

Exploring to Compile a Natural Resource Balance Sheet: Implications for China's Ecological Civilization Construction

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Abstract: Natural resource balance-sheet can be used as an innovative attempt to strengthen the construction of China's ecological civilization. However, in china, due to the fewer theoretic and practical research in this field, there exists many fundamental unsolved problems such as the complex statistic of natural resources, the difficult assessment of the resources assets, the incomplete disclosure of statement information. Hence, this paper is devoted to explore the compilation framework of natural resource balance sheet in order to provide some ideas of solving the problems. With the DPSIR chain model, it explores the physical quantity and the quality of the natural resources. Then, with the idea of classification accounting, the total economic value of a certain natural resource can be accounted and the intergrated physical and monetary sheet of natural resources assets can be developed. In addition, referring to the green input-output model, the liabilities sheet of natural resources can be obtained, and the equity account can be calculated by the balance equation. Finally, the framework of natural resource balance sheet consists of a set of static-dynamic statements, providing the comprehensive information for evaluating the ecological performance of the government, and achieving the eco-civilization goal.

Keywords: Natural resource balance sheet, ecological civilization, natural resource assets statistics, governmental ecological performance assessment

I. INTRODUCTION

The Decision adopted in the third Plenary Session of 18th Central Committee of the Communist has regarded the preparation of natural resource balance sheet as a national strategic mission, which is a significant improvement and perfection on the defects of China's traditional national economic accounting system, and is also to promote the construction of ecological civilization demands of the resources conservation and environmental protection. The compilation of natural resource balance sheet reflects the stock and flow of the resources in the social development, which exerts profound effects on resources & environment protection and social economic development in China. Firstly, it will open a new model of ecological civilization with Chinese characteristics, guiding the market economic body to use the resources efficiently. Secondly, it will realize new normal transformation from quantity to quality in the process of economic development, increasing the product benefits by the ecological benefits to promote industrial upgrading (Zhou Zhifang et al. 2014).

Thirdly, it will provide information suitable for analyzing the performance of governmental environment management.

II. DIFFICULTIES ANALYSIS FROM LITERATURE REVIEW PERSPECTIVE

The compilation of natural resources balance sheet is a new concept proposed by Chinese government, and the current domestic theoretical research is still in the exploratory stage. Some scholars adhere to the principle of starting with easy things first, putting forward ideas of the construction of natural resources balance sheet from hot theoretical issues (e.g., the purpose, significance and the main theories)(Hu Wenlong 2014; Chen Hongxin 2014). On a micro level, the literatures combed shows that the natural resource balance sheet presented comprehensively the assets, liabilities, the equity of natural resources on the ground of accounting theory. Yutang Zhang, Liu shuai used the two kinds of physical and value measurement model to measure and present the component of natural resources balance sheet on the premise of accounting theory. The natural resource accounting was the foundation of the resource balance

sheet, and a variety of the accounting methods were viewed to provide a probable path of the balance sheet (Feng Zhiming et al. 2014). Hangyan Zhang put forward some ideas about the natural resource accounting based on the character of accounting. On a macro level, some relevant scholars discussed natural resource balance sheet from the perspective of national balance sheet, natural resources statistics, ecological civilization and others. The natural resource balance sheet had a strong relationship with the national balance sheet, and the two kinds of sheets were the component of the System of National Account (SNA) (Geng Jianxin et al. 2014). Hongqiang Jiang, Jinnan Wang took the ecological and environmental protection as mainstay, proposed the preparing framework of natural resources balance sheet based on the system of the environmental capacity, environmental quality and ecological environment. Rongbing Huang discussed the functional orientation, government mechanism, frame structure, auditing assurance and other issues in view of ecological civilization.

