



Commentary on the Contribution to Greenhouse Gas Absorption by the Forestry Sector in Taiwan

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Abstract

In Taiwan, 59% of area (i.e., 2.15 million ha, or 5.3 million acre) is covered by forests, less forested than some developed countries like Sweden (70%), Japan (67 percent) and South Korea (64 percent). More significantly, forest resources contribute to greenhouse gas (GHG) emission reduction and climate change mitigation by removing atmospheric carbon dioxide (CO₂) and storing it in biomass and other carbon pools. According to the national GHG inventory, the percentage of contribution to GHG absorption by forestry sector in Taiwan are only about 7.4% based on total GHG emissions (284,514 kilotons of CO₂ equivalents) in 2013. On the other hand, the Greenhouse Gas Reduction and Management Act (GGRMA) has been officially promulgated on 1 July 2015. In the paper, the author first described the brief of the GGRMA regarding the role in the Taiwan's forestry sector. Thereafter, the contribution to GHG absorption by forestry sector in Taiwan was analyzed according to the "2015 Taiwan Greenhouse Gas Inventory". Finally, some perspectives were addressed to enhance carbon sequestration by the forestry sector in Taiwan.

Keywords: Forestry sector; Taiwan; Carbon dioxide absorption; Forestry policy

Introduction

It is well known that global warming could be caused by the emissions of greenhouse gases (GHG) from anthropogenic activities that may be the most significant driver of observed climate change since the mid-20th century. These GHG compounds contain carbon dioxide (CO₂), methane (CH₄), nitrous oxide (N₂O), and fluorinated gases. On the other hand, land use and management will influence a variety of ecosystem processes that affect GHG emissions and absorption, such as photosynthesis and combustion (or forest fire). These processes mainly involve transformations of carbon that is driven by the biological (e.g., activities of plants), thereby acting as atmospheric CO₂ sink, carbon stocks or carbon pools. The key greenhouse gas of concern is carbon dioxide (CO₂). CO₂ fluxes between the atmosphere and ecosystems are primarily controlled by uptake through plant photosynthesis. According to the "2006 IPCC Guidelines for National Greenhouse Gas Inventories" [1], CO₂ fluxes in the Forestry and Other Land Use sector can be estimated in the following way. The use of carbon (C) stock changes to estimate CO₂ emissions and removals is based on the fact that changes in ecosystem C stocks are predominately through CO₂ exchange between the land surface and the atmosphere. Hence, the annual increase in total C stocks is equal to net removal (absorption) of CO₂ from the atmosphere, while the loss in total C stocks (e.g., harvested wood products) are equated with net emission of CO₂.

In Taiwan, nearly 60% of area (i.e., 2.20 million ha, or 5.3 million acre) is covered by forests, according to a government forest resource and land use survey [2]. More than 70% of Taiwan's forests primarily contain hardwood trees (i.e., 1.54 million ha), just more than 14% contain conifers (i.e., 0.30 million ha) and about 8% contain mixed

hardwood and conifers (i.e., 0.17 million ha). The remaining forested area contains mostly bamboo (i.e., 0.18 million ha). More significantly, forest resources are useful tools against global warming because they can absorb large quantities of CO₂ from the atmosphere. According to the report by the International Energy Agency [3], Taiwan is a major GHG country. The country's CO₂ emissions from fuel combustion only more than doubled from about 110 million tons in 1990 to 250 million tons in 2014. The amount of CO₂ emission per capita in 2014 is 10.7 tons, as compared to 5.5 CO₂ tons per capita in 1990.

In order to cut GHG emissions significantly in the near future, the Greenhouse Gas Reduction and Management Act (GGRMA) was passed on 15 June 2015 by the Taiwan's congress. The act sets a mandatory reduction target for Taiwan's overall GHG emissions and also provide the way for a carbon cap-and-trade system to be established in Taiwan. In this regard, the forestry sector in Taiwan will play a vital role in the GHG absorption and climate change adaptation.

