

A Practical Framework for the Assessment and Management of Natural Capital in Qinghai-Tibet Plateau

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Abstract

The concept of Natural Capital and the mechanism for trading ecosystem services emerged in 1990s has provided us new possibilities to establish sustainable ways of balancing environment conservation and human well-being in economic development. The purpose of this paper, following the concept proposed by Millennium Ecosystem Assessment, is to design a practical framework for assessing and managing ecosystem services with the support of information technologies and human networks. This framework bridges local knowledge and global sciences with integration of multimedia information, practical fieldwork and world-wide participation. Qinghai Province located in the heart of the Qinghai-Tibet Plateau is considered to be the first region for the implementation by the uniqueness of the remote highland with peculiar biodiversity, rich water resources and traditional indigenous cultures.

Keywords: Natural Capital, ecosystems services, sustainable development, Qinghai-Tibet Plateau

1. Environment conservation and economic development in China

China has made a remarkable economic achievement since the Reform and Open Policy in the end of 1970s. China's national GDP has grown up to the sixth country in the world by 2000, equal to 800US\$ per capital. However, we should remember that this growth was largely achieved in cost of serious environment damages and low efficiency of natural resources. China is the second largest country of CO₂ emission. Environment problems such as air pollution, soil erosion and land degradation become severe since 1980s. Though Chinese Government has to pay attentions in environment protection recently, taking policies like "afforest program" in mountainous and highland regions, the environmental deterioration has not stopped yet.

The environment crises in China are considered to be caused by couples of reasons. First, most of

residents, especially in rural areas, are struggling with poverties. Second, citizen's environmental consciousness is generally weak due to low educational levels. Third, local executives stubbornly run for economic growth but paying little concerns on environment. Fourth, institutions or legislations don't work well for monitoring and supervising environmentally illegal activities. Fifth, financial support in national and local budgets to environment is not enough. As the results, people think the works of environment conservation are costly and the matter of governments while enterprises tend to pursue for short-term economic profits. These brought mysterious things that ecosystems are continuously to be destroyed in one hand, while some places are in rebuilding in other hand.

It is hard to recover natural ecosystems from the heavy damages if we do not take any actions soon. Our time is very limited. The Chinese Government has announced the national goal to make a somewhat all-out abundant society by 2020 and lead the country to the mid-developed level by 2050. It is doubted that the natural land could accept unplanned developments for another 20 years and the global communities would allow China to use the natural resources unrestrictedly for another 50 years. The national goal won't become true unless we change our strategy to sustainable ways harmonizing with nature.

It is not as easy as speaking to find the way of sustainable development. Fortunately, the industrialized countries have suffered from the environment crises previously and have accumulated experiences and theories. For example, environmental pollutions in industrialization have been recognized in the United States since 1960's (Carson, 1962). Methodologies for planning through inventorying and assessing natural resources have been created by Ian McHarg in 1970's (McHarg, 1971). Those thoughts and practices have evolved to the concept of Natural Capital in 1990's (Hawken et al, 1999). Based on such scientific research and practices United Nations has kicked off the project "Millennium Ecosystem Assessment (MEA)" in 2000 with the support of scientists and governments of the world. Then the first output, a conceptual framework for the assessment of ecosystems and the development of human well-being was published in 2003 (MEA, 2003).

With the above background, this paper presents a practical framework of the assessment of Natural Capital for environment conservation and social development. It is an application of MEA's proposal embedded with information technologies, local knowledge and global sciences. This practical framework will be applied first to Qinghai Province, the heartland of the Tibet Plateau, with support of local communities, governmental sectors, academic institutions and global organizations.

2. Concept of Natural Capital

Hawken et al published a book in title of "Natural Capitalism" in 1999, in which Natural Capital is defined and its benefits for economic development were clearly explained. Although economic indicators such as Green GDP (Uno et al, 2002) and Genuine Progress Indicator (Cobb et al, 1995)

have been advocated for long, they haven't been accepted popularly so far. It was not grateful for governments to subtract influence of industrial activities on environment from GDP which is generally used to measure governors' performance.

