Ministry of the Environment is responsible for coordinating the inventories
- required to report its data annually which necessitates having an institutional structure in place for creating these reports — results in a high level of coordination
- this sector is not really a target for future development as it is already mature

Korea
- still undergoing industrial restructuring, so important to refine the inventory now, while in development stage
- Ministry of Commerce and Industry (equivalent to Japan’s METI) collect activity data from other ministries (e.g. forestry) and other government entities (e.g. Korean gas and oil entities), and improve upon and publish the data
- shifting to cleaner, more efficient energy, so need to develop country-specific values — government-industry collaboration working towards developing these values
- now working on quality control and quality assurance
- refining their inventories by focusing on the development of country-specific values, ensuring that the calculations are up-to-date and that they reflect the current pace of technological development, and reporting their results back to industries
Lao
- system for collecting data is not yet adequate
- many improvements needed
- currently working on its second communication and working on improving data collection methods

Myanmar
- ALGAS was a study of national GHG emissions for 12 Asian countries
- mostly use supply-side figures in their inventories

Singapore
- has the advantage of being small, so its inventories can be simplified in some ways
- currently working on creating an Energy Balance and trying to close their data gaps.
- uses IPCC default values and has no plans to develop country-specific values at this time

Thailand
- uses top down calculations as a basis rather than bottom-up
- enough activity data available to make estimates
- Ministry of Energy is responsible for supplying and coordinating the data
- uses IPCC defaults for emission factors
- at this stage, compared to other sectors, the energy sector is relatively low priority for developing country-specific values
- inventories are basically only used for national communications at this point

Vietnam
- some main energy indicators in the national statistics, but the data is not adequate
- trying to use the data in the energy sector, but it is very difficult and has been taking a long time
- currently working on their second communication and trying to update the data
- lack of activity data is causing problems
- need to develop capacity for a national inventory group and policy-making

Key Point: Find Other Uses
- it is difficult (i.e. too expensive) to ask for statistics to be prepared only for the inventory
- if the data can be used in other kinds of analyses, it will be easier to ask for it to be collected
- it can also be fed back to the commercial sector so that companies can refine their emission strategies
Key Point: New Technologies

- in Asian countries, which are experiencing rapid development, it is necessary to pay attention to new technologies that can enhance efficiency and decrease emissions.
- certain industries should be examined on a regular basis (e.g. yearly, every five years) for new technologies that necessitate the recalculation of emission factors.

Key Point: IPCC vs. Country-Specific

- some countries that have already submitted one or two national communications may want to refine their results based on country-specific values.
- difference between the IPCC values and the country-specific values is not large in many cases, so it can be more cost-effective for certain countries to continue to use the IPCC values rather than spending a large amount of time and resources developing country-specific values.

Key Point: Target for Next WGIA

- come up with specific core activities to focus on in the energy sector before WGIA5.
- study specific cases and see what can be done to improve upon them.
- information exchange that takes place at WGIA is only the first step.
- need to set targets and work together to make improvements.
AGRICULTURE WG REPORT
Report presented during the 4th WGIA, 15 February 2007, Jakarta, Indonesia

Agriculture WG
- Chair – Dr. Batima Purualmaa (Mongolia)
- Reporter – Dr. Damasa Macandog (Philippines)
- Members:
  - Mr. Dominique Revet (UNIDO)
  - Dr. Osamu Enami (Japan)
  - Dr. Kazuyuki Yagi (Japan)
  - Dr. Nguyen Khac Tich (Vietnam)
  - Mr. Shuhaimi Ismail (Malaysia)
  - Dr. Mohamad Z. Abdul Ghani (Malaysia)
  - Mr. Muslihuddin (Indonesia)
  - Mr. Chan Thou Chea (Cambodia)

CH₄ emissions from rice ecosystems

Methane emissions from rice fields: Controlling factors:
- Soil properties
- Temperature
- Cultural practices (water regime/drainage, fertilizer, seeding/transplanting, straw/residue management)
- Rice variety

The Interregional Research Programme on Methane Emissions from Rice Fields
- International Rice Research Institute, Fraunhofer Institute for Atmospheric Environmental Research, Agricultural Research Institutes of China, India, Indonesia, Philippines and Thailand
- Funded by United Nations Development Program, Global Environmental Facility (UNDP/GEF GL0/91/G31)
- 1993-1999

- 109 -
Rice production and methane emissions

Management practices can be modified to reduce emissions without affecting yield
- Intermittent drainage in irrigated systems reduces emissions and also saves water
- Improved crop residue management can reduce emissions
- Direct seeding results in less labor and water input and reduce methane emissions
- Plants grown under good nutrition exhibit reduced methane emissions

Approach

- Closed chamber method

Countries with data from this approach:
- IRRI project – Philippines, Indonesia, Thailand, China, India
- Japan

Countries without data:
- Malaysia, Cambodia, Vietnam

Rice Ecosystem Activity Data Status

<table>
<thead>
<tr>
<th>Activity Data</th>
<th>Cam</th>
<th>India</th>
<th>Indonesia</th>
<th>Japan</th>
<th>Malaysia</th>
<th>Mongolia</th>
<th>Phil</th>
<th>Viet</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water regime</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Aggregated</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
</tr>
<tr>
<td>b. Disaggregat ed</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
</tr>
<tr>
<td>Organic Amendment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>a. Aggregated</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. Disaggregat ed</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
</tr>
<tr>
<td>c. No available data</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
<td>▲</td>
</tr>
</tbody>
</table>

COUNTRY SPECIFIC CH₄ EF FROM RICE ECOSYSTEMS

- With country-specific EF:
  - Japan
  - Philippines

- Without country-specific EF:
  - Indonesia
  - Malaysia
  - Cambodia
  - Vietnam

