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STUDY ON TEMPORAL AND SPATIAL VARIATION OF SERVICE VALUE OF REGIONAL FARMLAND ECOSYSTEM AND ITS INFLUENCING FACTORS: A CASE STUDY OF FUJIAN PROVINCE

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ABSTRACT

In order to deeply understand the status quo of regional farmland ecosystem service value and promote the sustainable development of regional farmland, selected farmland in Fujian Province as the research object to study the spatio-temporal changes of its ecosystem service value, and further analyzed the influencing factors of farmland ecological service in Fujian Province through the grey relational model.The results showed that: (1) The value of farmland ecosystem service in Fujian province increased during the study period, but fertilizer and pesticide produced great negative environmental value; (2) As for the spatial difference of farmland ecosystem service value in Fujian province in 2018, nanping has the highest positive service value and the highest per capita service value, Longyan has the highest service value per unit area, and Zhangzhou has the highest negative service value. (3) Among the factors influencing the value of ecological services, water resource utilization, crop planting area and effective irrigation area are the main factors influencing the change of the value of farmland ecosystem services, while the plastic film area and the total power of agricultural machinery have less influence.

Key words: Fujian Province, Farmland Ecosystem, Service Value, Grey Correlation Method

1. Introduction

Farmland ecosystem is an important component of terrestrial ecosystem, not only provides various agricultural products for human beings and guarantees the necessary material basis for human survival and production, but also plays a huge role in stabilising social and cultural development, and also plays an irreplaceable and important role in maintaining the support system of life and the dynamic balance of the environment[1], which is the necessary basis for human survival and production, and farmland ecosystem services play a vital role in regional Farmland ecosystem services play a crucial role in regional sustainable development. In order to firmly establish the concept of "green mountains are golden mountains" in agricultural development, it is necessary to adhere to the sustainable development of farmland. The use of chemical fertilisers, pesticides, agricultural films and irrigation in the current agricultural production process has effectively increased yields and production efficiency, but has also led to a series of environmental problems, hindering the sustainable development of farmland and the region. Therefore, it is of practical significance to sort out the ecological service functions of farmland ecosystems and weigh the positive and negative service values of farmland ecosystems for the sustainable development of regional agriculture.

As early as 1959, E.P. Odum put forward the initial idea of ecosystem services and provisioning as the benefits that human beings derive from ecosystems[2]. In 1997, Costanza and other scholars studied the ecosystem service functions globally, classified them into 17 types, and on the basis of which a global ecosystem service function valuation model was put forward, and the global The value of ecosystem services was estimated[3,4]. The service function of farmland ecosystem refers to the natural environmental conditions and utility formed by farmland ecological processes and human activities on which human beings rely for survival, and farmland ecosystem is a semi-natural ecosystem type, and its service function has special characteristics[5]. Traditional research mainly focuses on the economic value of crop yields in farmland, and the ecological service value of farmland arable land has been seriously underestimated, and with the attention to agro-ecosystems and the re-understanding of pollution in agricultural production, the research on the service function of farmland ecosystems has been strengthened. Since the new century, some scholars in China have taken Costanza's research as a basis and gradually applied his methodology to the practice of value assessment of farmland ecosystem services in China. Ren Jing et al. assessed the value of ecosystem services of spring maize-green manure farmland in Northwest Hexi Irrigation Area and found that the value of agricultural products supply and gas regulation value contributed more to the total value[6]. Zhang Weiwei et al. monetised the ecosystem service value of farmland ecosystems in the Guanzhong-Tianshui Economic Zone, quantified the ecosystem service value and its contribution

ISSN: 2455-8834

Volume:08, Issue:11 "November 2023"

to the environment, and concluded that the value of farmland ecosystems is mainly affected by the terrain, comprehensive geographic conditions, agricultural cultivation techniques and the degree of environmental pollution[7]. Zhou et al. used the theory of the value of farmland ecosystem services as the research basis to establish a system for assessing the value of farmland ecosystem services of winter green manure and spring maize, which provided a theoretical basis for the ecological compensation policy of planting green manure[8]. Qi Xingfen, on the other hand, conducted a status quo analysis of the value of farmland ecosystem management service enterprises in the regional farmland ecosystems of Shandong Province by citing the results of Costanza et al. as a reference number and combining the grey correlation method, and concluded that both positive and negative values of farmland ecosystems in Shandong Province are on an upward trend [9]. Niu Dundanet al. assessed the value of farmland ecosystem services of Jiafu Farm in Yichang City from six aspects: agricultural production, tourism, atmospheric regulation, soil and water conservation, environmental purification, and nutrient cycling, and found that the development of modern recycling agriculture can improve the ecosystem service function of the farm [10]. Xie Gao Di et al. took farmland biodiversity as an entry point and discussed the theoretical research progress of the value of farmland ecosystem services in China in the light of domestic and international studies, and recognised the importance of farmland ecosystems in agricultural production[11].