Compared with Green GDP and others, Natural Capital is more inclusive. It aims to rebuild the bases and processes of economic activities in modern society. While enumerating the successful cases with Natural Capital, Hawken et al advocated the possibilities of natural environment for producing economic profits. This thought attracted the researchers of the world. Its Chinese version was published soon in the title of "The Theory of Natural Capital" in 2000 (Wang et al, 2000). One year later, its Japanese version was on bookshelves as "Economy of Natural Capital" (Sawa, 2001).

Natural Capital, just as the word, is an environmental term. It is defined as the sum of ecosystem services supporting all of the life on the earth. Ecosystem services can be classified into direct services and indirect services, or internal services and external services. Taking trees and forest as examples, the production of fruits and timber is direct service and environmental functions like storage and sequestration of CO₂ are indirect services. The owners and managers of the forests accept direct services by harvesting timber and other products, surrounding residents and others enjoy the indirect services such as the regulation of atmosphere and the purification of water quality etc. Most of ecosystem services are external and their consumers are indefinitely widely distributed.

Natural Capital is an economic term, too. It implies that the conservation and restoration of natural environment are able to be achieved through market economy. Using natural environment in such a market-oriented way may bring the change of industrial structure and the growth of economic efficiency of a region. This is just the same as the idea to upgrade the performance of government-run corporations through capitalization in stock market. Natural Capital is such an innovative concept for China where economic development, environment conservation, and the movement towards market economy must be simultaneously progressed.

Modern industrial activities and urban life bring impacts on natural environment. Because of the high industrial concentration, cities can't limit their emission within the capacity of local environment. The overload of cities to environment must be complemented by local and global natural systems such as paddy fields and forests outside of cities. The sites where the ecosystem services produced and consumed are geographically separated, such as downtown and suburb, upstream and downstream of river basins, upper land and lower land of mountains etc. The unbalance in production and consumption of ecosystem services and the economic disparities between developed and undeveloped regions are common issues in front of us. It could be calibrated through financial transfer or revenue reassignment within a country if such financial systems work well. Otherwise, the dissatisfaction occurs and conflicts rise among regions with rich ecosystem services but without enough budget to maintain the natural treasure.

It is preferable to establish such a system that links the producers and consumers of ecosystem services directly through market. The CO₂ emission trading so-called CDM (the Clean Development Mechanism) proposed in Kyoto Protocol is just such a mechanism. is such an example. The central government imposes the allowable volumes of CO₂ emission for regions, industries, enterprises. These regions or enterprises must make efforts to cut the emission through technical innovations and energy savings etc. They could purchase the CO₂ emission right for covering the some part of their task through market from the regions, companies and corporations with abundant emission right. The CO₂ emission was begin to be traded in Britain since 2002. The United States has SO₂ emission trading systems since 1992 while the price changes up and down from about 60 dollars to 250 dollars per ton.

Japan has studied the application of CDM deeply and is intend to try the mechanism since 2005. This partly originates to the initiatives of constructing the country as an ecological nation (Nakagawa, 2003). Japan has authorized Natural Rebuilding Code in 2003, and is putting forward the ecosystem rebuilding program in country wide. The Japanese Government is intent to impose concrete numerical goals of energy savings and emission cutting to industrial sectors, prefectures and enterprises. This have made companies positively to join the afforest activities especial in Asian countries and to transfer environmental techniques to developing countries. Some local governments like Gifu and Mie domestically try to catch up the CDM as a chance of stopping population decrease and the industries deterioration in rural regions. They are engaged in investigating the natural stock and assessing the ecosystem services for trading CO₂ emission with enterprises in large cities.

3. Significance of Natural Capital for Qinghai-Tibet Plateau

Chinese Government has launched the Great Western Development Strategy at the end of the 20th century and subsequently announced the national goal to build a somewhat all-out abundant society by 2020. It is a chance which people in western provinces and districts including Qinghai have eagerly awaited. It is a challenge which they have never before experienced, too.

