Analysis and Development Suggestions of International Forest Carbon Sink Projects—Based on VCS Project Considerations

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Abstract: It has been more than 20 years since the signing of the *Kyoto Protocol*, and carbon sinks and carbon sink transactions have also undergone considerable development. A variety of emission rights unit carriers, mechanisms, and types of carbon sink projects have been developed in parallel. As an important part of the international carbon sink trading system, what is the development of the forest carbon sink project? This article selects the VCS project as the representative of the forest carbon sink project as the entry point, and summarizes and organizes the data of the VCS project, so as to statistically analyze the development status and uncertainty and risk of the VCS project. Finally, based on the international carbon sink trading According to the development situation, four suggestions are given to attach importance to the non-carbon benefits of carbon sink projects, open the carbon sink market, multiple mechanisms in parallel, constantly explore new paths, new methods, and standardize the market trading system.

1. Introduction

The term “carbon sink” is derived from the *“Kyoto Protocol”*, which entered into force on February 16, 2005. The agreement formed the international “carbon emissions trading system” (referred to as “carbon sink”). The purpose is to offset the carbon emissions of the relevant countries through the carbon sequestration of forests in order to deal with global climate change.

In layman's terms, forest carbon sinks refer to the ability of forests to absorb and store CO_2. Data show that forests with less than one third of the land area absorb nearly half of the carbon emissions. Although forest carbon sink projects have developed significantly in recent years, it still faces various problems in its specific development process. Therefore, systematically combing the development and uncertainty of global forest carbon sink projects, and then putting forward constructive opinions and suggestions, has important theoretical and practical significance.

2. Status Analysis

2.1 Theoretical Research

2.1.1 Research on Forestry Carbon Sink Projects

With the warming of the climate and the increasing carbon emissions, forestry has been included in the international process of combating climate change and has attracted wide attention from all parties in the world. Forestry-related issues have also frequently appeared at previous climate change conferences.

In order to promote the increase of forest carbon sinks in various countries and regions, carbon sinks are allowed to be traded in the market, on the one hand, to realize its ecological compensation value, and on the other hand, to provide economic compensation to sellers, transform ecological

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advantages into economic advantages, and encourage multiple parties to participate carbon sinks and carbon sink trading.

At present, international forestry carbon sink projects mainly include Clean Development Mechanism (CDM) projects, Gold Standards (GS) projects, and Voluntary Carbon Standard (VCS) projects. In recent years, China has also actively developed carbon sink trading. The completed forestry carbon sink projects include the Chinese Certified Emission Reduction (CCER) project, the Fujian Forestry Certified Emission Reduction (FFCER) project, the Guangdong PuHui Certified Emission Reduction (PHCER) project and so on.

Table 1 Forestry Content Reached at Some Conferences or Agreements.

years	Conference or Documents	Forestry content
1997	*Kyoto Protocol*	"Afforestation, reforestation, sustainable forest management" as one of the emission reduction measures in developed countries
2007	*Bali Action Plan*	Incorporating reducing deforestation and increasing forest carbon sinks in developing countries into action plans
2009	*Copenhagen Accord*	Substantial progress has been made in forestry issues, for example, countries will adopt mechanisms such as REED + and carbon trading
2010	Cancun Climate Conference	*REED* + and *LULUCF* issues passed, leading to breakthroughs in forestry issues
2011	Durban Convention	Adopted three forestry related issues
2013	Warsaw Climate Conference	*REED*+ action items pass package decision
2015	*Paris Agreement*	Forests and related content added to the *Paris Agreement* as separate articles

2.1.2 Research on Forest Carbon Sink Measurement Methods

After the signing of the *Kyoto Protocol*, forest carbon sinks have attracted worldwide attention. In order to better evaluate the ecological and expected economic benefits of projects, the measurement of forest carbon sinks is essential. In recent years, a large number of methods for estimating forest carbon have been developed globally, mainly including forest vegetation and soil carbon estimation based on inventory investigation, and empirical model estimation based on growth and harvest. In actual forest carbon measurement, according to the characteristics of different forest types and data acquisition, different carbon measurement methods are often adopted, even more than one.

