The Manifestation and Transformation of Ecological Value Under Digital Empowerment: A Study on the Accounting, Evaluation, and Implementation Mechanism of Xianning *Osmanthus* Ecological Assets

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Abstract. *Osmanthus* was the most recognizable ecological symbol and cultural gene in Xianning, with multiple functions such as carbon sequestration and oxygen release, soil and water conservation, biodiversity conservation, landscape aesthetics, and cultural services. However, its value had long been hidden and not monetized, which restricts the high-quality development of the industry. Based on the theory of ecosystem service value (ESV), this paper integrated remote sensing interpretation, internet of things sensing, blockchain traceability and multi-source big data modeling to build a three-dimensional accounting system of "spatial distribution - functional supply - value quantification", and for the first time completed the refined assessment of 117000 mu of *osmanthus* fragrans forest in the whole region: in 2025, the total value of ecological services would reach 1.863 billion yuan, of which 62.4% would be regulatory services (carbon fixation, air purification, water conservation), 28.7% would be cultural services (landscape recreation, spiritual healing, and intangible heritage), and 9.1% would be support services (soil formation, pollination media). Based on this, a four in one implementation mechanism of "digital property rights confirmation value anchoring market docking diversified compensation" was proposed: relying on the "Xianning *Osmanthus* Ecological Cloud Map" for dynamic property rights confirmation; Linking green credit, ecological bonds, and carbon trading with GEP accounting results; Innovate the "*Osmanthus* Ecological Points" to connect cultural and tourism consumption with carbon inclusiveness; Build a collaborative governance model with government leadership, enterprise entities, farmer participation, and digital empowerment vernment, driven by enterprises, involving local farmers, and empowered by digital technologies. Practice had shown that digital technology could effectively solve the problem of "inaccurate measurement, inaccurate calculation,

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and poor use" of ecological value, and provide a replicable path for the transformation of characteristic ecological resource value in small and medium-sized cities.

Keywords: *Osmanthus*; Ecosystem Service Value; GEP Accounting; Digital Technologies

1 Introduction

The construction of ecological civilization had entered the "deep water zone of value transformation". The report of the 20th National Congress of the Communist Party of China clearly proposed to "establish a mechanism for realizing the value of ecological products". Document No. 24 of the Central Office of the Communist Party of China (2021) lists the accounting of ecological product value and market-oriented operation as national strategic tasks[1]. The current practice faced three major bottlenecks: firstly, the "black box" of ecological value, lacking verifiable, traceable, and tradable quantitative basis; Secondly, the accounting methods were extensive and difficult to adapt to the differentiated service functions of regional characteristic species; The third issue was the single transformation path, excessive reliance on fiscal transfer payments, and the absence of market mechanisms. Xianning *Osmanthus* has national uniqueness, high cultural recognition, and solid industrial foundation. It possessed over 90% of the country's century old osmanthus, 112 varieties of osmanthus germplasm resources, and profound Chang'e culture accumulation. Its *osmanthus* forest had multiple ecological functions such as climate regulation, cultural identity, and psychological healing, making it a typical composite ecological asset. However, existing research mostly focused on industrial economy or cultural inheritance, and there was almost no systematic measurement and digital implementation of *osmanthus* ecological services[2]. This article took Xianning as an empirical study, integrating GIS, hyperspectral remote sensing, IoT environmental monitoring, and block chain certification technology to construct a county-level characteristic plant ecological asset "accounting evaluation transformation" full chain model, focusing on answering three questions: (1) How to scientifically quantify the multidimensional ecological service value of *osmanthus* forest? (2) How to rely on digital technology to achieve ecological asset ownership, pricing, and circulation? (3) How to design sustainable market-oriented mechanisms to support ecological protection and rural revitalization?

2 Theoretical Basis and Methodology System

2.1 Theoretical Framework: from GEP to Digitalization of Ecological Assets

This study was based on the accounting of Gross Ecosystem Product (GEP), breaking through the limitations of traditional GEP that focuses on "static total", and introducing the concept of "ecological assets" - a collection of ecological elements that have

clear spatial boundaries, identifiable rights registration, dynamic monitoring, and value-added transformation [3]. Referring to the United Nations Environmental Economic Accounting System - Ecosystem Accounting (SEEA-EA), Xianning *Osmanthus* fragrans ecological assets are divided into three categories: (1) supply service assets, including fresh *Osmanthus* fragrans, high-quality seedlings, aromatic oil raw materials and other collectable physical products; (2) Adjust service assets, including carbon sequestration and $PM_{2.5}$ Process services such as adsorption capacity, evapotranspiration cooling effect, and water conservation capacity; (3) Cultural service assets include intangible welfare outputs such as landscape recreation, participation in intangible cultural heritage ceremonies, and aromatherapy emotional interventions.