Qinghai Province is characterized as the vast highland and ethnic cultures. More than 5.3 millions of people live in the area about 720,000 km². Most of residents in the highland are poor without enough food and minimal education and healthcare services. These are mostly due to the remote geographic location and the religious tradition. More serious are the environment there. The growth of population and plundered cultivating and grazing activities have deteriorated the ecosystems and made the environment in crises such as soil erosions, land desertification and loss of biodiversities (Peng Ming, 2001) while global climate changes have made the situation worse. The difficulties are imaginable to achieve the national development goal in such natural and social situations.

Qinghai Province is a closed territory with no borderlines for international trades, no seas for ocean

transport and no rivers for channel communications. In a word, this geographic location makes the place unsuitable for modern industrialization. However, with information technologies, spatial distances become shorter and the geographic locations don't make much sense in some sectors. Any cities or regions have potentials to achieve big leaps as long as they could grasp their comparative advantages.

The So-called comparative advantages mean that cities or regions are dominative in some fields such as natural, economic, social, cultural resources. At this viewpoint, Qinghai, locating in the heartland of Qinghai-Tibet Plateau with attitude higher than 4000m in average, is the richest province in amount of storages of mineral resources in China. The beautiful highland sceneries and historical Tibetan Buddhistic culture are the yearnings of modern people. The plateau is the origins of many Asian big rivers such as Yangtze River, Yellow River and Mekong River so that people usually call the highland the water tower of China and Southeast Asia. The vast meadow land and wetland in the mountainous areas are one of the hotspot of the world in biodiversity. The highland has great influence on the climate of Asia while it is vulnerable to global climate changes (Liu and Chen, 2000).

Therefore, we must say the value of the highland is not in how many sheep or cattle can be grazed but the wetland, the meadow, the snow and the glaciers are worthy as long as they exist. These existences are the capital of Qinghai. The most important and urgent things is to draw out the potentials of the Natural Capital, and make them to be the driving forces for economy and social development.

4. Framework for applying Natural Capital in Qinghai

4.1 The structure of the framework

Following the concept of MEA, we designed a practical framework for assessing and managing ecosystem services as shown Figure 1, with the support of information technologies and networks. The framework is composed of five layers: *projections*, *processes*, *procedures*, *participations* and *products*. Meanwhile, the framework is organized with four stages: *inventorying*, *assessing*, *managing*, and *marketing*, as the columns in Figure 1. The *projections* are the target objects of the processes at each stage, here defined as ecosystems, services, ecotopes and capital from left to right respectively. The *procedures* express the contents or steps of operations at each stage. One of the creative points of the framework is that each stage clearly produces concrete outputs such as spatial data sets at inventorying, value-added ecomaps at assessing, policies at managing and human well-being at marketing. The *participations* express the involvement of local communities, governmental sectors and academic scientists etc.

As for the stages, *inventorying* surveys the realities of ecosystems with information from satellites images, ground monitoring and local communities. This stage will produce spatial data sets and

documents in various media. The inventoried data sets will be processed with Geographic Information Systems at *assessing* stage and the ecosystems will be spatially categorized into ecotopes according to the homogeneous or heterogeneous properties. The ecosystem services of some ecotopes will be sampled in fieldwork. The total assessment of ecosystem services of the whole region will be a scaling-up of the field survey. Ecomaps, expressing the relative values of ecosystems services of ecotopes, are the output of the *assessing* stage.

