The Rationality of Compiling a Forest Resource Balance Sheet

Meng Lin
Lijun Jin
Guoshuang Tian

Abstract

The existing forest resource accounting system is limited to the valuation of wood and forest products; the service value of the forest resource ecosystem is not yet included. This study adopts an empirical approach to studying the rationality and influencing factors of compiling a forest resource balance sheet (FRBS). An FRBS can systematically reflect the contribution of forest resources to the economy, ecology, and society in terms of both physical quantity and value quantity. A questionnaire survey was used to collect the data. We found that the determination and measurement of forest resource assets and liabilities and the calculation of the service value of the ecosystem had a supporting effect on the rationality of compiling an FRBS. This study expands the field and scope of forest resource accounting, facilitates the compilation of natural resources and government balance sheets, and presents the practical significance for the theory and practice behind the development of an FRBS.

Owing to market failures caused by factors such as public goods and other externalities, forest resources cannot be optimally allocated through the market, and as a result, those resources contribute to humanity in a complex and usually non–market-oriented way. Furthermore, the value of forests has not been studied scientifically; hence, forests are often excluded from the public market system. A globally unified carbon emission trading market has not been established yet, and there are great differences in forest carbon emission prices among different regions. Measurements using the fair value method are too subjective, and it is difficult to obtain the fair value of forest resource ecosystem services. According to the United Nations Food and Agriculture Organization (FAO), 22.30% of global forests are used for producing wood and nontimber forest products, and 73.53% are used for soil and water conservation, and biodiversity protection. However, the existing System of National Accounts (SNA) only reflects the value of forests through wood, food, energy, and medicinal materials that are attributable to forests in agriculture and manufacturing and excludes the utility of forests in the ecological environment. This leads to an ineffective macromanagement of forest resources, misjudgment of decision-makers, and blind predatory development of forest resources. Hence, the lack of forest accounting has had a negative impact on biodiversity and the economy (Patil 2017). Assessing the service value of the forest resource ecosystem is crucial for evaluating the achievements of the ecology of forests, thereby transcending the pursuit of short-term economic benefits in favor of ecological benefits.

In addition to many material products, forests provide society with a wealth of ecological products (Lebling et al. 2020). Since 1970, humanity's ecological footprint has surpassed Earth's capacity to regenerate, gradually destroying the planet's health and humanity's future (World Wildlife Fund [WWF] 2020). Without appropriate measures, it is estimated that by the end of this century, the global temperature will be 2.6 to 4.8°C higher than that prior to industrialization (Pachauri et al. 2014). Carbon sequestration in forests is one of the main ways to mitigate climate change. With the growing concern for fossil fuel depletion and the environmental carbon footprint, there is a strong interest in exploring the renewable biomass materials as substitutes for petroleum-based feedstock (Zhao et al. 2016). Trees absorb a large amount of carbon dioxide (CO_2) in the atmosphere through photosynthesis and release it in

The authors are, respectively, Lecturer, Heilongjiang Univ., Harbin, P. R. China (imlinmeng@126.com [corresponding author]); PhD Candidate, Northeast Forestry Univ. and Associate Professor, Heilongjiang Univ., Harbin, P. R. China (jlj0326@163.com); and Professor, Northeast Forestry Univ., Harbin, P. R. China (973636294@qq.com). The first two authors contributed equally to the project. This paper was received for publication in April 2021. Article no. 21-00022.

Forest Prod. J. 71(4):309–321.
doi:10.13073/FPJ-D-21-00022

vegetation and soil; this can slow down the greenhouse effect. In response to the goal of reducing climate change, Lebling et al. (2020) proposed restoring 350 million hectares of deforested and degraded lands by 2030, and 678 million hectares by 2050.

The current forest resource accounting system is distributed in fields like accounting, statistics, and finance, which is relatively scattered and cannot fully reflect the function and service value of forest resources. This study argues that the forest resources balance sheet (FRBS), which is compiled by using the principles of accounting equations and learning from the System of Environmental-Economic Accounting (SEEA), can systematically reflect the contribution of forest resources to the economic, ecological, and social fields in terms of both physical and value quantity. Questionnaires (Appendix 1) were designed to understand the knowledge and attitudes of the industry insiders on the necessity, feasibility, and scientific nature of the preparation of the FRBS. Factor analysis and multiple linear regression analysis were used to examine the influence of recognition and measurement of assets and liability of forest resources and the counting of ecological service value on the preparation of the forest resources balance sheet. This study argues that the FRBS can reflect the stock and change of forest resources assets, improve the performance evaluation and accountability of a system of relevant subjects or responsible personnel in forest resources management and protection, and provide information support for forest resources early warning, monitoring, and decision-making. In this study, we explore the composition of the FRBS and the measurements of these elements. This study will promote the preparation and application of forest resource balance sheets, as well as the recognition and measurement of forest resources assets and liabilities.

Theoretical Framework and Hypotheses

Large-scale production during the Industrial Revolution enabled tremendous improvements in productivity; however, the corresponding negative effects, such as pollution and depletion of natural resources, are not reflected in national income statistics (Kuznets 1971). The ''research report on the measurement and evaluation of forest public welfare efficiency,'' issued by the Japanese Forestry Agency in 1972, pointed out that the ratio of forest ecological benefits to economic benefits was 19:1 (Chen 1987). The research of Costanza et al. (1997) was the first of its kind to systematically design an indicator (environmental service indicator [ESI]) to calculate the service value provided by the world's ecosystem services and natural capital. It was estimated that the annual value of ecosystem services per hectare of forest in the world was USD $969, with total global cashflow of USD $47,060 trillion. The ESI is now a classic theory and approach for valuing the ecosystem services of natural resources (including forests).

China has carried out ecological value assessment of forest resources. Similar results were obtained in China's eighth national forest inventory: the total carbon stored in forest vegetation was 8.427 billion tons, and the annual value of ecosystem services reached USD $2.06 trillion (China Forest Resource Accounting Research Project Group. 2015). An FRBS is an institutional work for the dynamic accounting of forest resources, which facilitates the inclusion of forest resources into the SNA (Zhang and Li 2019). Based on the aforementioned studies, we contend that an FRBS is a scientifically necessary and practical approach to value forest resource ecosystem services.

As an international statistical standard, the SEEA Central Framework of 2012 has been used to solve the shortcomings of national economic accounting in dealing with the relationships between the economy and environment. At its core, this framework includes environmental flows, stocks of environmental assets, and economic activity related to the environment; it helps indicate the total amount and composition of environmental assets and reasons for any changes (UN 2014). The SEEA Experimental Ecosystem Accounting framework includes the Common International Classification of Ecosystem Services (CICES), which divides ecosystem services into three categories: provisioning, regulation and maintenance, and culture. For each category, the expected capital flow of ecosystem services is calculated according to the type of land use. In addition, the CICES provides available pricing methodologies for evaluating the economic value of different ecosystem services. Under SEEA's influence, the 2004 report published by the FAO (2020) categorized forest accounts into asset accounts, flow or production accounts, environmental protection and resource management expenditure accounts, and environmentally adjusted macroeconomic aggregates (Hada 2009). Meanwhile, the 2002 European Framework for Integrated Environmental and Economic Accounting for Forests integrated ''the monetary and physical data on nonmarket environmental and protective functions of forests, biodiversity, [and] the health status of forests'' (Eurostat 2000). Forest resource accounting has been applied in practice in Sweden, South Africa, and Romania, and its value has been demonstrated from the perspective of national forest resources (Lange 2004).