CH₄ & N₂O Source Database for Rice Fields

Field measurements in Asia
(103 site, 808 seasonal data)

Analysis by mixed linear model
$log(ef) = \beta_0 + \beta_1 \times \text{type of soil} + \beta_2 \times \text{straw amendment} + \beta_3 \times \text{compost amendment} + \beta_4 \times \text{water} + \text{errors}

National Inventory for Japan
CH₄ Emissions from Rice Cultivation

<table>
<thead>
<tr>
<th>Type of soil</th>
<th>No. of data</th>
<th>Straw amendment</th>
<th>Various compost amendment</th>
<th>No amendment</th>
<th>Proportion of area</th>
</tr>
</thead>
<tbody>
<tr>
<td>Andosol</td>
<td>2</td>
<td>8.50</td>
<td>7.59</td>
<td>6.07</td>
<td>11.9</td>
</tr>
<tr>
<td>Yellow soil</td>
<td>4</td>
<td>21.4</td>
<td>14.6</td>
<td>11.7</td>
<td>9.4</td>
</tr>
<tr>
<td>Lowland soil</td>
<td>21</td>
<td>19.1</td>
<td>15.3</td>
<td>12.2</td>
<td>41.5</td>
</tr>
<tr>
<td>Gley soil</td>
<td>6</td>
<td>17.8</td>
<td>13.8</td>
<td>11.0</td>
<td>30.8</td>
</tr>
<tr>
<td>Peat soil</td>
<td>2</td>
<td>26.8</td>
<td>20.5</td>
<td>16.4</td>
<td>6.4</td>
</tr>
</tbody>
</table>

- Based on field monitoring campaign during 1992-1994 at 35 sites over Japan
- Measured by conventional water management with mid-season drainage followed by intermittent flooding
Methane emission factors from rice fields in the Philippines.

<table>
<thead>
<tr>
<th>Ecosystem</th>
<th>Mean emission (mg/m²/day) from Sites</th>
<th>Emission Factor (kg/ha/day)</th>
<th>% Decrease from IPCC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Los Baños</td>
<td>233.1</td>
<td>225.5</td>
<td>Mean Derived IPCC</td>
</tr>
<tr>
<td>Malaya</td>
<td>229.3</td>
<td>2.3</td>
<td>5.9</td>
</tr>
<tr>
<td>Derived IPCC</td>
<td>61</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rainfed</td>
<td>40.3</td>
<td>40.3</td>
<td>0.4</td>
</tr>
<tr>
<td>Derived IPCC</td>
<td>89</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2006 IPCC Guidelines
Methodology for CH₄ Emissions from Rice Cultivation

Table 5.10

<table>
<thead>
<tr>
<th>CH₄ emission (kg/ha²/year)</th>
<th>Emission Factor</th>
<th>Error range</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.30</td>
<td>0.80-2.20</td>
</tr>
</tbody>
</table>

A baseline emission factor for:
- no flooded fields for less than 180 days prior to rice cultivation
- Continuously flooded during the rice cultivation period
- without organic amendments

CH₄ Emission from Enteric Fermentation

- Activity Data on Number of heads of different ruminants
- available for all countries
- National Statistics data
- Bureau of Animal Industry

Method for Estimation Current Methane Emission

Dividing animals into animal group

Collecting dry matter intake (DMI) of each animal group

Multiply the population by estimate methane emission for each animal group

Summing emissions across animal group

Prediction of methane emission from enteric fermentation in Japan

A trial of simple measurement technique of quantity of methane emission
Steps for Improvements of Activity Data in Agriculture:
- Statistical Yearbooks
- Agricultural Statistics
- Seek help for data gathering from National Ministries (Agriculture, Environment) and regional offices
- Experts' opinion
- Documentation/Archiving (sources, comments)
- Sampling to obtain data

Steps for Improvements of EF
- Develop a technology needed to estimate CH₄ emission accurately from ruminants
- For countries without country-specific EF, use EF values from other countries with similar climatic conditions and cultural practices
- Consult the EFDB
- Modeling, equations (Shiibata’s eqn)

Future directions
- Organic C in soil
- N₂O emissions from N inputs (inorganic fertilizer, manure, crop residues)
- CH₄ and N₂O emissions from residue burning
- Feed type and feed composition vs CH₄ emissions from ruminants
- Proper archiving of AD and EF (sources, notes, comments)
- Listing of AD, EF, data gaps, institutionalization of data gathering and compilation of AD and EF for national GHG inventories

THANK YOU!
Summary from LUCF Working Group

Chair: Rizaldi Boer
Reporter: Heng Chan Thoeun
Member: Chisa Umemiya, Samsudin Musa, Masahiro Amano, Bethia Lusiana, Dadang Hilmant ...

Key Issues
- Methods for deriving Mean Annual Increment
- Approaches to estimate the uncertainty of the estimates
- Experiences in using IPCC-GPG Guidance for LULUCF (Stock Change Approach)
- Proposals for Improving National Capacity to improve National GHG Inventory for LUCF sector

Methods for deriving MAI
- Indonesia presented a number of approaches to estimate MAI:
  - Natural Forest (Logged-over forest) using Reported Tree Diameter Increment Data collected by Forest Concession Companies
  - Plantation Forest using Wood Volume Data
- The selection of MAI for a certain forest categories has huge impact of the estimate of carbon removal. Level of certainty for the MAI for such forest categories is very crucial to increase the reliability the estimates. The key forest categories (of the 26 land use/forest categories) for Indonesia were production forest, conversion forest, rubber plantation and coconut/palm oil plantation. These four forest categories contributed to about 52% of total carbon removal of the country

Methods for deriving MAI
- Cambodia experience from field measurement study on MAI, ecological condition of forests affect very much on the MAI. However, such information is not taken into account in making Cambodia 1994 inventory as inventories were developed based on national forest classification only
- Malaysia has conducted good forest inventories four times (every 10 years) and the results are a good basis for improving the National GHG Inventory for LUCF sector. However, such resources have not been used by the National Inventory Team.

