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Proceedings of the 6th Workshop on Greenhouse Gas Inventories in Asia (WGIA6)

"Capacity building support for developing countries on GHG inventories and data collection (measurability, reportability, and verifiability)" as a part of the "Kobe Initiative" of the G8 Environment Ministers Meeting

16-18 July 2008, Tsukuba, Japan

Greenhouse Gas Inventory Office of Japan (GIO), CGER, NIES

Center for Global Environmental Research

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Foreword

Parties to the United Nations Framework Convention on Climate Change (UNFCCC) are required to develop, periodically update and publish national inventories of anthropogenic emissions by sources and removals by sinks of all greenhouse gases not controlled by the Montreal Protocol (GHG inventories). GHG inventories play a critical role as a basis for decision makers to track trends of emissions and removals, and develop strategies to reduce the emissions and to enhance the removals.

The National Institute for Environmental Studies (NIES) has been organizing the "Workshop on GHG Inventories in Asia" (WGIA) annually since November 2003 with the support from the Ministry of the Environment of Japan. The purpose of WGIA is to assist countries in Asia in developing and improving their GHG inventories through the promotion of regional information exchange. The WGIA-participating countries have submitted their first inventories in the initial national communications and are working on their second or subsequent communications.

Since its foundation in 1990, the Center for Global Environmental Research (CGER) has been engaged on global environmental issues including climate change. CGER conducts environmental monitoring, maintains a global environment database, and acts as a focal point for a number of international and domestic projects of innovative environmental research. Moreover, CGER publishes reports on its research findings and activities regularly.

This CGER report serves as the proceedings of the 6th WGIA, which was held on July 16-18, 2008, in Tsukuba, Japan. We believe that this report will be useful to all those who work in the field of GHG inventory as well as climate change.

Yasuhiro Sasano
Director
Center for Global Environmental Research (CGER)
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Preface

Global warming is one of the urgent problems facing international community. The Intergovernmental Panel on Climate Change (IPCC) stated in the Fourth Assessment Report (AR4) that most of the observed increase in global average temperature since the mid-20th century is “very likely” due to the observed increase in anthropogenic greenhouse gas (GHG) concentrations.

The Bali Action Plan adopted at the 13th Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC) (COP13) refers to nationally appropriate mitigation actions by developing country Parties in the context of sustainable development, supported and enabled by technology, financing and capacity-building, in a measurable, reportable and verifiable manner. GHG inventories are essential in implementing such actions since it provides information on emissions and removals of GHGs, and enables to track and manage the emissions. The importance of setting up and running the GHG inventories was noted at the G8 Environment Ministers Meeting held in Kobe, Japan from 24 to 26 May, 2008.

The 6th Workshop on GHG Inventories in Asia (WGIA6) - “Capacity building support for developing countries on GHG inventories and data collection (measurability, reportability, and verifiability (MRV))” as part of Kobe Initiative of the G8 Environment Ministers meeting was held from 16 to 18 July, 2008 in Tsukuba, Japan.

This proceedings describes the WGIA6 highlighting the issues concerning GHG inventory that were discussed and shared during the workshop. It also includes the workshop agenda and list of the participants.

We hope WGIA meetings and activities contribute to further enhancement of the cooperative network of inventory experts and improvement of GHG inventory in the region. We would like to thank all participants for their efforts and contribution to the success of this workshop.

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List of Acronyms and Abbreviations

AD	Activity data
CGE	Consultative Group of Experts
CH_4	Methane
CO_2	Carbon dioxide
EF	Emission factor
GHG	Greenhouse gas
GPG	Good practice guidance
HFCs	Hydrofluorocarbons
IPCC	Intergovernmental Panel on Climate Change
LULUCF	Land Use, Land-Use Change and Forestry
NC	National Communications
N_2O	Nitrous oxide
NGGIP	National Greenhouse Gas Inventories Programme
PFCs	Perfluorocarbons
QA	Quality assurance
QC	Quality control
SBSTA	Subsidiary Body for Scientific and Technological Advice
SBI	Subsidiary Body for Implementation
SF_6	Sulphur hexafluoride
UNFCCC	United Nations Framework Convention on Climate Change
WGIA	Workshop on Greenhouse Gas Inventories in Asia

Photos of the Workshop

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Mr. Hideki Minamikawa

Welcome speech

Dr. Ryutaro Otsuka

Plenary Sessions

Working Groups

Waste Sector Working Group

LULUCF Sector Working Group

GHG Inventory Working Group

Agriculture Sector Working Group

Closing Remarks

Dr. Yoshifumi Yasuoka

Executive Summary of WGIA6

The Ministry of the Environment (MoE) of Japan and the National Institute for Environmental Studies (NIES) has convened the 6th Workshop on Greenhouse Gas Inventories in Asia (WGIA6) “Capacity building support for developing countries on GHG inventories and data collection (measurability, reportability, and verifiability)” as a part of the “Kobe Initiative” of the G8 Environment Ministers Meeting on 16-18 July 2008 in Tsukuba, Japan.

The workshop was attended by 64 participants from thirteen WGIA-member countries (Cambodia, China, India, Indonesia, Japan, the Republic of Korea, Lao P.D.R., Malaysia, Mongolia, Philippines, Singapore, Thailand, Vietnam) in Asia and 10 participants/observers from Bangladesh, France, USA, United Nations Framework Convention on Climate Change (UNFCCC), Intergovernmental Panel on Climate Change (IPCC), United Nations Environment Programme (UNEP), and Regional Capacity Building Project for Sustainable National Greenhouse Gas Inventory Management Systems in Southeast Asia (SEA Project). The workshop as a whole was chaired by Mr. Takahiko Hiraishi (Institute for Global Environmental Strategies (IGES)/IPCC).

The objectives of the workshop were as follows:

- To discuss practical aspects of uncertainty assessment and key category analysis in GHG inventory
- To share experiences with time series estimates and projections
- To elaborate on possible improvements to data collection in Agriculture, Land use, land-use change and forestry (LULUCF) and Waste sectors
- To discuss issues on awareness raising about GHG inventory and GHG mitigation
- To discuss possible ways of enhancing cooperation among Japan, the United States, European countries and Asian countries to promote inventory-related work in Asian countries taking the Bali Action Plan and other recent international agreements into account

The workshop was opened with welcoming address from Mr. Hideki Minamikawa (MoE) which was followed by welcoming speech from Dr. Ryutaro Ohtsuka (NIES).

The session I was on the promotion of international cooperation. The discussions and presentations in this session were focused on policies and efforts on GHG inventory, measurement and reporting, activities and lessons learned from GHG inventory-related regional projects. It was recognized that there is a need to promote information exchange and collaborative relationship among donor countries (i.e., Japan, USA and European countries) in order to effectively support the countries in Asia in improving their GHG inventories. The participants welcomed the on-going cooperation between WGIA and the SEA Project. They encouraged the WGIA secretariat to further enhance this complementary and mutually-beneficial cooperation.

The session II was on uncertainty assessment of GHG inventory. The secretariat made an introductory presentation which was followed by the presentations on methodological guidance to uncertainty assessment from Technical Support Unit (TSU)-National Greenhouse Gas Inventories Programme (NGGIP)-IPCC and countries' experiences from India, Korea, Japan and Vietnam. Many participants noted the importance of uncertainty assessment in improving the accuracy of GHG inventory, in view of the fact that GHG inventories provide information for developing mitigation policies and monitoring their impacts. The participants agreed that it would be useful for WGIA-member countries to implement uncertainty assessment although it is not mandatory for non-Annex I Parties. It was therefore suggested that WGIA member countries voluntarily implement uncertainty analysis for part or whole of the inventory, to the extent possible, and report the results at the next WGIA meeting for further discussion on how to improve their GHG inventories.

The session III focused on time series estimates and projections of GHG emissions. It was pointed out that time series estimates and projections of GHG emissions/removals are beneficial in developing the mitigation policies and measures, and tracking their results. Participants agreed on the importance of establishing and maintaining institutional arrangements that facilitate time series estimates for GHG inventory. In order to facilitate time series development, case-studies are suggested for WGIA-member countries and Japan expressed its intention to consider supporting these case-studies upon request of the WGIA-member countries.

The session IV was working group (WG) discussions and participants were divided into four working groups: LULUCF, waste, agriculture sector and GHG inventory. The presentations and discussions at the LULUCF sector WG dealt with applications of remote sensing data and geographic information systems (GIS) -based model in and approaches for preparing the LULUCF GHG inventory. The WG identified major constraints encountered in preparing and improving the LULUCF sector inventory such as a lack of country-specific emission factors (EFs) that better reflect regional characteristics (e.g., climate, vegetation). It was recognized that the use of remote sensing and GIS data help improve the LULUCF inventory. The participants stressed the need for training on these techniques.

The agriculture sector WG discussed the current status and challenges in GHG inventory for agriculture sector in Asian countries with the focus on inventory data. Reliability of data is a major challenge for agriculture sector inventory, and estimation of EFs using the literature data, development of country-specific EFs and enhanced information exchange are identified as possible ways to improve the inventory data. The participants stressed that it is necessary to build a framework for using the shared information in identification of challenges and solutions to the problems. The participants expressed their interest in discussion of soil carbon-related issues at the next WGIA meeting. They stressed the need for sharing of strategies for communicating to policy makers on multipurpose application of inventory data.

The waste sector WG focused on availability and reliability of waste sector inventory data. The participants recognized that waste collection, treatment and composition vary with each country. They agreed that identification of country-specific waste stream and development of data collection common format are important in improving the quality of waste data and waste sector GHG inventory in Asian countries. It was recognized that identification of country-specific waste stream and awareness-raising of policy makers are also essential in improving waste sector inventory. The participants expressed their interest to discuss wastewater-related issues at the next meeting.

The GHG inventory WG dealt with awareness raising about GHG inventory, possible applications of inventory data and promotion of information exchange. The participants recognized the importance of awareness raising of a wide range of stakeholders about GHG inventory and mitigation. They also agreed that it is worth considering applications of inventory data in areas other than mitigation policies/measures. They noted that information on awareness raising activities in WGIA-member countries could be exchanged through WGIA-online network. Moreover, it was suggested that the WGIA and the SEA project should cooperate to develop template on communicating with policy makers. Some participants stressed the need to develop a roster of regional experts and relevant institutions. It was also noted that the WGIA could serve as a forum to evaluate/compare member countries' inventories in whole or part on a voluntary basis. After the WG discussions, a hands-on training on key source analysis was implemented.

In wrap-up session, summary of the discussions at plenary sessions and working groups were presented by rapporteurs. The participants also discussed about the future activities of WGIA. They stressed the need for continued and enhanced information exchange, and more targeted use of WGIA-online network. The participants expressed their interest to discuss GHG inventory issues in energy and industrial processes sectors, update or review of country/region-specific EFs, roster of experts and other ongoing WGIA-network activities at the next meeting. The need for continued support in training of inventory compliers was recognized. The WGIA secretariat proposed to offer such opportunities again at future meetings, which was welcomed by participants.

The workshop was closed by Dr. Yoshifumi Yasuoka (NIES) with expression of gratitude to all participants for their excellent presentations and fruitful discussion.

Workshop Report

Opening session

The workshop was opened by welcome address of Mr. Hideki Minamikawa, the Director-General of the Global Environmental Bureau, Ministry of the Environment (MoE), Japan. He welcomed all participants and noted the importance of GHG inventory in relation to international discussions on “measurability, reportability, and verifiability (MRV)”. Mr. Minimikawa pointed out that WGIA is one of the efforts of Japan to assist developing countries in preparing and improving their GHG inventories.

This was followed by welcome speech by Dr. Ryutaro Ohtsuka, the President of the National Institute for Environmental Studies (NIES). He pointed out the timeliness of the workshop following the G8 Environmental Ministers Meeting held in Kobe and G8 Hokkaido Toyako Summit. Dr. Otsuka also outlined the history and activities of NIES and Center for Global Environmental Research (CGER) including Greenhouse Gas Inventory Office (GIO).

Mr. Takahiko Hiraishi (IGES/IPCC), the chairperson of this workshop, stressed that the WGIA had served, and should continue to serve, as a forum for technical discussion by GHG inventory experts in the region, and that it should be distinguished from the other fora for political debate or negotiations.

Dr. Yukihiro Nojiri (GIO-CGER-NIES) introduced the objectives and structure of the workshop. The objectives of the workshop were as follows:

- To discuss practical aspects of uncertainty assessment and key category analysis in GHG inventory
- To share experiences with time series estimates and projections
- To elaborate on possible improvements to data collection in Agriculture, LULUCF and Waste sectors
- To discuss issues on awareness raising about GHG inventory and GHG mitigation
- To discuss possible ways of enhancing cooperation among Japan, the United States, European countries and Asian countries to promote inventory-related work in Asian countries taking the Bali Action Plan and other recent international agreements into account

Dr. Jamsranjav Baasansuren (GIO-CGER-NIES) reported on the progress of WGIA activities. She stated that WGIA online-network was initiated through the mailing list of WGIA experts to promote further exchange of information and experiences in preparation of second national communications (NC). Several activities have been undertaken through the online-network including collection of country-specific EFs developed in WGIA-participating countries. The data will be synthesized and integrated into common format in order to make available to WGIA-members. She also noted that to complement our activities and utilize effectively the resources in the region, WGIA works in close collaboration with other projects in the region such as Regional Capacity Building Project for Sustainable National GHG Inventory Management Systems in Southeast Asia (SEA Project), and Improvement of Solid Waste Management and Reduction of GHG Emission in Asia (SWGA).

Session I: Promotion of International Cooperation

The session I discussion was chaired by Dr. Yukihiro Nojiri (GIO-CGER-NIES) and rapporteur was Dr. Jose Ramon T Villarin (Xavier University, Philippines).

Mr. Kotaro Kawamata (MoE, Japan) reported the accomplishment of G8 Hokkaido Toyako Summit (July, 2008) and "Kobe Initiative" of G8 Environment Ministers Meeting (May, 2008). He introduced that this workshop was held as the first meeting of "Kobe Initiative" with capacity building support for developing countries on inventories and data collection.

Mr. Sei Kato (MoE, Japan) reported that the total GHG emissions in 2006 were about 1,340 million tons in CO_2 equivalents, which is a 6.2% increase from emissions in the base year under the Kyoto Protocol. He introduced the Japan's Voluntary Emissions Trading Scheme (JVETS) as Japan's policies and efforts on GHG inventory, measurement and reporting, and JVETS guidelines such as "JVETS Monitoring and Reporting Guidelines". He also noted that Japan will consider supporting capacity building in developing countries for the collection and provision of data through WGIA.

Mr. Dominique Revet (UNFCCC) gave a presentation on the latest news on non-Annex I NC and national GHG inventories. He reported that the 28th Session of the Subsidiary Body for Implementation (SBI 28) in June 2008 resumed discussions on the mandate and terms of reference of the Consultative Group of Experts (CGE) (Decision 3/CP.8) and draft decision with brackets forwarded to SBI 29 in December 2008. He also emphasized the importance of sharing the information through inventory preparation.

Mr. Kiyoto Tanabe (GIO-CGER-NIES) gave a presentation on cooperation with European countries. He emphasized that WGIA secretariat continues to maintain contact with the European countries. Relevant information may be obtained from Europe Aid and various bilateral capability building projects undertaken by member states. Some lessons can be learned from such projects and for instance from Technical Aid to the Commonwealth of Independent States (TACIS) 2002.

Ms. Mausami Desai (United States Environmental Protection Agency (US EPA)) reported U.S. and specifically EPA's capacity building activities focus on specific measurable and realistic outcomes as USA’s policies and efforts on GHG inventory, measurement and reporting. She also mentioned two sets of tools for national GHG inventories, namely the national system templates, and the targeted data collection strategies and software tools to assist developing countries in applying higher tier methods for key sectors.

Mr. Leandro Buendia (SEA Project) talked about the project activities and noted that the purpose of the project is to strengthen the capacity of Southeast Asian countries to improve the quality of their national GHG inventory for the development of sustainable inventory management systems. He also reported that kick-off workshop of the SEA Project was held in Singapore, April, 2008.

Mr. Todd Ngara (UNEP) reported that UNEP assists 22 African countries in the preparation of the second NC through GEF funding. He mentioned that the LULUCF sector was considered important because about 55% of GHG emissions are from the LULUCF sector in the region. He also noted the need to improve EFs, specific problems identified in both LULUCF and agriculture, and the notable peculiarities of the region.

Participants discussed each country’s specific issues related to capacity building, measurement, data collection system for preparation of GHG inventory and local research in EF and activity data (AD). Participants agreed on the necessity of developing country-specific values for EFs and other parameters based on data collection in each country. It was recognized that information exchange and collaborative relationship among donor countries (i.e., Japan, USA and European countries) should be promoted in pursuit of efficiency in supporting developing countries.

Session II: Uncertainty Assessment

This session was chaired by Mr. Leandro Buendia (SEA Project) and the rapporteur was Dr. Amnat Chidthaisong (King Mongkut's University of Technology Thonburi, Thailand). The session mainly focused on usefulness of uncertainty assessment and discussed how to address the assessment.

Mr. Kiyoto Tanabe (GIO-CGER-NIES) provided the introductory presentation and brought up questions; why uncertainty assessment was important; how useful it was; and what was the next step after completing uncertainty assessment. He invited participants to discuss these questions and consider whether it was really worth performing uncertainty assessment under their current circumstances. He also invited participants to consider how the WGIA participants could cooperate to facilitate uncertainty assessment in each country, if they concluded they needed to perform it.

Dr. Simon Eggleston (TSU-NGGIP-IPCC) explained the importance of uncertainty assessment and presented concrete methods how to do it. He illustrated two cases of uncertainty assessment and mentioned that uncertainty estimates would give useful information for improving inventories as well as for formulating mitigation approach and policy. He explained that even simple uncertainty assessment would assist improving GHG inventories and that good quality assurance (QA)/quality control (QC) and careful consideration on estimation methods could reduce uncertainties. Finally, he stated that assessment of uncertainty in the input parameters should be part of the standard data collection QA/QC.

Mr. Kohei Sakai (GIO-CGER-NIES) presented Japan's experiences with respect to uncertainty assessment. He explained that Japan decided which method was applied to each of EFs and AD in accordance with the decision tree established by the Committee for the GHG Emissions Estimation Methods of Japan and performed uncertainty assessment annually on EFs and AD on all sectors. He also presented concrete examples for Energy, Industrial Processes, Agriculture, LULUCF and Waste sectors. He mentioned that results of uncertainty assessment were generally considered to be useful to identify priority categories for inventory improvement, but the results were seldom utilized in Japan. The reasons were that reliability of uncertainty assessment was partially not high enough and that categories with high priority could be guessed without uncertainty assessment.

Dr. Sumana Bhattacharya (Ministry of Environment and Forests, India) made a presentation regarding India's experiences of uncertainty assessment. She mentioned that India applied uncertainty assessment for improving the accuracy and precision of its inventories, and that it developed institutional arrangements for reducing uncertainty in the initial and second NC. She also explained that uncertainty was reduced through developing local EFs, refining existing factors, moving towards higher tiers for key sources, bridging data gaps, and launching standard QA/QC. Moreover, she presented activities of India's LULUCF sector as an example of putting results of uncertainty assessment to practical use and stated that good databases were available for livestock and rice methane emissions.

Dr. Cheon-Hee Bang (Environmental Management Corporation (EMC), Republic of Korea) presented Korea's experiences of uncertainty assessment in the waste sector. He stated that uncertainty assessment was an essential part of inventory improvement, and it was useful for prioritizing efforts to improve inventory's accuracy. According to his presentation, two uncertainty assessment methods (the error propagation equation and the Monte-Carlo method) were used for Korea's waste sector. He mentioned that Korea would improve uncertainty assessment by utilizing the Monte-Carlo method in the future.

Dr. Nguyen Chi Quang (Vietnam National Coal-Mineral Industries Group) gave a presentation regarding uncertainty assessment in Vietnam. He stated that it was difficult for non Annex I Parties to implement uncertainty assessment appropriately because of lack of data. In order to overcome this problem, he recommended participants to share information on uncertainty estimates and background data that could be used in other countries in a similar situation.

Discussions were followed after the above presentations. Mr. Kiyoto Tanabe (GIO-CGER-NIES) encouraged countries that had not yet implemented uncertainty assessment to implement it by the next WGIA meeting. Several countries expressed their comments as responses to Mr. Tanabe's recommendation; some comments mentioned that they were willing to challenge uncertainty assessment, but others told that there were few values to implement it under insufficient data condition. Mr.

Takahiko Hiraishi (IGES/IPCC) stressed that uncertainty assessment would be easy and worthwhile "IF" data were available, and said that, otherwise it would not be feasible. Dr. Simon Eggleston (TSU-NGGIP-IPCC) mentioned that, although participants did not have to consume much time for uncertainty assessment, implementing uncertainty assessment on part of data collection would be valuable for improving their second NC. Finally, Mr. Leandro Buendia (SEA Project) recommended participants, if possible and if they wish to do so, to implement uncertainty assessment using GHG inventories in their initial NC and to present the results at the WGIA7 meeting.

Session III: Time Series Estimates and Projection

This session was chaired by Mr. Dominique Revet (UNFCCC), and the rapporteur was Dr. Todd Ngara (UNEP). The session mainly focused on importance of time series estimates and projection and discussed how to overcome barriers against developing time series and projection.

Mr. Kiyoto Tanabe (GIO-CGER-NIES) offered the introductory presentation and explained that time-series consistency was important for allowing the comparison of emissions between different years and for formulating appropriate projections of GHG emissions and removals. He recommended participants to discuss the following issues:

- What were barriers against developing time series and projections of GHG emissions and removals
- What actions would be effective for removing those barriers
- How we could cooperate within the WGIA framework

Mr. Sei Kato (MoE, Japan) presented Japan's time-series estimates and projections. He explained that Japan prepared time-series estimates, predicted future emissions based on the trend of the estimates as well as on necessary aspects such as population, and developed the Kyoto Protocol Target Achievement Plan for reducing its future emissions in accordance with its commitment under the Kyoto Protocol. He also presented various countermeasures for achieving the commitments.

Dr. Sirintornthep Towprayoon (King Mongkut's University of Technology Thonburi, Thailand) gave a presentation of Thailand's experience for time-series estimates and projection. She mentioned that time-series estimation helped to analyze historical activities of the country and to see trend in the future. She also stated that using only one national data source, which was the most reliable one, could avoid confusion and controversy of data analyses.

Mr. Dadang Hilman (State Ministry of Environment, Indonesia) presented Indonesia's experience. He explained that Indonesia's inventory in the second NC was improved comparing with its initial NC. For example, some default values of EFs used in the initial NC were converted to national-specific values in the second NC. He mentioned that strengthening institutional capacity to collect and collate data, establishing local EFs, and enhancing capability of Indonesia to reduce uncertainty of emission values were necessary for future improvement.

After the above presentations, participants discussed the importance and necessity of time-series estimates and projection. They agreed that time-series consistency and projection were important for developing an appropriate policy to reduce their GHG emissions even though they were not mandates for non-Annex I countries. They also pointed out the importance of documenting the data sets and methodologies used in developing time series. The participants suggested the WGIA secretariat should think of holding theme-specific workshops for different sectors in order to improve their time-series consistency and projection.

Session IV: Working Group Discussions

In this session the participants were divided into 4 working groups (Agriculture, LULUCF, Waste and GHG inventory) to:

- exchange technically detailed information about GHG inventory data collection in LULUCF, Waste, Agriculture sectors and elaborate on possible improvements
- discuss on GHG inventory related issues such as awareness raising about GHG inventory and application of inventory data

Agricultural Sector Working Group

The Agricultural working group discussion was chaired by Dr. Kazuyuki Yagi (National Institute for Agro-Environmental Sciences (NIAES), Japan) and rapporteur was Dr. Shuhaimen Ismail (Malaysian Agricultural Research and Development Institute (MARDI)). The group mainly focused on strategies to improve reliability of agricultural data and current status and challenges in agriculture sector inventory and discussed how to get reliable data of agriculture.

Strategies to improve reliability of agricultural data were reported by Japan. Dr. Osamu Enishi (National Institute of Livestock and Grassland Science (NILGS), Japan) reported GHG measurement from ruminants and manure managements. For enteric fermentation from livestock cattle, country-specific equation for estimating methane emissions from dry matter intake had been used. And this equation was developed from actual CH_4 emission data by researches. For manure management, EFs were developed from actual measuring emission using special equipment.

Dr. Hiroko Akiyama (NIAES), reported on CH_4 and N_2O from rice paddies in the 2006 IPCC Guidelines and estimation of Japanese country specific N_2O EFs. For CH_4 from rice paddies, key factors such as soil pH, temperature and moisture were introduced. For N_2O emissions from Japanese agricultural fields, collected data were consisted from 246 measurements from 36 sites. Research results were published as research paper, and these data had been used as Japan's EF to estimate N_2O emissions from agricultural soils, and these data were also described in the 2006 IPCC Guidelines.

Current status and challenges in agriculture sector inventory were reported from Malaysia, Thailand, Vietnam, SEA Project and Japan. Dr. Shuhaimen Ismail (MARDI) reported agriculture inventory in Malaysia, especially noted about second NC. AD were composed of the data of the Ministry of Agriculture, department of statistics, Food and Agriculture Organization (FAO) database and local experts. For manure management, factors were estimated by experts. Rice cultivation were a key category in Malaysia, and rice cultivation areas were divided by following sector; granary, non granary and upland. Emissions from agriculture sector in second NC reduced from the initial NC.

Dr. Amnat Chidthaisong (King Mongkut's University of Technology Thonburi, Thailand) reported Thailand's GHG inventory in agricultural sector. In Thailand, agriculture was the second most important sector as greenhouse gas emission source. CH_4 from Rice Production, CH_4 from enteric fermentation and N_2O from manure management were chosen as key categories by key category analysis (KCA) in agriculture sector.

Ms. Van Anh Nguyen (Ministry of Natural Resources and Environment, Vietnam) reported GHG inventory in agriculture of Vietnam. And main theme was second NC. Ratio of GHG emission for agriculture was about 45% in 2000 (with LULUCF), and this sector was the biggest GHG emission source in Vietnam. EF for rice cultivation, which was the biggest GHG emission source in agriculture sector, were separated by district as a follow: north, central and south.

Mr. Leandro Buendia (SEA Project) reported GHG inventory issues in Southeast Asian countries in agriculture sector. In Southeast Asia, key issues were following: categorization of water regime for rice cultivation, EF and AD for N_2O emission from cropland, enhanced characterization to estimate GHG emissions from enteric fermentation, local EF for manure management. Additionally, collaboration with International Rice Research Institute (IRRI) and Livestock Emissions and Abatement Research Network (LEARN) was proposed.

Dr. Toshiaki Okura (NIAES) presented on soil carbon in arable land. Soil carbon was an issue of LULUCF sector at this time, but agriculture sector and LULUCF sector were combined in the 2006 IPCC Guidelines, which will be used in near future. And this was the issue for agricultural soil, so it was introduced in this working group. Furthermore, by policy of the Ministry of Agriculture, Forestry and Fisheries of Japan, researches were advanced to consider agricultural soil practiced continual management as a sink of carbon in the next commitment period. In Japan, national soil monitoring project had been practiced. Variations in soil carbon over 20 years were introduced.

Based on the results and discussions for these presentations, participants discussed issues identified and possible solutions. They concluded that reliability of data was a major challenge for agriculture sector inventory, and estimation of EFs using the literature data, development of country-specific EFs and enhanced information exchange are identified as possible ways to improve the inventory data. The participants stressed that it was necessary to build a framework, including both international collaboration and in-national one, for using the shared information in identification of challenges and solutions to the problems.

Finally, participants recommended that each country present country-specific EFs developments and exchange agriculture information at the next WGIA. Soil carbon, sustainable agriculture production and enhanced international collaboration were also recommended as subjects for discussion at future WGIA meetings.

LULUCF Sector Working Group

This session was chaired by Dr. Sumana Bhattacharya (Ministry of Environment and Forests, India), and the rapporteur was Dr. Batimaa Punsalmaa (Ministry of Nature and Environment, Mongolia). The session mainly focused on usefulness of remote sensing data and modelling for obtaining AD on the LULUCF sector and discussed how to utilize the data.

Dr. Yoshiki Yamagata (NIES) offered a presentation regarding remote-sensing based monitoring system for the LULUCF sector. He explained that deforestation was a critical issue for addressing climate change because of the huge amount of its emissions in many developing countries. He mentioned that remote-sensing-based monitoring systems were effective for estimating CO_2 emissions from the LULUCF sector. As an example, he introduced Australia's inventory development system for the LULUCF sector, which used only remote sensing data for estimating emissions and removals by the LULUCF sector.

Dr. Sumana Bhattacharya (Ministry of Environment and Forests, India) presented India's experiences for developing inventories of the LULUCF sector. She mentioned that India generated remote sensed maps that were in line with the IPCC Good Practice Guidance for Land Use, Land-Use Change, and Forestry (GPG-LULUCF) and integrated remote sensing data on the GIS-based platform. She also explained that India used a tier 3 method – a modeling approach – for estimating carbon stock changes in soil.

Dr. Damasa B. Magcale-Macandog (University of the Philippines Los Banos) gave a presentation on improving secondary forest above-ground biomass estimates in Philippines. She explained how to use a GIS-based model for improving the estimates. She mentioned that the GIS-based model was effective for estimating density of above ground biomass nationwide at different locations and environmental conditions in the Philippines.

Dr. Mitsuo Matsumoto (Forestry and Forest Products Research Institute, Japan) offered a presentation of Japan's forest carbon accounting system for Kyoto reporting. He explained that Japan used detailed on-site data for inventory development and applied sampling and remote sensing data for inventory verification. He also presented the methodology of estimating carbon stock changes in dead organic matters and soils in Japan's forests, for which the CENTURY model tuned for fitting Japan's national-specific conditions (the CENTURY-jfos model) were applied.

In the discussions after the above presentations, participants agreed that the LULUCF sector was a key for most of the countries invited to WGIA6, and that remote sensing on GIS platform along with the ground truthing of permanent plots was the key for developing a good GHG inventory of this sector. Moreover, the participants were strongly interested in the use of tier 3 models, and recommended the WGIA secretariat to provide a training session on a tier 3 model such as the CENTURY model. Dr. Kyeong-hak Lee (Korea Forest Research Institute) recommended participants to present, at the next WGIA, countries' experience with respect to issues relating to uncertainties, AD collection, and so forth, taking into consideration any relevant discussions including what transpired form the expert meeting on the LULUCF sector held by the IPCC.

Waste Sector Working Group

The waste working group discussion was chaired by Dr. Tomonori Ishigaki (Ryukoku University, Japan) and rapporteur was Dr. Sirintornthep Towprayoon (King Mongkut's University of Technology Thonburi, Thailand). The group mainly focused on AD related issues and discussed how to improve the reliability of waste data.

Dr. Ishigaki presented the waste issues discussed at the second SWGA workshop held in February, Fukuoka, Japan. He highlighted the property and reliability of solid waste management data such as data on waste generation, waste stream and waste composition. He emphasized that waste management practices in each country and availability of reliable waste statistics greatly affect the property and reliability of the data. The presentation of Dr. Ishigaki was followed by three presentations from China, Japan and Malaysia.

The presentation by Dr. Qingxian Gao (Chinese Research Academy of Environmental Science (CRAES)) discussed the use of surrogate data in waste sector estimation (China's case). He highlighted that data sharing mechanisms is important in improving the AD as well as the inventory.

Mr. Hiroyuki Ueda (Suuri Keikaku Co., Ltd., Japan) gave a presentation on the development of waste sector GHG inventory in Japan. He introduced the history of the improvement and elaborated on the waste and carbon flow focusing on MSW plastics. Mr. Ueda highlighted the importance of developing statistics that covers all waste flow in order to improve the inventory.

Dr. Normadiah Haji Husien (Ministry of Natural Resources and Environment, Malaysia) made a presentation on GHG inventory of waste sector for second NC. The emissions from waste sector were estimated for 1994 and 2000 by using both the 1995 IPCC Guidelines and the Revised 1996 IPCC Guidelines. She noted that a lack of detailed data and information is still one of the major constraints in inventory preparation.

The participants recognized that waste management and waste composition vary with each country. They agreed that identification of country-specific waste stream and development of data collection common format are important in improving the quality of waste data and waste sector GHG inventory in Asian countries.

GHG Inventory Working Group

The GHG Inventory working group discussion was chaired by Mr. Thy Sum (Ministry of Environment, Cambodia), and the rapporteur was Dr. Simon Eggleston (TSU-NGGIP-IPCC). The group dealt with raising awareness about GHG inventory, possible applications of inventory data, and the promotion of information exchange.

Current experiences in raising awareness about GHG inventory and climate change in this working group were reported from the Philippines, Korea, Japan and Singapore. Dr. Jose Ramon T Villarin (Xavier University, Philippines) presented the outcomes of the activities as raising awareness of GHG inventories and climate change in the Philippines. They are currently working on its second NC and making efforts to improve their data collection methods.

Ms. Kyonghwa Jeong (Korea Energy Economics Institute) gave a presentation on the development of activities for awareness-raising about GHG inventory and climate change through events (seminars and campaigns), internet portal sites, and education. It is necessary to develop a long-term public awareness program through internet portal sites, TV and newspaper in order to, for example, disseminate information about what people can do at home and at work in an effort to reduce GHGs.

Mr. Takeshi Enoki (Mitsubishi UFJ Research & Consulting Co., Ltd., Japan), explained the “Team Minus 6%” campaign through TV, internet, newspapers, pamphlets and symposiums. Japan's commitment under the Kyoto Protocol is to reduce its GHG emissions during the first commitment period to 6% below 1990 levels. He highlighted information exchange on country-specific EFs, and methodologies that can help to improve our GHG Inventories.

Ms. Shu Yee Wong (National Environment Agency, Singapore) reported that National Climate Change Committee (NCCC) was formed to promote energy efficiency and a less carbon-intensive economy. The NCCC Main Committee is assisted in its work by four sub-committees and four workgroups, the Building Sub-committee, Households Sub-committee, Industry Sub-committee, Transportation Sub-committee, and R&D Workgroups. In addition, the National Climate Change Strategy presents their efforts to better understand vulnerabilities to climate change and to assess adaptation measures to address the impacts of climate change.

In Asian countries, in order to raise awareness about GHG inventories and climate change, it is important to share information with policy makers, and in order to gain support for inventory development in each country, it is necessary to train human resources. Discussion in the GHG inventory working group covered a wide variety of topics including communication with policy makers, human resources, inventory compiler training programs, and uncertainty analysis.

Hands-on Training on Key Source Analysis

After the working group discussions, a hands-on training on key source analysis (KSA) was implemented as it had been requested repeatedly in the previous meetings as well as through the on-line network by the WGIA colleagues. Dr. Jamsranjav Baasansuren (GIO-CGER-NIES) gave a presentation on KSA with the focus on Tier 1 quantitative approach. The participants performed KSA (level and trend) using sample data prepared for the training.

Wrap-up Session

The session was chaired by Mr. Takahiko Hiraishi (IGES/IPCC) and rapporteur was Ms. Mausami Desai (US EPA).

In this session, the rapporteurs from plenary sessions and working groups provided a summary of the discussions including the findings and recommendations, which was followed by final discussion to conclude the workshop.

The following are the major conclusions of this workshop.

- **Measurability, Reportability, and Verifiability**

The participants reaffirmed the importance of improving national GHG inventories to meet the requirements under the UNFCCC. In addition, taking note of the recent international discussion and agreement such as the Bali Action Plan and the Kobe Initiative of the G8 Environmental Ministers Meeting, the participants agreed on the importance of inventory-related data collection to pursue “measurability, reportability, and verifiability (MRV)”. They also shared the view that all countries including non-Annex I countries should be encouraged to make efforts to accurately estimate

GHG emissions at a macro level (i.e., national inventory) as well as at micro levels (e.g., at corporate, plant and household levels).

- **Promotion of International Cooperation**

It was recognized that there was a need to promote information exchange and collaborative relationship among donor countries (i.e., Japan, USA and European countries) in order to effectively support the countries in Asia in improving their GHG inventories. Some participants pointed out that networking the existing networks in different regions would be useful, and also that collaboration between regional programmes should be encouraged. In this context, the participants welcomed the on-going cooperation between WGIA and the SEA Project. They encouraged the WGIA secretariat to further enhance this complementary and mutually-beneficial cooperation.

- **Uncertainty Assessment**

Many participants noted the importance of uncertainty assessment in improving the accuracy of GHG inventory, in view of the fact that GHG inventories provide information for developing mitigation policies and monitoring their impacts. The participants agreed that it would be useful for WGIA member countries to implement uncertainty assessment although it is not mandatory for non-Annex I Parties. It was therefore suggested that WGIA member countries voluntarily implement uncertainty analysis for part or whole of the inventory, to the extent possible, and report the results at the next WGIA meeting for further discussion on how to improve their GHG inventories.

- **Time Series Estimates and Projection**

It was pointed out that time series estimates and projections of GHG emissions/removals were beneficial in developing the mitigation policies and measures, and tracking their results. The participants agreed on the importance of establishing and maintaining institutional arrangements that facilitate time series estimates for GHG inventory. In order to facilitate time series development, case-studies were suggested for WGIA-member countries. Japan expressed its intention to consider supporting these case-studies upon request of the WGIA member countries.

The participants also discussed the future WGIA activities. They stressed the need for continued and enhanced information exchange, and more targeted use of WGIA-online network. Some participants expressed their interest to discuss GHG inventory issues in energy and industrial processes sectors, update or review of country-specific EFs, roster of experts and other ongoing WGIA- network activities at the next WGIA. The need for continued support in training of inventory compliers was recognized. The WGIA secretariat proposed to offer such opportunities again at future meetings, which was welcomed by participants.

Dr. Yoshifumi Yasuoka, Executive Director of NIES, giving his closing address, thanked all participants for excellent presentations and fruitful discussion.

Working Groups' Discussions

Agriculture Sector

Summary of Discussions

Agriculture sector has accounted for more than 30% of total national GHG emissions in some Asian countries. Rice cultivation is a key category, important in many countries. The following were identified as main gases and sources: CH_4 from enteric fermentation, CH_4 and N_2O from livestock manure management, N_2O from agricultural soils, and so on.

The Agriculture working group discussion was attended by 13 participants, with a mixture of people experts in the field and inventory compilers. The major topics of the discussion in the working group were as follows:

- Strategies to improve reliability of agricultural data
- Current status of and challenges in agriculture sector inventory

GHG emissions measurement from livestock and CH_4 and N_2O EFs from crop fields were reported by Japan. Current status in agriculture sector inventory was reported by Malaysia, Thailand and Vietnam. SEA project reported GHG inventory issues in Southeast Asian countries in agriculture sector, and Japan presented a project for soil carbon.

Some participants were of the opinion that IPCC default values are not suitable for Asian countries in some cases. Since emission types vary depending on things such as climate, livestock species, soils, cultivation period and so on, EF and parameters were needed in some cases to make country-specific or semi-country-specific.

Japan's researchers noted that it is important to maintain or increase soil carbon stocks as a mitigation option, and that this research is also important to estimate removals/emissions and to develop inventory methods.

International collaboration as WGIA is important to share information, but WGIA meetings are held only once a year. Therefore, it was recommended that countries exchange information using tools such as websites and mailing lists, which will also help make WGIA meetings more fruitful.

It was pointed out that intra-national collaboration including experts and inventory compilers in each country is important to develop good national inventory and national research projects.

As the results of the presentations and the discussion, getting reliable data to improve EF and AD were identified as key issues. Participants noted three steps to improve methods of obtaining reliable data. One method is to search literature such as scientific papers and national statistics. Another is to hold field experiments, a method which is advisable for EF and AD as the data is various and location specific. The third such method is to modify IPCC default values to local-specific values by using literature review and field experiments if necessary.

The importance of collaboration was described as another factor in obtaining reliable data. Studies for EF and AD in a country can be extended and collaborated on with other countries in Asia. International collaboration to exchange information is important. Furthermore, it is important to enhance intra-national collaboration, since close cooperation between inventory researchers and compilers in the country was deemed crucial to successful improvement of national GHG inventories. Also, to compiling methodologies and data from WGIA countries in relation to GHG inventory is necessary in order to ascertain the situations in other similar countries.

Suggestions and Recommendations from the Working Group

The following activities were recommended for the next WGIA meeting. First, country presentation on specific EF developments is recommended. It is helpful for other countries when developing EFs for their agriculture sector. Furthermore, exchanging and checking inventory information for the agriculture sectors of each country by all WGIA participants is recommended. It will also be a practice to develop country-specific EFs. The following were requested for long-term work on WGIA:

1. Discussion of soil carbon inventory
2. Consideration of sustainable agriculture production related to GHG inventory
3. Enhancement of international collaboration

For (1), soil carbon inventory is associated with a cross-cutting issue with LULUCF sector. Ordinarily, when land use changes from forest to agricultural land, soil carbon gradually reduces via the decomposition of organic matter. But when compost continues to be deposited on agricultural land, a part of the organic carbon accumulates, and soil carbon increases. It is relevant also with (2), to consider sustainable agriculture production. It is related to adaptation, which is an important element of climate change. Furthermore, (3) means not only WGIA meetings, but also information exchange through web pages or mailing lists of WGIA.

Land Use, Land-Use Change and Forestry (LULUCF) Sector

Summary of Discussions

The LULUCF working group discussion was attended by participants from Cambodia, India, Japan, Korea, Mongolia and the Philippines. The objectives of this discussion were:

- To share countries' experiences with remote sensing, the GIS platform, and modeling in the LULUCF sector,
- To examine the effectiveness of these tools for estimating emissions and removals in the sector.

The discussion started with four presentations by three countries: India, Japan and the Philippines. These presentations were made in order to help improve understanding of the effectiveness of remote sensing, the GIS platform, and modeling in the LULUCF sector. Following the presentations, participants discussed ideas with respect to their effectiveness for improving GHG inventories in the LULUCF sector in Asia.

Suggestions and Recommendations from the Working Group

1. Effectiveness of Remote Sensing and the GIS platform

Remote sensing and the GIS platform are useful for estimating emissions and removals in the LULUCF sector, specifically when groundtruthing data are insufficient. In order to rectify the problem of insufficient groundtruthing data, remote sensing is a key tool because it provides nationwide land cover data.

Although it is difficult for remote sensing to convert land cover data to land use categories, experiences in India and the Philippines reveal that integrating remote sensing data on the GIS platform can overcome this difficulty. GIS-based models help improve the estimates of above-ground biomass in the Philippines, and integration of remote sensing data on a GIS-based platform provides improved stratification of land categories in India. Therefore, remote sensing on the GIS platform along with the groundtruthing of permanent plots is key for developing a good GHG inventory for this sector.

2. Modeling: Suggestions for organizing a training session on the tier 3 models

Use of models such as CENTURY may help develop databases of five carbon pools: above ground biomass, below ground biomass, litter, dead wood, and soil. Specifically, using models to calculate carbon stock changes in soils is effective. Carbon stock changes in dead organic matter (litter and dead wood) and soil are affected by climatic, geological and ecological conditions as well as by human land-use activities; the complexity of the interactions amongst these conditions and activities makes it difficult to calculate carbon stock changes. However, models enable complex calculations.

For example, India applies CENTURY and RothC models to calculate carbon stock changes in soil. Similarly, Japan modifies the CENTURY model so as to adapt it to Japan's specific circumstances, and applies the adapted model (CENTURY-jfos) for calculating carbon stock changes in dead organic matter and soils.

However, many countries participating in WGIA are unfamiliar with the use of models. Practical training would help aid in understanding model operation and identifying input data necessary for the operation. A training session on the use of the CENTURY model is recommended in order to take advantage of the fact that at least two participating countries are able to share their experiences of using it with the other countries.

3. Necessity of Sharing Countries' Experiences

The LULUCF sector is key for most of the countries invited to WGIA6, and there still remain issues that hinder preparation of the inventory. The issues are lack of data/information on:

- forest and other land use definitions
- land stratification
- biomass expansion factors
- volume assessments
- forest density
- root to shoot ratio

In order to deal with these issues, it is recommended that as many countries as possible provide information about their experiences with them during the next WGIA.. Countries may present their experiences taking into consideration any relevant discussions, including the results of the expert meeting on the LULUCF sector held by the IPCC.

Waste Sector

Summary of Discussions

The waste working group discussion was attended by participants from China, Japan, Korea, Malaysia and Mongolia. The major topics of the discussion in the working group were as follows:

- Use of surrogate data in emission estimation
- Analysis of carbon flow in waste streams
- Strategy to improve reliability of waste data

The participants heard presentations on the reliability and properties of solid waste management data, use of surrogate data in emission estimation in China, Japan's experiences with improving GHG inventory of waste sector, and Malaysia's experiences with preparing waste sector GHG inventory for SNC with a focus on emission estimation.

Landfilling of waste is a main solid waste disposal practice in Asian countries. A lack of detailed and reliable activity data/information on solid waste management for emission estimation is a major constraint in preparing and developing the inventory. The use of surrogate data is one short-term solution to the problems of insufficient activity data. For example, use of data on non-agriculture population, gross domestic product (GDP), city area, urban population, number of cities, and GDP per capita in estimation of amount of municipal solid waste (MSW) generated. However, development of waste statistics is essential in improving the inventory.

Recycling policy and informal recycling activities affect the waste stream as well as waste composition. Therefore, identification of country-specific waste streams and carbon flow is important in improving the accuracy, transparency, and completeness of waste sector inventory.

Because the development of accurate GHG inventory takes considerable time and effort, early, planned improvement of the inventory is important. For example, Japan's waste sector inventory has been revised 3 times between 1999 and 2006.

Suggestions and Recommendations from the Working Group

The group highlighted the need to enhance information/experience sharing through WGIA-online network, and collaboration with SWGA on development of data collection format for Asian countries which can be used to communicate with statistical agencies or data suppliers regarding data needs. The group suggested approaches given four levels of data collection systems: no data, not enough data, poor quality data and good quality data. The participants agreed that identification of country-specific waste streams and composition is important in addressing data constraints and improving data collection. The participants recognized the need for improved communication between data users and data suppliers.

The participants expressed their interest in discussing wastewater related issues, including methane emissions from wastewater.

GHG Inventory Working Group

Summary of Discussions

The GHG Inventory working group session was chaired by Mr. Thy Sum (Ministry of Environment, Cambodia) and reported on by Dr. Simon Eggleston (TSU-NGGIP-IPCC). Representatives from the Philippines, Korea, Japan and Singapore were present. The objectives of the working group discussion were:

- To discuss generic issues and strategies for mainstreaming inventory work

- To develop information exchange materials on GHG inventory

The major topics of the discussion in the working group were as follows:

- Developing a template on communication with policy makers and how to share information
- Compiling a list of regional experts/institutions as human resources
- Holding inventory compiler training programs in association with a UNFCCC training course
- Performing uncertainty analysis at least for key categories as a case study
- Encouraging case studies by some countries to develop time series

Current experiences in raising awareness about GHG inventory and climate change in this working group were reported from the Philippines, Korea, Japan and Singapore.

The group dealt with raising awareness about GHG inventory, possible applications of inventory data, and promotion of information exchange. Limited human resources in inventory preparation is a major constraint in preparing and developing inventory in Asian countries. The participants recognized the need to develop a roster of regional experts and relevant institutions, and an inventory compiler training programme perhaps in association with a UNFCCC training course. It was noted that the WGIA could serve as a forum to evaluate/compare member countries' inventories on a voluntary basis.

Suggestions and Recommendations from the Working Group

The participants highlighted the importance of raising awareness about GHG inventory in a wide range of stakeholders. They noted that information on awareness-raising activities in WGIA member countries could be exchanged through the WGIA-online network. It was suggested that the WGIA and the SEA project should cooperate to develop a template on communicating with policy makers.

Furthermore, WGIA encourages case studies by some countries to develop time series and uncertainty analysis. This session closed with the suggestion that the WGIA participating countries should be encouraged to perform uncertainty analysis at least for key categories and to report their results at the WGIA7.

Presentations

Overview of WGIA6

Yukihiro Nojiri
Greenhouse Gas Inventory Office of Japan (GIO)
National Institute for Environmental Studies (NIES)

6th Workshop on Greenhouse Gas Inventories in Asia

Tsukuba, JAPAN
July 16-18, 2008

Workshop on Greenhouse Gas Inventories in Asia (WGIA)

Objective	To support countries in Asia to improve the quality of inventories via regional information exchange
Style	Annual workshop since 2003
Participants	[One researcher + One government official] from 14 countries + UNFCCC Secretariat, etc.
Funds	Ministry of the Environment, Japan

WGIA6

- 3-Day Workshop (July 16-18, 2008)
- Objectives:
  - Discuss practical aspects of uncertainty assessment and key category analysis in GHG inventory
  - Share experiences with time series estimates and projections
  - Elaborate on possible improvements to data collection in Agriculture, LULUCF and Waste sectors
  - Discuss issues on awareness raising about GHG inventory and GHG mitigation
  - Discuss possible ways of enhancing cooperation among Japan, the United States, European countries and Asian countries to promote inventory-related work in Asian countries taking the Bali Action Plan and other recent international agreements into account

Welcome Participants!

- 40 Participants from 13 countries in Asia:

Cambodia, China, India, Indonesia, Japan, Republic of Korea, Lao P.D.R., Malaysia, Mongolia, Philippines, Singapore, Thailand, Vietnam.

- 32 Participants from international organization, other relevant organizations and projects
  - Bangladesh University of Engineering and Technology (BUET)
  - Embassy of France in Japan
  - Forestry and Forest Products Research Institute (FFPRI), Japan
  - Intergovernmental Panel on Climate Change (IPCC)
  - Japan International Cooperation Agency (JICA)
  - National Institute for Agro-Environmental Sciences (NIAES), Japan
  - National Institute of Livestock and Grassland Science (NILGS), Japan
  - National Institute for Environmental Studies (NIES), Japan
  - Ministry of Environment (MoE), Japan
  - Mitsubishi UFJ Research & Consulting (MURC), Co., Ltd., Japan
  - Regional Capacity Building Project for Sustainable National GHG Inventory Management Systems in Southeast Asia (SEA)
  - Ryukoku University, Japan
  - Suuri-Keikaku Co., Ltd., Japan
  - United Nations Framework Convention on Climate Change (UNFCCC) Secretariat
  - United States Department of State
  - United States Environmental Protection Agency (USEPA)

Workshop Flow

Day 1

Session I: Promotion of International Cooperation
- Reports from international organizations, other relevant organizations and projects

Session II: Uncertainty Assessment
- Reports from IPCC and participating countries

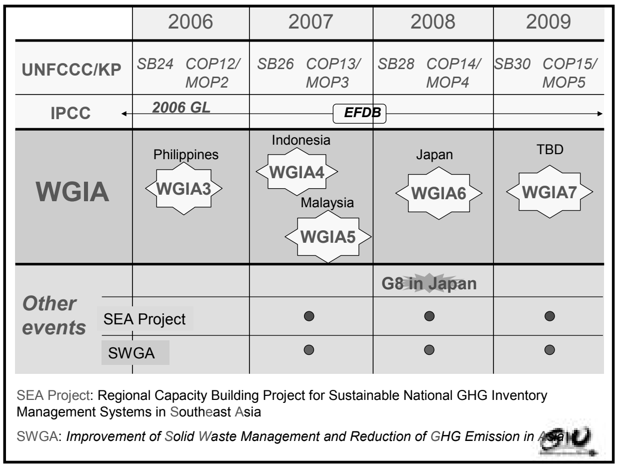
Day 2

Session III: Time Series Estimates and Projection
- Countries' Reports

Session IV: Working Group Discussion
- Working Groups: Agriculture, LULUCF, Waste and GHG Inventory
- Hands on training on KSA

Day 3

Wrap-up Session
- Summary reports of working group discussions
- Summary reports of Session I, II and III
- Discussion on future activities and wrap-up


2006
2007
2008
2009
UNFCCC/KP
SB24 COP12/ MOP2
SB26 COP13/ MOP3
SB28 COP14/ MOP4
SB30 COP15/ MOP5
IPCC
2006 GL
EFDB
WGIA
Philippines
WGIA3
Indonesia
WGIA4
Malaysia
WGIA5
Japan
WGIA6
TBD
WGIA7
Other events
G8 in Japan
SEA Project
SWGA
SEA Project: Regional Capacity Building Project for Sustainable National GHG Inventory Management Systems in Southeast Asia
SWGA: Improvement of Solid Waste Management and Reduction of GHG Emission in Asia


Thank you
GIO website: http://www-gio.nies.go.jp/index-j.html
WGIA website: http://www-gio.nies.go.jp/wwd/wgia/wgiaindex-j.html

Progress Report on WGIA Activities

Jamsranjav Baasansuren

Greenhouse Gas Inventory Office of Japan (GIO)
National Institute for Environmental Studies (NIES)

6th Workshop on Greenhouse Gas Inventories in Asia

Tsukuba, JAPAN
July 16-18, 2008

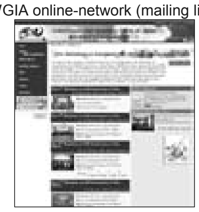
Workshop on Greenhouse Gas Inventories in Asia (WGIA)

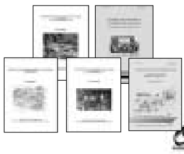
- To assist the countries in the Asia region in developing and improving their GHG inventories by creating the opportunities to exchange information and share their experiences
- Since November 2003, five meetings have been held on an annual basis, through which the network of government officials and researchers in the Asia region has been enhanced

• WGIA meetings in the past
  - WGIA1 – Phuket, Thailand, 13-14 November 2003
  - WGIA2 – Shanghai, China, 7-8 February 2005
  - WGIA3 – Manila, Philippines, 23-24 February 2006
  - WGIA4 – Jakarta, Indonesia, 14-15 February 2007
  - WGIA5 – Kuala Lumpur, Malaysia, 6-8 September 2007

Major Activities

- Share countries efforts and practices
- Identify common issues and possible solutions
- WGIA activity report *"Greenhouse Gas Inventory Development in Asia - Experiences from Workshops on Greenhouse Gas Inventories in Asia"*
- WGIA online-network to promote further exchange of information and experiences in preparation of SNC
  - WGIA website: http://www-gio.nies.go.jp/wwd/wgia/wgiaindex-j.html
  - WGIA online-network (mailing list of WGIA experts)





WGIA Online-Network Activities

- Discussion of WGIA topics
  - To develop the contents of the workshop most relevant to its participants
- Sharing of useful information on GHG inventory and climate change
- Data collection and compilation
  - To facilitate further exchange of experiences/information in the preparation of the SNC and promote information dissemination
    - ✧ Country or region-specific emission factors that were used in GHG inventories in INC as well as newly developed EFs since the submission of INC
    - ✧ List of experts' publication related with climate change issues and GHG inventory
    - ✧ Information about awareness raising activities related to climate change and GHG inventory in WGIA-participating countries (one of the needs identified in WGIA5)

➢ Status of data collection/submission

- *Country or region-specific emission factors*
  - ✧ CAMBODIA, CHINA, INDIA, KOREA, LAO P.D.R., MALAYSIA
  - ✧ 119 (Energy: 34, Industrial Processes 7, Agriculture: 22, LULUCF: 35, Waste: 21)
- *Publication list*
  - ✧ India, Indonesia
- *Information about awareness raising activities on climate change and GHG inventory*

✧ Country or region-specific emission factors

Inventory Sector	Source Category	Gas	Description	Value	Unit	Source of Data
Energy	1A - Fuel Combustion Activities	CO_2	Emission factor for combustion of Crude oil	20.0	tC/TJ	Measurements by Korea Institute of Petroleum Quality and Korea Polytechnic University
Energy	1A - Fuel Combustion Activities	CO_2	Emission factor for combustion of Gasoline	19.7	tC/TJ	Measurements by Korea Institute of Petroleum Quality and Korea Polytechnic University
Energy	1A - Fuel Combustion Activities	CO_2	Emission factor for combustion of Kerosene	19.5	tC/TJ	Measurements by Korea Institute of Petroleum Quality and Korea Polytechnic University
Energy	1A - Fuel Combustion Activities	CO_2	Emission factor for combustion of Heating oil	19.5	tC/TJ	Measurements by Korea Institute of Petroleum Quality and Korea Polytechnic University
Energy	1A - Fuel Combustion Activities	CO_2	Emission factor for combustion of Diesel	19.8	tC/TJ	Measurements by Korea Institute of Petroleum Quality and Korea Polytechnic University

✧ List of experts' publication related with climate change issues and GHG inventory

Singh, A, Gangopadhyaya, S., Nandaa, P. K., **Bhattacharya, S.**, Sharma, C., and Bhan, C. Trends of greenhouse gas emissions from road transport sector in India, *Science of the Total Environment*, 2008, 390, 124-131
http://www.sciencedirect.com/science/journal/00489697

Rizaldi Boer, and Elsa Surmaini. 2006. Economic Benefits of Using SOI Phase Information for Crop Management Decision in Rice-Base Farming System of West Java, Indonesia. International Conference on Living with Climate Variability and Change: Understanding the Uncertainties and Managing the Risks. Espoo, Finland, 17-21 July 2006. http://www.livingwithclimate.fi

Sharma, S., **Bhattacharya, S.,** and Garg, A. Greenhouse gas emissions from India: A Perspective, *Current Science,* 2006, 90, 326-333
http://www.ias.ac.in/currsci/feb102006/326.pdf

Rizaldi Boer, Delon Martinus, A. Faqih and Bambang D. Dasanto. 2004. Impact of Land Use and Climate Changes on Streamflow at Citarum Watershed. Proceeding of the 2nd AIACC Regional Workshop for Asia and the Pacific, 2-5 November 2004, Traders Hotel, 3001 Roxas Blvd., Pasay City, Manila, Philippines. http://www.aiaccproject.org/meetings/Manila.html

Swamy, M., and **Bhattacharya, S.** Budgeting anthropogenic greenhouse gas emission from Indian livestock using country-specific emission coefficients; *Current Science*, 2006, 91, 1340- 1353
http://www.ias.ac.in/currsci/nov252006/1340.pdf

Mitra A. P., Sharma, S., **Bhattacharya, S.**, Garg, S., Devotta, S., and Sen, K. Climate change and India: Uncertainty reduction in greenhouse gas inventory estimates, Universities Press, India, 2004, p.359
https://www.vedamsbooks.com/no40583.htm

Rizaldi Boer, Delon Martinus, A. Faqih and Bambang D. Dasanto. 2004. Impact of Land Use and Climate Changes on Streamflow at Citarum Watershed. Proceeding of the 2nd AIACC Regional Workshop for Asia and the Pacific, 2-5 November 2004, Traders Hotel, 3001 Roxas Blvd., Pasay City, Manila, Philippines. http://www.aiaccproject.org/meetings/Manila.html

Other activities of WGIA

- Collaboration with other projects in the region
  - Regional Capacity Building Project for Sustainable National GHG Inventory Management Systems in Southeast Asia (SEA Project)
  - Improvement of Solid Waste Management and Reduction of GHG Emission in Asia (SWGA)

Thank you

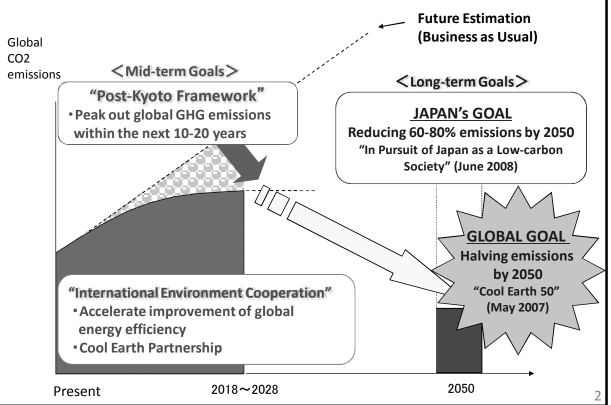
GIO website: http://www-gio.nies.go.jp/index-j.html
WGIA website: http://www-gio.nies.go.jp/wwd/wgia/wgiaindex-j.html

Importance of Measurement for Global GHG reduction

Kotaro Kawamata
Ministry of the Environment, Japan

1

Cool Earth Promotion Programme (Jan 2008)



2

G8 Hokkaido Toyako Summit (July 2008)

Environment and Climate Change

"Long-term Goals"

- We seek to share with all Parties to the UNFCCC the vision of, and together with them to consider and adopt in the UNFCCC negotiations, the goal of achieving at least 50% reduction of global emissions by 2050.

"Mid-term Goals"

- We acknowledge our leadership role and each of us will implement ambitious economy-wide mid-term goals in order to achieve absolute emissions reductions.
- All major economies will need to commit to meaningful mitigation actions.

→Developing countries' contributions are necessary for global reduction.

3

Measurable, Reportable and Verifiable Actions

Bali Action Plan (Dec 2007)

1. (b) (ii) Nationally appropriate mitigation actions by developing country Parties in the context of sustainable development, supported and enabled by technology, financing and capacity-building, in a measurable, reportable and verifiable manner.

Declaration of Leaders Meeting of Major Economies (May 2008)

10. To enable the full, effective, and sustained implementation of the Convention between now and 2012, we will "Intensify our efforts without delay within existing fora to improve effective greenhouse gas measurement."

4

G8 Environment Ministers Meeting (May 2008)

Chair's Summary

"It was noted that setting up and running GHG inventories in developing countries is of fundamental importance and G8 countries should consider supporting capacity building in developing countries for the collection and provision of data."

"Kobe Initiative"

- Aiming at holding meetings together with the outreach countries.

1. International research network on low-carbon societies
2. Analysis on bottom-up sectoral mitigation potentials
3. Promotion of co-benefits among relevant policies
4. Capacity building support for developing countries on inventories and data collection (MRV: Measurability, Reportability, and Verifiability)

→ This workshop is held as the first meeting of Kobe Initiative.

5

GHG Inventories and Data Collection

Both "macro" and "micro" levels of data collection are key

Macro: GHG inventories in national level

・National communication for UNFCCC

・Main theme for today's workshop

Micro: Emission data in facility level

・IEA (Indicator setting)

・APP Task Force (Reduction potential, indicator)

6

Japan's policies and efforts on GHG inventory, measurement and reporting

Sei Kato
Ministry of the Environment, Japan

Ministry of the Environment Government of Japan

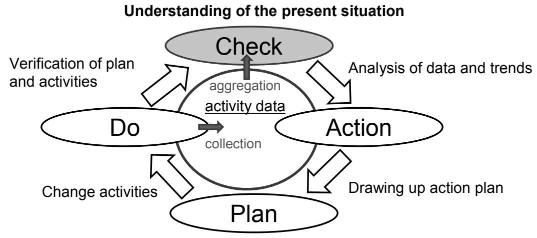
Stop Global Warming! Team minus 6%

1

GHG Inventories and Data Collection

Both "macro" and "micro" levels of data collection are key

Why?