In summary, the study of the value of farmland ecosystem services has been a more concerned issue in today's academic world, which is of great significance to the sustainable development of regional ecology and regional ecological compensation. On the basis of previous research, this paper takes farmland ecosystem services in Fujian Province as the research object, explores the spatial and temporal change pattern of farmland ecosystem service value in Fujian Province, and further explores the influencing factors through grey correlation analysis to find out the deficiencies of farmland development in Fujian Province, in order to provide certain references and lessons for the sustainable development of farmland through the research.

2. Study area, data sources and research methods

2.1. Study area

Fujian is located in the southeast of China and the coast of the East China Sea. The land area is between 23 ° 32 ' to 28 ° 19 ' north latitude and 115 ° 50 ' to 120 ° 43 ' east longitude. The east-west width is about 540 km, and the north-south length is about 550 km. Located across the Taiwan Strait and across the sea from Taiwan Province, is one of the important outlets of mainland China and one of the important windows and bases for China 's exchanges with the world. Fujian now includes nine prefecture-level cities such as Fuzhou, Xiamen, Zhangzhou and Quanzhou. The land area of the province is 124,000 square kilometers, and the marine area is

ISSN: 2455-8834

Volume:08, Issue:11 "November 2023"

136,000 square kilometers. Due to the influence of monsoon circulation and topography, a warm, hot and humid subtropical oceanic monsoon climate is formed, rich in heat, 70% of the province's area ≥10°C cumulative temperature between 5000°C -7600°C, abundant rainfall, abundant sunshine, the average annual temperature from north to south is 17-21°C, the average annual rainfall is 1,400-2,000 mm, and the total amount of water resources is rich, and the total area of land in Fujian Province is 1239.34 million square kilometres, and the area of sea area is 13 million square kilometres. The total land area of Fujian Province is 12,393,400 hectares, with arable land of 1,338,500 hectares. The cultivated land resources in Fujian Province are mainly concentrated in coastal and plain areas, river basins and low hilly terraces. According to the statistics of the yearbook data of the Ministry of Agriculture, the grain production in Fujian Province has been decreasing year by year, and it has been reduced to less than 5 million tons in 2016.

2.2. Data sources

In this paper, the data related to the value of farmland ecosystem services in Fujian Province, the basic data such as arable land area, sown area of crops, the use of mulch, pesticides, fertilisers and so on are obtained from the Statistical Yearbook of Fujian Province, Statistical Bulletin, and Statistical Yearbook and Bulletin of each region of Fujian Province from 2010 to 2019. The data about the utilisation rate of food and water as well as the utilisation rate of chemical fertilisers, pesticides, and the residual proportion of mulch film are referred to Fu Jingduan's research on the ecological service value of farmland in Danjiangkou Reservoir Area[11].

2.3. Research Methods

Farmland, due to its own characteristics, has further exerted the positive significance of farmland ecosystems for human society with the progress of science and technology and the modernisation of agriculture. However, at the same time, the impact of chemical agriculture represented by pesticides and fertiliserson the ecological environment should not be ignored, therefore, the value of farmland ecosystem services must also be considered both positive and negative values. The calculation of the value of farmland ecosystems in this paper includes both positive and negative values, and the positive values include: food production, raw material production, landscape enjoyment, gas regulation, climate regulation, water conservation, soil formation and retention, waste treatment, and biodiversity maintenance. Negative values include greenhouse gas emissions, environmental pollution, and excessive water consumption.