Approaches to estimate the uncertainty of the Estimates
- Indonesia presented two cases in assessing the uncertainty of the GHG Inventory for LUCF:
  - Monte Carlo simulation is found to be a good approach however this approach may lead to a greater uncertainty if the availability of the data is limited (e.g. Monte Carlo simulation requires information on standard deviations of the AD and EF where these values are readily available). Malaysia could be benefit from using this approach as it has better database of the AD and EF from its forest inventory.

Approaches to estimate the uncertainty of the Estimates
- ICRAF demonstrated the relationship between simplifying land use/forest categories (AD) and overall uncertainty of the Carbon stock estimates
  - Broad land use categories are desirable to reduce classification error (e.g. Forest, Tree-based, non tree-based, non-vegetation, settlement), however, there is a need to have C-stock samples in finer categories structured in a hierarchy that allows grouping into the broad categories used in image classification (to ensure that the combined land use/forest categories have slight different in C-Stock)
Experiences in using IPCC-GPG Guidance for LULUCF (Stock Change Approach)

- Japan has applied Carbon Stock Approach (IPCC-GPG for LULUCF) in developing its GHG inventory. Some important findings
  - The stock change method will provide good results if very accurate forest inventories are available, otherwise default method is recommended
- The choice of using default or stock change method at the appropriate tier level will therefore be a matter for expert judgment.

Experiences in using IPCC-GPG Guidance for LULUCF (Stock Change Approach)

- The challenges for tropical countries are
  - There are big differences of MAI between natural/plantation and among species,
  - Many stands composed of various species, and
  - There are a lot of natural regenerated forests and natural forests
- Single approach may not provide good inventory in tropical zone and tropical countries will need more works to do related to the above issues
- In the context of NATCOM, can developing countries use combination of the two approaches as appropriate?

Proposals for Improving National Capacity to improve National GHG Inventory for LUCF sector

- The WGIA should play role in facilitating the countries to
  - develop link and collaboration with other national, regional, international organizations to improve their inventories (e.g. opening access to satellite image database owned by the organizations)
- NIES may need to focus on disseminating works that have been done by the WGIA and how the countries can make use of these group to contribute to the process of the development of National GHG Inventories (e.g. developing list of targeted stakeholders/sectors that should receive the publications/articles produced by the NIES and the Group etc)

Proposals for Improving National Capacity to improve National GHG Inventory for LUCF sector

- For tropical countries, more supports are needed to improve their GHG inventories for LUCF sector
Report on WG: Waste

Chair: Dr. Sirintornthep Towprayoon
Reporter: Dr. Masatoshi Yamada
Participants: Mr. HB. Henky Sutanto, Ms. Upik Sitti Aslia,
Mr. Hiroshi Fujita, Mr. Khamphone Keodalavong,
Mr. Ne Winn, Ms. Raquel Ferraz Villanueva
and Mr. Kiyoto Tanabe

7 countries/organization and 9 participants

Theme one: Wastewater treatment and discharge

Presentations

- Methodology in IPCC's Guidelines
  by Mr. Kiyoto Tanabe
- Country Report: Philippines
  by Ms. Raquel Ferraz Villanueva
- Country Report: Lao PDR
  by Mr. Khamphone Keodalavong
- Country Report: Indonesia
  by Mr. HB. Henky Sutanto and Ms. Upik Sitti Aslia
- Country Report: Myanmar
  by Mr. Ne Winn
- Country Report: Thailand
  by Dr. Sirintornthep Towprayoon
- Country Reports: Japan
  by Mr. Hiroshi Fujita

Discussion (1): Comparision of wastewater flow in Asia

- Domestic WW flow
  - There are 4 types of flow in Asia
    - Untreated to river/sea
    - Septic tank to river/sea
    - Septic tank via sewer collection to river/sea
    - Septic tank through sewer collection to central treatment plant and discharging to river/sea
  - These flows are dependent on type of septic tank
  - The flowchart in 2006 guideline is not enough for Asian Countries.
Management flow of Wastewater

Discussion (1): Comparison of wastewater flow in Asia
- Domestic WW flow
  - There are 4 types of flow in Asia
    - Untreated to river/sea
    - Septic tank to river/sea
    - Septic tank via sewer collection to river/sea
    - Septic tank through sewer collection to central treatment plant and discharging to river/sea
  - These flows are depend on type of septic tank
  - The flowchart in 2006 guideline is not enough for Asian Countries.

Discussion (2): Comparison of wastewater flow in Asia
- Industrial WW flow
  - should depend on type of industry
    - Uncollected & untreated: small factory
    - Organics is mainly contained in WW from Food, Pulp and paper, Chemical, Textile... industries
    - Make attention to fate of sludge.

Industrial Wastewater Flow

Lao PDR
Discussion (3): Other Issues

- **Mixing of Domestic and Industrial WW**
  - is not common in Asian Countries.
- **EF**
  - MCF: less information in Asian countries.
  - We can use 2006 guideline data if they fit to Asian countries.