Although there are no theoretical explorations for natural resources balance sheet at abroad, there is a vast amount of practice on natural resources statistic internationally. Norway has established extensive resource-accounting system to supplement their national income accounts (Costanza 1997). Several nations, including Canada, France, the Netherlands and Japan, have proposed or established the natural resource accounts. Finland established the framework of natural resources accounting including the detailed forest accounting (Lange 2004). The Mexican government incorporated oil, land, water, air, soil and forest into Environmental and Economic Accounting, the stocks and flows of which are measured in physical and monetary unit (Ana 2008). The US established their System of Integrated Environmental and Economic Accounting by drawing from SEEA-1993 to reflect their environmental information (UN 2014). Australia always went ahead in the world in terms of natural resources accounting. It had compiled relatively mature land and water resources asset account according to SEEA -2012, and built the accounting standard for water so as to promote water management activity effectively (ABS 2013). China's statistics accounting of natural resources started late, it was authorized by the United Nations research institute., and established CSEEA in accordance with Chinese reality. Since 2003, China began a preliminary physical measurement of natural resources and a part of natural resources involving national economy development(e.g., land, forests, water) were statistic, but has yet to establish a complete accounting system of natural resources.

In summary, from a practical point of view, the practice research of natural resources at home and abroad starts from the perspective of the natural resources accounting, trying to build natural resources accounts consistent with the System of National Accounts (SNA). From a theoretical point of view, the domestic research is still at an early stage and most of scholars explained the concept, significance, content and framework of natural resources balance sheet. They probed into the construction of natural resources balance sheet from different aspects and obtained some achievement, but there are some problems with the preparation process of natural resources balance sheet:

1. Because of a large amount of natural resources in china, it is difficult to count. There is a certain mechanism of action relationship between natural resources, economic development and ecological environment, so statistics objects include not only the formation, development, application procedures, protection and recycling of natural resources, but quality changes of ecological environment. Therefore, it is very urgent to build up a wide scope of statistical system is the urgent issue.

2. The difficulties are the monetization of functioned-detailed natural resources with the function of economy, society and ecology. Even it is more difficult to grapple the non-market benefits associated with non-use value.

3. Due to the disclosure information on statements, it is difficult to produce normative tables. The preparation of natural resources balance sheet should reflect not only the stock and flow of natural resources assets, but also government performance evaluation, especially the key information reported, which is the eventual use of natural resources balance sheet.

Therefore, from the macro and micro perspectives, this paper tries to build the preparation framework of natural resources balance sheet followed by the accounting theory to find out the way to solve the problems.

III. FRAMEWORK DESIGN OF NATURAL RESOURCE BALANCE SHEET

The preparation of natural resources balance sheet, as a complicated and systematic project, depends not only on account, but couplings statistics and economics on disciplinary bases in order to build systematic accounts reflecting natural resources ownership, consumption, degradation. On the preparation content, natural resources balance sheet needs to dock current natural resources statistical system to make it become a detailed part of SNA. On the preparation methods, the balance sheet should play a monetary value on the physical measurement,

following by the principle of “first in stock and then in flow terms”. During the fiscal period, the amount of natural resource assets, the consumption, the degradation and the degree of ecological protection are disclosed comprehensively. Hence, natural resources balance sheet is not simply a kind of

accounting statements, it is more similar to a static-dynamic set of management statements, which is used to manage and monitor the state of natural resources assets, and audit and assess governmental ecological performance (Figure 1).