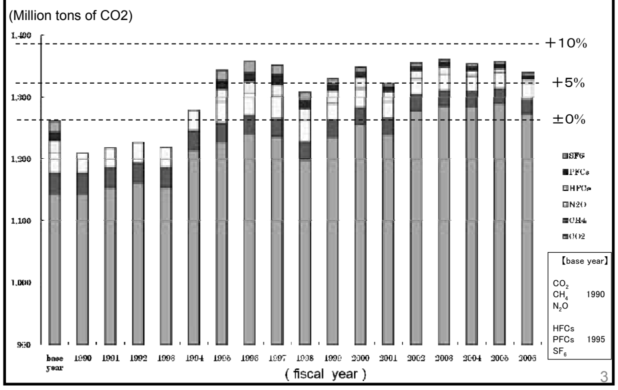


→Getting a clear grasp of the situation is the first step

2

"Macro" levels of data collection in Japan (1)

GHG inventory trend data in Japan



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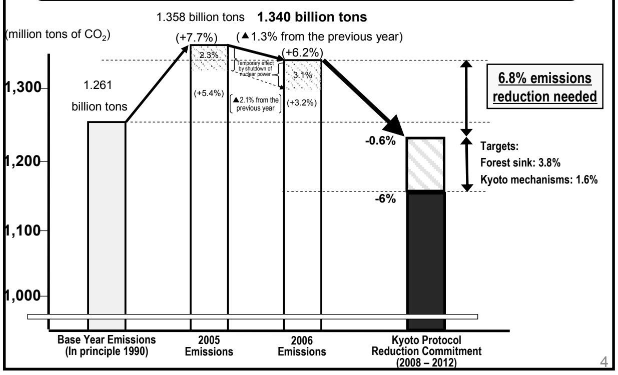
"Macro" levels of data collection in Japan (2)

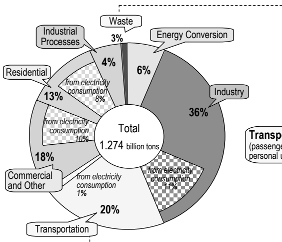
Japanese emissions for 2006 were 6.2% above those of the base year, meaning reductions of 6.8% are needed to meet the 6% reduction commitment under the Kyoto Protocol.

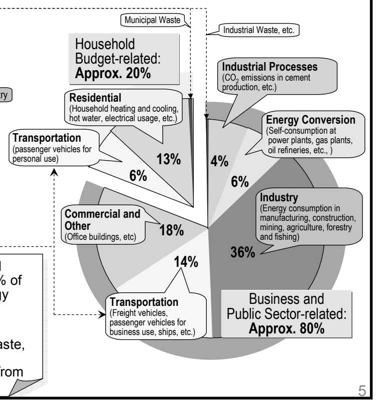


4

"Macro" levels of data collection in Japan (3)

CO_2 Emissions by Sectors and Actors (2006)



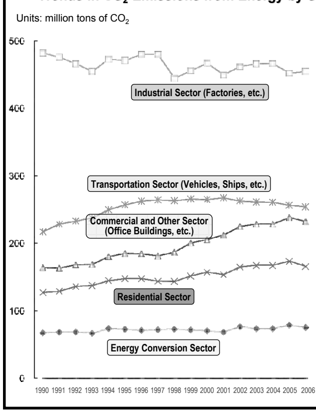


- ○Excluding Industrial Processes and Waste Products, the remaining 93% of CO_2 emissions are related to energy consumption.
- ○Household Emissions, including personal vehicles and municipal waste, comprise approximately 20% of emissions. The remaining 80% is from Business and Public sector.

5

"Macro" levels of data collection in Japan (4)

Trends in CO_2 Emissions from Energy by Sectors and the Targets for 2010



1990	Change form 1990	2006	Reduction Rate to meet Target	Targets(*) for 2010
482	−4.6%	460	−6.7%〜−7.6%	424〜428
217	+16.7%	254	−4.8%〜−6.4%	240〜243
164	+39.5%	229	−11.6%〜13.0%	208〜210
127	+30.0%	166	−19.1%〜21.5%	138〜141
68	+13.9%	77	−16.2%	66

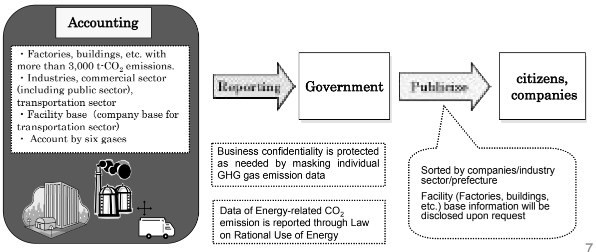
(*) As a target guide for emissions, a maximum predicted effect and a minimum predicted effect for reduction measures have been established. Naturally, the goal is to try and achieve the maximum effect; however, even if only the minimum effect is achieved, it has been formulated so that it will at least meet Japan's targets under the Kyoto Protocol.

6

"Micro" levels of data collection in Japan (1)

Mandatory Greenhouse Gas Accounting and Reporting System (1)

- ➢Introduced through the amendment of the Law on Global Warming Countermeasure(April, 2006), this system mandates entities which emit certain amount of GHGs to account and report their emissions every year to the government, which publishes the data to the public.
- ➢Encourage businesses to voluntarily reduce GHGs by promoting awareness of their carbon footprint.



7

"Micro" levels of data collection in Japan (2)

Mandatory Greenhouse Gas Accounting and Reporting System (2)

- ➢The first government report was released on March 28, 2008 for the emission data of FY2006.
- ➢14,000 factories and office buildings, etc (7,500 companies) and 1,400 companies of transportation sector reported emission data to the government this year.(There are about 6,000,000 business establishment in Japan. 14,000÷6,000,000≒0.2%)
- ➢Total amount of reported GHG emissions was 640 million t-CO2, equivalent to half of the country's emissions.
- ➢Top three emitters of power companies:
  (1)Tokyo Electric Power Co.; 69 Mt-CO_2,
  (2)Chubu Electric Power Co.; 47 Mt-CO_2,
  (3)J-Power; 44 Mt-CO_2.
- ➢Top three emitters of factories:
  (1)JFE Steel Co.; 60 Mt-CO_2,
  (2)Japan Steel Co.; 59 Mt-CO_2,

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"Micro" levels of data collection in Japan (3)

Aims of Japan Voluntary Emissions Trading Scheme (JVETS)

- JVETS started in 2005
- Over 200 participants (incl. steal, paper&pulp, ceramics, glass, car, chemical industries).
- The aims of JVETS are:
  - To accumulate knowledge and experience in domestic emissions trading scheme.
  - To learn how to manage the scheme efficiently ensuring the quality/accuracy of emission data.

9

"Micro" levels of data collection in Japan (4)

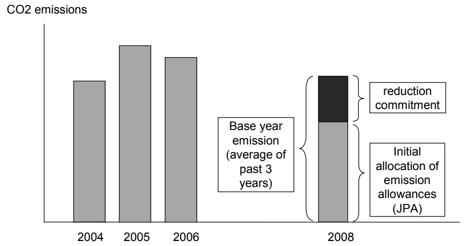
JVETS Rules and Guidelines

- "Operational rules"
- "Monitoring method/plan form"
- "Emission reporting format"
- "JVETS Monitoring and Reporting Guideline" (JVETS MRG)
  - Published on Feb. 2007, recently revised to Version 2.0
  - Defines specific accounting and reporting methodologies (monitoring patterns, monitoring points, Tier approach, etc.)
- "JVETS Verification Guideline"
  - Published on Mar. 31, 2007, to be revised on May, 2008 (version 2.0)
  - Defines specific verification methodologies (verification opinions, materiality, uncertainty, sampling methods, etc.)
- Rules/guidelines are revised as necessary (learning by doing)

10

"Micro" levels of data collection in Japan (5)

Emissions Target setting



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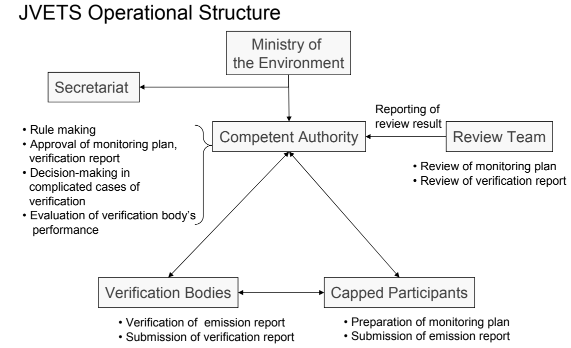
"Micro" levels of data collection in Japan (6)

JVETS Operational Structure



・31 factories and office buildings participated in primary period (FY2006) and made the pledge 21% reduction from the base year (Average CO2 emission from FY2002 to FY2004).
・ Actual performance of CO2 reduction was 29%(exceed estimates of the participants).

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Japan's policies and efforts

"macro" levels

- ・GHG inventory（Understanding of the present situation)
- ・Kyoto Protocol Target Achievement Plan (tomorrow's topic at session 3)

"micro" levels

- ・Mandatory Greenhouse Gas Accounting and Reporting System
- ・Japan Voluntary Emissions Trading Scheme (JVETS)

→Japan would like to share national experiences and best practices in this area with all countries.

→Japan consider supporting capacity building in developing countries for the collection and provision of data through WGIA

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Further information about JVETS

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Emission Reporting Flow (1/3)

Step 1: Identification of geographic boundary
■Identify the geographic boundary of the site, where emissions occur, by producing official documents such as Factory Location Law report to local municipality, Fire Defense Law report to fire station,, etc.

Step 2: Identification of emission sources
■Identify emission sources using documents such as Fire Defense Law report, High Pressure Gas Safety Law, equipment list, purchase bill, etc.
■Identify emission sources owned/operated by other companies and omit them from the boundary.
■Among the emission sources inside the boundary, those which are below the emission threshold (smaller instllations) may be omitted.

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Emission Reporting Flow (2/3)

Step 3 Determination of monitoring plan
■Determine the monitoring plan/monitoring point for each emission sources.
■Ensure the monitoring plan meets the required tier, which is defined by the predicted activity level at each monitoring point.

Step 4 Establishment of monitoring/calculation structure
■Assign responsible persons for monitoring and calculation.
■Set out "how" and "who" monitors the data, and "how" and "who" manages the quality of the calculation results.

⇔ **Approval of monitoring plan by Competent Authority (CA) (prior to the commitment year)**

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Emission Reporting Flow (3/3)

Step 5 Actual Monitoring and reporting
■Monitor the data according the monitoring plan, calculate and report the amount of CO2 emission based on the monitored data.

⇔ **Verification by Verification Bodies**
Approval of verification report by Competent Authority (CA)

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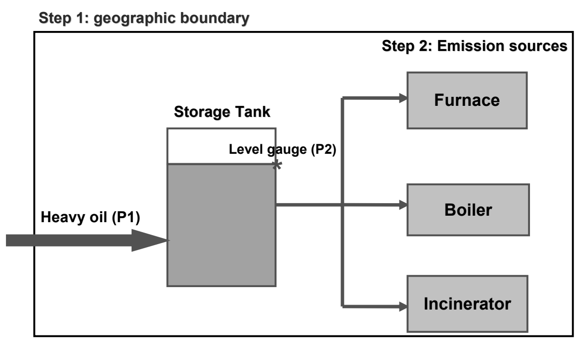
Emission Sources and Monitoring Data



Step 3: Monitoring Plan
P1: Purchased Oil (Purchasing data)
P2: Changes in storage(from the start of the year to the end of the year)

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JVETS is site-based: Why?

Existing law scheme can be fully utilized to minimize the burden of data collection:

- Law for Geographical Conditions of a Factory Location
  - The geographic boundary of any factory must be submitted to local municipality based on the law.
- Fire Defense Law
  - The location of the combustible installations (which are normally CO2 emission sources) must be submitted to fire station based on the law.
- Measurement Law
  - Amount of commercial energy inflow/outflow the site (which is boundary under JVETS) must be measured precisely by meters authorized by the law.

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Emission Reporting Flow via the JVETS Electronic Data System

1) Capped Participants — Preparation of the monitoring plan
→ 2) Competent Authority(CA) — Approval of the monitoring plan
→ 3) Capped Participants — Monitoring the data according to the approved monitoring plan
→ 4) Capped Participants — Preparation of the annual emission report
→ 5) Verification Bodies — Verification of the annual emission report
→ 6) Competent Authority(CA) — Approval of the verified annual emission report

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JVETS emission management system (JVETS electronic data system)

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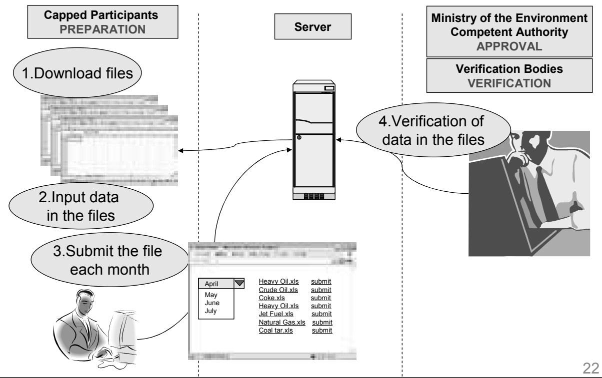
JVETS Emission Management System



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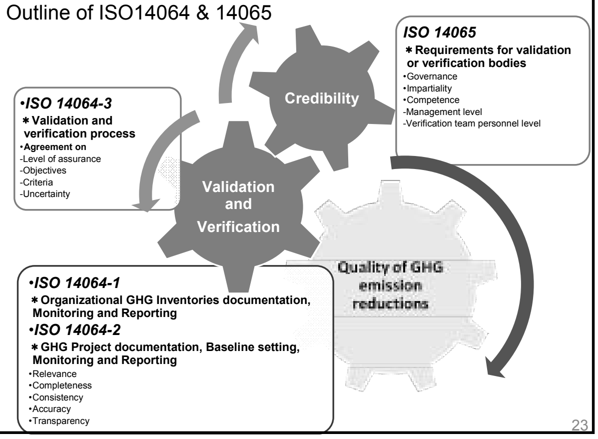
Outline of ISO14064 & 14065



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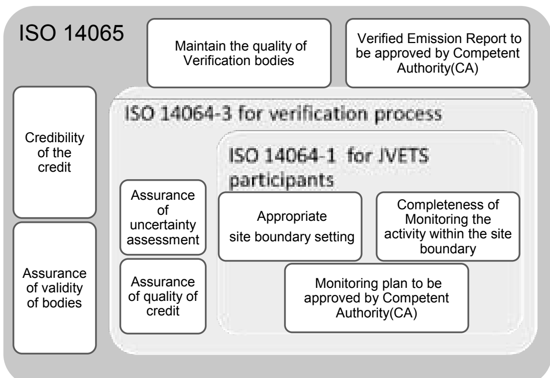
Application of ISO into JVETS



24

Comparisons between ISO and JVETS

ISO standards	JVETS	
	Relevant guidelines	Comments
14064-1	Monitoring and Reporting Guideline	Determined specific accounting and reporting methodologies (monitoring patterns, monitoring points, Tier systems, etc.)
14064-2	–	To be prepared?
14064-3	Verification Guideline	Determined specific verification methodologies (verification opinions, materiality, uncertainty, sampling methods, etc.)
14065	Accreditation criteria (draft)	• Provide detailed explanations for impartiality and quality control system • Define how far to be documented or recorded • Provide competence of verifiers
14066	Competence criteria for verifiers (idea)	To be prepared?

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Why JVETS takes ISOs into account?

ISOs can be one of the strong candidates for the international ETS linkage platform.

Topic	Reasons
Quality of allowance/credit	• Individual ETSs are seeking for linking. -> Standardized quality of allowance/credit is necessary for any ETSs.
ISO market	ISO14064 and 14065 have been implemented. -> Conformity with ISO is beneficial for JVETS when considering linkage issue.

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Future Challenges

- To establish highly qualified JVETS in conformity with global standards and to enable its operational costs to the bare minimum.
  - improve the emission management system to a more simple and easy-to-use one.

1. Implement "Pilot Programme" to be accredited as ISO14065 Verification bodies for two organizations in FY 2008.

2. Develop a simple and efficient verification system maintaining its quality level. (achieve good quality and low cost)

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For much further information:

- "JVETS Monitoring and Reporting Guideline" (English version) can be downloaded at

http://www.env.go.jp/earth/ondanka/det/emission_gl/monitoringrep-en.pdf

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Deputy Director
Office of Market Mechanisms
Ministry of the Environment, Japan

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Latest Update on non-Annex I National Communications

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Financial and Technical Support (FTS) Programme
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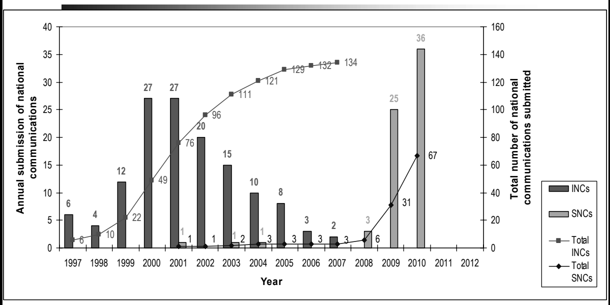
National Communications – Status (Quo)

No new initial national communication submitted since the 5th WGIA; but 124 NAI Parties have started the process of preparing for their Second National Communication.

- **Total number of submitted national communications from non-Annex I Parties**
  - Initial national communications: **134** (as at 8 January 2007)
  - Second national communications: **4** (as at 7 March 2008 - *Argentina*)
  - Third national communications: **1** (as at 11 November 2006 - *Mexico*)

Reminder: **Second National Communications to be submitted within 4 years of initial disbursement of funds (Decision 8/CP.11)**

Submission of INCs and projected* submissions of SNCs



FCCC/SBI/2007/10/Add.1

Projections based on most recent information from the Global Environment Facility (FCCC/SBI/2006/INF.5) and decision 8/CP.11.

Useful Tools for NAI GHG Inventories

- **GHG Inventory Experts Network** (NCSP funded)
  http://www.ghgnetwork.org/
- **GHG Management Institute (*NEW!*)**
  http://www.ghginstitute.org/
- **UNFCCC Software (*Version 1.3.2*)**
  http://unfccc.int/resource/cd_roms/na1/ghg_inventories/index.htm
- **ALU Software** (Colorado State University – *Jan. 2009*)
  http://www.nrel.colostate.edu/projects/ghgtool/index.php

SBI 28 (Bonn) and COP 14 (Poznan)

- SBI resumed discussions on the **mandate and terms of reference of the CGE** (Decision 3/CP.8). Draft decision (*with brackets*) forwarded to SBI 29 (Dec. 2008) **FCCC/SBI/2008L.9**
- Consideration of **information contained in national communications from NAI Parties** (held in abeyance)
- Provision of Financial and Technical (F&T) Support: GEF to provide complete and detailed information on NCs at SBI 29 **FCCC/SBI/2008L.10**
- **AWG KP** and **LCA** sessions (discussing future of the Convention process)

NAI Newsletter and NAI Update

- NAI Newsletter
  http://unfccc.int/national_reports/non-annex_i_natcom/nai_newsletter/items/354.php
- NAI Update
  http://unfccc.int/national_reports/non-annex_i_natcom/nai_update/items/347.php

GHG Data Interface and AI GHG Inventory Review Training

- Improved GHG Data Interface

http://unfccc.int/ghg_data/items/3800.php

- Annex I GHG Inventories review Training

http://unfccc.int/national_reports/annex_i_ghg_inventories/inventory_review_training/items/2763.php

(*Mr Aizawa*)

Concluding Remarks

- Hope everybody will make good use of this information and share it with appropriate experts so the ***networking*** is effective.
- Need your ***feedback*** on issues relating to your national communications, in general, and your GHG inventories in particular.
- We are here to help you!

Greenhouse gas Inventory Office of Japan

Cooperation with Europe

16 July 2008, Tsukuba, Japan
6th Workshop on GHG Inventories in Asia

Kiyoto Tanabe
Greenhouse Gas Inventory Office of Japan (GIO)
National Institute for Environmental Studies (NIES)

0

Contact with EC

- "Kobe Initiative" - wide support from G8
  i. International research network on low-carbon societies
  ii. Analysis on bottom-up sectoral mitigation potentials
  iii. Promotion of co-benefits among relevant policies
  iv. Capacity building support for developing countries on inventories and data collection (measurability, reportability, and verifiability)
- WGIA secretariat keeps in contact with possible counterparts in European Commission for future cooperation.
  – At present, EC is not engaged in any specific projects relevant to capacity building on GHG inventories
  – However, interested in being kept informed of WGIA activities

Greenhouse gas Inventory Office of Japan

Contact with EC

- WGIA secretariat will keep in contact with EC to exchange views, to share experiences and to seek the possibility of future collaboration.
- Relevant information may be obtained from, e.g,
  – EuropeAid
  – Capacity building projects (if any) conducted by individual EU Member States

Greenhouse gas Inventory Office of Japan

For example …

- TACIS – "Technical Aid to the Commonwealth of Independent States", e.g.,
  – Tacis Regional Action Programme 2002 - Technical assistance to Ukraine and Belarus with respect to their Global Climate Change commitments
  – Tacis Regional Action Programme 2002 - Technical assistance to Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan with respect to its Global Climate Change commitments
  – TACIS 2002 Russia Action Programme - Institutional Support to Kyoto Protocol Implementation (started in June 2005).
- Lessons useful to WGIA may be learnt from these projects in the past.

Greenhouse gas Inventory Office of Japan

- EC and/or individual European countries may undertake new capacity building projects relevant to GHG inventories.
- WGIA secretariat will keep in communication with them and share information with WGIA colleagues.

Greenhouse gas Inventory Office of Japan

6th Workshop on Greenhouse Gas Inventories in Asia: US programs and efforts on GHG inventories, measurement and reporting

Mausami Desai
Climate Change Division
U.S. Environmental Protection Agency

Tsukuba, Japan
July 16-18, 2008

Overview

- Inventories
  - Past and current work
    - Central America, SE Asia, Mexico, China
  - Synergies with REDD
- Mandatory GHG reporting program
- Questions

Addressing Challenges for Developing Countries

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

U.S. EPA Approach to building GHG Inventory Management Capacity

Two complementary sets of tools for National GHG inventories:

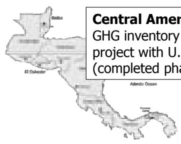
- **National System Templates** to document and institutionalize the inventory management process.
  - Establishing institutional arrangements, QA/QC, archiving, etc.
- **Targeted data collection strategies and software tools** to assist developing countries application of higher tier IPCC methods in key sectors

Next Steps: *"Intensify our efforts without delay within existing fora to improve effective greenhouse gas measurement"* - DECLARATION OF LEADERS MEETING OF MAJOR ECONOMIES ON ENERGY SECURITY AND CLIMATE CHANGE, July 9, 2008

Tools for GHG Inventory Development

- http://www.epa.gov/climatechange/emissions/ghginventorycapacitybuilding/index.html
- ALU: http://www.nrel.colostate.edu/projects/ghgtool/

Current and Past Projects



Central America: Regional GHG inventory improvement project with U.S. AID (completed phase I, 2004-2007)

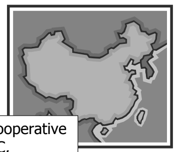
South East Asia: Regional GHG inventory improvement project in collaboration with UNFCCC, IRRI, Japan and other regional experts

Central America Phase II

- Improve land-use/cover maps in Central America
  - Project runs through Sept. 2009
  - Collect groundtruthing data to improve GIS maps for Nicaragua, Honduras, Costa Rica, El Salvador and Guatemala.
  - Designate IPCC Landuse Categories: Forestland, Cropland, Grassland, Wetland, Settlements, and Other Land
- Process
  - Review existing land-use/cover maps
  - Develop a plan for collecting groundtruthing data
  - Collect groundtruthing data
  - Update maps using groundtruthing data
  - Ensure compatibility of revised maps with ALU Tool

Current and Past Projects

Mexico: Improving facility-level GHG inventories in key sectors (power) in collaboration with SEMARNAT and US-Mexico Science Foundation (FUMEC)



China: Initiating cooperative activities with NDRC, translation of existing tools

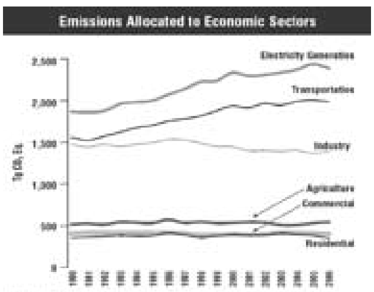
Reducing Emissions from Deforestation and Forest Degradation (REDD)

- Support capacity building and technical assistance to improve data collection, monitoring and reporting of emissions from deforestation and forest degradation (COP-13 decision, Bali)
- Technical program of work underway
  - workshop in Tokyo (June 2008)
- GHG Inventory data and expertise can be applied to development of REDD activities
- The ALU tool can be used for:
  - estimating national or regional baseline for evaluating REDD Projects
  - facilitating REDD calculations with region-specific C factors
- Data improvements and capacity-building achieved through REDD can also improve national GHG inventories

Mandatory GHG Reporting Program Development

- Mandate
  - Funding from 2008 Consolidated Appropriations Act
  - Legal authority: Clean Air Act Sections 114 and 208
- Directions
  - Economy-wide
  - Upstream AND downstream
  - Above ‘appropriate thresholds’
- Very ambitious schedule
  - Proposed rule within 9 months (September, 2008)
  - Final rule within 18 months (June, 2009)
  - First reporting? For year 2010 emissions at the earliest.
- Status
  - US EPA Administrator committed to meeting schedule
  - Technical staff are very busy…

U.S. 2006 GHG Emissions



Mandatory GHG Reporting Program Development: EPA Approach

1. Start with anthropogenic sources (direct GHGs), identified in IPCC Guidelines and U.S. Inventory
2. Review existing methodologies and reporting programs
   - Federal reporting programs- e.g., Title IV, Climate Leaders, 1605(b)
   - State Programs- e.g., California, The Climate Registry, RGGI, other state programs
   - Corporate Programs- e.g., WRI/WBCSD
   - Industry Protocols- e.g., API Compendium, CSI Protocol (cement), International Aluminum Institute
   - International (IPCC Guidelines, EU ETS)
3. Apply screening criteria to identify sources to be included in the rule:
   - Could be covered under the Clean Air Act
   - Thresholds
   - Number of reporters vs. coverage of emissions
   - Administrative burden
   - Ability to measure
4. Develop reporting methodologies for selected sources

Thank you

- For more information:
  - www.epa.gov/climatechange
  - www.state.gov/g/oes/climate/

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U.S. Environmental Protection Agency
Email: desai.mausami@epa.gov

Regional Capacity Building Project for Sustainable National Greenhouse Gas Inventory Management Systems in Southeast Asia (SEA Project)

The 6th Workshop of GHG Inventories in Asia (WGIA6)
16-18 July 2008, Tsukuba, Japan

Leandro Buendia
Project Coordinator

Background

- Collaborative scoping meeting for sustainable national ghg inventory management systems in SEA, 11-13 June 2007, Manila
- Common problems in SEA:
  - lack of local or country-specific EF and appropriate AD
  - inadequate database management system
  - difficulty in sustaining inventory system (team)
  - lack of capacity for inventory management
  - key category analysis not implemented (mostly)
  - need for sharing information/experience
  - Lack of financial and human resources

Project Title: Regional capacity building for sustainable national greenhouse gas inventory management systems in Southeast Asia (SEA Project)

Proponent/Lead Agency: UNFCCC

Collaborating Institutions/Partners:
- US- Environmental Protection Agency (US-EPA)
- Colorado State University (CSU)
- Workshop on GHG Inventories in Asia (WGIA (GIO/NIES))
- International Rice Research Institute (IRRI)

Participating Countries:

1. Cambodia
2. Indonesia
3. Lao P.D.R.
4. Malaysia
5. Philippines
6. Singapore *
7. Thailand
8. Viet Nam

Project Duration: 3 years (2007 – 2010)

Funding Source:
- US Government
- UNFCCC (in-kind, etc.)
- WGIA/GIO/NIES (in-kind, etc.)
- IRRI (in-kind)
- Participating countries (in-kind)

Project Objectives

Overall: To strengthen the capacity of SEA countries to improve the quality of their national GHG inventory for the development of sustainable inventory management systems

Project Objectives

Specifically:

1. To strengthen the institutional arrangement, its functions, and operations of managing national GHG inventories;
2. To enhance technical capacity of designated personnel in each sector (special attention to Agriculture and LULUCF);
3. To improve national methodologies, AD and EF through regional networking;
4. To support the preparation of SNC and subsequent NCs to UNFCCC; and
5. To develop sustainable inventory management systems in SEA.

Project Components

Component 1: Improving National Inventory Management Systems

Component 2: Comprehensive multi-tier GHG software for Agriculture and LULUCF (SEAALU software)

Component 3: Targeted improvements to LULUCF sector (Forest land)

Component 4: Targeted improvements to Agriculture sector

Component 5: Targeted improvements to Energy sector

Component 1: Improving National Inventory Management System

Component 1: Improving National Inventory Management System

Templates	Description
1. Key Category Analysis (KCA)	- first step in documenting NIMS - most important sources as focus of improvement efforts.
2. Institutional Arrangement (IA)	- assess and document the strengths and weaknesses - ensure continuity and integrity of the inventory - promote institutionalization of the inventory process - facilitate prioritization of future improvements.
3. Source-by-Source Background Document (SBS)	- document and report the origin of methodologies, AD, EF - future reference for each source
4. Quality Assurance and Quality Control (QA/QC)	- guides to establish a cost-effective QA/QC program - improve transparency, consistency, comparability, completeness, and confidence
5. Archiving System (AS)	- collection of records and where records are kept - appropriate and systematic archiving of all compilation - national inventory must be transparent and reproducible - foundation for development of subsequent inventories
6. National Inventory Improvement Plan (NIIP)	- priorities for future CB based on needs identified in 5 templates - serves as an official national road map for the national inventory

Component 2: Comprehensive multi-tier GHG software for Agriculture and LULUCF (SEAALU software)

"Kick-off" Workshop of the Regional Capacity Building Project for Sustainable National Greenhouse Gas Inventory Management Systems in Southeast Asia

21-23 April 2008
Singapore

Component 1: Progress and Plans

Templates	Accomplishments/Plans
1. Key Category Analysis (KCA)	- Each country presented preliminary KCA; need to check initial findings
2. Institutional Arrangement (IA)	- Already reported in the scoping meeting in June 2007; need to continue improving IA with template guidance
3. Source-by-Source Background Document (SBS)	- Each country presented SBS documentation of (one) key category; need to continue/complete for other key categories
4. Quality Assurance and Quality Control (QA/QC)	- Templates provided for use; follow up activity as part of the ALU software in-country training in early 2009
5. Archiving System (AS)	- Templates provided for use; follow up activity as part of the ALU software in-country training in early 2009
6. National Inventory Improvement Plan (NIIP)	- Templates provided for use; follow up activity as part of the ALU software in-country training in early 2009

Table 2. Summary of identified key categories based on preliminary key categories analysis by participating SEA countries

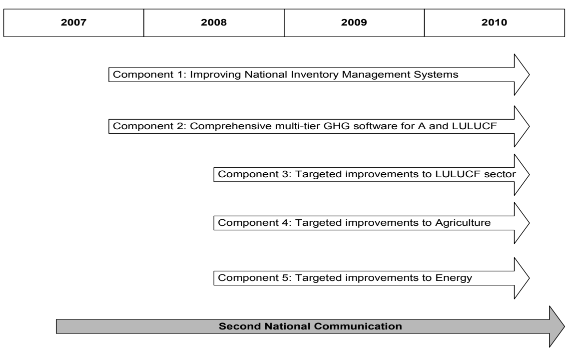
Country	CH_4 enteric fermentation	CH_4 rice cultivation	N_2O agricultural soils	CO_2 manufacturing and construction	CO_2 mobile combustion	CO_2 energy industries
	Rank (1 means highest level of contribution)					
Cambodia	1	2	4	NA	NA	NA
Indonesia	5	3	NA	2	4	1
Lao PDR	QA	QA	QA	QA	QA	QA
Malaysia	NA	NA	NA	4	2	1
Philippines	6	3	5	4	2	1
Singapore	-	-	-	-	-	-
Thailand	6	2	7	4	3	1
Viet Nam	4	1	2	3	6	5
TOTAL	**22**	**11**	**18**	**17**	**17**	**9**

NA = not applicable
QA = qualitative analysis was used

Component 2: Progress and Plans

Activity	Target Date
1. Distribute ALU Workbook	April 2008
2. Compiling activity data for all primary and secondary data	July – December 2008
3. Distribute ALU Software	January 2009
4. In-country ALU software training and workshop	January - June 2009
5. Participate in WGIA meeting	Q3 2009
6. Wrap-up Workshop	Q1 2010
7. Participate in WGIA Meeting	Q3 2010

Project Roadmap



Issues for Components 3, 4, and 5

Issues	Component 3 (LULUCF)	Component 4 (Agriculture)	Component 5 (Energy)
Common issues on emission factor (EF) and activity data (AD) that need to be addressed	- EF for biomass increment for managed native/secondary forest - Soil C EF (stock change factors i.e. input, management, land use) - Reference soil C stock (from soil survey, literatures, etc.) - need for GIS/RS data for SEA countries to improve AD	- rice cultivation – how to categorize water regime for rice (AD) - EF and AD (related to water mgt. and amount of fertilizer input); N_2O emissions from Cropland; soil C from cropland (soil category is broad) - crop residue ratio for use in biomass burning GHG inventory - enteric fermentation: enhanced characterization - need local EF for manure management for different AWMS	- reference approach vs. sectoral approach; how to reduce the gaps between the two approaches
Specific issues on EF and AD	- activity data; mostly based on statistical report from FAO, etc. - EF (removal factor) only for specific forests (for uncertainty assessment) - AD and EF only from plantation forest (data are limited) - need historic data on soil for soil C estimate; also for belowground - Peat fires (Indonesia); AD for fire is not easy; country-specific EF is needed - AD for forest type (consistent representation of land); EF for biomass increment; EF for biomass losses (fuelwood gathering)		

Issues for Components 3, 4, and 5

Issues	Component 3 (LULUCF)	Component 4 (Agriculture)	Component 5 (Energy)
Proposed methodology or approaches	- develop mechanism to share experiences in improving inventory (WGIA as a platform for info exchange) - e-group to be established (during project duration) - sharing not only EF and AD but also SBS (completed template) - need to be clear in categorization (e.g. forest) for AD before deciding what EF to use - collaborate with ICRAF and CIFOR - EF; literature review/scoping (Malaysia has some data) - Invite expert to come to country to assist inventory compilers	- refer to Huke Database of IRRI for rice AD based on rice ecosystems -refer to IPCC GPG - countries are encouraged to develop their own categories - Encourage participating countries to develop EFs using measured data -collaborate with IRRI (for rice) and New Zealand LEARN Project (for livestock)	- collaborate with institution having experience in terms of narrowing the gaps between the reference and the sectoral approaches - WGIA has gross calorific value (updated every 5 years by Japan); WGIA to share to SEA Project
Date needed	mid 2009	mid 2009	mid 2009

Thank You !

Some African experiences in GHG inventory preparation

Todd Ngara@UNEP RISOE

- UNEP - thru GEF funding - assists 22 African countries in the preparation of the 2nd National Communications

- A Senior Task Manager from UNEP Nairobi advises on the quality of the NATCOMS.

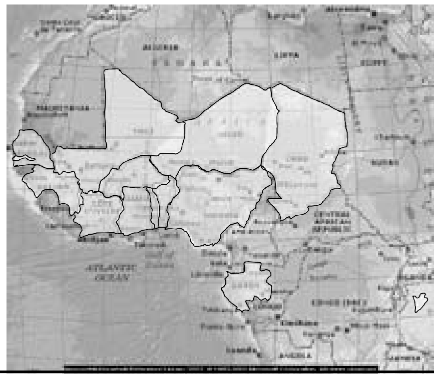
- Needless to say, this includes GHG's. UNEP facilitates consultants to conduct in-country training sessions on GHG inventory preparation

Experiences from West Africa

I should emphasize that these experiences have been gathered thru both UNEP and UNDP as well as other regional and international organisations in Africa.

14 participating Countries

- **Benin**
- **Burkina Faso**
- **Burundi**
- **Côte d'Ivoire**
- **Gabon**
- **Gambia**
- **Ghana**
- **Guinée**
- **Mali**
- **Niger**
- **Nigeria**
- **Sénégal**
- **Tchad**
- **Togo**



LULUCF relevance in the region

- On average in the region, 55% of GHG emissions are from the LULUCF sector
- LULUCF and Agriculture input data have the highest uncertainty
- LULUCF is specially cited for challenges regarding representative and historical activity data collection, and need for additional training on IPCC methods and software

Priorities identified under the regional inventory project

Need to improve emission factors for the following:

- Forest and Grassland Conversion (LULUCF)
- Enteric Fermentation in Domestic Livestock (Agriculture)

Expected regional project results

- Quality of inventories improved
- Strengthening of ghg inventory institutional framework
- Long-term comprehensive strategy for inventory preparation
- Improvement of data collection and management
- Improvement and dissemination of accurate emission factors in the region
- Establishment of a regional network/exchange of information

Expected regional project results(cont'd)

- Increased the number of trained experts
- Increased stakeholder awareness of climate change
- Establishment of technical peer review system in the region

How do we get to the desired results above?

Thru: Capacity building in regional and national theme-specific workshops as follows:

1. GPG (Accra)
2. Inventory Process (Niamey)
3. EF (Bamako)
4. QC/QA (Libreville)
5. ALU Software (Banjul)
6. Peer Review (Abidjan)

Networking among GHG inventory experts for information sharing

General problems identified by countries

- Most values used in INC are default values from IPCC
- Predominance of informal sector in the sectors e.g. energy and industry
- Most data are estimated from old surveys
- Inconsistencies and lack of coherence in data provided by different sources
- Data gaps for time series thru various techniques in the IPCC GIs
- Limited national coverage in some data items
- Lack of forest survey

Specific problems identified in agriculture and LULUCF sectors

- Data format, data are not directly usable for GHG e.g. crop residues
- Seasonal migration of animals
- Accurate biomass estimates
- Fraction of total savanna area burnt annually
- Combustion ratio
- Height and diameter measurements

Addressing some of the key problems:

- Institutional arrangement at national level for data collection
- Capacity building at different levels
- Harmonization of data collection
- Involvement of technical departments at country level

Addressing some of the key problems

- Use of satellite images, where feasible to improve data gathering in the LULUCF sector
- Development of country-specific EF's
- EF improvement through funding of regional research projects (i.e. burnt areas, methane from rice cultivation, quantity of nitrogen lost by denitrification)

The following slides dwell on notable pecularities from the region i.e.

- LULUCF
- Agriculture
- Regional collaboration
- Seasonal fires and sub-tropical vegetation

Some resources available used:

Site of number of fires per months or year + biomass
World Fire Atlas

http://wfaa-dat.esrin.esa.int/wfa.php
http://wfaa-dat.esrin.esa.int/wfa_user_guide.php

User Guide
A user via a web browser can extract ATSR World Fire Atlas fire detection classified data in the following formats:
Fires detected overlayed on a map
The number of fires detected on a monthly basis
The number of fires detected on a yearly basis

Improvements needed:

- Conversion Coefficients
  - Carbon content of plants
  - C/N Ratio of plants
  - Aboveground biomass and belowground biomass
  - Annual growth rate of forests and savannas
  - Biomass Fraction burnt
  - Biomass Fraction oxidized

Inventory management

- Information system in many countries
- Information technology widely spread (archiving & storage)
- Use of UNFCCC software –need for hands-on training

QA/QC

- There is need to institute QA/QC practices in a systematic fashion

Long term strategy to improve GHGI

- Institutional measures are identified
- Difficulties related to expertise mobility

Peer review system

- Implemented through regional workshop
- More realistic to have it on cross country basis (Not enough of expertise)

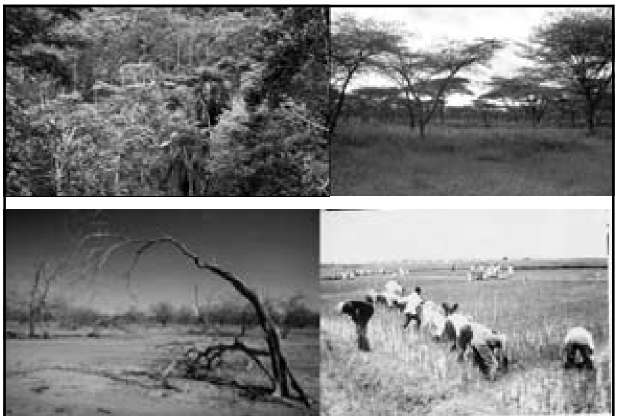
Nitrogen content of cattle manure from different locations in the Sudan Savanna Zone of Ghana

Source: Soil Research Institute – CSIR (1999)

Location	Nitrogen Content (%)
Baku - East	1.45
Baku - West	1.12
Bolgatanga	1.30
Bongo	1.53
Kasena-Nankana	1.32
Builsa	1.33
Mean	**1.34**
CV (%)	**28**

Carbon content of woody species can be obtained by multiplying woody carbon by 0.5 in the Sudanian sub zone and by 0.8 in the Sahalian sub zone.

(Breman, H., Kessler, J.J.,1995. Le rôle des ligneux dans les agro-écosystèmes des régions semi-arides)
(Caims et al., 1997. Root biomass allocation in the world's uplands forest, Oecologia 111, 1-11)



What have learnt from the West African Project?

- *Need for emission factors that reflect better the national circumstances than the IPCC EFDB*
- *Methodological and AD esp. in the LULUCF – need further refinement esp. link to 1996 IPCC GIs*
- *Regional projects – useful in assisting countries to develop National Inventory Systems*
- *There ought to be increased usage of available tech guidance from the UNFCCC and CGE, NGGIP-IPCC and UNDP-GEF & some Annex I countries i.e. UNFCCC software, satellite imagery for LULUCF, EFDB etc*
- *Hands-on training on methods for uncertainty management in GHG inventories e.g. sensitivity analysis*

Greenhouse gas Inventory Office of Japan

Session II: Uncertainty Assessment

Guidance

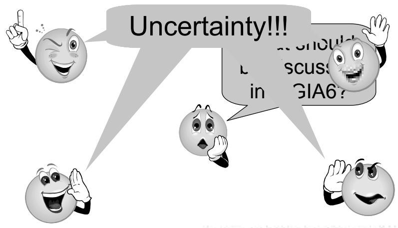
16 July 2008, Tsukuba, Japan
6th Workshop on GHG Inventories in Asia

Kiyoto Tanabe
Greenhouse Gas Inventory Office of Japan (GIO)
National Institute for Environmental Studies (NIES)

0

Long-awaited topic, but…

- Apparently, many WGIA colleagues have been so keen on "uncertainty assessment" being taken up in WGIA.



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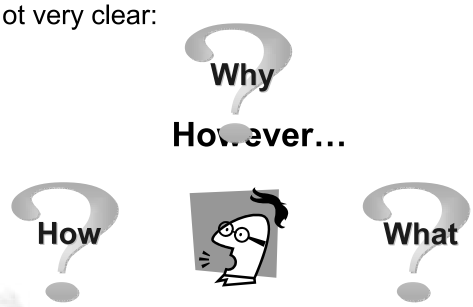
Long-awaited topic, but…

- Not very clear:



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Why? For what purposes?

- Non-Annex I Parties **are encouraged to** provide information on the level of uncertainty associated with inventory data.
  → **Not required!!**
- Why do you consider uncertainty information so important? For what purposes?
  - To develop adaptation & mitigation strategies?
    - How can these purposes be met in practice?
  - To prioritize data/categories to be improved?
    - Why don't you do key category analysis (Tier 1) first?
- Better to use resources for other purposes?

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How to do it? How useful?

- "Lack of activity data/country-specific EFs" = common problems in developing countries
- How can you quantify uncertainties?
  - Rely heavily on default uncertainty values as well as expert judgement?
    → **Uncertainty assessment itself may be highly uncertain!!**
- How useful is such uncertainty assessment? Does it really meet your purposes?
- Better to use resources for data collection?

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What to do with the results?

- When you complete the uncertainty assessment, what should be the next step?
  - Uncertainty assessment itself is not the goal.
  - What steps do you need to take to achieve your ultimate goals?
- If you do not have any clear ideas on what to do with the results, uncertainty assessment will be little use …
- Better to use resources for other purposes?

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Presentations are going to be made by:

- IPCC, on methodological guidance
- India, on the country's experience
- Korea, on the country's experience

Let's discuss and consider together:

- Why we should do uncertainty assessment;
- How we can do it;
- What we should do with the results; and
- How we can cooperate within the WGIA framework?

Now, let's start this session!!

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Uncertainty Analysis in Emission Inventories

Simon Eggleston
Head, Technical Support Unit,
IPCC Task Force on Inventories

Remember…

- Most important is producing high quality "Good Practice" emission and removal estimates
- Effort on uncertainty analysis should be small in comparison to effort on inventory estimates themselves
- Data collection activities should consider data uncertainties
  - This will ensure the best data is collected & ensures good practice estimates
  - As you collect data you should assess how "good" it is
- **At its simplest a well planned uncertainty assessment should only take a few extra hours!**

Why are you making an inventory?

- As part of compulsory reporting (e.g. NC)
- Policy development
  - Mitigation
  - Adaption
- Monitoring impacts of mitigation policies
- Look for co-benefits (or impacts of non-climate policies on GHG emissions/removals)
  - Urban or regional air quality
  - Energy efficiency

As part of compulsory reporting

- Non Annex I parties have to produce inventories as part of their National Communications
- Uncertainty assessment is part of any inventory that complies with Good Practice Guidance
- Uncertainty assessment should be part of any scientific estimate
- Reducing uncertainties means making the estimates better reflect the specific national circumstances
- You may wish to do the minimum necessary but remember – others will use your inventory to develop their policies…
  - Its always best for everyone to use the best figures

Policy development

- Inventories form the basis of any rational policy development.
  - They indicate the major sectors where abatement will have a real impact
  - They can be used to predict the impact of proposed policies
  - They are used to chose cost-effective options
- However, the results are only as reliable as the emission inventories uncertainty
  - ⇨ Minimising uncertainty improves results
  - ⇨ Knowledge of uncertainty tells users the limits of the results (i.e. their uncertainty)

Monitor impacts of mitigation policies

- Policy makers need to know if policies are working
- Inventory methods should be chosen to reflect mitigation measures
- Uncertainty will indicate the minimum changes that can be seen by the emission inventory
  - reducing uncertainties enables smaller effects to be detected
- Improving uncertainties will ensure the inventory better reflects the real situation in a country

Look for co-benefits: Impacts of non-climate policies:

Many policy areas have multiple benefits

ENERGY EFFICIENCY	***SOIL CARBON IN CROPLANDS***
•Reduced Costs	•Improved water availability
•Energy Security	•Improved drought tolerance
•Reduced Air Pollution	•Improved soil fertility (biodiversity)
•Reduced CO_2 Emissions	•Carbon sequestration

- Emission Inventories enable policy choices to be based on an proper understanding of these issues
- Emission Inventories enable GHG benefits to be claimed and acknowledged
  - Uncertainty assessment is an important part to add credibility to this process

Benefits of Uncertainty Analysis

Credibility: Inventories are estimates – uncertainty analysis gives a clear statement on what we do and do not know

Utility: Users of the inventory need to know how reliable the numbers are – especially if they are input into policy or inventory improvement actions

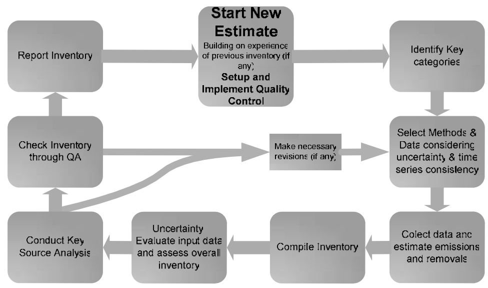
Requirement: Uncertainty analysis is a requirement of all good practice inventories

Scientific: All scientific analysis should include an uncertainty assessment

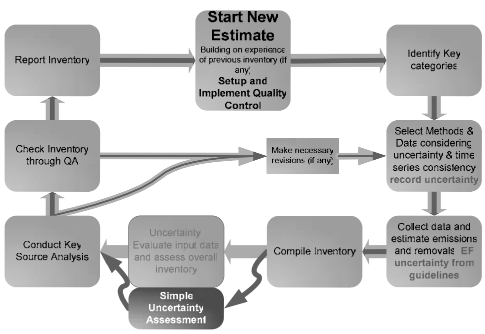
Comparable Inventories

- This is the aim of the IPCC guidelines
- They allow for choice of methods by inventory compilers
- Methods have to be demonstrably consistent
- GPG is way to ensure comparable inventories and uncertainty assesment is a part of this
- Inventory should be
  - Transparent
  - Complete
  - Consistent
  - Comparable
  - Accurate

Inventory Cycle



Inventory Cycle



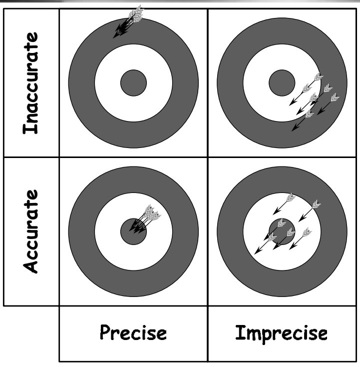
Task Force on Inventories

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

IPCC National Greenhouse Gas Inventory Programme

Some Concepts

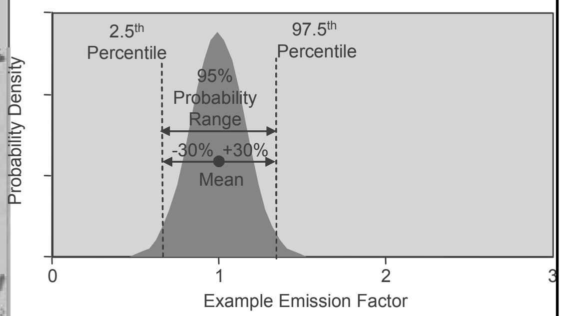
Accuracy & Precision



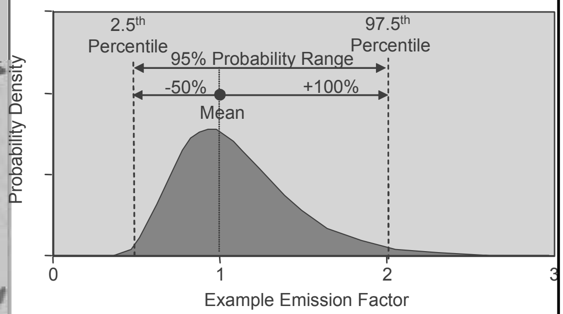
Specifying Uncertainty

- Uncertainty is quoted as the 2.5 and 97.5 percentile i.e. bounds around a 95% confidence interval
- This can be expressed as
  - 234 ± 23%
  - 26400 (- 50%, + 100%)
  - 2000 (a factor of 2) (i.e. - 50%, + 100%)
  - 10 an order of magnitude (i.e. 1 to 100)

Probability Density



Probability Density



Task Force on Inventories

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

IPCC National Greenhouse Gas Inventory Programme

Determining Data Uncertainties

Simplified Approach

Sources of Uncertainty

- Assumptions and methods
  - These method may not accurately reflect the emission. Good Practice requires that biases be reduced as much as possible. Guidelines aim to be as unbiased and complete as possible.
- Input Data
  - Measured values have errors and emission factors may not be truly representative
- Calculation errors
  - Good QA/QC to stop these

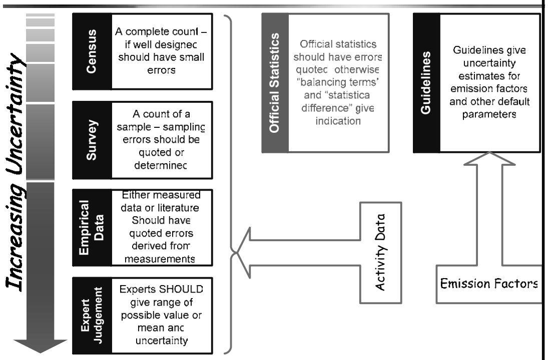
Uncertainties arise in Input Data…

- Lack of data
  - Use of proxies, extrapolation etc.
  - Missing data
- Data not truly representative
- Statistical Random Sampling Error
- Measurement error
- Misreporting
- **Consideration of these during data collection phase will minimise errors**

Sources of data

- **National Statistics Agencies**
- **Sectoral experts, stakeholder organisations**
- **Other national experts**
- **IPCC Emission Factor Database**
- **Other international experts**
- **International organisations publishing statistics e.g., United Nations, Eurostat or the International Energy Agency, OECD and the IMF (which maintains international activity as well as economic data)**
- **Reference libraries (National Libraries)**
- **Scientific and technical articles in environmental books, journals and reports.**
- **Universities**
- **Web search for organisations & specialists**
- **National Inventory Reports from Parties to the United Nations Framework Convention on Climate Change**

Uncertainty Information



Expert Judgement

- In many cases empirical data are not available.
- A practical solution is using well-informed judgements from experts.
  - Possible biases: Availability bias, representativeness bias, anchoring and adjustment bias, motivational bias, managerial bias…
  - Solution: use formal expert elicitation protocols
- Expert elicitation

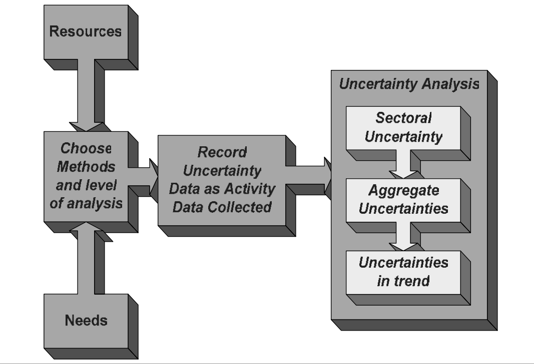
Expert judgement

- Expert judgement on methodological choice and choice of input data to use is ultimately the basis of all inventory development and sector specialists can be of particular use to fill gaps in the available data, to select data from a range of possible values or make judgements about uncertainty ranges as described in Section 3.2.2.3. Experts with suitable backgrounds can be found in government, industrial trade associations, technical institutes, industry and universities.
  The goal of expert judgement may be choosing the proper methodology; the parameter value from ranges provided; the most appropriate activity data to use; the most appropriate way to apply a methodology; or determining the appropriate mix of technologies in use. A degree of expert judgement is required even when applying classical statistical techniques to data sets, since one must judge whether the data are a representative random sample and, if so, what methods to use to analyze the data. This requires both technical and statistical judgement. Interpretation is especially needed for data sets that are small, highly skewed or incomplete[1]. In all cases the aim is to be as representative as possible in order to reduce possible bias and increase accuracy. Formal methods for obtaining (or eliciting) data from experts are known as expert elicitation, see Annex 2A.1 for details.

  [1] Methods for characterising sampling distributions for the mean are described by Cullen and Frey (1999), Frey and Rhodes (1996), and Frey and Burmaster (1999).

- Wherever possible, expert judgement should be elicited using an appropriate protocol. An example of a well-known protocol for expert elicitation, Stanford/SRI protocol, has been adapted and is described below.
  Motivating: Establish a rapport with the expert, and describe the context of the elicitation. Explain the elicitation method to be used and the reason it was designed that way. The elicitor should also try to explain the most commonly occurring biases to the expert, and to identify possible biases in the expert.
  Structuring: Clearly define the quantities for which judgements are to be sought, including, for example, the year and country, the source/sink category, the averaging time to be used (one year), the focus activity data, emission factor or, for uncertainty, the mean value of emission factors or other estimation parameter, and the structure of the inventory model. Clearly identify conditioning factors and assumptions (e.g., resulting emissions or removals should be for typical conditions averaged over a one-year period).
  Conditioning: Work with the expert to identify and record all relevant data, models, and theory relating to the formulation of the judgements.
  Encoding: Request and quantify the expert's judgement. The specific qualification will differ for different elements and be present in the form of a probability distribution for uncertainty, and an activity or emission factor estimate for activity data and emission factors. If appropriately managed, information on uncertainty (probability density function) can be gathered at the same time as gathering estimates of activity or emission factor. The section on encoding in Chapter 3 describes some alternative methods to use for encoding uncertainty.
  Verification: Analyze the expert's response and provide the expert with feedback as to what has been concluded regarding his or her judgement. Is what has been encoded really what the expert meant? Are there inconsistencies in the expert's judgement?