Framework for the assessment and management of Natural Capital

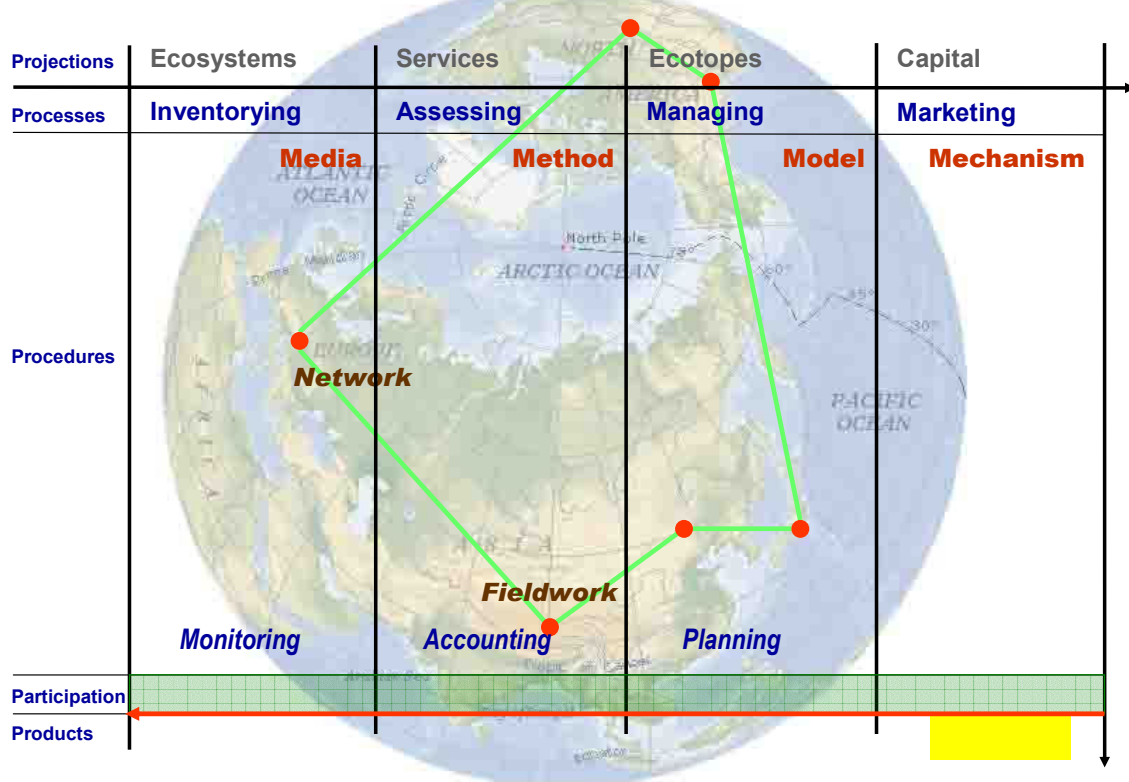


Figure 1 the framework for the assessment and management of Natural Capital

With the ecomaps produced at the *assessing* stage, the spatial plans of ecological ecotopes could be created with spatial, political and cultural consideration. The spatial plans clarify the policies for each ecotope to be developed, protected, restored or rebuilt. The discussions will be finally summarized as documents with maps for making legislations. Only the areas with plans and legislations that ensure the ecosystem services to be kept persistently can apply for certifications. Then the services within the area can be traded at the *marketing* stage. The ecosystem service trading provides capital for implementing environment conservation and regional development plans. This is the mechanism we considered with Natural Capital as sustainable financial channels for the balance of environment, economic and human well-being.

Except the processes and procedures explained above, there are two important threads crossly

embedded in the framework. One thread is the concept so-called *practicing in fieldwork and participating with network*, illustrated as the background map and the geographic nodes in Figure 1. Residents, communities, volunteers, and researchers are recommended to work in field for collecting local knowledge and enhancing their understanding on local ecosystems. The outputs of fieldwork will be linked to the world and the local findings are expanded to the global community through the computer and human networks.

Another thread is the scientific scheme behind the processes and procedures in each stage, illustrated as keywords *media*, *method*, *model* and *mechanism* in Figure 1. Media resources, such as maps, images, texts and local tales, provide knowledge on nature and society while digital media contents will composite the findings of fieldwork for appealing to the world by the Internet. We must find scientific methods and models for assessing and managing ecosystems systematically. The method of the *assessing* stage is of overlaying, zoning, sampling, scaling-down and scaling-up. The overlay model practiced by Ian McHarg (1971) will be a good reference with the support of GIS. At the third stage, the performance of policies of development, protection, restoration and rebuilding must be analyzed and simulated quantitatively. This requires introduction of scientific models. Making mechanisms for trading ecosystem services is the final goal of this framework. It must be progressed on the base of all previous stages and procedures in technical and scientific.