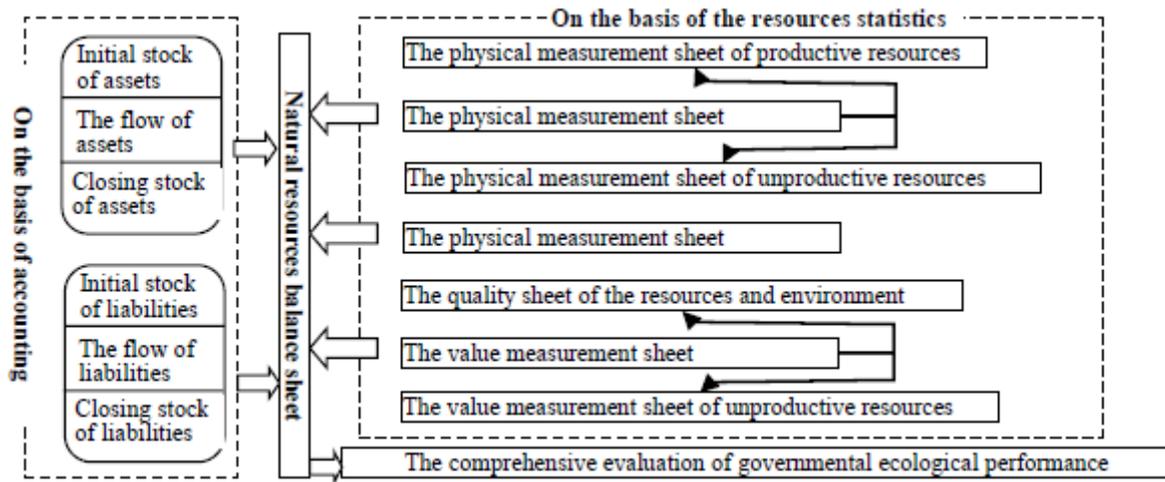


Figure 1. The general framework of natural resources balance sheet

As shown in Figure 1, the preparation of natural resources balance sheet should be split into several steps as follows: 1. According to the true, accurate and continuous statistics, get the information of natural resources utilization, development and others by the resources and environment statistical means, and then reflect the physical quantity and quality of natural resources to draw up the physical accounting accounts of natural resources and quality of ecological environment. 2. For the different construction of natural resources, appropriate valuation methods should be selected categorically to draw up the value accounts of natural resources. 3. By using the balance sheet principle, natural resources assets and environmental profit and loss brought by exploiting natural resources are measured in physical and monetary units so as to make the calculation on natural resources assets, liabilities and net assets. 4. Based on the above information, the comprehensive evaluation can be used for the ecological performance appraisal of the government.

A. The Construction System of the Resources Statistics Based on the Dpsir Chain Model

Natural resources, as natural medium that shaped in the specific conditions, participate in the economic production and incorporate as the waste into the ecosystem ultimately. In consideration of the interactive relationship between natural resources, environment and economy, the paper focuses on the increase or the decrease of natural resources products

and environmental quality changing with the view of the mutual relation to build the statistic system of natural resources. The theory of DPSIR chain model was put forward by Organization for Economic Cooperation and Development (OECD), which was used to reflect the interaction between natural resources and economy and do classify as natural resources statistical content. DPSIR stands for a system analysis view on environmental problems and the way society deals with them, which expresses that social and economic developments (Driving Forces, D) exert Pressures (P) on the natural resources and environment. As a consequence, the State (S) of the environment changes, which leads to Impacts (I) on ecosystems, human health, and society, eliciting a societal Response (R) that feeds back on Driving Forces, on State or on Impacts (Karen 2013).

Among the statistical indexes, the Driving Forces, Impacts and Response belong to the qualitative indicators, which are used to describe a certain kind of economic activities that will exert some negative effects on natural resources & environment. The statistical indexes reflecting Pressures and State belong to the quantitative indicators, which mainly calculate the consumption of natural resources and the environmental damages in social production activities, which is the core of natural resources statistics. But in reality, most of natural resources statistics is State indicators, but Impact and Reflection scattered in relevant economic and social statistics. Therefore, the author will focus

on analyzing the role of three indicators playing in the compilation of natural resource balance sheet.

1. The natural resources are physically accounted based on State indicator. The object of natural resources and environment statistics is mainly natural resources and environment corresponding to human economic and social system. As the reference of the classification by System of Economy-Environment Accounting of China (CSEEA), natural resources are divided into two kinds: productive and unproductive

natural resources; The former puts on the accounting of forest and grassland; The latter includes economic land resources (e.g., cultivated land, energy, et al.), energy resources (e.g., oil, coal, natural gas, et al.) and non-economic natural resources such as air, water and so on. Around the depletion of natural resources, a kind of natural resources is reflected the physical flow process according to its life cycle, thus setting up the physical accounting table of natural resources (Table 1).

Table 1. The physical accounting table of natural resources in an area.

	Forest	Grassland	Cultivated Land	Energy	Water
Initial stock quantity						
Increased: Natural growth New discoveries Increased by economic and revalued causes Revaluation added						
Decreased: Natural loss Decreased by economic and revalued causes Revaluation decreased						
Closing stock quantity						

In Table 1, the columns calculate physical quantity of different categories of natural resources under different states; the rows display the initial and closing stocks, and flow changes of each kind of natural resources. The flow changes are classified according to the cause for the increase and the decrease of natural resources. The increase includes natural growth, new discoveries, increased by economic and revalued causes; the reduction includes natural loss, decreased by economic and revalued causes. The revaluation adjustment is caused by the change of external conditions, exerting the effects on the natural resources statistics, such as technology, price change and the improvement of the evaluation methods. Taking as an example, the equilibrium relation between stocks and flows of certain natural resources is drawn in the each column, that is “Initial quantity+ increase quantity-decrease quantity =closing quantity”.