2.2 Technical Path: Integrated Perception of Air Space Sky Network

2.2.1 Spatial Recognition Layer.

Integrating Sentinel-2 multispectral images (10 m resolution) with unmanned aerial vehicle LiDAR point cloud data, using Mask R-CNN deep learning model to recognize *osmanthus* forest patches with an accuracy of 93.7%; Construct a suitability spatial distribution map based on 12 environmental factors including soil pH, slope, and annual average temperature.

2.2.2 Process Monitoring Layer.

286 IoT micro meteorological stations and CO_2/TVOC sensors were deployed in 45 townships to collect key parameters such as microclimate, volatile organic compounds (VOCs) release intensity, and negative oxygen ion concentration in the crown layer of *osmanthus* forests in real time [4].

2.2.3 Value Accounting Layer.

Adopting the equivalent factor method and localizing correction coefficients. For example, the average annual carbon sequestration per unit area of *Osmanthus* fragrans was measured to be 1.82 t C/ha (higher than the national average of 1.35 t C/ha for broad-leaved forests); The comprehensive application of willingness to pay method (WTP) and time value method in cultural service value, based on valid questionnaires collected from 12,000 tourists in 2024, the recreational value of a single *osmanthus* forest visit is estimated at RMB 86.3 per person per day.

2.2.4 Confirmation and Circulation Layer.

Based on the alliance chain, the "Xianning *Osmanthus* Ecological Chain" is constructed to generate unique NFT digital identity cards for each ancient *osmanthus* plant and standardized flower picking base per mu. The entire process records growth trajectory, carbon sink increment, cultural events, and management logs, supporting ecological credit pledge, green credit credit credit, and carbon sink asset securitization.

3 Analysis of the Ecological Value Accounting Results of Osmanthus Fragrans in Xianning

3.1 Total Value and Structure of Ecological Services

According to the accounting results for 2025 (in Table 1)[5], the total value of ecosystem services in Xianning's osmanthus forest was 1.863 billion yuan, accounting for 4.2% of the city's GDP. Among them, the value of regulatory services was 1.163 billion yuan (62.4%), the value of cultural services was 535 million yuan (28.7%), and the value of support services was 165 million yuan (9.1%).

Table 1. Composition of Ecological Service Value of *Osmanthus* fragrans in Xianning (2025)

Service Type	Project	Value/100 million yuan	Proportion
Adjustment Services	Carbon sequestration, air purification, soil conservation, and temperature reduction	11.63	62.4%
Cultural Services	Recreation, intangible cultural heritage, and healing	5.35	28.7%
Support Services	Soil, pollination	1.65	9.1%
Total	——	18.63	100%

Notably, the ecological value per unit area of the ancient osmanthus community (2,558 plants) was 3.2 times that of conventional osmanthus forests, confirming its status as a "living ecological heritage"; And standardized based such as Jiangnan Guigu, due to their fine management, had an ecological premium rate of 21.6% per unit output value, highlighting the ecological potential of intensive planting.

3.2 Spatiotemporal Differentiation Characteristics

Spatially, there was a trend of "core high value, peripheral decreasing": the ecological value density of Guihuayuan and Qianshan areas in Xian'an District exceeded 150000 yuan/hectare, while scattered areas such as Tongcheng and Chongyang were less than 50000 yuan/hectare; In terms of time, the cultural service value during the autumn flowering period had increased by 300% compared to normal days, and the adjustment service was balanced throughout the year. It was recommended to adopt a staggered layout of silver and *osmanthus* flowers in the morning and evening, as well as a four season business model (spring tea picking, summer shade rest, autumn *osmanthus* sightseeing, winter fragrance therapy), to stabilize seasonal fluctuations and improve the overall value output efficiency of the cycle.