2.3.1.Estimation of the positive value of farmland ecosystem services

According to Costanza et al[3]. the equation for the positive value of ecological services of agro-ecosystems is:

ISSN: 2455-8834

Volume:08, Issue:11 "November 2023"

$$V_p = \sum_{j=1}^{9} V_j * A = \sum_{j=1}^{9} C_0 * A * R_j \ (1)$$

$$C_0 = \frac{1}{7}\sum_{i=1}^{n} \frac{m_i * q_i * p_i}{M} (2)$$

Where V_p is the value of basic services of farmland ecosystems; V_j is the value of each ecological service per unit area; C_0 is the value of food production services per unit area of farmland ecosystems per year; A is the area of arable land in the study area; R is the ecosystem service value equivalent factor; m_i is the sown area of food crops in category i; q_i is the level of yields of food crops in category i; p_i is the market price of food crops per unit area of category i; M is the total sown area of food crops; and M is the total sown area of food crops. M is the total sown area of food crops.

Xie Gao Di et al. classified the value of basic services of farmland ecosystems into nine categories, which are food production, raw material production, landscape pleasure, gas regulation, climate regulation, water conservation, soil formation and conservation, waste treatment, and biodiversity conservation. And a table of equivalence factors for the value of terrestrial ecosystem services in China was proposed, defining the economic value of the annual natural food production of one hectare of arable land with the national average yield as 1, and the ecosystem service value equivalence factor refers to the size of the contribution of the ecosystem produced by the ecosystem to the farmland's food production services[13]. In this paper, this equivalence factor table is used to calculate the service value per unit area of farmland ecosystems in Fujian Province, which is used to calculate the positive value of farmland ecosystem services in Fujian Province.

2.3.2 Estimation of negative values generated by agro-ecosystems

2.3.2.1 Negative values from greenhouse gas emissions

Greenhouse gases (GHGs), as the main environmental pollutant gases emitted during agricultural production, are able to affect the ecosystem by changing the composition of the atmosphere. In this paper, the economic value of the environmental impact of CO_2 is estimated using the warming potential method. The formula for the value generated by GHG emissions is as follows:

$$V_1 = -C * \sum S_a * R_{ab} * GWP_b \ (3)$$

Where V_1 is the value generated by GHG emissions; C is the carbon trading price (this paper adopts the protection price stipulated by the National Development and Reform Commission (NDRC): 8-10 euros/t, taking the middle value of 9 euros/t, and 1 euro is converted into 10 RMB RMB); S_a is the planted area of a crop; R_{ab} is the emission flux of b gas from a crop; and GWP_b is the warming potential of b gas.

ISSN: 2455-8834

Volume:08, Issue:11 "November 2023"

2.3.2.2 Negative values from environmental pollution

At present, the issue of environmental protection has become an important topic hotly discussed by the whole society. With the promotion of chemical agriculture, the extensive use of chemical fertilisers, pesticides and mulch in agricultural cultivation not only enhances the income brought by agricultural cultivation, but also generates environmental problems such as surface pollution and difficult degradation of mulch. Therefore, this paper calculates the negative value of chemical fertilisers, pesticides and mulch on agricultural ecosystems with the following formula:

$$V_2 = V_m + V_p \qquad (4)$$

$$V_m = -J * E * q * r * p \qquad (5)$$

$$V_p = -M' * (1 - r') * P \qquad (6)$$

Where V_2 is the value generated by environmental pollution; V_m is the negative value generated by the application of mulch; V_p is the sum of the negative values generated by the application of chemical fertilisers and pesticides V_h and V_n ; J is the area covered by mulch; E is the residual proportion of mulch; q is the yield of grain; r is the rate of grain loss; p is the market price per unit of area of grain; M′ is the amount of fertiliser and pesticide applied; r′ is the utilisation rate of chemical fertilisers and pesticides; and P is the price of fertilisers, price of pesticides.

2.3.2.3 Negative values from water consumption

Water is the source of life, agricultural ecosystem, crop growth is inseparable from agricultural irrigation, agricultural irrigation is the most important production link. Good agricultural irrigation means to improve agricultural output value has a significant role, but the reality of agriculture as a large water consumption industry, excessive waste of water resources will inevitably have a negative impact on the ecological environment, such as over-exploitation of groundwater caused by surface subsidence. Therefore, this paper also calculates the negative value generated by water consumption with the following formula:

$$V_3 = -W * R * C_w \qquad (7)$$

where V_3 is the value of water consumption; W is the amount of water used in agriculture; R is the rate of water consumption in agriculture; and Cwis the cost of water storage in reservoirs.