Theme two: Solid waste disposal on land

Presentations

- **Country Reports: Lao PDR**
  by Mr. Khamphone Keodalavong
- **Country Reports: Indonesia**
  by Mr. HB. Henky Sutanto
- **Country Reports: Philippines**
  by Ms. Raquel Ferraz Villanueva
- **Country Reports: Thailand**
  by Dr. Sirintornthep Towprayoon
- **Country Reports: Japan**
  by Dr. Masato Yamada

Discussion (4): Comparison of Solid Waste Stream in Asia

- **2 Waste recycling activities**
  - Separation at Source (or House): almost every countries for valuables
  - Material Recovery Facility: some countries (Philippines, Thailand)
- **Access to data on recycling is possible.**
- **Pre-treatment (or waste reduction) technologies in Asian countries are composting and incineration.**
- **Waste stream of each countries is also affected from policy of local municipality, law, society...**

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**SOLID WASTE STREAM FROM GENERATION TO DISPOSAL**

- Segregation at Source
  - Recyclables
  - Residuals
  - Biodegradable
  - Materials Recovery Facility
  - COMPOSTING

- Segregation at MRF
  - Residuals
  - Biodegradable
  - Sell to Junkshop or Livelihood Products
  - LANDFILL
  - COMPOSTING

Current MSW flow Thailand

Waste generate from sources

- Waste stream 1
  - Valuable waste 1
    - Collected by tricycle

- Waste stream 2
  - Valuable waste 2
    - Collected by collectors

- Waste stream 3
  - To landfill
  - Valuable waste 3
    - Collected by scavengers
**Discussion (5): Comparison of Solid Waste Stream in Asia and Others**

- **Database on mass and quality (or composition) of waste and its continuity is important.**
  - This can be also used for future improvement of management with incineration, RDF, Waste to Energy or so on...
  - Composition will be change due to growing recycling activities.
  - Data acquisition is important. Guideline could be helpful.
- **Main co-benefit in improvement of waste management such as waste recycling and energy recovery depends on country's situation.**

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**Capital and Industrial Waste**

- Only 5 major town has was collection systems
- Disposal Method: Lao PDR
  - Disposal at the land field sites
  - Burning in open areas
  - Dumping on selected spots or water body
- Waste Production in urban areas 0.75 kg per capita per day.

**Composition of Solid Waste:**
- Organic Material (Compost) - 60%
- Reuse waste (Glass,can...) - 10-15%
- Recycle Waste (Plastic , Paper, Steel...) - 10-15%
- Hazardous Waste - 10%

(Urban and Commercial Waste has the same composition)
Discussion (5): Comparison of Solid Waste Stream in Asia and Others

- Database on mass and quality (or composition) of waste and its continuity is important.
  - This can be also used for future improvement of management with incineration, RDF, Waste to Energy or so on...
  - Composition will be change due to growing recycling activities.
  - Data acquisition is important. Guideline could be helpful.
- **Main co-benefit in improvement of waste management such as waste recycling and energy recovery depends on country’s situation.**

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Thank you for your attention
Quality Assurance/Quality Control and Verification

Kyoto Tanabe
Technical Support Unit, IPCC NGGIP
The 4th Workshop on GHG Inventories in Asia (WGA)
14-15 February 2007, Jakarta, Indonesia

Outline
- Aims
- Definition (from 2006 IPCC Guidelines)
- Practical considerations
- Major elements

QA/QC and Verification – Why?
- QA/QC and verification procedures serve:
  - to develop national GHG inventories that can be readily assessed in terms of quality
  - to drive inventory improvement
- A QA/QC and verification system contributes to improvement of national GHG inventory
  - Transparency
  - Consistency
  - Comparability
  - Completeness
  - Accuracy

What is “Quality Control”?
- System of routine technical activities to assess and maintain the quality of the inventory as it is being compiled
- Performed by personnel compiling the inventory
- QC system is designed to:
  - Provide routine and consistent checks to ensure data integrity, correctness, and completeness
  - Identify and address errors and omissions
  - Document and archive inventory material and record all QC activities

What is “Quality Assurance”?
- Planned system of review procedures conducted by personnel not directly involved in the inventory compilation/development process (preferably by independent third parties)
- Performed upon a completed inventory following the implementation of QC procedures
  - Verify that measurable objectives were met
  - Ensure that the inventory represents the best possible estimates given the current state of scientific knowledge and data availability
  - Support the effectiveness of the QC programme

What is “Verification”?
- Collection of activities and procedures conducted during the planning and development, or after completion of an inventory that can help to establish its reliability for the intended applications of the inventory
- Methods that are external to the inventory and apply independent data, including comparisons with inventory estimates made by other bodies or through alternative methods
- May be constituents of both QA and QC
**Inventory Development Cycle**

- Start new estimate, building on experience of previous inventories (if available)
- Report inventory
- Check/Review inventory through QA
- Conduct key category analysis
- QC Checking & Documentation
- Collect data and estimate emissions/removals ensuring adequate QA/QC & time series consistency
- Conduct uncertainty analysis: Evaluate input data and assess overall inventory
- Compile inventory: considering time series consistency and QA/QC
- Identify key categories
- Select methods while considering data collection, uncertainty and time series consistency good practice
- QC Checking & Documentation

**Practical Considerations**

- Seek to achieve the balance of both requirements
  - QC requirements
    - Improved accuracy
    - Reduced uncertainty
  - Requirements for timeliness & cost effectiveness
- Also seek to enable continuous improvement of inventory estimates
- Try to identify where to focus more intensive analysis and review

**Major Elements**

- Participation of an inventory compiler who is also responsible for coordinating QA/QC and verification activities and definition of roles/responsibilities within the inventory
- A QA/QC plan
- General QC procedures that apply to all inventory categories
- Category-specific QC procedures
- QA and review procedures
- QA/QC system interaction with uncertainty analyses
- Verification activities
- Reporting, documentation, and archiving procedures

**Roles and Responsibilities**

- The inventory compiler should:
  - Be responsible for coordinating the institutional and procedural arrangements for inventory activities.
  - Define specific responsibilities and procedures for the planning, preparation, and management of inventory activities.

**QA/QC Plan**

- Fundamental element of the system
- Should include a scheduled time frame for the QA/QC activities
- A key component – List of data quality objectives (measurable)
- Important to accommodate procedural changes and a feedback of experience
  - The periodic review and revision of the QA/QC plan is an important element to drive the continued inventory improvement.