Uncertainty Analysis



Methods to combine uncertainties

1. Error Propagation
   - ❖ Simple - Standard Spreadsheet can be used
     - ✓ Guidelines give explanation and equations
   - ❖ Difficult to deal with correlations
   - ❖ Strictly (standard deviation/mean) < 0.3
     - ✓ A simple solution is provided
2. Monte-Carlo Simulation
   - ❖ More complex - Use specialised software
   - ❖ Needs shape of pdf
   - ❖ Suitable where uncertainties large, non-Gaussian, complex algorithms, correlations exist and uncertainties vary with time

From 2006 Guidelines:

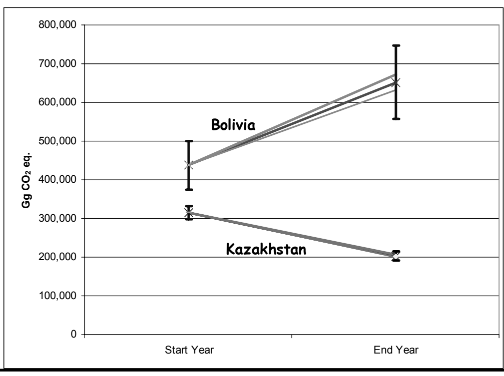
TABLE 3.2
APPROACH 1 UNCERTAINTY CALCULATION

A	B	C	D	E	F	G	H	I	J	K	L	M
IPCC category	Gas	Base year emissions or removals	Year *t* emissions or removals	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Contribution to Variance by Category in Year *t*	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data	Input data	Input data Note A	Input data Note A	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert\frac{D}{\sum C}\right\rvert$	$I \bullet F$ Note C	$J \bullet E \bullet \sqrt{2}$ Note D	K^2+L^2
		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
E.g., 1.A.1. Energy Industries Fuel 1	CO_2											
E.g., 1.A.1. Energy Industries Fuel 2	CO_2											
Etc...	…											
Total		$\sum C$	$\sum D$				$\sum H$					$\sum M$
					Percentage uncertainty in total inventory:		$\sqrt{\sum H}$				Trend uncertainty:	$\sqrt{\sum M}$

Approach 1 uncertainties calculation

A	B	C	D	E	F	G	H	I	J	K	L	M
IPCC category	Gas	Base year emissions or removals	Year *t* emissions or removals	Activity data uncertainty	Emission factor / estimation parameter uncertainty	Combined uncertainty	Contribution to Variance by Category in Year *t*	Type A sensitivity	Type B sensitivity	Uncertainty in trend in national emissions introduced by emission factor / estimation parameter uncertainty	Uncertainty in trend in national emissions introduced by activity data uncertainty	Uncertainty introduced into the trend in total national emissions
		Input data	Input data	Input data	Input data	$\sqrt{E^2+F^2}$	$\frac{(G \bullet D)^2}{(\sum D)^2}$	Note B	$\left\lvert\frac{D}{\sum C}\right\rvert$	$I \bullet F$	$J \bullet E \bullet \sqrt{2}$	K^2+L^2
		Gg CO_2 equivalent	Gg CO_2 equivalent	%	%	%		%	%	%	%	%
1.A.1. Energy Industries	CH4	35.5346662	32.9951217	5	25	25.50	0.0	3.20506E-05	0.00010495	0.000801264	0.000742109	1.19275E-0
1.A.2. Manufacturing Industries and Constructior	CH4	57.0302899	51.8776096	5	25	25.50	0.0	4.80131E-05	0.000165011	0.001200328	0.001166804	2.80222E-0
1.A.3. Transport	CH4	81.7067834	37.1466612	5	25	25.50	0.0	-4.94664E-05	0.000118155	-0.00123666	0.000835483	2.22736E-0
1.A.4. Other Sectors	CH4	1041.24025	428.554682	5	25	25.50	0.0	-0.000772946	0.001363136	-0.019323647	0.009638828	0.0004663
1.A.5. Other	CH4	330.338228	97.5658895	5	25	25.50	0.0	-0.000367351	0.000310335	-0.009183772	0.002194401	8.91571E-0
1.B.1. Solid Fuels	CH4	24867.6834	12364.38	10	25	26.93	2.7	-0.011678579	0.039328314	-0.291964463	0.556186352	0.39458650
1.B.2. Oil and Natural Gas	CH4	12570.348	4022.34735	10	25	26.93	0.3	-0.012988732	0.012794183	-0.324718297	0.180937071	0.13818019
2.B. Chemical Industry .	CH4	40.53	37.5018	10	25	26.93	0.0	3.61373E-05	0.000119285	0.000903433	0.001686942	3.66196E-0
4.A. Enteric Fermentation.	CH4	14054.9863	7346.85	15	30	33.54	1.5	-0.005462727	0.023368679	-0.163881819	0.495724537	0.27260006
4.B. Manure Management.	CH4	1903.28061	1199.63088	15	30	33.54	0.0	-8.88245E-05	0.003815756	-0.002664735	0.080944413	0.00655909
4.C. Rice Cultivation.	CH4	522.9	338.94	10	30	31.62	0.0	5.3609E-06	0.001078092	0.000160827	0.015246523	0.00023248
4.F. Field Burning of Agricultural Residues.	CH4	64.3314	37.59	20	30	36.06	0.0	-1.24107E-05	0.000119565	-0.000372321	0.003381819	1.15753E-0
6.A. Solid Waste Disposal on Land.	CH4	1959.72	3738.63	15	30	33.54	0.4	0.00787088	0.011891742	0.236126385	0.252261939	0.11939175
6.B. Wastewater Handling.	CH4	787.08	747.18	15	30	33.54	0.0	0.000761896	0.002376612	0.022856865	0.050415547	0.00306416
1.A.1. Energy Industries	CO2	102607.31	95966.95	5	5	7.07	11.2	0.094441853	0.305249301	0.472209267	2.158438506	4.88183837
1.A.2. Manufacturing Industries and Constructior	CO2	33991.06	30164.34	5	5	7.07	1.1	0.02618491	0.095945987	0.130924551	0.678440577	0.47742285
1.A.3. Transport	CO2	23987.07	8406.48	5	5	7.07	0.1	-0.022453294	0.026739124	-0.11226647	0.189074157	0.04835279
1.A.4. Other Sectors	CO2	44532.52	11784.04	5	5	7.07	0.2	-0.053800014	0.037482383	-0.269000072	0.265040472	0.1426074
1.A.5. Other	CO2	8370.16	4124.19	5	5	7.07	0.0	-0.004052209	0.013118122	-0.020261045	0.092759127	0.00901476
1.B.2. Oil and Natural Gas	CO2	3408.21	5171.49583	10	15	18.03	0.2	0.009456387	0.016449366	0.141845811	0.232629165	0.07423656
2.A. Mineral Products.	CO2	5744.63	2507.20146	10	15	18.03	0.0	-0.003809586	0.007974844	-0.057143788	0.112781331	0.01598504
2.B. Chemical Industry .	CO2	1355.56	171.93456	10	15	18.03	0.0	-0.002233954	0.000546885	-0.033509311	0.007734125	0.00118269
2.C. Metal Production.	CO2	12932.6799	10507.4715	10	15	18.03	0.9	0.006887639	0.033421905	0.103314586	0.47265712	0.23407865
5.A. Changes in Forest and Other Woody Bioma	CO2	97.19		50	80	94.34	0.0	-0.000199385	0	-0.015950798	0	0.00025442
5.A. Changes in Forest and Other Woody Bioma	CO2	-7810.79	-7721.7341	50	80	94.34	12.9	-0.008539362	0.024561101	-0.683148991	1.736732102	3.48293093
5.B. Forest and Grassland Conversion.	CO2	6.26	280.43888	25	75	79.06	0.0	0.00087917	0.000892013	0.065937785	0.031537424	0.00534240
1.A.1. Energy Industries	N2O	388.516902	328.741673	5	50	50.25	0.0	0.000248607	0.001045653	0.012430334	0.007393886	0.00020918
1.A.2. Manufacturing Industries and Constructior	N2O	112.709781	114.844426	5	50	50.25	0.0	0.000134069	0.000365294	0.006703468	0.002583021	5.16085E-0
1.A.3. Transport	N2O	57.3319301	21.6195922	5	50	50.25	0.0	-4.88495E-05	6.87671E-05	-0.002442474	0.000486257	6.20212E-0
1.A.4. Other Sectors	N2O	194.497577	46.1816455	5	50	50.25	0.0	-0.000252117	0.000146893	-0.01260587	0.001038693	0.00015998
1.A.5. Other	N2O	27.4386549	13.5195061	5	50	50.25	0.0	-1.3288E-05	4.30025E-05	-0.000664398	0.000304074	5.33886E-0
4.B. Manure Management.	N2O	375.1	198.4	15	30	33.54	0.0	-0.000138451	0.000631066	-0.004153541	0.013386927	0.00019646
4.D. Agricultural Soils(2).	N2O	25217.694	9798.17	20	30	36.06	3.0	-0.020551916	0.031165777	-0.616557485	0.881501284	1.15718764
4.F. Field Burning of Agricultural Residues.	N2O	24.304	21.297	20	30	36.06	0.0	1.78812E-05	6.7741E-05	0.000536437	0.001916004	3.95884E-0
6.B. Wastewater Handling.	N2O	452.6	384.4	15	30	33.54	0.0	0.000294175	0.00122269	0.008825264	0.025937172	0.00075062
Keep Blank!	...										0	
Total		314388.7626	202771.1719				∑H 34.6				∑M	11.4670044
					Percentage uncertainty in total inventory:		5.880740472				Trend uncertainty:	3.38629656

Example Results



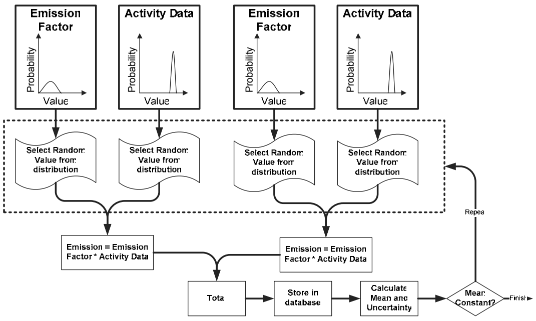
Results

	Kazakhstan			Bolivia		
Emissions	Changes in Forest and Other Woody Biomass Stocks.	CO2	86%	Enteric Fermentation	CH4	95%
	Energy Industries	CO2		Forest and Grassland Conversion	N2O	
	Agricultural Soils	N2O		Agricultural Soils	N2O	
	Solid Fuels	CH4		Forest and Grassland Conversion	CO2	
Varience	Energy Industries	CO2	69%	Enteric Fermentation	CH4	72%
	Manufacturing Industries and Construction	CO2		Agricultural Soils	N2O	
	Solid Fuels	CH4		Forest and Grassland Conversion	N2O	
	Other Sectors	CO2			CO2	

Monte-Carlo Method

- Key Requirements
  - Not just uncertainties but also probability density function (pdf)
    - Mean
    - Width
    - Shape (e.g. Normal, Log-normal, Weibul, Gamma, Uniform, Triangular, Fractile, …)
- Principal
  - Select random values of input parameters form their pdf and calculate the corresponding emission. Repeat many times and the distribution of the results is the pdf of the result, from which mean and uncertainty can be estimated

Monte-Carlo Method



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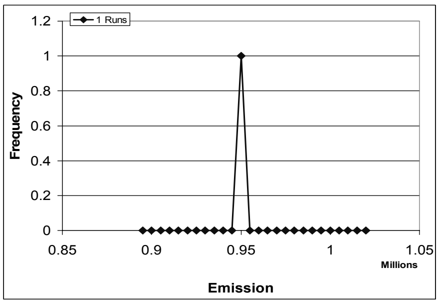

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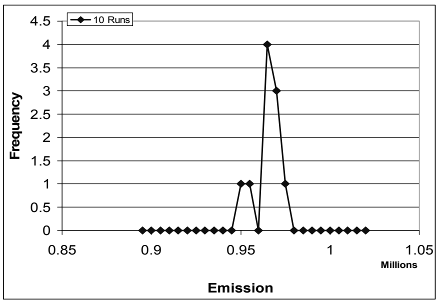

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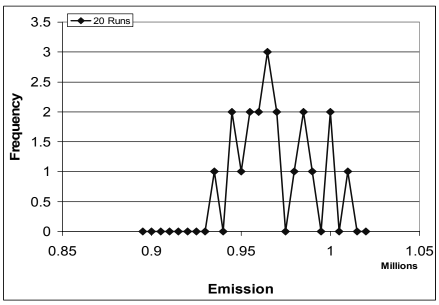

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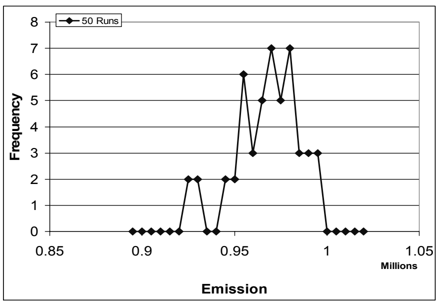
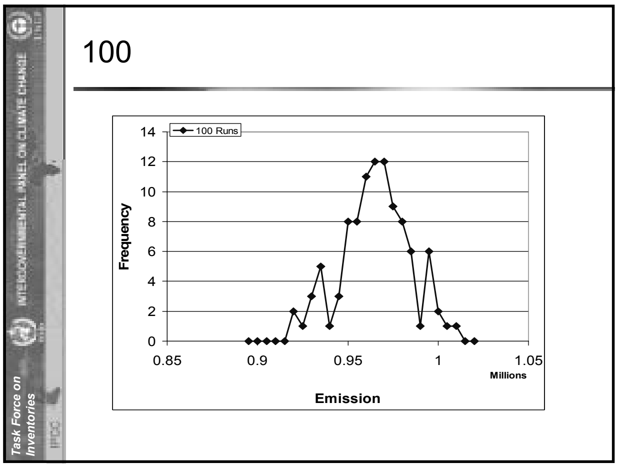
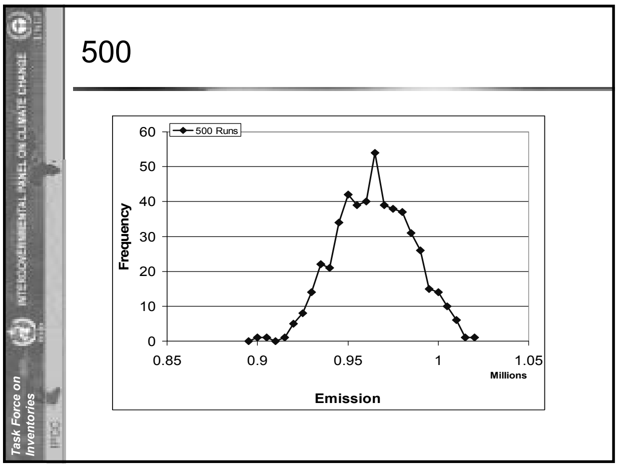



100
100 Runs
Frequency
Emission
Millions
Task Force on Inventories
INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE


500
500 Runs
Frequency
Emission
Millions
Task Force on Inventories
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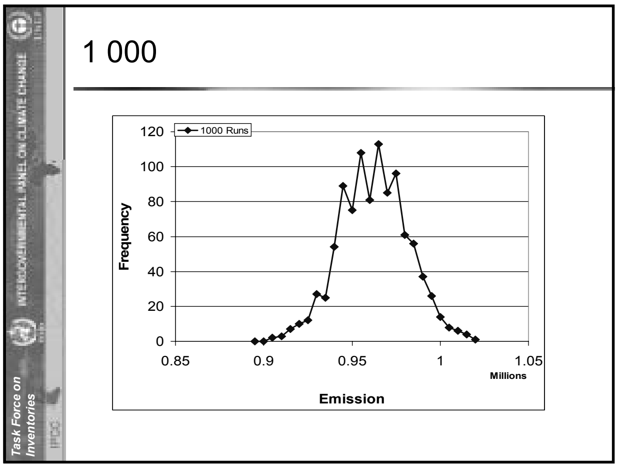
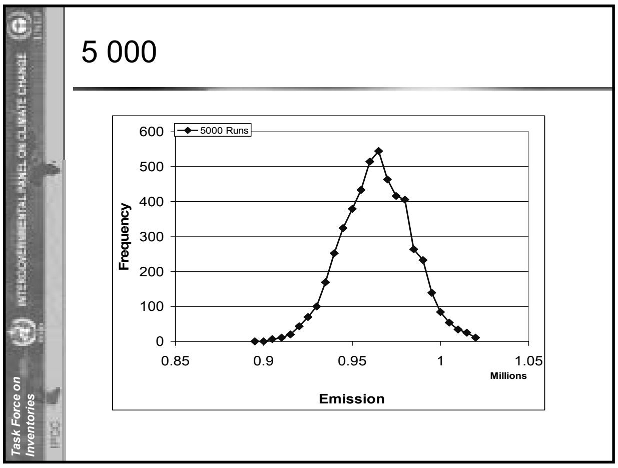
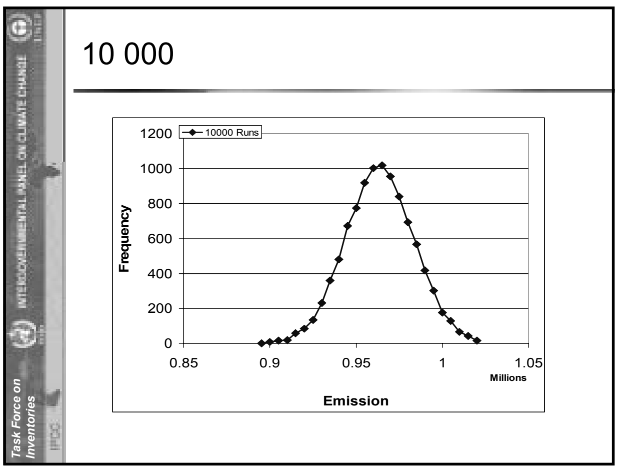
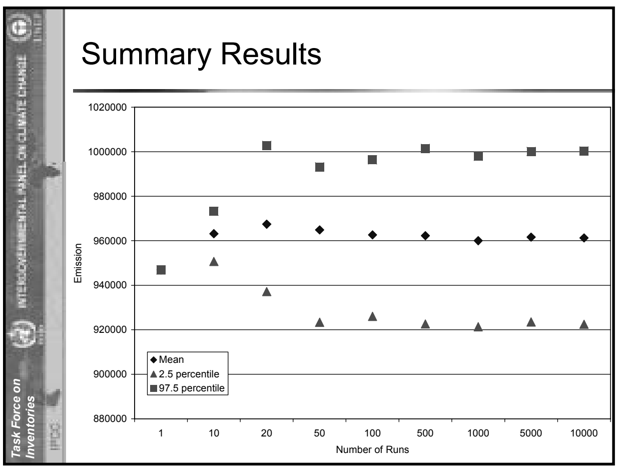

1 000
1000 Runs
Frequency
Emission
Millions
Task Force on Inventories
INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE


5 000
5000 Runs
Frequency
Emission
Millions
Task Force on Inventories
INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE


10 000
10000 Runs
Frequency
Emission
Millions
Task Force on Inventories
INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE


Summary Results
Emission
Number of Runs
Mean
2.5 percentile
97.5 percentile
Task Force on Inventories
INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

Summary

- Even simple uncertainty estimates give useful information
- Good QA/QC and careful consideration of methods can reduce uncertainty
- Assessment of uncertainty in the input parameters should be part of the standard data collection QA/QC
- There are two approaches to combining uncertainty - or a hybrid approach can be used
- For simple estimates
  - Uncertainty in activity data assesssed as data collected
  - Uncertainty in emission factors from guidelines
  - Aggregate categories to independent groups of sources/sinks
  - Use Approach 1 - spreadsheet requires little statistical knowledge

Task Force on Inventories

INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE

IPCC National Greenhouse Gas Inventory Programme

Thank-you

Any Questions?

Greenhouse gas Inventory Office of Japan

Uncertainty Assessment of Japan's GHG Inventory

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WGIA 6 in NIES, Tsukuba, Japan
July 16, 2008

Outline

- Overview of Uncertainty Assessment
- General Procedure of Uncertainty Assessment
- Uncertainty Assessment for Emission Factor (EF) and Activity Data (AD)
- Uncertainty Assessment in each sector (characteristic categories)
- Results of Uncertainty Assessment
- Issues for Uncertainty Assessment
- From Japan's experiment for uncertainty assessment

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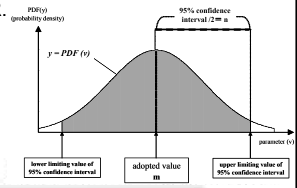
Overview of Uncertainty Assessment

- ***GPG(2000)*** is base concept for assessment methods.
- **Uncertainty range** is **95% confidential interval**.
- Discussed for uncertainties on the ***Committee for GHG Estimation Methods*** in 2001.
- Japan has **annually conducted** uncertainty assessment based on *the Committee for GHG Estimation Methods*.
- Describe in **Annex 7 of NIR**.
  - 7.1 Methodology
  - 7.2 Results



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General Procedure of Uncertainty Assessment

1st STEP: Estimate uncertainties for Emission Factor (EF) / Activity Data (AD) of each source/sink (describe in detail later)

2nd STEP: Combine uncertainties for EF and AD to estimate uncertainties of emission from each source/sink uncertainty.

$$U=\sqrt{U_{EF}^2+U_A^2}$$

U : Uncertainties of Emissions from Source(%)
U_{EF} : Uncertainties for Emission Factor (%)
U_A : Uncertainties for Activity Data (%)

3rd STEP: Combine each source/sink uncertainty to estimate total uncertainty.

$$U_{total}=\frac{\sqrt{(U_1\cdot E_1)^2+(U_2\cdot E_2)^2+\cdots+(U_n\cdot E_n)^2}}{E_1+E_2+\ldots+E_n}$$

U_{total} : Uncertainties of total Emissions of Source(%)
U_i : Uncertainties of Emissions from Source "i" (%)
E_i : Emission from Source "i" (Gg)

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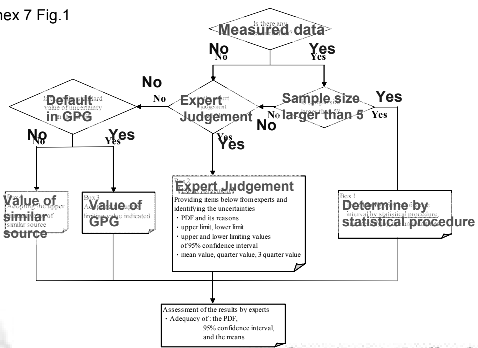
Uncertainty Assessment for EF

NIR Annex 7 Fig.1



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Uncertainty Assessment for EF

- Calculate by finding the 95% confidential interval using statistical procedure.
- Decide by Expert Judgement.
  - document and archiving about the basis for their decision, and factors contributing to uncertainty that are excluded from consideration.
- Adopt default data provided by *GPG (2000)*.
- Adopt the standard uncertainty for similar emission source provided by *GPG (2000)*.

About multiple parameter EF

- Calculate combined uncertainty for EF from each parameter uncertainty.

$$U_{EF}=\sqrt{U_1^2+U_2^2+\cdots+U_n^2}$$

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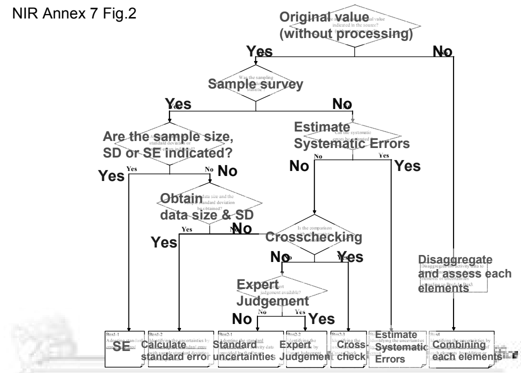
Uncertainty Assessment for AD

NIR Annex 7 Fig.2



Uncertainty Assessment for AD

Statistical values based on a Sample survey

- Adopt statistical values on a sample survey
- Decide by Expert Judgement
- Adopt the standard value established by *the Committee for GHG Estimation Methods*

	Designated statistics	Other statistics
Sample survey	50 %	100%

Statistical values **not** based on a Sample survey

- Estimate of systemic error.
- Crosscheck with other statistics
- Expert Judgement
- Adopt the standard value established by the *Committee for GHG Estimation Methods*

	Designated statistics	Other statistics
Complete survey (no rounding)	5%	10%
Complete Survey (rounding)	20%	40%

Uncertainty Assessment for AD

Using statistical values processed as AD

Step1: Breakdown of each element of AD and assessment

Step2: Combining elements

- Sum method (Rule A) : AD is expressed as **A_1+A_2**

$$U_{A-total} = \frac{\sqrt{(U_{A1} * A_1)^2 + (U_{A2} * A_2)^2}}{A_1 + A_2}$$

- Product method (Rule B) : AD is expressed as **A_1 x A_2**

$$U_A = \sqrt{U_{A1}{}^2 + U_{A2}{}^2}$$

Uncertainty Assessment in Energy Sector

1.A. Fuel Combustion

CO2

EF Use **Standard Deviation** of **sample data** of **each fuel's calorific value**
-**Carbon content** of **each fuel** is decided by **C/H ratio**, and **C/H ratio is strongly correlating with calorific value**

CO2

AD Based on the given **statistical error** of solid fuels, liquid fuels, and gaseous fuels, in TJ given in the ***General Energy Statistics***.

Emission Uncertainties are lower than other sector.

Combined uncertainties of each category: 0.3~6%

Uncertainty Assessment in Industrial Processes Sector

2.B.5. Chemical industry (Other)

EF Carbon Black (CH4) | Styrene (CH4) | Coke (CH4) (Sample number >= 5)

Calculated by finding the **95% confidential interval** of **measured data**

Ethylene (CO2, CH4) | 1,2-dichloroethane (CH4) (Sample number < 5)

Estimated by finding the **95% confidential interval** using **Expert Judgement** (in consideration of measured data)

AD **Standard value of 5%** given by the *Committee for the GHG Estimation Methods*

Emission Combine EF & AD $U = \sqrt{U_{EF}{}^2 + U_A{}^2}$

Uncertainty Assessment in Agricultural Sector

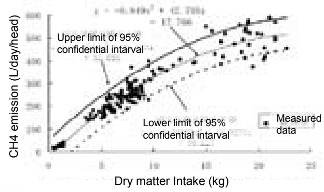
4.A.1. Enteric Fermentation (Cattle) CH4

Estimate by each category (Dairy cattle: 4 categories, Non-dairy cattle: 11 categories)

AD **Standard Error** given in the ***Livestock Statistics***

EF Calculated by finding the **95% confidential interval** of **measured data** in accordance with the equation indicated below

Emission Combine EF & AD $U = \sqrt{U_{EF}{}^2 + U_A{}^2}$



Uncertainties Assessment in LULUCF Sector

5. A.1. Forestland remaining Forestland CO2

AD forest area

- Evaluated by **comparing** sample forest areas in **Forest Status Survey** with those on **orthophotos** and calculating the uncertainty in accordance with the following equation

$$U\ (\%) = \frac{\left(\frac{|A_1 - a_1|}{a_1} + \frac{|A_2 - a_2|}{a_2} + \cdots + \frac{|A_n - a_n|}{a_n}\right)}{n} \times 100$$

Emission and Removal Factors evaluated by combining the uncertainties of following parameters

• stand volume, basic wood density, biomass expansion factor, root-to-shoot ratio: Evaluated by applying **95% confidential interval** of actually measured data

• carbon fraction: Evaluated by applying a default value in LULUCF-GPG

•Combination Equation:

$$U_E = \sqrt{U_V^2 + U_D^2 + U_{BEF}^2 + U_R^2 + U_{CF}^2}$$

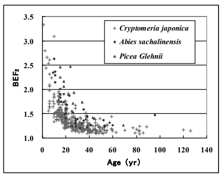


Figure: Measured Data on Biomass Expansion Factor related with Age

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Uncertainty Assessment in Waste Sector

6.C.1.a. Incineration of Municipal Solid Waste (plastics) CO2 (CH4) (N2O)

U_{EF}
- C content
- Combustion efficiency

Using 95% confidence interval

Estimated using IPCC default values (upper and lower limit)

U_{AD}
- Uncertainty in incinerated amount
- Uncertainty in percentage of solids

Standard values adopted by the *Expert Committee on GHG Emission Estimation Method*

Based on Expert Judgement

Emission

$$U = \sqrt{U_{AD}^2 + U_{EF}^2}$$

U: Uncertainty in **emissions**, 17%

U_{EF}: Uncertainty in **emission factors**, 4.3%

U_{AD}: Uncertainty in **activity data**, 16%

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Results of Uncertainty Assessment

Uncertainty of Japan's Total Emissions in FY2006

Approximately 2%

IPCC Category	GHGs	Emissions / Removals [Gg CO2eq.]		Combined Uncertainty [%] 1)	rank	Combined uncertainty as % of total national emissions	rank
1A. Fuel Combustion (CO2)	CO2	1,185,874	95.0%	1%	10	0.68%	3
1A. Fuel Combustion (Stationary:CH4,N2O)	CH4、N2O	5,129	0.4%	30%	2	0.12%	7
1A. Fuel Combustion (Transport:CH4,N2O)	CH4、N2O	3,238	0.3%	352%	1	0.91%	1
1B. Fugitive Emissions from Fuels	CO2、CH4、N2O	462	0.0%	19%	6	0.01%	8
2. Industrial Processes (CO2,CH4,N2O)	CO2、CH4、N2O	55,643	4.5%	7%	8	0.33%	5
2. Industrial Processes (HFCs,PFCs,SF6)	HFCs、PFCs、SF6	17,290	1.4%	20%	5	0.28%	6
3. Solvent	N2O	266	0.0%	5%	9	0.00%	9
4. Agriculture	CH4、N2O	27,368	2.2%	26%	3	0.57%	4
5. LULUCF	CO2、CH4、N2O	-91,501	-7.3%	19%	7	-1.38%	10
6. Waste	CO2、CH4、N2O	44,811	3.6%	23%	4	0.81%	2
Total Emissions	(D)	1,248,580	100.0%	(E) **2%**			

Greenhouse gas Inventory Office of Japan

Results of Uncertainty Assessment

- Japan's total uncertainty is lower than its of other Annex I Countries.
  >>> Ratio of GHG emissions from agricultural sector, which has high level uncertainties, is **lower** than other Annex I Countries.
- Uncertainties are used for **Tier 2 Key Categories Assessment**.
  >>> In Tier 2 KCA, categories with high uncertainty are identified as key categories.
  Example of Japan: N2O Emissions from Civil aviation is small emission, but its category is chosen as key category by Tier 2 KCA.

Greenhouse gas Inventory Office of Japan

Issues for Uncertainty Assessment

- Results of uncertainty assessment are seldom utilized in Japan. Reasons are as follows.
  1. Since uncertainty assessment itself includes a certain degree of uncertainty for some parameter, reliability for uncertainty assessment is partially not high enough.
  2. Without uncertainty assessment, we can guess categories with high priority, which should improve in Japan's case. (Categories with high priority are using "NE", using default data, pointed by ERT and so on.)
- In the *Initial Review Report*, ERT recommended that Japan improve the estimate of the overall uncertainty of its inventory.
  > To decide each uncertainty for parameter is so difficult that Japan is also seeking more better methodology.

Greenhouse gas Inventory Office of Japan

From Japan's experiment for uncertainty assessment

- Result of uncertainty assessment is one of good index to decide priority of inventory.
- It is difficult to decide uncertainties for each parameter without statistical distribution.

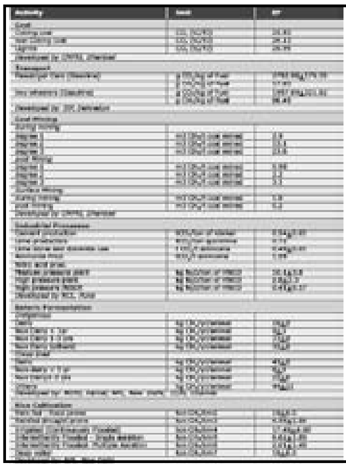
Greenhouse gas Inventory Office of Japan

Uncertainty Assessment: India's Experience

Sumana Bhattacharya
NATCOM, MoEF, India

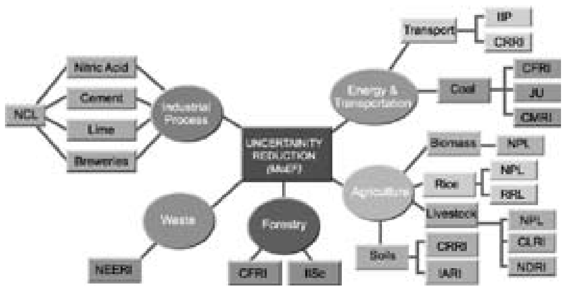
Approach towards reducing uncertainties in GHG estimates

- Development of country specific GHG emission factors
  - Updating the same with time
  - Evaluating key sources over time and developing new emission factors
- Identifying uncertainties in the steps of GHG estimates itself by using the IPCC guidelines



NATCOM-I

Institutional arrangement: NATCOM I



Moving on to NATCOM - II

- Refinement of existing factors
- Development of new emission factors
- Moving towards higher tier estimates for key source categories
- Bridging data gaps identified in NATCOM I
- Launching standard QA/QC procedures for each of the categories

Key Sources analysis

Planning for reducing uncertainties

Sources of emission	EF used in INC	Status of EF envisaged in SNC	Activities proposed in SNC	Rationale	Tier used in INC	Proposed in SNC
Energy and transformation industries	CS	R	o Refinement of NCV of different types of coal o Determine technology specific point source level EFs of CO_2, CO and NOX for thermal power plants	o Inadequate sample size taken in INC o Thermal power plants is the key category within the energy and transformation sector	Tier I	Tier II
Enteric Fermentation	CS	R	o Sample survey of age wise domestic livestock population, feed type, milk production in various climate regions of India o Develop CH_4 EF for enteric fermentation through estimation and measurement	o It is a key category in the agriculture sector o In INC, appropriate activity data was not available to make a correct assessment o The sample size for which measurements were taken was small, and could not be validated through estimates because lack of activity data	Tier II	Tier III
Industry (fuel combustion)	D	D	-not targeting-	-not targeting-	Tier I	Tier I
Rice Cultivation	CS	R	Undertake CH_4 flux measurements in hotspot areas	This is the second largest GHG emitting category amongst all the agriculture categories. As the emission from this source is dominated by emissions from hotspots, therefore it is proposed to investigate the EFs from these regions.	Tier II	No change
Transport	CS	R	o Conduct survey to apportion the fossil fuel used in various types of road vehicles o Refine EFs from different kinds of gasoline and diesel driven vehicles by incorporating driving cycles	These two approaches will be used to reconcile the top down and bottom up emission estimates from this source	Tier I	Tier II
Emissions from Soils	D		o Development of N_2O EFs from	This is a major source of N_2O emission	Tier I	

Planning for reducing uncertainties

		CS	different soils	amongst all the categories.		Tier II
Iron and steel production	D	CS	o Plant level assessment of CO_2 EFs (resulting from combustion of fuel & production process)	It is a fast growing sector of the economy in addition to being a major source of GHG emissions	Tier I	Tier II
Energy use in Residential sector	D	D	-not to be targeted-	-not to be targeted-	Tier I	No change
Biomass burnt for energy	D	D	-not to be targeted-	Data available	Tier I	No change
All other source sectors	D	D	-not to be targeted-	Individually not in key category	Tier I	No change
Cement production	CS	R	Plant level assessment of CO_2 EFs due to production process	It is a fast growing sector of the economy in addition to being a major source of GHG emissions	Tier I	Tier II
Energy consumed in Commercial-institutional	D	D	-not to be targeted-	-not to be targeted. As source category too diverse, and enough resources not available.	Tier I	No change
Manure Management	D	D	-not to be targeted-	Manure management not done in a systematic manner in India	Tier I	No change
Ammonia production	D	CS	Determine plant level CO_2 EF	Key category – not targeted in INC	Tier I	Tier II
Land use, Land-use change and Forestry	D	CS	o Develop land use change matrix o Assess biomass stock, carbon fraction of biomass, biomass growth rates of various types of species (crops/forests) to be considered under this category	A key category, and targeted in SNC to bring in the GPG LULUCF (2003) guidance in the inventory estimation process	Tier I	Tier II
Coal mining	CS	CS	-not targeted-	-not targeted-	Tier III	Tier III
Oil and natural gas system	D	D	Develop methodology for accessing data on a regular basis on oil and natural gas transport, storage, venting and flaring	Though not a key category, but the consumption of oil and natural gas shows the highest growth rate w.r.t. other fossil fuel, so efforts will be made to obtain first assessment of activity data	Tier I	Tier I

Planning for reducing uncertainties

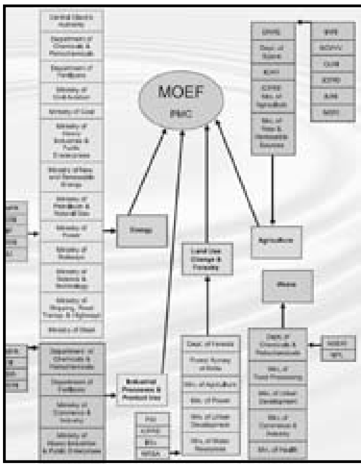
Municipal Solid Waste Disposal			o Assess per capita MSW generation, composition and handling process o Generate EFs for managed and unmanaged landfill sites	Rapid urbanization resulting in increased generation of waste and changed composition	Tier I	Tier II
Domestic Waste water	D	D	-not targeted-	-not a key category-	Tier I	No change
Lime stone and dolomite use	D	D	-not targeted-	-not a key category-	Tier I	No change
Agricultural crop residue	D	D	-not targeted-	-not a key category-	Tier I	No change
Nitric acid production	CS	CS	-not targeted-	-not a key category-	Tier II	No change
Human Sewage	D	D	-not targeted-	-not a key category-	Tier I	No change
Lime production	D	D	-not targeted-	-not a key category-	Tier I	No change
Industrial Waste Water	D	CS	Chemical analysis of waste water in selected key industries	Rapid growth of certain industries like paper, pulp, beverage etc.	Tier I	Tier II
Ferro alloys production	D	D	-not targeted-	-not a key category	Tier I	No change
Aluminium production	D	D	-not targeted-	-not a key category	Tier I	No change
Carbide production	D	D	-not targeted-	-not a key category	Tier I	No change
Soda ash use	D	D	-not targeted-	-not a key category	Tier I	No change
Black carbon and styrene production	D	D	-not targeted-	-not a key category	Tier I	No change

NATCOM-II

- Improving NCV of coal
- CO2 emission factors from two power plants due to combustion of coal
- CO2 emission factor from an integrated iron and steel plant due to combustion of fuel and the processes itself
- Updating CH4 from Coal mining
- CH4 from transport of oil/natural gas

NATCOM-II

- CH4 from continuously irrigated rice fields
- N2O from agricultural soils
- Improving CH4 EF from enteric fermentation in Livestock
- Soil C from Forests
- CH4 from MSW
- CH4 from Waste water from key industries



Institutional Arrangement: NATCOM II

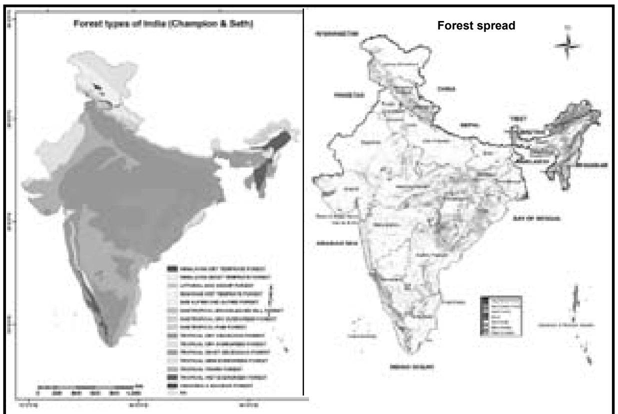
An example – LULUCF – Soil C

Problems to address..

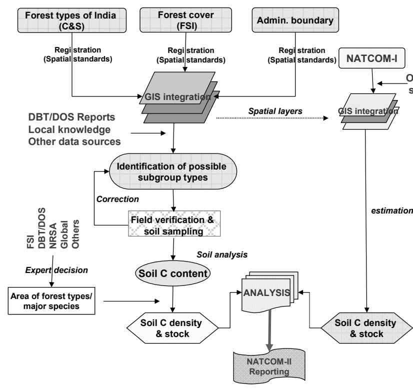
- ✓ Preparation of Forest type and sub-group type map of India (Champion & Seth, 1968)
- ✓ Harmonization of different spatial layers of India (forest types, actual forest cover, administrative boundaries and collateral data sources), and assigning them uniform spatial standards
- ✓ Non-existence or localized presence of some of the forest sub-group types and difficulty in locating them
- ✓ Even modern tools like RS and recent published estimates gives only forest types and sub-group type associations/equivalents

Opportunities..

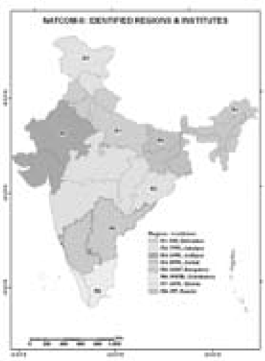
- ✓ Preparation of Forest type map and sub-group type details of India in tabular format (Champion & Seth, 1968)
- ✓ Harmonization of different spatial layers of India (forest types, actual forest cover, administrative boundaries and collateral data sources) in GIS and assigning them uniform spatial standards
- ✓ Use of FSI and DBT-DOS reports



Flow diagram showing overview of methodology



ICFRE participating Institutes and their area of jurisdiction



Nodal ICFRE Institutes and number of sample locations

Region	Name of the Institute	Area coverage	No. of subgroup types	Number of samples (@ 3 per type + from non-forest area)
R1	FRI, DEHRADUN	UA, UP, PUN,HA, ND, Chandigarh	31	33+10=43
R2	TFRI, JABALPUR	MP, MS, OR,CH	17	51+10=61
R3	AFRI, JODHPUR	RA,GU, D&N Haveli, D&Diu	18	54+10=64
R4	RFRI, JORHAT	North East	29	87+12=97
R5	IWST, BANGALORE	KA, AP, GOA	15	45+08=53
R6	IFGTB, COIMBATORE	TN, KE, A&N Is. Pondy,	32	96+10=106
R7	HFRI, SHIMLA	HP, J&K,	16	48+08=58
R8	IFP, RANCHI	BH, JH, WB, Sikkim	13	39+10=49
	Total No. of samples		**171**	**513+78=591**

What is given…

- Forest types, sub-groups, sub-group types, C & S code, distribution and dominant species along with the identified institute is supplied to every participating institutes.
- This will be supplemented with any other map available for now or as soon is become available.

Detailed methodology Prepared for :

Sample collection
Storage
Analysis and calculation

Inception meeting with Nodal officers from different ICFRE Institutes conducted 9-10 May

Sampling procedure to be uniformally adopted by all teams demonstrated in the field

QA/QC plan developed

Annexure – I

Basic information about the soil samples and sampling site

Compartment/Village______________________**Block/Tehsel**__________________
Division/Distt.____________________**State**___________________
Altitude_______**Aspect** ________**Latitude**____________ **Longitude**_____________
Forest type :________________ Dominant species________________________
Slope (%) : ______________ **Rock out crop (%) :** _______________
Coarse Fragments (%)_ _______________
Tick on appropriate feature:
a) Erosion class : Slight Moderate Severe Gullied
b) Physiographic: Hill top Hill slope Plateau Plain Valley
c) Moisture : Wet Moist Dry
d) Plant litter : Light (25 % surface area coverage)
Moderate (25-50 % surface area coverage)
Heavy (>50 % surface area coverage)
e) Soil depth: Shallow (<25 cm.) , Moderately deep (25-50)
Moderate (50-100) Deep (>100 cm)
Sample Collected By:
Division:____
Institute:____
Date_
Soil Sample No.: __________ (Region No./ Forest types / Sample No.- Replication No.)
Foe ex. (R6/ TEG / 1-2)
Note: Separate sheet should be filled at each sampling site and handed over in lab with samples

Soil Sample Collection Protocol

Most carbon accounting purposes require a volumetric estimate of soil carbon. This requires measures of bulk density and the volumetric proportion of coarse fragments (e.g. gravels).

Existing guidelines (IPPC, 1997) for carbon accounting refer only to the upper 0.30 m. This zone is intended to cover the actively changing soil carbon pool.

SOC Density (t/ha) = Organic Carbon Content (%) * Bulk density * Soil Layer depth * (1- volume fraction of coarse fragments)

While sampling certain points should be kept in mind.

- *Locate sample site away from roads, houses and construction sites, etc.,*
- *In a forested area sample should be drawn away from the trunk of the tree or between trees.*
- *Avoid eroded and locations where large plant material is under decay.*
- *Always dig **a fresh rectangular pit** and in grass land first clear the top layer and dig the profile.*

1. Estimating Rock Outcrop

It is desirable to have a more accurate estimate of the volume of rock within the soil individual. Measure rock outcrop along a series of linear transects. At each transect intercept, record the length of rock surface (>50 mm). The area of rock outcrop is estimated using:

$$Aro = 100\ (\Sigma r / L)$$

where *Aro* is the areal percentage of of rock outcrop, *L* is the total transect length and *r* is the length of rock intercepted (m).

Rock outcrop can also be measured using the 10 m grid (100 m^2 area) assuming that the observer is at the middle of the grid. Make schematic sketch of the rock out crop on the grid and estimate the percentage.

2. Estimating Percent Coarse Fragment in the Soil

Percent coarse fragment (>2mm size) in soils will be estimated by morphological examination of soil.

Coarse fragments by volume in layer of 0-30 cm. using the visual estimation of coarse fragments key should be observed.

An area of 10 cm. by 10 cm. (100 cm2) can be visualized in layer covering of coarse fragments.

It is also useful to indicate the size of coarse fragments (CF) by type, as given in table 4b:

Type of coarse fragments and its size

Gravels (G) *2 -75 mm*; Cobbles (C) *75-250 mm*; Stones (S) *> 250 mm* (25 cm).

3. Collection of Samples

In each sampling units, three sampling points will be selected as replicates.

At each point soil sample of 0-30 cm. depth will be collected.

One sample will also be collected in non-forested area (agricultural area) close to the major forest types.

Detailed number of samples, forest sub types and nodal institutes are given in sampling plan with participating institute.

3.1 Soil sample for carbon estimation:

- Forest floor litter of an area of 0.5m x 0.5 m, at sampling point will be removed and a pit of 30 cm wide, 30 cm deep and 50 cm in length will be dug out.
- Soil from three sides of the pit, will be scraped with the help of Kurpee from 0 to 30 cm depth and bulked. Scrap uniform thickness of soil layer from top to bottom (0-30m cm)
- This soil will be mixed thoroughly and removed gravels. Quarter the bulked soil sample and select opposite quarter approximately of 500 gm. Here, coarse fragments can also be approximated.
- Keep in a polythene bag and tightly closed with thread.
- A label showing the sampling details should be put in side of polythene bag before closing the bag.
- Proper entry to be made in field note book

3.2 For bulk density estimation by Core sampler

3.3 Storage of the samples

- If numbers of samples are large and not possible to analyze / process immediately after collection from field, then samples collected for soil organic carbon, should be placed in refrigerator or deep freezer.
- Taken out desired numbers of sample and prepare them for estimation.

4. Preparation of sample

4.1 Carbon estimation in the laboratory

- Open the polythene bag and spread the samples on a brown paper sheet in the laboratory. Let the sample dry at room temperature in the laboratory.
- *Avoid direct sun drying or oven drying.*
- Marking of the sample (which was given on the label at the time of the collection of sample) should be written on the brown paper sheet to avoid the mixing of the samples.
- After drying the samples, grind it and sieve it through 100 mesh sieve (2 mm sieve). This sieved sample will be used for soil organic carbon estimation.

4.2 Analysis

Soil organic carbon will be estimated by standard Walkley & Black method and

Vegetation characteristics of the sample site

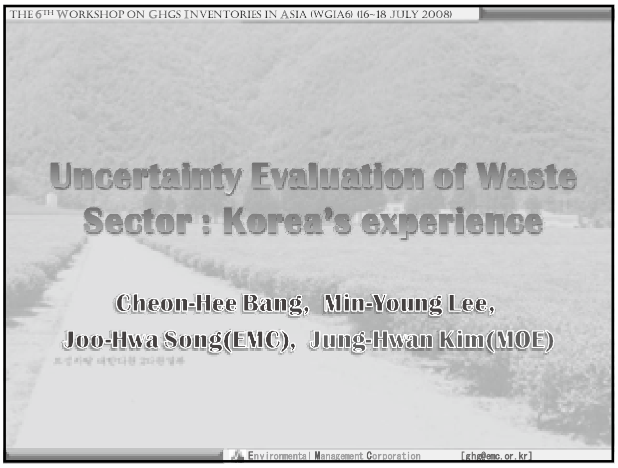
Measure 22x22m either side of sample location (Quadrat of 31x31 m=0.1 ha)

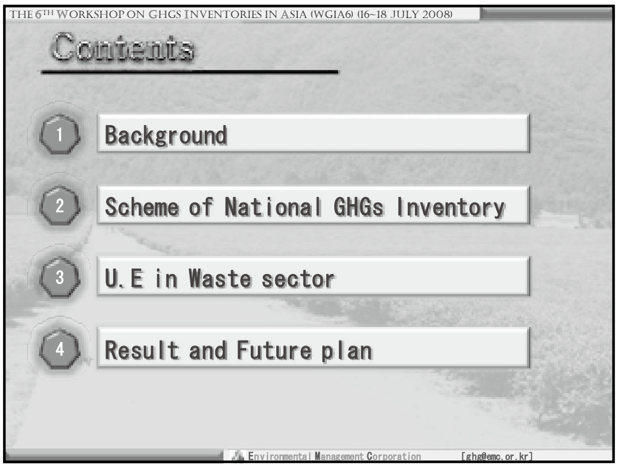
Enumerate all tree species > 10 cm dia within the quadrat

For shrubs 5x5 m qudart

For herbs and grasses 1x1 m quadrat


Thank You


THE 6TH WORKSHOP ON GHGS INVENTORIES IN ASIA (WGIA6) (16~18 JULY 2008)
Uncertainty Evaluation of Waste Sector : Korea's experience
Cheon-Hee Bang, Min-Young Lee,
Joo-Hwa Song(EMC), Jung-Hwan Kim(MOE)
Environmental Management Corporation [ghg@emc.or.kr]


THE 6TH WORKSHOP ON GHGS INVENTORIES IN ASIA (WGIA6) (16~18 JULY 2008)
Contents
1 Background
2 Scheme of National GHGs Inventory
3 U.E in Waste sector
4 Result and Future plan
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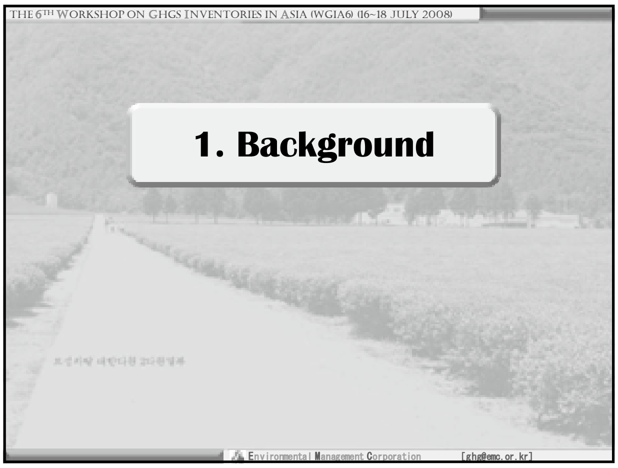
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1. Background
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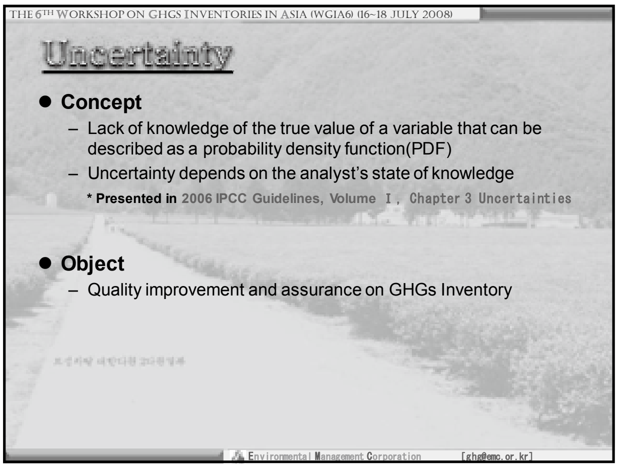
THE 6TH WORKSHOP ON GHGS INVENTORIES IN ASIA (WGIA6) (16~18 JULY 2008)
Uncertainty
Concept
– Lack of knowledge of the true value of a variable that can be described as a probability density function(PDF)
– Uncertainty depends on the analyst's state of knowledge
* Presented in 2006 IPCC Guidelines, Volume Ⅰ, Chapter 3 Uncertainties
Object
– Quality improvement and assurance on GHGs Inventory
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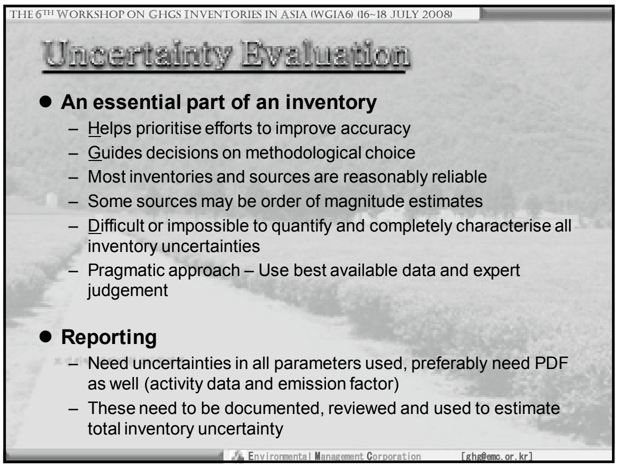
THE 6TH WORKSHOP ON GHGS INVENTORIES IN ASIA (WGIA6) (16~18 JULY 2008)
Uncertainty Evaluation
An essential part of an inventory
– Helps prioritise efforts to improve accuracy
– Guides decisions on methodological choice
– Most inventories and sources are reasonably reliable
– Some sources may be order of magnitude estimates
– Difficult or impossible to quantify and completely characterise all inventory uncertainties
– Pragmatic approach – Use best available data and expert judgement
Reporting
– Need uncertainties in all parameters used, preferably need PDF as well (activity data and emission factor)
– These need to be documented, reviewed and used to estimate total inventory uncertainty
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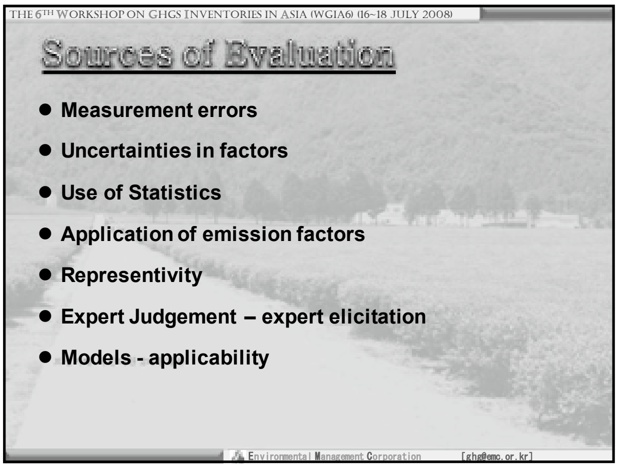
THE 6TH WORKSHOP ON GHGS INVENTORIES IN ASIA (WGIA6) (16~18 JULY 2008)
Sources of Evaluation
Measurement errors
Uncertainties in factors
Use of Statistics
Application of emission factors
Representivity
Expert Judgement – expert elicitation
Models - applicability
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Generic Method

- **Tier 1 approach**
  - Estimating uncertainties by source category with simplifying assumptions : Using the error propagation equation in two steps.

Rule	Description
A approximation	Used to arrive at the overall uncertainty in national emissions and the trend in national emissions between the base year and the current year.
B approximation	Used to combine emission factor and activity data ranges by source category and greenhouse gas.

* Suggested in IPCC GPG and Uncertainty Management in National Greenhouse Gas Inventories, Chapter 6 Quantifying Uncertainties in Practice

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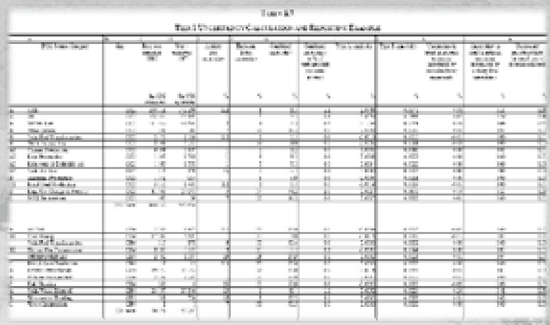
Generic Method



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Generic Method

- **Tier 2 approach**
  - Estimating uncertainties by source category using Monte Carlo analysis (principle)
    - □ Selecting random values of emission factor and activity data from within their individual probability density functions
    - □ Calculating the corresponding emission values.
  - Monte Carlo approach's five clearly defined steps

Step 1	Step 2	Step 3	Step 4	Step 5
Specify source category uncertainties	Set up software package	Select random variables	Estimate emissions	Iterate and monitor results

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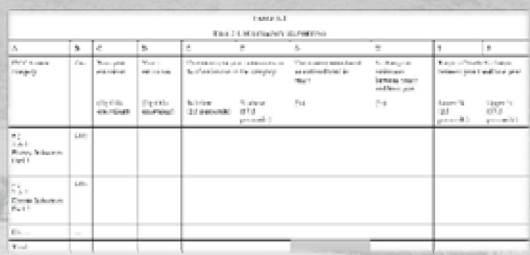
Generic Method



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For example

Country	Method	Country	Method
Austria	Tier 1 / Tier 2	Italy	Tier 1
Belgium	Tier 1	Latvia	Tier 1
Bulgaria	-	Lithuania	Tier 1
Cyprus	-	Luxembourg	Tier 1
Czech Republic	Tier 1	Malta	Tier 1
Denmark	Tier 1	Netherlands	Tier 1
Estonia	Tier 1	Poland	Tier 1
Finland	Tier 1 (LULUCF) / Tier 2 (LULUCF excluded)	Portugal	Tier 1 2005
		Romania	-
France	Tier 1	Slovakia	Tier 1
Germany	Tier 2	Solvenia	Tier 1
Greece	Tier 1	Spain	Tier 1
Hungary	Tier 1	Sweden	Tier 1
Ireland	Tier 1	United Kingdom	Tier 1/ Tier 2 2005

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THE 6TH WORKSHOP ON GHGS INVENTORIES IN ASIA (WGIA6) (16~18 JULY 2008)

2. Scheme of National GHGs Inventory

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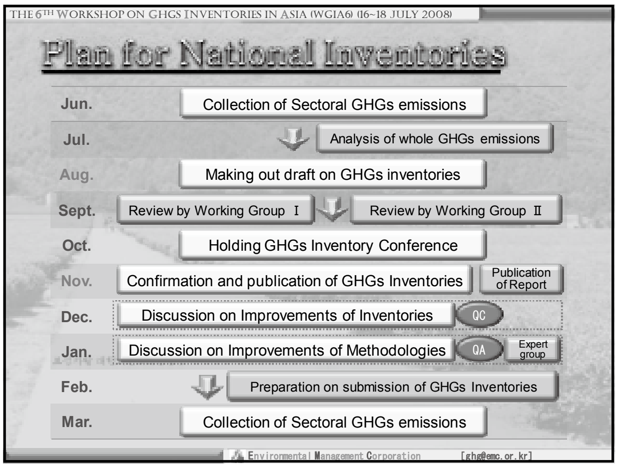
THE 6TH WORKSHOP ON GHGS INVENTORIES IN ASIA (WGIA6) (16~18 JULY 2008)
Plan for National Inventories
Jun.
Collection of Sectoral GHGs emissions
Jul.
Analysis of whole GHGs emissions
Aug.
Making out draft on GHGs inventories
Sept.
Review by Working Group Ⅰ
Review by Working Group Ⅱ
Oct.
Holding GHGs Inventory Conference
Nov.
Confirmation and publication of GHGs Inventories
Publication of Report
Dec.
Discussion on Improvements of Inventories
QC
Jan.
Discussion on Improvements of Methodologies
QA
Expert group
Feb.
Preparation on submission of GHGs Inventories
Mar.
Collection of Sectoral GHGs emissions
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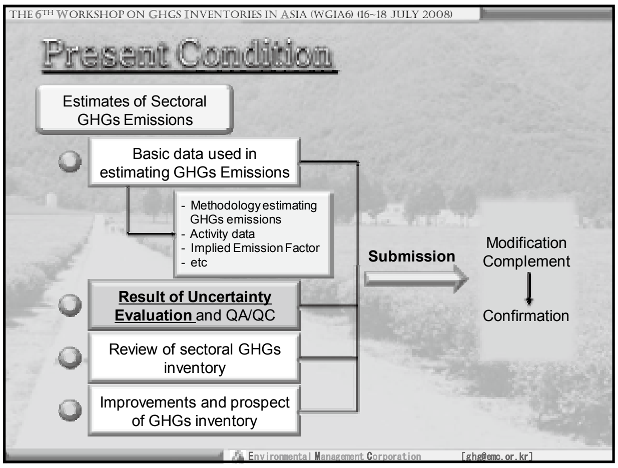
THE 6TH WORKSHOP ON GHGS INVENTORIES IN ASIA (WGIA6) (16~18 JULY 2008)
Present Condition
Estimates of Sectoral GHGs Emissions
Basic data used in estimating GHGs Emissions
- Methodology estimating GHGs emissions
- Activity data
- Implied Emission Factor
- etc
Result of Uncertainty Evaluation and QA/QC
Review of sectoral GHGs inventory
Improvements and prospect of GHGs inventory
Submission
Modification
Complement
Confirmation
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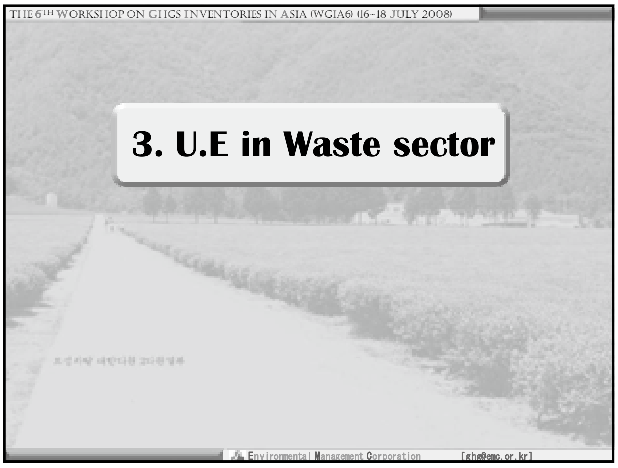
THE 6TH WORKSHOP ON GHGS INVENTORIES IN ASIA (WGIA6) (16~18 JULY 2008)
3. U.E in Waste sector
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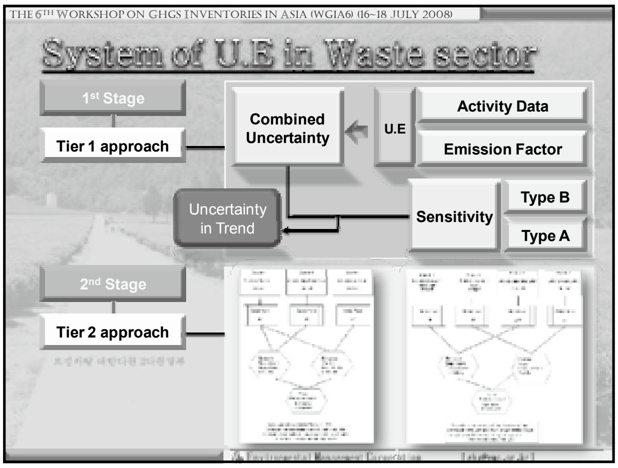
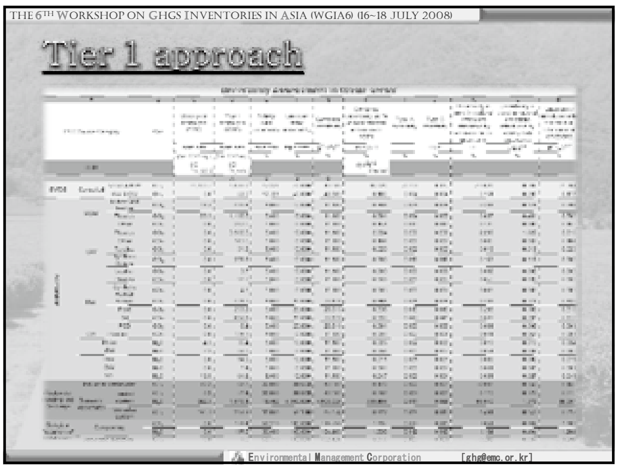

THE 6TH WORKSHOP ON GHGS INVENTORIES IN ASIA (WGIA6) (16~18 JULY 2008)
System of U.E in Waste sector
1st Stage
Tier 1 approach
Combined Uncertainty
U.E
Activity Data
Emission Factor
Uncertainty in Trend
Sensitivity
Type B
Type A
2nd Stage
Tier 2 approach


THE 6TH WORKSHOP ON GHGS INVENTORIES IN ASIA (WGIA6) (16~18 JULY 2008)
Tier 1 approach
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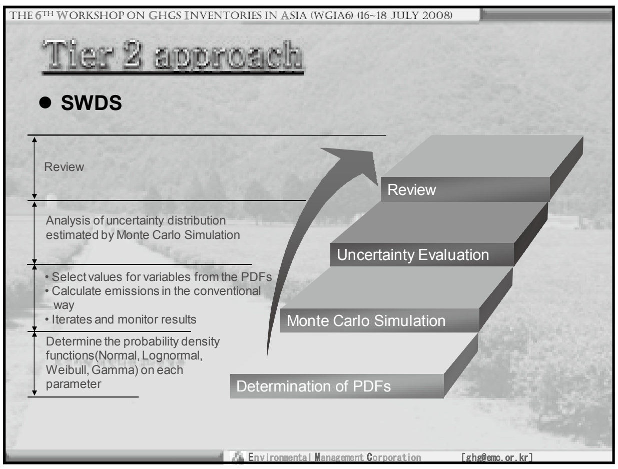
THE 6TH WORKSHOP ON GHGS INVENTORIES IN ASIA (WGIA6) (16~18 JULY 2008)
Tier 2 approach
● SWDS
Review
Analysis of uncertainty distribution estimated by Monte Carlo Simulation
• Select values for variables from the PDFs
• Calculate emissions in the conventional way
• Iterates and monitor results
Determine the probability density functions(Normal, Lognormal, Weibull, Gamma) on each parameter
Review
Uncertainty Evaluation
Monte Carlo Simulation
Determination of PDFs
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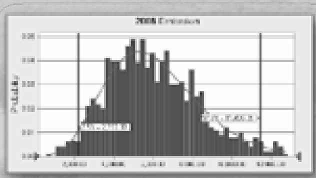
THE 6TH WORKSHOP ON GHGS INVENTORIES IN ASIA (WGIA6) (16~18 JULY 2008)

Tier 2 approach

- **SWDS**

- Determination of PDFs
- Monte Carlo Simulation
- Uncertainty evaluation



A	B	C	D	E	F	G	H	I	J
IPCC Source category	Gas	Base year emissions	Year t emissions	Uncertainty in year t emissions as % of emissions in the category		Uncertainty introduced on national total in year t	% change in emissions between year t and base year	Range of likely % change between year t and base year	
		(Gg CO_2 eq.)	(Gg CO_2 eq.)	% below (2.5)	% above (97.5)	(%)	(%)	Lower % (2.5)	Upper % (97.5)
SWDS	CH_4	8,169	7,483	3,382	12,966	-	-8	-10	-3

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THE 6TH WORKSHOP ON GHGS INVENTORIES IN ASIA (WGIA6) (16~18 JULY 2008)

4. Results & Future Plan

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THE 6TH WORKSHOP ON GHGS INVENTORIES IN ASIA (WGIA6) (16~18 JULY 2008)

Results

- **Method**
  - Refer to IPCC GPG 2000 and 2006 IPCC G/L
  - Input the uncertainty of activity data and emission factor → Estimate the combined uncertainty
    * by Tier 1 and Tier 2(Monte Carlo simulation) approach
- **Issues**
  - Can't know the uncertainty on GHGs emissions of the whole sectors
  - Doesn't have information on Probability Density Functions of emission factor and activity data for applying for Tier 2
- **Implications**
  - For advanced uncertainty evaluation, it is meaningful that we only attempted uncertainty evaluation by Tier 1 and Tier 2

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THE 6TH WORKSHOP ON GHGS INVENTORIES IN ASIA (WGIA6) (16~18 JULY 2008)

Future Plan

- Improvement on Uncertainty Evaluation in the Tier 2
  - Benchmark on the Annex Ⅰ countries
  - Based on the IPCC GPG 2000 or 2006 IPCC G/L
- What we must do,
  - Development of decision tree on uncertainty
  - Decision on estimation method of uncertainty

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THE 6TH WORKSHOP ON GHGS INVENTORIES IN ASIA (WGIA6) (16~18 JULY 2008)

Thank you for your attention

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THE 6TH WORKSHOP ON GHG INVENTORIES IN ASIA
16-18 July 2008; Tsukuba - Japan

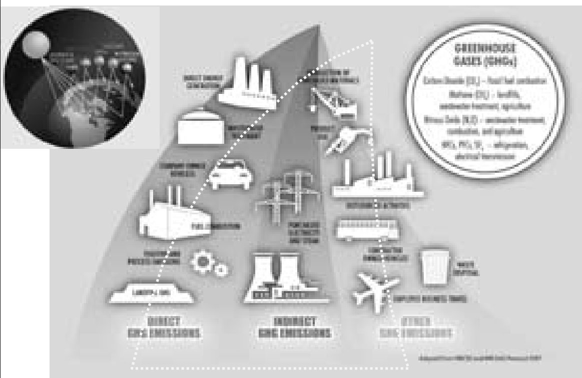
Uncertainty Assessment in GHG Inventories in Viet Nam

Nguyen Chi Quang, Ph.D.
Senior Advisor to Chairman of Board
VINACOMIN - VIET NAM

Uncertainty in GHG Inventories

- A general and imprecise term which refers to the lack of certainty in emissionsrelated data resulting from any causal factor, such as the application of non-representative factors or methods, incomplete data on sources and sinks, lack of transparency etc. Reported uncertainty information typically specifies a quantitative estimates of the likely or perceived difference between a reported value and a qualitative description of the likely causes of the difference
- *Uncertainty investigations should be integrated within your QA/QC plan*!