Therefore, the framework gives each technical and practical operation a clear orientation to the final goal of ecosystem assessment. It shows the component and structures of assessing and managing ecosystem services from techniques to policies. It is an integration of multimedia contents like images, maps, documents, local knowledge for inventorying knowledge; an integration of scientific methods and models for assessing ecosystems; an integration of fieldwork for practice in local and networks for participations in global. Although the framework is designed globally, carefully selected applications will be grateful to demonstrate the embedded thoughts. The Qinghai-Tibetan Plateau is one of such a place for implementation by the uniqueness of the remote highland with peculiar biodiversity, rich water resources and traditional indigenous cultures.

4.2 Research issues for applying the framework to Qinghai-Tibet Plateau

Therefore, how to make the ecosystem services as driving forces of environment conservation and social development is a key issue of the Qinghai-Tibet Plateau. For the realization of this strategic concept, the proposed framework could be implemented to the highland with following steps.

1) Inventorying information resources and monitoring the environment

The ecosystem services in the vast highland haven't been understood well so far because of the limit of the financial resources and the technical powers. Even the most basic data such as land uses and

land covers has not been surveyed in detail for more than twenty years in Qinghai.

The great progresses of information communication and satellite observation technologies have brought us possibilities to carry out the investigation in speedy and efficient ways. With multi-resolution satellite sensors, spatial information of topography, geology, vegetation, climate and water resources etc. could be acquired in low cost. Historical maps and in situ observations are essential, too. Scientists from Chinese Academy of Sciences have explored the highland for more than 50 years and published shelves of documents. These stocks provide us useful information for inventorying and monitoring.

It is impossible to acquire data over the huge land under the severe conditions by few of scientists. We must establish monitoring networks with reasonable spatial density to collect in situ information automatically. The participation of residents and NGOs working in the highland are grateful, too. They could provide local knowledge usually unavailable from satellite images, statistical data, and scientific observations. The modern communication networks allow us to borrow the power from such organizations and individuals. Not only information collection, the networks could play roles in feeding back information to local communities.

Thus, with the modern satellite observation networks, the reasonable ground observation networks and the grassroots human networks, a functional investigation and monitoring systems could be established and managed with low cost and high performance.

2) Assessing the ecosystem services of the highland

The assessment of ecosystem services is the necessity for regional economic development, the regional environmental conservation as well as the improvement of human well-being (MEA, 2003). Costanza et al (1997) have classified services of earth ecosystems into 17 categories and calculated the values with currency in global scale, based on the survey of published scientific resources. The ecosystem services of the Qinghai-Tibet Plateau were not identified well in the published map. The water head region in Qinghai-Tibet Plateau is one of the hotspot of the world in biodiversity. The problem is that we don't know enough due to lack of English publications. In this sense it is a great work to let the world know the plateau better.

De Groot et al (2002) have classified the ecosystem services into 4 classes including production, regulation, habitat and information with 23 items. This classification is applicable to the highland, too. On the production there are peculiar plants and animals serving as healthy food and medicinal resources. On regulation, the ecosystems and the highland itself control the climate of East Asia and impose great impacts on the global environment. On habitat, there live valuable animals and plants which are irreplaceable for genome bank and biodiversity. As for information, the beautiful natural

landscape, various ethnic customs and traditional religious cultures are worthy resources of human being with potential for traveling industry.

So the ecosystem services of the plateau can be systematically addressed from four classes: production services of highland special goods, peculiar biodiversity services, balance services of water and atmosphere, and cultural information services.

3) Making policies for conservation and development

Natural Capital must be kept in a way of offering service persistently. This requires the insurance of policies and legislations. Half of the administrative land of Qinghai Province has already been enclosed as the Sanjuangyuan (Three Rivers' Heads) Natural Protection Zone. However, there live more than 300 thousands of people. Moreover, the meadow and the grassland have been largely degraded with the increase of population and livestock during the passed decades.

This reality implies that the environment conservation in the highland couldn't work well by simply banning development. There needs a way to achieve the targets of protecting natural environment, empowering local economy and improving human well-being together. This requires us to verify the suitability of each ecotope for developing, protecting, restoring and rebuilding with the properties of ecosystem services and social structures. The proposed plans will be authorized as legislations for execution in an irreversible way.