In the SEEA-2012 Central Framework, the physical asset accounts for natural resources are applied using the following formula: Opening stock + additions to stock − reductions of stock = closing stock; this is a new framework for forest resource accounting that establishes the basis for the assessment of the ecological value of forest resources. However, the formula only provides a general framework and does not consider liabilities; therefore, the SEEA-2012 framework does not fully reflect the value of forest stock (Huang and Zhao 2015). In the 1930s, several scholars proposed applying corporate balance sheet techniques to national economic accounting (Dickinson and Eakin 1936). Given that the balance sheet reflects the logical relationship between items, value of resources, and financial risk, it has become one of the key macroeconomic analysis methods used since the beginning of this century (Li et al. 2013a. In addition to using the SNA and Global Forecast System to prepare government balance sheets, the United Kingdom, Canada, and Australia have also applied accounting methods for this purpose. The former approach is led by the statistics department of the state, while the latter by the finance department. The basis for compilation subsequently shifted from cash-based accounting toward accruals accounting (Yoshida 2001, Wilson et al. 2006, Du 2015). Morgan (1968) explored the compilation of the natural resources balance sheet to account for the economic and ecological value of natural resources based on the format of corporate balance sheets. Alcamo et al. (2005) used a ''nature balance sheet'' to reflect the progress made in ecosystem services and used a global ecosystem service early warning model, based on soft-linked demographics, economic development, climate, and biosphere cycles, to predict changes in global ecosystem services from 2050 to 2100. However, research on FRBSs does not have a long history, and a comprehensive theoretical system is still absent.

Forest resource assets, as an indicator of the value of forest resources, are a unique type of asset and a foundational requirement for forest resources to be included in the national economic accounting system (Xu 1991, Wei et al. 2001). The standing timber of forest products creates the direct value of forest ecological services. It constitutes the main content of the economic value of forest resources (Zhang 2016, Zhao and Zhao 2019). The role of forest ecological function has been gradually recognized and accepted during the centuries of human economic pursuits. Thus, the ecological value of forests should be included in asset category accounting (Liu et al. 2012a). Zhang (2018) referred to the system of physical asset accounts for forests and other wooded land, physical asset accounts for timber resources, monetary asset accounts for land, and monetary asset accounts for timber resources—established by SEEA-2012—as the ''forest resource balance sheet.'' For forests, this sheet is an extension of, an important resource account for, and a subcategory of the natural resource balance sheet. The natural resource balance sheet plays an important role in promoting the compilation of national and government balance sheets. The theoretical framework of this study is presented in Figure 1.

In 2014, Chinese scholars began conducting research on FRBSs. Subsequently, in 2016, the National Forestry Administration and National Bureau of Statistics of China jointly designed a general plan for the compilation of FRBSs. The purpose was defined as the promotion and improvement of the ecological accountability system, allowing audits to be conducted prior to the departure of officials from their positions in forest management and protection, and establishing and promoting the compensated use of forest resources and other ecological compensation systems (China Forest Resource Accounting Research Project Group 2015). Pilot projects for the compilation of FRBSs have been implemented in several regions in China, such as Zhalantun (Inner Mongolia), Jingdong County (Yunnan Province), the state-owned forest farm of Guangdong Province, and the state-owned forest farm of Hunan Province (Zhang 2016). However, current practice lacks standardized and unified theoretical guidance as well as institutional norms. In summary, forest resource assets are a prerequisite for the formation of liabilities; forest resource liabilities need to be determined to ensure the integrity of the forest resource balance sheet. Referring to the principles of accounting equations, the SEEA-2012 framework, and Zhang's (2018) proposal, we hypothesize that the practical assessment of forest resource assets and liabilities is an important factor in the compilation of FRBSs.

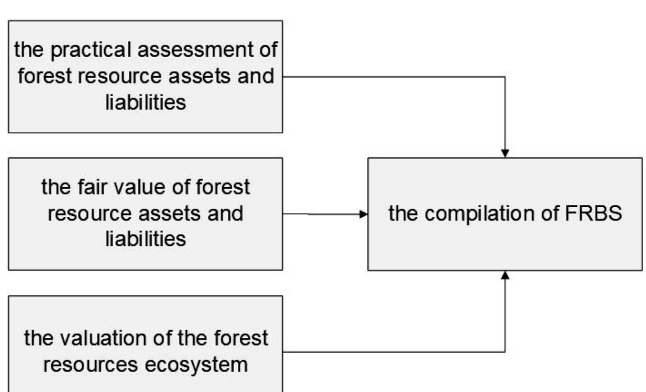

Figure 1.—The theoretical framework.

The International Accounting Standard (IAS) 41 adopts the fair value principle when valuing assets; fair value can be defined as the price that would be received to sell an asset or paid to transfer a liability in an orderly transaction between market participants at the measurement date (namely, an exit price). This is a better method compared to using historical costs and improves predictive accuracy and decision-making. For example, the market price of tradable CO_2 can be used for the valuation of the carbon sink service of forests (Haiilemariam et al. 2012). Referring to the viewpoints of Morgan (1968), Yoshida (2001), Haiilemariam et al. (2012), and IAS, we hypothesize that the fair value of forest resource assets and liabilities is an important factor in the compilation of FRBSs.

Forest coverage and biodiversity are important evaluation indicators of the ecological environment. Furthermore, the quality of the ecological environment is directly proportional to the density of forest resources. Referring to the ESI and SEEA Experimental Ecosystem Accounting Framework, we hypothesize that the valuation of the forest resources ecosystem service is diversified and an important factor in the compilation of FRBSs.

Methodology

Data collection

In order to increase the public's awareness on the roles that forests play in curbing global warming and maintaining biodiversity and other ecosystem functions, this study explores the necessity of the preparation of the balance sheet of forest resource and the items that this balance sheet should contain. Referring to the literature review, the interview results of experts and scholars in the field, and our own viewpoints, we designed a questionnaire to investigate the factors that influence the rationality of the design and compilation of FRBSs. The questionnaire used the Likert scale to rate respondents' understanding and perceived importance of the items. The results were used to test the hypotheses and explore influential factors. An FRBS collocates various categories of resources, such as forest, ecological, and environmental resources, and applies an array of calculation methods including statistics, accounting, and asset valuation; hence, the statements are highly technical and require individuals with specific professional backgrounds to ensure the validity of the survey results. To improve the quality of the survey results, the survey was conducted among individuals in specific professional fields and included enterprise managers in the forest industry, leaders of the government departments of forestry and ecological environment, and researchers in ecoenvironmental protection and forestry economic management. The questionnaires were distributed to representatives of universities, research institutes, journals, newspapers, and academic organizations participating in the 2020 Annual Meeting of the China Forestry Economics Association. Social networking platforms were also used for distributing the questionnaire, allowing easy access and response from the participants. As such, the participation rate (100%) was satisfactory, and the distribution and collection of the questionnaires progressed smoothly.

The questionnaire was divided into six parts and included 46 items. Part 1 was used to collect the demographic information of the participants (five items), including their affiliated industry and organization (industry/organization), educational background (education), time of employment or enrollment in the institution (service year), academic degrees received (academic degree), and the region in which they worked or studied (work/study region). These data were used to examine the differences in responses for each demographical variable. Parts 2, 3, 4, 5, and 6, respectively, investigated respondents' attitudes and understanding of: the rationality of compiling FRBSs (seven items), the influence of identifying forest resource assets, and liabilities (12 items), the influence of forest resource asset and liability valuation in the context of FRBSs (five items), the influence of valuing ecosystem services in the context of FRBSs (nine items), and other information related to the compilation of FRBSs, such as foundational theories and frameworks (eight items). Parts 2 to 5 represented the core components of the questionnaire and used Likert scales. Part 1 mainly included multiple choice questions where the respondents were asked to select just one of the choices, while part 6 mainly included multiple choice questions where the respondents were asked to select several choices, as applicable. During the design stage of the questionnaire, seven experts and scholars in the field were interviewed, and revisions were made according to their suggestions.

