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Research on opportunities of using GEP accounting in Mongolia: A case study of the valuation of ecosystem services in Khovd

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ABSTRACT

The study could be a basis for designing and choosing appropriate economic valuation methods for ecosystem goods and services in Mongolia. Ecosystem economic valuation is an effective way to measure and understand the significance of the benefits people receive from ecosystems. Gross Ecosystem Product (GEP) is the monetary value of ecosystem services, making the findings comparable to GDP. The GEP concept seeks to employ specific indicators to quantify the economic value of all ecosystem products and services. GEP is the total value of final ecosystem goods and services supplied to human well-being in a region annually. We have developed the first GEP framework for Mongolia and conducted a case study using the market valuation method, shadow engineering method, replacement cost method, avoided cost method, conservation value method, and travel cost method. The GEP was calculated at the provincial level, and a framework was customized for the unique economic and ecological situations of Khovd Province. Our findings revealed that the total GEP in Khovd Province ranged from 110040.7 million dollars to 113650.2 million dollars in 2015 and 2020, respectively. The GEP to GDP ratio varied between 815 and 390 during this time. Among the different components of GEP, the value of ecosystem regulating services played a crucial role, accounting for 99.6% equally in both 2015 and 2020. The research results show that the distribution of GEP components in Khovd province is entirely distinct. The contribution of soil conservation services is the highest to the GEP of the selected case.

KEYWORDS

Mongolia, Ecosystem services, GEP accounting, Khovd province, Ecosystem valuation

1. INTRODUCTION

Ecosystem valuation is an effective method for measuring the connections between ecosystem assets and humans. These ecosystems offer a range of benefits crucial for human well-being (MA, 2003). The United Nations Statistical Commission affirmed the "System of Environmental-Economic Accounting (SEEA) Core Framework", indicating the United Nations' attitude towards it as an equally important indicator as the System of National Accounts. Based on this, countries have conducted diverse ecosystem accounting and assessment practices using the SEEA framework in 2012. Chinese GEP accounting project provides an important reference for quantifying the ability of natural resources to provide ecosystem service and their contribution to human well-being. In the same year, China first proposed exploring the compilation of a Natural Resource Balance Sheet (NRBS) and proposed auditing advanced leaders for eco-environmental responsibility [1]. GEP is not without theoretical flaws [2]. GEP is delineated as the cumulative value of final products and services offered by the ecosystem for the betterment of human well-being and societal advancement within a defined timeframe [3]. This research is the first attempt to apply GEP accounting and establish an appropriate framework in Mongolia. Drawing on the study results regarding the valuation of ecosystem goods and services, this paper seeks to explore the concept and significance of GEP. Additionally, this study brings several innovative contributions to the field. First, it will use comprehensive valuation methods, combining both market and non-market approaches to capture the full spectrum of ecosystem services. Second, it will bridge the gap between academic research and policy applications by offering concrete strategies for integrating GEP into Mongolia's governance. Thirdly, it analyzes the categories of ecosystem goods and services and their accounting methods, aiming to provide a reference for developing an evaluation mechanism. Generally, our study will help create a more holistic framework for ecosystem value assessment in Mongolia, using Khovd province in western Mongolia as a case study.

2. RESEARCH METHODS

2.1. Study area

Khovd, the administrative center of Khovd province in the Western Region of Mongolia, is 1,470 km from the capital, Ulaanbaatar. Khovd province, which includes a central administrative area and 16 main counties, referred to as soums. It is located in the far west of Mongolia (90°40'~94°18'E, 45°00'~48°55'N), has a total area of 76000 km^2 and a total population of about 88974 in 2020. Khovd province borders the People's Republic of China, such as provinces Bayan-Olgii, Uvs, Zavkhan, and Gobi-Altai. Khovd province encompasses the Great Lake Basin in the northeast, the Central Mongolian Altai in the northwest and central regions, and the Dzungarian Gobi in the south. Khovd province's diverse ethnic groups show notable cultural differences, widely studied ethnographically.