**General QC Procedures**

- Generic quality checks applicable to all source and sink categories, related to:
  - Calculations
  - Data processing
  - Completeness
  - Documentation
- Automated checks are encouraged where possible – to effectively check large quantities of input data
**Category-specific QC Procedures**
- Complements general QC procedures
- Directed at specific types of data used in the methods for individual source or sink categories
- Applied on a case-by-case basis focusing on:
  - Key categories
  - Categories where significant methodological and data revisions have taken place

**QA Procedures**
- Activities outside the actual inventory compilation, performed preferably by third party reviewers who are independent from the inventory compiler
  - Expert peer review
  - Audits
- Priority should be given to:
  - Key categories
  - Categories where significant methodological and data revisions have taken place

**QA/QC and Uncertainty Estimates**
- Provide valuable feedback to each other on critical components of the inventory estimates and data sources that:
  - Contribute to both the uncertainty level and inventory quality
  - Should therefore be a primary focus of inventory improvement efforts
- Uncertainty analysis can provide insights into:
  - Weaknesses in the Estimate
  - Sensitivity of the estimate to different variables
  - The greatest contributors to uncertainty

**Verification**
- Activities to provide information for countries to improve their inventories
  - Comparisons of national estimates
    - Applying different tier methods
    - Comparisons with independently compiled estimates
    - Comparisons of intensity indicators between countries
  - Comparisons with atmospheric measurements

**Documentation, Archiving and Reporting**
- Document and archive all information relating to the planning, preparation, and management of inventory activities
  - Records of QA/QC procedures are important information to enable continuous improvement to inventory estimates.
- Report a summary of implemented QA/QC activities and key findings as a supplement to each country's national inventory
Objectives

Why we need the internal and external quality assurance/control?

- to identify potential problems and make corrections where possible
- to perform GHG inventory with good quality
  - Internal
  - External

Internal assurance/control

- Organizations and implementing units that responsible for GHG national inventory will set up working group consisted from the professional organizations and experts to check accuracy and quality of NIR
- The working group will take quality control according to approved guidelines

Steps

- Check AD
- Check EF
- Check Methodology
- Check calculations
- Check the completeness
- Check documentation and archiving
- Check the report

Accuracy and completeness of AD

- Check the reliability of data sources
- All AD from each source have to be checked and compared with ones of previous inventory.
- AD checked against data sources
- Any changes from the previous inventory have to be checked whether the changes adjusted appropriately

Accuracy and completeness of EF

- To check reliability of EFs used
- To check estimated CS EFs
Methodology

- Check any changes in methodology

Estimation/calculation

- Identify any mistakes in calculation
- Check the recalculations

Completeness

- Check whether all sectors are included
- Check whether all gases are estimated

Documentation and archiving

Whether documentation and archiving was done according to the National Manual

External assurance/control

External assurance/control will be carried out by a third party that did not involve in inventory preparation

External assurance/control

Public Administrative organizations responsible for the implementation of the UNFCCC will set up a working group to take the external control/assurance.
External assurance/control

- Check and evaluate how the internal QA
- Compare the National inventory with other country's inventory
- Recommendation for improvement

Thank you
Quality Assurance & Quality Control in Japan

Outline

Japan’s QA/QC procedures has installed to each step of the inventory preparation and development

- Inventory Planning
- Inventory Preparation including QA/QC
- Inventory Management
- Further Improvement

1. Inventory Planning

Based on the Law Concerning the Promotion of Measures to Cope with Global Warming

1-3. Quality Assurance/Quality Control Plan

- Current QA/QC plan was established 2nd February 2006 which is included in the report of the Estimation Method Committee (only in Japanese).
- Summary of the QA/QC plan is indicated in the Initial Report.
  - QC: conducted by the MOE (including GIO and consultants), as well as by other related agencies and organizations
  - QA: conducted by Japanese experts within the Committee for the Greenhouse Gases Emissions Estimation Methods

1-4. Official Consideration and Approval

- In the case that changes in the estimate are made, study is carried out in the Committee for the Greenhouse Gas Emissions Estimation Methods.
- The prepared GHG inventories are circulated with electrical basis such as CD-ROM among the related ministries and after they have all confirmed and approved them.
- If necessary, a report is also made to the Global Warming Prevention Headquarters.
1-5. Inventory Improvement Process

2. Inventory Preparation including QA/QC

2-1. GHG Inventories Compilation Processes

2-2. GHG Inventories Compilation Processes (cont.)

3. Inventory Management

- Historical data on GHG inventories are archived in Electric Basis in GHG Inventory Office of Japan (GIO).
- MOE, GIO and relevant ministries and organization have been responding to review processes and have been providing archived information.
4. Further Improvement

- By definition quality assurance (QA) activities include a planned system of review procedures conducted by personnel not directly involved in the inventory compilation process, to verify that data quality objectives are met, ensure that the inventory represents the best possible estimate of emissions and sinks given the current state of scientific knowledge and so on.
- We will establish further QA process in line with the definition above.
- ISO like document archive system is needed to establish.
2006 IPCC Guidelines for National Greenhouse Gas Inventories

Kiyoto Tanabe
Technical Support Unit,
IPCC NGOIP

The 4th Workshop on GHG Inventories in Asia (WGA)
14-15 February 2007, Jakarta, Indonesia

Outline
- Features of 2006 IPCC Guidelines
  - History
  - Approach to developing 2006GLs
  - Coverage
  - Specific developments
- 2006 IPCC Guidelines and UNFCCC
  - Requirements under UNFCCC
  - Relevance of 2006GLs
- Further developments in prospect