2.3.3 Total service value of agro-ecosystems

V_{all} is the total value of services provided by farmland ecosystems to humans over a certain period of time, and its value can be divided into the positive value generated by natural

ISSN: 2455-8834

Volume:08, Issue:11 "November 2023"

ecological processes V_p and the negative value V_a, then there are:

$$V_{all} = V_p + V_a = V_p + V_1 + V_2 + V_3 + \cdots \quad (8)$$

2.3.4 Calculation of correlation

Grey correlation data analysis is a method to quantify the correlation, through the correlation between each other to compare, can be in the system to find out the main factors, secondary factors, and get the main factors of which affect a certain variable, the object of its operation is the time series of the relevant factors[14,15]. Its calculation method is:

Let the parent sequence$x_0(t)$ and the subsequence$x_i(t)$ and first pair of$x_0(t)$ and$x_i(t)$ dimensionless, and write down their absolute differences at moment t as:

$$\Delta_{0i}(t) = |x_0(t) - x_i(t)|,(t, i=1,2,......n)(9)$$

The absolute maximum and minimum values are respectively:

$$\Delta_{max} = \max_i \max_t |x_0(t) - x_i(t)| \quad (10)$$

$$\Delta_{min} = \min_i \min_t |x_0(t) - x_i(t)| (11)$$

$x_0(t)$ and$x_i(t)$ The correlation coefficients at time t are.

$$\xi_{0i}(t) = \frac{\Delta_{min} + \rho\Delta_{max}}{\Delta_{0i}(t) + \rho\Delta_{max}} \quad (12)$$

where $\rho$is the resolution coefficient, ($\rho \in [0,1]$), which is taken as 0.5 in this paper.

The mean value of the correlation is:

$$\gamma_{0i} = \frac{1}{n}\sum \xi_{0i}(t) \quad (13)$$

Where, the degree of correlationγ_{0i} is expressed as the degree of correlation between the parent sequence and the subsequence, the larger the value of correlation, the higher the degree of correlation.

3 Results and analyses

3.1 Changes in the value of regional farmland ecosystem services in Fujian Province

Based on the data collected and the formula above, the results of the positive ecological service

ISSN: 2455-8834

Volume:08, Issue:11 "November 2023"

value generated per unit area of farmland ecosystems in Fujian Province for each sub-indicator can be obtained in Table 1, and the changes in the positive and negative service value of farmland ecosystem services can be seen in Fig. 1, and the composition of the negative service value of environmental pollutants can be seen in Fig. 2.

Table 1 Ecological service value per unit area of farmland ecosystem in Fujian Province from 2009 to 2018 (Unit: RMB/hm)^2

Year	Food production	Commodity trading	Landscape pleasure	Gas regulation	Climate regulation	water conservation	Soil formation and conservation	Waste disposal	Biodiversity maintenance
2009	2928.20	292.82	29.28	1464.10	2606.10	1756.92	4275.17	4802.24	2079.02
2010	2987.94	298.79	29.88	1493.97	2659.27	1792.76	4362.39	4900.22	2121.44
2011	3313.60	331.36	33.14	1656.80	2949.10	1988.16	4837.86	5434.30	2352.66
2012	3598.64	359.86	35.99	1799.32	3202.79	2159.18	5254.01	5901.77	2555.03
2013	3827.50	382.75	38.28	1913.75	3406.48	2296.50	5588.15	6277.10	2717.53
2014	3891.08	389.11	38.91	1945.54	3463.07	2334.65	5680.98	6381.38	2762.67
2015	2859.68	285.97	28.60	1429.84	2545.12	1715.81	4175.14	4689.88	2030.38
2016	3933.29	393.33	39.33	1966.64	3500.63	2359.97	5742.60	6450.59	2792.63
2017	3787.47	378.75	37.87	1893.74	3370.85	2272.48	5529.71	6211.45	2689.11
2018	3784.23	378.42	37.84	1892.11	3367.96	2270.54	5524.97	6206.13	2686.80

From Table 1, it can be seen that the positive ecological service value per unit area of farmland ecosystems in Fujian Province shows an overall upward trend in all sub-indicators. In the sub-indicators of farmland ecosystem services, food production increased from RMB 2,928.20/hm2 to RMB 3,784.23/hm2, indicating that the production of agricultural products increased or the price of agricultural products increased in the same year; the gas regulation increased from RMB 1,464.10/hm2 to RMB 1,892.11/hm2, because the gas regulation of farmland mainly consists of