Preliminary data analysis and hypotheses formation

Cronbach's alpha (α) was used to assess the internal consistency and reliability of the questionnaire. The proximity of the value of Cronbach's α to 1 indicates the reliability of the questionnaire (Cronbach 1951). The lowest α in this study was 0.781, and the remaining three were all above 0.8, suggesting that the reliability was satisfactory. Exploratory factor analysis was applied for dimension reduction of the 33 items, yielding four common factors (Table 1). The factor load matrix for each variable is listed in Appendix 2. SPSS 21.0 was used to perform principal component analysis (PCA); the characteristic root was defined as 1, and matrix rotation was performed to maximize variance. The Kaiser-Meyer-Olkin Measure of Sampling Adequacy test and Bartlett sphere test were performed prior to the factor analysis to determine whether the questionnaire was suitable for factor analysis. Four factor analyses (FAs) were conducted to evaluate the independent variables (for parts 2, 3, and 4) and the dependent variables (for part 1). For independent variables, there are two factors with the first dimension eigenvalue greater than 1; therefore, two common factors are extracted. Similarly, there is one factor with the second dimension eigenvalue greater than 1, so one common factor is thus extracted. The third dimension of the independent variable has only one factor whose eigenvalue is greater than 1, so one common factor is extracted. For dependent variable, there is only one factor whose eigenvalue is more than 1, hence, a common factor is extracted. Factor loading of item 19 was approximately 0.5. Following matrix rotation, the factor loadings revealed few changes. Removing the items did not affect the FA results, while the value of Cronbach's α improved following rotation for each. The results suggest that the respondents prefer a mixed measurement model for forest resource assets and liabilities based on fair value.

The compilation of FRBSs aims to comprehensively reflect the consumption of forest resources in economic activities. It is crucial in evaluating the quality of the ecological environment and an important tool for political decision-making. From 1990 to 2020, the global forest area has decreased by approximately 178 million hectares, and natural and biological diversity has declined at an alarming rate (FAO 2020). The respondents agreed on the necessity, required scientific rigor, and importance of feasibility of the FRBS. They believed that it was a reasonable approach to value forest resources. Specifically, 85.19% respondents believed that forest resource accounting was extremely necessary, and only 8.89% thought it was not necessary. Further, 74.82% believed that the forest resource balance sheet played a positive role in strengthening the ecological supervision of relevant officials, and 80.74% believed that under current conditions, efforts to compile FRBSs were feasible. Additionally, 82.96% believed that, besides natural resource balance sheets, it was also necessary to compile FRBSs; only 3.7% disagreed. Also, 79.26% believed that FRBSs could provide more information than simple forest resource accounts. Although the respondents either worked, studied, or conducted research in related fields, 43.71% reported lack of in-depth understanding of FRBSs.

Identifying assets and liabilities.—Assets are resources that bring economic benefits to the entity that owns the resource, while liabilities are a realistic obligation that leads to the outflow of economic benefits at some point in the future (IASB 2018). Canada was among the earlier nations that implemented the asset management of forest resources, which played a significant role in the establishment of a sound forest resource management system (Openshaw 1980). In 1993, China initiated a study of forest resource

Table 1.—Hypothetical factors.

Factor name	Questions included	Cronbach's α	KMO test	Bartlett test	
				Approximate χ^2	Sig.
Identification of forest resource assets (H1-1)	13, 14, 16, 17, 18, 21	0.898	0.868	685.076	0.000
Identification of forest resource liabilities (H1-2)	15, 20, 22, 23, 24				
Using a fair value-based hybrid model to measure forest resource assets and liabilities (H2)	25, 26, 27, 28, 29	0.781	0.790	171.981	0.000
Methods used to measure the value of forest resource ecosystem services are diversified (H3)	30, 31, 32, 33, 34, 35, 36, 37, 38	0.893	0.875	564.769	0.000
The rationality of compiling FRBS (dependent variable)	6, 7, 8, 9, 10, 11, 12	0.854	0.877	352.404	0.000

asset accounting as a primary component of resource asset management. The SEEA uses forest resource asset accounts as a platform to calculate the economic value of forests. The International Public Sector Accounting Standards (IPSAS) proposes that forest resource assets are forest resources formed by an entity's past economic business, controlled by the entity, expected to generate service potential, or bring inflow of economic benefits, and should possess the characteristics of scarcity, usefulness, and clarity in the ownership of property rights. To achieve the sustainable development of forests more effectively, Yue (2008) and Liu et al. (2012b) defined the value of forest ecosystem services as ecological assets. Haiilemariam (2012) proposed that forests supply valuable environmental benefits to the nation by providing watershed protection services (protection of soil erosion, logging, and downstream agriculture), carbon sink services, and habitats for a variety of animals and plants (biodiversity warehouses). Qu and Tian (2013) adopted an accounting perspective and proposed that forest biodiversity assets reflect preexisting unmeasured or undiscovered value. Forest ecosystem assets can be considered the fifth type of forest resource asset, in addition to forest, forest land, wildlife, and landscape assets (Xiao and Yin 2014).

Based on existing research on natural resource assets, Hu and Shi (2015) suggested that natural resource liabilities are obligations that humans undertake when using natural resources and can be measured in economic terms that need to be repaid with capital assets or labor services. Chen et al. (2015), Feng et al. (2017), and Chen et al. (2015) asserted that natural resource liabilities are excessive losses of natural resources caused by humans during social and economic activity and include a range of negative externalities on the environment. Thus, forest resource liabilities represent the costs of forest resource depletion, environmental protection, ecological compensation, and ecological restoration (Zhang 2018), or the consumption of forest land and resources caused by economic activities that exceed reasonable use (or resource depletion, e.g., use exceeding forest land use quotas and forest logging quotas). Thus, liabilities are overexploitation of forest resources (Zhang et al. 2018).

Forest resource liabilities are an important aspect of natural resource liabilities and have an inherent logical relationship with forest assets. Thus, they should be separately identified and measured. With that in mind, the following subhypotheses were proposed:

H1-1: Identification of forest resource assets has a significant positive impact on the rationality of compiling FRBSs.

H1-2: Identification of forest resource liabilities has a significant positive impact on the rationality of compiling FRBSs.

Based on the hypothesis, we tested following equation:

$$y = \propto_0 + \propto_1 x_{11} + \propto_2 x_{12} + \varepsilon$$

where y represents rationality of compiling FRBSs, x_{11} represents identification of forest resource assets, x_{12} represents identification of forest resource liabilities, $\propto_0$ is a constant, and ε is random error.

Measuring assets and liabilities.—Assets and liabilities are static figures. Therefore, forest flow data obtained through statistics, business, and accounting measures should be converted into stock data through discounting and other processing methods. In the 1980s, France issued the Natural Resource Accounting and Environmental Accounting System, which focused on stock statistics and economic valuation of natural resources (Huang and Zhao 2015). Finland uses forest quality indicators (including ecological indicator, special-purpose indicator, and changes, prices, and quality indices) to measure forests' comprehensive ecological benefits. The SEEA-2012 Central Framework advocates the use of two systems (physical assets and monetary asset accounts) to measure natural resources; the framework uses methods such as written-down replacement costs and the discount value of future returns to measure natural resource assets without referring to market price. Japan's forest accounting system mainly adopts a construction-substitution method of valuation. Specifically, projects with equivalent benefits to specific functions in forest ecosystem services are selected, and the annual depreciation and operating costs of the project construction are used to replace the unit benefit price, which is used to calculate the value of forest ecosystem services (Huang and Zhao 2015). IAS 41 adopts the fair value of the asset in its standards; however, the standards only account for the economic value of biological resources (Herbohn and Herbohn 1998).