2. The natural resources are quality statistics based on Impacts indicator. The impact of human economic activities on quality of natural resources is mainly manifested in two aspects: one is the change in the quantity and the other in the quality. Although

quality statistics of natural resources has great uncertainty on statistical methods and data processing, it is more realistic and reliable to use the existing quality indicators for natural resources. Therefore, from the perspective of environmental damage, the paper tends to evaluate natural resource qualities by calculating the degree of one kind of natural resources quality and ecological environmental media deviating from internationally recognized quality standards, or the degree of environmental medium deterioration (Gao Minxue 2004). For example, in accordance with land-use types, the main quality indicators are set to reflect land quality rank separately, which is shown in Table 2.

3. The natural resources balance sheet carries out the ecological performance evaluation based on Response indicator. Carrying out the work by government departments in the field of natural resource management and recovery, pollution control, supervision, prevention reveals the governmental effort for natural resource usage and protection, which was regarded as part of the ecological performance appraisal.

Table 2. The quality table of land resources in a region.

Unit: Square Kilometer

Indicators	Desertification	Land invasion	Toxicity influence land	Acid-deposition Influence land	Irrigation influence land
Agriculture land					
Woodland					
Industrial and residential land					
Unused land					

B. The Evaluation Methods of the Resources Assets: Classifying The Value Methods

John V. Crewe Umatilla proposed the value classification of natural resources dividing into the use value and the non-use value. From the perspective of environmental economics, the total value (TEV) of natural resources can be divided into the use value (UV) and the non-use values (NUV). The use value component refers to the set of benefits individuals deriving from using the resources directly or indirectly, and can be further divided into direct use, indirect use, and option use value, respectively DUV, IUV and OUV. Non-use values reflect the values individuals attached to a natural resource even if they themselves do not use it, and is divided into bequest values (BV) and existence values (EV). This leads to the following equation:

$$TEV = UV + NUV = (DUV + IUV + OUV) + (BV + EV) \quad (1)$$

In formula 1, the total value of natural resources gathers from their different values, so it needs to use

the appropriate evaluation methods to account according to the different value constructions. Market valuation method is used to estimate the direct use value (DUV) of natural resources, and uses the observations of market prices to estimate the economic value directly. There is the net price method adopted to estimate future cash flows of the resources by reasonable discounted rates on the basis of current market prices, development costs and tax rate (Salvatore 2012). Non-market valuation methods are used to estimate non-use values (DUV) and indirect use values (IUV), which can be defined as un-priced benefits from natural resources because they are not commonly traded in the market. They include the Contingent Valuation Method (CVM), Replacement cost (RE) (e.g., Averting Behavior approach, Travel Cost Method (TCM)), maintenance cost method (MC) and so on. Each evaluation method is different in the characteristics and application scope (Table 3).

Table 3. The evaluation methods for measuring natural resources.

Methods	Market valuation		Non-market valuation		
	Market price	Net price	CVM	RE	MC
Application scope	DUV		IUV, NUV		
Main content	estimating future cash flows of the resources by certain discounted rates, on the basis of current market prices		The willingness to pay for the resources improvement of public health and welfare in future, which is taken as the decrease of the resources quantity and quality.	Estimating the natural resources by the replaced resources in the trading market	The resources valuation focus on the quality changes, MC is to account the maintenance and recovery cost that is insusceptible in future.
Shorts	The resources without market price lack of realistic basis.		It is necessary to the consistent with investigators' understandings of the resources value, if not it will influence the accuracy of natural resources.	The standard of the replaced resources is hard to identify.	The estimated recovery costs has a certain deviation from the estimated effects.

In Table 3, several major valuation methods of natural resources have advantages and disadvantages. Present value approach, guided by the market reference, takes into account the relationship between market supply and demand, and reflects the characteristics of resources scarcity, so they are easy to be accepted within the limited range. While others without market reference have more superiority in the lack of perfect capital market, they have some problems as the more reliable data prediction and the stronger subjectivity. As the result, it needs to build the idea of the contingent valuation method. The value construction of the specific natural resource should be analyzed at start, then selects the appropriate evaluation methods after the distinction of use value and non-use value.