ISSN: 2455-8834

Volume:08, Issue:11 "November 2023"

CO_2 fixation and O_2 release. complement each other, indicating that over the past 10 years, farmland in Fujian Province has played an increasingly large role in the regulation of regional gases; climate regulation from 2606.10 RMB/hm2 to 3367.96 RMB/hm2, an increase of 29.2% over the past 10 years, indicating that farmland in Fujian Province not only contributes to a higher and higher level of regulation of the regional climate, but also reduces the extreme weather, indirectly reducing the losses caused by extreme weather; water Water conservation increased from RMB 1756.92/hm2 to RMB 2270.54/hm2, which means more effective soil and water conservation for coastal and mountainous Fujian; Soil formation and conservation increased from RMB 4275.17/hm2 to RMB 5524.97/hm2, which improves the soil structure and maintains the soil fertility, and effectively alleviates the situation of little land and little good land in Fujian; Waste disposal Waste treatment increased from RMB 4802.24/hm2 to RMB 6206.13/hm2, indicating that the scale of farmland waste treatment is getting bigger and bigger, which can effectively deal with the soil, water and air pollution caused by waste. As can be seen from Table 1, among the nine ecosystem service values per unit area, the sum of the cumulative functional values of food production, soil formation and waste treatment occupies about 3/5 of the total value; the functional value of the production services of farmland accounted for no more than 1/6 of the value of the production services of farmland during the study period, which shows that, in addition to being an important basis for food production, farmland ecosystems also provide humans with a number of ecological functions, which are important for the atmospheric environment, climate regulation, and soil and water conservation cannot be ignored. In addition, it can also be found that the positive service value data in 2015 showed abnormal changes, through relevant research and historical climate data review found that the climate in Fujian Province in 2015 was more extreme, with overall low temperatures and high total rainfall, resulting in low sunshine, which in turn had a serious impact on farmland production [16].

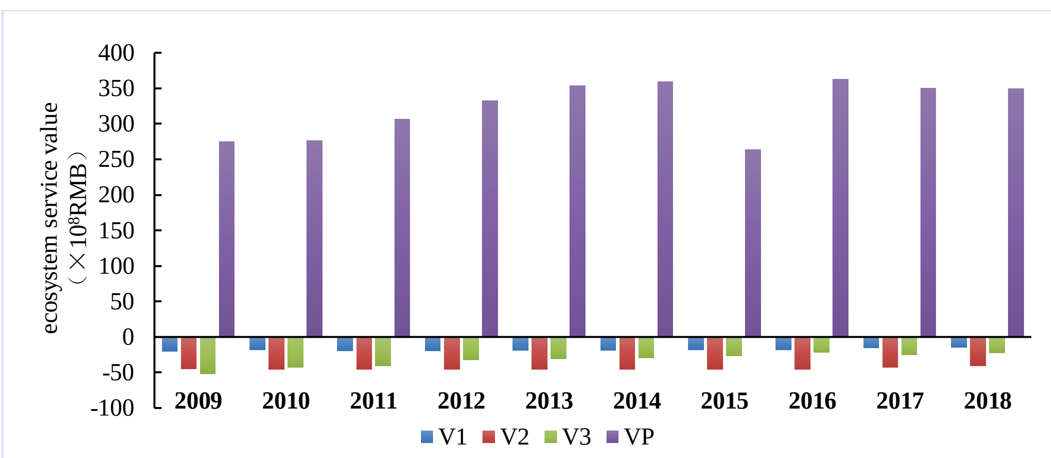

Fig. 1 Temporal changes in the value of farmland ecosystem services

ISSN: 2455-8834

Volume:08, Issue:11 "November 2023"

From Figure 1, V1, V2, and V3 are the negative values generated by greenhouse gas emissions, environmental pollution, and water resource consumption, respectively, and V_P is the value of farmland ecosystem services. It can be seen that the service value of regional farmland in Fujian Province has maintained an increase, of which the positive service value has increased from 275.1 × 108 RMB in 2009 to 349.5×108 RMB in 2018, with an average annual increase of 8.2×108 RMB. The negative value of agricultural ecosystem decreased from 116.9 ×108 RMB in 2009 to 77.2×108 RMB in 2018. From the perspective of the negative value generated by the agricultural ecosystem, the negative value generated by greenhouse gas emissions, environmental pollution, and water consumption accounted for 19%, 48%, and 33%, respectively. In the past 10 years, the negative value of each agricultural ecosystem has been relatively reduced. The negative value generated by greenhouse gas emissions decreased from 21.1×108 RMB to 14.4 ×108 RMB, the negative value generated by environmental pollution decreased from 45.1 × 108 RMB to 40.6 × 108 RMB, and the negative value generated by water consumption decreased from 51.7×108 RMB to 22.2 ×108 RMB. Among them, the negative value of water resources consumption is the largest, which is reduced by 57%.