History
- 1995 Guidelines
- 1996 Revised IPCC Guidelines
- 2000 Good Practice Guidance and Uncertainty Management
- 2003 Good Practice Guidance for Land Use, Land-Use Change and Forestry
- 2006 IPCC Guidelines

Approach to developing 2006GLs
- An evolutionary development starting from 1996GLs and two GPGs
- Retain the definition of "good practice"
  - neither over- nor under-estimates so far as can be judged
  - uncertainties are reduced as far as practicable.
- Generally provide advice on estimation methods at three levels of detail
  - from Tier 1 (the default method) to Tier 3 (the most detailed method)

Coverage

- 2006 Guidelines
  - Vol.1 General Guidance and Reporting
  - Vol.2 Energy
  - Vol.3 Industrial Processes and Product Use
  - Vol.4 Agriculture, Forestry and Other Land Use
  - Vol.5 Waste

- Cross-cutting Issues
  - Vol.2 Sectoral Guidance Metodological Issues
  - Vol.3 Industrial Processes and Product Use
  - Vol.4 Agriculture, Forestry and Other Land Use
  - Vol.5 Waste
Coverage - Gases

- Gases for which GWP values are available in the IPCC-TAR
  - CO₂, CH₄, N₂O, HFCs, PFCs, SF₆
  - NF₃, SF₅CF₃, Halogenated Ethers, etc.
- Gases for which GWP values are not available in the IPCC-TAR
  - C₇F₁₈, C₆F₁₆, C₅F₁₀, etc.
- Other gases (Precursors)
  - 2006GLs contain links to information on methods used under other agreements and conventions

Coverage - Specific Developments

Vol 1: General Guidance and Reporting

- New chapter on introductory advice
  - Overview of greenhouse gas inventories
  - Steps needed to prepare an inventory for the first time
- Extended advice on data collection
  - Systematic cross-cutting advice on data collection from existing sources and by new activities
- Key category analysis
  - Better integrated across emission and removal categories

Vol 2: Energy

- Treatment of CO₂ capture and storage (CCS)
  - Emissions from geological CO₂ capture, transport and storage are covered comprehensively
    - Fugitive losses from CO₂ capture and transport stages
    - Any losses from CO₂ stored underground
  - Consistent with IPCC Special Report on Carbon Dioxide Capture and Storage (2005)
- Methane from abandoned coal mines
  - A methodology for estimating these emissions is included for the first time.
Specific Developments
Vol 3: IPPU

- New categories and new gases
  - Expanded to include more manufacturing sectors and product uses (e.g., Production of TiO₂, petrochemicals, LCD)
  - Additional GHGs identified in the IPCC TAR (e.g., N₂O, SF₆, CH₃CCL₃)

- Non-Energy Uses of Fossil Fuels
  - Improved guidance on demarcation with the Energy Sector

- Actual emissions of F-gases as Tier 1
  - Potential emissions - no longer considered appropriate
  - New Tier 1 - Actual emission estimation based on default activity data where better data are not available.

Specific Developments
Vol 4: AFOLU

- Integration between Agriculture and LULUCF
- Managed land as a proxy for identifying anthropogenic emissions and removals
- Consolidation of previously optional categories
  - Emissions and removals from all fires on managed land
  - CO₂ emissions and removals associated with terrestrial carbon stocks in settlements and managed wetlands
- Approach-neutral methods to include HWP
- "Appendix" - Basis for future methodological development
  - e.g., CH₄ emissions from managed flooded lands

Specific Developments
Vol 5: Waste

- Revised methodology for CH₄ from landfills
  - New Tier 1 method - a simple first order decay model
  - Option to use data available from the UN and other sources
  - Regional and country-specific defaults on waste generation, composition and management

- Carbon accumulation in landfills
  - Relevant for the estimation of HWP in AFOLU

- Biological treatment and open burning of waste
  - To ensure a more complete coverage of sources

Specific Developments
Relevant to all volumes

- CO₂ resulting from emissions of other gases
  - 2006GLs estimate carbon emissions in terms of the species which are emitted
  - CO₂ from atmospheric oxidation of non-CO₂ species can be estimated additionally, if necessary

- Treatment of nitrogen (N) deposition
  - Formerly only agricultural sources were covered
  - 2006GLs cover all significant sources of N deposition, including agriculture, industrial and combustion sources

- Relationship to entity- or project level estimates
  - Methods for national inventories can also be relevant for estimating actual emissions or removals at the entity or project level.

Requirements under UNFCCC

- 1996 Guidelines (+GPGs)
  - Annex I Parties "shall" use 1996GLs and GPGs
  - Non-Annex I Parties:
    - "should" use 1996GLs [Dec 17/CP.8]
    - "are encouraged to" use GPGs [Dec 13/CP.9]

- 2006 Guidelines
  - Not yet approved by UNFCCC for use as a whole
  - Nevertheless, 2006GLs may assist Parties in fulfilling their inventory reporting requirements under the UNFCCC

Relevance of 2006 IPCC Guidelines

- Individual methods in 2006GLs can be used within the 1996/UNFCCC reporting guidelines
  - "... Users are encouraged to go beyond these minimum default methods where possible, ..." (1996GLs Vol.1 Overview)
  - Remember! The 2006GLs are:
    - An evolutionary development
    - Authors' best methodologies available (accepted by IPCC)
    - For the use of all countries

- For example:
  - New or revised default EF data for Fuel Combustion
  - Tier 1 methods to calculate actual emissions of F-gases
  - Tier 1 FOD method to estimate CH₄ from SWDSSs
Further developments in prospect

- Non-English 2006 IPCC Guidelines
  - Translation into 5 UN languages under way
- Software for 2006 IPCC Guidelines
  - Development under way
- Emission Factor Database (EFDB)
  - Will be upgraded in accordance with 2006GLs
- Others (e.g., FAQs on website)
Current and Future Greenhouse Gas Inventory Development in non-Annex I Parties