Focus on Direct and Indirect GHG Emissions



GHG Emissions Inventory Modeling

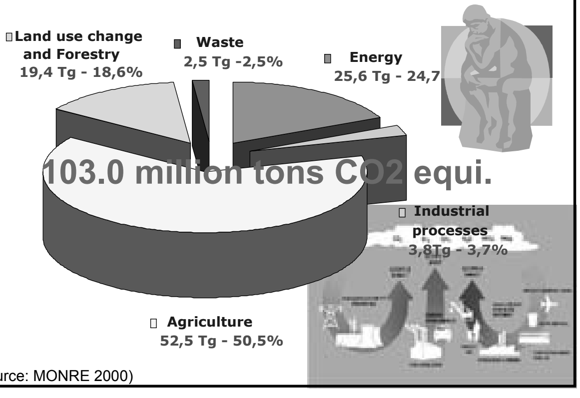
Guidance → Data → Implement → Review

- Guidance:
  - Read the IPCC guidance
  - Consider comments made by Expert Reviewers and in Peer Reviews
- Data:
  - Country specific information on EFs and AD
  - Use IPCC defaults only if sufficient information cannot be found
- Implement:
  - Careful with uncertainty analysis – easy to produce poor quality work
  - Get the help of a statistician
- Review:
  - Ask for peer review
  - Reflect on output of the uncertainty analysis – is it sensible?

(Emission factors, Activity Data, etc.) $x_1, x_2, \ldots, x_J$ → $y = F_i(x)$ → $y_1, y_2, \ldots, y_K$ (GHG Inventory, Trend, etc.)

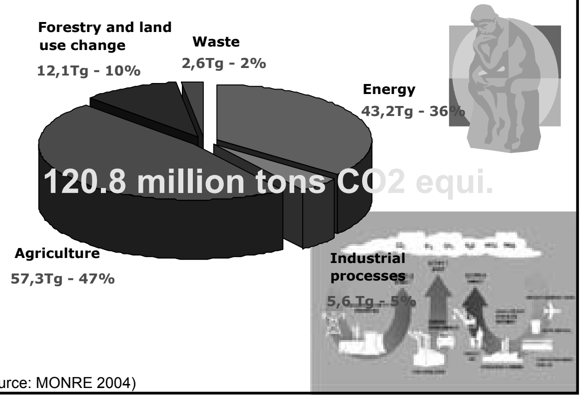
Inventory Model: Spatial Database and Processing

The GHG inventory in 1994 in INC



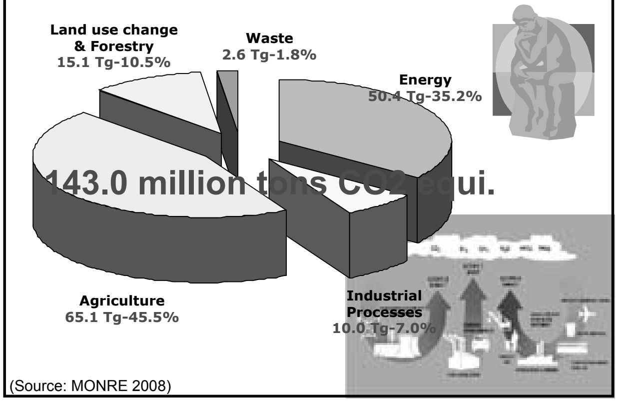
(Source: MONRE 2000)

The National GHG inventory in 1998



(Source: MONRE 2004)

The GHG inventory in 2000 in SNC



(Source: MONRE 2008)

Strictly uncertainties in GHG inventories cannot be exactly quantified

1. **Activity data**
- Gaps in time series
  - Unknown sources
  - Gaps in understanding of existing sources
- Use of surrogate or proxy variables
- Lack of references (calculation or estimation methods, representativeness at local or national level)

2. **Emission Factors**
- Usually high uncertainty
  - Measurement for emission factors are inadequate to quantify uncertainties
  - Emission factors may be inappropriate for specific sources
- Scarcity of quantitative information (measurements, sample representativeness) as compared to qualitative information (experts judgement)

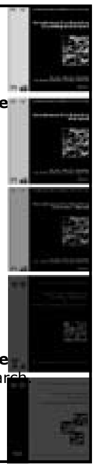
Uncertainty of the Knowledge that is Predicted

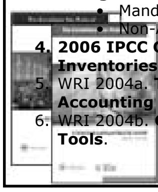
Variability and Uncertainty in GHG Inventories

Sources of Uncertainty:
- Random sampling error for a random sample of data
- Measurement errors
  - Systematic error (bias, lack of accuracy)
  - Random error (imprecision)
- Non-representativeness
  - Not a random sample, leading to bias in mean (e.g., only measured loads not typical of daily operations)
  - Direct monitoring versus infrequent sampling versus estimation, averaging time
  - Omissions
- Surrogate data (analogies with similar sources)
- Lack of relevant data, Lack of completeness
- Misreporting or misclassification
- Problem and scenario specification
- Bias and random errors from modeling

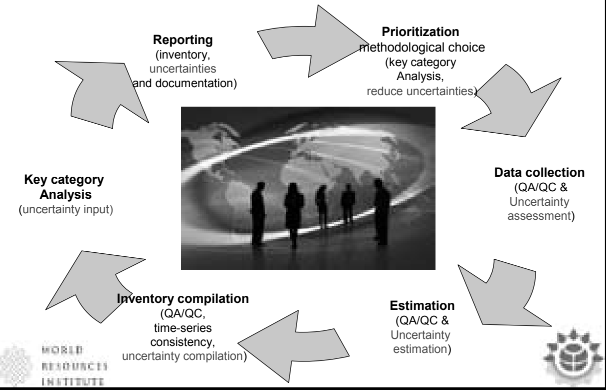
IPCC Guidelines and Guidance

Methods agreed by the COP
1. **Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories (IPCC 1996)**
   - Mandatory for **all** Parties
2. **IPCC Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories (2000)**
   - Mandatory for Annex I Parties
   - Non-Annex I Parties encouraged to use
3. **IPCC Good Practice Guidance for land use, land-use change and forestry (2003)**
   - Mandatory for Annex I Parties
   - Non-Annex I Parties encouraged to use
4. **2006 IPCC Guidelines for National Greenhouse Gas Inventories**
5. WRI 2004a. **The Greenhouse Gas Protocol – A Corporate Accounting and Reporting Standard**. Revised Edition. March.
6. WRI 2004b. **GHG Protocol Initiative – GHG Estimation Tools**.





Good practice inventories contain under or over estimates and uncertainties are reduced as far as is practicable



Overview of methods and guidance

- **Approach 1:**
  - emission sources aggregated up to level similar to IPCC Summary Table 7A
  - uncertainties then estimated for these categories
  - uncertainties calculated **based on error propagation equations**
  - Provides basis for Key Source analysis
- **Approach 2:**
  - corresponds to **Monte Carlo** approach
  - Can use software such as @RISK and MS excel spreadsheets
- Combine Monte Carlo and design-based methods to account for
  - sampling uncertainty
  - input uncertainty
  - model uncertainty
- Recommend reading the IPCC Guidelines – "Uncertainties"

Error propagation equations

Uncertainty of a product of several quantities

$$U_E = \frac{\sqrt{(U_1 \bullet E_1)^2 + (U_2 \bullet E_2)^2 + \cdots + (U_n \bullet E_n)^2}}{|E_1 + E_2 + \cdots E_n|}$$

where:
U_E : percentage uncertainty of the sum
U_i : percentage uncertainty associated with source i
E_i : emission estimate for source I

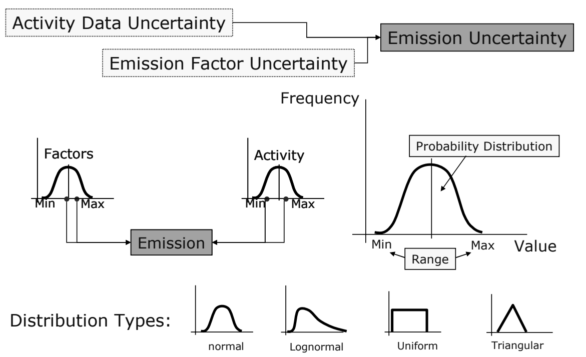
(Equation 5.2.1, IPCC GPG 2004)

Uncertainty assessment of CO2 Emission by Error Propagation Equations

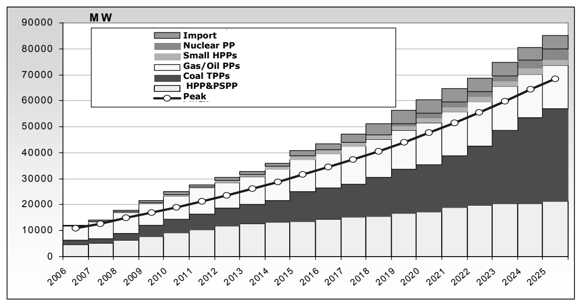
Emission Sources	GHG Emission (GT)		
	1994	**1998**	**2000**
Energy	25,600.00	43,200.00	50,368.03
Industrial Processes	3,800.00	5,600.00	10,005.72
Agriculture	52,450.00	57,300.00	65,090.61
Land use change and Forestry	19,380.00	12,100.00	15,104.72
Waste	2,560.00	2,600.00	2,601.08
Total	**103,790.00**	**120,800.00**	**143,170.16**
Cummulated Uncertainty	**9.10%**	**9.30%**	**8.90%**

(Source: MONRE 2000,2004,2008)

Uncertainties Assessment: Monte Carlo Simulation

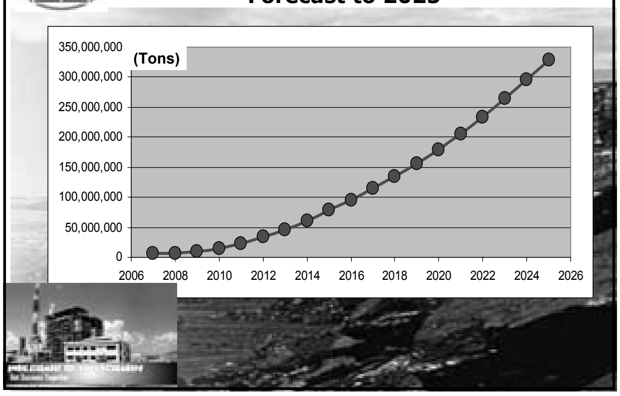


Electricity Demand and Resources Forecast to 2025

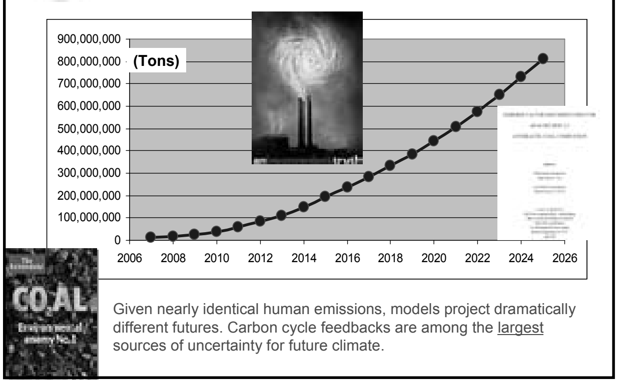


(Source: Sixth Master Plan – EVN, November 2007)

Coal Supply for Electicity Generation Forecast to 2025



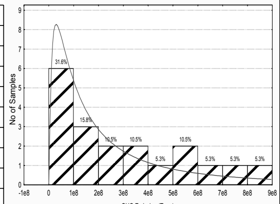
CO2 Emission from Coal for Electricity Generation - Forecast to 2025



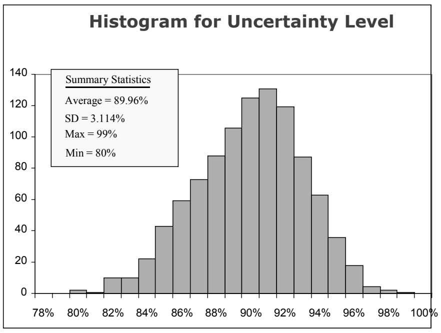
Given nearly identical human emissions, models project dramatically different futures. Carbon cycle feedbacks are among the largest sources of uncertainty for future climate.

Uncertainty Assessment of CO2 Emission by Statistical Analysis

Number of values	19.00
Sum	5,637,297,240.00
Minimum	14,439,970.00
Maximum	809,464,095.00
Range	795,024,125.00
Mean	296,699,854.70
Median	236,294,900.00
First quartile	64,859,080.00
Third quartile	489,206,981.30
Standard error	59,258,864.07
95% confidence interval	124,502,873.40
99% confidence interval	170,547,010.80
Variance	66,720,646,450,000,000.00
Average deviation	216,534,572.30
Standard deviation	258,303,400.00
Coefficient of variation	0.87



Uncertainty Assessment of CO2 Emission by Monte Carlo Simulation



Sample Number	Sample Percentage
14,439,970	91%
16,187,655	88%
23,639,350	82%
37,975,790	94%
58,694,115	91%
83,353,975	97%
111,787,750	86%
149,041,295	95%
192,804,905	96%
236,294,900	94%
282,400,260	91%
332,373,205	91%
384,300,895	88%
441,681,165	90%
505,048,920	92%
575,616,940	92%
651,640,005	88%
730,552,050	89%
809,464,095	84%

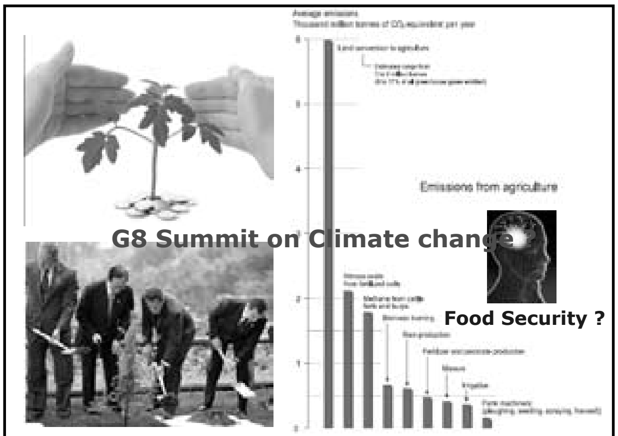
Conclusions and future prospects

- Uncertainties are not a good measure of inventory quality
- The subjectivity component in uncertainty estimates will probably be reduced through use of the 2006 IPCC Guidelines and better competence of inventory compilers
- Inventory quality needs to be measured using also other indicators (transparency and review reports)
- Uncertainties can be reduced and uncertainty estimates improved by addressing category-specific QA/QC and uncertainties at the data collection step
- Need to develop systematic methods for expert judgments addressing all errors
- Uncertainties are quantified for every submission; Sensitivity analysis is used to guide inventory improvement

Areas for co-operation proposal

- Exchange of information and experiences.
- Share of information, studies, more uncertainty data available within emission inventory guidebook.
- Clarify approaches for expert judgement to exclude subjective approaches and have influence on uncertainty estimates.
- Improve utilisation of analysis results by arranging a course in sensitivity analysis.
- It is possible to assess the uncertainty of national, sector and corporation GHG emission inventories.
- Scenario analysis and sensitivity runs allow to assess this influence and to understand/evaluate it.

Intuitive aspect gains weight when uncertainties are larger.



Source: Greenpeace, *Cool farming: Climate impacts of agriculture and mitigation potential*, January 2008 (data for 2005).

Greenhouse gas Inventory Office of Japan

Session III: Time Series Estimates and Projection

Guidance

17 July 2008, Tsukuba, Japan
6th Workshop on GHG Inventories in Asia

Kiyoto Tanabe
Greenhouse Gas Inventory Office of Japan (GIO)
National Institute for Environmental Studies (NIES)

0

Time Series Estimates

- A listing of emission estimates for a number of years
- In order to allow the comparison of emissions between different years of the inventory, the time series must be internally consistent, i.e., the methods, emission factors and assumptions must be the same for all inventory years.
- Ideally, the data sources used for the activity data will be the same for all years, but this is not always possible.

(UNDP, 2005 "Managing the National Greenhouse Gas Inventory Process")

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Time Series Estimates

- Under the UNFCCC, Non-Annex I Parties shall estimate national GHG inventories:
  - for the year **1994** (or alternatively for **1990**) for the **initial national communication**
  - for the year **2000** for the **second national communication**
  - The least developed country Parties could estimate their national GHG inventories for years at their discretion.
- Thus, time series estimates are not required.

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Projection (of GHG emissions)

- Development of ***future*** time series based on certain assumptions
  - appropriate "drivers" and reasonable scenarios
- Non-Annex I Parties are not required to do projections of GHG emissions
  - No mention of "projection" in the UNFCCC Guidelines for Non-Annex I National Communications
- *However…*

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Not required, nevertheless…

- Apparently, many WGIA colleagues are interested in "time series" and "projection" being taken up in WGIA.
- Some countries reported time series and/or projections of GHG emissions/removals already in their initial national communications.

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Country	Sectors	Gases	Projected year	Time series
Cambodia*	LUCF, Agrriculture, LUCF, Waste	CO_2	2020	
Indonesia	National and sectoral (Energy, Forestry, Agriculture, Waste)	CO_2, CH_4、N_2O	2025	1990-1994
Korea (NC2)	Energy, Agriculture, LUCF, Waste	CO_2, CH_4、N_2O	2020	1990,1995,1998-2001
Lao*			-	
Malaysia	Energy	CO_2	2020	
Mongolia	Energy, Agriculture, Forestry	CO_2, CH_4	2020	1990-1998
Philippines	Energy, Industry, Agriculture, LUCF, Waste (Solid waste, wastewater, human sewage)	CO_2	2008	
Thailand	Energy, Agriculture, Forestry	CO_2, CH_4	2020	
Vietnam	Energy, Agriculture, Forestry	CO_2	2020	

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Why…?

- To analyze the impact of policies & measures on GHG emissions/removals
  - Development of time series estimates is essential.
- To formulate an appropriate mitigation plan
  - Projections of GHG emissions/removals are necessary.
- High quality time series estimates would lead to high quality projections.
  - Analysis of time series would help selection of appropriate drivers to be used for projections.

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Presentations are going to be made by:
- Japan, on the country's experience (particularly on the Kyoto Protocol Target Achievement Plan)
- Thailand, on the country's experience
- Indonesia, on the country's experience

Let's discuss and consider together:
- What are barriers to development of time series and projections of GHG emissions/removals;
- What actions would be effective to remove those barriers; and
- How we can cooperate within the WGIA framework?

Now, let's start this session!!

Greenhouse gas Inventory Office of Japan

Global Warming-related Policies of the Japanese Government

– Kyoto Protocol Target Achievement Plan–

Sei Kato

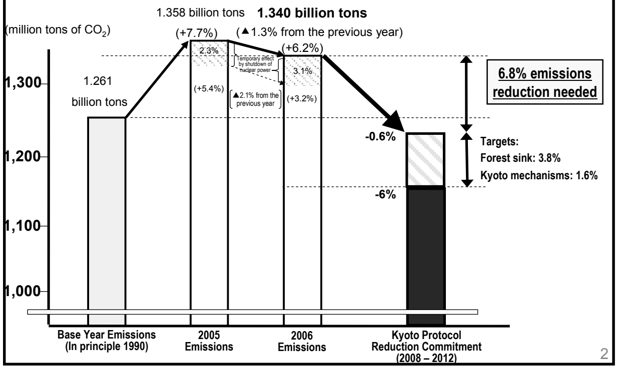
Ministry of the Environment, Japan

Stop Global Warming !
Team minus 6%

1

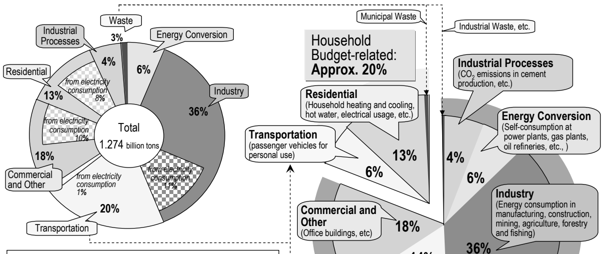
Greenhouse Gas Emissions in Japan

Japanese emissions for 2006 were 6.2% above those of the base year, meaning reductions of 6.8% are needed to meet the 6% reduction commitment under the Kyoto Protocol.



2

CO_2 Emissions by Sectors and Actors(2006 Preliminary Figures)



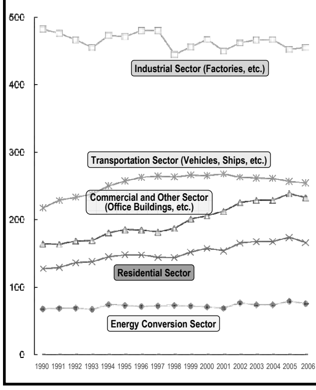
○Excluding Industrial Processes and Waste Products, the remaining 93% of CO_2 emissions are related to energy consumption.

○Household Emissions, including personal vehicles and municipal waste, comprise approximately 20% of emissions. The remaining 80% is from Business and Public sector.

3

Trends in CO_2 Emissions from Energy by Sectors and the Targets for 2010

Units: million tons of CO_2



1990	Change form 1990	2006	Reduction Rate to meet Target	Targets(*) for 2010
482	−4.6%	460	−6.7%～−7.6%	424～428
217	+16.7%	254	−4.8%～−6.4%	240～243
164	+39.5%	229	−11.6%～13.0%	208～210
127	+30.0%	166	−19.1%～21.5%	138～141
68	+13.9%	77	−16.2%	66

(*) As a target guide for emissions, a maximum predicted effect and a minimum predicted effect for reduction measures have been established. Naturally, the goal is to try and achieve the maximum effect; however, even if only the minimum effect is achieved, it has been formulated so that it will at least meet Japan's targets under the Kyoto Protocol.

4

How to predict the future GHG

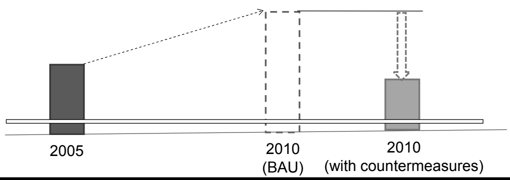
1.Forecast population, energy prices, GDP and so on in the future (ex.2010).

2.Predict business as usual (BAU) case (without any countermeasure case).

3. List the countermeasures (energy saving, renewable energy supply increasing etc.)

4.Estimate each countermeasure's mitigation impact (with no overlaps) reducing GHG emissions.

5. Predict the GHG emissions with all countermeasures.



5

Energy efficiency standards for electric appliances and automobiles: Top Runner Program

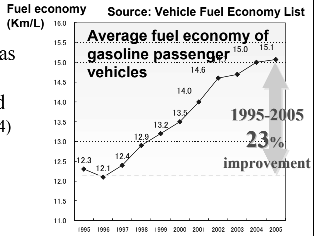
Equipment	Improvement in energy efficiency (Results)
TV sets	25.7% (FY 1997 > FY 2003)
Video-cassette recorders	73.6% (FY 1997 > FY 2003)
Air conditioners *	67.8% (FY 1997 > FY 2004)
Electric refrigerators	55.2% (FY 1998 > FY 2004)
Electric freezers	29.6% (FY 1998 > FY 2004)
Gasoline passenger vehicles *	22.8% (FY 1995 > FY 2005)

* Note that the effects of reducing energy consumption are indicated as inverse numbers because COP or fuel economy (km/L) is used as an energy consumption efficiency index.

6

Energy efficiency Standards - Top Runner Program for Vehicles -

- The fuel standard in 2010 was almost achieved in 2004.
- New fuel efficiency standard
  - Target year: 2015 (base year 2004)
  - Coverage: automobiles, trucks, buses both gasoline and diesel
  - Efficiency target



Type	Efficiency target [2004 > 2015]	
Automobiles	13.6km/l > 16.8km/l	23.5% improvement
Small-size Buses	8.3km/l > 8.9km/l	7.2% improvement
Small-size Trucks	13.6km/l > 16.8km/l	12.6% improvement

7

Evaluation and Review Schedule for the Kyoto Protocol Target Achievement Plan

◆ A comprehensive review of the Kyoto Protocol Target Achievement Plan has been scheduled to coincide with the start of the first commitment period in 2008 in order to ensure that Japan's 6% reduction commitment is met.

Evaluation and Review Schedule for the Kyoto Protocol Target Achievement Plan

Joint deliberation by the Central Environmental Council and the Industrial Structure Council

Nov. 2006 – Dec. 2007	30 deliberations
(Sep. 2007	Interim Report)
(Feb. 2008	Final Report)

Global Warming Prevention Headquarters

Oct. 2007	Decision on basic policy for conducting review of the Kyoto Protocol Target Achievement Plan
Mar, 28, 2008	Revision of the Kyoto Protocol Target Achievement Plan

<Future Schedule>

2008: **Cabinet approval of revised target achievement plan**

Carry out strict checks each year, in light of actual values, and get Cabinet approval of plan revisions on an as-needed basis.

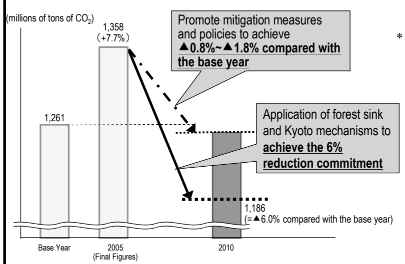
April: Publicly announce final emissions figures for the year before last
June: Perform progress check for the year before last (and the previous year)
October: Publicly announce preliminary emissions figures for the previous year
Within the year: Perform progress check for the previous year (and the first half of the year)

2009: **Comprehensive evaluation and review**

8

Overview of the Revision of the Kyoto Protocol Target Achievement Plan (March 28, 2008)

○Projected Greenhouse Gas Emissions for 2010



* In the final report issued jointly by the Central Environmental Council and the Industrial Structure Council in February of this year, it was determined that, despite the fact that relying solely on current reduction measures will likely leave Japan short of its commitment target by 22 – 36 million tons of CO_2, the full-scale implementation of additional measures and policies in each sector will enable Japan to reduce an extra 37 million tons or more of CO_2 and thereby **meet its reduction target of 6% under the Kyoto Protocol**.

9

Framework for the Revision of the Kyoto Protocol Target Achievement Plan

Measures and Policies for Achieving Targets

1. Measures and Policies relating to Greenhouse Gas Emissions Reduction, Removal, etc.
(1) Measures and Policies relating to Greenhouse Gas Emissions Reduction
[Examples of Primary Additional Measures]
○ Promotion of voluntary action plans
○ Increased energy-saving performance of houses and buildings
○ Improvement of energy efficiency of equipment that meets Top-runner Standards, etc.
○ Ensuring thorough energy management at factories and offices, etc.
○ Improvement of automobile fuel efficiency
○ Promotion of emissions reduction measures amongst small and medium-sized enterprise
○ Measures for the agriculture, forestry and fisheries, water and sewage, traffic flow, etc.
○ Measures for urban greening, waste, and Three Fluorinated Gases (HFCs, PFCs and SF6), etc.
○ Promotion introduction of new energy sources
(2) Greenhouse Gas Sink Measures
○ Forest management such as tree thinning, promotion of the "Beautiful Forest Building National Campaign"

2. Cross-sector Policies
○ Systems for Calculation, Reporting and Public Disclosure of Greenhouse Gas Emissions
○ Development of national campaigns

Issues needing to be addressed promptly
○ Domestic Emissions Trading System
○ Environment tax
○ Departure from late-night work and lifestyles
○ Introduction of daylight savings

Targets of Greenhouse Gas Emissions and Removals

	Emissions Targets for 2010*: Million tons of CO_2	Emissions Targets for 2010*: Base Year Total Emissions Comparison
CO_2 from Energy	1,076~1,089	**+1.3%~+2.3%**
Industry	424~428	-4.6%~-4.3%
Commercial and Other	208~210	+3.4%~+3.6%
Residential	138~141	+0.9%~+1.1%
Transportation	240~243	+1.8%~+2.0%
Energy Conversion	66	-0.1%
CO_2 from non-Energy, CH_4, N_2O	132	**-1.5%**
HFCs, PFCs SF6	31	**-1.6%**
Greenhouse Gas Emissions	1,239~1,252	**-1.8%~-0.8%**

(*) As a target guide for emissions, a maximum predicted effect and a minimum predicted effect for reduction measures have been established. Naturally, the goal is to try and achieve the maximum effect; however, even if only the minimum effect is achieved, it has been formulated so that it will at least meet Japan's targets under the Kyoto Protocol.

For definite progress towards 6% reduction commitment under the Kyoto Protocol, all measures, including sink measures and Kyoto mechanisms, will be implemented.

10

Procedure of Measures and Policies based on the Target Achievement Plan

Achieving both Economic and Environmental Progress

Bold execution of Global Warming mitigation measures accompanying the Transformation of a broad Socio-economic System

Utilize diverse policy tools

Promote measures through the mobilization of all available policy methods, such as voluntary methods, regulatory methods, economic methods, and informational methods

- Follow up on the voluntary action plans by Industry
- Greening of the automobile tax
- Domestic emissions trading system, etc. (prompt, comprehensive examination)
- "Top Runner" regulations from the Law Concerning the Rational Use of Energy
- Systems for Calculation, Reporting and Public Disclosure of Greenhouse Gas Emissions (Law Concerning the Promotion of Measures to Cope with Global Warming)

Perform strict checks on plan implementation twice a year, and ensure that revisions to the plan can be made flexibly on an as-needed basis
(In 2009, perform a comprehensive evaluation and review for the entire first commitment period)

PDCA: Plan – Do – Check – Action

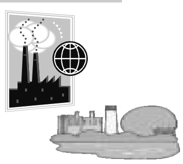
・Definite achievement of Kyoto Protocol targets
・Further long-term, ongoing emissions reductions in greenhouse gases on a global scale
→ **Build a low carbon society centering on the development of innovative technologies**

11

Measures in Industrial Sector

Promotion and strengthening of voluntary action plans in industry 66.9 million tons of CO_2

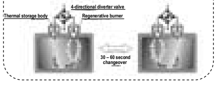
○ **Steady implementation and follow-up of voluntary action plans**
① Draw up new plans for sectors without them
② Quantify qualitative targets
③ Perform strict follow-up by the government
④ Raise targets when original target is exceeded



Introduction and Promotion of highly energy conserving facilities and equipment 3.6~5.1 million tons of CO_2

○ **Diffusion of energy-conserving equipment in the manufacturing sector (3.4~4.9 million tons of CO_2)**
○ **Diffusion of more fuel efficient construction machinery in the construction sector (200,000 tons of CO_2)**

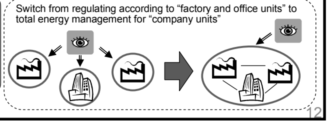
Support for switch to high-performance industrial furnaces to **conserves energy by 30% or more**



Ensuring thorough energy management, etc. 10.2~11.8 million tons of CO_2

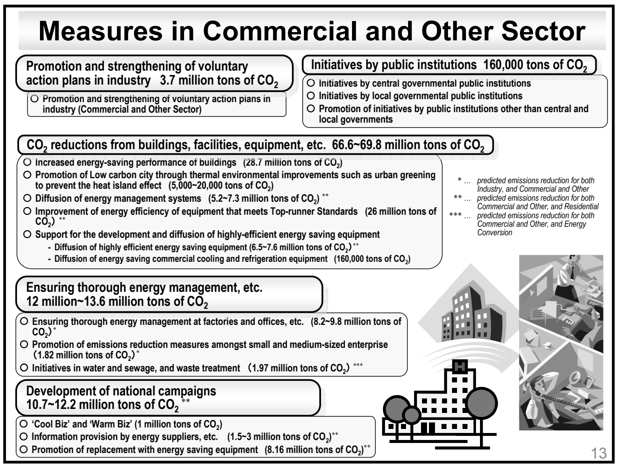
○ **Ensuring thorough energy management at factories and offices, etc. (8.2~9.8 million tons of CO_2)**
○ **Promotion of emissions reduction measures amongst small and medium-sized enterprise (1.82 million tons of CO_2)***
○ **Measures by the agriculture, forestry and fisheries industry (220,000 tons of CO_2)**
○ **Measures by Industry in the Commercial and Residential, and Transportation Sectors**

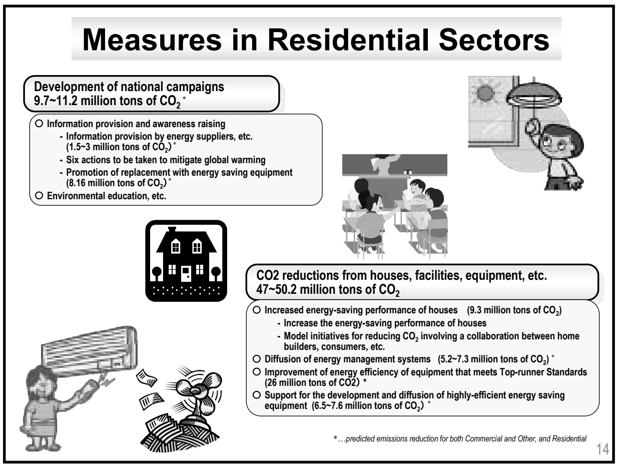
Switch from regulating according to "factory and office units" to total energy management for "company units"

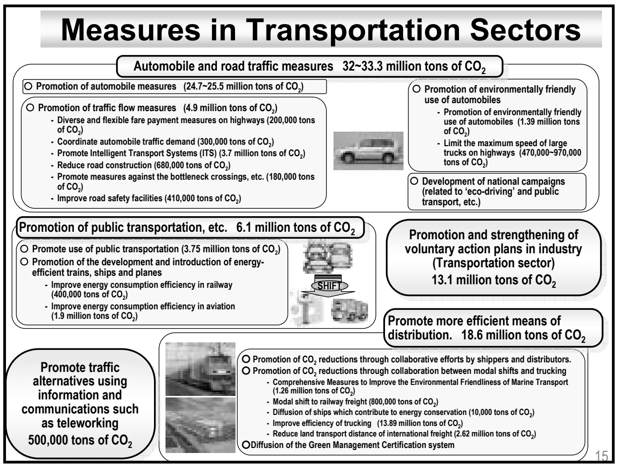


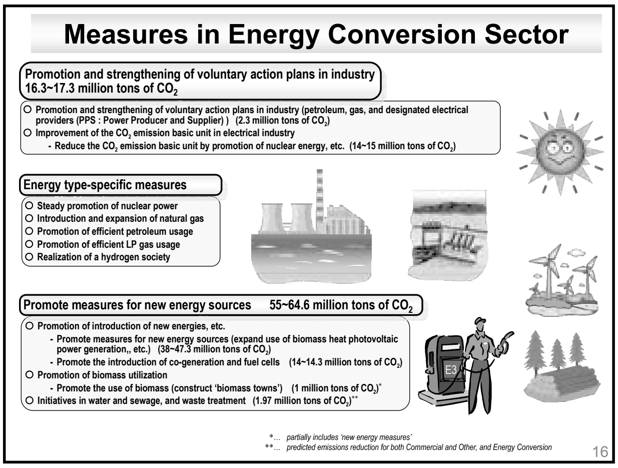
*…predicted emissions reduction for both Industry, and Commercial and Other

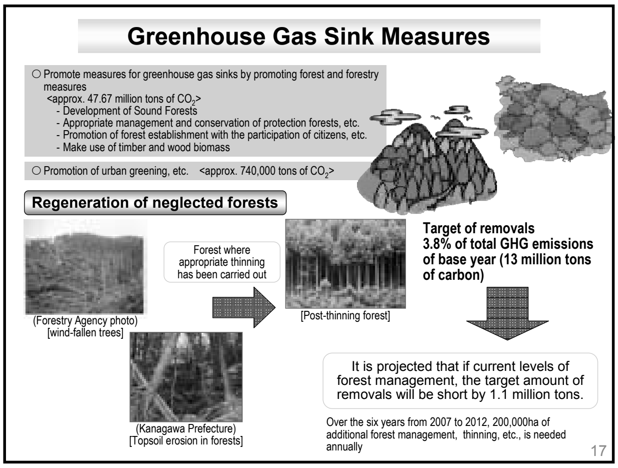
12

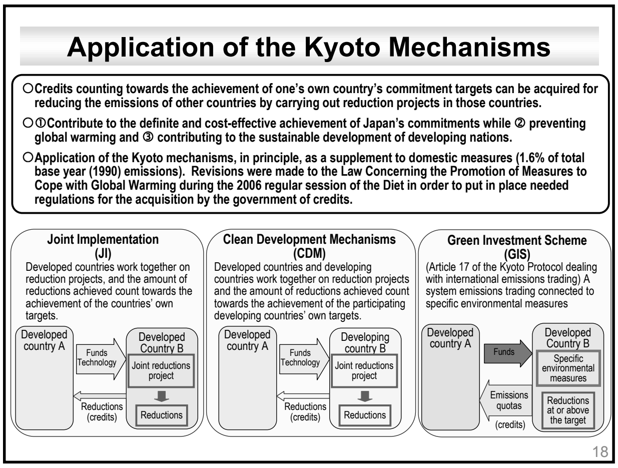

Measures in Commercial and Other Sector
Promotion and strengthening of voluntary action plans in industry 3.7 million tons of CO_2
○ Promotion and strengthening of voluntary action plans in industry (Commercial and Other Sector)
Initiatives by public institutions 160,000 tons of CO_2
○ Initiatives by central governmental public institutions
○ Initiatives by local governmental public institutions
○ Promotion of initiatives by public institutions other than central and local governments
CO_2 reductions from buildings, facilities, equipment, etc. 66.6~69.8 million tons of CO_2
○ Increased energy-saving performance of buildings (28.7 million tons of CO_2)
○ Promotion of Low carbon city through thermal environmental improvements such as urban greening to prevent the heat island effect (5,000~20,000 tons of CO_2)
○ Diffusion of energy management systems (5.2~7.3 million tons of CO_2) **
○ Improvement of energy efficiency of equipment that meets Top-runner Standards (26 million tons of CO_2) **
○ Support for the development and diffusion of highly-efficient energy saving equipment
- Diffusion of highly efficient energy saving equipment (6.5~7.6 million tons of CO_2) **
- Diffusion of energy saving commercial cooling and refrigeration equipment (160,000 tons of CO_2)
* … predicted emissions reduction for both Industry, and Commercial and Other
** … predicted emissions reduction for both Commercial and Other, and Residential
*** … predicted emissions reduction for both Commercial and Other, and Energy Conversion
Ensuring thorough energy management, etc. 12 million~13.6 million tons of CO_2
○ Ensuring thorough energy management at factories and offices, etc. (8.2~9.8 million tons of CO_2) *
○ Promotion of emissions reduction measures amongst small and medium-sized enterprise (1.82 million tons of CO_2) *
○ Initiatives in water and sewage, and waste treatment (1.97 million tons of CO_2) ***
Development of national campaigns 10.7~12.2 million tons of CO_2 **
○ 'Cool Biz' and 'Warm Biz' (1 million tons of CO_2)
○ Information provision by energy suppliers, etc. (1.5~3 million tons of CO_2)**
○ Promotion of replacement with energy saving equipment (8.16 million tons of CO_2)**
13

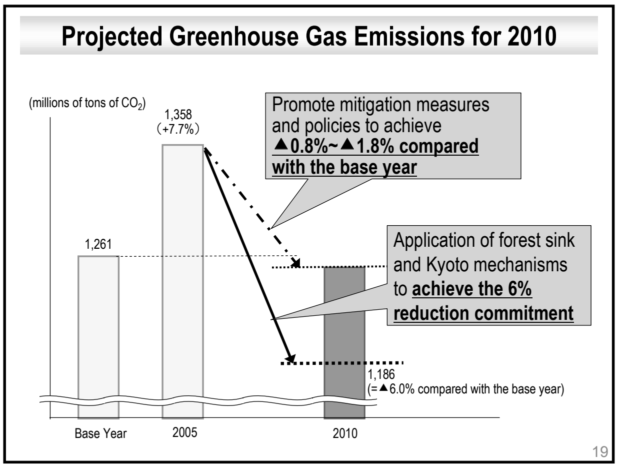

Measures in Residential Sectors
Development of national campaigns 9.7~11.2 million tons of CO_2 *
○ Information provision and awareness raising
- Information provision by energy suppliers, etc. (1.5~3 million tons of CO_2) *
- Six actions to be taken to mitigate global warming
- Promotion of replacement with energy saving equipment (8.16 million tons of CO_2) *
○ Environmental education, etc.
CO2 reductions from houses, facilities, equipment, etc. 47~50.2 million tons of CO_2
○ Increased energy-saving performance of houses (9.3 million tons of CO_2)
- Increase the energy-saving performance of houses
- Model initiatives for reducing CO_2 involving a collaboration between home builders, consumers, etc.
○ Diffusion of energy management systems (5.2~7.3 million tons of CO_2) *
○ Improvement of energy efficiency of equipment that meets Top-runner Standards (26 million tons of CO2) *
○ Support for the development and diffusion of highly-efficient energy saving equipment (6.5~7.6 million tons of CO_2) *
*…predicted emissions reduction for both Commercial and Other, and Residential
14


Measures in Transportation Sectors
Automobile and road traffic measures 32~33.3 million tons of CO_2
○ Promotion of automobile measures (24.7~25.5 million tons of CO_2)
○ Promotion of traffic flow measures (4.9 million tons of CO_2)
- Diverse and flexible fare payment measures on highways (200,000 tons of CO_2)
- Coordinate automobile traffic demand (300,000 tons of CO_2)
- Promote Intelligent Transport Systems (ITS) (3.7 million tons of CO_2)
- Reduce road construction (680,000 tons of CO_2)
- Promote measures against the bottleneck crossings, etc. (180,000 tons of CO_2)
- Improve road safety facilities (410,000 tons of CO_2)
○ Promotion of environmentally friendly use of automobiles
- Promotion of environmentally friendly use of automobiles (1.39 million tons of CO_2)
- Limit the maximum speed of large trucks on highways (470,000~970,000 tons of CO_2)
○ Development of national campaigns (related to 'eco-driving' and public transport, etc.)
Promotion of public transportation, etc. 6.1 million tons of CO_2
○ Promote use of public transportation (3.75 million tons of CO_2)
○ Promotion of the development and introduction of energy-efficient trains, ships and planes
- Improve energy consumption efficiency in railway (400,000 tons of CO_2)
- Improve energy consumption efficiency in aviation (1.9 million tons of CO_2)
SHIFT
Promotion and strengthening of voluntary action plans in industry (Transportation sector) 13.1 million tons of CO_2
Promote more efficient means of distribution. 18.6 million tons of CO_2
Promote traffic alternatives using information and communications such as teleworking 500,000 tons of CO_2
○ Promotion of CO_2 reductions through collaborative efforts by shippers and distributors.
○ Promotion of CO_2 reductions through collaboration between modal shifts and trucking
- Comprehensive Measures to Improve the Environmental Friendliness of Marine Transport (1.26 million tons of CO_2)
- Modal shift to railway freight (800,000 tons of CO_2)
- Diffusion of ships which contribute to energy conservation (10,000 tons of CO_2)
- Improve efficiency of trucking (13.89 million tons of CO_2)
- Reduce land transport distance of international freight (2.62 million tons of CO_2)
○Diffusion of the Green Management Certification system
15


Measures in Energy Conversion Sector
Promotion and strengthening of voluntary action plans in industry 16.3~17.3 million tons of CO_2
○ Promotion and strengthening of voluntary action plans in industry (petroleum, gas, and designated electrical providers (PPS : Power Producer and Supplier)) (2.3 million tons of CO_2)
○ Improvement of the CO_2 emission basic unit in electrical industry
- Reduce the CO_2 emission basic unit by promotion of nuclear energy, etc. (14~15 million tons of CO_2)
Energy type-specific measures
○ Steady promotion of nuclear power
○ Introduction and expansion of natural gas
○ Promotion of efficient petroleum usage
○ Promotion of efficient LP gas usage
○ Realization of a hydrogen society
Promote measures for new energy sources 55~64.6 million tons of CO_2
○ Promotion of introduction of new energies, etc.
- Promote measures for new energy sources (expand use of biomass heat photovoltaic power generation,, etc.) (38~47.3 million tons of CO_2)
- Promote the introduction of co-generation and fuel cells (14~14.3 million tons of CO_2)
○ Promotion of biomass utilization
- Promote the use of biomass (construct 'biomass towns') (1 million tons of CO_2)*
○ Initiatives in water and sewage, and waste treatment (1.97 million tons of CO_2)**
E3
*… partially includes 'new energy measures'
**… predicted emissions reduction for both Commercial and Other, and Energy Conversion
16


Greenhouse Gas Sink Measures
○ Promote measures for greenhouse gas sinks by promoting forest and forestry measures
<approx. 47.67 million tons of CO_2>
- Development of Sound Forests
- Appropriate management and conservation of protection forests, etc.
- Promotion of forest establishment with the participation of citizens, etc.
- Make use of timber and wood biomass
○ Promotion of urban greening, etc. <approx. 740,000 tons of CO_2>
Regeneration of neglected forests
(Forestry Agency photo) [wind-fallen trees]
Forest where appropriate thinning has been carried out
[Post-thinning forest]
(Kanagawa Prefecture) [Topsoil erosion in forests]
Target of removals 3.8% of total GHG emissions of base year (13 million tons of carbon)
It is projected that if current levels of forest management, the target amount of removals will be short by 1.1 million tons.
Over the six years from 2007 to 2012, 200,000ha of additional forest management, thinning, etc., is needed annually
17


Application of the Kyoto Mechanisms
○Credits counting towards the achievement of one's own country's commitment targets can be acquired for reducing the emissions of other countries by carrying out reduction projects in those countries.
○①Contribute to the definite and cost-effective achievement of Japan's commitments while ② preventing global warming and ③ contributing to the sustainable development of developing nations.
○Application of the Kyoto mechanisms, in principle, as a supplement to domestic measures (1.6% of total base year (1990) emissions). Revisions were made to the Law Concerning the Promotion of Measures to Cope with Global Warming during the 2006 regular session of the Diet in order to put in place needed regulations for the acquisition by the government of credits.
Joint Implementation (JI)
Developed countries work together on reduction projects, and the amount of reductions achieved count towards the achievement of the countries' own targets.
Developed country A
Funds Technology
Developed Country B
Joint reductions project
Reductions
Reductions (credits)
Clean Development Mechanisms (CDM)
Developed countries and developing countries work together on reduction projects and the amount of reductions achieved count towards the achievement of the participating developing countries' own targets.
Developed country A
Funds Technology
Developing country B
Joint reductions project
Reductions
Reductions (credits)
Green Investment Scheme (GIS)
(Article 17 of the Kyoto Protocol dealing with international emissions trading) A system emissions trading connected to specific environmental measures
Developed country A
Funds
Developed Country B
Specific environmental measures
Emissions quotas (credits)
Reductions at or above the target
18



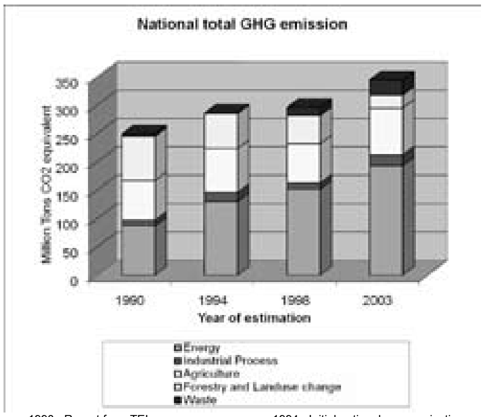
Projected Greenhouse Gas Emissions for 2010
(millions of tons of CO_2)
1,358
(+7.7%)
Promote mitigation measures and policies to achieve ▲0.8%~▲1.8% compared with the base year
1,261
Application of forest sink and Kyoto mechanisms to achieve the 6% reduction commitment
1,186
(=▲6.0% compared with the base year)
Base Year
2005
2010
19

JGSEE

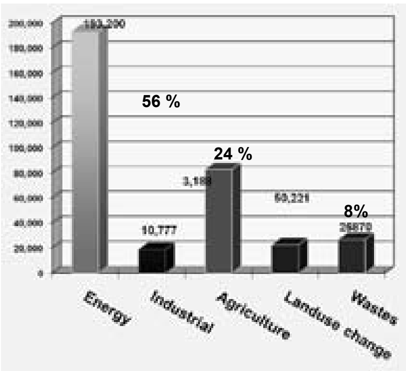
Time Series Estimation and Projection of GHG Emissions

Sirintornthep Towprayoon
The Joint Graduate School of Energy and Environment
King Mongkut's University of Technology Thonburi
Bangkok Thailand

Presented at 6th WGIA 16-18 July 2008 Tsukuba Japan

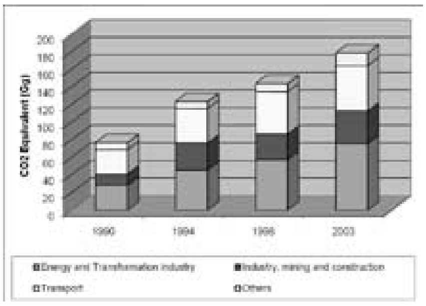


1990 : Report from TEI
1994 : Initial national communication
1998 : National Strategic Studies
2003 : ERM report



GHG Emission by sector 2003

Emission from energy sub-categories



1990 : Report from TEI
1994 : Initial national communication
1998 : National Strategic Studies
2003 : ERM report

Time series estimations : Energy sector

- Method applied
  - IPCC 1996 revised GL
- Data used in estimation
  - Statistical report from Ministry of Energy
  - GDP form Office of National Economics and Social Development Board

GHG Emission from Energy sector

Three major sub-categories

Electricity

- Thermal power plant
- Combined cycle power plant
- Gas turbine power plant
- Diesel power plant
- Cogeneration power plant
- Gas engine power plant (2004)

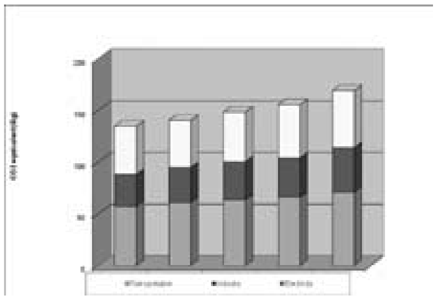
Industry

- Food and beverages
- Textiles
- Wood and furniture
- Paper
- Chemical
- Non-Metallic
- Basic Metal
- Fabricated metal
- Other (Unclassified)

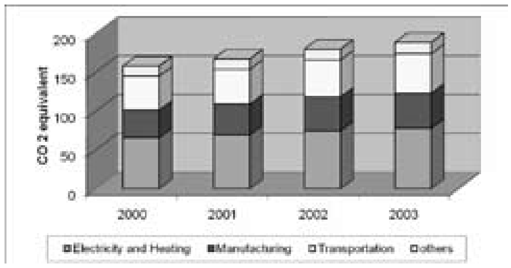
Transportation

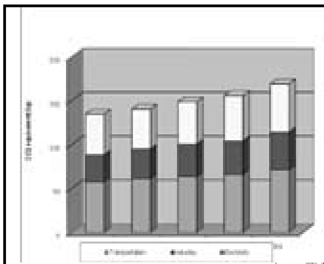
- Road transport
- Rail transport
- Air transport
- Water transport

Time series emission from energy sub-categories
Activity data from Ministry of Energy

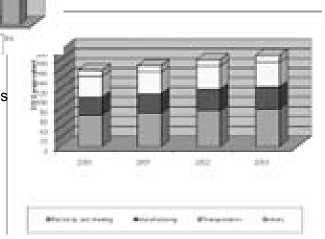


Emission from energy sub-categories CAIT data



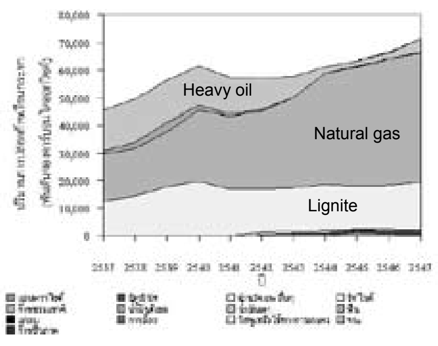


Emission from energy sub categories
National data

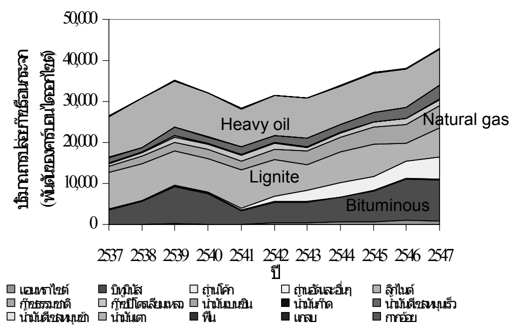


Emission from energy sub categories
CAIT data

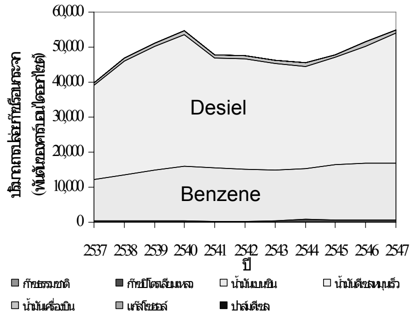
- Analysis of emission by sub-categories



Thousand tons of CO2 from **energy and transformation** from 1994-2004



Thousand tons of CO2 from **Industry** from 1994-2004

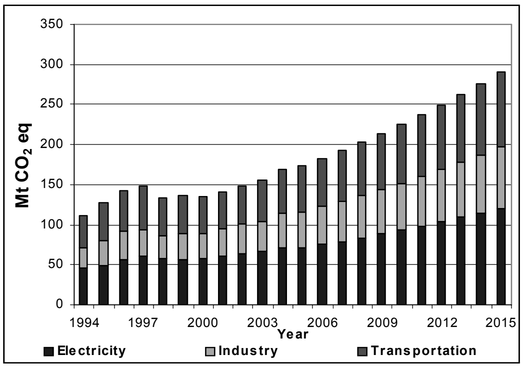


Thousand tons of CO2 from **Transport** from 1994-2004

Projection of emission

- **Estimate GHG emission of energy sector (past-present) : Using data energy consumption from "Thailand Energy Situation (DEDE)" since 1994-2004**
- **Forecast GHG emission from energy sector : using correlation GDP growth rate and population to fuel consumption in future**

GHGs emission under base case (BAU)



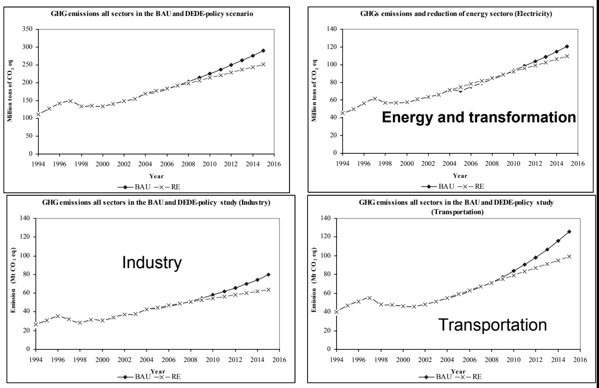
GHGs emission under policy and planning

Department of Alternative Energy Development and Efficiency (DEDE)

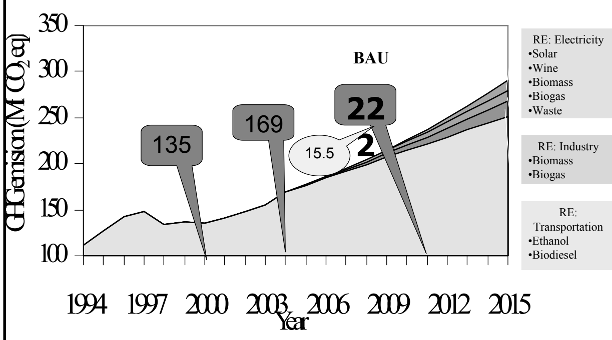
Policy and plan of DEDE Study

	Energy reducing (Ktoe)	GHG emission reducing (Mt CO_2 equivalent)
Renewable Energy at 2011 (RE)		
Electricity	1,169	2.7
Industry	1,650	5.3
Transportation	2,484	7.5
Total	**5,303**	**15.5**
GHG emission under scenario DEDE in 2011 **GHG emission under BAU in 2011**	222 **(Mt CO2 equivalent)** 235.5 **(Mt CO2 equivalent)**	

DEDE Study



DEDE Study



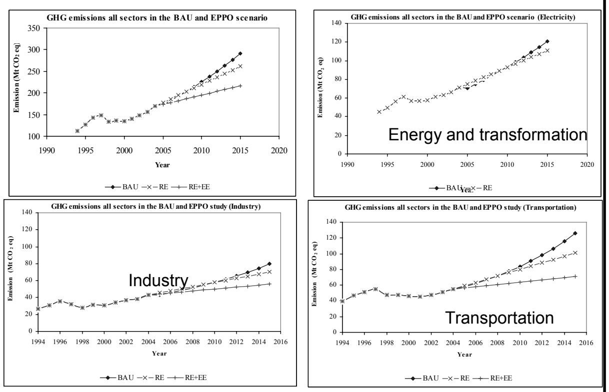
RE = Renewable Energy

GHGs emission under policy and plan
of
Energy Policy and Planning Office (EPPO)

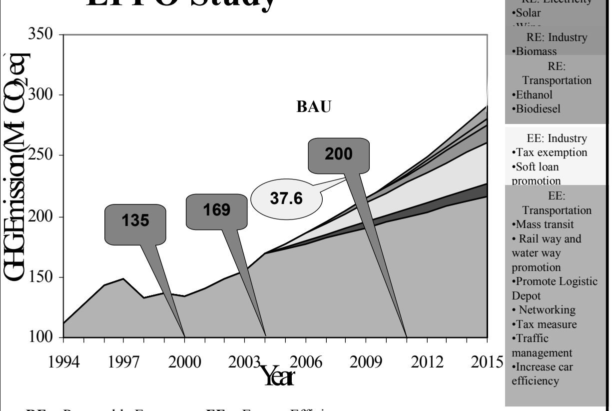
Policy and plan of EPPO Study

	Energy reducing (Ktoe)	GHG emission reducing (Mt CO_2 equivalent)
Renewable Energy at 2011 (RE)		
Electricity	741	1.7
Industry	453	1.4
Transportation	2,074	6.3
Energy Efficiency at 2011 (EE)		
Industry	3,411	9.0
Transportation	6,269	19.2
Total	**12,948**	**37.6**
GHG emission under scenario of EPPO in 2011 **GHG Emission BAU in 2011**		**200(Mt CO_2 equivalent)** **237.6 (Mt CO_2 equivalent)**

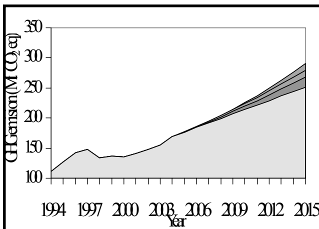
EPPO Study



EPPO Study

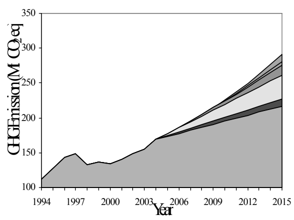


RE = Renewable Energy **EE** = Energy Efficiency

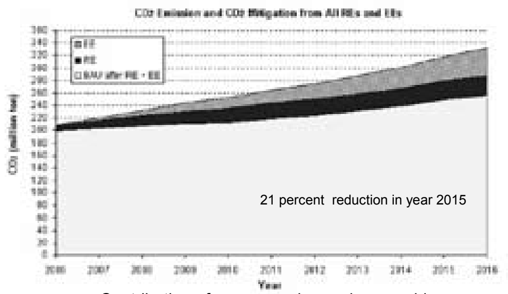


DEDE : 6.6 % reduction (2011)
RE only

EPPO : 16.0 % reduction (2011)
RE and extremely plan for EE



Comparison to LEAP model



Contribution of energy saving and renewable energy
Substitution in CO2 mitigation

Bundit Limmeechokecha 2007 i Energy policy project

Conclusion

- Time series estimation help analysis historical activities of the country and to see trend in the future
- Use only one national data source (most reliable) to avoid confusing and controversy
- Historical tracking of data is important

Acknowledgement

- Energy policy project supported by EPPO and TRF
- GHG mitigation option project supported by TRF

Thank you and Kop khun Ka

JGSEE

www.JGSEE.kmutt.ac.th

Indonesia's Experiences in Developing of Time Series Estimates and Projections

(Inluding Evaluation of Impacts of Policies and Measures)

The 6th Workshop on GHG Inventories in Asia (WGIA6)

Tsukuba – Japan
16 – 18 July 2008

OUTLINE

1. Practical aspects of uncertainty assessment and key category analysis in GHG inventory
2. Indonesia experiences with time series estimates & projections
3. Possible improvements to the data collection in Agriculture, LULUCF and Waste sectors
4. Possible ways of enhancing cooperation among Japan, the US, European countries and Asian countries to promote inventory-related work in Asian countries taking the Bali Action Plan and other recent international agreements into account

Practical Aspects of Uncertainty Assessment and Key Category Analysis in GHG Inventory

1. Existing data concerning GHG sources & sinks of Indonesia are those given in GHG Inventory of INC → in the INC the term 'Key' category of GHG sources & sinks have not been yet analysed.
2. The most up-dated data regarding key source & sink categories analysis for GHGs of Indonesia is currently under preparation by a national working group administered by Ministry of Environment & other relevant institutions that will produce the Second National Communication (SNC).
3. In preparing 'Key' sources & sinks, IPCC 1996 guidelines relevant to the methodology & computational procedures for determining Key category of sources & sinks is used. In addition, IPCC Good Practice Guidance (IPCC, 2000) and the IPCC Good Practice Guidance for LULUCF (IPCC, 2003) are used in identifyng of key categories of emissions and removal.

4. Furthermore, the SNC will assess possible impacts of the changes of government structure from centralized to decentralized (regional autonomy) to the SNC reporting coverage.
5. Indonesia is grouping the source & sink categories into 6 sectors: energy, industrial process, agriculture, LUCF, waste, coastal.
   - energy sector: the national inventory only covers emission from fuel combustion, in which the fugitive emissions are not included in SNC
   - At the moment, the inclussion of solvent and other products in the national inventory are difficult to be achieved (but not for the years when the relevant activity data are available)
   - SNC will include the emisions from antrophogenic activity in coastal area and the coastal potential as emisions sink.
   - SNC will cover emissions from various wastes (waste sector in INC only cover domestic solid waste). The SNC are carying out sensitivity & uncertainty analyses for some waste categories.

Key Source & Sink categories

	SECTORS	DESCRIPTION OF ACTIVITIES INCLUDED
1	Energy	Total emission of all greenhouse gases from stationary and mobile energy activities (fuel combustion as well as fugitive fuel emissions).
2	Industrial Process	Emissions within this sector comprise by-product or fugitive emissions of greenhouse gases from industrial processes. Emissions from fuel combustion in industry will be reported under Energy. Emissions should, wherever possible, be reported according to the ISIC Group or Class within which they occur.
3	Solvent & Other Product Use	Not covered
4	Agriculture	Describes all anthropogenic emissions from this sector, except for fuel combustion & sewage emissions, which are covered in energy and waste modules.
5	LUCF	Emissions & removals from forest & landuse change
6	Waste	Emissions from waste management
7	Coastal/Ocean	GHG emissions & removals from ocean activities.