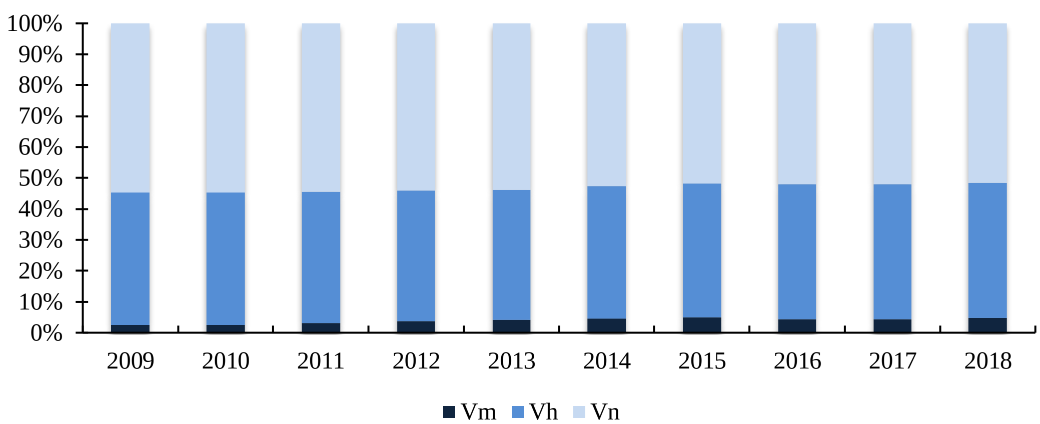

Fig. 2 Proportion of negative values generated by environmental pollution

From Figure 2, Vm, Vh, and Vnare the negative values generated by land film, chemical fertiliser, and pesticide application, respectively. The proportion of the three in Fujian Province in the past 10 years has not changed much, the proportion of pollution generated by landfilm residue is about 3.8%, the proportion of pollution generated by fertiliser application is 42.8%, and the proportion of pollution generated by pesticide application is 53.2%. The above data show that Fujian Province has attached great importance to the protection of the ecological environment in the past ten years, adhering to the concept of ecological civilisation development, and paying attention to the protection of the environment in the development of the agricultural economy at the same time.

ISSN: 2455-8834
Volume:08, Issue:11 "November 2023"

3.2 Spatial differences in the value of farmland ecosystem services in Fujian Province

Table 2 Spatial changes in the value of farmland ecosystem services across Fujian Province in 2018

Area	Positive service value(1×10^8)	Negative service value(1×10^8)	Value of Services (RMB/hm^2)	Value of services per capita(RMB/person)
Fuzhou city	17.50	-7.71	11672.24	205.08
Putian city	9.49	-3.84	12956.01	228.45
Longyan city	25.53	-8.80	15269.34	647.29
Nanping city	33.60	-13.03	14054.11	840.59
Ningdecity	23.05	-7.36	12020.76	570.19
Quanzhou city	18.47	-7.65	12827.77	182.56
Sanming city	25.77	-9.94	13118.41	711.17
Xiamencity	2.36	-0.58	12596.99	240.31
Zhangzhou city	26.26	-15.49	14670.18	282.77

From Table 2, it can be seen that the differences in ecosystem service values among regions in Fujian Province are relatively obvious. The largest positive service value of farmland ecosystem is Nanping City (33.6×10^8RMB), followed by Zhangzhou City (26.3×10^8RMB), Sanming City (25.8×10^8RMB), and the smallest is Xiamen City (2.3×10^8RMB). The largest negative value from farmland ecosystems is Zhangzhou City (15.5×10^8RMB), followed by Nanping City (13.0×10^8RMB), Sanming City (9.9×10^8RMB), and the smallest is Xiamen City (0.59×10^8RMB); the largest prefecture-level city with the largest negative value from greenhouse gas emissions is Nanping City (3.7×10^8RMB), and the smallest is Xiamen City (0.05×10^8RMB); The prefecture-level city with the largest negative value generated by environmental pollution is Zhangzhou City (10.1×10^8RMB), and the smallest is Xiamen City (0.37×10^8RMB); the largest negative value generated by water resource consumption is Zhangzhou City (4.2×10^8RMB), and