The case study area has a wide variety of ecosystems, including forests, steppes, wild rivers, lakes, deserts, snow-capped mountains and abundant wildlife. Twenty percent of the territory is semi-desert and steppe. The highest point of the territory is the Munkh-khairkhan peak height of 4204 m above sea level, and the lowest point is the Altain-Bor-Tsonj depression, whose altitude is 1,126 m above sea level.

Khovd province, like much of Mongolia, has a continental steppe climate with long, dry, cold winters and short, warm summers (avg. July temp ~19 °C). Most rainfall occurs in summer. Its landscape ranges from dry plains in the Great Lake Basin to humid peaks in the Mongolian Altai, featuring steppes and meadows used for grazing [4]. Soils are mainly black in plains and meadows in mountains, classified into 36 types across mountain and valley regions [5]. The region is rich in resources such as anthracite, copper, iron, and marble. An ecological assessment shows most areas are environmentally vulnerable [6].

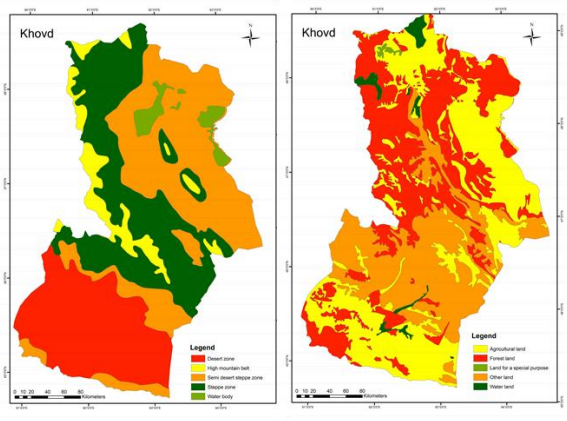

Figure 1. Ecosystem types of Khovd Province and land use classification

Agriculture—mainly livestock and crops—is central to the economy, supplying food and over 70% of rural employment.

2.2 GEP Accounting Method

Building on previous studies, a GEP accounting system has been developed to reflect the specific ecological conditions of the selected area [7-15]. The selection of GEP indicators was guided by frameworks from case studies in IMAR, Arxan, Dalian, and Qinghai, as these regions share key ecosystem characteristics with the study area.

The calculations followed the GEP technical guidelines, ensuring standardization, accuracy, and reliability. Equation (1) outlines the components of GEP, which quantifies the economic value of ecosystem services. This primarily encompasses the value of ecosystem material products, regulatory services, and cultural services.

$$GEP = EPS + ERS + ETS \quad (1)$$

As Equation (1), ecosystem material services (EPS) refer to various material products obtained by humans from ecosystems that can be exchanged in the market, such as food, fiber, wood, medicine, decorative materials, and others. The value of material service (EPS) should be noted, as it is one of the three primary ecosystem services. This service category should be defined in greater detail, as it more effectively reflects the economic benefits of a selected area compared to the other two service categories in Mongolia. In this case, material services mainly include agricultural crop production, animal husbandry production, ecological energy, water supply, fishery and aquatic production, forestry production, and others.

Ecosystem regulating services (ERS) provide benefits for improving human survival and living environments, such as regulating climate, conserving water sources, maintaining soil, regulating floods, degrading pollutants, fixing carbon dioxide, and providing oxygen.

$$ERS=FM+SR+WP+AP+CS+OS+WR+CR+PM \quad (2)$$

As Eq (2), ERS was defined as the accounting framework for GEP in the Inner Mongolia Autonomous Region [7]. It was used as an indicator of regulating services in Mongolia, which mainly includes soil conservation (SR), water purification (WP), air purification (AP), carbon sequestration (CS), oxygen supply (OS), water retention (WR), climate regulation (CR) and flood storage (FM). Because Mongolia is a landlocked country, the value of coastal protection is not involved.