The liabilities listed in the forest resource balance sheet should be the forest resource gap caused by economic development defined by current technology and existing resource reserves, or the cost required to make up for the gap (Qiao et al. 2015). For exhaustible resources, liabilities refer to the economic cost to further reduce resource consumption or finding alternative energy sources. For nonexhaustible resources, liabilities refer to the demand for resources in a given period that exceeds its regeneration rate, or the threshold of maintaining regeneration (Huang and Zhao 2015). Forest resource assets and liabilities should be measured with a method that combines fair value (market price) and cost. Furthermore, the measurement methods and means should be standardized and unified. Based on this discussion, the following hypothesis was proposed:

H2: Using a fair value-based hybrid model to measure forest resource assets and liabilities has a significant positive impact on the rationality of compiling FRBSs.

Based on the hypothesis, we tested following equation:

$$y = \propto_0 + \propto_1 x_2 + \varepsilon$$

where y represents rationality of compiling FRBSs, x_2 represents a fair value-based hybrid model to measure forest resource assets and liabilities, $\propto_0$ is a constant, and ε is random error.

The valuation of forest resource ecosystem services.—Forest ecosystem services are formed by forest ecosystem and ecological process, which aim to maintain the natural environment conditions and utility of human survival. According to Millennium Ecosystem Assessment (2003), forest ecosystem services should include supply services, regulation services, cultural services, and support services. Forest Ecosystem function is the internal characteristic of the ecosystem. It is related to a series of states and processes that maintain the integrity of the forest ecosystem. It is the quality of the components of the forest ecosystem. It includes processes such as decomposition, nutrient production, cycling, and converting energy into matter. Forest ecosystem functions include water conservation, soil carbon fixation, oxygen release, nutrient accumulation, atmospheric environment purification, forest protection, biodiversity protection, and forest recreation, among others. At present, the research of forest resources has changed from the evaluation of forest resources ecology to the development of forest ecological service market, indicating that the research has changed from demonstrating the importance of forest resources to the realization of forest ecological value.

Studies in the United States and Japan suggested that the ecological benefits of forests are 10 times their economic value. Currently, there is no unified system of accounting for valuing forest ecosystem services between nations. Furthermore, the standards and contents of the accounting systems are different. Costanza et al. (1997) evaluated the economic value of 17 ecosystem services in 16 biomes. Hou and Wang (1995) evaluated the value of three ecosystem services of forest resources in China, including water conservation, wind prevention and sand fixation, and air purification. Zhao et al. (2004) assessed the total ecological economic value of 13 functional indicators of China's forest ecosystem. Wang et al. (2011) used the methods proposed in the ''Specifications for Assessment of Forest Ecosystem Services'' to assess the value of the national forest ecosystem services, such as water conservation, biodiversity protection, carbon fixation and oxygen release, soil conservation, atmospheric purification, and nutrient accumulation. Li et al. (2013b) used market value and shadow pricing methods to evaluate the ecological benefits of China's national public welfare forests. The value of forests in terms of carbon sequestration and oxygen releasing could be measured using afforestation costs, carbon tax, damage avoidance costs, carbon tax and mean distribution, industrial oxygen production cost-benefit analysis, and shadow pricing (Long et al. 2018). The value of forests in terms of water-protection can be measured through the shadow project method (the cost of a water storage project, such as a reservoir, with the same function) (Brugnach et al. 2017). The value of forests, in terms of maintaining soil fertility, can be evaluated using expected income capitalization and substitution costs (Shi et al. 2018; Cortés-Flores et al. 2019). Based on this discussion, the following hypothesis was proposed:

H3: Methods used to measure the value of forest resource ecosystem services are diversified and have a significant positive impact on the rationality of compiling FRBSs.

Based on the hypothesis, we tested following equation:

$$y = \propto_0 + \propto_1 x_3 + \varepsilon$$

where y represents rationality of compiling FRBSs, x_3 represents methods used to measure the value of forest resource ecosystem services are diversified, $\propto_0$ is a constant, and ε is random error.

Based on the above analysis, the initial research framework was revised (Fig. 2).

Results and Discussion

The survey yielded 135 valid responses (Table 2). According to the results of part 1, 39.26% respondents were managers and accounting personnel of enterprises in the forest industry, 22.22% were researchers of natural resources and ecological environment, 17.78% were staff from the government department of natural resources and ecological environment, 11.11% were students of forestry and economic management, 9.63% were staff from the government forestry department. Further, 37.04% respon-

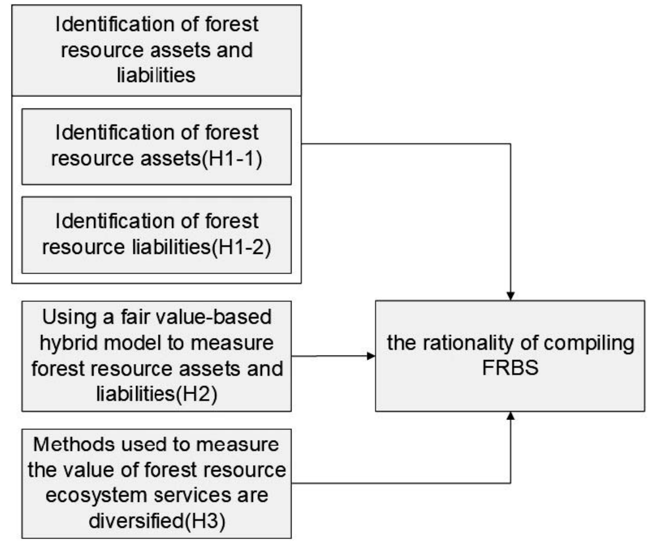

Figure 2.—Revised research framework.

Table 2.—Sample characteristics.

Demographic characteristics	Frequency in the sample	Rate (%)
Profession		
Students of forestry and economic management	15	11.11
Staff from the government forestry department	13	9.63
Staff from the government department of natural resources and ecological environment	24	17.78
Researchers of natural resources and ecological environment	30	22.22
Managers and accounting personnel of enterprises in the forest industry	53	39.26
Professional field		
Forestry economics and management	38	28.15
Forest science and related disciplines	12	8.89
Other majors in economics and management (including accounting, auditing, financial management and statistics)	43	31.85
Environmental and ecological protection	21	15.56
Other majors	21	15.56
Education level		
PhD graduate	32	23.7
Master graduate	52	38.52
Undergraduate	33	24.44
Junior college	11	8.15
Others	7	5.19
Region		
Northeast	73	54.07
South	13	9.63
Northwest	17	12.59
Central	22	16.3
Southwest	10	7.41
Years of study and work		
20 or more	22	16.3
10–19	21	15.56
5–9	39	28.89
1–4	37	27.41
Less than 1	16	11.85

dents studied forestry related subjects, 60.75% had more than 5 years of work or study experience in the area, and 62.22% had master's or doctoral degrees. Thus, respondents were highly educated, and their work experience was strongly associated with the theme of the survey, indicating that they had a good understanding of the questions. The respondents came from various regions, including Northeast, Southern, Southeast, Central, Northwest, and Southwest China, suggesting wide geographical coverage of the respondents. Therefore, the structure of the respondents was representative, adding to the overall validity of the results.