ISSN: 2455-8834

Volume:08, Issue:11 "November 2023"

Xiamen City (0.17×10^8RMB). The highest value of service per unit area is Longyan City (15,269.34 RMB/hm^2) the smallest is Fuzhou City (11,672.24 RMB/hm^2); the highest value of service per capita is Nanping City (840.59 RMB/person) and the smallest is Quanzhou City (182.56 RMB/person). From the table, it can be seen that the value of agro-ecosystem services in each region of Fujian Province in 2018 is significantly different, in terms of the value of services per unit, because the cities of Zhangzhou and Longyan, in addition to having better geo-hydrothermal conditions, have a larger area of farmland and it has been a stronger agricultural region in Fujian Province, with a high level of agricultural productivity, which improves the value of ecosystem services per unit of area; and most of the farmland in Fuzhou is located in the Thesituation in Quanzhou and Xiamen is similar to that in Fuzhou. The lower ecosystem service value in Ningde City is mainly due to the fact that regional farmland is affected by topography and elevation in terms of standing conditions, resulting in lower productivity levels. The lower ecosystem service value in Ningde is mainly due to the fact that the regional farmland is greatly affected by topography and elevation in terms of land position, resulting in a lower productivity level. In terms of per capita service value, the low ecosystem service value of farmland in the coastal region is due to the reduction of farmland due to the expansion of cities and factories, but also to the low per capita service value due to the total population of the region, while the high per capita ecosystem service value of farmland in Longyan, Nanping, and Sanming is due to the opposite reason.

3.3 Grey correlation analysis of agro-ecosystems

There are many factors in the agroecosystem that will affect the change of the value of agroecosystem services, this paper selects four first-level indicators of economic development, agricultural modernization, water resource use, planting structure, in which the first-level indicators contain 12 second-level indicators (the corresponding relationship is as shown in the table), and through the grey correlation analysis method, quantitatively analyzes the factors that affect the change of ecosystem service value, and the results are shown in Table 3.

Table 3 Grey correlation analysis between the value of farmland ecosystem services and selected indicators

First indexes	degree of association	connection sequence	second index	degree of association	connection sequence
Economic development	0.5450	2	GDP (10^8RMB)	0.4600	10
			Gross agricultural output (10^8RMB)	0.4688	9

ISSN: 2455-8834

Volume:08, Issue:11 "November 2023"

			Per capita net income of farmers (RMB/person)	0.7063	4
			Fertiliser use (t)	0.5201	6
			Plastic film area (hm^2)	0.4032	12
Modernization of agriculture	0.5124	4	Amount of pesticide (t)	0.7132	3
			Total power of agricultural machinery (kw)	0.4494	11
			Electricity for agriculture (kw/h)	0.4762	8
Utilization of water resources	0.8190	1	Effective irrigated area (10^8 hm^2)	0.7918	2
			Area sown with crops (hm^2)	0.8462	1
Planting structure	0.5366	3	Grain yield (kg/hm^2)	0.5065	7
			Total value of services (RMB10^8)	0.5666	5

From Table 3, it can be seen that among the farmland ecosystem level 1 indicators, water resource use has the greatest impact value, with a correlation of 0.8190, followed by economic development, planting structure, and the smallest is agricultural modernisation. The most influential of the secondary indicators is the sown area of crops, with a correlation of 0.8462, which shows that the total sown area of crops is particularly important to the value of farmland ecosystem services, and it can be assumed that the larger the sown area is, the greater the food production, and thus the greater the benefits; and then it is the effective irrigated area of farmland, with a correlation of 0.7918, which shows that the rational use of water resources has a great impact on the value of farmland ecosystem services. has a huge impact on the value of farmland ecosystem services, increasing from the effective irrigated farmland area of 9.6×10^6 ha in 2009 to 1.08×10^7 ha in 2018, and decreasing agricultural water consumption from 10 billion cubic metres in 2009 to 8.75 billion cubic metres in 2018, suggesting that more effective