Taking the marine resource for example, it is divided into the use value and the non-use value on the basis of their functions, and the use value includes aquaculture, fisheries, coastal recreation benefits, tourism, underground mining resources, oil and gas, sea salt and so on. The part of these values can be calculated by market value or net price value approach. This leads to the following equation: the marine DUV= (Revenue from marine development-Costs of marine development)/discounted rate (Kyriaki 2010). Indirect use value includes watershed protection, CO2 sequestration and so on. Non-use values includes the potential unknown biodiversity, satisfaction from passing the availability of marine related benefits to future generations, etc.. CVM, TCM, RE and others are used to evaluate these values. Through a virtual trading market, the values are calculated by the satisfaction that the public will accept, or estimate approximately the function value of marine resource by the recovery costs and disposal costs that must be spent.

C. *The Presentation of the Balance Sheet: Building The Statements System*

- *Three accounting elements of the balance sheet*

1. All natural resources of value and reliable measurement owned by government are considered an asset. They are divided into the productive natural resources assets and the level subject of the non-productive natural resources assets consisting of two and three subordinate subjects calculating the newly-increased value of natural resources. Resources taxes and fees from the development and utilization of natural resources are charged by government to launch special funds for resource recovery and management.

2. Liability refers to the resource recovery and the environmental management costs caused by over-consumption of natural resources and environmental destruction in the process of social productive activity. Its contents includes: the expense recovering the natural resources after the depletion and degradation, the consideration cost of environmental management after worsening ecosystem of the fog haze, noise, debris flow, water pollution and so on.

3. Natural resources equity is composed of the governmental early-stage ventures, natural resources value-added and the retained earnings belonging to government. According to the degree of equity requirement listed in natural resources balance sheet, the equity includes the owned, the developed and undeveloped resources equity that owned by government (Xu Jialin 2006).

- *The Norm of Natural Resources Balance Sheet*

Although the paradigm of compiling a natural

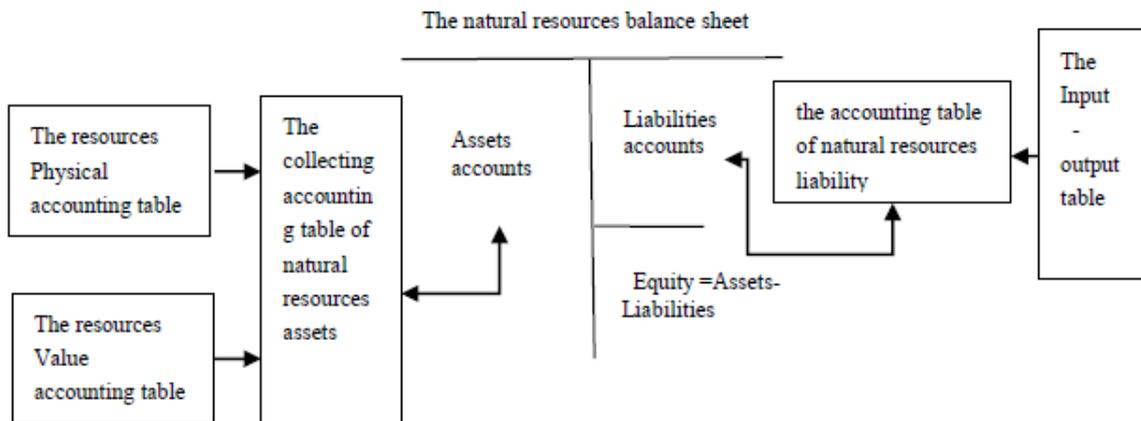


Figure 2. The programmed framework of balance sheet of natural resources.

resource balance sheet has not a unified standard, the main three elements can be shown by the follow accounts (Figure 2). The resource assets accounts can be formed by establishing the intergrated accounting table of natural resources assets; the liabilities accounts by building the table of the resource liability according to the redesign of the green input-output table, and the resources equity with the principle of accounting equation.

1. On the basis of the detailed resources physical statistics, the paper makes use of appropriate valuation methods of natural resources to build the physical accounting table and monetary accounting table of natural resources in an area. The stock and flow changes of natural resources can be acquired by the simple aggregation, so as to reflect the governmental ownership on the natural resources assets at a specific data. This is shown in Table 4:

Table 4. The collecting accounting table of natural resources assets.