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National Communications - Status
- Total number of submitted national communications from non-Annex I Parties
  - Initial national communications: 134 (as of 6 January 2007)
  - Second national communications: 3 (as of 27 March 2006)
  - Third national communications: 1 (as of 11 November 2006)
- 10 most recent submissions
  - Sierra Leone (8 January 2007)
  - United Arab Emirates (UAE) 2 January 2007
  - Mexico (11 November 2006)
  - Mozambique (2 June 2006)
  - Fiji (18 May 2006)
  - Suriname (27 March 2006)
  - Guinea-Bissau (1 December 2005)
  - Saudi Arabia (29 November 2005)
  - Venezuela (13 October 2006)
  - Rwanda (6 September 2005)

National Communications – Web Page
http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php
- National communications
- Second national communications (status of submission)
- Third national communications (status of submission)
- Non-Annex I Parties

National Communications Process
- NC commitment of all Parties (Art. 4.1)
- Inventory (Art. 3.1)
- Other info (Art. 12.5)
- Non-Annex I Parties
- COP
- Decision 17/CP.8
- Decision 8/CP.11
- NAIP to prepare project proposals, even in advance of substantially completing their previous NCs, in order to avoid a lack of continuity in project financing
- NAIP should apply for the financing of their subsequent NCs at any time between 3 to 5 years of the initial disbursement of funds for the actual preparation of their previous NCs
- Shall make all efforts to submit their 2nd NC (or when appropriate 3rd) within 4 years of the disbursement of financial resources
- May use an extension of up to 1 year (after having informed the secretariat), but this shall not imply additional financial resources

Decision 17/CP.8
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Decision 8/CP.11
Status of submission of Initial (INC) and Second National Communications (SNC) projected submissions of SNC

Projected Regional Distribution of Second National Communications (2010-2012)

Important Opportunities in Preparing Second National Communication

Schematic representation of possible support requirements in the future

Useful Tools for NAI GHG Inventories

- **UNFCCC Software**
  http://unfccc.int/resource/cd_roms/na1/ghg_inventories/index.htm

- **CAALU** (Central American Agriculture and Land Use)
  Stephen Ogle, Colorado State University,
  ogle@rrl.colostate.edu

- **GHG Inventory Experts Network (NCSP funded)**
  http://www.ghgnetwork.org/

The Integrated GHG database makes it possible to generate thousands of analysis reports + the expected future public access to the GHG data

The Evolving Role of National Communications

- **Timely** submission of second round of national communication for use by all Parties in assessing the status of climate change issues

- Informing the CGE on technical needs of the region - where are the technical gaps? (new mandate to be discussed at COP 13)

- Providing the UNFCCC secretariat any comments or suggestions on the CGE training materials and the secretariat’s inventory software secretariat@unfccc.int
Report on Sessions I to III

Mr. Dadang Hilman

Session 1: Myanmar
-Introduced experience of working under ALGAS project
-Has just started working on preparing initial national communication
-Gaps: lack of vulnerability assessment, lack of analysis of adaptation options, lack of national strategy and action plan, lack of expertise, lack of impact assessment, need capacity building

Session 1: Singapore
-4-pronged national climate change strategy
-Main contribution is CO₂ from energy
-Main mitigation strategy: energy efficiency, clean energy
-Will submit second national communication in 2009

Session 1: Japan
-Introduced current institutional arrangement for annual inventory submissions
-Introduced latest trends of GHG emissions
  -Total GHG emissions in 2005 showed 8.1% increase over base year, so have to reduce emissions by 14.1%

Session 1: Mongolia
-Short-term strategy: develop infrastructure by identifying data gaps, developing national procedures for collecting activity data, including data in statistical yearbook, designing database of AD and EF
-Long-term strategy (2007-2010): focus on bringing it into practice by improving database, developing national guidance

Session 1: WGIA Survey
-Purpose: understand the current situation and identify areas for improvement
-Results
  -Areas of "high" need may indicate problems with collecting activity data, country-specific values, categories
  -Areas of "low" need may indicate that data and/or country-specific values already exist
Session 1: WGIA Survey
- Energy: collection of AD, calorific values and carbon EF of fuels
- Agriculture: rice cultivation and livestock characteristics
- LUCF: mean annual increments of aboveground biomass
- Waste: wastewater flow and sources, solid waste stream and composition

Session 2: Energy
- Find other uses for the data
- Pay attention to new technologies
- Decide whether to use IPCC defaults or develop country-specific values
- Need to determine target for WGIA5

Session 2: Agriculture
- Improvement of availability of disaggregated Activity Data through institutionalization of data collection
- Improvement of EF through research or EF from EFDB or data from other countries with similar environmental conditions and cultural practices
- Proper documentation and archiving of AD and EF used in the national GHG inventories

Session 2: LUCF
- Methods for deriving reliable Mean Annual Increment are a challenge for many tropical countries in Asia
- Uncertainty of estimates involves various factors, therefore needs to be assessed carefully (e.g. Expert judgment in deciding which assessment methodology to be taken)
- Need WGIA to facilitate the development of linkages and collaboration between different organisations

Session 2: Waste
- 4 types of domestic wastewater flow with/without septic tank exist in Asia
- Recycling activates are important for the solid waste stream in Asia
- Establishment of database on mass and quality of waste and its continuity is important

Session 3: QA/QC
- Quality Control (QC) – performed by inventory personnel during development of inventories
- Quality Assurance (QA) – performed by external evaluators after development of inventories
  - INTEGRAL PART of inventory process
    - Leads to continuous improvement of inventories, facilitates comparison of estimates, comparison with other countries
    - Not obligatory, but very useful tool
- Minimal Elements
  - Define roles and responsibilities
  - Develop QC/QA plan
- Trade-off between QC requirements and timeliness/cost effectiveness
  - Identify key areas to focus QA/QC on
Session 3: QA/QC in Mongolia