Brief Description of the GGRMA Regarding the Role in the Taiwan's Forestry Sector

In Taiwan, the GGRMA was officially promulgated on 1 July 2015, providing a legal basis for mitigating GHG emissions, and also stipulating the carbon reduction targets in Taiwan. The Act aims at establishing strategies to reduce and manage GHG emissions, strengthening environmental justice, and the shared responsibility of environmental protection and sustainable development. In this regard, it groups 34 articles into six chapters, including general principles, authority and responsibility of government agencies, emission reduction measures, education and grants, penalty provisions, and supplementary provisions. In addition, the Environmental Protection Administration (EPA) is the central competent authority, which charges it with formulating national climate change guideline and action programs to reduce GHG emissions response. More

significantly, long-term national GHG emission reduction goal in Taiwan stipulated by the Act shall be to reduce GHG emissions to no more than 50% of 2005 GHG emission by 2050.

To meet global GHG emission reduction strategy, the central competent authority has formulated "Healthy Forest Carbon Management" as a comprehensive target under the Forestry Act. The policy entails implementation of three management strategies: carbon sequestration, carbon conservation, and carbon substitution. Active ways towards "Healthy Forest Carbon Management" are good forest management and expansion of reforestation. For example, the Taiwan government has actively encouraged "Afforestation in the Flat Area" and "Green Afforestation" projects that targets abandoned farm and lands. In the past two decades (1992-2012), total reforestation area with hardwoods has reached over 120,000 ha. Planting trees will increase absorption of CO₂ from the atmosphere. Regarding the role in the Taiwan's forestry sector, the relevant central government agencies, including the Forestry Bureau and the Taiwan Forestry Research Institute under the Council of Agriculture, shall promote GHG reduction and climate change adaptation through the following actions: Forest resource management, biodiversity conservation, and strengthening of forests' carbon sequestration. Under the promulgation of the GGRMA, the Forestry Bureau in Taiwan must actively promote reforestation in the near future by providing economic incentives for the farmers. In addition, the GHG offset project operators may request the central competent authority (i.e., EPA) to issue reduction credits representing emission reductions (including carbon sinks) verified by verification bodies. According the definition by the Act, carbon sink means any process or mechanism, which removes a GHG from the atmosphere such as trees and forests.

The Contribution to GHG Absorption by Forestry Sector in Taiwan

According to the 17th Convention of the Parties (COP17) of the United Nations Framework Convention on Climate Change (UNFCCC), the national GHG emissions inventory in Taiwan has been carried out in accordance with the "2006 IPCC Guidelines for National Greenhouse Gas Inventories". Table 1 summarized the annual statistics on total GHG emissions, net GHG emission and GHG absorption by the forestry sector in Taiwan since 1990 [4] is based on It can be seen that total GHG emissions in Taiwan increased from 136, 178 kilotons of CO₂ equivalents in 1990 to 284,514 kilotons of CO₂ equivalents in 2013, which is equivalent to the increase by about 109% at an annual growth rate of 3.0% on average. By contrast, net GHG emissions in Taiwan increased from 116,913 kilotons of CO₂ equivalents in 1990 to 263,445 kilotons of CO₂ equivalents in 2013, with GHG emissions by 125% and an average annual growth rate of 3.2%.

In Taiwan, the main source of GHG absorbed by land use and forestry sector is carbon dioxide (CO₂) and the annual carbon stock increase from forestry resources. According to the "2006 IPCC Guidelines for National Greenhouse Gas Inventories", carbon pool stored in forest should include biomass, dead organic matter (including dead wood and litter) and soil organic matter. The contribution to the GHG absorption by the latter two sources was assumed to be ignorable in the "2015 Taiwan Greenhouse Gas Inventory". The GHG emission and absorption by land use and forestry sector for Taiwan from year 1990 to 2013 (mainly consists of CO₂ absorption by forestry resources) is shown in Table 1. Herein, the GHG emissions (year-on-year loss) from existing forests include wood