2.1.3 Certification and Supervision Certification of Carbon Trading Objects

Carbon trading is the trading of carbon emissions, which is essentially a carbon credit transaction. Carbon sink projects need to be certified before they are listed for trading, and different emission unit carrier mechanisms and their supervision and certification institutions are also different.

Table 2 Global Carbon Emission Rights Ownership Mechanism and Supervision and Certification Agency.

Emission Unit Carrier	Owning mechanism	Supervisory Certification Authority
AAUs RMUs	IET	National registries of Annex I countries to the *Kyoto Protocol*
EUAs	IET	*EU Country Distribution Pla*n
ERUs	JI	"Supervisory Committee" regulated by Article 6 of the *Kyoto Protocol*
CERs	CDM	Clean Development Mechanism Executive Board
VERs	Voluntary emission	Independent third party assessment and certification

CFI VCS	reduction mechanism	not covered by the *Kyoto Protocol*

2.1.4 Research on the Evaluation Method of Forest Carbon Sink Economic Value

The index of estimating the economic value of forest carbon sinks is mainly the price of its, and its unit is / t C. The carbon sink economy is a new type of economic format, and its price determination is also a new field. The expected economic value is also used as the main indicator to consider the value of a forest carbon sink project. At present, Carbon tax rate method and afforestation cost method are more commonly used in carbon sink economic value assessment methods [1]. Other methods include, but are not limited to, the cost-benefit method and the carbon tax method.

2.2 Main Compensation Standards and Mechanisms of the International Carbon Sink Market

2.2.1 Clean Development Mechanism. (CDM)

The CDM is a flexible mechanism arranged in the *Kyoto Protocol*. It allows developed countries to provide developing countries with funding and technology to implement greenhouse gas emission reduction projects in developing countries [2]. This mechanism not only fulfills the emission reduction requirements of developed countries to a certain extent, but also helps developing countries achieve sustainable development, and project implementers can also realize income through projects. Because of its Win-Win, the CDM project is also very popular in various countries, and it is also the largest compensation mechanism currently in place.

2.2.2 Gold Standard. (GS)

GS is a standard established by the World Wide Fund for Nature (WWF) to ensure the authenticity of emission reduction projects and the smooth realization of social, economic and environmental benefits.

2.2.3 Voluntary Carbon Standard. (VCS)

VCS was jointly developed by the Climate Group (CG), the International Emissions Trading Association (IETA) and the World Economic Forum (WEF) in 2005 with the goal of providing a global quality assurance standard for voluntary emissions trading projects.

2.2.4 Chicago Climate Exchange. (CCX)

CCX is the world's first and only North American greenhouse gas emission trading platform established by the United States in 2003. CCX operates on a membership basis, if members' emission reductions exceed the quota, they can sold the excess, but if it does not meet the standard, it must be purchased to the full in the market.

Table 3 Comparison of Major Compensation Standards in the International Carbon Sink Market.

Carbon compensation standard	Main supporter	Project type	Market mechanism	Price / Euro
CDM	UN Climate Change Organization	In addition to nuclear energy projects, REED projects	Project-based carbon credit trading	14~30
GS	Non-Governmental Environmental Organization	Only EE and RE projects	Project-based carbon credit trading	VERs:10~20 CERs:>10
VCS	Carbon market participants	All items	Project-based carbon credit trading	5~15

CCX	CCX members and carbon market participants	All items	Emissions permit trading	1.2~3.1

2.3 VCS project Development Analysis

2.3.1 Overview of VCS Project

With the popularization of the carbon sink concept and the continuous development of carbon sink projects [7], carbon sink trading also requires a wider trading market and more reliable quality assurance standards. In this context, CG, IETA and WEF developed VCS in 2005. This standard refers to the provisions of ISO14064-2 to quantify, monitor and report on emission reduction projects in order to measure the most reliable reductions. It is currently the most widely used carbon emission measurement standard in the world. So far, VCS has covered 15 sectors including energy demand, chemical industry, transportation, agriculture, forestry, and land use and others.

