

Proceedings of International Workshop on

**Evaluation and Sustainable Management of
Soil Carbon Sequestration in Asian Countries**

Bogor, Indonesia, September 28-29, 2010



Indonesian Soil Research Institute (ISRI),
ICALRRD, IAARD,
Ministry of Agriculture, Indonesia



Food & Fertilizer Technology Center
for the Asian and Pacific Region
(FFTC), Taiwan



National Institute for
Agro-Environmental Sciences
(NIAES), Japan

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Edited by

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Foreword

Soil is not only important for supporting the livelihood of the human beings, fauna and flora, but also an important storage of carbon. The soil organic carbon (SOC) pool is about 3.3 times the amount of the atmospheric C pool and 4.5 times the amount of the biotic C pool. SOC affects the soil fertility and in turns determine the plant and animal biomass.

The SOC pool to 1m depth ranges from 30 Mg ha⁻¹ in arid climates to 800 Mg ha⁻¹ in organic soils in cold regions as well as in the tropical peatland, with a predominant range of 50 to 150 Mg ha⁻¹ in mineral soils. The SOC pool represents a dynamic equilibrium of gains and losses of C in soil system. Conversion of natural forest to agricultural ecosystems causes depletion of the SOC pool by as much as 60% in soils of temperate regions and 75% or more in cultivated soils of the tropics. Management of degraded soils may restock the soil carbon and, to some extent, mitigate the global warming and climate changes.

This proceedings is a compilation of invited papers presented in the international workshop on *Evaluation and Sustainable Management of Soil Carbon Sequestration in Asian Countries*, held at the IPB International Convention Center, Bogor, Indonesia, from 28 to 29 September, 2010. The invited papers cover ranges of topics from soil database and mapping of SOC, soil management and spatial and temporal changes of SOC by different land uses, as well as properties and dynamics of carbon in peatland areas.

We are confident that the publication of this proceedings is very timely for scientists, researchers, academicians, as well as students and the intensive discussion on green house gas emission reduction and carbon sequestration from all sectors.

September 2010
Editors

Welcome Address: The Role of Organic Matter for Life on Earth; the Past, Present, and Future

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On behalf of the National Institute for Agro-Environmental Sciences (NIAES), it's my great pleasure and honor to give the welcome address on the opening of the International Workshop on Evaluation and Sustainable Management of Soil Carbon Sequestration in Asian Countries. First of all, I would like to express my deepest appreciation to the Food and Fertilizer Technology Center, Indonesian Soil Research Institute, and to all participating in this workshop. This workshop is very timely organized as the continuing rise in the atmospheric concentration of carbon dioxide (CO₂) is driving change in the Earth's climate. Fear of global warming is becoming reality.

Soil is a very important storage place of carbon on the Earth. The global soil carbon pool is more than three times the size of the atmospheric pool, and 4.5 times the size of the biotic pool. From the viewpoint of global environmental issues, one of the most important functions of soil is to exchange gases with the atmosphere, consequently influencing the CO₂ concentration of the atmosphere and, consequently, the climate of the Earth.

More than 60% of the soil carbon pool is organic carbon, which is in a dynamic equilibrium of gains and losses. The gains of soil organic carbon can be called "biosequestration," the capture and storage of CO₂ by biological processes.

Biosequestration as a natural process has occurred throughout geological history, and has had a great effect on the climate. In the early Paleozoic, around 0.4 to 0.5 billion years ago, the concentration of CO₂ in the atmosphere was 20 times higher than it is now. However, in the late Paleozoic, during the Carboniferous period (3.67-2.89 billion years ago) in particular, the atmospheric CO₂ level decreased significantly, to the level it is now. This was a result of biosequestration. A huge amount of CO₂ was captured by biomass, and sequestered in soil and under water, resulting in large deposits of coal. Two factors made this possible. First, plants acquired the ability to produce lignin—in particular the appearance of bark-bearing lignin. The second was the development of extensive lowlands, which were a result of lower sea levels. The early part of the Carboniferous period was mostly warm. Forests sprung up around swamps, and a large quantity of wood was buried during the period. Microorganisms and animals had not acquired the ability to degrade lignin. This large amount of carbon sequestration also brought about an increase in atmospheric oxygen (O₂), which was as high as 35%, compared to 21% today. In the later part of the Coniferous period, the climate cooled as the atmospheric CO₂ level decreased due to carbon sequestration. Then the period of glaciation started.

A huge biosequestration event also occurred about 10,000 years ago, spanning the postglacial period down to the present era, which was relatively recently in the geological time scale. A large amount of carbon was stored as peat and soil organic matter. Peat is an accumulation of partially decayed plant matter, formed in wetlands. In peat formation, because of anoxic and acidic conditions, microbial decomposition is repressed. By volume, there is about 4 trillion m³ of peat in the world, covering around 2% of the global land mass. The world's peat lands are thought to contain 180 to 455 Gt of sequestered carbon. This figure is almost comparable to the level of the biotic carbon pool. As carbon sequestration as peat occurred after the postglacial period, the atmospheric CO₂ level would have been much higher than the current level without it.