removals (harvest), fuel wood, and disturbance (e.g., typhoon, forest fire, illegal logging, and reclamation). For example, the loss value in 2009 (i.e., 2,753 kilotons of carbon dioxide equivalents) was caused by the Typhoon Morakot, which was the deadliest typhoon to impact Taiwan on August, triggering enormous mudflow, severe flooding and hill slide [5]. On the other hand, the term "other lands turned to forests" means the biomass increase by afforestation and reforestation in the plain area. In 2013, the CO₂ absorption by the forestry sector was 21,069 kilotons of carbon dioxide equivalents, up by 26 kilotons of carbon dioxide equivalents compared to that in 2012 (0.13%). The CO₂ absorption between 1990 and 2013 was increased to about 9.4%, which is equivalent to an average annual growth rate of 0.39%.

Conclusions and Perspectives

Sustainable forest management not only reduces GHG emissions from deforestation and forest degradation, but also provides an adaptation pool for air quality and bio resource activity. Thus, as international concerns about climate change and CO₂ emission mitigation have increased, the central government agency in Taiwan (i.e., the Forestry Bureau) must shift the focus of afforestation and reforestation from helping farmers and stabilizing hill slopes to sequestering carbon by existing forest resources and other plain lands turned to forests.

It is especially of significance that the Greenhouse Gas Reduction and Management Act (GGRMA), promulgated on 1 July 2015, shall provide the legal basis for the Taiwan's GHG reduction target for the year 2050. As the forest resource is only sector for carbon sequestration in the calculation of national GHG inventory, the following perspectives can be drawn below.

Year	Total GHG	CO ₂ absorption				Net GHG
		Existing forests		Other lands turned to forest	Overall	
		Increase	Loss			
1990	1,36,179	-19,782	607	-91	-19,265	1,16,913
1995	1,86,005	-19,831	202	-288	-19,917	1,66,088
2000	2,46,877	-19,893	389	-663	-20,168	2,26,709
2005	2,89,435	-19,956	369	-1,029	-20,616	2,68,819
2006	2,95,800	-19,968	251	-1,043	-20,616	2,75,040
2007	2,97,994	-19,980	308	-1,077	-20,616	2,77,245
2008	2,81,873	-19,993	199	-1,138	-20,616	2,60,941
2009	2,65,700	-20,005	2,753	-1,162	-20,616	2,47,286
2010	2,83,609	-19,911	218	-1,236	-20,616	2,62,681
2011	2,88,582	-19,929	140	-1,198	-20,616	2,67,595
2012	2,82,004	-19,944	145	-1,279	-20,616	2,60,927
2013	2,84,514	-19,981	135	-1,223	-20,616	2,63,445

Table 1: Greenhouse gas (GHG) emission inventories and carbon dioxide absorption by forestry sector in Taiwan. ^aData source [4]; Unit: kilotons of carbon dioxide equivalents.

The percentages of contribution to GHG absorption by forestry sector in Taiwan are only about 7-14% based on total GHG emissions. The values are less than those by other developed countries. The contributions to the GHG absorption by the dead organic matter and soil organic matter should be counted in using some methodical ways.

Woods or wood-based products belong to green (building) materials due to their ecological and recycled features. Unfortunately, current rate of wood self-sufficiency in Taiwan is less than 1%. In this regard, the domestic timber supplies should be increased and upgraded, while maintaining a commitment to sustainable forest management.

References

1. Intergovernmental Panel on Climate Change (IPCC) (2006) 2006 IPCC guidelines for national greenhouse gas inventories. IPCC/WMO/UNEP, Hayama, Japan.
2. Council of Agriculture (COA) (2016) 2015 Taiwan Agriculture statistics yearbook. COA, Taipei, Taiwan.
3. Fatih B (2016) Key world energy statistics 2016. The European Commission, International Energy Agency, Paris, France.
4. EPA (2016) 2015 Taiwan greenhouse gas inventory. Environmental Protection Administration, UNFCCC, Taipei, Taiwan.
5. Chien FC, Kuo HC (2011) On the extreme rainfall of Typhoon Morakot (2009). *J Geophys Res* 116: 1-22.