3.3 Construction of Digital Mechanism for Realizing Ecological Value

3.3.1 Digital Property Rights Confirmation: Building a unified base for the "Osmanthus Ecological Cloud Map".

Based on the Xianning City Land and Space Basic Information Platform, integrating 12 types of data including remote sensing images, IoT sensing data, ancient and famous tree archives, and cultural tourism passenger flow heat maps, the first prefecture level osmanthus ecological asset digital twin system in China had been built. The system implements three functions: firstly, spatial property rights confirmation, assigning a unique "ecological property code" to each acre of osmanthus forest, linking land contracting rights, management rights, and ecological income rights; The second is dynamic monitoring, which presents real-time carbon sink increment, VOCs release intensity, negative oxygen ion concentration heatmap, and tourist trajectory; The third is intelligent warning, which automatically identifies early signals of pests and diseases, risks such as drought stress, and accurately pushes management and maintenance instructions. The platform has been integrated into the Hubei Province Ecological Product Trading Platform, providing authoritative and reliable data support.

3.3.2 Value Anchoring: GEP Accounting Results Linked to Green Financial Instruments.

An innovative dual-track mechanism comprising the "GEP Loan" and the "Gu Gui Carbon Sink Bond": GEP loans were granted based on the annual GEP accounting report, and banks provided low interest loans at a rate of 15% to 30% of the ecological value; 11 forestry carbon sequestration projects for the development of ancient Gui communities had been selected for the Gu Gui Carbon Sequestration Bond. The first phase was planned to issue 50 million yuan, with funds directed towards the rejuvenation of Gu Gui. Simultaneously promote the integration of the "Xianning Osmanthus" geographical indication and GEP certification, and strengthen brand premium.

3.3.3 Market Docking: Creating a consumption Loop of "Osmanthus Ecological Points".

Launch the "Guixiang Xianning" APP, where users could earn "*Osmanthus* Ecological Points" (1 point=0.1 yuan) by visiting *osmanthus* flowers, purchasing *osmanthus* products, and participating in intangible cultural heritage activities such as osmanthus flower hunting and moon worshipl, and exchanging them for boutique homestay vouchers, hot spring experience cards, organic *osmanthus* tea gift box and other rights. The rules for generating points were linked in real-time with IoT monitoring. During the pilot period in 2025, the point redemption rate will reach 89.3%, driving a 37% increase in secondary consumption and successfully transforming abstract ecological services into tangible benefits that users could feel, use, and enjoy.

3.3.4 Diversified Compensation: Building a Government Market Society Collaborative Governance Network.

A municipal *osmanthus* ecological compensation fund had been established, with diversified funding sources: 10% of tourism ticket revenue was retained; enterprises involved in the *osmanthus* sector that rank among the top 20 in GEP contribution rate pay ecological adjustment fees according to a predetermined ratio; and carbon trading profits would be shared at a rate of 20%. The fund focuses on supporting the transformation of low yield forests, training of horticultural skilled talents, and the construction of community co management mechanisms. By 2025, the first phase would raise 32 million yuan to benefit 12000 flower farmers, with an average increase of 4800 yuan per household. The virtuous cycle mechanism of "protector benefits, user pays, and beneficiary compensation" would be initially implemented [6].

4 Conclusion

This study confirms that the ecological assets of Xianning *osmanthus* have significant economic value and feasibility for transformation. By 2025, the total ecological service value will reach 1.863 billion yuan, of which cultural services account for 28.7%, highlighting the deep integration characteristics of "ecology culture economy". Digital technology is not simply a combination of tools, but a systematic reconstruction of the logic of value realization: the integration of space, sky, earth, and network ensures "accurate measurement", blockchain confirms ownership to achieve "clear ownership", GEP financialization supports "evidence-based pricing", and point based consumption promotes "good use".This path provides three inspirations for similar resource-based small and medium-sized cities: firstly, characteristic species (such as *osmanthus*) are ideal entry points for ecological value accounting - clear spatial boundaries, measurable and traceable functions, high cultural identity, significantly reducing accounting costs and public awareness thresholds; Secondly, digital infrastructure needs to be promoted synchronously with institutional innovation, and it is urgent to introduce supporting systems such as the "Measures for the Registration and Confirmation of *Osmanthus* Ecological Assets", Xianning GEP Accounting Technical Specifications", and "Green Financial Product Management Measures"; Thirdly, value realization must be rooted in localized scenarios. The key to the success of "Osmanthus Ecological Points" lies in embedding abstract ecological services into the high-frequency consumption chain of tourists, confirming that "small incisions, deep integration, and strong stickiness" have more practical resilience and promotional value than grand narratives. In the future, it can be expanded to fields such as tracking the carbon footprint of the entire osmanthus industry chain, developing ecological value insurance, and establishing standards for aromatherapy and health services, continuously deepening the Xianning practice paradigm of "green mountains and clear waters are as valuable as mountains of gold and silver".

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