As for the methods to make the spatial plans the ecotopes divided at the *assessing* stage will be classified by different scenarios and their effects will be simulated with scientific models. At the same time, the social, economic, and cultural structure of the region are discussed for identifying demands. The policies for each ecotope are made under the restricted comparison of environmental capacity and social demands. The decisions on the proposed plans and legislations will be made under the consensus of residents, local communities and governmental sectors.

4) Establishing the mechanism for trading ecosystem services

The value of ecosystem services can only be funded in market. Thus, establishing trade mechanisms of ecosystem services between developed and undeveloped area, western and eastern regions, the highland and plains, China and foreign countries becomes an important issue of this framework. As mentioned in the previous stage, only the regions with conservation plans and legislations are permitted to apply for certification and to enter the market for fundraising. The raised budget will directly return to local communities as investment for improvement of environment conservation and living conditions.

Although it is not easy to establish such market mechanisms, the Clean Development Mechanism (CDM) on CO₂ emission and absorption has been examined and tested internationally. Does China need such a market mechanism like CDM? The answer is absolutely *yes*. First, the establishment of the market mechanism of ecosystem services is the irreversible trend of the world. No country can move backward when the environmental problems become crucial to human securities as today. China is the largest developing country and the second largest one in CO₂ emission in the world. It is a status to confront the global warming issue positively as a responsible country in global community.

What the difficulties in environment conservation up to now in China are people do not recognize the value of ecosystems properly. As for development, industrialization is hit on at first. Taking the ongoing Great Western Development as an example, currently the strategy is largely working on exploring mineral resources though the central government is continuously calling for the priority of environment conservation and restoration. The development of mineral resources is of course an alternative of using Natural Capital but not a renewal one. Moreover, digging underground resources in unplanned way might bring second pollutions and damage the near surface ecosystems.

Environmental rebuilding requires huge finance support for long period. The environment conservation programs in western regions largely depend on subsidies of central government and the cooperation of farmers. It is not sustainable when farmers know the limit of this policy for increasing income. Considering the externality of ecosystem services of forests, who should pay the investment for environment in west? Without buyers, how we could ask for the western farmers to suffer more from poverties?

There exist possibilities to make enterprises pay for environment in Chinese society today. The industrial behaviors pursuing commercial profits in the cost of environment damage is often criticized. The government comes to understand the limitation of administrative instructions for environment protection. There exist pilot cases of exchanging ecosystem services with financial transfer systems between the upstream and downstream of rivers in Zhejiang Province. Although the financial transfer is different from the CDM, it clearly shows the necessity and possibility of establishing trading mechanism of ecosystem services in China.

5) Promoting Environment Education and Public Involvement

Public participation is important in construction of the market mechanism of ecosystem services. Speaking frankly, the environmental moral of enterprises and people in China is still weak compared with developed countries. The pollution control legislations do not work well in some places. People in eastern regions think the environment conservation is the matter of western people or the duty of governments. The proposed framework encourages people to understand the importance of ecosystems and to make them positive to participate in the environment conservation programs. It will let the

western people know that the natural environment can make great profits if we learn to use it properly. We must let them know that conserving the natural ecosystem are just the same things as saving their own capital for their children.

Although Qinghai-Tibet Plateau keeps peculiar Natural Capital, it is not well-informed in the world so far. We must explore the treasure land more by the fieldwork in local and appeal our findings through the network in global. The networks are benefits of all participants in sharing data, talent, and knowledge etc.

5. Conditions for applying the framework in Qinghai

Qinghai with peculiar highland ecosystems has advantages to investigate, evaluate and utilize the Natural Capital in prior to other western provinces. Nearly half of Qinghai Province is enclosed in Sanjuanguyuan Natural Protected Zone. The vulnerable ecosystems in the highland are not suitable for large-scale industrial development. Tibetans who are used to traditional nomadic life are not welcome sudden changes of lifestyles and industrial styles, too. Thus, establishing the exchange market of ecosystem services between the highland and other regions becomes the considerable approach.