The results of part 6 showed that 47.41% respondents believed that forestry authorities at all levels of the government should be the main body responsible for compiling FRBSs. Further, 55.56% believed that the interval of compilation should be aligned with the forest resource inventory period (once every 5 years), while 25.93% believed that the annual reporting period that is currently implemented was more appropriate. Additionally, 62.96% believed that accounting and statistical methods should be combined when constructing FRBSs. More than half of the respondents believed that the difficulties faced while compiling FRBSs are related to the need for cross-disciplinary data collection methods, a lack of supporting technological infrastructure, challenges in identification and measurement of assets and liabilities, and inconsistencies in accounting methods. More than half of the respondents believed that FRBSs required operational data from the forestry department and statistical and accounting data. Furthermore, 77.78% respondents recognized the ecological value of forest resources, 76.3% recognized their economic value, and 63.7% recognized their social value. The analysis results of their attitudes toward the specific types of value of forest resources further support these findings. The recognition of the forest health, landscape, and recreational value (social value) was smaller than 50%; the recognition of the forest's function in carbon sequestration and oxygen release, water conservation, and biodiversity (ecological value) was greater than 50%.

In the regression analysis, the independent variable adopts the average of the actual scores of all questions included in the common factors grouped after factor analysis, not the mean value or the sum of the factor scores, and the same to the dependent variables. The results of the hypothesis test are exhibited in Table 3.

Effects of identifying assets and liabilities

The regression results, using the identification of forest resource assets and liabilities as the independent variable, were statistically significant. The regression equation is

$$y = 0.251 + 0.606x_{11} + 0.067x_{12}.$$

This indicates that identifying assets and liabilities and the rationality of compiling FRBSs had a significant relationship. Identifying assets and liabilities helps determine the categories and structural arrangement of FRBSs; hence, it is a key step in the compilation process and promotes understanding of the balance sheets for all relevant stakeholders.

The balance sheet reflects the status of forest resource assets, liabilities, and equity in each geographical area, or those that are owned/controlled by the balance-sheet-compiling entity at a certain point in time (Zhang 2020). As a component of the natural resource balance sheet system, FRBSs are useful in compiling natural resource balance sheets and other macro-level reports, such as government and national balance sheets. However, uncertainties in the value created by forest resource assets should not be a contributing factor for not assessing them. Identifying assets is a gradual process. To speed up this process, accounting standards should be formulated and improved swiftly so that forest resource accounting, despite its special requirements, can be included into the accounting of natural resources. The results showed that the recognition of the ecological value of forest resource assets was the highest, followed by economic value; meanwhile, the recognition of social value was the lowest. Forest ecological value, an important component of the value of forest assets, reflects the quantitative results of the ecological benefits in each period and region and is not mutually exclusive from economic value. The proportion of ecological and economic values to total value may vary according to the environment and cultivation goals. For example, in regions with fragile ecological environments, the ecological value of the environment should be highlighted more than the economic value.

The notion of forest resource liabilities is not recognized and accepted by all scholars; however, the survey results show that identifying forest resource liabilities is a rational approach. Forest resource liabilities include the legal obligations of overuse of resources during the process of maintenance and restoration of the asset stock in the economic system and the subsequent reduction in resource quality. These liabilities also include the negative externalities of the inventory of assets

Table 3.—The regression analysis.[a]

Factors	Adjusted R^2	Variable	mean	β	t	Collinearity	
						Tolerance	VIF
Identification of forest resource assets and liabilities	0.670	Constant		0.251	2.057		
		Identification of forest resource assets	1.933	0.606**	9.189	0.549	1.822
		Identification of forest resource liabilities	2.247	0.271**	4.017	0.549	1.822
Using a fair value-based hybrid model to measure forest resource assets and liabilities	0.446	Constant	2.262	0.544	3.591		
				0.657**	10.437	1.000	1.000
Methods used to measure the value of forest resource ecosystem services are diversified	0.440	Constant	2.381	0.465	2.896		
				0.657**	10.303	1.000	1.000

[a] In this analysis, the rationality of compiling a forest resource balance sheet is a dependent variable with a mean of 2.031. b values with asterisks are significantly correlated at 0.05. N = 135.

caused by deforestation and expropriation beyond the line of sustainable use. Forest resource liabilities reflect resource depletion and damage of forest resources, the management and protection costs, compensation expenditures that may occur in each period in the future, and the restoration costs of maintaining or meeting the ecological red line. Forest resource liabilities are unnatural losses of forest resources caused by the mismanagement of the resource or natural loss caused by natural disasters. When identifying forest resource liabilities, property rights and responsibilities should be made clear and measurable, and economic or ecological losses that have occurred or are likely to occur in the future should be included.

Effects of measuring assets and liabilities

The regression results, using forest resource asset and liability measurement as the independent variable, were statistically significant. The regression equation is

$$y = 0.544 + 0.657x_2$$

This indicates that measuring assets and liabilities and the rationality of compiling FRBSs had a significant relationship. This measurement is also an important component of all FRBSs.

Owing to the particularity and complexity of forest resources, it is difficult to accurately measure them as assets and liabilities; hence, finding a basis for valuation is an important task (Wu et al. 2020). Assets should be valued at fair value (market price) to be in line with social trends; however, considering the different uses and cultivation methods of forests, combining fair value and replacement costs may be a more realistic approach (Macedo 2012). Furthermore, a balance sheet that only reflects the physical inventory of forest resources does not meet the needs of macrogovernance. Hence, setting up physical inventory accounts and monetary values that meet the unique requirements of forest resources valuation facilitates the identification, measurement, and reporting of the physical and monetary value of forest resources, thereby generating a value-based FRBS (Jiao et al. 2018). Both the physical inventory and monetary value of assets are useful information for users, while the calculation of the value of liabilities is more meaningful. Assets and liabilities in the balance sheet are static data. Using discount value to turn resource flows into stock requires the determination of the discount rate and calculation period and a calculation of the indicator values. To resolve issues with converting physical inventory into monetary value, the monetary values of forest land, timber, and ecological values are all calculated according to benchmarks following certain standards, methods, and procedures. From an accounting perspective, the theoretical basis of a forest resource balance sheet is ‘‘forest resource assets = forest resource liabilities + forest resource equity.’’ Forest resource equity is the difference between assets and liabilities, and, therefore, need not be measured separately.

Accounting factors of the value of forest resources ecosystem services

The regression results, using the value of forest resource ecosystem services as the independent variable, were statistically significant. The regression equation is

$$y = 0.465 + 0.657x_3$$

Expanding the coverage and improving accounting methods make compiling FRBSs more feasible. Furthermore, the information provided by the balance sheet plays a significant role in sustainable development and provides a basis for policy decision-making in fields such as energy conservation and emissions reduction.

From 2001 to 2019, global forests absorbed approximately twice as much carbon dioxide as they emitted, at approximately 7.6 billion tons absorbed per year. These figures provide an intuitive view of their role as a ‘‘carbon sink’’ (Lebling et al. 2020). The ecological function of forests, in terms of air purification, soil and water conservation, and wind and sand stagnation, is apparent. Although identifying, measuring, and disclosing these ecological functions is a difficult and complex process, ignoring the value of services provided by forests could reduce awareness of the significance of planting and maintaining trees. Most nations no longer regard forests as a material resource that only provides fuel, food, furniture, and housing, but rather value them more for their ecological functions. Thus, the purpose of compiling the forest resource balance sheet is to reflect the ecological value of forest resources in the form of assets and to recognize the liabilities of various inputs needed to maintain forest resources and achieve sustainable social development.

CONCLUSION

Using a questionnaire survey, this study used empirical methods to study the rationality of compiling FRBSs. To the best of our knowledge, this is the first study in the field to do so.