Unite: physical measurement (PM) / monetary measurement (MM)

Project	Forest		Grassland		Cultivated land		Water	
	PM	MM	PM	MM	PM	MM	PM	MM	
Initial stock quantity									
Increased									
Natural growth									
New discoveries									
Increased by economic and revalued causes									
Revaluation added									
Others									
Decreased:									
Natural loss									
Deduced by economic and revalued causes									
Revaluation decreased									
Others									
Net assets change									
Closing stock quantity									

In Table 4, the physical measurement table and monetary measurement table provide the necessary prerequisites for the natural resources assets accounting. The resources addition belongs to the newly increased assets in the period. The resources reduction is taken as the resources assets impairment. This leads to a form: natural resources net assets change = additional assets-the resources assets impairment. As a result, natural resources assets = Initial stock quantity +net assets change.

2. Social output, including physical products and waste emissions, is determined by the external character of social production. The external diseconomy of production gives rise to environmental pollution and ecological damage. Through using the model of Green input-output, the paper redesigns the input and output of the resources material to focus on the natural resources depletion and environmental degradation.

In Table 5, the columns show the utilization of the resources in a certain period and the rows have a break down by departments, including the resource

recovery & compensation departments, environmental management departments and production departments. The resources utilizations and pollutant emissions costs are read as the resources depletion and ecological degeneration in the green input-output table. So from the stock point of view, the resources over-consumption amount indicates as the difference between the resources utilization and recovery (X-N) in the process of economical production, and the ecological degeneration degree indicates as the difference between the resources emissions and the management (E-C) in economic activities(Chen et al. 2015). Based on the information provided by the green input-output table, the integrated accounting table of natural resources liability can be built as follows.

3. Based on the previous research, the natural resources balance sheet can be prepared according to the equilibrium of "Equity=Assets-Liabilities". The concrete forms are shown in Table 7.

Table 5. The accounting table of green input-out in an area.

Input \ Output	Resource Recovery Department	Production Department	Environmental Management Department	Total Output
The resources utilizations				X
The productive resources				
The unproductive resources				
production department				
pollutant emissions				E
Newly-increased value resources				
Total input of resources	N		C	
The cost of resources depletion	X-N			
The cost of ecological degeneration	E-C			

Table 6. The integrated accounting table of natural resources liability.

	PM		MM	
	over-consumption amounts	the ecological degeneration degree	The costs of over-consumption amounts	The costs of the ecological degeneration degree
Forest				
Water				
Energy				
.....				

Table 7. The balance sheet of natural resources.

Data:

Unite: PM / VM

Projects	Initial Balance		Closing Balance		Projects	Initial Balance		Closing Balance	
	PM	VM	PM	VM		PM	VM	PM	VM
The productive resources assets					Natural resources liabilities				
Forest					over-consumption of the resources				
Grassland									
.....					Environmental degeneration				
The unproductive resources assets								
Cultivated land					The total of the liabilities				
Energy					The resources equity				
Water					the developed resources equity				
.....					the undeveloped resources equity				
the resources assets impairment								
Resources taxes and fees									
The total of the resources assets					The total of liabilities and equity				

D. *The Comprehensive Evaluation of Governmental Ecological Performance on the Basis of the Statement Information*

Based on the detailed information provided by

natural resources balance sheet, the paper can carry on the comprehensive evaluation of the resource management performance, resource & environment quality and governmental ecological performance.

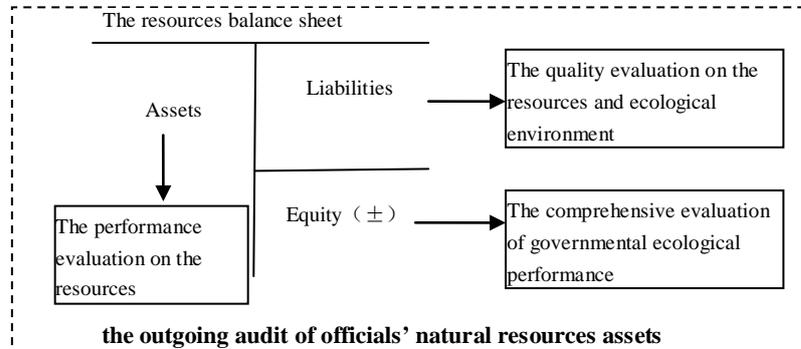


Figure 3. The relationship framework of balance sheet of natural Resources between governmental ecological performances.