Deforestation, land use change, and the drainage of peat bogs are occurring in this area at the moment, which will contribute to an increase in the world CO₂ level. Peat deposits will be depleted by 2040. It is a pressing matter to review the current status of soil carbon pools in this region and to formulate a strategy to prevent losses, as well as to increase the storage of soil carbon in this region. The development of a soil information system that is useful in this field is highly anticipated. I believe that it is of great value that researchers and experts get together and share their insights in this workshop. My sincere hope is that we will have fruitful discussions.

Finally, I would like once again to thank all the participants. I really hope that this workshop will be successful and mark the start of intimate collaboration among the countries in the ASPAC region.

Welcome and Opening Address

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*International Workshop on Evaluation and Sustainable Management of Soil Carbon
Sequestration in Asian Countries
Bogor, 28-29 September 2010*

Dr. Hideo IMAI, Deputy Director of the Food and Fertilizer Technology Center (FFTC), Taiwan
Dr. Kiyotaka MIYASHITA, Vice President of the National Institute for Agro-Environmental Sciences (NIAES), Japan
Dr. Zueng-Sang Chen, Distinguished Professor of Department of Agricultural Chemistry, National Taiwan University

Distinguished guests, ladies and gentlemen.

For our guests who have travelled from abroad, we would like to extend our warm welcome to Indonesia, especially to the rain city of Bogor. We are very grateful that you make it to this International Workshop on Evaluation and Sustainable Management of Soil Carbon Sequestration in Asian Countries.

With the growing attention among the global community on the global warming and climate change, the discussion on soil carbon stock and sequestration is indeed very timely. The two climatic phenomena are not only important for the global community, but it also affects the farming community, because of the lack of adaptability of the current varieties to warmer temperatures, more serious infestation of crops to pests and diseases, and more frequent and intense droughts and floods. In general, agricultural commodities in the tropics are victimized by the global warming and climate change, and thus we should advocate to the global community to move from just paying attention to real action in climate change mitigation. If the current trend of global warming continues, it will affect food security and the livelihoods of the world community.

Under the current debates of the United Nations Framework Convention on Climate Change (UNFCCC), agriculture is not a sector that is targeted to reduce green house gas emissions. Efforts in agriculture is more focused on the adaptation, rather than the mitigation. Nevertheless, agriculture can potentially contribute to the climate change mitigation and carbon sequestration through carbon restocking of the degraded *Imperata* grassland with tree based agriculture, improved management of peatland, as well as improved soil management to increase the soil capacity to sequester carbon.

Sustainable management of soil carbon sequestration is relevant to the land owners, in addition to the surrounding community. Reasonable carbon stock in the soils is an indication of resilient system. Soils with very low organic carbon are usually related to poor and degraded condition, whereas soils with 'reasonably good carbon storage' is an indication of good fertility, and environmentally protective soils. Therefore good soil carbon storage can normally support better plant growth as well as high carbon storage in the plant biomass, especially of the tree crops.

Ladies and gentlemen,

There are several efforts in Indonesia, specifically within the Ministry of Agriculture, which are relevant with this workshop. The Indonesian Agency for Agricultural Land Resources Research and Development through the various research centres and institutes has been contributing in the formulation of the Nationally Appropriate Mitigation Action (NAMA) plan of the Reducing Emissions from Deforestation and Degradation (REDD). IAARD has also engaged in several research

projects both under the national program and international collaboration along this line. So far we have been focusing on CO₂ emission and carbon stock measurements in peatland, assessment of carbon losses and uptake as affected by land use changes and methane emission from paddy soils. This workshop will definitely increase our awareness that carbon sequestration by soil may be significant and therefore, this subject will be incorporated into our future research agenda.

I appreciate the fact that the papers to be discussed in this workshop range from evaluating soil carbon stock using the archive of soil data base to the management systems for improving soil carbon, as well as the fate of carbon in peatland. All of this coverage is relevant for Indonesia. I hope that the discussion will lead to the strategic plan of how to go about improving the soil database, soil survey and soil management systems in the future.

I thank FFTC for all of the supports and collaboration in arranging in financing this workshop. Appreciation is also due to NIAES for the technical supports. I appreciate the organizers from FFTC and ISRI. And finally, the key to the success of this workshop depends on active participations of all of the speakers and the participants, to whom I address special thanks.

Following the two day discussion, I would recommend that all of the foreign participants will have opportunity to see more of Indonesia. I understand that the foreign participants will have opportunity to see not only more of Indonesian soil, but also Indonesian culture and landscape. I hope you will have opportunity to witness the nice scenery of tea plantation in Puncak, the moss collection at Cibodas Botanical Garden, the performance of Angklung - a Bamboo music instrument of West Java in Bandung and the crater of Tangkuban Perahu in Lembang.

I now would like to announce this workshop officially open. Have a fruitful discussion.

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WORKSKOP PROGRAM

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