The results of the questionnaires have passed the reliability and validity test, the contents of the questionnaire and the quality of the data obtained are both highly reliable, hence, it is suitable for factor analysis. In factor analysis, 33 Likert scales variables are divided into five common factors, and representative questions are extracted to represent independent and dependent variables. In regression analysis, all independent variables have significant effects on dependent variable. The forest resource balance sheet should reflect not only the economic value of forest resources, but also the ecological value of forest resources. This balance sheet can also show the physical and value quantity of forest resource assets, as well as the value quantity of forest resource liabilities. FRBSs should change the flow index into the stock index by means of discounts. The measurement of forest resource assets can use the fair value (market price) and the cost of mixed value. The carbon sink in the ecological value of forest resources has the conditions to adopt the measurement of fair value. The values of other ecological service should be measured according to the conditions of value quantity or physical quantity. The results showed that respondents recognized the necessity, alongside the importance of scientific rigor and feasibility, of compiling FRBSs. Most respondents believed that identifying forest resource assets and liabilities, using hybrid valuation methods based on fair value, and assessing the value of forest resource ecosystem services were the main influential factors for this compilation. This study enriched the forest resource accounting literature, laid a foundation for subsequent compilation of FRBSs, and provided a reference for other natural resource accounting studies.

Limitations and suggestions for future research

This research on FRBSs was exploratory. The conclusions drawn based on the survey results are of practical significance for the compilation. However, the industries and regions investigated were limited, and the questionnaire design could be further improved. Given that the literature on FRBSs is still in its infancy, theoretical results that can be used as a reference are limited; therefore, the approaches to constructing FRBSs have not yet been unified into standards, and their overall framework has not been fully validated. There is still no relatively authoritative and unified system for evaluating the service value of forest resource ecosystem, and the differences in levels of fair value measurement can result in the uncertainty of value evaluation results. The channels for obtaining the basic data for FRBSs are neither unified nor standardized, and the responsible body for preparing the report is unclear. The aforementioned shortcomings require further study. Future research can determine the boundaries of natural resources through identification and valuation of forest resource assets and liabilities and ecosystem services, providing useful forest resource information for all sectors of society.

Acknowledgments

We gratefully acknowledge financial support from the Planning Project of Humanities and Social Sciences for basic Scientific Research Business expenses in Colleges and Universities in Heilongjiang Province: Study on the Construction of Forest Resources balance sheet based on Green Development (HDRC 201604). We also acknowledge financial support from the Basic Scientific Research Business expenses in Universities in Heilongjiang Province (2020-KYYWF-0967).

Literature Cited

Alcamo, J., D. V. Vuuren, C. Ringler, W. Cramer, and K. Schulze. 2005. Changes in nature's balance sheet: Model-based estimates of future worldwide ecosystem services. *Ecol. Soc*. 10(2):19.

Brugnach, M., M. Craps, and A. Dewulf. 2017. Including indigenous peoples in climate change mitigation: Addressing issues of scale, knowledge and power. *Climatic Change* 140(1):19–32.

Chen, D. F. 1987. The measurement and evaluation of the public welfare efficiency of forest. *Forestry Sci. Technol*. 1:25–27. (In Chinese.)

Chen, Y., Y. Z. Yang, H. M. Yan, and Z. M. Feng. 2015. Progress in natural resource accounting and its implications for the preparation of natural resource balance sheet. *Res. Sci*. 9:1716–1724. (In Chinese.)

China Forest Resource Accounting Research Project Group. 2015. Study on China's Forest Resource Accounting in the Construction of Ecological Civilization System. China Forestry Publishing House, Beijing, China. pp. 129–146.

Cortés-Flores, J., G. Cornejo-Tenorio, L. A. Urrea-Galeano, E. Andresen, A. González-Rodríguez, G. Ibarra-Manríquez. 2019. Phylogeny, fruit traits, and ecological correlates of fruiting phenology in a Neotropical dry forest. *Oecologia* 189(1):159–169.

Costanza, R., R. d'Arge, R. de. Groot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R. V. O'Neill, J. Paruelo, R. G. Raskin, P. Sutton, and M. van den Belt. 1997. The value of the world's ecosystem services and natural capital. *Nature* 387:253–260.

Cronbach, L. J. 1951. Coefficient alpha and the internal structure of tests. *Psychometrika* 16:297–334.

Dickinson, F. and F. Eakin. 1936. A Balance Sheet of the Nation's Economy. University of Illinois, Champaign.

Du, J. F. 2015. Government Balance Sheet: Fundamentals and Applications in China. China Financial Publishing House, Beijing, China. (In Chinese.)

Feng, Z. M., Y. Z. Yang, H. M. Yan, T. Pan, D. Jiang, and C. W. Xiao. 2017. Some basic issues in the preparation of natural resource balance sheets. *Res. Sci*. 9:1615–1627. (In Chinese.)

Food and Agriculture Organization (FAO). 2020. The Global Forest Resources Assessment 2020: Main Report. United Nations, Rome. pp. 13–17.

Hada, T. 2009. Aspects of the accounting activities in forestry. *Bull. UASVM Horticulture* 66(2):218–225.

Haiilemariam, S. N., M. Kassie, and E. Mungatana. 2012. Forest Resource Accounts for Ethiopia. Implementing Environmental Accounts. Springer, Dordrecht, the Netherlands.

Herbohn, K. F. and J. L. Herbohn. 1998. Accounting for forestry assets: The development of an Australian policy. *Australian Forestry* 61(3):220–225.

Hu, W. L., and D. Shi. 2015. Research on the Framework System of - Natural Resource Statement of Assets and Liabilities: An Idea Based on the SEEA2012, SNA2008 and the National Balance Sheetas Research Approaches. *China Population, Resources and Environment* 8:1–9. (In Chinese.)

Huang, R. B., and Q. Zhao. 2015. Natural resource accounting from accounts to balance sheet: Evolution and enlightenment. *Theory Practice Finance Econ*. 1:74–77. (In Chinese.)

Hou, Y. Z., and Q. Wang. 1995. Research on China's Forest Resources Accounting. *World Forestry Res*. 3:51–56. (In Chinese.)

International Accounting Standards Board (IASB). 2018. Conceptual Framework for Financial Report. Publications Department of IFRS Foundation, London, UK.

Jiao, Z. Q., H. R. Wang, X. Y. Xun, and B. Yang. 2018. Design and application of the natural resources balance sheet prepared I: design. *J. Natural Res*. 10:1706–1714. (In Chinese.)

Kuznets, S. 1971. Modern economic growth: Findings and reflections. The Sveriges Riksbank Prize in Economic Sciences in Memory of Alfred Nobel 1971.

Lange, G. M. 2004. Manual for environmental and economic accounts for forestry: A tool for cross-sectoral policy analysis. Food & Agriculture Organization of the United Nations, Rome.

Lebling, K., M. Ge, K. Levin, R. Waite, J. Friedrich, C. Elliott, C. Chan, K. Ross, F. Stolle, and N. Harris. 2020. State of Climate Action: Assessing Progress Toward 2030 and 2050. World Resources Institute (WRI), Washington, D.C.

Li, Y., X. J. Zhang, and X. Chang. 2013a. China National Balance Sheet.2013, Theory, Method and Risk Assessment. China Social Sciences Press, Beijing, China. (In Chinese.)

Li, T., H. Li, and Y. Zhang. 2013b. Calculation of ecological benefit value of national public welfare forest. *Res. Development Markets* 2:122–126. (In Chinese.)

Liu, M. J., Z. M. Wen., and Y. Z. Wei. 2012a. Research on Accounting Recognition and Measurement of Forest Ecological Assets. *Chinese Forestry Sci. and Tech.* 11(3):90. (In Chinese.)

Liu, M. J., Z. M. Wen, and Y. Z. Wei. 2012b. Characteristics, accounting recognition and measurement of forest ecological assets. *J. Zhejiang Agric. Forestry Univ*. 1:88–96. (In Chinese.)

Long, H., J. Liu, and C. Tu. 2018. From state-controlled to polycentric governance in forest landscape restoration: The case of the ecological forest purchase program in Yong'an Municipality of China. *Environ. Manag*. 62:1–12. (In Chinese.)