6. Completeness of SNC inventory will be improved by including sources that were not included in INC. The SNC will include more sources of emissions, sinks, and GHG components as mandated in 17/CP8 Kyoto Protocol. The new data of estimated HFCs, *PFCs* and SF_6 emissions are included in SNC while in INC only cover CO_2, CH_4, and N_2O. If necessary, NOx and CO components will be included as written in the IPCC guideline (revised 1996) and Indonesia's document on the INC.
7. The IPCC (1996) Inventory Guidelines will be adopted in developing the GHG inventory for the SNC. However, if the emission factors are not available, the National GHG Inventory Team will assess the use of the 2006 or 1996 IPCC guidelines. The assessment aims to see potential problems, barriers and approach to remove the barriers if the 2006 IPCC guideline will be adopted in future national communications
8. Differing interpretations of source & sink categories, or other definition, unit, assumption, etc will be main causes of uncertainty → SNC are preparing key categories analysis as well as uncertainty analysis for some of key categories.

Indonesia Experiences with Time Series Estimates & Projections

- The estimation of GHG Inventory in SNC uses 2000 as base year with the time series 5 years (INC base line 1994 and time series 5 years). The projection of the GHG source & sink potentials of the SNC is up to 2025 (INC is also 2025) → KEN (National Energy Policy of Indonesia), i.e. estimation data in energy sector is up to 2025.
- In estimating GHGs from sectors in the SNC, Indonesia uses as much as possible local emission factors that are already available, particularly from agriculture and forestry sector. However, not all sectors covered in the GHG inventory have local emission factors.
- The emission factors used in INC are default value as provided in the IPCC guideline (revised 1996) while in the SNC, some of those factors are revised according to recent Indonesia's circumstances, particularly those that are not available in the INC document i.e. agriculture & forest sectors.

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Methods Applied for Time Series Estimation & Projection

- Energy sector: Model for projection will depend on that are already used in energy sector (PUSDATIN and BPPT). ALGAS project (1997) used Dynamic Model. Components of dynamic model that are not included in Markal :
- − Delay of impacts when a certain policy is implemented.
- − Markal uses econometry base since dynamic model uses dynamic base in which feed back is important;
- − Markal (new version) uses specific program (BPPT) since Dynamic uses common program, i.e. Powersym, Vensym, Stella, etc
- **Industry & Waste Sectors**: Econometry model seems promissing for GHG estimation and projection in the SNC inventory, however, for future inventory dynamic model can be considered.
- **AFOLU**:

Agriculture

- − Estimating: Satelite images and local emission factor.
- − Proyection: BAU scenario target is based on the projection demand and other scenarios will include mitigation optins.

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Forestry

−For estimating forest covers: using Satelite images ('Citra Landsat)'.

−Two sources of data / information might be applied:

a. Main source: Ministry of Forestry;

b. Second sources: MoE ('Towards Greener Indonesia' Program), as well as other institutions (National Aeronautics and Space Agency)

−Projection: BAU scenario target is based on the projection demand and other scenarios will include mitigation options.

−Assessments of GHGs mitigation options in forestry sector show that cost effectiveness and mitigation potential of the same option vary among studies (primarily due to the change in input data) [INC] → Identify mitigation activities in forestry and estimates their cost-effectiveness & carbon mitigation potential using the most recent available data and analyzed the impact of mitigation options on national carbon stock. [SNC]

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GHG Inventory and Emission Factors

- In the SNC, total emissions from energy sector are estimated with topdown (reference) approach and compared with those obtained from bottom-up (sectoral) approach. Other sectorS → topdown
- The various emissions from the energy system are organised in two main categories: namely fuel combustion emissions and fugitive emissions generated from energy production systems (coal mining, oil and gas production facilities, refinery, fuel transportation, etc).
- The methododology for estimating the gases from energy sector will apply Tier 3, except for fuel combustion (bottom-up): are divided in Tiers encompassing different levels of activity and technology detail. While, other sectors (including AFOLU): Tier 1.
- Local emission factors are going to be used, particularly for energy, forest, Agriculture (rice field), and waste sectors. Other sectors use default factors (as listed in IPCC guideline 1996) that are internally consistent and it is essential to preserve this consistency when replacing the default by local values so that total emissions of carbon (for example) do not exceed the carbon available in the fuel.

Gaps & Priorities of GHG Inventory:

a. INC GHG Inventory covers CO_2 & CH_4 in energy, industrial process, agriculture, waste, LUCF sectors (IPCC Guidelines 1996 with the base year 1994)

b. Experience from INC - :
- main problems: gaps & uncertainty of some data, and non-availability of related local emission factors)
- identified needs: strengthen institutional capacity to collect & collate data, and establish local emission factors
- recommendation: the need to reduce uncertainties, verification & interpretation of collected data, and develop user-friendly database system for future updating.

c. GHG inventory for SNC:
- Main focus on CO2, CH4, N2O, and other gases (PFC, SF6, HFC) where possible (depending on data availability) with base year 2000
- Uses IPCC Revised Guidelines (1996), IPCC Good Practice Guidance and Uncertainty Management for National GHG Inventories (2000), Good Practice Guidance for LULUCF (2003)
- Sectors: energy, industrial processes, agriculture, waste, land-use & forestry, and coastal
- Consider the New governmental structure

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e. Key Sources of GHG emissions/removals:
- Energy – combustion in energy industries, manufacturing industries, transportation, residential & commercial, & agriculture; fugitive emissions from coal mining & handling, and oil & gas operations; burning of biomass fuels
- Industrials processes – cement production; lime production (mineral products); ammonia/fertiliser & petrochemicals (chemical industries); iron & steel, and aluminium productions (metal products)
- Agriculture – enteric fermentation in domestic livestock; manure management; flooded rice cultivation; field burning of agriculture
- Land-use change & forestry – changes in forest & other woody biomass stock; forest & grassland conversion; abandonment of managed lands; emissions & removals from soil; on-site burning of forest
- Waste – landfills; domestic & commercial wastewater treatment; industrial wastewater treatment
- Coastal: Antropogenic activitlies in the coastal area

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Proposed Improvements of the National GHG Inventory

ITEM	INC	Needs of improvement
Type of GHG emissions	CO_2, CH_4, N_2O	Inclusion of other GHGs under IPCC 1996 guideline
Emissions sources	Energy sector	Improve all sources as fuel combustion as well as fugitives
	Industrial Processes (mineral, chemical, metal)	More detail for emission sources in industrial processes (by type of industry)
	Agriculture (domestic livestock, rice cultivation, prescribed burning of savanna, field burning of agricultural residues, agriculture soils) Land Use Change and Forestry (LUCF)	Completing all emissions from all sub-sectors of Agriculture since in INC not all emissions of these sources were covered. In addition, the SNC will use more local emission factors. Improve sources of LUCF (changes in forest & other woody biomass stocks, CO2 from forest & grassland conversion, on site burning of forest, e.g. emissions of non-CO2 trace gases, abandonment managed lands, CO2 emissions or uptake by soil from land-use change & management) In the SNC, agriculture & LUCF will be merged as AFOLU
	Waste (landfill) and other wastes	Inclusion of emissions from various wastes (domestic and commercial/Industry WWT)
Inventory Methodology	Referring to IPCC (revised 1996) Methodology	Full mplementation of the 1996 IPCC Methodology
Methodology to calculate GHG emissions	Energy sector (fuel combustion) - IPCC reference approach - IPCC Tier 1 methodology or sectoral approach	Energy Sector: - IPCC reference approach - Detailed Methods (IPCC Tiers 2/3): Emission estimations are based on detailed fuel information covering stationary and mobile sources
Emission factors	Default value of the 1996 IPCC	Local emission factors (if available) otherwise use IPCC 1996 default value

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Possible improvements to the data collection in Agriculture, LULUCF and Waste sectors

- Waste Sector: the inclussion of domestic & commercial wastewater treatment; industrial wastewater treatment;
  - improving local emission factors and taking into consideration the implementation of mitigation projects in a number of large industrial companies.
  - Establishment of regional dumpsites will increase the potential of waste to energy projects, especially in urban cities
- LUCF: improving activity data through the use of GIS/satellite assessment, emission and removal factors through the use of NFI and researches and adding new sources (emission from wetlands, particularly from peatlands)
- Agriculture: improving emission factors for rice and cattle and taking into consideration the implementation of

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Potentially Identified activities for cooperation

- Strengthen institutional capacity to collect & collate data, and establish local emission factors
- Enhancing capability of Indonesia to reduce uncertainty of emission inventory data through:
  - Developing local emission factor that may have implication to availability of sampling and measurment laboratory
  - Upadating land use change and forest cover map
  - carry out research on the assessment of local emission factors for forestry (peat), agriculture, waste sectors
  - GHG emissions and removal potential of Anthopogenic activities in coastal areas
- Establishing National CC data center (including inventory data/information) that have to support with national capacity in dealing with the CC
- Developing Indonesia climate model concerning emission projection and analysis of the impact of policy and measures to the emission projection

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Thank you

Greenhouse gas Inventory Office of Japan

Session IV: Breakout Group Discussion

Guidance

17 July 2008, Tsukuba, Japan
6th Workshop on GHG Inventories in Asia

Kiyoto Tanabe
Greenhouse Gas Inventory Office of Japan (GIO)
National Institute for Environmental Studies (NIES)

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Four Groups

- **Group 1: LULUCF**
- **Group 2: Waste**
- **Group 3: Agriculture**

To discuss sector-specific issues and seek possible solutions

  - Energy and IP sectors are not covered this time, but will probably be discussed next time

- **Group 4: GHG Inventory**
  - Issues raised in sessions I, II & III may be further discussed

To discuss generic issues and strategies for mainstreaming inventory work.

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Group 1: LULUCF Sector

- Suggested topics
  - Data/techniques that may be helpful to Asian countries
    - Remote sensing
    - GIS-based model
  - Issues and possible solutions in SNC preparation
  - *REDD may be relevant, but not go into discussion on political issues such as baseline setting, crediting schemes!!*
- Presentations: India, Japan, Philippines
- Chair & Rapporteur
  - Chair: Sumana Bhattacharya
  - Rapporteur: Punsalmaa Batiimaa

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Group 2: Waste Sector

- Suggested topics
  - Strategies to improve reliability of waste data: Proposal arisen from SWGA discussion
  - Use of surrogate data in emission estimation
  - Analyze of carbon flow in waste stream
- Presentations: China, Japan
- Chair & Rapporteur
  - Chair: Tomonori Ishigaki
  - Rapporteur: Sirintornthep Towprayoon

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Group 3: Agriculture Sector

- Suggested topics
  - Strategies to improve reliability of agricultural data
  - Current status and challenges in agriculture sector inventory
  - Possible sources of new EF data applicable to Asian countries
- Presentations: Japan, Malaysia, SEA project, Thailand, Vietnam
- Chair & Rapporteur
  - Chair: Kazuyuki Yagi
  - Rapporteur: Shuhaimen Ismail

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Group 4: GHG Inventory

- Suggested topics
  - Awareness raising about GHG Inventory and GHG mitigation
  - Application of inventory data to policy-making: What kind of co-benefits can be pursued from inventory work and results?
  - Development of information exchange materials on GHG inventory: How to make better use of WGIA network?
  - Further consideration of issues raised in Sessions I, II & III: What activities should WGIA undertake?
- Presentations: Korea, Philippines, etc
- Chair & Rapporteur
  - Chair: Thy Sum
  - Rapporteur: Simon Eggleston

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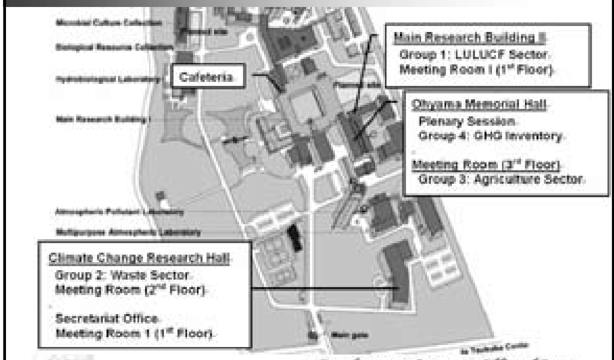
Location of discussion rooms



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Schedule

Day 2 (Thursday, 17 July)

- 12:50-13:05 Guidance
- 13:05-14:45 Presentations & discussion
- *14:45-15:05 Tea Break – Do not miss it!!*
- 15:05-16:45 Discussion & preparation of summary report
- 17:00-18:00 Hands-on training on KCA

Day 3 (Friday, 18 July)

- 9:30-10:30 Report of each group

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On Day 3, each group is expected to report:

- Issues identified and possible solutions
- Recommendation on activities to be carried out within the WGIA framework
  - What to be done by WGIA7?
  - What to be done in the longer term?

Now, let's move to each discussion room.
Good luck!!

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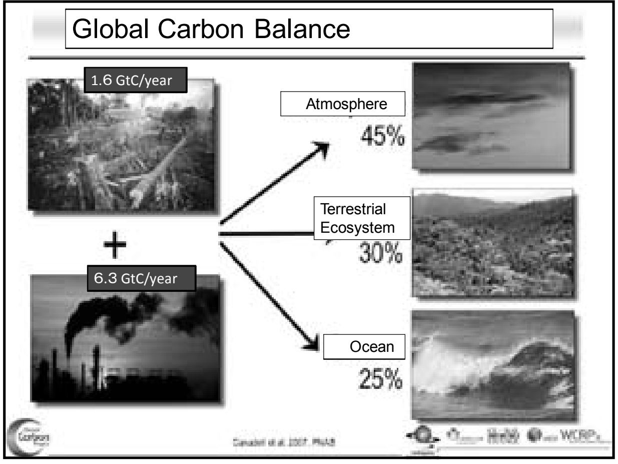
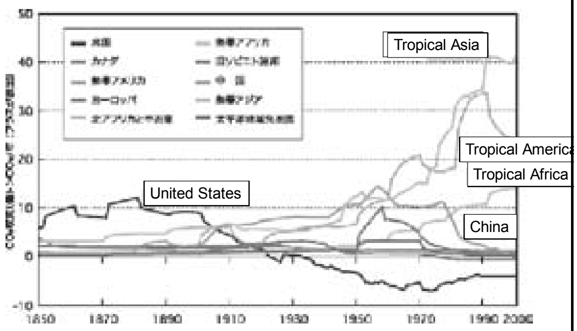
REMOTE SENSING BASED MONITORING SYSTEM FOR LULUCF

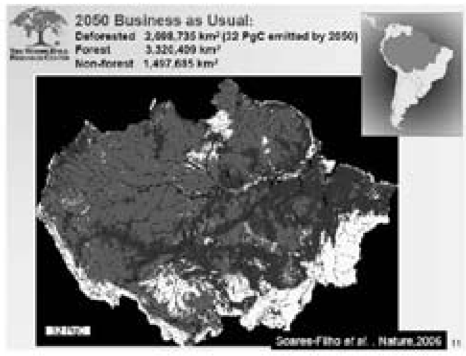
National Institute for Environmental Studies

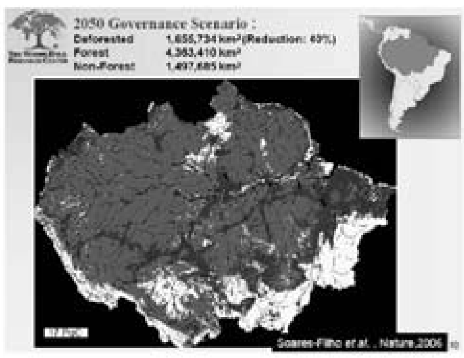
Yoshiki Yamagata





Emission of CO2 from Deforestation in the past 150 years
(created from Houghton's data)





Emission reduction and forest conservation

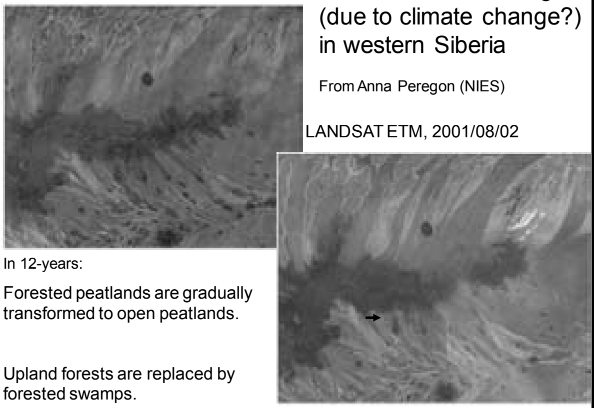
- Carbon stored in above and below ground biomass, and soil. After harvest, decay of biomass occurs in a few years time
- CO2 emission from deforestation is around 20% of global fossil fuel emission. Deforestation is increasing due to global rapid economic growth
- Consideration for the inclusion of reducing deforestation (REDD) is currently discussed as a new mitigation measures
- Forest conservation is also critically important for preserving Biodiversity (inter-linkage of UNFCCC, CBD, RAMSAR) and as an adaptation measures

Forest-Wetland change (due to climate change?) in western Siberia

From Anna Peregon (NIES)

LANDSAT TM, 1989/08/01

LANDSAT ETM, 2001/08/02



In 12-years:

Forested peatlands are gradually transformed to open peatlands.

Upland forests are replaced by forested swamps.

IPCC *Good Practice Guidance for LULUCF*: reporting tier options for UNFCCC Annex I country reporting

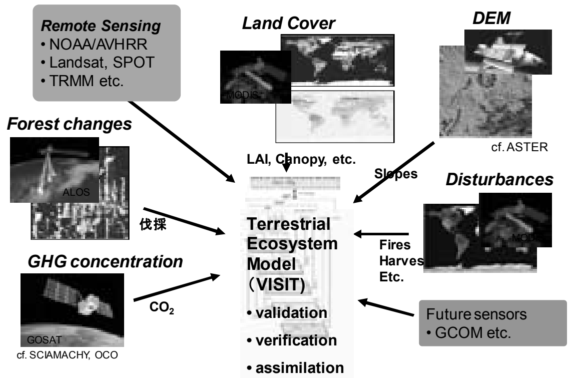
- **Tier 3** - higher order methods including models and inventory measurement systems tailored to address national circumstances, repeated over time, and driven by high-resolution activity data and disaggregated at sub-national to fine grid scales
  - may be GIS-based combinations of age, class/production data systems with connections to soil modules, integrating several types of monitoring

---

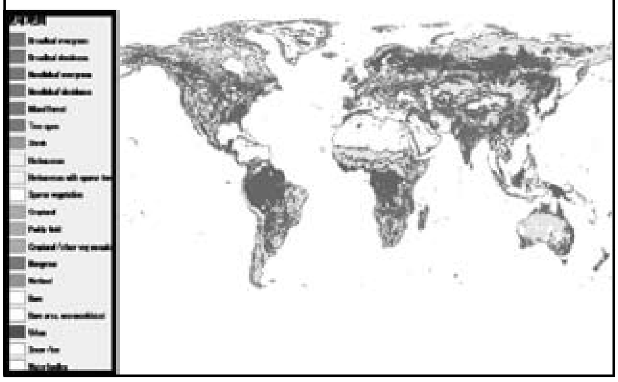
LULUCF monitoring issues

1. **How to define Deforestation and Forest degradation (Land use/ Land cover?)**
2. **Remote sensing can monitor Land Use/Land Cover change?**
3. **Is the global Forest Carbon Monitoring System for evaluating CO2 emission/absorption due to Land Use and Land Cover changes is possible?**

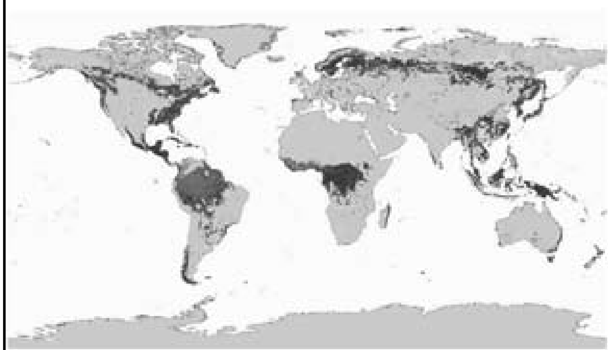
NEW RESEARCH PROJECT : FOREST CARBON MONITORING SYSTEM



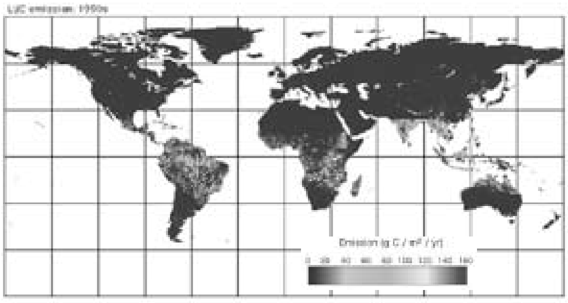
Global Mapping (Land Cover)



GLOBAL MAPPING (TREE COVER)



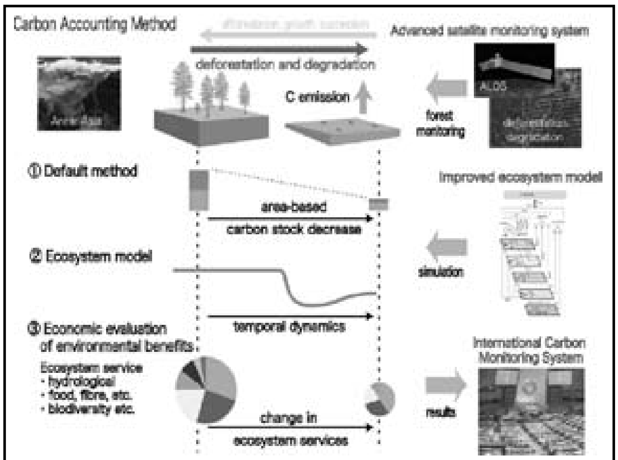
Model estimate: CO2 emission during 1990's

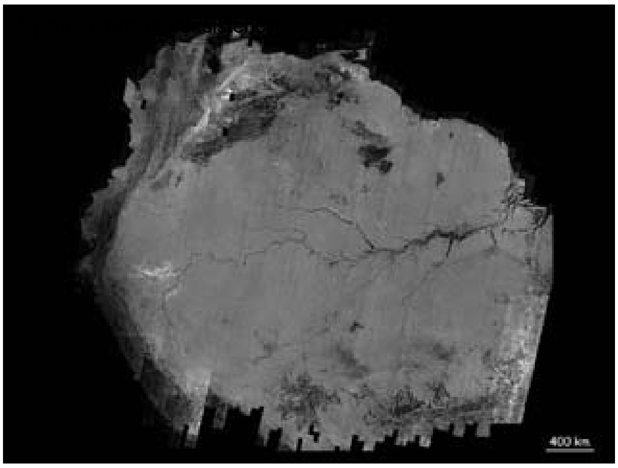


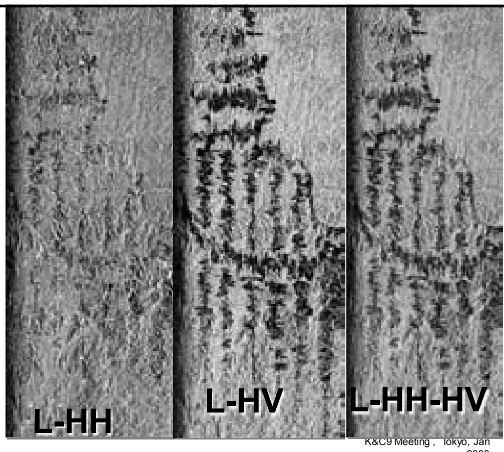
NIES

Needs for an Remote Sensing data for monitoring

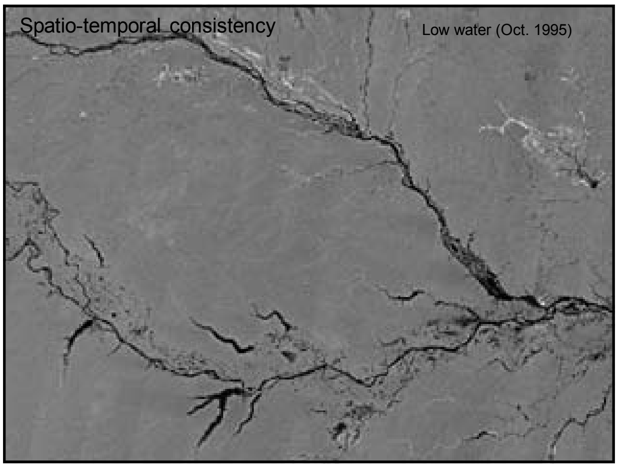
- Remote sensing can provide the objective means to observe land use /land cover changes
- Especially for the tropical forests monitoring, cloud-penetrating radar imaging is a key tool
- Coordinated use of latest R/S sensors with in-situ measurements and model will be crucial for LULUCF monitoring

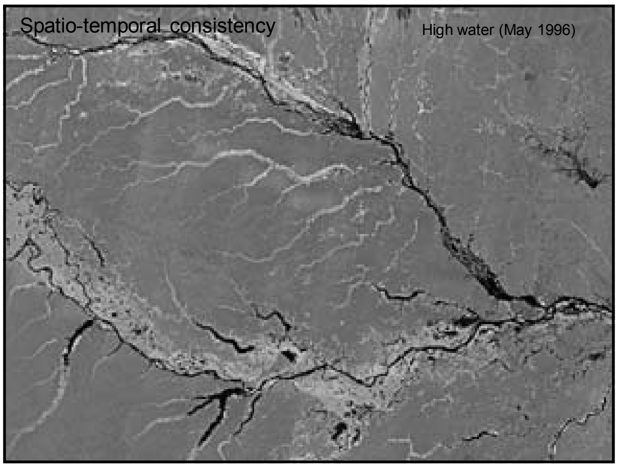


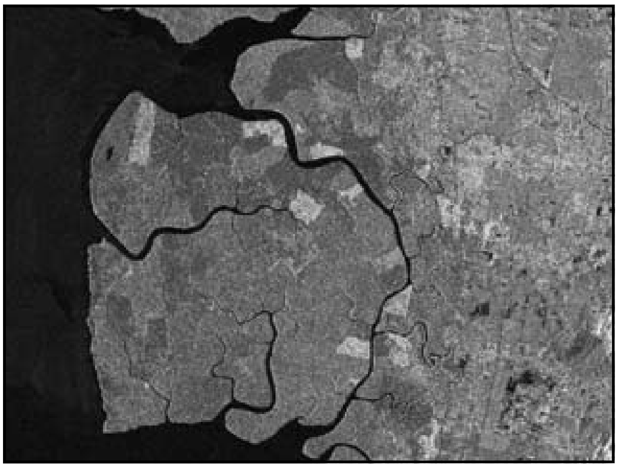




K&C9 Meeting , Tokyo, Jan 2008



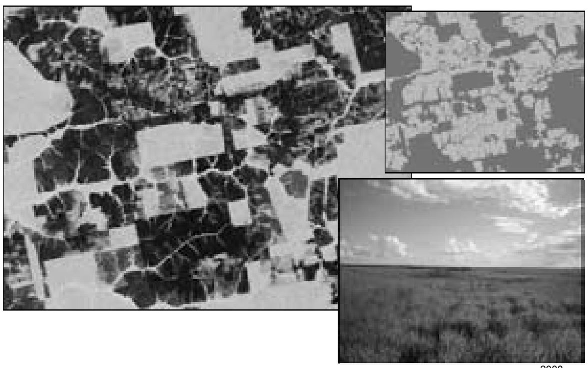




Change Detection ALOS-JERS

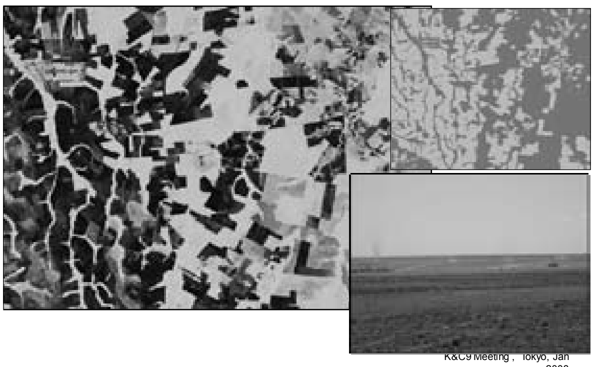
- Can Japanese SAR sensors ALOS (2006~) and JERS (1992~1998) historical data be used jointly to establish decadal deforestation rates?
- What types of changes are detected? What types are not detected?
- Forest, Grassland, Agricultural land, and Wetland

Large-Holder Pasture Expansion as seen by ALOS/PALSAR

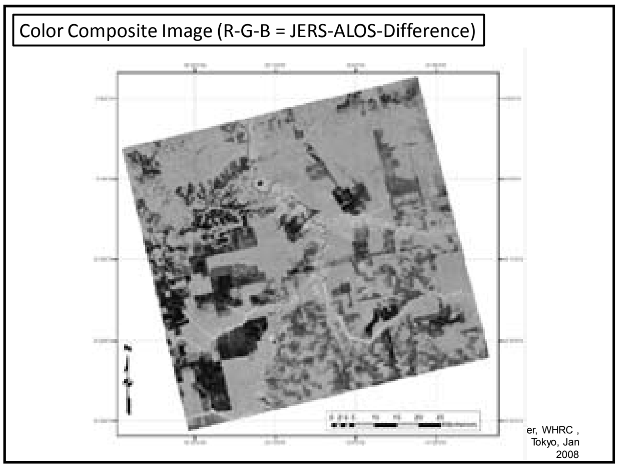


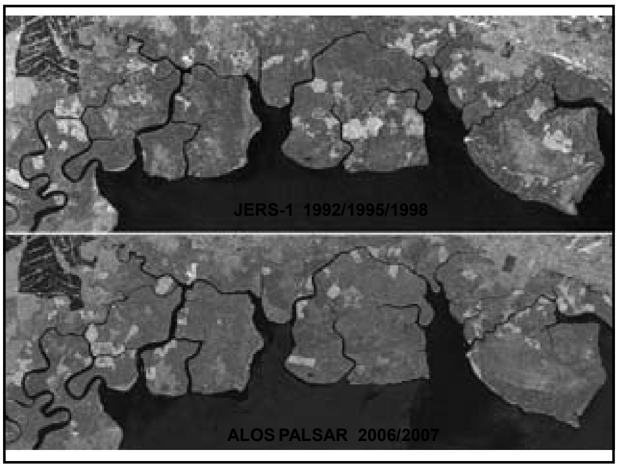
2008

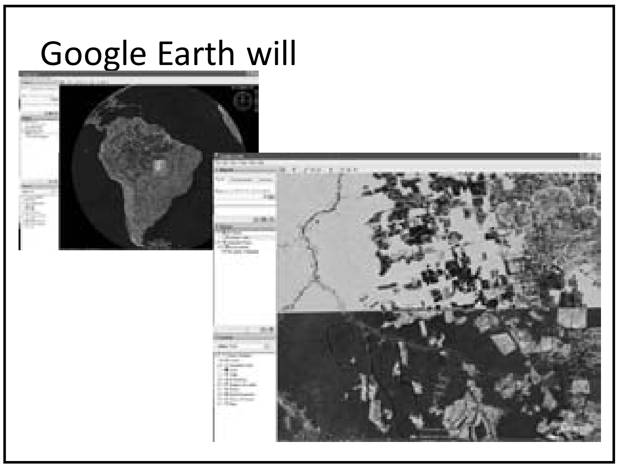
Large-Holder Soy-Field Expansion as seen by ALOS/PALSAR

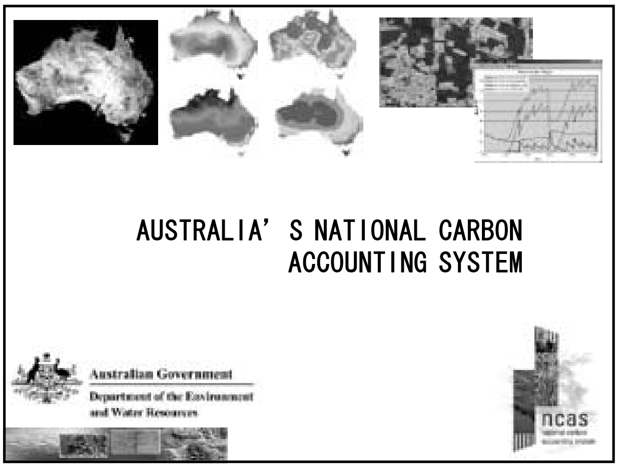


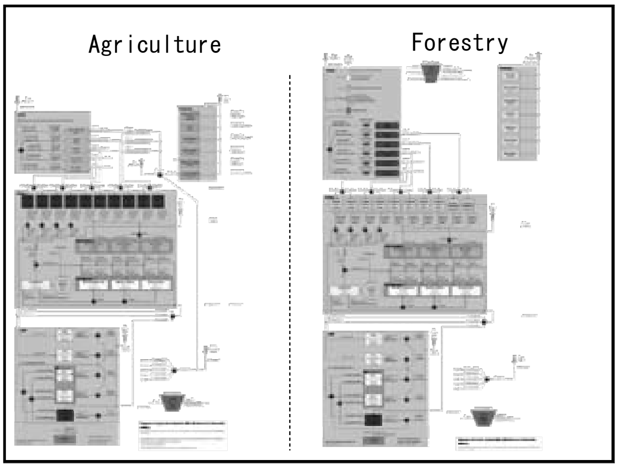
K&C9 Meeting , Tokyo, Jan 2008

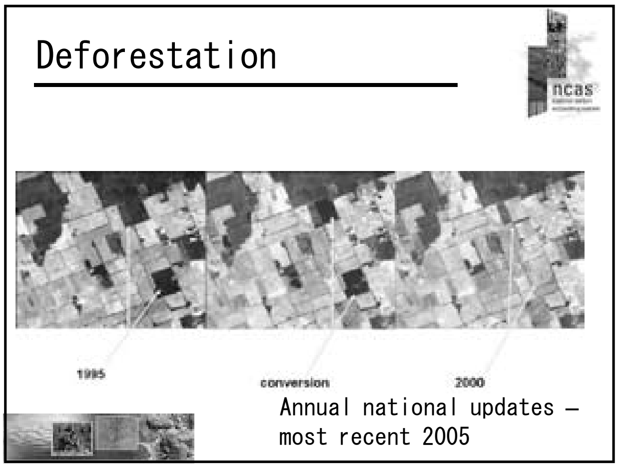

Color Composite Image (R-G-B = JERS-ALOS-Difference)
er, WHRC , Tokyo, Jan 2008

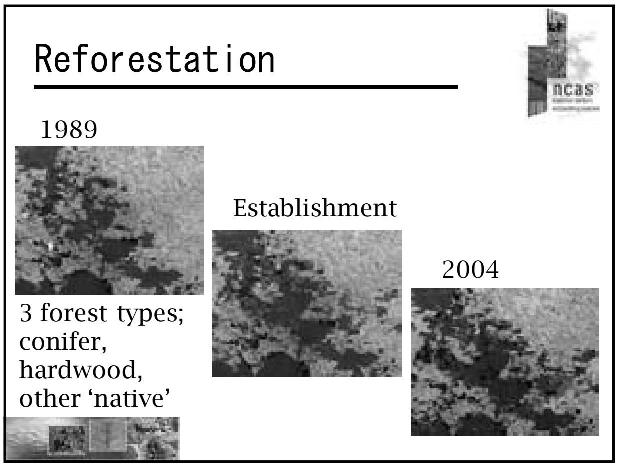

JERS-1 1992/1995/1998
ALOS PALSAR 2006/2007

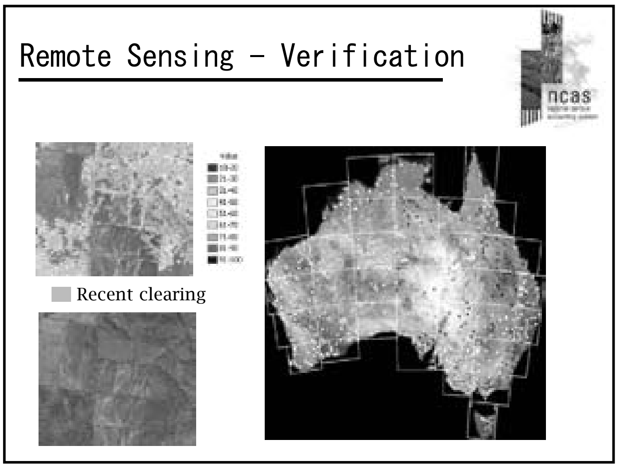

Google Earth will

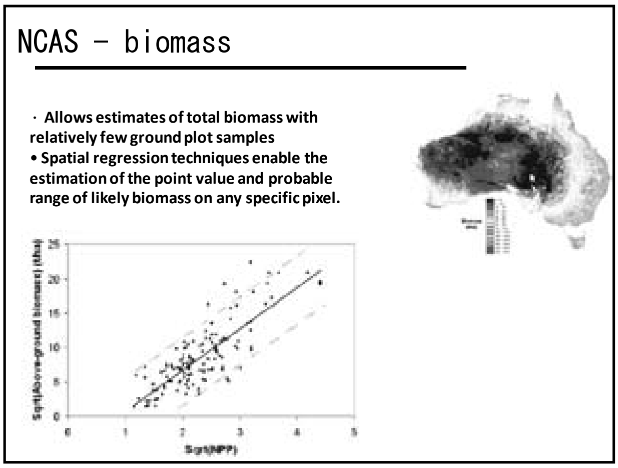

AUSTRALIA' S NATIONAL CARBON ACCOUNTING SYSTEM
Australian Government
Department of the Environment and Water Resources
ncas

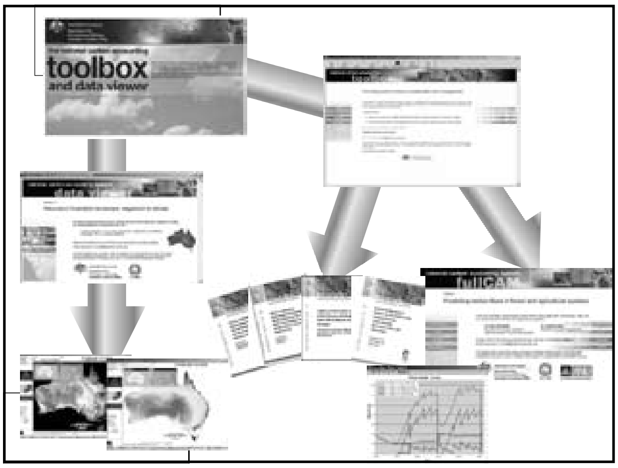

Agriculture
Forestry


Deforestation
ncas
1995
conversion
2000
Annual national updates –
most recent 2005


Reforestation
ncas
1989
Establishment
2004
3 forest types;
conifer,
hardwood,
other 'native'


Remote Sensing - Verification
ncas
Recent clearing


NCAS - biomass
· Allows estimates of total biomass with relatively few ground plot samples
• Spatial regression techniques enable the estimation of the point value and probable range of likely biomass on any specific pixel.
Sqrt(NPP)


toolbox
and data viewer

Approach for Preparing GHG Inventory from the LULUCF Sector in India

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GOI

*Office Location:
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Moving from NATCOM-I to NATCOM-II

- Forests + Other Land uses
- Generating remote sensed maps that are in line with the IPCC categories
- Integrating Remote sensing data on GIS based platform
- Campaign mode measurement for forest soil C
- Tier III for key categories – modeling approach to estimate change in C stock
- Addressing QA/QC and Uncertainty Issues

Basic Equation

$$\Delta C_{LUi} = \Delta C_{AB} + \Delta C_{BB} + \Delta C_{DW} + \Delta C_{LI} + \Delta C_{SC}$$

ΔC_{LUi} is carbon stock change for a land-use category,
AB=Above-ground biomass,
BB=below-ground biomass,
DW=deadwood,
LI-litter and
SC=soil carbon.

Challenges

- Introduction of IPCC GPG LULUCF/ 2006 IPCC methodology Guidelines (Grass L, Crop L, Settlements., Wet L, Other L +Forest L)
- Identification of data needs and data sets according to/either of the two methods , namely, stock difference or gain-loss method
- Integration of remote sensing and land based surveys
- Allocation of area under each category of land use & then tracking the changes in Land use over time period

Challenges

- To chose sub-classification criteria for land categories other than forests
- Climate zone?
- Vegetation Type?
- Ecological zone?
- Species?
- National Land classification?

Stratification of Land Categories

1. Forest land; FSI strata or Champion & Seth or any other
2. Crop land; Annual crops & perennial crop, irrigated / dry land
3. Grassland; AEZ
4. Wetland – lakes creted
5. Settlements; cities, towns and villages
6. Other land; rocky, snow cover, desert, water bodies, etc

Challenges

- Determination of parameters such as:
  - Soil OC by region/Forest type/land use type?
  - Above and below ground biomass stock
  - Corresponding C stock Change
  - Extent of fuel wood generated/wood gathering
  - Litter
- Tier of Methodology to be used
- Steps to be taken for QA/QC and
- Strategies for reducing uncertainties

- Forest land remaining Forest Land
- Land Converted to Forest Land

Forest Land Remaining Forest Land

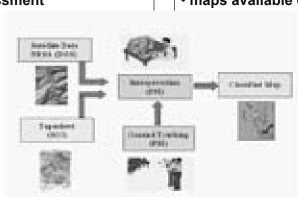
- Stratify Forest land into various existing categories
- Estimates changes in carbon stock
- Carbon Pools
  - above ground biomass
  - below ground biomass
  - dead wood
  - litter
  - soil organic carbon
- Assess source specific uncertainties

Land Converted to Forest Land

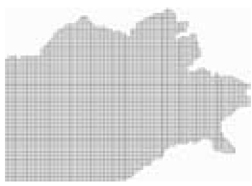
- Stratify lands into homogeneous sub categories
- Estimates changes in carbon stock
- Carbon Pools
  - above ground biomass
  - below ground biomass
  - dead wood
  - litter
  - soil organic carbon
- Assess source specific uncertainties

Forest Cover Mapping

Methodology	Analysis and output
• biennial cycle	• district wise area figures
• digital interpretation of satellite data	• change matrix
• intensive ground truthing	• Mangrove cover separately
• change maps	• area figures for hill and tribal districts
• accuracy assessment	• maps available on 1:50,000 scale

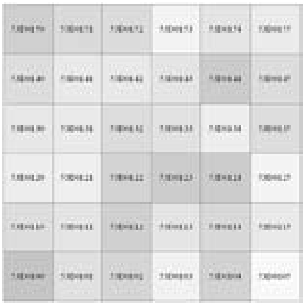


Nation Wide Vector Coverage of Polygons (2.5' x 2.5')

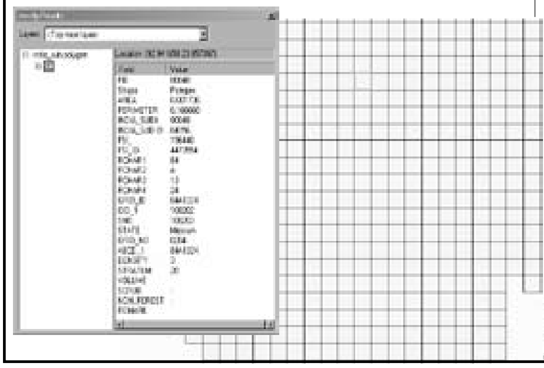


- Total number of polygons – 171,028
- Attribute data has been linked to the polygons

Unique Grid ID



Information Display of a Selected Polygon

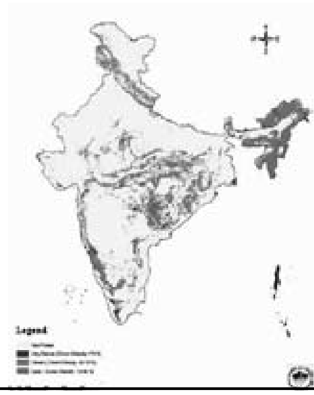


Forest Strata

Legend

- 01 Fir
- 02 Spruce
- 03 Fir-Spruce
- 04 Blue-Pine(Kail)
- 05 Deodar
- 06 Chir-pine
- 07 Mixed conifer
- 08 Hardwoods mixed with conifers or Conifers mixed with Hardwoods
- 09 Up-land Hardwoods
- 10 Teak
- 11 Sal
- 12 Bamboo Forest
- 13 Mangrove
- 14 Depterocarpus (Gurjan) Hollong
- 16 Khasi pine
- 17 Khair forest
- 18 Salai forest
- 19 Alpine pastures
- 20 Miscellaneous forest
- 22 Western Ghat evergreen forest
- 23 Western Ghat semi-evergreen forest
- 24 Deciduous forest

Forest Density



Forest Type/ Strata

- **Source**
  - **Thematic maps on 1:50,000 scale prepared FSI using aerial photographs**
  - **Stock maps of SFDs**
  - **Information contained in the inventory field forms**
  - **Information of the adjoining areas falling in the same agro-ecological zone**
- **Output- 25 major forest types/strata:**

1. Fir
2. Spruce
3. Fir and Spruce
4. Blue Pine
5. Deodar
6. Chir Pine
7. Mixed Conifers
8. Hardwood mixed with conifers
9. Upland Hardwood
10. Teak
11. Sal
12. Bamboo forests
13. Mangrove
14. Dipterocarpus
15. Hollong Makai
16. Khasi pine
17. Khair
18. Salai
19. Alpine Pastures
20. Miscellaneous
21. Chilgoja Pine
22. Western Ghat evergreen
23. Western Ghat semi-evergreen
24. Deciduous
25. Junipers

Forest Inventory

- Over 80% of forested area inventoried so far
- More than 130 inventory reports published
- Systematic random sampling with 0.01% intensity is carried out
- Area divided into grids of 2.5’ x 2.5’ and in each grid two random plots of 0.1 ha are marked
- Inventory data collected in prescribed forms and processed to generate inventory reports

INFORMATION IN INVENTORY REPORTS

- Area estimates
- Topographic description
- Classification of forests into industrial, social and environmental forests.
- Composition by species
- Status of forests - healthy or degraded
- Ownership pattern
- Record of tree species, diameter and height
- Estimation of volume in different types of forests
- Estimation of growth, regeneration, mortality, volume equations etc. for important species
- Wood consumption study of the inventory area
- Soil Sample Data
- Litter Sample data

Assessment of Forest Biomass and Carbon

•Forest type mapping project currently under progress at FSI is expected to map forest types of India according to Champion & Seth Classification. It may finally result in a map showing 200 forest types of the country on 1: 50,000 scale

•Nation-wide forest cover mapping done by FSI biennially on 1: 50,000 scale gives three classes of canopy density

•An overlay analysis of the above two spatial layers in GIS would give 600 strata (of homogeneous floral composition and canopy density)

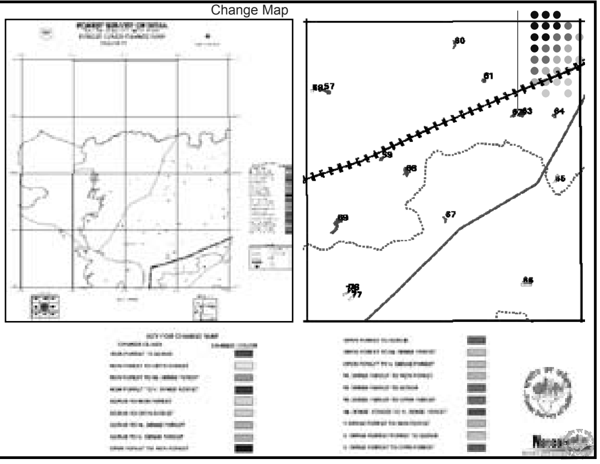
• Branch expansion factors and factors for under ground biomass to be developed to estimate total biomass in each stratum

•Using inventory data, volume factor (growing stock per ha of forest) for each of the above 100 strata may be determined.

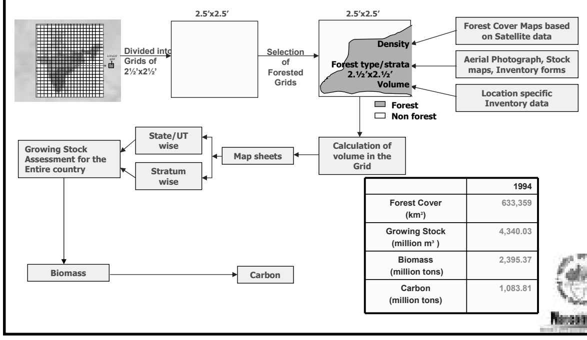
•The approach can be used to assess carbon changes in forests at the sub national or district level

•Rapid assessment using grid approach

Change Map



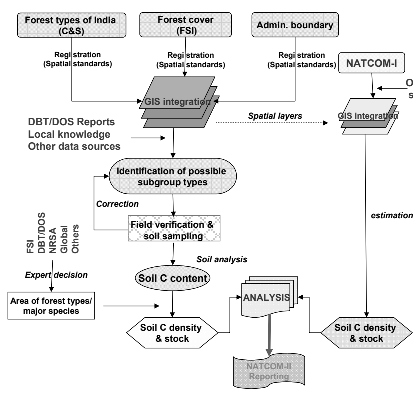
Integrating Growing Stock, Biomass And Carbon



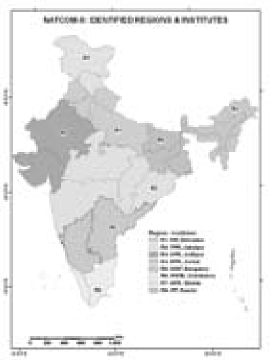
	1994
Forest Cover (km²)	633,359
Growing Stock (million m³)	4,340.03
Biomass (million tons)	2,395.37
Carbon (million tons)	1,083.81

Estimating Soil C from Forests

- Measurement
- Modeling



ICFRE participating Institutes and their area of jurisdiction



Nodal ICFRE Institutes and number of sample locations

Region	Name of the Institute	Area coverage	No. of subgroup types	Number of samples (@ 3 per type + from non-forest area)
R1	FRI, DEHRADUN	UA, UP, PUN,HA, ND, Chandigarh	31	33+10=43
R2	TFRI, JABALPUR	MP, MS, OR,CH	17	51+10=61
R3	AFRI, JODHPUR	RA,GU, D&N Haveli, D&Diu	18	54+10=64
R4	RFRI, JORHAT	North East	29	87+12=97
R5	IWST, BANGALORE	KA, AP, GOA	15	45+08=53
R6	IFGTB, COIMBATORE	TN, KE, A&N Is. Pondy,	32	96+10=106
R7	HFRI, SHIMLA	HP, J&K,	16	48+08=58
R8	IFP, RANCHI	BH, JH, WB, Sikkim	13	39+10=49
	Total No. of samples		**171**	**513+78=591**

Modeling Soil C

Introduction

- GPG approach permits using process based models for inventory estimation using Tier III approach
- However, soil carbon stock change data is not easily available
- Many among the annex I countries are using modeling for assessing Soil carbon stock changes

Modeling Soil Carbon Changes

FAO has conducted a study (Hernandez et al. 2004) and they find they recommend the use of the following four studies for modeling soil carbon stock changes:

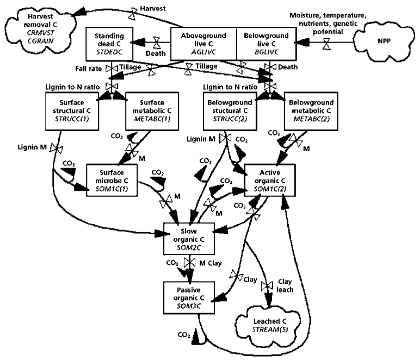
- RothC
- CO2 fix
- Century
- DNDC etc.

We propose to use Century / and RothC for the purpose of present inventory estimation.

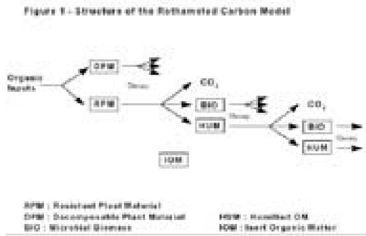
Century

- CENTURY model simulates the long-term dynamics of C, nitrogen (N), phosphorus (P), and sulphur (S) for different plant-soil systems.
- Model can simulate the dynamics of grassland systems, agricultural crop systems, forest systems, and savannah systems.
- The grassland/crop and forest systems, have different plant production submodels that are linked to a common SOM submodel
- It is assumed that the following factors affect organic matter decomposition - Soil moisture, Soil temperature, Clay content PH, N Content

Model Structure



Modeling with ROTHC



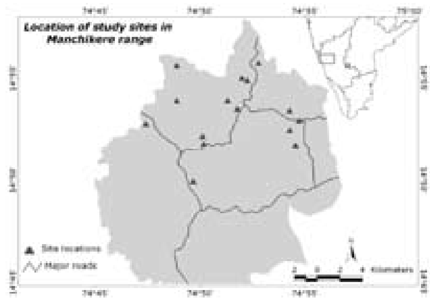
Roth C: Data Needs

Data required:

1) Weather data
- Monthly temperature (degree C)
- Monthly rainfall (mm)
- Monthly Evaporation (mm)

2) Land Management data
- Plant residues (tC/ha) – Monthly
- Farm yard manure (tC/ha) – Monthly
- Soil cover (covered/fallow)

Validatation of Roth C : A case study of Manchikere range



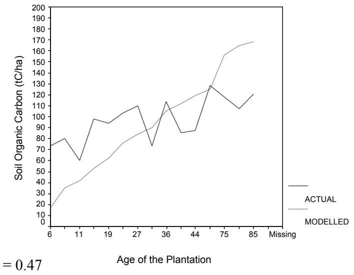
Field work

Sampling Design			
Pools	Plot dimensions (Meters)	No. of Plots	Parameters sampled
AGB (Trees)	50 * 20	45	GBH & H
Litter	5 * 5	135	Woody litter (wt)
Soil	50 * 20	90	250 gm each (0-15 & 15-30 Cms)

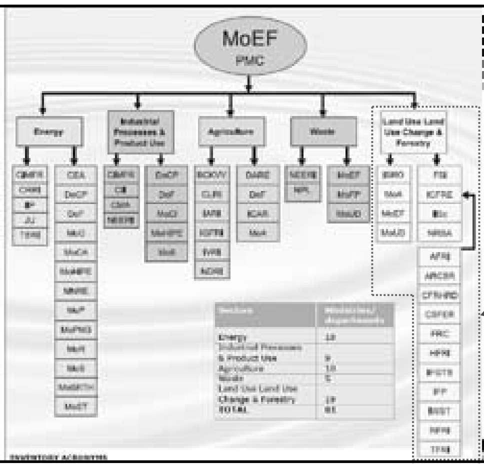
Modeled & Field based actual SOC density

	SOC (tC/ha)	
Age	Actual value	Modelled value
6	73.7	17.2
8	80.4	35
11	60.3	42
13	97.82	53
19	93.8	62
23	103.18	76
27	109.88	84
31	73.7	90
36	113.9	105
41	85.76	112
44	87.1	119
48	128.64	125
75	117.92	156
79	107.2	165
85	120.6	168

Actual Vs. Modeled SOC



R square = 0.47
N = 15



Other Land Uses

- RS Maps are being generated for crop land, waste land, settlements, wet lands and other land

THANK YOU

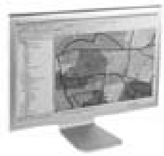
Improving Secondary Forest Above-ground Biomass Estimates using GIS-based Model

Damasa B. Magcale-Macandog

Associate Professor
Ecoinformatics Lab., Institute of Biological Sciences, College of Arts and Sciences
University of the Philippines Los Banos, College, Laguna, Philippines

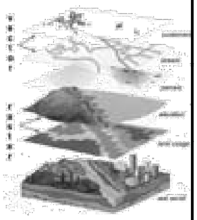
INTRODUCTION

- Secondary forests in the Philippines are scattered across the country, with an estimated forest cover of 2.7 M ha
- These forest areas comprise the largest remaining natural forest type in the country
  - Under severe pressure from human activities
  - Main source of wood and other forest-based resources



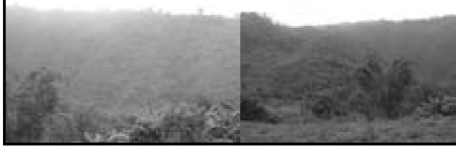
INTRODUCTION

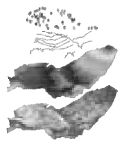
- Data reporting aboveground biomass density of secondary forests has been poor and insufficient to extrapolate biomass estimates to areas where data are lacking.
- GIS technology can provide a means to estimate biomass density for regions with little data because consistent patterns of biomass density frequently result from similar biophysical characteristics in the study area.



OBJECTIVE

Develop a GIS-based model that can be used to predict estimates of aboveground biomass of secondary forests at different locations and environmental conditions in the Philippines.

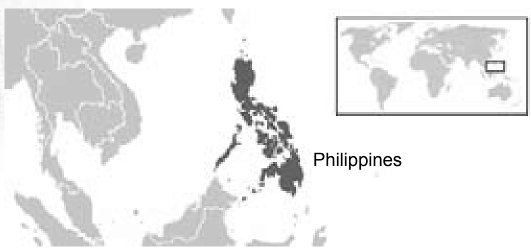




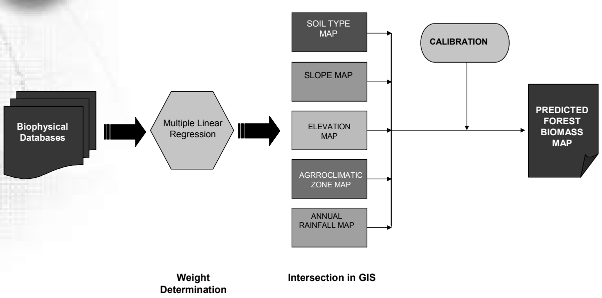
METHODOLOGY

Study area

- Main types of forest vegetation are dipterocarp, mangrove, pine and mossy forests



Flow diagram of GIS-modeling approach



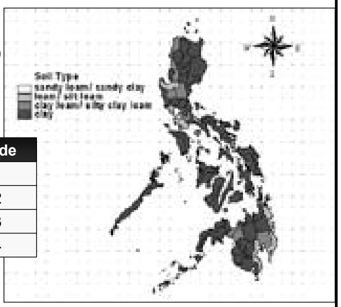
RESULTS

Major soil types of remaining secondary forests

Clay (70.7%)
Clay loam and silty clay loam (17.3%)
Loam and silty loam (9.3%)
Sandy loam to sandy clay (2.7%)

Soil type	Code
Sandy loam/ sandy clay	1
Loam/ silt loam	2
Clay loam/ silty clay loam	3
Clay	4

Fernandez and Clar de Jesus, 1980

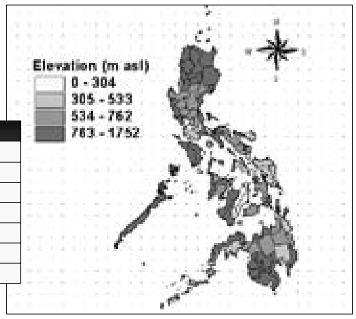


Major elevation ranges

Majority of forests are in the 700-1100 m asl and few are found in 300-600 m asl and greater than 1500 m asl elevation classes.

Elevation (meters)	Elevation (feet)
0-151	0-499
152-456	500-1499
457-1066	1500-3499
1067-1523	3500-4999
1524-1980	5000-6499
1981-2437	6500-8000
2438+	8000+

National Mapping and Resource Information Authority (1995)

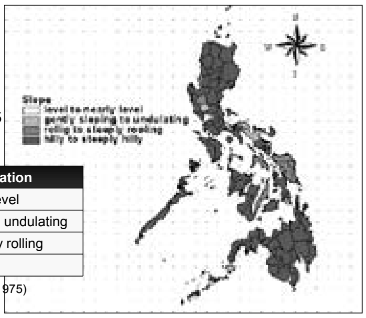


Major slope distribution

- Fifty-seven percent of the remaining secondary forest areas are found in the 60-65% slope class.
- The remaining 43% is unevenly distributed the 0 to 25% and 45 to 50% slope classes.

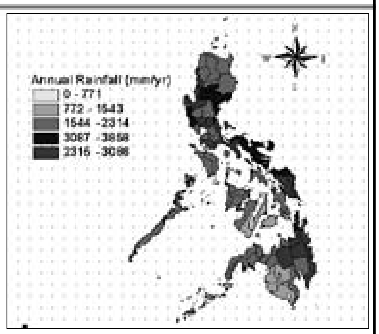
Slope range (%)	Classification
0-3	Level to nearly level
3-15	Gently sloping to undulating
15-30	Rolling to steeply rolling
30-65+	Steeply hilly

Bureau of Soil and Water Management (1975)



Major annual rainfall distribution

Thirty-seven percent of the secondary forests have 2000-2500 mm/yr precipitation, and the remaining proportion are unevenly distributed to greater than 1000 and 4000 mm/yr precipitation values.



Data source: Climatological normals from the Philippine Atmospheric, Geophysical and Astronomical Services Administration (1961-1995)

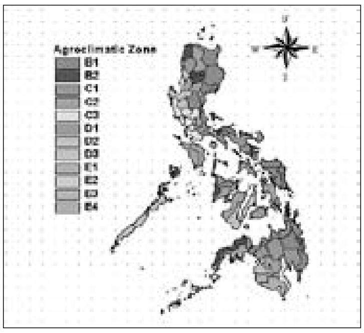
Major agroclimate distribution

Majority of forest areas are under

Climate type B1(less than 2 dry months, 7-9 wet months)

Climate type C2 (2-4 dry months, 5-6 wet months)

Climate type C3 (5-6 wet and dry months)



Data Source: Philippine Atmospheric, Geophysical and Astronomical Services Administration (1990)

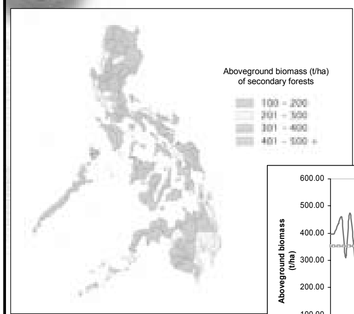
Potential biomass

Potential biomass (t/ha) =
Physical factor 1* Weight 1 + Physical factor n…* Weight n…

Physical factor	Weight
Annual rainfall	-0.1033
Climate	17.1668
Elevation	-0.1621
Slope	3.66446
Soil type	108.244

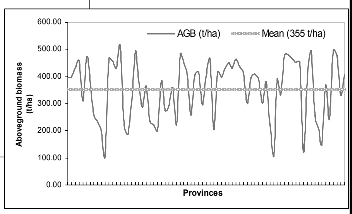
Data sources: Lasco et al, (2001); Guillermo (1998); Racelis (2000)

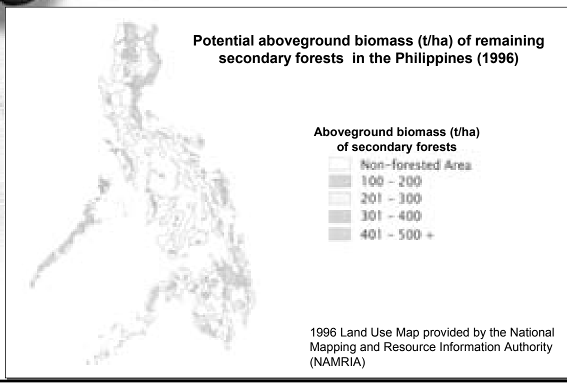
Potential aboveground biomass



Potential aboveground biomass (t/ha) of secondary forests per province in the Philippines

Mean = 355.46 t/ha
n= 75 provinces
Range = 107.91 to 511.56 t/ha





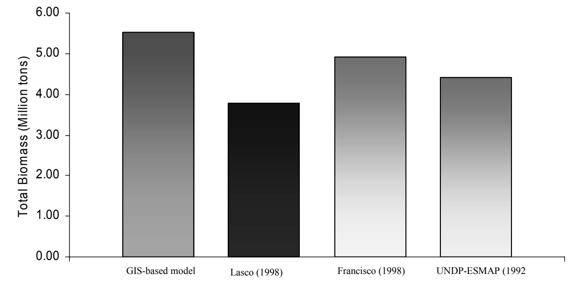
Aboveground biomass computation

Computation of the aboveground biomass of secondary forests:

1. Biomass density (t/ha) **x** forest area per province
   = Total biomass/province
2. Total aboveground biomass in secondary forests
   = Σ Total biomass/province

Author	Biomass density (t/ha)
Lasco (1998)	258
Francisco (1998)	335
UNDP-ESMAP(1992)	300
GIS-based model	Province-specific values (100-500 t/ha)

Comparison of the total aboveground biomass in secondary forest (million tons) in the Philippines using biomass density values reported by different authors using IPCC default values and using the GIS-based model.