1. The performance evaluation on the resources. The resource balance sheet reflects directly the stocks and flow changes of the resource assets by the rate of stocks changes, exploitation, service efficiency and so on. In addition, it can reveal indirectly the resources pricing mechanism and the enforcement standard of the property rights system on the method of physical and monetary measurement. And the account of Resources Taxes and Fees can show that the degree of governmental regulation on the resources utilization and development by means of tax, and optimization of the resources assets.

2. The quality evaluation on the resources and ecological environment. The liability accounts can reflect the degree of the over-consumption of the resources and the degradation of ecological environment. The evaluation index can be designed from three ways to evaluate the quality. Firstly, the indicators are confirmed on the resources classification, such as the vegetation destruction. Secondly, the quality was assessed from the perspective of ecological environment, such as the ecological environment pressure indexes, the degree of pollution of the environment. Finally, the resources recovery and the environmental governance can be accessible to the protection investment and environmental total costs with regard to environment costs.

3. The comprehensive evaluation of governmental ecological performance. The plus-minus situation of the resources equity can reflect the governmental ecological performance in the area. According to the equation of $Equity = Assets - Liabilities$, the resources assets are increased if the resources equity is positive and the performance is

great. On the contrary, the assets are decreased and the performance is poor. In the natural resources balance sheet, when even the monthly reporting figures emerge, the relevant officers stir. Should the net equity figures be negative or lower than those of the preceding month, the recession of the ecological performance is declared, the strategies and competence of environment administration are impugned and the ecological performance is heavily discounted.

IV. CONCLUSION AND SUGGESTION

The natural resource balance sheet, aiming at making clear the exact value of natural resources and revealing governmental occupation and responsibility of various resources, is an important part of China's ecological civilization construction. Based on the scientific statistic accounting, this paper uses the DPSIR chain model to count natural resources thoroughly. Besides, it builds the physical accounting table of natural resources and the ecological environment quality table by the index of the State and Impacts. On the basis of physical accounting, it introduces the idea of classifying natural resources according to their value and perfects the method of natural resources evaluation. The natural resource balance sheet is worked out by this proceed, measuring physical natural resources and their value, gathering the stock of natural resources and their flow changes, accounting the liabilities of natural resources by applying local green input-output model, and using balance equation of the balance sheet finally. The ultimate goal of the resource balance sheet is to evaluate government's performance, which can be served as a fact when auditing those leaders leaving their posts.

The natural resource balance, as the performance evaluation sheet of economic development and the resources consumption, plays a profound role on the construction of ecological civilization and the achievement of sustainable economic development. However, how to better the preparation of natural resources balance sheet and the evaluation of leaders' performances still have a long way to go. Nowadays, the theoretical researches on natural resources lags far behind the practical requirements. We don't have a complete theoretical system, which is also our research goal in the future.

In a long run, the preparation of natural resources balance sheet is a complicated system work. The paper argues that the compilation tasks should go step by step, from being simple to being complicated. The idea of multi-stages can give a way to standardize and update the preparation of the balance sheet. We can decompose the specific suggestions conferred by the preparation into three main steps:

1. In the near term, the country should build up the unification of the interdisciplinary, inter-departmental working platform, and introduce the third independent party accounting appraisal institutions. Besides, the officials should accelerate to expand the pilot work area to test the feasibility of the compilation framework and the methods, which provides experience and reference for the rest of the country.

2. In the middle term, the country should focus on the breakthrough work in layers. Important statistical index system, the approaches & techniques of the resources value evaluation, report information disclosure system and the government performance appraisal system should be the key point of promoting on the natural resources, so as to solve the virtual problems in the process of preparing.

3. In the long term, the country should perfect the policy from the multi perspectives. The property rights of the resources and ecological environment assets should be improved deeply, as well as the natural resources accounting and management system. Building up statistics system supporting the natural resources balance sheet can be devoted to make clear the resources assets to develop the green economy.

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