Macedo, D. 2012. The fair value of forestry assets: Analysis of precious woods and green resources. Catholic University of Portugal, Lisbon, Portugal.

Millennium Ecosystem Assessment. 2003. Ecosystems and Human Wellbeing: A Framework for Assessment. Island Press, Washington, D.C.

Morgan, R. 1968. The wealth of the nation. The national balance sheet of the United Kingdom 1957–1961. by J. Revell; G. Hockley; J. Moyle. *Econ. J.* 78(309):110–112.

Openshaw, K. 1980. Cost and financial accounting in forestry: A practical manual. Pergamon Press, Oxford, UK.

Pachauri, R. K., M. R. Allen, V. R. Barros, J. Broome, W. Cramer, R. Christ, J. A. Church, L. Clarke, Q. D. Dahe, P. Dasqupta, N. K. Dubash, O. Edenhofer, I. Elgizouli, C. B. Field, P. Forster, P. Friedlingstein, J. Fuglestvedt, L. Gomez-Echeverri, S. Hallegatte, G. Hegerl, M. Howden, K. J. Jiang, C. B. Jimenez, V. Kattsov, H. Lee, K. J. Mach, J. Marotzke, M. D. Mastrandrea, L. Meyer, J. Minx, Y. Mulugetta, K. O'Brien, M. Oppenheimer, J. J. Pereira, R. Pichs-

Madruga, G. K. Plattner, H. O. Pörtner, S. B. Power, B. Preston, N. H. Ravindranath, A. Reisinger, K. Riahi, M. Rusticucci, R. Scholes, K. Seyboth, Y. Sokona, R. Stavins, T. F. Stocker, P. Tschakert, D. V. Vuuren, J. P. V. Ypersele. 2014. Climate change 2014 synthesis report. Contribution of working groups I, II, and III to the fifth assessment report of the Intergovernmental Panel on Climate Change. Intergovernmental Panel on Climate Change (IPCC), Geneva.

Patil, P. 2017. Forest accounting: A theoretical perspective. *Int. J. Accounting Econ. Studies* 5(1):36.

Qiao, X., Y. He, and L. Cui. 2015. Research on the balance sheet of natural resources: Theoretical basis and preparation ideas. *J. Hangzhou Municipal Party School of CPC Committee* 2:73–83. (In Chinese.)

Qu, Y. M. and G. S. Tian. 2013. Study on dynamic value measurement of forest biodiversity assets. *Forestry Econ*. 4:104–107. (In Chinese.)

Shi, Y., X. Xu, and H. Du. 2018. Estimation of gross primary production in Moso bamboo forest based on light-use efficiency derived from MODIS reflectance data. *Int. J. Remote Sensing* 39:210–231. (In Chinese.)

Statistical Office of the European Communities (Eurostat). 2000. Valuation of European Forests: Results of IEEAF Test Applications. European Commission, Brussels.

United Nations (UN). 2014. System of Environmental-Economic Accounting 2012: Central Framework. UN, New York.

Wang, B., X. Ren, and W. Hu. 2011. Forest ecosystem services and their value assessment in China. *Scientia Silvae Sinicae* 2:145–153. (In Chinese.)

Wei, Y. Z., H. Q. Ren, and C. X. Zhang. 2001. Necessity and feasibility analysis of forest resource asset management. *Issues Forestry Econ*. 4:197–201. (In Chinese.)

Wilson, A. Y., J. Mcdonald and A. Sayegh. 2006. Australian government balance sheet management. National Bureau of Economic Research (NBER) Working Papers.

World Wildlife Fund (WWF). 2020. Living Planet Report 2020—Bending the curve of biodiversity loss. Almond, R., M. Grooten, and T. Petersen (Eds.). WWF, Gland, Switzerland.

Wu, J., F. M. Qi, and J. R. Zhang. 2020. Study on the formulation of Chinese government natural resources accounting standards from the perspective of national governance. *Accounting Res*. 9:3–15. (In Chinese.)

Xiao, J. W. and S. H. Yin. 2014. Construction of stochastic control model for forest ecological asset pricing. *Forestry Econ*. 5:103–106. (In Chinese.)

Xu, W. H. 1991. Study on forest resource accounting and its integration into national economic accounting system. *Forestry Econ*. 5:41–51. (In Chinese.)

Yoshida, T. 2001. Problems in the introduction of balance sheet to government accounts: Public finance of welfare state in the shaking. *Bull. Niigata Seiryo Univ*. pp. 143–152.

Yue, S. Z. 2008. Forest social benefit accounting. *J. Shanghai Lixin Accounting Univ*. 6:16–22. (In Chinese.)

Zhang, R. C. 2020. Study on the construction of the conceptual framework of forest resource balance sheet financial report based on value quantity. *Accounting Res*. 9:16–28. (In Chinese.)

Zhang, W., and C. Li. 2019. Study on forest resource balance sheet accounting system. *J. Natural Res*. 6:1245–1258.

Zhang, X. Y. 2018. A study on the dispute between the balance sheet and liabilities of forest resources. *Forest Econ*. 40(4):68–72+112. (In Chinese.)

Zhang, Y. 2016. Study of natural resources accounting and the balance sheet management—Taking forest resources in Zhalantun City of Inner Mongolia for an example. *Environ. Prot*. 44(3):35–38. (In Chinese.)

Zhang, Z. T., G. C. Dai, Y. Guo, N. Zhang, and X. Y. Zhang. 2018. Study on the basic framework of forest resource balance sheet preparation. *Res. Sci*. 5:929–935. (In Chinese.)

Zhao, T. Q., Z. Y. Ouyang, H. Zheng, X. K. Wang, and H. Miao. 2004. Forest ecosystem services in China and their value assessment. *J. Nat. Res*. 4: 480–491. (In Chinese.)

Zhao, Y., Y. Ning, and F. Martin. 2016. Synthesis and characterization of bio-based phenol-formaldehyde resol resins from bark autoclave extractives. *Forest Prod. J*. 66:18–28.

Zhao, W. X. and Q. J. Zhao. 2019. Research on the compilation of forest resources balance sheet. *China Forestry Econ*. 5:28–30. (In Chinese.)

Appendix I

QUESTIONNAIRE
PART 1: PERSONAL INFORMATION

Q1. Profession

A. Students of forestry and economic management; **B.** Staff from the government forestry department; **C.** Staff from the government department of natural resources and ecological environment; **D.** Researchers of natural resources and ecological environment; **E.** Managers and accounting personnel of enterprises in the forest industry.

Q2. Professional field

A. Forestry Economics and Management; **B.** Forest science and related disciplines; **C.** Other majors in economics and management (including accounting, auditing, financial management and statistics); **D.** Environmental and ecological protection; **E.** Other majors.

Q3. Education

A. PhD graduate; **B.** Master graduate; **C.** Undergraduate; **D.** Junior college; **E.** Other.

Q4. Region

A. Northeast; **B.** South; **C.** Northwest; **D.** Central; **E.** Southwest.

Q5. Years of study and work

A. 20 years and more; **B.** 10–19 years; **C.** 5–9 years; **D.** 1–4 years; **E.** Less than 1 year.

PART 2: ATTITUDES ON WHETHER IT IS NECESSARY TO COMPILE A FOREST RESOURCE BALANCE SHEET

Please choose the one that you think is the best according to the actual situation:

1. Strongly disagree; 2. Disagree; 3. Neutral; 4. Agree; 5. Strongly agree.

No.	Question	1	2	3	4	5
Q6.	Forest resource accounting is very necessary.					
Q7.	The existing forest resource accounting system can't meet the requirements of ecological construction and information.					
Q8.	Through the previous reading or introduction, you have a good understanding of the forest resource balance sheet.					
Q9.	On the basis of the natural resource balance sheet, the forest resource balance sheet still needs to be compiled.					
Q10.	Forest resource balance sheets can provide more information than pure forest resource accounting accounts.					
Q11.	The leader's outgoing audit requires a forest resource balance sheet.					
Q12.	Existing conditions can meet the requirements for compiling a forest resource balance sheet.					