2.3.2 Overall Situation of VCS Project Market Development

Under the objective environment of climate warming and the high-efficient carbon sequestration capacity of forests, the subjective conditions of government assistance and active participation of international agencies, VCS has been widely recognized worldwide, and multi-national and multi-stakeholders actively participate in the declaration of VCS projects. According to statistics, VSC has received 164 applications for agricultural, forestry and land use projects of different scales, of which 79 have been approved and put into use. It is expected that the total annual emissions will reach 65215324 tCO_2e.

Table 4 Active Service Status of VCS Projects on all Continents.

Continents	East Asia	Oceania	North America	South Asia	Southeast Asia	Central America	Africa	South America	Total
Active duty	1	1	1	1	5	5	28	37	79

Source: collated from VCS project database https://www.vcsprojectdatabase.org/

It can be seen in the VCS database that the global participation of the entire project is low. Among them, only 37 countries or regions including unapproved projects participated in the VCS project application; of these 37 countries, only three were developed, namely the United States, Canada, and Australia. Of all the applications, only 79 were approved, accounting for 48.17% of the total number of applications.

2.3.3 Regional Distribution and Differences of Forest Carbon Sink Projects

The average forest coverage rate in the world is 22.0%, the continent with the most forests is Latin America, which accounts for 24% of the world's forest area, with forest coverage reaching 44%. And more than 50% of the world's forest resources are concentrated in five countries: Russia, Brazil, Canada, the US and China.

According to the data obtained, the applicant countries of the VCS project are mainly from Asia and the Americas, but unexpectedly, African countries have the highest participation, accounting for 35.14% of the total participating countries. There are significant differences between countries and between continents. Brazil, Colombia, Peru, and Kenya all have 10 or more applications, and the approval rate is as high as 69.84%. The gap between continents not only reflects the number of applications is more reflected in the estimated annual emissions. Africa leads the pack, followed by South America and Southeast Asia, the Americas dominate the total.

Table 5 Annual Estimated Emissions by Continent. (Including Temporarily Unapproved Projects)

Continents	South Asia	North America	East Asia	Oceania	Central America	Southeast Asia	South America	Africa
Estimated annual emissions tCO_2e	155322	377913	850501	1299150	2919715	17405081	20642523	21565119

Source: collated from VCS project database https://www.vcsprojectdatabase.org/

Combining the distribution of the world's forestry resources with the location of the VCS project applicant countries, each project is roughly located in a region rich in forestry resources, such as Southeast Asia, Western Africa, North of South America and its West Coast, and Central and Eastern North America.

3. Risk and Uncertainty

3.1 Shrinking Market Demand

After the initial growth of the VCS project market, with the increasing number of emission unit carriers, various factors have caused the demand for forest carbon sinks in the VCS project market to shrink. It can be seen from Table 2-4 that the price of VCS is lower than that of CDM and GS. Because of interest-driven, the sellers of VCS projects will naturally turn to the higher-priced CDM and GS markets.

Furthermore, compared with the first implementation period (2008-2012) of the *Kyoto Protocol*, the number of countries that have committed to reduce emissions in the second implementation period (2013-2020) is significantly reduced. Developed countries, including but not limited to the United States, Russia, Canada, and other countries withdrew from the *Kyoto Protocol* for political and economic reasons, and no longer undertake obligations or promise to reduce emissions. This in turn has led to a reduction in the global commitment to reduce emissions, which has also led to a relatively reduced carbon sink demand for VCS projects.

3.2 High Dependency on Forest Resources

A major feature of forest carbon sink projects is their high dependence on forestry resources. Forest rich areas have inherent advantages in the development of forest carbon sink projects. But it is clear that most countries rich in forestry resources are second- and third-world countries, and it is obviously difficult to require them to undertake excessive emission reduction obligations or carry out carbon sink projects before the economy has developed. Even the richer First World countries such as the United States [3], Russia, and Canada have no longer assumed emission reduction obligations because they withdrew from the *Kyoto Protocol*. The mismatch between the forestry resource rich land and the country that is mainly responsible for reducing emissions makes it difficult to launch carbon sink projects, which in turn leads to low market demand for VCS.