• Use QA/QC to identify potential problems and make corrections

• Check
  – AD
  – EF
  – Methodology
  – Calculations
  – Completeness
  – Documentation
  – Report

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Session 3: QA/QC in Japan

• QC – by MOE, GIO, related agencies, organizations
• QA – by committee of 70 Japanese inventory experts with 6 subgroups

• Mandatory yearly inventories – working on inventory of one year and QA of previous year simultaneously

• Archive historical data every year

• Necessary to establish document archive system (e.g., similar to ISO)
Part 4

Annex
Annex 1: Agenda

<table>
<thead>
<tr>
<th>Time</th>
<th>Session I: Updates on GHG inventories in Asia</th>
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</thead>
<tbody>
<tr>
<td>10:15~11:50</td>
<td><strong>Country News</strong></td>
</tr>
<tr>
<td>10:15~10:30</td>
<td>Mr. Ne Winn</td>
</tr>
<tr>
<td>10:30~10:45</td>
<td>Ms. Wong Shu Yee</td>
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<tr>
<td>10:45~11:00</td>
<td>Mr. Hiroshi Fujita</td>
</tr>
<tr>
<td>11:00~11:15</td>
<td>Dr. Batimaa Punsalmaa</td>
</tr>
<tr>
<td>11:15~11:30</td>
<td>Ms. Chisa Umemiya</td>
</tr>
<tr>
<td>11:30~11:50</td>
<td>All</td>
</tr>
</tbody>
</table>

**12:00~**

**Lunch Time**
### WG: Land Use Change and Forestry (LUCF)

**Chair: Dr. Rizaldi Boer, Reporter: Mr. Heng Chan Thoeun**

- **Countries and Methodology**
  - **Mean Annual Increments**
    - Cambodia’s Experience: Ms. Chisa Umemiya
    - Indonesia’s Experience: Dr. Rizaldi Boer
    - Malaysia’s Experience: Mr. Samsudin Musa
    - Japan’s Experience: Dr. Masahiro Amano
  - **Model Measurement/Survey Methodology**
    - Methodology in IPCC’s GPG-LULUCF: Dr. Masahiro Amano

- **Comparison of Measurement/Survey Methodology**

- **Summary and Preparation of WG Presentation**

### WG: Waste

**Chair: Dr. Sirintornthep Towprayoon, Reporter: Dr. Masato Yamada**

- **Wastewater Handling**
  - How To Estimate Emissions From Wastewater Handling: Mr. Kiyoto Tanabe, IPCC-NGGIP/TSU
  - Comparison of Wastewater Flow and Its Sources:
    - Indonesia (by Mr. HB. Henky Sutanto)
    - Lao PDR (by Mr. Immala Inthaboualy)
    - Philippines (by Ms. Raquel Ferraz Villanueva)
    - Thailand (by Dr. Sirintornthep Towprayoon)

- **Solid Waste Disposal on Land**
  - Management of Wastewater in Japan: Mr. Hiroshi Fujita
  - Comparison of Solid Waste Stream and Its Composition: Dr. Masato Yamada
  - Recent Development on Japan’s Inventories with regard to Solid Waste Disposal: Dr. Masato Yamada

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Annex

Dr. Sirintornthep Towprayoon Evaluation of SWDS Methane Emission Estimate - Summary and Preparation of WG Presentation

19:00~
*Reception hosted by the organisers*

<table>
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<tr>
<th>Time</th>
<th>Event</th>
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</table>
| 9:00~10:40 | **Session II (Continued)**
Chair: Mr. Dominique Revet, UNFCCC secretariat                           |
| 9:00~9:20  | Mr. Saleh Abdurrahman Energy                                           |
| 9:20~9:40  | Dr. Damasa M. Macandog Agriculture                                    |
| 9:40~10:00 | Mr. Heng Chan Thoeun Land-Use Change and Forestry (LUCF)             |
| 10:00~10:20 | Dr. Masato Yamada Waste                                               |
| 10:20~10:40 | All Questions and discussions                                        |

**10:40~10:55**  
*Tea Break*

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<th>Time</th>
<th>Event</th>
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</table>
| 10:55~12:10 | **Session III: Cross-Cutting Issue- Quality Assurance and Quality Control (QA/QC)**
Chair: Mr. Dominique Revet                                                                 |
| 11:15~11:35 | Dr. Batimaa Punsalmaa Quality Assurance/Quality Control in Mongolia |
| 11:35~11:55 | Dr. Yukihiro Nojiri Quality Assurance/Quality Control in Japan        |
| 11:55~12:10 | All Questions and discussions                                        |

**12:10~**
*Lunch Time*

<table>
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<tr>
<th>Time</th>
<th>Event</th>
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</table>
| 14:00~16:00 | **Session IV: Toward Better GHG Inventory Development in Asia**
Chair: Dr. Shuzo Nishioka                                                             |
| 14:00~14:20 | Mr. Kiyoto Tanabe 2006 IPCC Guidelines for National Greenhouse Gas Inventories |
| 14:20~14:40 | Mr. Dominique Revet Current and Future GHG Inventory Development in non-Annex I Parties |
| 14:40~14:50 | Mr. Dadang Hilman Report on Session I to III, by Rapporteur           |
| 14:50~15:50 | All Overall Discussion and Wrap-up
- Regional cooperation for future GHG inventory development
- Proposals and suggestion for next activities of WGIA |
| 15:50~15:55 | Mr. Dadang Hilman Closing Remark                                       |
| 15:55~16:00 | Mr. Hiroshi Fujita Closing Remark                                       |

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Sectors are indicated in bold following the participants’ names.

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