Non-material services (ETS), also referred to as cultural services, mainly include ecotourism values. ETS are he intangible benefits that humans derive from ecosystems through spiritual experiences, knowledge acquisition, leisure and entertainment, and aesthetic experiences. The GEP is accounted for using biophysical quantities and valuing several ecosystem services. This study employed various methodologies to achieve its research objectives. These methodologies include both physical measurement and monetary valuation techniques, as outlined in the technical guidelines of the GEP (version 1.0). For instance, the value of material services is mainly assessed using the direct market price technique, the value of regulating services is primarily determined by the replacement cost method, the shadow engineering method, and other methods. The value of cultural services is gauged using the individual travel cost method. To address limitations in data availability, primary data collection, such as household surveys and interviews, was supplemented with secondary data sources, particularly in the valuation of material services. The data used in this study covered the years 2015 and 2020. Units are calculated in millions of dollars.

3. RESULT AND DISCUSSION

3.1 GEP values and changes

Despite the pandemic in 2020, Khovd province's GEP that year was 110,041.0 million dollars, reflecting a 12.5% increase since 2015 (Table 1). Ecosystem-regulating services, such as water purification, comprised 50.7% of the total GEP. Another significant regulatory service was flood regulation and storage, which accounted for 35.6%. Even with wild tea, wild onions, and wild white mushrooms instead of cultivated mushrooms, tea, and medicinal herbs, material services constituted only 3% of the total value. The most critical material service was animal husbandry production, particularly livestock and related products, which accounted for 67.6%. Other notable material services included water supply at 19.6% and ecological energy production at 9.76%. A unique feature of the third-level indicators in Khovd province's GEP framework is lawful hunting, which represented a minor 0.001%. Unfortunately, we have not yet accounted for the illegal hunting assessment.

Table 1. GEP accounting in Khovd province, by million USD (2015 to 2020)

Types of service	Category of ecosystem services	Accounting items	2015		2020		2015-2020 (current price, not inflation-adjusted)	
			Monetary value	Percent of total value	Monetary value	Percent of total value	Amount of change	Percent change
Material services	Production of ecosystem goods	Agricultural crop production	12.1	0.0120%	14.3	0.0126%	2.2	18.16%
		Animal husbandry production	285.374	0.2824%	322.8	0.2838%	37.2	13.04%
		Fishery production	0.024	0.0000%	0.052	0.0000%	0,028	120.13 %
		Forestry production	0.58	0.0006%	0.003	0.0000%	-0.577	-99.41%
		Others	0.15	0.0002%	0.048	0.0000%	-0.103	-68.05%
	Water supply	Water use in agricultural irrigation	3.1	0.0031%	5.8	0.0051%	2.653	84.45%
		Water use in households	3.9	0.0039%	4.6	0.0041%	0.7	17.53%
		Water use in industry	57.2	0.0566%	83.1	0.0731%	25.8	45.16%
	Ecological Energy	Hydropower	0.5	0.0005%	0.8	0.0007%	0.325	64.17%
		Coal	27.1	0.0269%	40.9	0.0360%	13.7	50.63%
		Households used biogas	2.9	0.0029%	4829.38	0.0042%	1.9	67.58%
Regulating services	Flood mitigation	Flood control and storage	37024.0	36.6427%	40248.4	35.4143%	3224.4	8.71%
	Soil retention	Retained soil, N, and P	740.8	0.7332%	819.1	0.7207%	78.3	10.57%
	Water purification	Purification (COD, NH-N, TP)	52469.3	51.9288%	57368.1	50.4777%	4898.8	9.34%
	Air purification	Purification (SO_2, NO_x, PM)	72.7	0.0719%	671.2	0.5906%	598.6	823.69 %
	Carbon fixation& Oxygen supply	Carbon sequestration & Oxygen supply	147.2	0.1457%	2851.8	2.5093%	2704.6	1836.68 %
	Water conservation	Water retention	1828.9	1.8100%	1665.4	1.4654%	-163.4	-8.94%
	Climate regulation	Evaporation &Transpiration	8361.2	8.2751%	9545.3	8.3989%	1184,1	14.16%
Cultural services	Non-material services	Ecotourism	3.5	0.0035%	3.8	0.0033%	0.2	7.12%
Grand total			**101040.7**	**100%**	**113650.2**	**100%**	**12609.5**	**12.48%**