3.3 Differences in the Carbon Sink Market

There are currently 8 types of carbon sink markets that are generally recognized by the international market (see Table 2-3). Different unit carriers have their own control over different regions. For example, EUAs control the European market. The review and approval procedures for different unit carriers are also different, complicated and simple. The economic value of projects implemented under different unit carriers is also different, high or low. Different projects also have different review standards, technical standards, execution standards, etc, and the differences in standards make project owners prefer simpler projects.

VCS has its own characteristics, it has comparative advantages in terms of coverage of project types and wide application, but also has obvious disadvantages in terms of market prices and review processes.

3.4 Differences in the Development of Carbon Sink Markets in Various Countries

Although carbon sinks and carbon sink trading have officially entered the horizons of various countries since the end of the last century with the signing of the *Kyoto Protocol*, the time of the initial development of each country is different, and the degree of development of the carbon sink trading market is natural [4].

The development of markets to varying degrees makes the development of carbon sink projects in different countries different, and of course also makes the development of VCS different in different countries. In countries or regions with higher levels of development, a complete set of trading mechanisms has long been established and continuously improved, and it also plays a leading role in the carbon sink market and controls market transactions and rulemaking. As a latecomer, there are problems such as the unsettled relationship between carbon sinks and carbon emissions trading, the definition and legal status of carbon sink property rights, the carbon sink accounting method system and certification mechanism and facing market squeeze and moral pressure, etc.

3.5 Forestry Carbon Sink Trading is Deeply Affected by Emission Reduction Policies

Theoretically, forestry carbon sink trading is only a loose collection based on afforestation, reforestation, forest management, and deforestation project development and acquisition of the resulting carbon emission reductions and transactions. Therefore, only when a government sends a strong signal to reduce emissions will market demand increase substantially. For example, the implementation of emission reduction policies of the California and Australian governments in the United States has been strengthened, which has largely stimulated the market demand for forestry carbon sink trading in the California-Quebec carbon market, which has caused a surge in carbon trading volume [9].

4. Some Recommendations

4.1 Attaching Importance to the Non-carbon Benefits of Carbon Sink Projects

In addition to the ecological benefits brought by the carbon sequestration function, forest carbon sink projects also have economic and social benefits. Market participants value forest carbon sink projects not only because of their economic benefits, but also more importantly the "by-products"-ecological and social benefits that come with economic benefits, such as protecting biodiversity, tackling poverty, Enhance corporate image and more. Therefore, paying attention to the benefits of non-carbon sinks can not only tap the multiple effects of forest carbon sink projects, but also attract investors, thereby expanding the market demand for carbon sink trading and promoting better development of forest carbon sink projects.

4.2 Opening the Carbon Sink Market with Multiple Mechanisms in Parallel

Each country or region should implement a diversified mechanism to achieve diversification of the forest carbon sink trading market. Especially in underdeveloped areas, in the early stages of the development of forest carbon sink projects, we must avoid one size fits all, let alone rely on policies to form preferences in the early stages. We should actively encourage the parallelism of diversified mechanisms and gradually promote the pilot work of forest carbon sink market transactions, so that the market can choose the appropriate system and mechanism according to the specific conditions of each country or region.

4.3 Constantly Exploring New Paths and New Methods

The improvement and development of the carbon sink trading system will not happen overnight. It is not only related to the relevant technical standards of carbon sinks, but also to the economic development. Even CCX, which was established in 2003, has been continuously improved so as to cater to the market to the greatest extent and bring out the comprehensive benefits of carbon sink projects. Therefore, for less-developed countries or regions, we must first apply the existing model,

and use the experience of the forerunner to develop the forest carbon sink project first, and gradually build a unique carbon sink trading market system in the region.

4.4 Standardize the Market Trading System

In order to develop a forest carbon sink project [5], the ownership of property rights must be addressed first. Forest carbon sinks are the management and management of forest trees to achieve income. When the property owner is not clear, development will become a problem. Therefore, wherever forest carbon sinks are developed, property rights must be clarified first.

And development of forest carbon sink projects has problems such as long duration, large investment, and high uncertainty. The solution of these problems should be in line with reality and deal with scientifically. Governments, investors, and third-party institutions should perform their respective duties and do a good job of monitoring, managing, and evaluating projects in their respective links in order to reduce risks and potential losses and reduce unnecessary expenditures.

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