CONCLUSIONS

Use of GIS approach can:

- Reduce the uncertainty in estimates of aboveground biomass;
- Improve the quality of biomass estimates;
- Predict more accurate biomass estimates at different locations and environmental conditions; and
- Improve the computations for C stocks and preparation of national GHG inventory report

RECOMMENDATION

Improvements to this approach can be achieved:

- Further research on other factors that influence biomass production in forests and that should be included in future estimates;
- Enhancing the resolution of input maps;
- Incorporation of more recent GIS techniques as the technology; and
- Advances to reduce variability of biomass estimates at the local level.

THANK YOU!!!

http://www.uplb.edu.ph

Property and Reliability of Waste Data

Tomonori ISHIGAKI
Ryukoku University, Japan
Masato Yamada
NIES, Japan

Topics in Waste Group

- Strategy to improve reliability of waste data (arisen from SWGA)
- Using surrogate data in emission estimation
- Analysis of carbon flow

Second Session
"Reporting on Country-Specific MSW Flow and GHG Emissions"

a. Mass and carbon flow in waste streams in city, region or country
b. GHG emissions from each SWDS estimated by IPCC spread sheet

Fourth Session
"Short Reporting on Recent Waste Management Technology and Practice in Asian Countries"

Fifth Session Discussion on
"What is Appropriate Waste Management in Asia?"

Fifth Session

- Subject 1: **Characteristics of MSW Stream in Asia and How to obtain reliable data from this.**

Fifth Session

- Subject 2: **Advantage and Disadvantage of Technologies/Practice in Waste Management in Asia** (from viewpoint of GHG Reduction and Environmental Protection)

Fifth Session

- Subject 3: **What is Appropriate Waste Management in Asia?** : Balance of Environment, Economy and Society

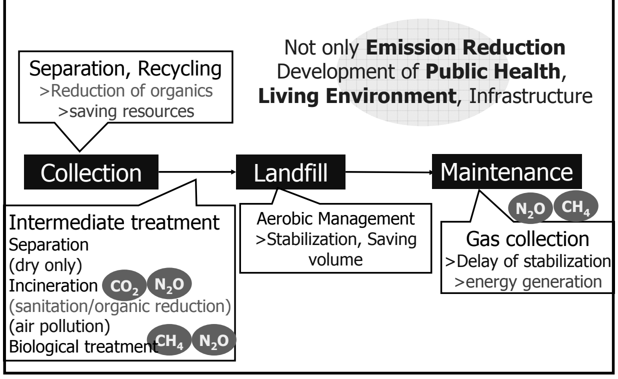
From SWGA: Discussion topics in session 2

1. Difficulty to apply IPCC waste model in Asian countries
   - –Lack of waste historical data
   - –Low accuracy for national calculation: separation in each landfill should be better
   - –Need more researches for parameter evaluation
   - –Add LFGTE calculation in the model
   - –Establish standard for waste data collection

2.If FOD model is not suitable for methane emission calculation, how do we do next?

3.k value

GHGs emission and Waste Management



Data on Solid Waste Management

- **Waste Generation**
- **Waste Stream**
- **Waste Composition**
- **Physicochemical Property**
- **Cost/ Revenue**

Data on Solid Waste Management

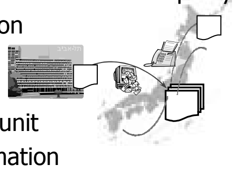
- **Waste Generation**
- **Waste Stream**
- **Waste Composition**
- **Physicochemical Property**
- **Cost/ Revenue**

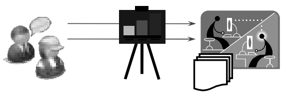
Waste Generation (Rate)
- source and property of data?-

- **Method for Estimation**
  - Weighing every truck on a scale
  - Sampling the representative activity
  - Estimation from Number of truck, Revenue…
  - Base Unit/Population, Economic Drivers or Trends…
- **Unit of Mass**
  - Weight or Volume
  - Precise Density
- **Basis of Measurement**
  - Wet (fresh)
  - Dry (after pretreatment)
- **Time of Estimation**
  - Annual, Some years interval
  - Some case studies…

Survey on Waste Generation and Stream in Japan

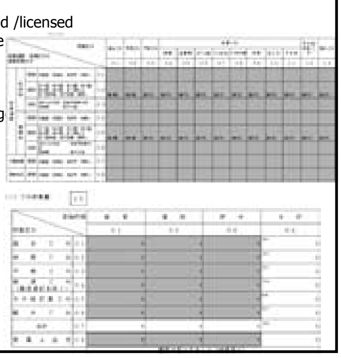
- **Municipal**
  - Actual data collection from all municipality
  - Cumulative estimation
- **Industrial**
  - Interviewing/ Basic unit
  - Computational Estimation

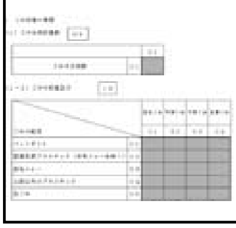




Data collection on Municipality

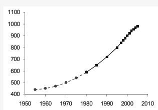
- Questionnaire
  - Population
  - Workers
  - Direct management/commisioned /licensed
  - Collection/Transportation Vehicle
  - Separation Category of Plastic
  - Charge/fee
  - Amount of collection
  - Treatment/Recycle of each categ



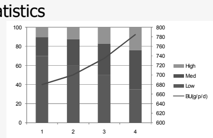


Past Waste Generation (from LF)

- Extrapolation from
  - Trend of existent data on waste generation



  - Base unit for each class (authentic statistics)
    - Residential: income, household composition...
    - Business: sector, annual sales, employee number
  - Temporal variation of each class composition
  - Estimation from available/reliable statistics
    - Population
    - GDP,GNP
    - other economic indicator



- Consideration
  - Data Location
  - Method of Estimation
  - Accuracy, Reliability
  - Continuity (disconnection)

How to make reliable base unit

- Classification of activities
  - Link to available/ Reliable statistics
- Appropriate information collection
  - Total inspection
  - Selection of interviewing party
    - Municipality, Industry, Company, Scale
  - Questionnaire
    - Population, Household, workers for primary/tertiary industries
    - Expenditure, Shipment value

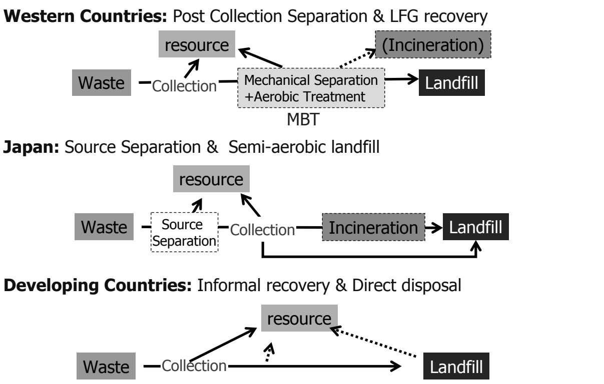
Data on Solid Waste Management

- Waste Generation
- **Waste Stream**
- Waste Composition
- Physicochemical Property
- Cost/ Revenue

Waste Stream

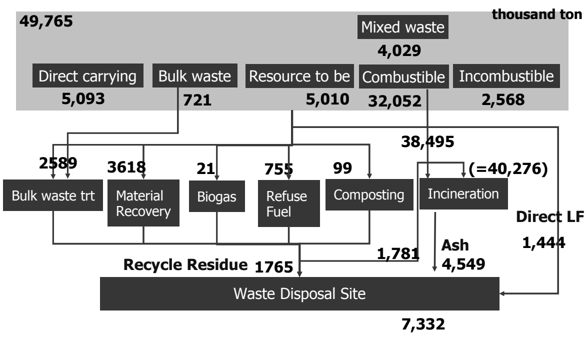
- Waste Generation
- rate of collection
- resource recovery
  - Source/post collection
  - Informal recovery
- land disposal (open burning)
- treatment
  - separation, composting, incineration etc.

Solid Waste Stream



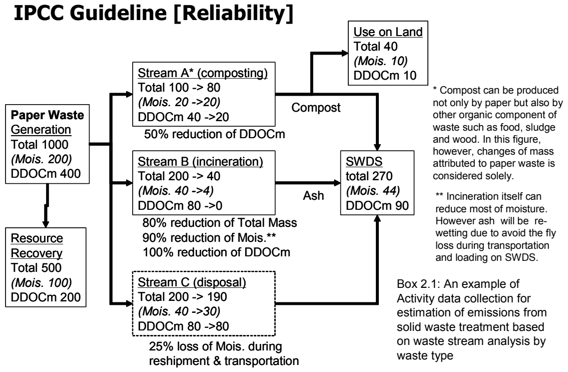
Waste Stream: Mass Flow

Change the quantity/quality during the stream
Necessary but Insufficient for Emission Estimation



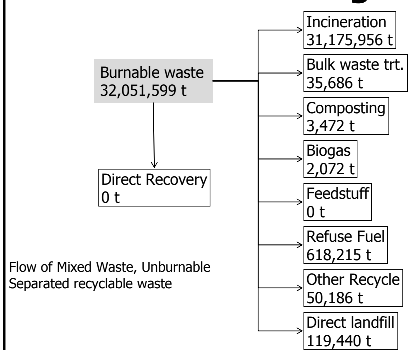
Substance Flow

IPCC Guideline [Reliability]

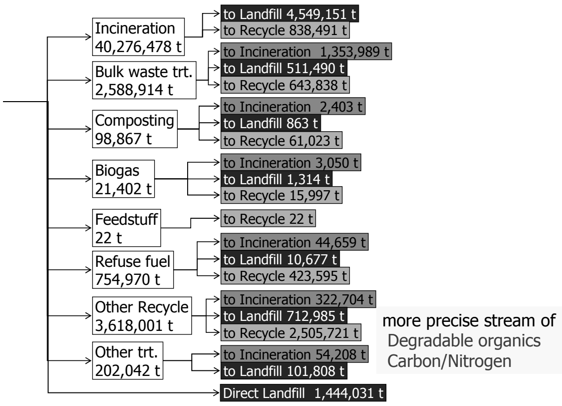


Values in each box explain weight of total mass and compositions of waste as ton, kg or so on.

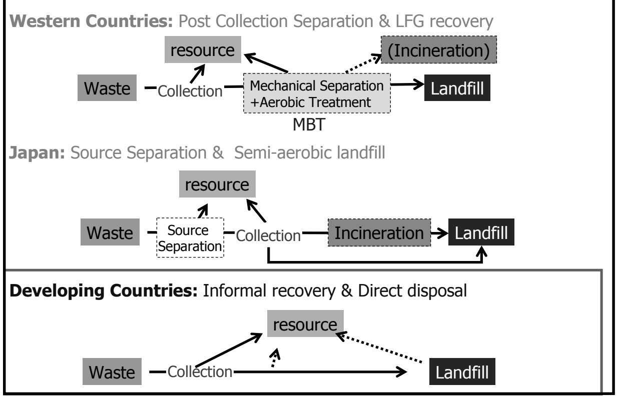
Stream of Each Category: Where to go



Stream after treatment



Solid Waste Stream



Simple Waste Stream

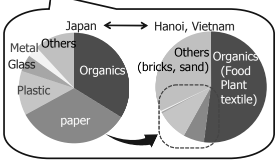
- Waste Generation: Most important data
  - Change of quality/amount between generation and disposal
  - Weight
  - Generator (Municipal, Industrial)
  - Temporal difference
  - Measurement : at landfill, at transfer station
- Current Generation
- Estimation of Past Generation

Data on Solid Waste Management

- Waste Generation
- Waste Stream
- **Waste Composition**
- Physicochemical Property
- Cost/ Revenue

Waste Composition

- Category
  - percentage of garbage, paper, plastics, metals
  - Country/ Regional Difference
  - Classification
- Impact of Informal Recovery
- Where to investigate
  - Collection Station
  - Transfer station
  - Incineration/Landfill
- Description of Method



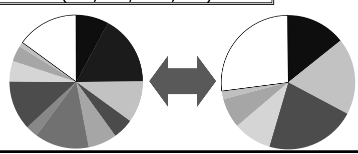
Waste Composition - common categories?

- food waste
- garden (yard) and park waste
- paper and cardboard
- wood
- textiles
- nappies (disposable diapers)
- rubber and leather
- plastics
- metal
- glass (and pottery and china)
- other (ash, dirt, dust, soil)

- Organics
- paper and cardboard
- plastics
- metal
- glass
- Textiles and others

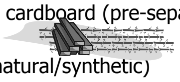
Country difference
Re-Categorization

- Food waste
- Plants
- paper
- plastics
- metal
- Pottery
- Textiles
- Soils and others



Waste Composition- Real Contents


- food waste
- garden (yard) and park waste
- paper and cardboard (pre-separated?)
- Wood



- Textiles (natural/synthetic)
- nappies (disposable diapers)
- rubber and leather (natural/synthetic)
- plastics (soft/hard, usage)
- Metal (Fe, Cu, Al)
- glass (pottery and china)
- other (e.g., ash, dirt, dust, soil, electronic waste)

Data on Solid Waste Management

- Waste Generation
- Waste Stream
- Waste Composition
- **Physicochemical Property**
- Cost/ Revenue

Physicochemical Property

- How to estimate
  - "**B**io**D**egradable **O**rganic **C**arbon/**N**itrogen"
- Investigation
  - **water content**/ **Ignition loss**/ ash content
  - calorific value
  - Solid phase TOC
  - AT4, GB21
  - Eluates analysis (BOD, DOC)
  - content of **carbon**/ nitrogen/ sulfur/ chlorine
  - heavy metals/ dioxins…

Physicochemical Property - quality of data?-

- Method of sampling (representativeness?)
- Method of pretreatment (drying, grinding, mixing, extracting…)
- Analytical method (common or experimental?)
- Statistical parameters (average, range, error…)
- unity of unit (dry/wet weight, volume, pieces…)
- Purpose of Analysis
  - For appropriate treatment/ disposal/ recycling
  - assessment of pollution/ risk/ GHG emission/ energy

Other factors

- Background information
  - (nature, economy, industry, culture…)
- Legal/economical framework
- History of waste management
- Description of facility/site for waste management
  - (transportation station, treatment plant, landfill…)

How to construct the record structure of database and which is information first?

SUMMARY: To be considered

- Waste Generation
  - Base Unit
  - Past generation
- Waste Stream
  - Mass flow/Substance flow
  - Stream of each category
- Composition
  - Impact of informal recovery
  - Category
  - Real contents

Problem in your country
Priority/ Suggestion of other factor
Situation of Waste Data Collection

Use of surrogate data in waste sector estimation (China's Case)

Gao Qingxian
Chinese Research Academy of Environmental Science (CRAES)

focusing on

- Purpose of using the surrogate data
- Methods and data used in estimation
- Results of estimation
- Useful advice / recommendation China's experience

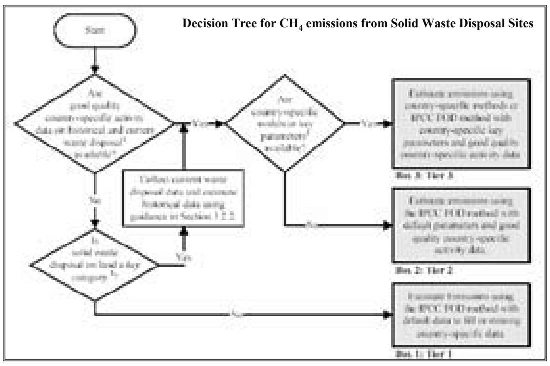
Purpose of using the surrogate data

Why Surrogate data needed?

- No Data
- No Enough data
- Quality of data

Good quality country-specific activity data mean country-specific data on waste disposed in SWDS for 10 years or more

Purpose of using the surrogate data



Purpose of using the surrogate data

data needed (1/2)

Total production of MSW and its composition

- Municipal Solid Waste (MSW) (food waste, Garden, paper, wood and straw , textiles, disposable nappies)
- Sewage sludge
- Industrial waste (Manufacturing Industries and Construction waste)
- Other waste (Clinical and Hazardous waste)

The Ratio of treatment of MSW(%)

- Resource Recovery
- Composting
- Incineration
- Disposal

Purpose of using the surrogate data

data needed (2/2)

The Methane Correction Factor (MCF)

- Managed: anaerobic
- Managed: semi-aerobic
- Unmanaged: deep (>5 m) and /or high water table
- Unmanaged: shallow (<5 m)
- Uncategorised SWDS

Oxidation factor (OX)

- Managed, unmanaged and uncategorised SWDS
- Managed covered with CH_4 oxidizing material

Methane Generation rate constant (k)

Fraction of DOC dissimilated (DOC_F)

Delay time (month)

Fraction of Methane (F)

Conversion factor

Methane Recovery (Gg/yr)

Purpose of using the surrogate data

No Data

- **The Methane Correction Factor (MCF)**
  - Managed: anaerobic
  - Managed: semi-aerobic
  - Unmanaged: deep (>5 m) and /or high water table
  - Unmanaged: shallow (<5 m)
  - Uncategorised SWDS

  → **Expert judgment**
- **Oxidation factor (OX)**
  - Managed, unmanaged and uncategorised SWDS
  - Managed covered with CH4 oxidizing material

  → **Expert judgment** / **IPCC defaults**
- **Methane Generation rate constant (k)**
  Fraction of DOC dissimilated (DOC_F)
  Delay time (month)
  Fraction of Methane (F)
  Conversion factor
  Methane Recovery (Gg/yr)

  → **IPCC defaults**

Purpose of using the surrogate data

No Enough Data

- **Total production of MSW and its composition**
  - Municipal Solid Waste (MSW) (food waste, Garden, paper, wood and straw , textiles, disposable nappies)
  - Sewage sludge
  - Industrial waste (Manufacturing Industries and Construction waste)
  - Other waste (Clinical and Hazardous waste)

  → **Country specific methodology** / **Expert judgment**

  The Municipal Construction Statistics Yearbook
  - carrying amount (MSW treated)
  - disposal percentage of municipal waste
- **The Ratio of treatment of MSW(%)**
  - Resource Recovery
  - Composting
  - Incineration
  - Disposal

  → **Survey data** (specific years & region) / **Expert judgment**

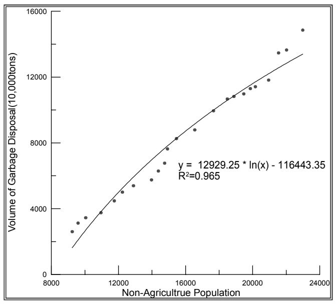
Purpose of using the surrogate data

Data Quality

- **Time series** → **Country specific method** / **Expert judgment**
- **Consistent** → **Expert judgment**
- **Transparency** → **Expert judgments**

Methods and data used in estimation

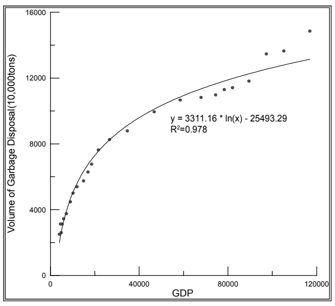
Urban non-agricultural population



The relation of non-agriculture population and the generate amount of MSW

Methods and data used in estimation

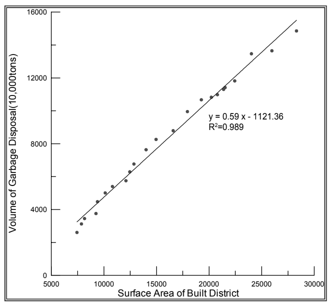
Gross Domestic Product (GDP)



The relation of GDP and the generate amount of MSW

Methods and data used in estimation

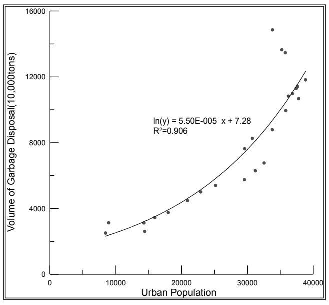
The area of city



The relation of area of city and the generate amount of MSW

Methods and data used in estimation

Urban population

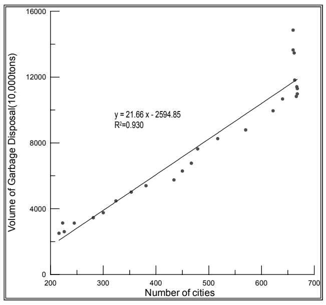


The relation of urban population and the generate amount of MSW

4/7

Methods and data used in estimation

The number of city

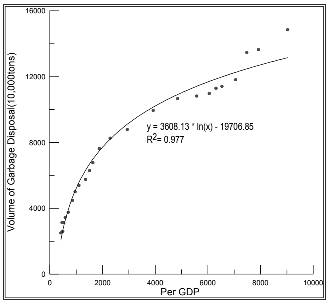


The relation of city numbers and the generate amount of MSW

5/7

Methods and data used in estimation

GDP per capita



The relation of per GDP and the generate amount of MSW

6/7

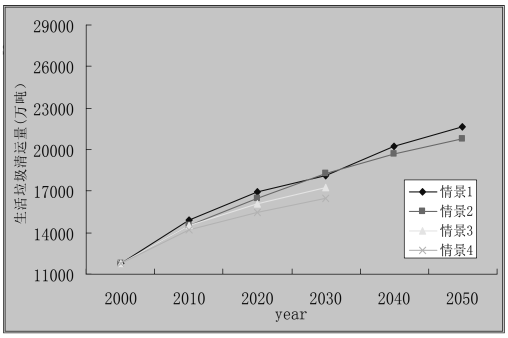
Methods and data used in estimation

The relationship of MSW Generation amount and its driving forcing

- **Estimate model for MSW**
  - **Non-agricultural population:**
    MSW = 12929.25ln(x) －116443.35
    Where, x resprent non-agricultural population (ten thousand person)
  - **GDP:**
    MSW = 3311.16 ln(x) －25493.29
    Where, x resprent GDP (100 million Yuan RMB)
  - **GDP per capita**
    MSW = 3608.13 ln(x) －19706.85
    Where, x resprent GDP per capita (Yuan RMB)

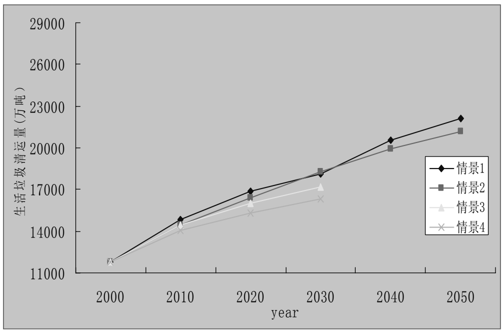
7/7

Results of estimation



1/6

Results of estimation

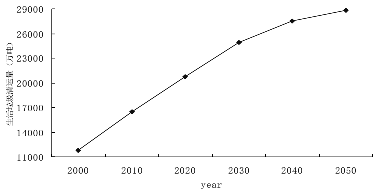


2/6

Results of estimation

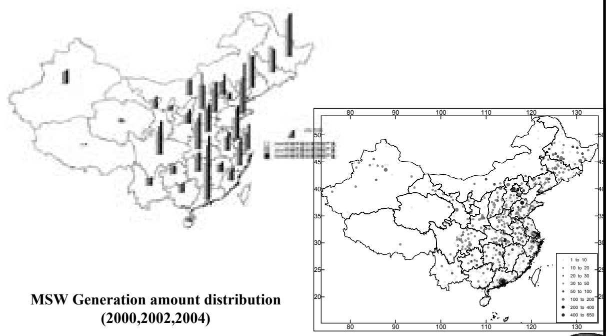
Non-Agriculture Population Scenarios

Year	2000	2010	2020	2030	2040	2050
Non-A Population	20952.5	29101.4	40419.6	56139.6	68433.9	75593.6



3/6

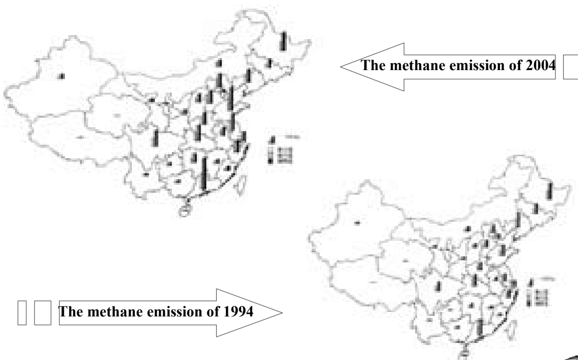
Results of estimation



MSW Generation amount distribution (2000,2002,2004)

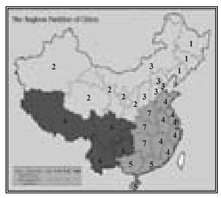
4/6

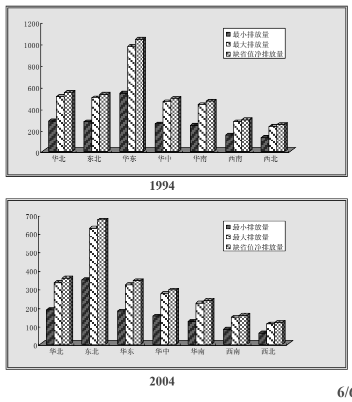
Results of estimation



5/6

Results of estimation





6/6

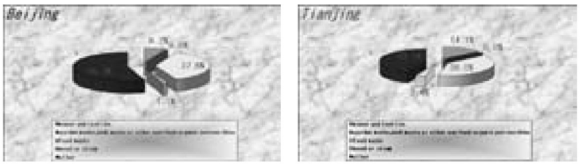
Useful advice / recommendation China's experience

- Regional issues
  - *economic level*
  - *industrial level*
  - *climate condition*
  - *life style*
- Manage Issues
  - *law and regulation as well as standard*
  - *Statistics system*
  - *Data sharing mechanism*

Thanks for your attention!

The Composition of MSW in China

The weighted average of carbon content of various components of waste stream



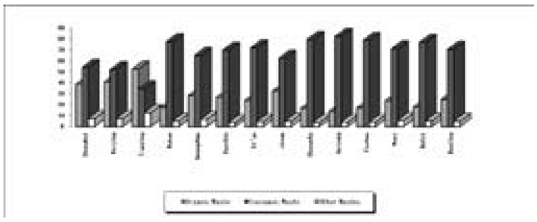
Sample	Tianjing	Beijing	Average
Paper and Textiles	14.08	6.24	10.16
Food waste	39.02	37.63	38.33
Wood and straw	3.4	1.15	2.28
Others	43.5	54.99	49.25

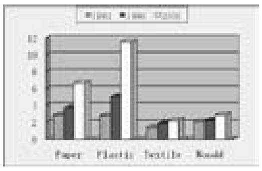
components of waste stream	Organic Caron percentage (Weight)
Paper	26
Wood and straw	28
Textiles	30
Food waste	7

Fresh waste

1/4

The Composition of MSW in China





① Organic waste increase (~50%);
② Inorganic Waste decrease (~23.34%);
③ Recycle waste increase (~26.6%);
④ Combustible waste increase.

2/4

The Composition of MSW in China

- ☑ Because there are more containing amount of moisture in kitchen waste in China, the DOC value of kitchen waste(10.2%) in China is lower than IPCC default value(15%).
- ☑ Due to the wood and straw waste in China mostly is dry, and there are not too much fresh woods and straw waste in China, so the DOC value of wood and straw (35.5%)in China is higher than IPCC default value(30%).

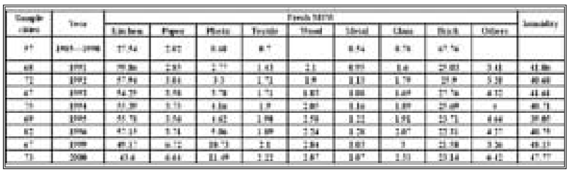
Waste Streams	DOC（Weight）
Papers	28.53
Wood and Straw	35.51
Textiles	27.68
Kitchen waste	10.19
Dust (Sweeping dust)	2.48

For fresh waste only

3/4

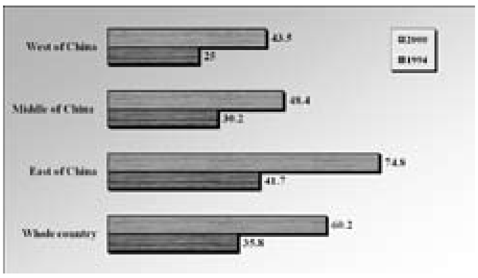
The Composition of MSW in China

Collect different city historical data



4/4

The Disposal Rate of MSW in China

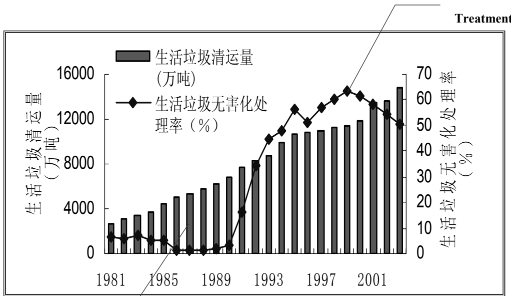


The disposal rate in different region of China (1994 and 2000)

1/2

The Disposal Rate of MSW in China

Treatment ratio



Generate amount of MSW

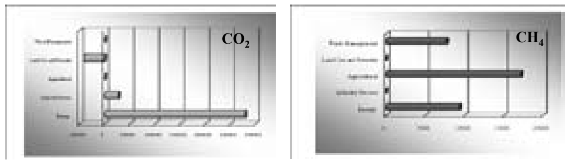
1981 - 2003

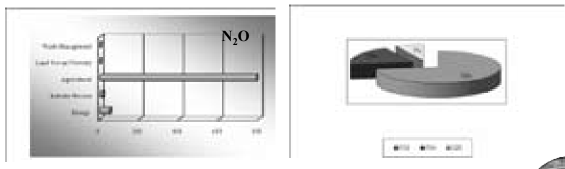
2/2

Information of SNC

- To submit lately National Greenhouse gases inventory
  - *INC：1994*
  - *SNC：2005*
- To add new gases sources
  - *INC：CO_2、N_2O、CH_4*
  - *SNC：CO_2、N_2O、CH_4、HFCs、PFCs、SF_6*
- Geographical Scope
  - *INC：China mainland*
  - *SNC：China Mainland + Hongkong SAR + Macao SAR*

The Greenhouse Gas Emission in different sector of China (1994)





UNCERTAINTY ASSESSMENT

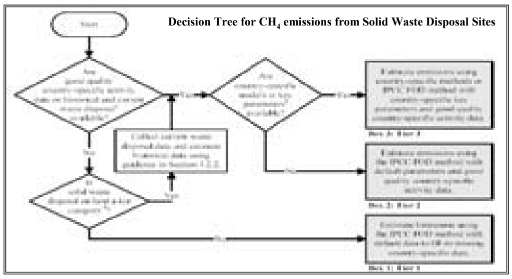
There are two areas of uncertainty in the estimate of CH4 emissions from SWDS:

- the uncertainty attributable to the method;
- the uncertainty attributable to the data

  (activity data and parameters)

UNCERTAINTY ASSESSMENT

- the uncertainty attributable to the method



UNCERTAINTY ASSESSMENT

- the uncertainty attributable to the data **how the data is obtained ?**
  - activity data
    weighed
    - **waste generation data** **(total municipal solid waste, total industrial waste)**

City	*662*	✓
Counties	*2861*	
village and town	*44821*	

    - **composition data**

      based on the survey in typical cities or region

    - **management data** **(the fraction of solid waste sent to SDWS)**

UNCERTAINTY ASSESSMENT

- the uncertainty attributable to the data
  - parameters

    - **Methane correction factor (MCF)------→***Expert judgments*
    - **Degradable organic carbon (DOC)-----→***country specific*
    - **Fraction of degradable organic carbon which decomposes (DOCf)**
    - **Fraction of CH4 in landfill gas (F)**
    - **Methane recovery (R)**
    - **Oxidation factor (OX)**
    - **The half-life**

6th Workshop on Greenhouse gas inventories in Asia

Development of Waste Sector GHG Inventory in Japan

Hiroyuki Ueda
Suuri-keikaku (SUR) , Japan
17th July 2008

6th Workshop on Greenhouse Gas Inventories in Asia

Objective of presentation

- **To find solutions for problems each country is facing / will face, by sharing experiences of Japan in development of waste sector GHG inventory.**
  - **Japan's experience:**
    - Japan's waste sector inventory has been revised 3 times between 1999 to 2006.
    - Japan has organized expert committee for efficient improvement of waste sector.
    - Japan has constructed a new waste material flow statistics for inventory improvement.
  - **Lessons from Japan's experience:**
    - Importance of early and planned improvement of waste sector GHG inventory.
    - Importance of construction of statistics that covers all waste material flow.
    - Importance of practical use of IPCC documents.

SUR 2

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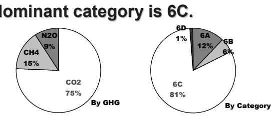
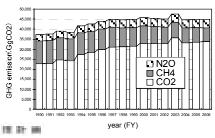
Japan's waste sector inventory

2006 GHG emissions (GgCO2)

- **51 sub categories, including 7 sub categories for energy use.**
- **The dominant GHG is CO2 and the dominant category is 6C.**



- **GHG emissions have increased by 21% from 1990 to 2006.**



SUR 3

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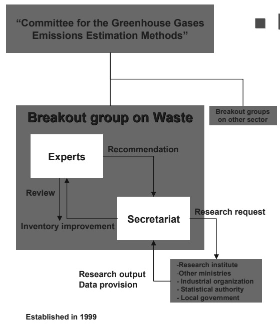
Inventory improvement system



- **Breakout group on Waste**
  - **Organized under the "Committee for the Greenhouse Gases Emissions Estimation Methods"**
  - **6 waste and GHG experts**
  - **Secretariat : MOE / GIO / Consultant**
  - **Japan's waste sector inventory has been revised 3 times under this improvement system between 1999 to 2006.**
    - **1st (1999 - 2000) : Preparation for future improvement**
    - **2nd (2001 - 2002) : Establishment of main framework**
    - **3rd (2005 - 2006) : Fixing all major problems**

SUR 4

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1st Improvement in 1999 to 2000

- **Preparation for future improvement**
  - **"The Committee for the Greenhouse Gases Emissions Estimation Methods" and "Breakout Group on Waste" were established to develop / improve methodologies, EFs and AD.**

Under the Breakout group on waste

  - **Consistency between former GHG emissions estimation method and IPCC GPG and 1996 revised GL was reviewed.**
  - **All problems to be solved in the future were identified and they were classified according to importance, to promote domestic research and statistical arrangement.**

- Lack of statistics and data for country specific EFs
- Lack of methodology (at NE source categories)
- Lack of TCCCA

TCCCA : transparent, consistent, comparable, complete, accurate

SUR 5

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2nd Improvement in 2001 to 2002

- **Establishment of main framework**

Amount of waste goes to intermediate treatment, landfill, recycled for material / energy …

  - **New statistics prepared for waste sector GHG inventory was introduced.**
    - To complete whole emission sources of waste sector, it was important to grasp waste material flow. Therefore, MOE constructed statistics that covers all waste material flow from existing waste and waste-relating statistics.

- Waste used for energy
- Untreated household wastewater
- Landfilled organic sludge

  - **Important problems like NE source categories were solved.**
  - **Remaining or new problems to be solved before submission of the initial report under the Kyoto Protocol were identified.**
    - According to the new statistics, NE sources categories were still identified.
  - **Uncertainty analysis for improvement of accuracy of waste sector GHG inventory was conducted.**

SUR 6

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3rd Improvement in 2005 to 2006

Some source categories are difficult to estimate emissions without 2006 IPCC GL.

- **Fixing all major problems**
  - New methodology and EFs from 2006 IPCC GL were introduced for estimating emissions from some NE source categories.
  - Almost all of existing problems identified in former improvement were settled.
  - The Initial Report under the Kyoto Protocol was submitted in August 2006.
  - But some new problems to be solved before the commitment period were identified through domestic research outputs and expert's comments.

- Data quality and accuracy
- Inappropriate EFs and parameters
- NE source categories

→ Next improvement

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6.A Landfill

EF : Emission Factor
AD : Activity Data
M : Method

● : Newly introduced
○ : Revised
NE: Not estimated
--- : Not changed

Source categories			emissions in 2006 GgCO2 CO2	CH4	N2O	1st revise 1999-2000 EF	AD	M	2nd revise 2001-2002 EF	AD	M	3rd revise 2005-2006 EF	AD	M	Remarks
6.A.1 Managed waste disposal on land	MSW	Kitchen garbage		367		○	---	---	---	○	---	○	○	○	- Method is revised to 2006 IPCC in 3rd rev.
	MSW	Waste paper		1,652		○	---	---	---	○	---	○	○	○	- Method is revised to 2006 IPCC in 3rd rev.
	MSW	Waste textile		89		○	---	---	---	○	---	○	○	○	- Method is revised to 2006 IPCC in 3rd rev.
	MSW	Waste wood		519		○	---	---	---	○	---	○	○	○	- Method is revised to 2006 IPCC in 3rd rev.
	MSW	Human waste treatment sludge Septic tank sludge		104		NE	NE	NE	NE	NE	NE	●	●	●	- EF and Method were introduced from 2006 IPCC.
	ISW	Kitchen garbage		372		○	---	---	---	○	---	○	○	○	- Method is revised to 2006 IPCC in 3rd rev.
	ISW	Waste paper		231		○	---	---	---	○	---	○	○	○	- Method is revised to 2006 IPCC in 3rd rev.
	ISW	Waste textile		31		○	---	---	---	○	---	○	○	○	- Method is revised to 2006 IPCC in 3rd rev.
	ISW	Waste wood		569		○	---	---	---	○	---	○	○	○	- Method is revised to 2006 IPCC in 3rd rev.
	ISW	Sewage sludge		363		NE	NE	NE	NE	NE	NE	●	●	●	- EF and Method were introduced from 2006 IPCC.
	ISW	Waterworks sludge		58		NE	NE	NE	NE	NE	NE	●	●	●	- Method was introduced from 2006 IPCC.
	ISW	Organic sludge from industries		341		NE	NE	NE	NE	NE	NE	●	●	●	- Method was introduced from 2006 IPCC.
	ISW	Livestock waste		636		NE	NE	NE	NE	NE	NE	●	●	●	- EF and Method were introduced from 2006 IPCC.
	MSW	CH4 recovery		-8		NE	NE	NE	NE	NE	NE	●	●	●	
	ISW	CH4 recovery		NE		NE	NE	NE	NE	NE	NE	NE	NE	NE	- AD is not available.
6.A.3 Other	ISW	Inappropriate disposal		47		NE	NE	NE	NE	NE	NE	●	●	●	- AD and Method were developed with domestic experts.
	MSW	Composting		8	8	NE	NE	NE	NE	NE	NE	●	●	●	- Method was introduced from 2006 IPCC.
	ISW	Composting		14	16	NE	NE	NE	NE	NE	NE	●	●	●	- Method was introduced from 2006 IPCC.

MSW : Municipal Solid Waste
ISW : Industrial Solid Waste

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6.B Wastewater

EF : Emission Factor
AD : Activity Data
M : Method

● : Newly introduced
○ : Revised
NE: Not estimated
--- : Not changed

Source categories			emissions in 2006 GgCO2 CO2	CH4	N2O	1st revise 1999-2000 EF	AD	M	2nd revise 2001-2002 EF	AD	M	3rd revise 2005-2006 EF	AD	M	Remarks
6.B.1 Industrial wastewater				103	122	NE	NE	NE	●	●	●	○	---	○	- CH4 emission was estimated in 2nd rev. - N2O emission was added in 3rd rev.
6.B.2 Domestic and commercial wastewater	Sewage treatment plant			250	678	○	---	---	○	○	○	---	---	---	- N2O emission was added in 2nd rev.
	Septic tank	Community plant		2	7	NE	NE	NE	●	●	●	---	---	---	- Method was introduced from domestic research output in 2nd rev.
	Septic tank	*Gappei-shori* septic tank		297	105	NE	NE	NE	●	●	●	---	---	---	- Method was introduced from domestic research output in 2nd rev.
	Septic tank	*Tandoku-shori* septic tank		76	114	NE	NE	NE	●	●	●	---	---	---	- Method was introduced from domestic research output in 2nd rev.
	Vault toilet			57	86	NE	NE	NE	●	●	●	---	---	---	- Method was introduced from domestic research output in 2nd rev.
	Human waste treatment facilities	High-load denitrification		19	0	NE	NE	NE	●	●	●	○	---	---	- N2O EF was revised in 3rd rev.
	Human waste treatment facilities	Membrane separation		0	0	NE	NE	NE	●	●	●	○	---	---	- N2O EF was revised in 3rd rev.
	Human waste treatment facilities	Anaerobic treatment		1	0	NE	NE	NE	●	●	●	---	---	---	- Method was introduced from domestic research output in 2nd rev.
	Human waste treatment facilities	Aerobic treatment		0	6	NE	NE	NE	●	●	●	---	---	---	- Method was introduced from domestic research output in 2nd rev.
	Human waste treatment facilities	Standard denitrification		0	1	NE	NE	NE	●	●	●	---	---	---	- Method was introduced from domestic research output in 2nd rev.
	Human waste treatment facilities	Other		1	0	NE	NE	NE	●	●	●	---	---	---	- Method was introduced from domestic research output in 2nd rev.
	Discharge of untreated domestic wastewater	*Tandoku-shori* septic tank		337	33	NE	NE	NE	NE	NE	NE	●	●	●	- Method was introduced from 2006 IPCC.
	Discharge of untreated domestic wastewater	Vault toilet		256	25	NE	NE	NE	NE	NE	NE	●	●	●	- Method was introduced from 2006 IPCC.
	Discharge of untreated domestic wastewater	Household treatment		5	0	NE	NE	NE	NE	NE	NE	●	●	●	- Method was introduced from 2006 IPCC.
	Human waste Sludge disposal at sea			4	2	NE	NE	NE	NE	NE	NE	●	●	●	- Method was introduced from 2006 IPCC.

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6.C Incineration

EF : Emission Factor
AD : Activity Data
M : Method

● : Newly introduced
○ : Revised
NE: Not estimated
--- : Not changed

Source categories			emissions in 2006 GgCO2 CO2	CH4	N2O	1st revise 1999-2000 EF	AD	M	2nd revise 2001-2002 EF	AD	M	3rd revise 2005-2006 EF	AD	M	Remarks
6.C. Incineration of waste	MSW	Waste plastics	12377	2	104	○	---	---	---	○	---	○	---	---	- AD was revised to new statistics in 2nd rev.
	MSW	Synthetic textile scraps	709	0	0	NE	NE	NE	NE	NE	NE	●	●	●	
	MSW	Other biomass-derived waste		14	653	○	---	---	○	○	---	---	---	---	- AD was revised to new statistics in 2nd rev.
	ISW	Waste oil	5,887	0	7	○	---	---	---	○	---	---	---	---	- AD was revised to new statistics in 2nd rev.
	ISW	Waste plastic	5,092	1	111	○	---	---	---	○	---	---	---	---	- AD was revised to new statistics in 2nd rev.
	ISW	Waste paper and wood		1	17	○	---	---	○	○	---	---	---	---	- AD was revised to new statistics in 2nd rev.
	ISW	Waste textile		0	0	NE	NE	NE	NE	NE	NE	●	●	●	
	ISW	Animal residue		0	1	NE	NE	NE	NE	NE	NE	●	●	●	
	ISW	Sludge		2	1,974	○	---	---	○	○	---	---	---	---	- AD was revised to new statistics in 2nd rev.
	ISW	Hazardous waste	1,865	0	13	NE	NE	NE	NE	NE	NE	●	●	●	
6.C. Incineration of waste derived fuel	MSW	Waste plastics	477	0	0	NE	NE	NE	NE	NE	NE	●	●	●	
	ISW	Waste oil	3,549	1	13	NE	NE	NE	NE	NE	NE	●	●	●	
	ISW	Waste plastic	1,167	3	4	NE	NE	NE	NE	NE	NE	●	●	●	
	ISW	Waste wood		57	10	NE	NE	NE	NE	NE	NE	●	●	●	
	Waste tire		945	1	3	NE	NE	NE	NE	NE	NE	●	●	●	
	Refuse derived fuel	Refuse derived fuel	322	0	2	NE	NE	NE	NE	NE	NE	●	●	●	
	Refuse derived fuel	Refuse plastic and paper fuel	888	0	5	NE	NE	NE	NE	NE	NE	●	●	●	

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6th Workshop on Greenhouse Gas Inventories in Asia

6.D Other

EF : Emission Factor
AD : Activity Data
M : Method

● : Newly introduced
○ : Revised
NE: Not estimated
--- : Not changed

Source categories	emissions in 2006 GgCO2 CO2	CH4	N2O	1st revise 1999-2000 EF	AD	M	2nd revise 2001-2002 EF	AD	M	3rd revise 2005-2006 EF	AD	M	Remarks
6.D Petroleum-derived surfactants discharged into wastewater treatment facilities and nature decompose	521			NE	NE	NE	NE	NE	NE	●	●	●	- EF, AD and Method were developed with domestic experts.

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6th Workshop on Greenhouse Gas Inventories in Asia

Outcome and comment

- **Importance of early and planned improvement of waste sector GHG inventory.**
  - It took long time and considerable effort to make accurate waste sector GHG inventory (Japan spent 7 years).
- **Importance of establishment of statistics that covers all waste material flow.**
  - Japan identified many NE source categories by this new statistics.
- **Importance of practical use of IPCC documents.**
  - Some source categories are difficult to estimate emissions without 2006 IPCC Guidelines.

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Waste inventory in Asia

GHG Emissions from Waste Sector in Asian Countries in 1994

Source : **UNFCCC Non-Annex I national communications**
http://unfccc.int/national_reports/non-annex_i_natcom/items/2979.php

	CO_2 (Gg)		CH_4(Gg)				N_2O(Gg)		
	Industrial Wastewater	Waste Incineration	Solid Waste Disposal	Domestic and Commercial Wastewater	Industrial Wastewater	Waste Incineration	Human Sewage	Industrial Wastewater	Waste Incineration
Cambodia	-	-	6	1	0	-	0	-	-
China	-	-	2,030	1,530	4,160	-	-	-	-
India	-	-	582	359	62	-	7	-	-
Indonesia	-	-	402 1)				-	-	-
Japan	-	26,742	416	86	5	3	4	0	7
Lao P.D.R. 2)	-	-	11	0		-	-	-	-
Malaysia	318 3)	-	1,043	4	220	-	-	-	-
Mongolia	-	-	3	0	0	-	-	-	-
Myanmar	Not Available 4)								
Philippines	-	-	203	46	44	-	3	-	-
Republic of Korea 5)	-	4,756	461	2	2	0	3	-	1
Singapore	-	152	NO 6)	NO 7)		NO	0	-	NO
Thailand	-	-	20	2	14	-	-	-	-
Viet Nam	-	-	66	1	1	-	4	-	-

1) Only the total CH_4 emissions from waste sector are reported.
2) Emissions in 1990
3) The production mechanism of CO_2 from this source is not explained by the party in the National Communication.
4) The Initial National Communication is not yet submitted.
5) Emissions in 2001
6) All organic wastes are incinerated.
7) The biogas produced at the wastewater handling sites is used as fuel and the fugitive CH_4 emissions are negligible.

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Japan's next improvement

- **More accurate waste sector GHG inventory**
  - **Some new problems to be solved before the commitment period were identified in 3rd improvement. Therefore, Japan is planning to revise waste sector inventory in 2008 – 2009.**
    - Statistics that covers all waste material flow constructed for waste sector inventory has some problems regarding accuracy.
    - Domestic research outputs for new EFs and parameters will become available in few years.
    - Some NE source categories may still exist.
  - **Solutions :**
    - New EFs / parameters could be introduced through close relation with experts.
    - Information from waste industry could be useful for some parameters.
    - Constructing waste and carbon flow at every type of waste, the accuracy of statistics may be improved.
    - …

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Information from waste industry

- **Industrial waste treatment association established self action plan for reducing GHG in 2007.**
  - **The association established "12 GHG Reducing Actions".**
  - **The association begins to collect annual information of GHG emissions data and result of GHG reducing actions from each member company. Hopefully, these information will be available at the end of 2008FY.**

- Semi-aerobic landfill rate in ISW
- Rate of high efficiency incinerator
- …

12 GHG Reducing Actions

1. Promotion of 3R
2. Promotion of energy recovery at combustion plant
3. Introduction of high-efficiency incinerator
4. Introduction of semi-aerobic landfill
5. Appropriate management of landfill site
6. Reduction of biomass waste without incineration
7. Forestation / reforestation at landfill site
8. Reduction of fuel consumption at waste transportation
9. Efficient transportation management
10. Introduction of biofuel (bio-ethanol and bio-diesel)
11. Low energy action at office
12. Introduction of high efficiency device at office

About the association

- National Federation of Industrial Waste Management Associations
- There are over 15,000 members of industrial waste treatment companies including landfill, combustion and transportation.
- http://www.zensanpairen.or.jp/

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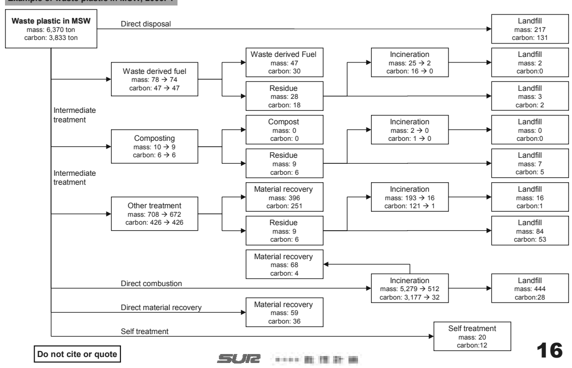
Waste and carbon flow (1)

Example of waste plastic in MSW, 2003FY



Do not cite or quote

16

Waste and carbon flow (2)

- **By constructing waste and carbon flow:**
  - **It could be possible to identify NE source categories in the waste sector / between waste sector and other sectors.**
  - **It could be possible to identify AD that needs further improvement of accuracy.**
  - **It will become easy to explain accuracy, transparency and completeness of waste sector GHG inventory.**

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Thank you for your attention.

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1.0 OBJECTIVES

1. To present the findings of GHG Inventory for the Waste Sector i.e methane emission from the following sources:

   - Waste water from domestic and commercials;
   - ii) Waste water from industries (palm oil mills and natural rubber mills); and
   - Solid waste disposal sites (landfills).

2. To compare GHGs emission load for the year 1994 and 2000 using both IPCCC Guidelines 1995 and 1996

3. To present conclusion of several meetings and workshops held to confirm and verify the data collected in accordance with the IPCCC Guideline 1996.

2. BUDGET

The Project was carried out under the support of the United Nation Development Programme (UNDP) and in-kind contribution by the Malaysian Government.

A sum of RM38,000.00 is allocated for the Project (Waste Sector) and the details expenditure to date is shown below:

Budget Used for GHG Waste Sector Till 30 June 2008
(Amount allocated for the Project is RM 38, 000.00)

Activities	Year 1 2007 (RM)	Year 2 2008 (RM)	Year 3 2009 (RM)	Total (RM)
Preparing National GHG Inventory Procurement of Notebook PC 5 unit of Flash Drives EFT of Waste SWG to Sabah & Sarawak Consultant fee	-	 4, 419.00 250.00 1, 756.20 3, 000.00	-	-
Meeting / Workshop	120.00	14, 597.83	-	-
Final Technical Reports National Communication Procedural Document Draft NC2 Report	-	-	-	-
Second Annual Progress, Financial Report	-	-	-	-
TOTAL:	120.00	24, 023.03	-	24, 143.03

3. METHODOLOGY

1. For the purpose of preparing NC2, Revised IPCC 1996 Guidelines had been used, however other guidelines such as Good Guidance Practice 2000 and 2003 (GPG 2000 &2003), UNFCCC Software and IPCCC 2006 Guidelines were also used as references

2. Based on Decision Article 17/CP.8 of COP (Appendix 1) required non- Annex 1 Parties preparing for their second or third National Communication to use the Revised 1996 Guidelines in estimating and reporting their national GHG inventories.

3. According to the IPCCC Guideline 1996, two types of waste need to be considered, that is **waste water** and **municipal solid waste**. As for the waste water it is divided into two main groups, that is waste water from industries and waste water from domestic as well as commercials. The Sub Working Group (SWG) Waste Sector in their Second meeting on 24th August 2007 decided to focus GHGs inventory only on 2 major industries in the country i.e palm oil mills and raw natural rubber mills which consists of latex concentrate mill and Standard Malaysia Rubber mill (SMR).These industries are being licensed by the Department of Environment (DOE) and thus complete data inventory are available.

This spreadsheet contains sheet 4 of Worksheet 6-3, in accordance with the

Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories.

MODULE	**WASTE**
SUBMODULE	**METHANE EMISSIONS FROM INDUSTRIAL WASTEWATER AND SLUDGE TREATMENT**
WORKSHEET	**6-3**
SHEET	4 OF 4 ESTIMATION OF METHANE EMISSIONS FROM INDUSTRIAL WASTEWATER AND SLUDGE
COUNTRY	Malaysia
YEAR	0

STEP 4					
	A Total Organic Product (kg COD/yr)	B Emission Factor (kg CH_4/kg COD)	C Methane Emissions without Recovery/Flaring	D Methane Recovered and/or Flared (kg CH_4)	E Net Methane Emissions (Gg CH_4)
	Worksheet 6-3, Sheet 1	Worksheets 6-3, Sheets 2 and 3	C = (A x B)		E = (C - D) / 1 000 000
Wastewater	1,436,577,587.50	0.05625	80,807,489.30		80.80749
Sludge	0.00000	0.00625	0.00		0.00
				Total:	80.80749

Note : For Malaysia Yr 2000

Industrial Source : i. Oil & Grease - crude oil palm

Source : Dept. of Statistics, Malaysia : 1975 - 1985

MODULE	WASTE				
SUBMODULE	METHANE EMISSIONS FROM DOMESTIC AND COMMERCIAL WASTEWATER AND SLUDGE TREATMENT				
WORKSHEET	6-2				
SHEET	4 OF 4 ESTIMATION OF METHANE EMISSIONS FROM DOMESTIC/COMMERCIAL WASTEWATER AND SLUDGE				
COUNTRY	Malaysia				
YEAR	0				
STEP 4					
	A Total Organic Product (kg BOD/yr)	B Emission Factor (kg CH_4/kg BOD)	C Methane Emissions Without Recovery/Flaring	D Methane Recovered and/or Flared (kg CH_4)	E Net Methane Emissions (Gg CH_4)
	from Worksheet 6-2, Sheet 1	from Worksheet 6-2, Sheets 2 and 3	C = (A x B)		E = (C - D)/1 000 000
Wastewater	135,721,230.43750	0.01875	2,544,773.07070	0.00	2.54477
Sludge	67,894.56250	0.01405	953.91860	0.00	0.00095
				Total:	2.54573

Note : For Yr 2000

Source : Dept. of Statistics, Malaysia

Indah Water Konsortium Sdn Bhd, Malaysia

This spreadsheet contains sheet 4 of Worksheet 6-3, in accordance with the IPCC 1996 Guidelines

MODULE	WASTE				
SUBMODULE	METHANE EMISSIONS FROM INDUSTRIAL WASTEWATER AND SLUDGE TREATMENT				
WORKSHEET	6-3				
SHEET	4 OF 4 ESTIMATION OF METHANE EMISSIONS FROM INDUSTRIAL WASTEWATER AND SLUDGE (Rubber- Standard Malaysia Rubber)				
COUNTRY	Malaysia				
YEAR	0				
STEP 4					
	A Total Organic Product (kg COD/yr)	B Emission Factor (kg CH_4/kg COD)	C Methane Emissions without Recovery/Flaring	D Methane Recovered and/or Flared (kg CH_4)	E Net Methane Emissions (Gg CH_4)
	Worksheet 6-3, Sheet 1	Worksheets 6-3, Sheets 2 and 3	C = (A x B)		E = (C - D) / 1 000 000
Wastewater	15,852,727.80	0.14625	2,318,461.44075		2.31846
Sludge	6,794,026.20	0.01625	110,402.92575		0.11040
				Total:	2.42886

Note : For Yr 2000

Industrial Source : i. Rubber - Standard Malaysian Rubber

Source : ii. Dept. of Statistics, Malaysia ; and

iii. Malaysia Rubber Board : 1996 - 2006

MODULE	WASTE				
SUBMODULE	METHANE EMISSIONS FROM INDUSTRIAL WASTEWATER TREATMENT				
SOURCE	Oil & Grease (palm oil) & Rubber				
WORKSHEET	6-3				
SHEET	3 OF 4 ESTIMATION OF EMISSION FACTOR FOR SLUDGE HANDLING SYSTEMS				
COUNTRY	0				
YEAR	0				
STEP 2					
A Sludge Handling System	B Fraction of Sludge Treated by the Handling System	C Methane Conversion Factor (MCF)	D Product	E Maximum Methane Producing Capacity (kg CH_4/kg COD)	F Emission Factor for Industrial Sludge Source (kg CH_4/kg COD)
			D = (B x C)		F = (D x E)
Biological	0.1	0.65	0.06500		
	Reference: IPP 96 GL, 90% is wastewater, so, 10% is the sludge. Workbook Moudule 6-Waste, Page 6.19, Table 6-8		0.00		
			0.00		
			0.00		
		Aggregate MCF:	0.06500	0.25	0.01625

Urban Population in Malaysia - By State For Year 2000

State	Total Population	Percentage Urban Population	Total Urban Population
Johor	2,740,625	65.2	1,786,888
Kedah	1,649,756	39.3	648,354
Kelantan	1,313,014	34.2	449,051
Melaka	635,791	67.2	427,252
Negeri Sembilan	859,924	53.4	459,199
Pahang	1,288,376	42	541,118
Perak	2,051,236	58.7	1,204,076
Perlis	204,450	34.3	70,126
Pulau Pinang	1,313,449	80.1	1,052,073
Sabah	2,603,485	48	1,249,673
Sarawak	2,071,506	48.1	996,394
Selangor	4,188,876	87.6	3,669,455
Terengganu	898,825	48.7	437,728
Kuala Lumpur	1,379,310	100	1,379,310
Labuan	76,067	77.7	59,104
Total	**23,274,690**		**14,429,800**

	A Population whose Waste goes to SWDSs (Urban or Total) (persons)	B MSW Generation Rate (kg/capita/day)	C Annual Amount of MSW Generated (Gg MSW)	D Fraction of MSW Disposed to SWDSs (Urban or Total)	E Total Annual MSW Disposed to SWDSs (Gg MSW)
STATE			C = (A x B x 365)/1 000 000		E = (C x D)
JOHOR	1,786,888	1.35	880.48882	1	880.488816
KEDAH	648,354	1.08	255.58119	1	255.581189
KELANTAN	449,051	0.5	81.95177	1	81.951769
MELAKA	427,252	1.2	187.13618	1	187.136180
NEGERI SEMBILAN	459,199	1.2	201.12934	1	201.129344
PAHANG	541,118	0.92	181.70740	1	181.707398
PERAK	1,204,076	0.8	351.59006	1	351.590055
PERLIS	70,126	0.5	12.79806	1	12.798059
PULAU PINANG	1,052,073	0.96	368.64626	1	368.646256
SABAH	1,249,673	0.91	415.07882	1	415.078821
SARAWAK	996,394	0.91	330.95240	1	330.952395
SELANGOR	3,669,455	1.26	1,687.58253	1	1,687.582527
TERENGGANU	437,728	0.86	137.40275	1	137.402749
KUALA LUMPUR	1,379,310	1.57	790.41360	1	790.413596
LABUAN	59,104	0.91	19.63141	1	19.631413
Total/Avg	**14,429,800**	**0.99533**	**5,902.09057**		

MSW Generation Rate based on the National Strategic Plan for Solid Waste Management Aug 2005(Local Government Department, Ministry of Housing and Local Government Malaysia, Volume 2, page 2-17)

STATE							G= (C x D x E x F)	H= (B x G)	J= (H x A)		L= (J - K)		N= (L x M)
JOHOR	880.48882	0.6	0.55	0.9	0.5	16/12	0.33	0.198	174.33679	0	174.33679	1	174.33679
KEDAH	255.58119	0.6	0.55	0.9	0.5	16/12	0.33	0.198	50.60508	0	50.60508	1	50.60508
KELANTAN	81.95177	0.6	0.55	0.9	0.5	16/12	0.33	0.198	16.22645	0	16.22645	1	16.22645
MELAKA	187.13618	0.6	0.55	0.9	0.5	16/12	0.33	0.198	37.05296	0	37.05296	1	37.05296
NEGERI SEMBILAN	201.12934	0.6	0.55	0.9	0.5	16/12	0.33	0.198	39.82361	0	39.82361	1	39.82361
PAHANG	181.70740	0.6	0.55	0.9	0.5	16/12	0.33	0.198	35.97806	0	35.97806	1	35.97806
PERAK	351.59006	0.6	0.55	0.9	0.5	16/12	0.33	0.198	69.61483	0	69.61483	1	69.61483
PERLIS	12.79806	0.6	0.55	0.9	0.5	16/12	0.33	0.198	2.53402	0	2.53402	1	2.53402
PULAU PINANG	368.64626	0.6	0.55	0.9	0.5	16/12	0.33	0.198	72.99196	0	72.99196	1	72.99196
SABAH	415.07882	0.6	0.55	0.9	0.5	16/12	0.33	0.198	82.18561	0	82.18561	1	82.18561
SARAWAK	330.95240	0.6	0.55	0.9	0.5	16/12	0.33	0.198	65.52857	0	65.52857	1	65.52857
SELANGOR	1,687.58253	0.6	0.55	0.9	0.5	16/12	0.33	0.198	334.14134	0	334.14134	1	334.14134
TERENGGANU	137.40275	0.6	0.55	0.9	0.5	16/12	0.33	0.198	27.20574	0	27.20574	1	27.20574
KUALA LUMPUR	790.41360	0.6	0.55	0.9	0.5	16/12	0.33	0.198	156.50189	0	156.50189	1	156.50189
LABUAN	19.63141	0.6	0.55	0.9	0.5	16/12	0.33	0.198	3.88702	0	3.88702	1	3.88702
												Total	**1,168.61393**

4. GAPS AND RECOMMENDATIONS

Several constrains were raised and discussed among the relevant agencies during SWG meetings and the workshops. Among others, four points were highlighted and agreed to be reported in the NC2 for the Waste Sector for Malaysia as follows:

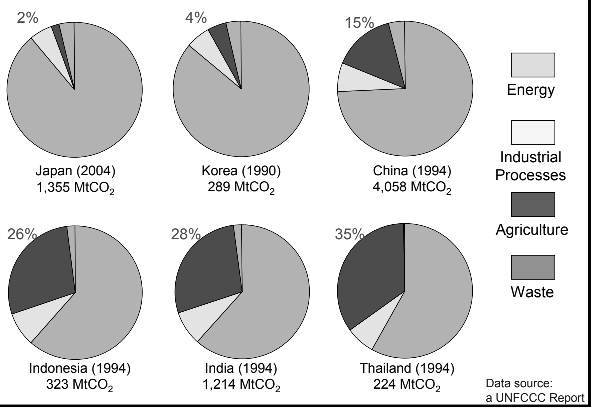
- The Guidelines used;
- Default value used, where in NC2 the SWG for the Waste Sector applied local default values instead of default value given in the IPCCC Guideline;
- Lack of detail data and information; and
- Lack of expertise.