While we have done our best to calculate the GEP in Khovd under current conditions, it is important to note that we identified and substituted some new third-level indicators, such as natural sand and sea salt. Nonmaterial services value accounted for only 0.003% of GEP and were solely represented by ecotourism, estimated using individual travel cost methods. Due to the pandemic lockdown, foreign tourists rarely visited Khovd province, while the number of domestic tourists increased. The changes in the Gross Ecosystem Product (GEP) of Khovd province from 2015 to 2020 can be explained by changes in supply, demand, and other influences like the impact of pandemic shocks on the utilization of ecosystem

services. Between 2015 and 2020, the total valuation of regulating services in Khovd increased from 100,644.1 million to 12,525.3 million dollars, maintaining a nearly constant percentage of 99.6% of the total value. The changes in the valuation of carbon fixation and air purification were significant. Between 2015 and 2020, the combined value carbon fixation-oxygen supply and air purification values increased 19-fold and 9-fold, respectively. During the same period, the water retention value declined by 8.94%.

3.2 GEP works in parallel with GDP

Gross Domestic Product (GDP) is calculated in Mongolia at only two municipal levels, the country and the province. The Gross Ecosystem Product (GEP) of the Khovd in 2020 was $113,650.2 million, which is 420 times higher than the GDP for that year. Of the different ecosystem services, regulating services accounted for $113,169.4 million, making up 99.6% of the total GEP.

Table 2. GEP and GDP ratio, by million dollars

Items	2015	2020
GEP	101040.7	113650.2
GDP	124.0	291.2
GEP/GDP ratio	815	390
Population	83127	88974
GDP per capita	1.5	3.3

In 2020, water purification services were valued at $573,681 million, the highest among all ecosystem service types, with flood mitigation services coming next. Water retention, climate regulation, and air purification services were valued at $1,665.4 million and $9,545.3 million, respectively.

In Mongolia, GDP growth and GDP per capita are frequently used together to inform decision-making and analyze economic growth and human development at both the sectorial and municipal levels. Evaluating both GEP and GDP together, enabling the simultaneous use of these indices, is essential for fostering integrated economic development and environmental protection. In 2014, the Mongolian parliament approved the Green Development Policy and later introduced Vision-2050 in 2020. Among the 21 provinces, Khovd, Arkhangai, Uvurkhangai, Khentii, and Bulgan have set local objectives to prioritize green development. To reach the objectives outlined in the aforementioned policy documents, we have carried out a more detailed assessment of GEP and GDP at both the provincial and regional levels. Since more than 50% of the gross domestic product in 14 of the 21 provinces, including our case, is derived from agricultural industry products, these provinces are both socially and economically dependent on their natural environment and more vulnerable to climate change [16].

4. CONCLUSION

Evaluation of the ecosystem can speed up the recognition and realization of ecological product value. This study was the first complex research on the economic valuation of the ecosystem in Mongolia. GEP accounting enhances our understanding of the ecological connections between regions and helps assess the value of ecosystem services, including ecological product supply and regulatory functions. To achieve the primary goals of this study, we introduced new knowledge and developed the first framework for GEP in Mongolia. Moreover, to precisely identify new secondary indicators for ecosystem material products, we introduced or replaced certain primary products derived from agricultural ecosystems, such as tea, mushrooms, and medicinal herbs, with new indicators. Given the presence of wild white mushrooms and onions in the high mountain zone, we chose data from our primary survey instead of relying on official data. During the study, the valuation of ecosystem regulating services highlighted their critical role in maintaining ecological balance and supporting sustainable development. The travel cost method was applied to calculate ecosystem non-material services for the first time in Mongolia. Applying GEP accounting as a decision-making tool is an effective approach to fostering sustainable development and boosting regional economic growth. Finally, this study underscores the critical role of ecosystem accounting-"GEP accounting" in fostering sustainable development and shaping environmental policy in Mongolia.

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