PART 3: UNDERSTANDING OF HOW TO IDENTIFY THE ASSETS AND LIABILITIES OF THE FOREST RESOURCES BALANCE SHEET

Please choose the one that you think is the best according to the actual situation:

1. Strongly disagree; 2. Disagree; 3. Neutral; 4. Agree; 5. Strongly agree.

No.	Question	1	2	3	4	5
Q13.	Forest resource balance sheets should not just reflect the economic value of forest resources.					
Q14.	The economic value and ecological value of forest resource assets are not mutually exclusive and should be calculated together in the forest resource balance sheet.					
Q15.	In the forest resource balance sheet, assets reflect both physical quantity and value, while liabilities only reflect value.					
Q16.	The economic and ecological values of forest land and trees need to be reflected in the forest resource balance sheet.					
Q17.	The public welfare forest in the forest resource balance sheet reflects not only ecological value, but also economic value.					
Q18.	The commercial forest in the forest resource balance sheet reflects not only the economic value, but also the ecological value.					
Q19.	The assets in the forest resource balance sheet should be classified according to the age of mature forests, over mature forests, near-mature forests, young forests, etc.					
Q20.	The assets in the forest resource balance sheet should be classified according to arbor forests, shrubs, bamboo forests, etc.					
Q21.	The recognition of liabilities in the forest resource balance sheet is significant.					
Q22.	The liabilities in the forest resource balance sheet reflect resource depletion, damage, management and protection, and compensation expenditures in the next year.					
Q23.	The liability in the forest resource balance sheet is to maintain or meet the ecological red line standard, that is, the restoration cost that exceeds the critical value of the sustainable use of resources.					
Q24.	The net assets in the forest resource balance sheet do not need to be classified and accounted separately, it is just the difference between assets and liabilities.					

PART 4: UNDERSTANDING OF HOW TO MEASURE THE ASSETS AND LIABILITIES OF THE FOREST RESOURCES BALANCE SHEET

Please choose the one that you think is the best according to the actual situation:

1. Strongly disagree; 2. Disagree; 3. Neutral; 4. Agree; 5. Strongly agree.

No.	Question	1	2	3	4	5
Q25.	Assets and liabilities in the forest resource balance sheet are static data. Therefore, the flow indicator should be converted into a stock indicator through discounting and other methods.					
Q26.	The assets in the forest resource balance sheet should be priced at the historical cost or replacement cost actually incurred.					
Q27.	In order to reflect the actual value of forest resources, the assets in the forest resource balance sheet should be measured at fair value (market price).					
Q28.	The assets in the forest resource balance sheet should be priced at a mixed valuation based on fair value (market price) and cost valuation.					
Q29.	The methods for measuring assets and liabilities in the forest resource balance sheet should be unified across the country.					

PART 5: ABOUT THE VALUE ACCOUNTING OF FOREST RESOURCES ECOSYSTEM SERVICES

Please choose the one that you think is the best according to the actual situation:

1. Strongly disagree; 2. Disagree; 3. Neutral; 4. Agree; 5. Strongly agree.

No.	Question	1	2	3	4	5
Q30.	The most important ecological value of forest resources is the forest carbon sink.					
Q31.	The value of carbon sequestration of forest resources should be priced at the domestic carbon sink market price.					
Q32.	The value of carbon sequestration of forest resources should be priced at the international carbon sink market price.					
Q33.	In the ecological value of forest resources, the value of water conservation should be calculated by replacing the construction cost of the reservoir.					
Q34.	In the ecological value of forest resources, the value of conserving soil should be calculated using the market price of fertilizer converted from soil fertility.					

Q35. The value of forest resources to purify the air should be calculated using the cost of using air cleaners.
Q36. The value of purified water quality of forest resources should be replaced by the processing cost of tap water.
Q37. The value of forest resources for farmland protection should be calculated according to the converted value of reducing wind and sand and increasing grain production.
Q38. The value of forest resources for oxygen release should be priced at the market price of medical oxygen.

PART 6: OTHER ISSUES ON THE FOREST RESOURCE BALANCE SHEET

Q39. The main body of preparation of natural resource balance sheet or forest resource balance sheet is: (single choice)

A. Accounting department; **B.** Forestry Administration; **C.** Statistics Department; **D.** The leader's outgoing audit department; **E.** Other departments with information needs.

Q40. The time interval for preparing the forest resource balance sheet should be: (single choice)

A. 1 year; **B.** Inventory period of forest resources (5 years); **C.** A term of leadership; **D.** Irregular period.

Q41. The principle of forest resource balance sheet compilation is: (single choice)

A. assets = liabilities + net assets; **B.** Beginning inventory + current increase − current decrease = ending inventory; **C.** Other.

Q42. The method of compiling the forest resource balance sheet is: (single choice)

A. Accounting method; **B.** Statistical method; **C.** Combination of accounting method and statistical method; **D.** Other.

Q43. The main difficulty in compiling the forest resource balance sheet is: (Multiple choice)

A. Accounting methods are not uniform; **B.** Technology and data collection are cross-domain; **C.** Uses are not clear; **D.** No actual value; **E.** It is difficult to identify and measure assets and liabilities.

Q44. The data source of the forest resource balance sheet is: (multiple choice)

A. Accounting data; **B.** Statistics data; **C.** Forestry department business data; **D.** Other department data.

Q45. Considering the feasibility and necessity, currently, the value accounting in the forest resource balance sheet should include: (multiple choice)

A. Economic value; **B.** Ecological value; **C.** Social value; **D.** Cultural value

Q46. Considering the feasibility and necessity, the ecological value of forest resources should include: (multiple choice)

A. Carbon fixation and oxygen release; **B.** Forest protection; **C.** Conservation of soil; **D.** Conservation of water sources; **E.** Biodiversity; **F.** Forest nutrient retention; **G.** Purification of the atmospheric environment; **H.** Forest health.

Appendix 2 FACTOR ANALYSES

	Factor load 1	Eigenvalues	Cumulative interpretation variance percentage	Common factors
Q6	0.667	3.775	53.926	The rationality of compiling FRBS (dependent variable)
Q7	0.754			
Q8	0.547			
Q9	0.746			
Q10	0.791			
Q11	0.801			
Q12	799			

	Factor load		Eigenvalues	Cumulative interpretation variance percentage	Common factors
	1	2			
Q13	0.639	0.381	3.778	34.343	Identification of forest resource assets (H1-1)
Q14	0.688	0.368			
Q16	0.766	0.263			
Q17	0.700	0.254			
Q18	0.737	0.216			
Q21	0.798	0.068			
Q15	0.343	0.589	2.783	59.639	Identification of forest resource liabilities (H1-2)
Q20	0.309	0.713			
Q22	0.427	0.628			
Q23	0.494	0.605			
Q24	−0.029	.838			
Q19					

	Factor load 1	Eigenvalues	Cumulative interpretation variance percentage	Common factors
Q25	0.805	2.680	53.601	Using a fair value-based hybrid model to measure forest resource assets and liabilities (H2)
Q26	0.734			
Q27	0.689			
Q28	0.717			
Q29	0.710			

	Factor load 1	Eigenvalues	Cumulative interpretation variance percentage	Common factors
Q30	0.727	4.861	54.009	Methods used to measure the value of forest resource ecosystem services are diversified (H3)
Q31	0.667			
Q32	0.701			
Q33	0.779			
Q34	0.722			
Q35	0.755			
Q36	0.781			
Q37	0.711			
Q38	0.763			