5. CONCLUSION

- By using IPCCC Guideline 1996, as of 30th June 2008, the total amount of CO2 Equivalent of methane gas emission from waste sector was estimated at 26,358.80 Gg in CO2 Equivalent for the year 2000, which had reduced from the total amount of 26, 614.77 Gg in CO2 Equivalent of methane gas emission for the year 1994 as reported in the INC.
- However the grand total GHGs emission load in terms of CO2 Equivalent for waste sector as reported in INC is higher i.e 26,925 Gg due to the fact that in the earlier reporting CO2 emission from waste water of palm oil mills was taken into account.
- The comparison between GHGs emission load for the year 1994 and 2000 using both IPCCC Guidelines 1995 and 1996 are shown below:

Sources	1995 IPCC Guidelines						1996 IPCC Guidelines					
	INC(1994)			NC2(2000)			INC(1994)			NC2(2000)		
	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O	CO_2	CH_4	N_2O
Categories	Gg	Gg	Gg	Gg	Gg	Gg	Gg	Gg	Gg	Gg	Gg	Gg
1 Landfills		1043			1999.72			625.8			1168.61393	
2 Domestic &Commercial Wastewater Treatment		3.5			4.78			1.88			2.54573	
3 Industrial Wastewater Treatment	318	220.87			326.47			60.92			84.02137	
a. Palm Oil		213.5			320			57.4			80.80749	
b. Rubber-Latex		2.64			1.54			1.24			0.78501	
c. Rubber-SMR		4.73			4.93			2.28			2.42886	
Total (Gg)	318	1267.37		478.14	2330.97			688.6			1255.18102	
Global Warming Potential	1	21	290	1	21	290	1	21	310	1	21.00000	310
Total (Gg CO_{2e})	318	26614.77		478.14	48950.37			14460.6			26358.80147	
Grand Total (Gg CO_{2e})	26932.77			49428.51			14460.6			26358.80147		

GHG Inventories in Selected Asian Countries



Monsoon Asia

- **importance of agricultural activities in the area**
- **many common issues about agricultural GHG emissions in the area**
- **many research outputs on agricultural GHG emissions up to the present**
- **also many international cooperative research projects are exist**

GPG2000

Chapter 4: AGRICULTURE

1. CH_4 from domestic animals
2. CH_4 from manure management
3. N_2O from manure management
4. CH_4 & N_2O from savanna burning
5. CH_4 & N_2O from ag. residue burning
6. DIRECT N_2O from ag. Soils
7. INDIRECT N_2O from N in ag.
8. CH_4 from rice production

Revised 2006 IPCC Guidelines

Volume 1: Cross-Cutting Issues and Reporting Tables
分野横断的問題と報告表

Volume 2: Energy
エネルギー

Volume 3: Industrial Processes and Product Use
工業過程と生産物の使用

Volume 4: Agriculture, Forestry and Other Land Use (AFOLU)
農林業とその他の土地利用

Volume 5: Waste
廃棄物

IPCC- GLs2006

Volume 4: AFOLU

Key points of the revision

- Integration of previous reports
  - ► GLs1996 + GPG2000 + GPG-LULUCF
- 'Agriculture' + 'LULUCF' ← Obligation to reports soil C changes
- Being based on landuse and its change ← To calculate for all the landuses
  - ►xxxland remaining xxxland
  - ►xxxland converted to yyyland
- Revisions of some EFs
  - ►CH_4 from rice: 130 mg m^{-2} day^{-1}
  - ►Direct N_2O from fertilizer: 1.0% (0.3% for flooded rice)
- Updating of methodologies that make possible to evaluate mitigation options

WGIA6 Group 3: Agriculture

Suggested topics from secretariat

- Strategies to improve reliability of data (EF & AD)
- Current status and challenges in inventory
- Possible sources of new EF (& AD) application to Asian countries

WGIA6 Group 3: Agriculture

Major items for discussion

- Data (EF & AD) for animal sources (CH_4 & N_2O)
- Data (EF & AD) for soil sources (CH_4 & N_2O)
- Soil C issue
- Networking and collaboration in Asia

WGIA6 Group 3: Agriculture

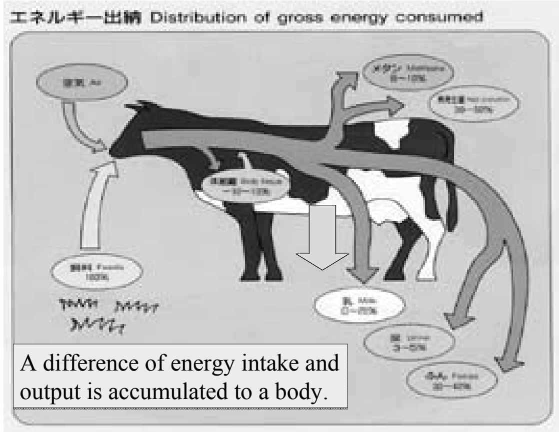
Expected items to report on Day 3

- Issues identifies and possible solutions
- Recommendation on activities to be carried out within the WGIA framework
  - What to be done by WGIA7
  - What to be done in the long term

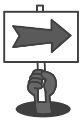
Measurement method of GHG emission from ruminants and manure management

Osamu ENISHI
Takashi OSADA

National Institute of Livestock and Grassland Science
Livestock Research Team on Global Warming



1. **Measurement method of methane emission from ruminants .**
2. Calculation method of methane emission from ruminant in Japan.

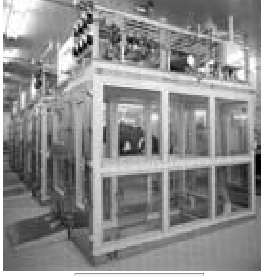


Many current inventories for enteric methane production are based on measurements of emission rates from ruminants in several methods.

Several methods are
1. Open circuit respiration chamber
2. Gas mask method
3. SF_6 method
4. *In vitro* method

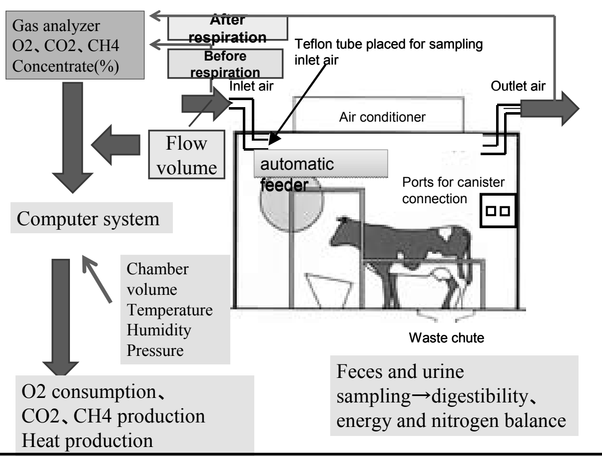
Many current inventories for enteric CH_4 production are based on measurements of emission rates from animals in **open circuit respiration chamber** in strictly controlled environments.

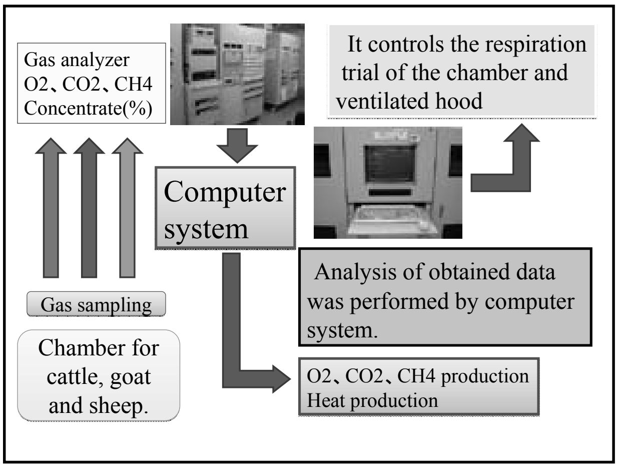
Open circuit respiration apparatus



For cattle

For goat and sheep





Method for Estimation Current Methane Emission

Methane emissions from livestock in Japan are estimated by:

1)Dividing animals into animal group and collecting population data

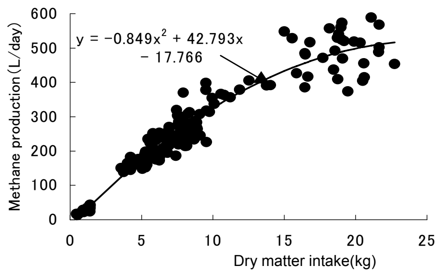
2)Collecting dry matter intake of each animal group

3)Estimate methane emission by Shibata's equation (Methane production(L/day) = -0.849×DMI² + 42.793×DMI- 17.766) DMI:Dry matter intake(kg/day)

4) Multiplying the population by estimate methane emission for each animal group

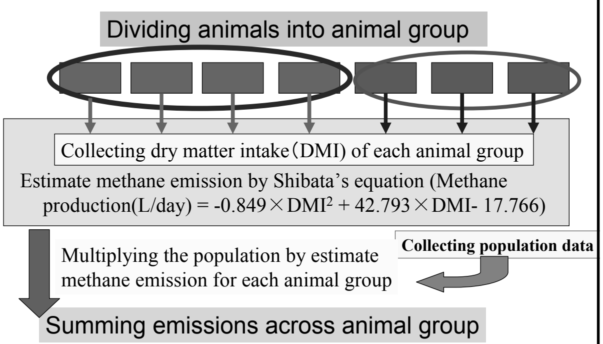
5)Summing emissions across animal group

Prediction of methane emission from enteric fermentation in Japan



Shibata et al. (1993)

Method for Estimation Current Methane Emission



For next step

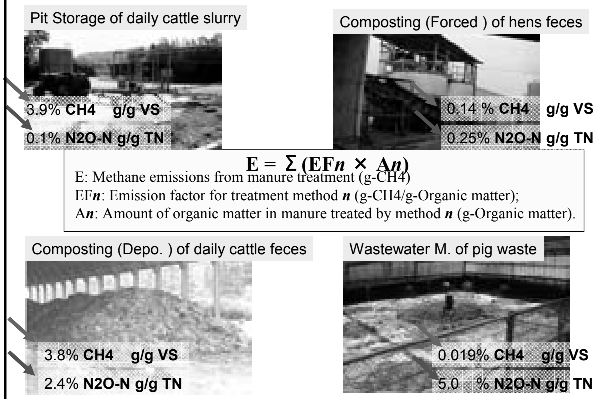
1. **It is important to develop the technology needed to estimate CH4 emission accurately from ruminant and practically method to reduce the amounts of CH4.**
2. **Evaluation and a prediction of global warming impact on animal production.**

GHG emission from Manure management

Manure is a source of organic fertilizer and unfortunately, a source of CH4 and N2O emission. Unsuitable management will offset the validity of resource circulation by an environmental impact called greenhouse-gases generating.

Measurement systems are important for the development of regulation technology.
Not only that, It is useful also for your judgment which technology should be introduced for this issue resolution into your country.

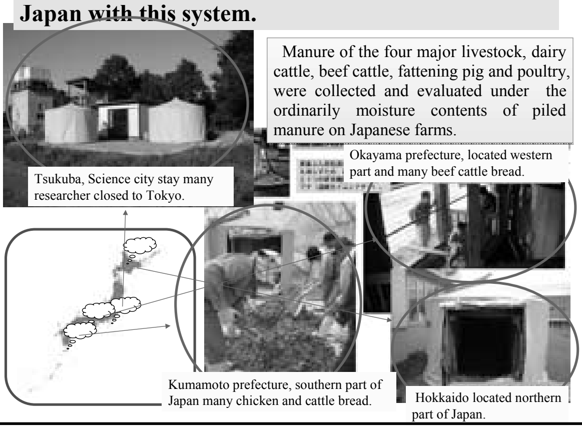
GHG measurement systems for manure treatment



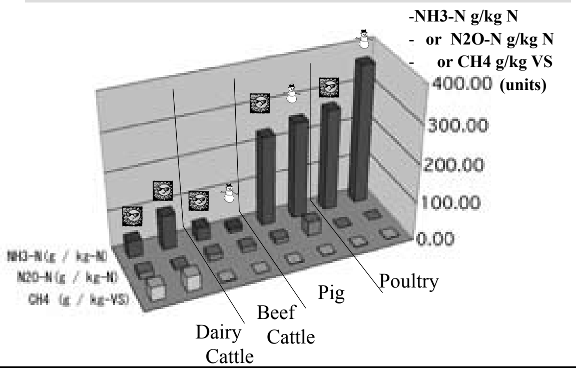
$$E = \Sigma (EF_n \times A_n)$$

E: Methane emissions from manure treatment (g-CH4)
EF*n*: Emission factor for treatment method *n* (g-CH4/g-Organic matter);
A*n*: Amount of organic matter in manure treated by method *n* (g-Organic matter).

we are going to measure GHG at several location of Japan with this system.



NH_3,N_2O and CH_4 emission during composting of each livestock manure -result-



Conclusion of manure management

We developed a system for the quantitative measurement of emissions from composting using a large dynamic chamber in an experiment.

Not only the compost, but the emission factor of each treatment system should be evaluated under each countries procedure and general conditions, because those factors might be widely varied.

It is important that each country has the measurement technique of GHG emission, not only for inventory data but for the development of greenhouse gas regulations and technologies. (Country-specific emission factor, please)

CH_4 and N_2O from rice paddies in 2006 IPCC GLs & Estimate of Japanese country specific N_2O emission factors

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†National Institute for Agro-Environmental Sciences, Japan
*Frontier Research Center for Global Change
Current address: Nanjing Institute for Soil Science, China

1. CH_4 from rice paddies in 2006 IPCC GLs

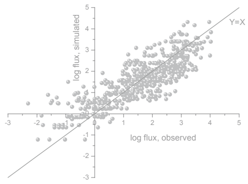
A database of methane emission from rice field

Collected over 800 field measurement data

A statistical model

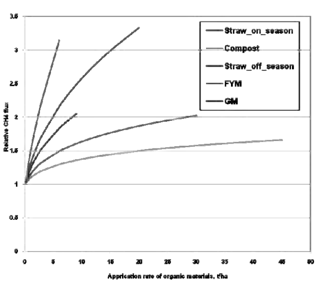
$$Ln(flux) = Intercept + a \times \ln(OC) + pH_m + PW_i + Water_j + Climate_k + OM_l \times \ln(1 + AOM)$$

- Soil properties: soil pH, SOC
- Preseason water: flooded, short drainage, long drainage
- Rice season water: continuous flooding, single drainage, multiple drainage
- Organic amendment: rice straw, rice straw off season, green manure, farm yard manure, compost
- Climate



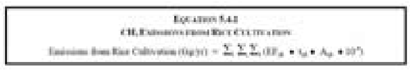
Statistical results: Effects of major influencing factors

Organic amendment

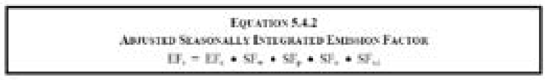


2006 IPCC Guidelines for National Greenhouse Gas Inventories

5.4 CH4 EMISSIONS FROM RICE CULTIVATION



i, j, and k: different ecosystems, water regimes, organic amendments, etc.



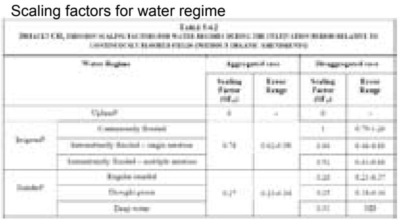
Default baseline emission

kg CH4 ha-1 day-1

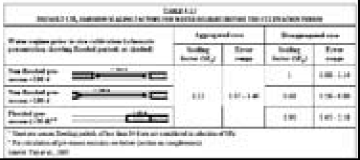
2006 IPCC Guidelines for National Greenhouse Gas Inventories

5.4 CH4 EMISSIONS FROM RICE CULTIVATION

Scaling factors for water regime



Scaling factors for preseason water regime



2006 IPCC Guidelines for National Greenhouse Gas Inventories

5.4 CH4 EMISSIONS FROM RICE CULTIVATION

Scaling factor for organic amendments

EQUATION 5.3
ADJUSTED CH_4 EMISSION SCALING FACTORS FOR ORGANIC AMENDMENTS

$$SF_o = \left(1 + \sum_i ROA_i \cdot CFOA_i\right)^{0.59}$$

TABLE 5.14
DEFAULT CONVERSION FACTOR FOR DIFFERENT TYPES OF ORGANIC AMENDMENT

Organic amendment	Conversion factor (CFOA)	Error range
Straw incorporated shortly (<30 days) before cultivation[a]	1	0.97 - 1.04
Straw incorporated long (>30 days) before cultivation[a]	0.29	0.20 - 0.40
Compost	0.05	0.01 - 0.08
Farm yard manure	0.14	0.07 - 0.20
Green manure	0.50	0.30 - 0.60

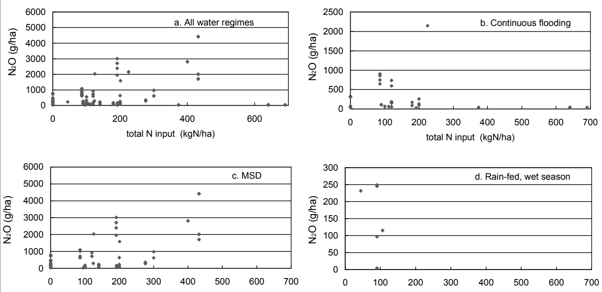
[a] Straw application means that straw is incorporated into the soil, it does not include case that straw just placed on the soil surface, nor that straw was burnt on the field.
Source: Yan et al., 2005

2. N_2O from rice paddy fields in 2006 IPCC GLs

Materials & Methods:

- Collected results of N_2O emission from rice fields published in peer-reviewed journals before 2004
- After excluding some extreme data (e.g., atypical field management), 113 measurements from 17 sites were used.
  - China (8 sites), India (1 site), Indonesia (1 site), Japan (4 sites), Philippines (2 sites), USA (1 site)

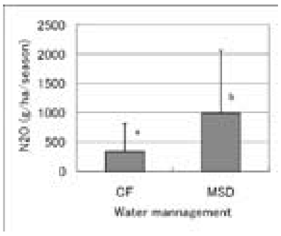
- *Classification of water regime*
  - Continuous flooding (CF)
    - Fields flooded whole rice growing season and drained only at the end of the season.
  - Midseason drainage (MSD)
    - Fields drained one or more times during the rice-cropping season. (Common practice in Japan)
  - Rain-fed, wet season (RF)
    - Fields with no irrigation system and planted during wet season.



Relationships between total N input and N_2O emission during the growing season.

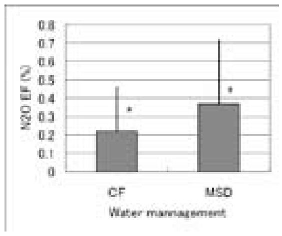
- N_2O emission : CF < MSD
- All water regime & CF : No clear relationship
- MSD : a weak linear relationship (r^2 = 0.28, P < 0.01)

Mean N_2O emission from fertilized fields during cropping season



N_2O emission：MSD ＞ CF

Mean EF during cropping season



•No significant difference between CF and MSD
•Mean EF = 0.31 %

The IPCC default emission factors for N_2O from agricultural soil (IPCC, 2006)

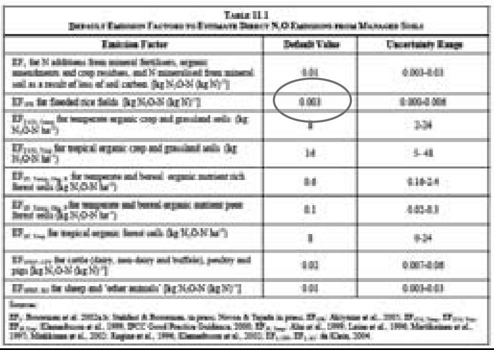


Table 11.1
Default Emission Factors to Estimate Direct N_2O Emissions from Managed Soils

Emission Factor	Default Value	Uncertainty Range
EF_1 for N additions from mineral fertilisers, organic amendments and crop residues, and N mineralised from mineral soil as a result of loss of soil carbon [kg N_2O-N (kg N)$^{-1}$]	0.01	0.003-0.03
EF_{1FR} for flooded rice fields [kg N_2O-N (kg N)$^{-1}$]	0.003	0.000-0.006
$EF_{2CG,Temp}$ for temperate organic crop and grassland soils (kg N_2O-N ha^{-1})	8	2-24
$EF_{2CG,Trop}$ for tropical organic crop and grassland soils (kg N_2O-N ha^{-1})	16	5-48
$EF_{2F,Temp,Org,R}$ for temperate and boreal organic nutrient rich forest soils (kg N_2O-N ha^{-1})	0.6	0.16-2.4
$EF_{2F,Temp,Org,P}$ for temperate and boreal organic nutrient poor forest soils (kg N_2O-N ha^{-1})	0.1	0.02-0.3
$EF_{2F,Trop}$ for tropical organic forest soils (kg N_2O-N ha^{-1})	8	0-24
$EF_{3PRP,CPP}$ for cattle (dairy, non-dairy and buffalo), poultry and pigs [kg N_2O-N (kg N)$^{-1}$]	0.02	0.007-0.06
$EF_{3PRP,SO}$ for sheep and 'other animals' [kg N_2O-N (kg N)$^{-1}$]	0.01	0.003-0.03

Sources: [illegible]

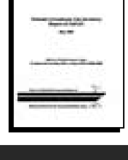
3. Estimate of country specific N_2O emission factors from agricultural soils in Japan

Before revision: The National Greenhouse Gas Inventory Report of Japan (2005)

Table 6-19 Nitrous oxide emission factors, by type of crop

Type of crop	Emission Factors [kgN_2O-N/kgN]
Vegetables	0.00773
Rice	0.00673
Fruit	0.0069
Tea	0.0474
Potatoes	0.0201
Pulse	0.0073
Feed crops	0.006
Sweet potato	0.00727
Wheat	0.00486
Buckwheat	0.0073
Mulberries	0.0073
Industrial crops	0.0073
Tobacco	0.0073

Source: Haruo Tsuruta, *Establishment of GHGs reduction model*, Incorporated foundation, Society for the Study of Agricultural Technology, *A Report on an Investigation of how to quantify the amount of Greenhouse Gases Emissions reduced in 2000F.Y.*



•Tier 2:
country specific EFs
: 13 different EFs
by crop type
based on a report by
Tsuruta (2001)

Advantages and disadvantages of the EFs in the *National GHGs Inventory Report of Japan* (2005)

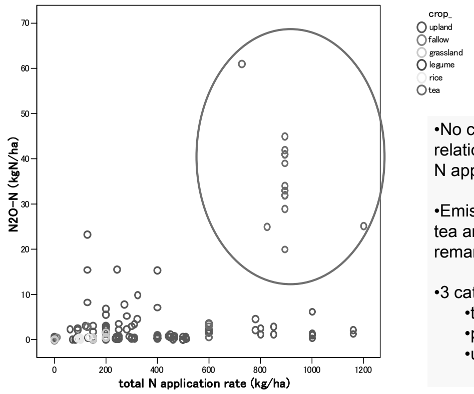
- Advantage:
  - based on the most extensive measurement campaign of N_2O emissions from Japanese agricultural fields conducted from 1992 to 1994.
- Disadvantages:
  - (1) background emission is included in EFs, because of lack of data at that point.
  - (2) Measurement periods were not sufficient to estimate annual emissions — 3 months in many cases, but less than 2 months in some cases.

And also…
Small number of data were

Need for Revision

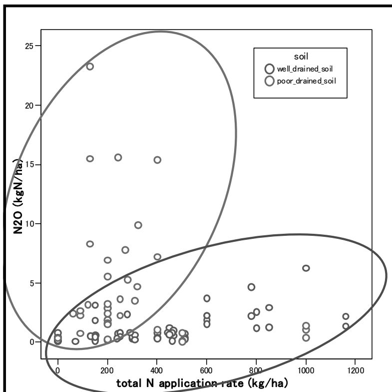
Collected data

- N_2O emissions from Japanese agricultural fields
  - 246 measurements from 36 sites
  - reported in peer-reviewed journals and research reports, published before 2005.



- No clear relationship with N application rate
- Emissions from tea are remarkably high
- 3 categories:
  - tea
  - paddy rice
  - upland

Relationship between N inputs and N_2O emissions from different crop types



upland

- Soil drainage classes were categorized from soil types
- Poorly drained soil > well-drained soil
- No clear relationship for poorly drained soil
- Well-drained soil: R^2= 0.38

Relationship between N inputs and N_2O emissions from <u>upland fields</u> with <u>different soil drainage type</u> (measurement period more than 90 days)

Table
Summary of N2O-N emission and fertilizer induced N2O-N emission factor from Japanese upland field (except tea filed)
<u>measurement period more than 90 days</u>

soil drainage #	n	mean	standard deviation	median	min	max
<u>N2O-N emission (kgN ha-1)</u>						
well drained soil	67	1.03 a**	1.14	0.61	0.09	6.28
poorly drained soil	35	4.78 b	5.36	2.88	0.07	23.3
<u>Fertilizer induced N2O-N emission factor (%)</u>						
well drained soil	15	0.32 a**	0.49	0.16	0.07	2.02
poorly drained soil	9	1.40 b	0.95	1.26	0.57	3.30
estimated emission factor for all soil		0.62 $	0.48 $$			

☻ poorly drained soil ＞ well-drained soil
☻ EF for upland = 0.62 ± 0.48 % <u>(weighted by area of soil type)</u>
☻ measurement period: <u>more than 90 days</u>
assuming that most of the fertilizer-induced N2O emission should be included in this period, because data availability

Table
Summary of N2O-N emission (kg ha-1) and
Fertilizer induced N2O-N emission factor (%) from Japanese tea fields

	n	mean	standard deviation	median	min	max
<u>N2O-N emission (kgN ha-1)</u>						
	26	24.3	16.3	27.11	2.39	61.0
<u>Estimated fertilizer induced emission factor (%) $</u>						
	26	2.82	1.80	3.02	0.35	8.25

☻ background emission was assumed as same as IPCC default value (1kg ha-1),
because no reliable data from zero-N control plot was available.
☻ Measurement period: <u>210 to 365 days</u>

Summary of estimated EF for Japanese Agricultural soil

- Upland = 0.62 ± 0.48 %
  - lower than the IPCC default EF of 1%.
  - lower than the EF of 0.8% by FAO/IFA (2001).
    - poorly drained soils are mainly used for rice paddy fields in Japan.
    - Ratio of well-drained soil among upland field is relatively high (78%) in Japan.
- Tea = 2.82 ± 1.82 %
- Rice paddy = 0.31 ± 0.31 %
  - *estimated from N2O emission data of rice paddy fields worldwide (Akiyama et al., 2005; IPCC, 2006)

4. Issues related to compiling GHG database for inventory work

~ estimate EF from papers with field measurement data

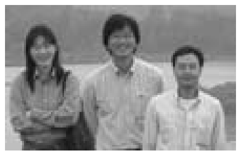
Missing information

- Lack of basic information in many papers
  - soil type, soil property, type and amount of chemical and organic fertilizer, etc
  - impossible to calculate total emission
    - Only average flux is shown, but measurement period is not stated.
    - Only emission from fertilizer applied area of band application is shown, but not emission from entire field.

How to get representative data

- Each paper have its own objective, not for GHG inventory
  - Few measurement include zero N control, which is needed to calculate fertilizer induced emission factor
  - Measurement periods of many experiment are not enough to estimate annual emission
- Danger of Bias : location, crop, soil type, etc
  - Each field measurement are planned individually, Not systematically designed for inventory
  - Small number of data is easily to be biased – get enough number of data to represent your country, otherwise default EF is better than country specific EF!

Thank you!



NC2 – GHG Inventory

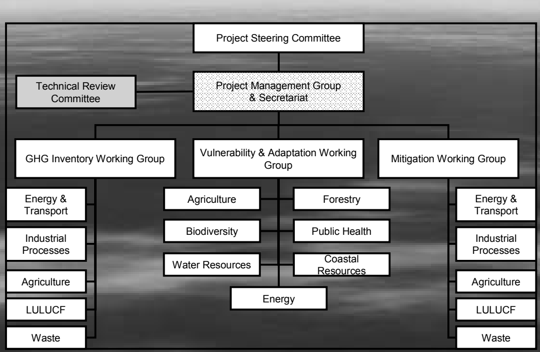
Malaysia

WGIA6 – Tsukuba, Japan 16-18 July 2008

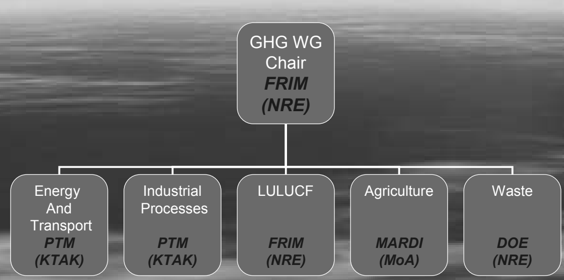
Presentation Outline

- ✓ NC2 Operational Framework
- ✓ GHG Inventory WG
- ✓ NC2 Inventory Status
- ✓ NC2 Constraints and Gaps
- ✓ NC2 Agriculture Inventory
- ✓ Agriculture - Constraints and Gaps
- ✓ Agriculture - Activity Data and Assumptions
- ✓ Agriculture Inventory
- ✓ INC and NC2

NC2 Operational Framework



GHG Inventory WG



PTM - Pusat Tenaga Malaysia
FRIM - Forest Research Institute of Malaysia
MARDI - Malaysian Agriculture Research and Development Institute
DOE - Department of Environment
NRE - Ministry of Natural Resources and Environment
KTAK - Ministry of Energy, Water and Communications
MoA - Ministry of Agriculture and Agro-based Industry

NC2 – Inventory Status

Sectors	Status	CO_2 Equivalent (Gg)	
		Emissions	Removal
Energy	Finalised	155,588	
Industrial Processes	Finalised	20,365	
Agriculture	Finalising	5,906	
Land Use Change and Forestry	Finalised		386,566
Waste	Finalising	23,417	
Total (emission only)		205,276	
Net Total			181,290

INC - Level Assessment

Level Assessment Results	Current Year Estimate (Gg CO_2 Eq.)	Level Assessment (%)	Cumulative (%)
Landfills	21,375	22.8	22.8
Transportation	18,083	22.3	45.1
Industrial	12,453	18.8	63.9
Fugitive emission- O&G	12,453	13.0	76.9
Flooded rice fields	3,014	5.5	82.4
Cement production	2,790	5.2	87.6
Wastewater-Industrial	1,296	4.8	92.4
Residential & commercial	882	3.1	95.5

NC2 - Level Assessment

Level Assessment Results	Current Year Estimate (Gg CO_2 Eq.)	Level Assessment (%)	Cumulative (%)
Energy industries	37,126	18.9	18.7
Transport	35,587	17.9	36.6
Fugitive emission –CH4 (oil &gas)	28,329	14.3	50.8
Manufacturing & construction	28,329	12.2	63.0
Solid waste disposal	21,122	10.6	73.6
Transformation & military	18,018	9.1	82.7
Mineral products	9,671	4.9	87.9
Metal production	6,392	3.0	90.8
Energy Residential and Commercial	3,947	2.0	92.8
Chemical products	2,340	1.0	93.9
Rice cultivation	1,861	0.9	94.9
Industrial wastewater	1761	0.9	95.7

NC2 - Constraints and Gaps … 1

Gaps and Constraints	Description	Potential Measures for improvement
1. Data Organisation	• Mismatch in sectoral detail across different published documents • Inconsistency in top-down and bottom-up data sets for same activities • Data scattered in many agencies	• Design consistent reporting formats • Design consistent reporting formats • Database for reporting the raw data according to IPCC requirements
2. Non-availability of relevant data	Data for refining inventory to higher tier levels	Data depths to be improved, some requires data surveys
3. Non-accessibility of data	• Lack of institutional arrangements for data sharing – time consuming to compile data • Time delays in data access • Proprietary data for inventory reporting at Tier II and Tier III level	• Establish protocols and establish effective networking with data providers • Awareness generation • Involve industry and monitoring institutions

NC2 - Constraints and Gaps … 2

Gaps and Constraints	Description	Potential Measures for improvement
4. Technical and institutional capacity needs	Training the activity data generating institutions in GHG inventory methodologies and data formats	Arrange extensive training programs
5. Non-representative emission factor/coefficients	Inadequate data for representative emission measurements in the sectors	Conduct measurement for key categories and develop local EF
6. Resources to sustain national communication effort	Sustain and enhance research networks established under Initial and second National Communications	Regular Updates are required to ensure sustainability of GHG Inventory
7. Continuity of expertise	Those involved in inventory and NC works are at retirement age. Further NC works will be affected	Planned and encouraged involvement of junior and new officers in NC works

NC2: Agriculture Inventory

GHG Sources:

- ✓ *Domestic Livestock*
- ✓ *Flooded Rice Cultivation*
- ✓ *Field Burning of Agricultural Residues*
- ✓ *Agricultural Soils*
- × *Prescribed Burning of Savannas*

Revised 1996 IPCC Guidelines

NC2: Agriculture Inventory

Sources of Activity Data:

- ✓ *Ministry of Agriculture*
- ✓ *Department of statistics*
- ✓ *FAO Database*
- ✓ *Local Experts*
- ✓ *Workshops*

Revised 1996 IPCC Guidelines

Agriculture - Constraints and Gaps

Sectors	Description	Potential Measures for improvement
1. Domestic Livestock	• Non uniform of available data eg: cattle / beef cattle / dairy cattle • Non-availability of relevant data eg: AWMS • Local EF	• Extrapolation • Workshops and local experts • IPCC default values
2. Flooded Rice	• Data not in the form required by IPCC guideline eg: water regimes • Local EF	• Workshops and local expert • IPCC default values and local study
3. Burning of Agriculture Residues	• Lack of available data eg: burning of rice straw / season / irrigation status	• Workshops and local experts
4. Agriculture Soils	• Lack of local data available	• FAO statistics

NC2: Agriculture Inventory

1. Domestic Livestock - Data

Livestock	1999	2000	2001	2000's
Buffaloes	149,554	142,042	140,000	143,862
Non-dairy cattle	679,170	697,197	705,062	693,810
Dairy cattle	35,746	36,695	37,109	36,516
Sheep	151,537	15,7070	129,108	145,905
Goats	237,680	237,634	247,338	240,884
Horses	4,500	4,000	3,900	4,133
Swine	1,954,940	1,807,590	1,972,530	1,911,687
Poultry	121,000,000	123,650,000	149,586,000	131,412,000

Source: FAOSTAT 2007

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NC2: Agriculture Inventory

1. Domestic Livestock – Notes & Assumptions

1. *6% of the total poultry is "ayam kampung" (based on Semenanjung JPH statistics)*
2. *Dairy cattle derived as 5% of total cattle (based on Semenanjung JPH statistics)*
3. *Manure management (AWMS) based on following assumptions (%): (Expert estimate)*

Animal	Anaerobic Lagoon	Liquid System	Daily spread	Solid Storage and Drylot	Pasture Range and Paddock	Used Fuel	Other System
Non-dairy Cattle (%)	30 (0)	0 (0)	0 (16)	30 (14)	40 (29)	0 (40)	0 (0)
Dairy Cattle (%)	30 (6)	0 (4)	0 (21)	40 (0)	30 (24)	0 (46)	0 (0)
Poultry (%)	0 (1)	0 (2)	0 (0)	95 (0)	5 (44)	0 (1)	0 (52)
Sheep (%)	0 (0)	0 (0)	0 (0)	50 (0)	50 (83)	0 (0)	0 (17)
Swine (%)	95 (1)	0 (38)	0 (1)	5 (53)	0 (0)	0 (7)	0 (0)

Revised 1996 IPCC Guidelines (*) IPCC Defaults

NC2: Agriculture Inventory

1. Rice Cultivation – Hectareage Data

Area \ Year	1999	2000	2001	2000's
Granary	394076	391012	375116	386,735
Non granary	214796	223790	221186	219,924
Upland	83517	83900	77332	81,583
Total	692389	698702	673634	688,242

Source: Paddy Statistics of Malaysia 2002, DOA

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NC2: Agriculture Inventory

2. Rice Cultivation – Notes & Assumptions

1. *Non granary area include rainfed and small scale irrigation schemes*
2. *All rice in granary areas under continuous flooding*
3. *Non granary areas are under continuous flooding (40%), subjected to flooding (30%) and drought (30%)*
4. *No organic amendment added to rice field*
5. *Thailand emission factor (EF) was used for flooded rice methane emission*

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NC2: Agriculture Inventory

Scaling Factors For Methane Emissions

Category	Sub-Category			Scaling Factors	Hectareage
Upland	None			0	81,583
Lowland	Irrigated	Continuously flooded		1	386,735
		Intermittently flooded	Single aeration	0.5 (0.2-0.7)	
			Multiple aeration	0.2 (0.1-0.3)	
	Rainfed	Continuously flooded		1	87,970
		Flood prone		0.8 (0.5-1.0)	65,977
		Drought prone		0.4 (0-0.5)	65,977
	Deep water	Water depth 50-100 cm		0.8 (0.6-1.0)	
		Water depth > 100 cm		0.6 (0.5-0.8)	

Revised 1996 IPCC Guidelines **Total Lowland 606,659**

NC2: Agriculture Inventory

3. Field Burning of Agriculture Residues - Data

Rice Production (Metric tonnes)

Year	1999	2000	2001	2000's
Granary	1,456,505	1,465,735	1,437,659	1,453,300
Non granary	521,538	610,520	596,561	576,206
Upland	58,598	64,649	60,775	61,341
Total	2,036,641	2,140,904	2,094,995	2,090,847

Source: Paddy Statistics of Malaysia 2002, DOA

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NC2: Agriculture Inventory

3. Field Burning of Agriculture Residues Notes & Assumptions:

1. *Amount of rice straw is derived through rice yield and harvest index* *(IPCC default)*
2. *No rice straws are burned in upland area* *(Expert estimate)*
3. *An average of 20% and 10% of straw are burned in granary and rainfed non-granary area respectively.* *(Expert estimate)*

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NC2: Agriculture Inventory

4. Agriculture Soils - Data

N Fertilizer Consumption (tonnes)

Fertilizer \ Year	1999	2000	2001	2000's
Ammonium Nitrate	52200	55600	5000	52600
Ammonium Phosphate	**9700**	**5800**	**6100**	**7200**
Ammonium Sulphate	116100	104000	10000	106700
Urea	**94800**	**134000**	**134000**	**120933**
Other Complex Fert (N)	69800	39000	35000	47933
Other Nitrogenous Fert	**19800**	**10188**	**6817**	**12268**
Total (Nitrogenous Fert)	*362,400*	*348,588*	*331,917*	***1,311,870***
Cultivation on Histosol (Ha)				
Pineapples	*4053*	*3636*	*4267*	***3,985***

Source: FAOSTAT 2007

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NC2: Agriculture Inventory

4. Agriculture Soils – N Fertilizers

Fertilizers	N Content (%)
Ammonium Nitrate	*33*
Ammonium Phosphate	***20***
Ammonium Sulphate	*20.6*
Urea	***46***
Other complex N Fertilizers	*15**
Other nitrogenous fertilizers	***15****

* Estimated

Source: FAOSTAT 2007

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NC2: Agriculture Inventory

4. Agriculture Soils – Notes & Assumptions

1. *Complex N and other N fertilizers contains 15% N* *(Expert estimate)*
2. *50% of the pineapples been planted on histosol (peat) soil <20 years* *(Expert estimate)*

Source: FAOSTAT 2007

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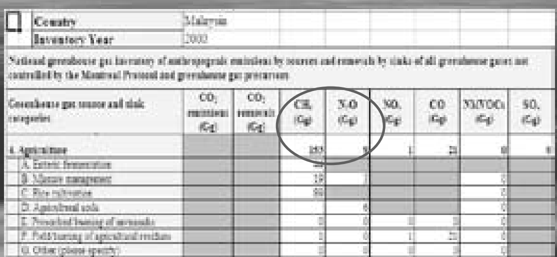
NC2: GHG - Agriculture Inventory

Agriculture Inventory (Ver. 4)



Source: IPCC Worksheet Module 4

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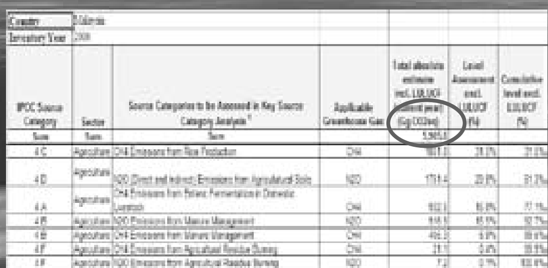
NC2: GHG - Agriculture Inventory

Inventory – CO_2 Equivalents (Ver. 2)



Source: IPCC Worksheet Module 4

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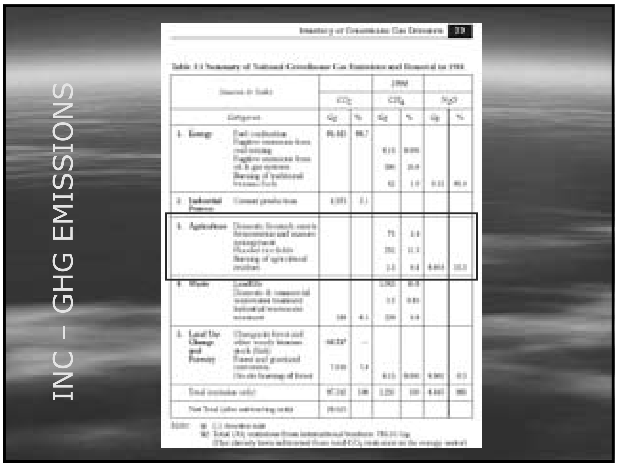
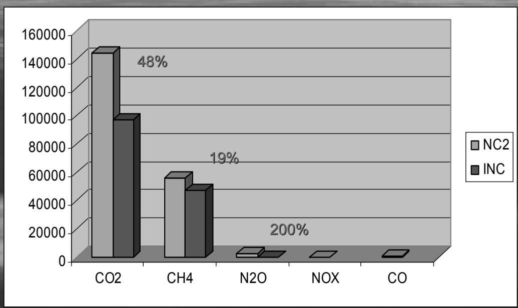


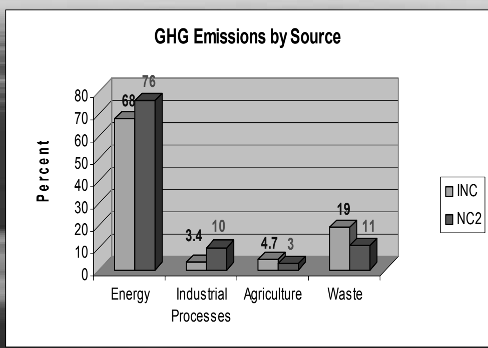
INC and NC2 Draft Inventory (Gg)

GHG	INC	NC2 (Ver.2)
CH_4	329.3	153
Enteric Fermentation	*75*	*44*
Manure Management		*19*
Rice Cultivation	*252*	*89*
Field Burning	*2.3*	*1*
N_2O	0.054	9
Manure Management	*-*	*3*
Agriculture Soils	*-*	*6*
Field Burning	*0.054*	*0*
NO_x	-	1
Field Burning		*1*
CO	-	21
Field Burning		*21*
CO_2 Equivalents	***6,932.0***	***5,906***

GHG Emissions – by Gas



GHG Emissions – by Sector

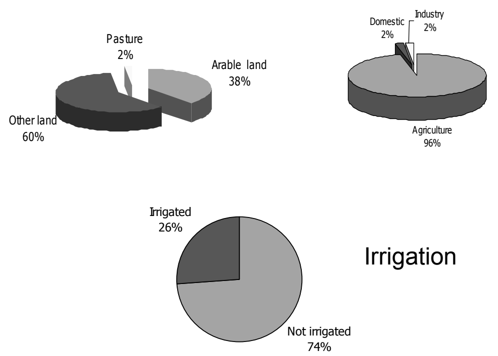


Thank You

Thailand Greenhouse Gas Inventory in Agricultural Sector

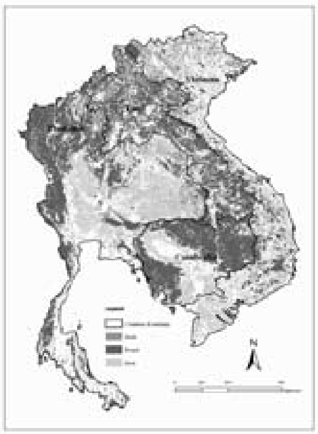
Amnat Chidthaisong
Joint Graduate School of Energy and Environment

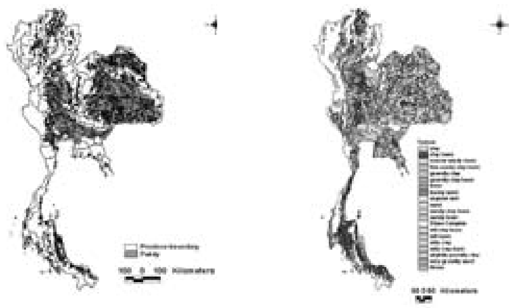
Land use 2000 | Water use 2000



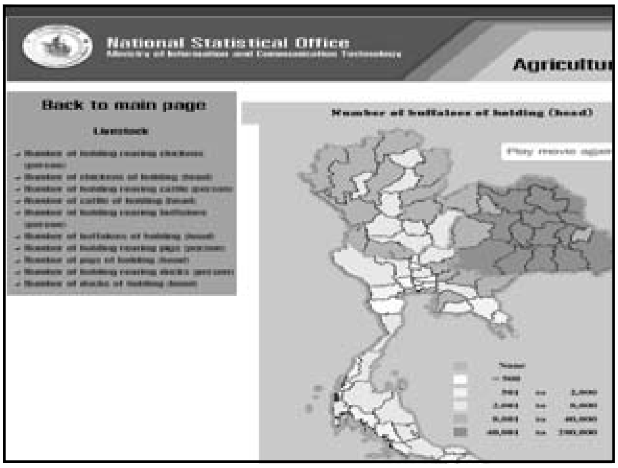
Irrigation

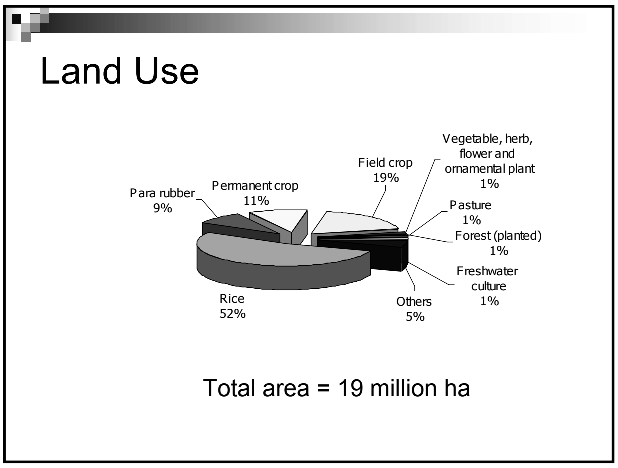
Land use

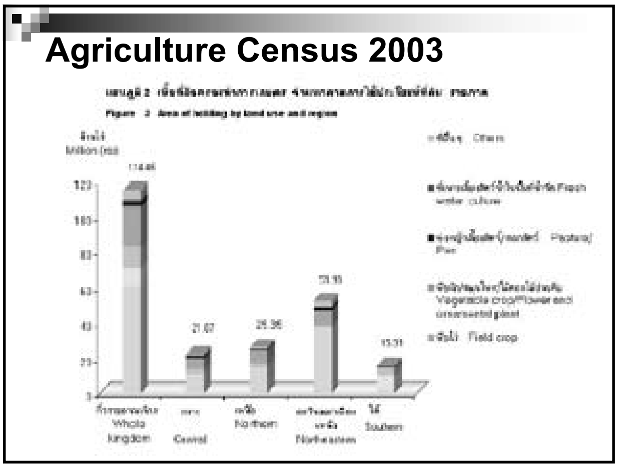


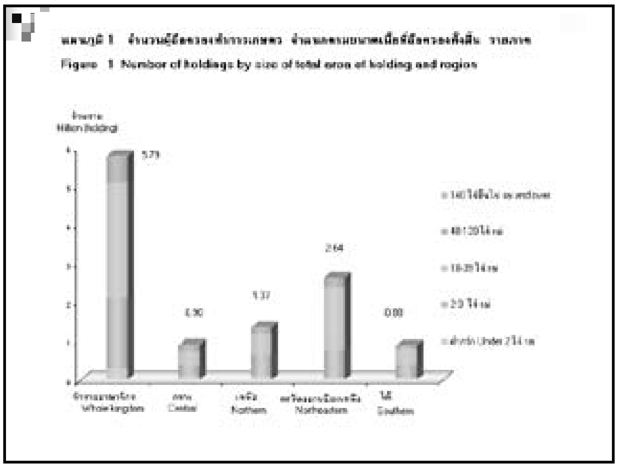


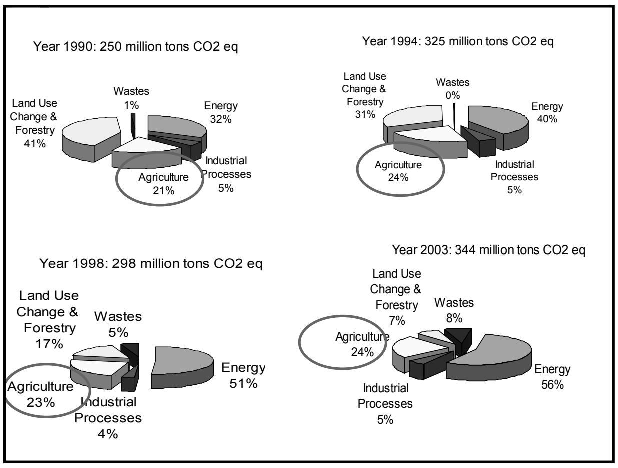
Towprayoon et al. 2005

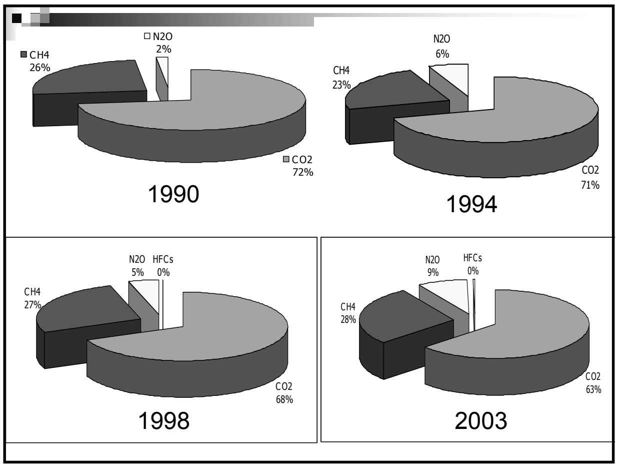


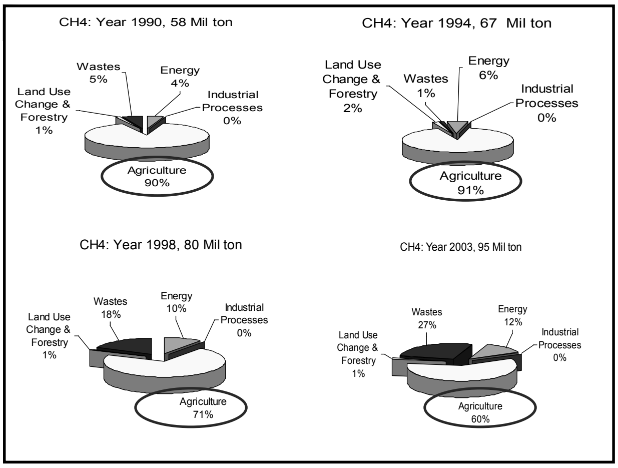

Land Use
Para rubber 9%
Permanent crop 11%
Field crop 19%
Vegetable, herb, flower and ornamental plant 1%
Pasture 1%
Forest (planted) 1%
Freshwater culture 1%
Others 5%
Rice 52%
Total area = 19 million ha

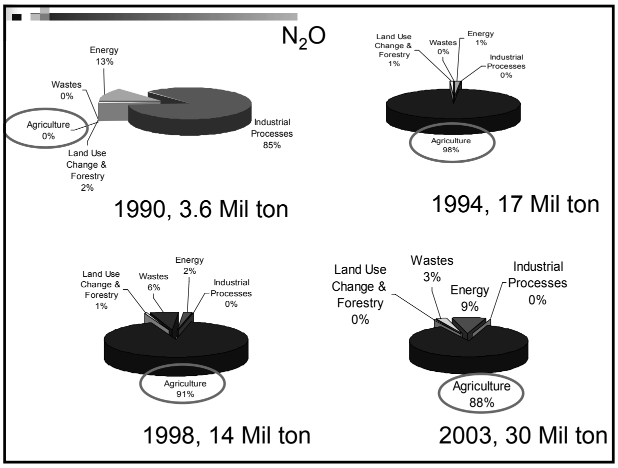

Agriculture Census 2003
Others
Field crop
Whole Kingdom
Central
Northern
Northeastern
Southern

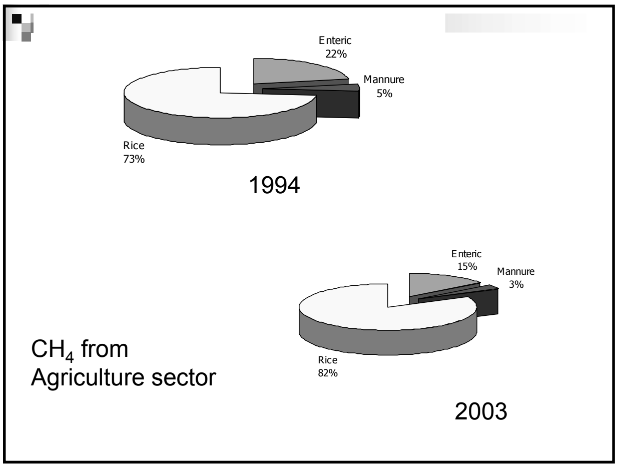

Whole Kingdom
Central
Northern
Northeastern
Southern

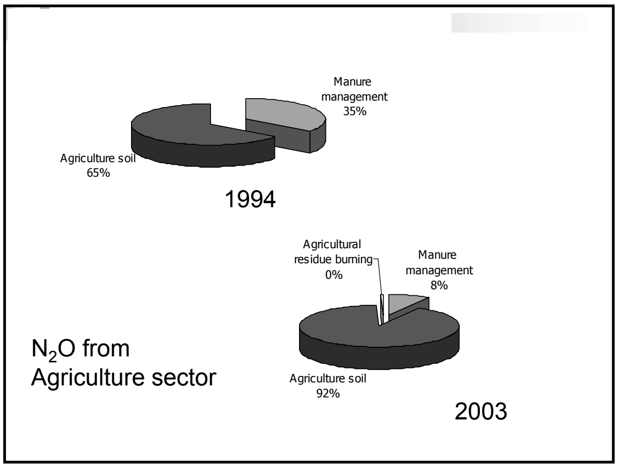

Year 1990: 250 million tons CO2 eq
Land Use Change & Forestry 41%
Wastes 1%
Energy 32%
Industrial Processes 5%
Agriculture 21%
Year 1994: 325 million tons CO2 eq
Land Use Change & Forestry 31%
Wastes 0%
Energy 40%
Industrial Processes 5%
Agriculture 24%
Year 1998: 298 million tons CO2 eq
Land Use Change & Forestry 17%
Wastes 5%
Energy 51%
Agriculture 23%
Industrial Processes 4%
Year 2003: 344 million tons CO2 eq
Land Use Change & Forestry 7%
Wastes 8%
Agriculture 24%
Energy 56%
Industrial Processes 5%


CH4 26%
N2O 2%
CO2 72%
1990
CH4 23%
N2O 6%
CO2 71%
1994
CH4 27%
N2O 5%
HFCs 0%
CO2 68%
1998
CH4 28%
N2O 9%
HFCs 0%
CO2 63%
2003


CH4: Year 1990, 58 Mil ton
Wastes 5%
Energy 4%
Land Use Change & Forestry 1%
Industrial Processes 0%
Agriculture 90%
CH4: Year 1994, 67 Mil ton
Land Use Change & Forestry 2%
Wastes 1%
Energy 6%
Industrial Processes 0%
Agriculture 91%
CH4: Year 1998, 80 Mil ton
Wastes 18%
Energy 10%
Industrial Processes 0%
Land Use Change & Forestry 1%
Agriculture 71%
CH4: Year 2003, 95 Mil ton
Wastes 27%
Energy 12%
Industrial Processes 0%
Land Use Change & Forestry 1%
Agriculture 60%







Thailand KCA

	Level Assessment Results	*Current Year Estimate (Gg CO_2 Eq.)*	*Level Assessment (%)*	*Cumulative (%)*
1.A.1	**CO2 Emissions from Stationary Combustion**	**45529**	**20.33%**	**20.33%**
4.C	**CH4 Emissions from Rice Production**	**44321**	**19.79%**	**40.11%**
1.A.3	**CO2 Mobile Combustion: Road Vehicles**	**39920**	**17.82%**	**57.94%**
1.A.2	**CO2 Manufacturing Industries and Construction**	**30824**	**13.76%**	**71.70%**
2.A	**CO2 Emissions From Cement Production**	**14920**	**6.66%**	**78.36%**
4.A	**CH4 Emissions from Enteric Fermentation in Domestic Livestock**	**13220**	**5.90%**	**84.26%**
4.D	**N2O (Direct and Indirect) Emissions from Agriculutural Soils**	**10983**	**4.90%**	**89.17%**
4.B	**N2O Emissions from Manure Management**	**5949**	**2.66%**	**91.82%**
1.A.4	**Other Sectors: Agriculture**	**4849**	**2.16%**	**93.99%**
1.B.2	**CH4 Fugitive Emissions from Oil and gas Operations**	**3731**	**1.67%**	**95.65%**

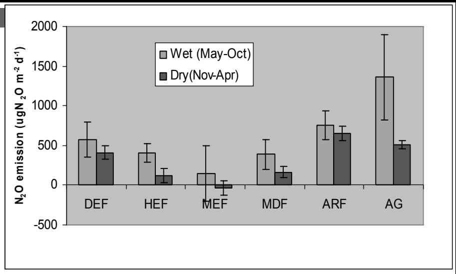
LULUCF

LULUCF Level Assesment Results (LULUCF Category Key Sources Only)	*Current Year Net Estimate (Gg CO_2 eq.)*	*LULUCF Level Assessment (%)*
CO2 from conversion to Cropland	59,396.84	16.33%
CO2 emission from Wood and fuel wood consumption	40,180.51	11.05%
CO2 removals from changes in forest and other woody biomass stocks	|-39,101.60|	10.75%

Additions in SNC

- Emission factor
- KCA
- QA/QC
- Agricultural residue burning

N_2O flux



The monthly average (±SD) ($\mu g\ N_2O\ m^{-2}\ day^{-1}$)	DEF	491±321
	HEF	261.9±268
	MEF	46±456
	MDF	276±321
	ARF	627±346
	AG	829±851

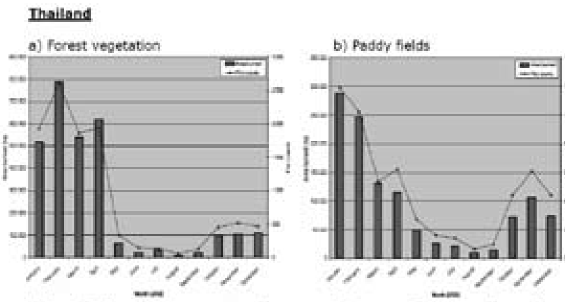
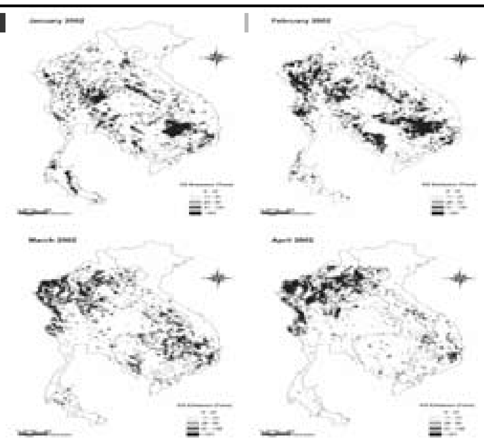
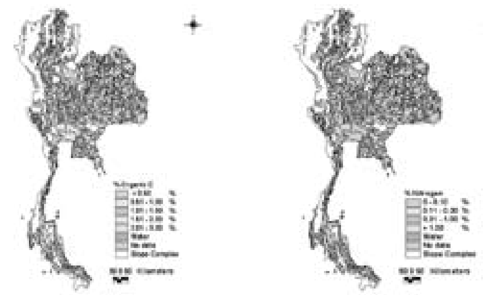


Figure 2. Monthly Fire counts and corresponding area of biomass burned in Thailand during 2002 for a) forest vegetation, and b) paddy fields

Towprayoon et al. 2007

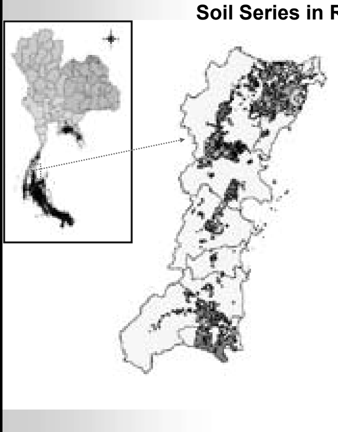


Towprayoon et al. 2007



Towprayoon et al. 2005

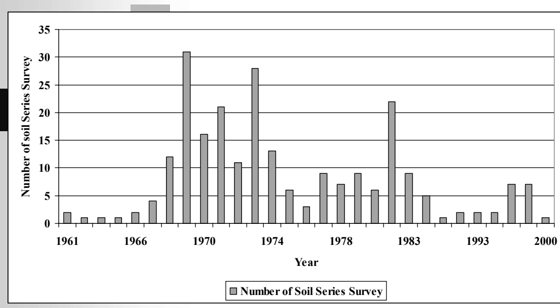
Soil Series in Rubber Tree Plantation Area



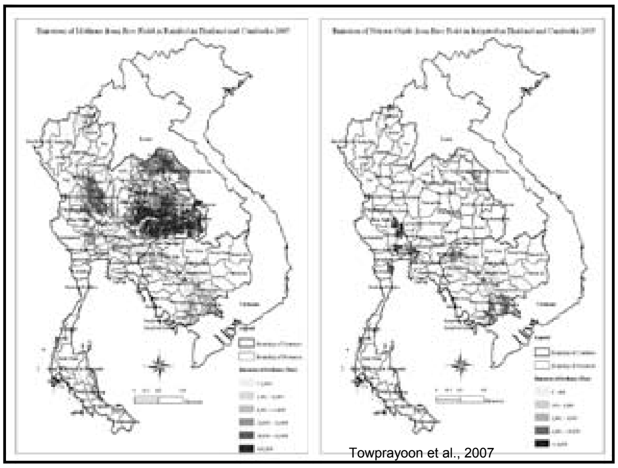
No.	Soil series	Area (m²)
1	AC	1,163,183.76
2	Ak	11,395,951.20
3	Ba	10,673,272.00
4	Beach	3,579,335.50
5	Bh/Wpry	135,499.76
6	Bp-gy	628,795.10
7	Cb	1,764,090.50
8	Cb-hi	7,692,489.42
9	Cp	183,923,713.22
10	Hh	902,842.62
.		
.		
.		
51	Wp	318,585.56
	Total	2,009,939,294.52

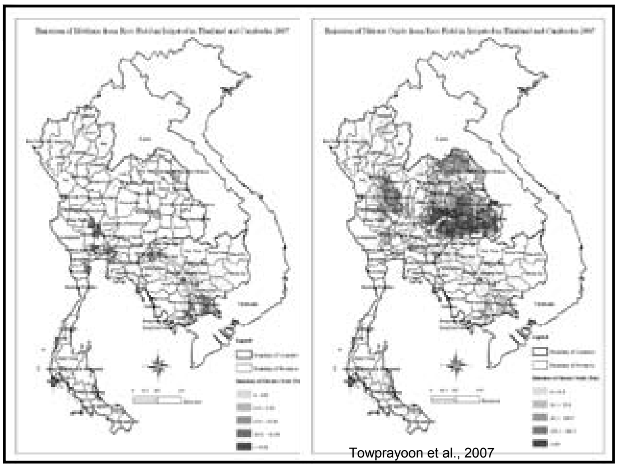
Pechsri et al., 2007

Year of Soil Series Survey



Pechsri et al., 2007





Conclusions

- Agriculture is the second most important sector as greenhouse gas emission source
- Main gas is CH4 (>80% of total CH4 emission in 2003)
- Also the main N2O sources (livestock & manure management)

The 6th Workshop on GHG Inventories in Asia (WGIA6)
16-18 July 2008, Tsukuba, Japan

VIETNAM'S GHG INVENTORIES IN AGRICULTURE SECTOR

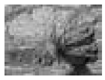
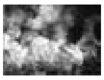
Nguyen Van Anh
Standing Office of the Vietnam National Steering Committee for UNFCCC and Kyoto Protokol
Ministry of Natural Resources and Environment
VIET NAM

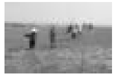
National GHG Inventories in Agriculture for 2000

GHG emissions from Agriculture sector were divided into five following sub-sectors:

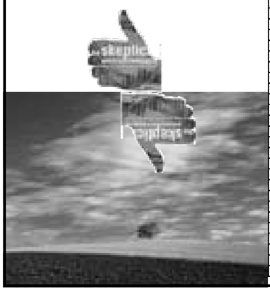
1. Livestock
2. Rice cultivation
3. Agricultural soil
4. Prescribed burning of savannas
5. Field burning of agricultural residues





Key Category Analysis for GHG Inventory in Agriculture Sector for SNC – Viet Nam



	CH_4	N_2O	NO_x	CO
A Enteric Fermentation	●			
1 Cattle	●			
2 Buffalo	●			
3 Sheep	●			
4 Goats	●			
5 Camels and Llamas	●			
6 Horses	●			
7 Mules and Asses	●			
8 Swine	●			
9 Poultry	●			
10 Other (please specify)	●			
B Manure Management	●			
1 Cattle	●			
2 Buffalo	●			
3 Sheep	●			
4 Goats	●			
5 Camels and Llamas	●			
6 Horses	●			
7 Mules and Asses	●			
8 Swine	●			
9 Poultry	●			
10 Anaerobic	●	●		
11 Liquid Systems	●	●		
12 Solid Storage and Dry Lot	●	●		
13 Other (please specify)	●	●		
C Rice Cultivation	●			
1 Irrigated	●			
2 Rainfed	●			
3 Deep Water	●			
4 Other (please specify)	●			
D Agricultural Soils	●	●		
E Prescribed Burning of Savannas	●	●	●	●
F Field Burning of Agricultural Residues				
1 Cereals	●		●	●
2 Pulse	●		●	●
3 Tuber and Root	●		●	●
4 Sugar Cane	●		●	●
5 Other (please specify)	●		●	●
G Other (please specify)	●			

Emission factors

1. Livestock (emission factors for CH_4) *Unit: kg/head/yr*

	Enteric fermentation	Manure management
Dairy cattle	**56**	**27**
Non-dairy cattle	**44**	**2**
Buffalo	**55**	**3**
Goats	**5**	**0.22**
Horses	**18**	**2.18**
Swine	**1**	**7**
Poultry	**0**	**0.023**

Source: the revised 1996 IPCC Guidelines for National GHG Inventories

Country – Specific Emission Factors

Rice cultivation (seasonally integrated emission factors for continuously flooded rice without organic amendment of CH_4)

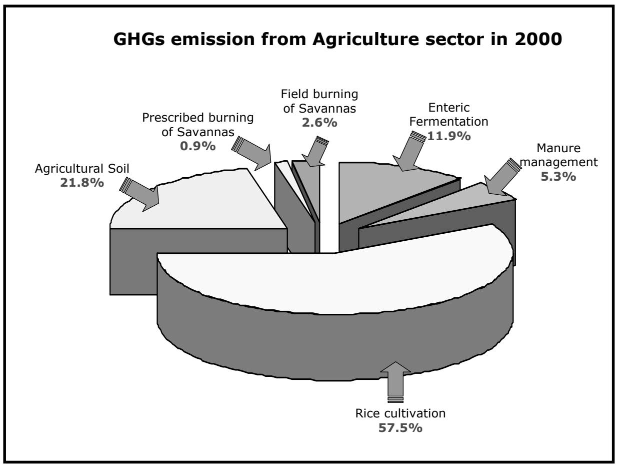
Unit: g/m^2

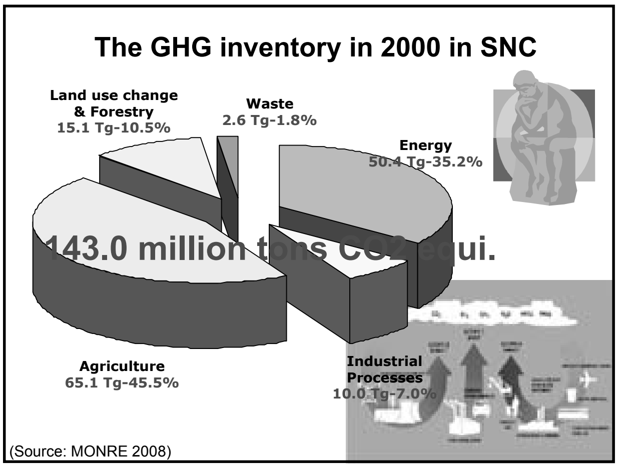
	The North	The Central	The South
Continuously Flooded	**37.5**	**33.59**	**21.7**
Intermittently flooded – single aeration	**18.8**	**16.79**	**10.85**
Flood prone	**30**	**26.87**	**17.36**

National GHG Inventories in Agriculture for SNC

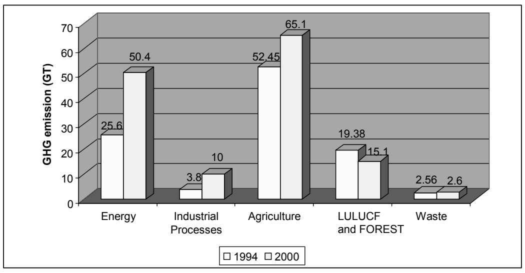
Unit: Gg

Sub-sector	CH_4	N_2O	CO	NO_x	CO_2 equivalent	%
Enteric Fermentation	368.12				7,730.54	11.9
Manure Management	164.16				3,447.30	5.3
Rice Cultivation	**1,782.37**				**37,429.77**	**57.5**
Agricultural Soil		45.87			14,219.70	21.8
Prescribed Burning of Savannas	9.97	1.23	261.71	4.46	590.67	0.9
Field Burning of Agricultural Residues	59.13	1.39	1,214.68	50.28	1,672.63	2.6
Total	**2,383.75**	**48.49**	**1476.39**	**54.74**	**65,090.61**	**100**





GHG emissions by sector in 1994 (INC), 2000 (SNC)
(*GT CO2 equivalent*)



Total GHG Emission (1994): 103.0 million tons CO2 equi.
Total GHG Emission (2000): 143.0 million tons CO2 equi.