The scientific team of Chinese Academy of Sciences has investigated the highland for 50 years, and accumulated abundant findings and information on the ecosystems there. Earth Observation Satellites, information and communication technologies offer systems for investigating and monitoring the wild land in high speed and low cost. A China continuously opened to the world secures fundamental condition for international collaborations. The Great Western Development Strategy of central government and the peoples' desire for beautiful national land promise the backup from national policy and people's consensus for introducing the market mechanism of trading ecosystem services.

China government and Chinese scientists have already participated in "Millennium Ecosystem Assessment" project, using cases in Gansu Province and Yunnan Province. These activities offer us good experience for implementing this practical framework in Qinghai-Tibet Plateau. Qinghai University, emphatically supported by the Chinese Ministry of Education as a key university in western region and equipped with basic education and research facilities, has achieved a workable research level in investigation, management and assessment of the highland environment.

The international exchanges of Qinghai University are active in recent years to collaborate with foreign experts and scholars. Particularly an international network with environmental experts who are willing to contribute to the development and conservation of the highland is established. This network, correspondent to the call from the Embassy of China in Tokyo and the auspices of Chinese Education Ministry, is working functionally as a node for assisting Qinghai with resources abroad.

Keio University, one of the most famous university in Japan, has started the project under the auspices of the Japanese Government's 21 Century Center of Excellence (COE) Program, "Policy Innovation Initiative: Human Security Research in Japan and Asia" since 2003, in which the collaboration of China and Japan on environment policy is a key task. Even before the COE project, Keio University has accomplished many collaborative works with China such as afforest in Kangping County, Liaoning Province and Tongliao City in Inner Mongolia Autonomous District. All of the projects aim to assess the effect of CO₂ absorption by afforest and to explore the possibility to build the scheme for economic development by CDM.

The Qinghai-Tibet Plateau is selected as one of the study area of the COE project. With the auspices of the project and the sponsors of Chinese Ministry of Science and Technology, the Agency of Science and Technology of Qinghai Province, Keio University, Beijing University and Qinghai University have successfully held the "International workshop on Environment Conservation and Sustainable Development Strategies in Qinghai-Tibet Plateau" in Beijing and Xining City from November 30 to December 4, 2003. The research issues defined at the workshop match the objectives of Millennium Ecosystem Assessment. It implies the possibility of our study in the Qinghai-Tibet Plateau to be one of sub-global region of Millennium Ecosystem Assessment.

Therefore, the assessment and the management of the highland ecosystems with market mechanisms show great coincidence with the strategy of China's national development strategy and the needs of local government and residents. The research and experiment in the highland will largely contribute to the establishment of the scheme of collaboration of Japan and China in the 21 Century. Meanwhile it will contribute to create a sustainable model which can balance environment conservation, social development and human security in Asia countries.

6. Summary

Since the Chinese Government worked out the Great Western Development Strategy five years ago, a large amount of budget has been invested to the west for infrastructure construction. The investment environment has been improved largely. However, the west development is facing difficulties, as pointed out by Zeng Peiyan, the General Director of the Leading Group for China's Western Region Development (LGCWRD) at the Yingchuan Conference on west development in July 26, 2003. *We must investigate more deeply and to look for new methods for the west development. We must find good mechanisms to make the progress of environment conservation, and the improvement of farmers' lives and local economy development in balance. We need to establish stable channels for obtaining capital in a sustainable way.*

Although western regions owe abundant underground mineral resources, there are not necessary to become the material bases of enterprises in costal regions because of the cost of mining and

transportation. We must put forward the western development in a way suitable for the reality of the west, as stated by Li Zibin, the vice General Director of LGCWRD. *This is neither a way used in the planned economy time nor one practiced in coastal regions recently. It must be such one with new thought, new method and new mechanism.*

The practical framework proposed in this paper is such an alternation which fits to the above request. This framework links the west and the east with ecosystem services. It is suitable for the entire western region and other developing countries, though we have explained implementation by using Qinghai Province as an example. Even somewhere the Natural Capital is poor at present the ecosystem services could be value-added if there is potential to be improved by our efforts such as reforestations.

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