Conclusions

- At present, Agriculture is the biggest GHG emission source in Viet Nam
- In 2000, GHG emission from this sector was 65.1 million tonnes of CO_2 equivalent, representing 45.5% of total emissions
- There are some uncertainties associated with activity data in Agriculture sector
- Most of emission factors in 2000 GHG Inventory are from the revised 1996 IPCC Guidelines for National GHG Inventories. Due to using these default emission factors, there are some uncertainties that should be verified, analyzed and made clear in the coming time.

GHG Inventory Issues in SEA countries: Agriculture Sector

The 6th Workshop of GHG Inventories in Asia (WGIA6)
16-18 July 2008, Tsukuba, Japan

Issues	Component 4 (Agriculture)
Common issues on emission factor (EF) and activity data (AD) that need to be addressed	- rice cultivation – how to categorize water regime for rice (AD) - EF and AD (related to water mgt. and amount of fertilizer input); N_2O emissions from Cropland; soil C from cropland (soil category is broad) - crop residue ratio for use in biomass burning GHG inventory - enteric fermentation: enhanced characterization - need local EF for manure management for different AWMS

Issues	Component 4 (Agriculture)
Proposed methodology or approaches	-refer to Huke Database of IRRI for rice AD based on rice ecosystems - Encourage participating countries to develop EFs using measured data -collaborate with IRRI (for rice) and New Zealand LEARN Project (for livestock)

A Perspective of Agriculture Sector Involvement in Asian GHG Inventory beyond 2013

Toshiaki Ohkura
Natural Resources Inventory Center
National Institute for Agro-Environmental Sciences

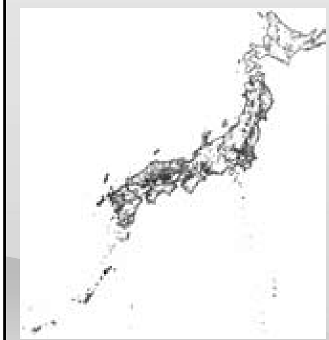
Soil Carbon in Arable Land

- Lesson from National Soil Monitoring Project in Japan

- Soil Fertility Improvement Act
- Organic Agriculture Act
- Sustainable Agriculture Act

Soil Carbon as an indicator of agricultural land management (OECD)

Soil Monitoring (Longitudinal)



About 20,000 sites

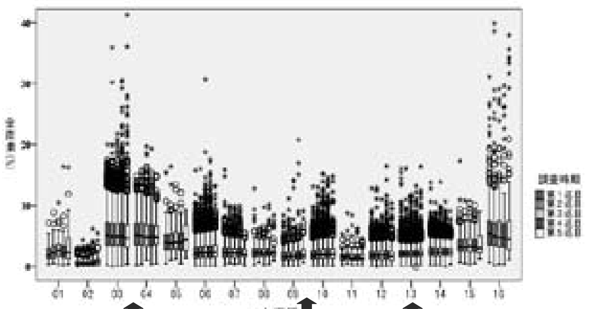
1st to 4th period survey

About 5,000 sites

5th period survey

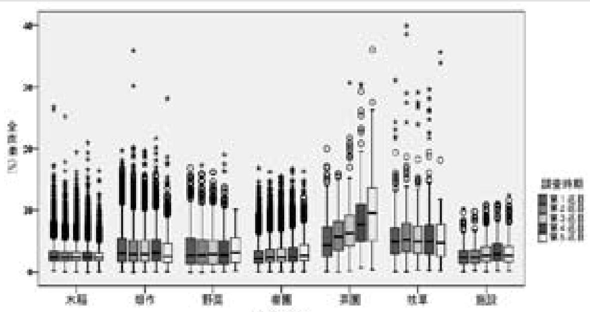
Total Agricultural Land Area is about 5 million ha

Variations in SC over 20years



Andisols (upland) | Ultisols like upland | Major Paddy soils

Same Data Analysis by Crop Type



Paddy Rice | Cereals upland | Vegeta bles | Orchard | Green Tea | Pasture | Green house

Facts and Fallibilism in Science

- Setting Base Year (ex. 1990)
- Justification of Base Period (ex. 20years)
- Inventory Status and Data Availability in Asian Countries
- Public Consensus for Accelerating Soil Carbon Sequestration in Arable land regarding Multifunctionality of Agriculture

Raising awareness of GHG Inventories and CC in the Philippines

Jose Ramon T Villarin
Klima Center
Manila Observatory

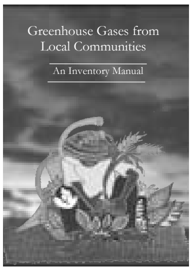
July 2008

Outline

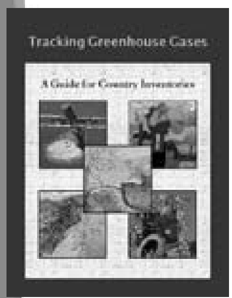
- Activities undertaken
- Outcomes
- Future activities
- Recommendations

Activities undertaken

- IEC
- Actual compilation
- Training
- Policy
- Research



Outcomes



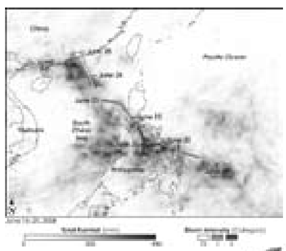
- Greater awareness top-down, bottom-up
- Train, train, train
- IEC collaterals
- Uneven capacity
- Policy interventions
- Projects

Future activities

- Training
- Policy
- Research
- IEC

Recommendations

- Periodic inventorying
- Networking
- Research and training
- IEC
- Co-benefits
- Mobilizing culture



House of Dacay

Phil Daily Inq, 29 June 2008, Photo by Nino Jesus Orbeta

KOREA'S EXPERIENCE IN AWARENESS RAISING ABOUT GHG INVENTORY AND CLIMATE CHANGE

THE 6TH WORKSHOP ON GHG INVENTORIES IN ASIA(WGIA6)
16-18 JULY, 2008, TSUKUBA, JAPAN

Kyonghwa Jeong
Korea Energy Economics Institute

Contents

- Activities in Awareness Raising about GHG Inventory and Climate Change in Korea
- Outcomes of the Activities
- The Way Forward

Korea Energy Economics Institute

Activities in awareness raising about GHG inventory and climate change in Korea

- Korea Climate Change Week
- Internet Portal Sites
- Education

Korea Energy Economics Institute

1. Climate Change Week

- Awareness Raising and Information Campaign
  - Events
    - Performance of global warming
    - Exhibitions
    - Carbon Neutral Campaign
    - CO2 emission calculation events(Carbon Tree Calculator)

Korea Energy Economics Institute

1. Korea Climate Change Week
Performance of global warming

Source: KEMCO

Korea Energy Economics Institute

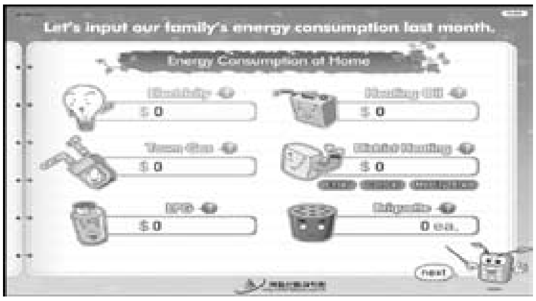
1. Korea Climate Change Week
Launching Carbon Neutral Campaign

Source: KEMCO

Korea Energy Economics Institute

1. Korea Climate Change Week
Carbon Emission Calculation Events

Carbon Tree Calculator



Korea Energy Economics Institute

1. Korea Climate Change Week
Carbon Emission Calculation Events

Carbon Footprint

Source: Yonhap News

Korea Energy Economics Institute

1. Climate Change Week

- Strengthening the capacity of private and public sectors
  - Seminars on climate change and sectors
    - Climate change and industry
    - International carbon market trends
    - Climate change and local government
  - Seminar tour in regions with topics about GHG reduction and post 2012 framework

Korea Energy Economics Institute

2. Internet Portal Sites

- GHG emissions
- Publication/Information on climate change
- GHG emissions accounting guidelines
- ET & CDM-related training programs

Korea Energy Economics Institute

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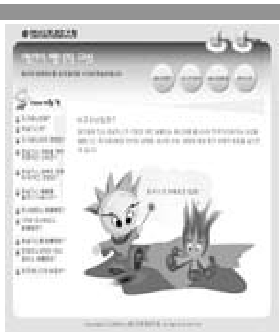
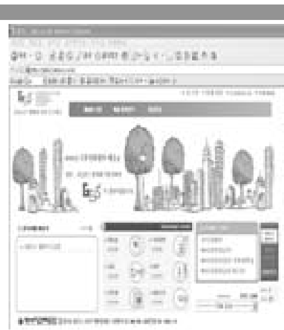


Korea Energy Economics Institute

Korea Energy Management Corporation



Korea Energy Economics Institute

Korea Energy Management Corporation

- GEIS (Greenhouse gas Emission Information System)
  - Web program for accounting and registration of companies GHG emissions(voluntary)
    - Developed for generation, chemical, steel, and semiconductor
    - Developing for refinery, cement, paper, non-metallic, and transportation

Climate Change Information Website

Korea Energy Economics Institute

3. Education

- Integrating climate change issues into the curriculum and developing instructional materials
- Appointing 3 universities as research institutes specialized in climate change and GHG inventory
  - Seoul National University : GHG emission inventory
  - Gyemyong University : GHG reduction policy
  - Korea University : Assessment of climate change effect and adaption

Korea Energy Economics Institute

Outcomes of the activities

Korea Energy Economics Institute

Outcomes of the Activities

- Raising public awareness about global warming by integrating climate change issues into the curriculum and developing instructional materials
- Facilitating public participation in actions to reduce GHGs by launching carbon neutral campaign and events

Korea Energy Economics Institute

Outcomes of the Activities

- Facilitating public and private access to information about climate change and GHG inventory by opening user- friendly climate change portal sites and implementing web training programs for CDM and ET
- Strengthening the capacity of domestic industry on climate change convention by sharing industry’s experience on climate change

Korea Energy Economics Institute

The Way Forward

Korea Energy Economics Institute

The Way Forward

- Develop a comprehensive regional GHG inventory DB system
- Develop a long-term public awareness program such as information dissemination about what we can do at home and at work for an effort to reduce GHGs(through internet portal sites, TV, newspaper)
- Help local government on climate change issues

Korea Energy Economics Institute

Thank you

Korea Energy Economics Institute

6th Workshop on Greenhouse Gas Inventories in Asia

Other GHG Inventory Related Issues

Discussion Group 4: Other GHG Inventory Related Issues

July 17, 2008

Takeshi Enoki
Senior Analyst, Mitsubishi UFJ Research & Consulting Co., Ltd.
Cooperative Researcher, GIO Japan

6th Workshop on Greenhouse Gas Inventories in Asia

Contents

- Relevance of inventory data on policy making
- Awareness-raising in Japan
- Information exchange

6th Workshop on Greenhouse Gas Inventories in Asia

Relevance of inventory data on policy making

6th Workshop on Greenhouse Gas Inventories in Asia

Roles of GHG Inventories in Policy Making

- Identify priorities for reduction policies
  - Developing an accurate GHG inventory can help define priorities and set objectives for reducing emissions.
- Evaluate reduction policies
  - An accurate, complete inventory is necessary to evaluate GHG emissions mitigation policies on current levels of emissions.
- Forecast emissions
  - The GHG inventory is the basis for forecasting future emission levels to determine which emission sources might require further controls.

6th Workshop on Greenhouse Gas Inventories in Asia

Roles of GHG Inventories in Policy Making

- Identify CDM opportunities
  - Developing an accurate GHG inventory can help identify areas where CDM potentials exist.
- Identify priorities for local air pollution policies
  - The GHG inventory data can be used to compile inventories for NOx, SOx, etc. and help prioritize sources for reducing local air pollution.
- Improve quality of parameter data
  - Improving the GHG inventory requires improvement of parameter data (energy/industry/land use statistics) which can benefit other policies.

6th Workshop on Greenhouse Gas Inventories in Asia

Awareness raising

Awareness-raising in Japan

- Awareness of the climate change issue and the amount of emissions is very high in Japan, thanks to the **"Team Minus 6%"** campaign.
- The name is a reference to Japan's commitment to reduce its GHG emissions to 6% below 1990 levels.
- Public announcements on the national GHG emissions inventory are made every year showing the emissions from all major sources.
- Industries emitting over 3,000 tons CO_2 equivalent are required to report amount of emissions and their emissions are made public.

6th Workshop on Greenhouse Gas Inventories in Asia

The "Team Minus 6%" campaign

- Japan promotes "Team Minus 6%" campaign through:
  - Media (television, internet, newspapers, etc.);
  - Distribution of pamphlets;
  - Holding of symposiums.
- Examples of campaigns under the "Team Minus 6%" :
  - **Cool Biz, Warm Biz**: encourages people to dress to keep cool in summer and warm in winter to reduce energy consumption in the workplace.
  - **1 kg-CO_2 reduction a day per person challenge**
- "Team Minus 6%" website describes all campaigns and ways the public can reduce their emissions.

6th Workshop on Greenhouse Gas Inventories in Asia

Information exchange

6th Workshop on Greenhouse Gas Inventories in Asia

Benefits of Information Exchange

- Improve the quality of GHG inventories
  - Default emission factors in the IPCC Guidelines may not appropriately reflect national/regional circumstances in Asian countries. Using a country-specific emission factor from an Asian country may be more appropriate.
  - Sharing of information improves efficiency in making improvements to the inventory.
- Explore possibilities to develop region/country-specific methodologies and emission factors

6th Workshop on Greenhouse Gas Inventories in Asia

Status of Information Exchange

- In Europe…
  - The EU holds workshops that address challenges Member States face to improve specific issues together.
- In Asia…
  - WGIA provides Asian countries a chance to exchange information, but more general information is presented and discussed.
  - Focusing on more specific issues during WGIA meetings may prove useful to Asian countries.

6th Workshop on Greenhouse Gas Inventories in Asia

Summary

- GHG Inventories is a useful tool for
  - Formulating/evaluating policies;
  - identifying CDM possibilities; and
  - Improving quality of data collection.
- Awareness is important so that people realize how much GHG is being emitted and can be involved in dealing with climate change.
- Information exchange on country-specific emission factors and methodologies can help improve our GHG Inventories.


6th Workshop on Greenhouse Gas Inventories in Asia
ありがとうございました
(thank you very much)

Awareness Raising on GHG Inventory and Climate Change

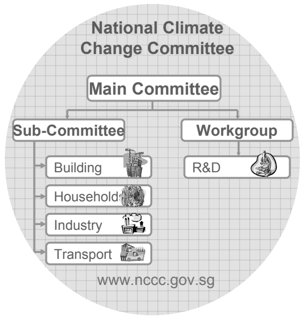
Singapore

6th Workshop on GHG Inventories in Asia (WGIA6)

16-18 July 2008

National Climate Change Committee

- National Climate Change Committee formed to promote energy efficiency and a less carbon-intensive economy
- Chaired by Senior Parliamentary Secretary for the Environment and Water Resources
- Wide representation:
  - Government, private sector, academia, NGOs

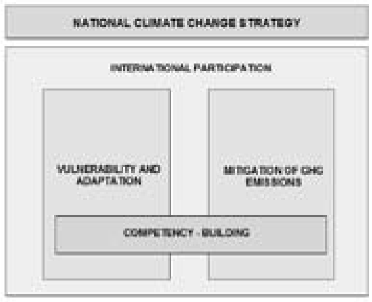


National Climate Change Strategy

- Consultations with stakeholders:
  General public
  Industries and businesses

  – Online consultation
  – Dialogue sessions, consultation forum

National Climate Change Strategy



E² Singapore

- Energy efficient Singapore
  - Promotion of energy efficiency and energy conservation
    - Power generation
    - Industry
    - Transport
    - Buildings
    - Households

www.e2singapore.gov.sg

Industries and Businesses Sector

Key messages

- Benefits of improving energy efficiency
  ⇒ Companies can remain competitive
  ⇒ Maximize profits
  ⇒ Reduce GHG emissions

Activities

- Seminars on CDM
- Talks on energy efficiency
- Incentives e.g. for companies to carry out energy appraisals
- Profile success stories

Households, Transport Sectors

Key messages

- Impact of climate change
  - ⇒ Simple changes in lifestyle and habits can help to reduce carbon footprint

Activities

- 10% energy challenge draw for households
- Project carbon zero competition for schools, in partnership with Singapore Environment Council
- Climate change exhibition at Science Centre Singapore
- 'Go green with public transport' campaign by rail and bus operator

Thank you

Key Source Category Analysis

Jamsranjav Baasansuren

Greenhouse Gas Inventory Office of Japan (GIO)
National Institute for Environmental Studies (NIES)

6th Workshop on Greenhouse Gas Inventories in Asia,
Tsukuba, JAPAN

July 16-18, 2008

Key source category

- *A key source category is one that is prioritised within the national inventory system because its estimate has a significant influence on a country's total inventory of direct greenhouse gases in terms of the absolute level of emissions, the trend in emissions, or both.*

- Identification of key source categories enables to prioritise available resources for preparing inventory and improve quality of overall estimates.

Methodology for identifying key source categories

- Quantitative (identify KSCs in terms of contribution to both the level and the trend in national emissions)
  - Tier 1
  - Tier 2 (accounts for uncertainty)
- Qualitative (identify KSCs not captured by quantitative analysis using qualitative criteria)
  - mitigation techniques and technologies
  - high expected emission growth
  - high uncertainty
  - unexpectedly low or high emissions

Tier 1 approach to identify key source categories

- **Level Assessment**

Source category level assessment = Source category estimate / Total estimate

$$L_{x,t} = E_{x,t} / E_t \qquad (1)$$

Where:
$L_{x,t}$: Level Assessment for source category x in year t
$E_{x,t}$: Emission estimate of source category x in year t
E_t : Total inventory estimate in year t

Tier 1 approach to identify key source categories

- **Trend Assessment**

Source Category Trend Assessment = (Source Category Level Assessment)• | (Source Category Trend – Total Trend) |

$$T_{x,t} = L_{x,t} \bullet | \{[(E_{x,t} - E_{X,0}) / E_{x,t}] - [(E_t - E_0) / E_t]\} | \qquad (2)$$

Where:
$T_{x,t}$: Contribution of the source category trend to the overall inventory trend
$L_{x,t}$: Level Assessment for source x in year t
$E_{x,t}$ and **$E_{x,0}$** : Emissions estimates of source category x in years t and 0, respectively
E_t and **E_0** : Total inventory estimates in years t and 0, respectively

Performing Tier 1 Assessment (without LULUCF)

- Tier 1 approach can be readily performed using a spreadsheet analysis. Separate spreadsheets are suggested for the Level and Trend Assessments.

Tier 1 Level Assessment

A IPCC Source Category	B Direct GHG	C Base Year Estimate [Mg CO_2 eq.]	D Current Year Estimate [Mg CO_2 eq.]	E Level Assessment	F Cumulative Total of Column E
Total					

Tier 1 Trend Assessment

A IPCC Source Category	B Direct GHG	C Base Year Estimate [Mg CO_2 eq.]	D Current Year Estimate [Mg CO_2 eq.]	E Level Assessment	F Trend Assessment	G (%) Contribution to Trend	H Cumulative total of Column G
Total							

Tier 1 Level Assessment

1. Input data

A PCC Source Category	B Direct GHG	C Base Year Estimate [Mg CO_2 eq.]	D Current Year Estimate [Mg CO_2 eq.]
1A Stationary Combustion-Liquid fuel	CO_2	125,478	135,264
1A Stationary Combustion-Solid fuel	CO_2	235,648	265,745
1A Stationary Combustion-Gaseous fuel	CO_2	50,487	68,457
1A Stationary Combustion	CH_4	3,154	1,524
1A Stationary Combustion	N_2O		
1A Mobile Combustion-Civil Aviation	CO_2		

CO_2 equivalent emissions calculated using the global warming potentials (GWP) should be entered

2. Compute the total of the BY and current year emissions

=SUM(C3:C64) =SUM(D3:D64)

Total		**1,126,723**	**1,221,934**

Tier 1 Level Assessment

2. Level Assessment is calculated following the Equation 1 and should be displayed in the column E.

A IPCC Source Category	B Direct GHG	C Base Year Estimate [Mg CO_2 eq.]	D Current Year Estimate [Mg CO_2 eq.]	E Level Assessment
1A Stationary Combustion-Liquid fuel	CO_2	125,478	135,264	0.11
1A Stationary Combustion-Solid fuel	CO_2	235,648	265,745	0.22
1A Stationary Combustion-Gaseous fuel	CO_2	50,487	68,457	0.06
1A Stationary Combustion	CH_4	3,154	1,524	0.00
1A Stationary Combustion	N_2O	2,156	1,502	0.00
1A Mobile Combustion-Civil Aviation	CO_2	25,687	25,489	0.02
1A Mobile Combustion-Road Transportation	CO_2	265,489	255,847	0.21
1A Mobile Combustion-Railway	CO_2	500	485	0.00
1AMobile Combustion-Navigation	CO_2	2,654	6,854	0.01
1A Mobile Combustion-Civil aviation	CH_4	965	4,125	0.00
1A Mobile Combustion-Road Transportation	CH_4	674	641	0.00
1A Mobile Combustion-Railway	CH_4	1,689	4,597	0.00
1AMobile Combustion-Navigation	CH_4	6,249	5,248	0.00
1A Mobile Combustion-Civil Aviation	N_2O	2,569	1,255	0.00
1A Mobile Combustion-Road Transportation	N_2O	98,253	78,549	0.06
1A Mobile Combustion-Railway	N_2O	3,254	5,682	0.00
1AMobile Combustion-Navigation	N_2O	3,265	6,245	0.01

=D3/$D$65

Source category emission / Total emission

3. Source categories should be sorted in descending order of magnitude of the level assessment

A IPCC Source Category	B Direct GHG	C Base Year Estimate [Mg CO_2 eq.]	D Current Year Estimate [Mg CO_2 eq.]	E Level Assessment
1A Stationary Combustion-Solid fuel	CO_2	235,648	265,745	0.22
1A Mobile Combustion-Road Transportation	CO_2	265,489	255,847	0.21
1A Stationary Combustion-Liquid fuel	CO_2	125,478	135,264	0.11
1A Mobile Combustion-Road Transportation	N_2O	98,253	78,549	0.06
1A Stationary Combustion-Gaseous fuel	CO_2	50,487	68,457	0.06
2A Mineral Product-Limestone and Dolomite use	CO_2	26,475	64,825	0.05
4D Agricultural Soils	N_2O	63,259	59,687	0.05
2A Mineral Product-Lime Production	CO_2	31,526	56,298	0.05
6C Waste Incineration	N_2O	36,852	35,249	0.03
2A Mineral Product-Cement Production	CO_2	26,589	32,569	0.03
4A Enteric Fermentation	CH_4	36,524	32,549	0.03
1A Mobile Combustion-Civil Aviation	CO_2	25,687	25,489	0.02
2E Production of Halocarbons and SF6-Fugitive Emissions	PFCs	9,856	9,548	0.01
2B Chemical Industry-Other	CO_2	6,254	6,855	0.01
1AMobile Combustion-Navigation	CO_2	2,654	6,854	0.01
6C Waste Incineration	CO_2	6,584	6,852	0.01
4B Manure Management	N_2O	8,655	6,485	0.01
1AMobile Combustion-Navigation	N_2O	3,265	6,245	0.01
2A Mineral Product-Other	CO_2	6,852	5,822	0.00
2B Chemical Industry-Ammonia Production	CO_2	8,457	5,748	0.00
1A Mobile Combustion-Railway	N_2O	3,254	5,682	0.00
1AMobile Combustion-Navigation	CH_4	6,249	5,248	0.00

4. The cumulative total of the column F should then be computed in Column G.

A IPCC Source Category	B Direct GHG	C Base Year Estimate [Mg CO_2 eq.]	D Current Year Estimate [Mg CO_2 eq.]	E Level Assessment	F Cumulative Total of Column E
1A Stationary Combustion-Solid fuel	CO_2	235,648	265,745	0.22	0.22
1A Mobile Combustion-Road Transportation	CO_2	265,489	255,847	0.21	0.43
1A Stationary Combustion-Liquid fuel	CO_2	125,478	135,264	0.11	0.54
1A Mobile Combustion-Road Transportation	N_2O	98,253	78,549	0.06	0.60
1A Stationary Combustion-Gaseous fuel	CO_2	50,487	68,457	0.06	0.66
2A Mineral Product-Limestone and Dolomite use	CO_2	26,475	64,825	0.05	0.71
4D Agricultural Soils	N_2O	63,259	59,687	0.05	0.76
2A Mineral Product-Lime Production	CO_2	31,526	56,298	0.05	0.81
6C Waste Incineration	N_2O	36,852	35,249	0.03	0.83
2A Mineral Product-Cement Production	CO_2	26,589	32,569	0.03	0.86
4A Enteric Fermentation	CH_4	36,524	32,549	0.03	0.89
1A Mobile Combustion-Civil Aviation	CO_2	25,687	25,489	0.02	0.91
2E Production of Halocarbons and SF6-Fugitive Emissions	PFCs	9,856	9,548	0.01	0.92
2B Chemical Industry-Other	CO_2	6,254	6,855	0.01	0.92
1AMobile Combustion-Navigation	CO_2	2,654	6,854	0.01	0.93
6C Waste Incineration	CO_2	6,584	6,852	0.01	0.93
4B Manure Management	N_2O	8,655	6,485	0.01	0.94
1AMobile Combustion-Navigation	N_2O	3,265	6,245	0.01	0.94
2A Mineral Product-Other	CO_2	6,852	5,822	0.00	0.95
2B Chemical Industry-Ammonia Production	CO_2	8,457	5,748	0.00	0.95
1A Mobile Combustion-Railway	N_2O	3,254	5,682	0.00	0.96
1AMobile Combustion-Navigation	CH_4	6,249	5,248	0.00	0.96

=SUM($E$3:E3)

• The categories that cumulatively account for 95% of the total of the level assessment are considered key categories.

A IPCC Source Category	B Direct GHG	C Base Year Estimate [Mg CO_2 eq.]	D Current Year Estimate [Mg CO_2 eq.]	E Level Assessment	F Cumulative Total of Column E
1A Stationary Combustion-Solid fuel	CO_2	235,648	265,745	0.22	0.22
1A Mobile Combustion-Road Transportation	CO_2	265,489	255,847	0.21	0.43
1A Stationary Combustion-Liquid fuel	CO_2	125,478	135,264	0.11	0.54
1A Mobile Combustion-Road Transportation	N_2O	98,253	78,549	0.06	0.60
1A Stationary Combustion-Gaseous fuel	CO_2	50,487	68,457	0.06	0.66
2A Mineral Product-Limestone and Dolomite use	CO_2	26,475	64,825	0.05	0.71
4D Agricultural Soils	N_2O	63,259	59,687	0.05	0.76
2A Mineral Product-Lime Production	CO_2	31,526	56,298	0.05	0.81
6C Waste Incineration	N_2O	36,852	35,249	0.03	0.83
2A Mineral Product-Cement Production	CO_2	26,589	32,569	0.03	0.86
4A Enteric Fermentation	CH_4	36,524	32,549	0.03	0.89
1A Mobile Combustion-Civil Aviation	CO_2	25,687	25,489	0.02	0.91
2E Production of Halocarbons and SF6-Fugitive Emissions	PFCs	9,856	9,548	0.01	0.92
2B Chemical Industry-Other	CO_2	6,254	6,855	0.01	0.92
1AMobile Combustion-Navigation	CO_2	2,654	6,854	0.01	0.93
6C Waste Incineration	CO_2	6,584	6,852	0.01	0.93
4B Manure Management	N_2O	8,655	6,485	0.01	0.94
1AMobile Combustion-Navigation	N_2O	3,265	6,245	0.01	0.94
2A Mineral Product-Other	CO_2	6,852	5,822	0.00	0.95
2B Chemical Industry-Ammonia Production	CO_2	8,457	5,748	0.00	0.95
1A Mobile Combustion-Railway	N_2O	3,254	5,682	0.00	0.96
1AMobile Combustion-Navigation	CH_4	6,249	5,248	0.00	0.96

Tier 1 Trend Assessment

• Trend assessment can be calculated (if inventory agencies have data for more than 2 years) following the Equation 2 and should be displayed in the column F.

A PCC Source Category	B Direct GHG	C Base Year Estimate [Mg CO_2 eq.]	D Current Year Estimate [Mg CO_2 eq.]	E Level Assessment	F Trend Assessment
1A Stationary Combustion-Liquid fuel	CO_2	125,478	135,264	0.11	0.00
1A Stationary Combustion-Solid fuel	CO_2	235,648	265,745	0.22	0.01
1A Stationary Combustion-Gaseous fuel	CO_2	50,487	68,457	0.06	0.01
1A Stationary Combustion	CH_4	3,154	1,524	0.00	0.00
1A Stationary Combustion	N_2O	2,156	1,502	[illegible]	0.00
1A Mobile Combustion-Civil Aviation	CO_2	25,687	25,489	[illegible]	0.00
1A Mobile Combustion-Road Transportation	CO_2	265,489	255,847	[illegible]	0.02
1A Mobile Combustion-Railway	CO_2	500	485	[illegible]	0.00
1AMobile Combustion-Navigation	CO_2	2,654	[illegible]	0.01	0.00
1A Mobile Combustion-Civil aviation	CH_4	965	[illegible]	0.00	0.00
1A Mobile Combustion-Road Transportation	CH_4	674	[illegible]	0.00	0.00
1A Mobile Combustion-Railway	CH_4	1,689	[illegible]	0.00	0.00
1AMobile Combustion-Navigation	CH_4	6,249	[illegible]	0.00	0.00
1A Mobile Combustion-Civil Aviation	N_2O	[illegible]	[illegible]	0.00	0.00
1A Mobile Combustion-Road Transportation	N_2O	[illegible]	[illegible]	0.06	0.02
1A Mobile Combustion-Railway	N_2O	[illegible]	5,682	0.00	0.00

=E3*ABS(((D3-C3)/D3)-(($D$65-$C$65)/$D$65))

Trend assessment is a product of source category level assessment and the absolute difference between the source category trend and the total trend.

• Contribution to the trend should be computed in the Column G

A PCC Source Category	B Direct GHG	C Base Year Estimate [Mg CO_2 eq.]	D Current Year Estimate [Mg CO_2 eq.]	E Level Assessment	F Trend Assessment	G (%) Contribution to Trend
1A Stationary Combustion-Liquid fuel	CO_2	125,478	135,264	0.11	0.00	0.4%
1A Stationary Combustion-Solid fuel	CO_2	235,648	265,745	0.22	0.01	4.8%
1A Stationary Combustion-Gaseous fuel	CO_2	50,487	68,457	0.06	0.01	6.5%
1A Stationary Combustion	CH_4	3,154	1,524	0.00	0.00	0.9%
1A Stationary Combustion	N_2O	2,156	1,502	0.00	0.00	0.4%
1A Mobile Combustion-Civil Aviation	CO_2	25,687	25,489	0.02	0.00	1.1%
1A Mobile Combustion-Road Transportation	CO_2	265,489	255,847	0.21	0.02	15.2%
1A Mobile Combustion-Railway	CO_2	500	485	0.00	0.00	0.0%
1AMobile Combustion-Navigation	CO_2	2,654	6,854	0.01	0.00	1.9%
1A Mobile Combustion-Civil aviation	CH_4	965	4,125	0.00	0.00	1.5%
1A Mobile Combustion-Road Transportation	CH_4	674	641	0.00	0.00	0.0%
1A Mobile Combustion-Railway	CH_4	1,689	4,597	0.00	0.00	1.3%
1AMobile Combustion-Navigation	CH_4	6,249	5,248	0.00	0.00	0.7%
1A Mobile Combustion-Civil Aviation	N_2O	2,569	1,255	0.00	0.00	0.7%
1A Mobile Combustion-Road Transportation	N_2O	98,253	78,549	0.06	0.02	13.3%
1A Mobile Combustion-Railway	N_2O	3,254	5,682	0.00	0.00	1.0%
1AMobile Combustion-Navigation	N_2O	3,265	6,245	0.01	0.00	1.3%
1B Fugitive Emission-Coal Mining and Handling (underground)	CH_4	2	6	0.00	0.00	0.0%
1B Fugitive Emission-Coal Mining and Handling (surface)	CH_4	25	65	0.00	0.00	0.0%
1B Fugitive Emission-Oil	CO_2	125	125	0.00	0.00	0.0%

=F3/$F$65

• Source categories should be sorted in descending order of magnitude of Column G

A PCC Source Category	B Direct GHG	C Base Year Estimate [Mg CO_2 eq.]	D Current Year Estimate [Mg CO_2 eq.]	E Level Assessment	F Trend Assessment	G (%) Contribution to Trend
2A Mineral Product-Limestone and Dolomite use	CO_2	26,475	64,825	0.05	0.03	17.1%
1A Mobile Combustion-Road Transportation	CO_2	265,489	255,847	0.21	0.02	15.2%
1A Mobile Combustion-Road Transportation	N_2O	98,253	78,549	0.06	0.02	13.3%
2A Mineral Product-Lime Production	CO_2	31,526	56,298	0.05	0.02	10.5%
1A Stationary Combustion-Gaseous fuel	CO_2	50,487	68,457	0.06	0.01	6.5%
1A Stationary Combustion-Solid fuel	CO_2	235,648	265,745	0.22	0.01	4.8%
4D Agricultural Soils	N_2O	63,259	59,687	0.05	0.01	4.2%
4A Enteric Fermentation	CH_4	36,524	32,549	0.03	0.01	3.3%
6C Waste Incineration	N_2O	36,852	35,249	0.03	0.00	2.2%
1AMobile Combustion-Navigation	CO_2	2,654	6,854	0.01	0.00	1.9%
2A Mineral Product-Cement Production	CO_2	26,589	32,569	0.03	0.00	1.8%
4B Manure Management	CH_4	6,457	3,566	0.00	0.00	1.6%
2B Chemical Industry-Ammonia Production	CO_2	8,457	5,748	0.00	0.00	1.6%
1A Mobile Combustion-Civil aviation	CH_4	965	4,125	0.00	0.00	1.5%
4B Manure Management	N_2O	8,655	6,485	0.01	0.00	1.4%
1A Mobile Combustion-Railway	CH_4	1,689	4,597	0.00	0.00	1.3%
1AMobile Combustion-Navigation	N_2O	3,265	6,245	0.01	0.00	1.3%
1A Mobile Combustion-Civil Aviation	CO_2	25,687	25,489	0.02	0.00	1.1%
1A Mobile Combustion-Railway	N_2O	3,254	5,682	0.00	0.00	1.0%
2B Chemical Industry-Nitric Acid Production	N_2O	215	2,155	0.00	0.00	0.9%
1A Stationary Combustion	CH_4	3,154	1,524	0.00	0.00	0.9%
2B Chemical Industry-Adipic Acid Production	N_2O	3,156	5,247	0.00	0.00	0.9%
6B Wastewater Handling	CH_4	4,621	3,264	0.00	0.00	0.8%
2A Mineral Product-Other	CO_2	6,852	5,822	0.00	0.00	0.8%
1A Mobile Combustion-Civil Aviation	N_2O	2,569	1,255	0.00	0.00	0.7%
1AMobile Combustion-Navigation	CH_4	6,249	5,248	0.00	0.00	0.7%

• The cumulative total of the column G should then be computed in Column H.

A PCC Source Category	B Direct GHG	C Base Year Estimate [Mg CO_2 eq.]	D Current Year Estimate [Mg CO_2 eq.]	E Level Assessment	F Trend Assessment	G (%) Contribution to Trend	H Cumulative total of Column G
2A Mineral Product-Limestone and Dolomite use	CO_2	26,475	64,825	0.05	0.03	17.1%	17.1%
1A Mobile Combustion-Road Transportation	CO_2	265,489	255,847	0.21	0.02	15.2%	32.3%
1A Mobile Combustion-Road Transportation	N_2O	98,253	78,549	0.06	0.02	13.3%	45.5%
2A Mineral Product-Lime Production	CO_2	31,526	56,298	0.05	0.02	10.5%	56.0%
1A Stationary Combustion-Gaseous fuel	CO_2	50,487	68,457	0.06	0.01	6.5%	62.5%
1A Stationary Combustion-Solid fuel	CO_2	235,648	265,745	0.22	0.01	4.8%	67.3%
4D Agricultural Soils	N_2O	63,259	59,687	0.05	0.01	4.2%	71.5%
4A Enteric Fermentation	CH_4	36,524	32,549	0.03	0.01	3.3%	74.9%
6C Waste Incineration	N_2O	36,852	35,249	0.03	0.00	2.2%	77.1%
1AMobile Combustion-Navigation	CO_2	2,654	6,854	0.01	0.00	1.9%	79.0%
2A Mineral Product-Cement Production	CO_2	26,589	32,569	0.03	0.00	1.8%	80.7%
4B Manure Management	CH_4	6,457	3,566	0.00	0.00	1.6%	82.4%
2B Chemical Industry-Ammonia Production	CO_2	8,457	5,748	0.00	0.00	1.6%	84.0%
1A Mobile Combustion-Civil aviation	CH_4	965	4,125	0.00	0.00	1.5%	85.4%
4B Manure Management	N_2O	8,655	6,485	0.01	0.00	1.4%	86.8%
1A Mobile Combustion-Railway	CH_4	1,689	4,597	0.00	0.00	1.3%	88.1%
1AMobile Combustion-Navigation	N_2O	3,265	6,245	0.01	0.00	1.3%	89.4%
1A Mobile Combustion-Civil Aviation	CO_2	25,687	25,489	0.02	0.00	1.1%	90.5%
1A Mobile Combustion-Railway	N_2O	3,254	5,682	0.00	0.00	1.0%	91.5%
2B Chemical Industry-Nitric Acid Production	N_2O	215	2,155	0.00	0.00	0.9%	92.5%
1A Stationary Combustion	CH_4	3,154	1,524	0.00	0.00	0.9%	93.4%
2B Chemical Industry-Adipic Acid Production	N_2O	3,156	5,247	0.00	0.00	0.9%	94.2%
6B Wastewater Handling	CH_4	4,621	3,264	0.00	0.00	0.8%	95.0%
2A Mineral Product-Other	CO_2	6,852	5,822	0.00	0.00	0.8%	95.8%
1A Mobile Combustion-Civil Aviation	N_2O	2,569	1,255	0.00	0.00	0.7%	96.5%
1AMobile Combustion-Navigation	CH_4	6,249	5,248	0.00	0.00	0.7%	97.3%

• Identify those source categories that contribute 95% to the trend of the inventory in absolute terms.

A PCC Source Category	B Direct GHG	C Base Year Estimate [Mg CO_2 eq.]	D Current Year Estimate [Mg CO_2 eq.]	E Level Assessment	F Trend Assessment	G (%) Contribution to Trend	H Cumulative total of Column G
2A Mineral Product-Limestone and Dolomite use	CO_2	26,475	64,825	0.05	0.03	17.1%	17.1%
1A Mobile Combustion-Road Transportation	CO_2	265,489	255,847	0.21	0.02	15.2%	32.3%
1A Mobile Combustion-Road Transportation	N_2O	98,253	78,549	0.06	0.02	13.3%	45.5%
2A Mineral Product-Lime Production	CO_2	31,526	56,298	0.05	0.02	10.5%	56.0%
1A Stationary Combustion-Gaseous fuel	CO_2	50,487	68,457	0.06	0.01	6.5%	62.5%
1A Stationary Combustion-Solid fuel	CO_2	235,648	265,745	0.22	0.01	4.8%	67.3%
4D Agricultural Soils	N_2O	63,259	59,687	0.05	0.01	4.2%	71.5%
4A Enteric Fermentation	CH_4	36,524	32,549	0.03	0.01	3.3%	74.9%
6C Waste Incineration	N_2O	36,852	35,249	0.03	0.00	2.2%	77.1%
1AMobile Combustion-Navigation	CO_2	2,654	6,854	0.01	0.00	1.9%	79.0%
2A Mineral Product-Cement Production	CO_2	26,589	32,569	0.03	0.00	1.8%	80.7%
4B Manure Management	CH_4	6,457	3,566	0.00	0.00	1.6%	82.4%
2B Chemical Industry-Ammonia Production	CO_2	8,457	5,748	0.00	0.00	1.6%	84.0%
1A Mobile Combustion-Civil aviation	CH_4	965	4,125	0.00	0.00	1.5%	85.4%
4B Manure Management	N_2O	8,655	6,485	0.01	0.00	1.4%	86.8%
1A Mobile Combustion-Railway	CH_4	1,689	4,597	0.00	0.00	1.3%	88.1%
1AMobile Combustion-Navigation	N_2O	3,265	6,245	0.01	0.00	1.3%	89.4%
1A Mobile Combustion-Civil Aviation	CO_2	25,687	25,489	0.02	0.00	1.1%	90.5%
1A Mobile Combustion-Railway	N_2O	3,254	5,682	0.00	0.00	1.0%	91.5%
2B Chemical Industry-Nitric Acid Production	N_2O	215	2,155	0.00	0.00	0.9%	92.5%
1A Stationary Combustion	CH_4	3,154	1,524	0.00	0.00	0.9%	93.4%
2B Chemical Industry-Adipic Acid Production	N_2O	3,156	5,247	0.00	0.00	0.9%	94.2%
6B Wastewater Handling	CH_4	4,621	3,264	0.00	0.00	0.8%	95.0%
2A Mineral Product-Other	CO_2	6,852	5,822	0.00	0.00	0.8%	95.8%
1A Mobile Combustion-Civil Aviation	N_2O	2,569	1,255	0.00	0.00	0.7%	96.5%
1AMobile Combustion-Navigation	CH_4	6,249	5,248	0.00	0.00	0.7%	97.3%

Thank you

WGIA-6
Wrap-up Session Summary

18 July 2008

Overall Recommendations

- Continued and enhanced information exchange,
  - More targeted use of WGIA online network list serve and newsletter to share information (i.e. soil carbon inventory)
  - Meetings should include an update or review of country contributions to "Asian region" EF database, literature, etc.
  - Discuss other sectors (industrial processes, energy)
  - Sharing on availability and use of remote sensing data?

Note: Dependent upon active participation and contributions from WGIA countries

Group Recommendations

- **LULUCF working group recommendations**
  - Consider organizing training session can be organized on Century model to enable participating countries to simulate the five carbon pools essential for the inventory estimates
    - This will help in identifying the input data needs that each country may need
  - Continued exchange - challenges and opportunities countries are various stages in inventory preparation and have also varying levels of data and capacity (good exchange opportunity)
- **Waste working group recommendations**
  - Next WGIA should focus on methane emissions from wastewater treatment
  - Information sharing through WGIA online network and SWGA
    - Establishment of data collection format (some general form that inventory teams can use to communicate to statistical agencies about data needs)
    - Identification of country specific waste composition (best practices for addressing data constraints)
      - Provide customized approaches or guidance given four levels of data collection systems namely: no data, not enough data, poor data quality and good quality data

Group Recommendations cont.

- **Agriculture working group recommendations**
  - Short-term (next meeting)
    - Country presentations on specific EF developments
    - Exchange and review of Ag inventory information of each country by all the WGIA participants
  - Long-term
    - Include soil C inventory as a category for discussion (use of Century model?)
    - Sharing of strategies for communicating "multipurpose" use of inventory data to policymakers (estimates emissions, but also indicator of sustainable agriculture production)
    - Enhanced international collaboration (1 meeting is not necessarily enough?)

Group recommendations cont.

- General GHG Inventory working group recommendations:
  - WGIA members and SEA project will develop a template on communicating with policy makers and how to share information-results to be presented at future WGIA meetings and (sooner if possible)
  - Compile list of Regional Experts/Institutions as resource
  - WGIA could serve as forum to evaluate/compare inventories (in whole or part for QA – not formal process
  - WGIA encourages case studies by some countries to develop time series and Japan will consider supporting these case studies [how]
  - Try to hold inventory compiler training programme perhaps in association with a UNFCCC training course with next WGIA meeting (Annex I review are good training for reviewers, but require resources.)
  - WGIA participant could volunteer to develop an Uncertainty Analysis as a Case Study:
    - Make spreadsheet available
    - Develop uncertainty analysis based on key categories and use simple approach
    - Consider outcome at next WGIA meeting

Some Questions/Comments

- Many recommendations, priorities?
  - Consider key sources
  - Clarify technical assistance needs and how best WGIA can help (or others)
  - Training requires participation of appropriate experts (Ag, LULUCF) to be effective

Annex

- Detailed group summaries

Working Group 1: LULUCF

- Working Group 1 "information exchange":
  - Experiences of other countries also sought regarding the preparation of LULUCF Inventory
    - This is expected to bring forth a wider range of issues that are posing as constraints towards the development of their respective inventories
    - Training on methodology itself (definitions)
- Working Group 1 recommendations:
  - A training session can be organized on Century model to enable participating countries to simulate the five carbon pools essential for the inventory estimates

    This will help in identifying the input data needs that each country may need
  - Challenges and opportunities – countries are various stages in inventory preparation and have also varying levels of data and capacity (good exchange opportunity)

Working Group II: Waste

- Working group 2 "information exchange":
  - Discussed strategies for data collection
  - Recognized need for improved communication is needed between data users and data suppliers (statistical agencies)
- Working group 2 recommendations:
  - Next WGIA should focus on methane emissions from wastewater treatment
  - Information sharing through WGIA online network and SWGA
    - Establishment of data collection format (some general form that inventory teams can use to communicate to statistical agencies about data needs)
    - Identification of country specific waste composition (best practices for addressing data constraints)
      - Provide customized approaches or guidance given four levels of data collection systems namely: no data, not enough data, poor data quality and good quality data

Working Group 3: Agriculture

- Working group 3 "information exchange":
  - Sharing of inventory preparation for specific source categories
  - Sharing of data improvement strategies
  - Improve collaboration between researchers and compilers
- Working group 3 recommendations:
  - Short-term:
    - Country presentations on specific EF developments
    - Exchange and review of Ag inventory information of each country by all the WGIA participants
  - Long-term:
    - Include soil C inventory as a category for discussion (use of Century model?)
    - Sharing of strategies on communicating "multipurpose" use of data (GHG inventories, but also indicator of sustainable agriculture production)
    - Enhanced international collaboration (1 meeting is not necessarily enough?)
    - More targeted use of WGIA list serve and newsletter

Working Group 4: GHG Inventory

- Working group 4 "information exchange":
  - Share strategies for communicating and linking GHG inventories to other priority activities to ensure continuity of inventories
- Working group 4 recommendations:
  - WGIA members and SEA project will develop a template on communicating with policy makers and how to share information-results to be presented at future WGIA meetings and (sooner if possible)
  - Compile list of Regional Experts/Institutions as resource
  - WGIA could serve as forum to evaluate/compare inventories (in whole or part for QA – not formal process
  - WGIA encourages case studies by some countries to develop time series and Japan will consider supporting these case studies [how]
  - Try to hold inventory compiler training programme perhaps in association with a UNFCCC training course with next WGIA meeting (Annex I review are good training for reviewers, but require resources.)
  - WGIA participant could volunteer to develop an Uncertainty application Case Study:
    - Make spreadsheet available
    - Develop uncertainty analysis based on key categories and use simple approach
    - Consider outcome at next WGIA meeting

Annex 1

Agenda

Day 1, Wednesday 16th July		
10:00~10:30		**Participant Registration**
10:30~11:40	**Opening Session** Chair: Takahiko Hiraishi	
10:30~10:35	Hideki Minamikawa	Welcome Address (MoEJ)
10:35~10:40	Ryutaro Ohtsuka	Welcome Speech (NIES)
10:40~11:00	All	Introduction of Participants
11:00~11:10	Yukihiro Nojiri	Overview of WGIA6
11:10~11:25	Jamsranjav Baasansuren	Progress Report on WGIA Activities
11:25~11:40	All	Q&A
11:40~11:50		***Photo***
11:50~15:30	**Session I: Promotion of International Cooperation** Chair: Yukihiro Nojiri Rapporteur: Jose Ramon T Villarin	
11:50~12:00	Kotaro Kawamata	Importance of Measurement for Global GHG Reduction
12:00~12:20	Sei Kato	Japan's Policies and Efforts on GHG Inventory, Measurement and Reporting
12:20~12:35	Dominique Revet	Latest Update on non-Annex I National Communications
12:35~13:45		***Lunch Break***
13:45~13:55	Kiyoto Tanabe	Cooperation with Europe
13:55~14:15	Mausami Desai	U.S. Programs and Efforts on GHG Inventories, Measurement and Reporting
14: 15~14:35	Leandro Buendia	Regional Capacity Building Project for Sustainable National GHG Inventory Management Systems in Southeast Asia (SEA Project)
14:35~14:50	Todd Ngara	Some African Experiences in GHG Inventory Preparation

14:50~15:20	All	Q&A and Discussion
15:20~15:40		***Tea Break***
15:40~18:00	**Session II: Uncertainty Assessment** Chair: Leandro Buendia Rapporteur: Amnat Chidthaisong	
15:40~15:50	Kiyoto Tanabe	Guidance to Session II
15:50~16:10	Simon Eggleston	Uncertainty Analysis in Emission Inventories
16:10~16:30	Kohei Sakai	Uncertainty Assessment of Japan's GHG Inventory
16:30~16:50	Sumana Bhattacharya	Uncertainty Assessment: India's Experience
16:50~17:10	Cheon-Hee Bang	Uncertainty Evaluation of Waste Sector : Korea's Experience
17:10~17:30	Nguyen Chi Quang	Uncertainty Assessment in GHG Inventories in Vietnam
17:30~18:00	All	Q&A and Discussion
18:30~20:30		***Dinner (at the NIES canteen)***
Day 2, Thursday 17th July		
9:30~11:40	**Session III: Time Series Estimates and Projection** Chair: Dominique Revet Rapporteur: Todd Ngara	
9:30~ 9:40	Kiyoto Tanabe	Guidance to Session III
9:40~ 10:00	Sei Kato	Global Warming-related Policies of the Japanese Government: Kyoto Protocol Target Achievement Plan
10:00~10:20	Sirintornthep Towprayoon	Time Series Estimation and Projection of GHG Emissions
10:20~10:40	Dadang Hilman	Indonesia's Experiences in Developing of Time Series Estimates and Projections (Including Evaluation of Impacts of Policies and Measures)
10:40~11:00		***Tea Break***
11:00~11:40	All	Q&A and Discussion
11:40~12:50		***Lunch Break***

12:50~16:45	**Session IV: Working Group Discussion**	
12:50~13:05	Kiyoto Tanabe	Guidance to Session IV
13:05~16:45	**WG: LULUCF Sector** Chair: Sumana Bhattacharya	 Rapporteur: Batimaa Punsalmaa
	Yoshiki Yamagata	Remote Sensing Based Monitoring System for LULUCF
	Sumana Bhattacharya	Approach for Preparing GHG Inventory from the LULUCF Sector in India
	Damasa B. Magcale-Macandog	Improving Secondary Forest Above-ground Biomass Estimates Using GIS-based Model
	Mitsuo Matsumoto	Japan's Forest Carbon Accounting System for Kyoto Reporting
	WG	Q&A and Discussion
13:05~16:45	**WG: Waste Sector** Chair: Tomonori Ishigaki	 Rapporteur: Sirintornthep Towprayoon
	Tomonori Ishigaki	Property and Reliability of Waste Data
	Gao Qingxian	Use of Surrogate Data in Waste Sector Estimation (China's case)
	Hiroyuki Ueda	Development of Waste Sector GHG Inventory in Japan
	Normadiah Haji Husien	Malaysia: Report for Greenhouse Gas Inventories for Second National Communication (NC2), (Waste Sector)
	WG	Q&A and Discussion
13:05~16:45	**WG: Agriculture Sector** Chair: Kazuyuki Yagi	 Rapporteur: Shuhaimen Ismail
	Kazuyuki Yagi	Introductory Presentation
	Osamu Enishi	Measurement Method of GHG Emission from Ruminants and Manure Management
	Hiroko Akiyama	CH_4 and N_2O from Rice Paddies in 2006 IPCC GLs and Estimate of Japanese Country Specific N_2O Emission Factors
	Shuhaimen Ismail	NC2 - GHG Inventory
	Amnat Chidthaisong	Thailand Greenhouse Gas Inventory in

		Agricultural Sector
	Nguyen Van Anh	Vietnam's GHG Inventories in Agriculture Sector
	Leandro Buendia	GHG Inventory Issues in SEA Countries: Agriculture Sector
	Toshiaki Ohkura	A Perspective of Agriculture Sector Involvement in Asian GHG Inventory beyond 2013
	WG	Q&A and Discussion
13:05~16:45	**WG: GHG Inventory** Chair: Thy Sum Rapporteur: Simon Eggleston	
	Jose Ramon T Villarin	Raising Awareness of GHG Inventories and CC in the Philippines
	Kyonghwa Jeong	Korea's Experience in Awareness Raising About GHG Inventory and Climate Change
	Takeshi Enoki	Other GHG Inventory Related Issues
	Shu Yee Wong	Awareness Raising on GHG Inventory and Climate Change: Singapore
	WG	Q&A and Discussion
14:45~15:05		***Tea Break***
17:00~18:00	**Hands-on Training Session on Key Category Analysis**	
17:00~17:15	Jamsranjav Baasansuren	Introduction to Key Source Analysis
17:15~18:00	All	Training
	Day 3, Friday 18th July	
9:30~12:40	**Wrap-up Session** Chair: Takahiko Hiraishi Rapporteur: Mausami Desai	
9:30~10:30	Speakers from the Working Groups	Reports of Group Discussions
10:30~11:00	All	Discussion
11:00~11:15		***Tea Break***
11:15~12:00	Rapporteurs	Overall Summary of Session I , II & III
12:00~12:30	All	Discussion on Future Activities

	Mausami Desai	Wrap-up
12:30~12:40	Yoshifumi Yasuoka	Closing Remarks (NIES)

Annex II: List of Participants

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