ISSN: 2455-8834

Volume:08, Issue:11 "November 2023"

farmland irrigation techniques not only improve the ecological benefits of farmland, but also reduce water resource consumption; the application of pesticides and fertilisers also has a certain degree of influence on the value of farmland ecosystem services, with a correlation of 0.7132 and 0.5201, respectively, in which the influence of pesticides on the value of farmland ecosystem services is at the front of all the influencing factors, probably due to the fact that fertilizers and pesticides improve yields in the process of facilitating agricultural production, but they also inevitably produce the negative environmental pollution value, so how to rationally use fertiliser and pesticide is an important proposition for agricultural modernisation. The correlation of per capita income of farmers is 0.7063, which is also one of the important influencing factors.

4. Conclusion and discussion

4.1 Conclusion

This paper studies the spatial and temporal changes in the service value of farmland ecosystems and the influencing factors from 2009 to 2018 in Fujian Province, accounts for the time of its service value and analyses the spatial changes in each region of Fujian Province in 2018, and also analyses the influencing factors of farmland ecosystems through the grey correlation method, and the conclusions are as follows:

(1) The value of ecosystem services in Fujian Province showed an increasing trend from 2009 to 2018. The total service value per unit area of farmland ecosystem increased by 29%; the positive service value increased with an average annual trend of 8.3×10^8RMB; the negative service value generated by environmental pollution was the largest, and the negative service value gradually decreased, among which the negative service value generated by water resource consumption decreased the most, by 57%. Among the negative service values generated by environmental pollution, the proportion of land film, pesticide and chemical fertiliser use is stable and unchanged.

(2) There are spatial differences in the value of farmland ecosystem services among regions in Fujian Province in 2018. The highest positive service value is Nanping City (33.6×10^8RMB), and the highest negative service value is Zhangzhou City (15.5×10^8RMB); among the negative service values, greenhouse gas emissions generate the largest negative value in Nanping City, environmental pollution generates the largest negative service value in Zhangzhou City; water resource depletion generates the largest negative value in Zhangzhou City; the per capita service value and the service value per unit area of each area in Fujian Province There is a big difference between the per capita service value and the service value per unit area in each region of Fujian Province.

(3) According to the grey correlation analysis, the primary indicator that affects the value of

ecosystem services in Fujian Province is the use of water resources, and the secondary indicators are the sown area of crops, the effective irrigated area, the amount of pesticide application, and the per capita income of farmers.

4.2. Discussion

Farmland ecosystem is an important component of terrestrial ecosystem, which not only provides various agricultural products for human beings, but also plays an irreplaceable and important role in maintaining the support system of life and the dynamic balance of the environment, which is the necessary foundation for human survival and production. Taking into account the current status of the value of farmland ecosystem services in Fujian Province, the following is discussed:

(1) Over the past 10 years, the value of farmland ecosystem services in Fujian Province, in general, has shown an increasing trend, but the value of positive farmland ecosystem services in Fujian Province in 2015 was significantly out of order compared to other years. Due to the global warming in recent years, the impact of extreme climate on agriculture is larger, combined with the results of the impact factors, and regional climate data, it is very likely that the extreme climate in 2015 led to a reduction in the effective production area of farmland, which led to a reduction in the value of farmland services in that year.

(2) From the data of the last 10 years, it can be seen that the negative impact of water consumption has gradually decreased, and also according to the grey correlation, it can be seen that water resources have a greater impact on the value of ecosystem services of farmland, so it can be found from the results that the level of the irrigation system of Fujian's farmland has been continuously improved, and the water resource efficiency has been increased more quickly. From the perspective of ecosystem services of farmland, further accelerating the construction of high-standard farmland and strengthening the level of irrigation facilities will be beneficial to farmland in terms of both reducing expenditure and ecologically and economically sustainable development of farmland.

(3) According to the grey correlation, it can be seen that the sowing area of farmland has a greater impact on the value of farmland ecosystem services, and combined with the impact of food production on positive ecosystem services, it can be shown that food production in farmland ecosystems is highly planned production system, with the obvious effect of diminishing marginal utility of inputs, and thus changes in area have the greatest impact on yields. Generally speaking, the larger the production area, the higher the yield, and thus the greater the value of farmland ecosystem services. However, it cannot be ignored that compared with forestry, wetland and grassland ecosystems, the amount of chemical substances used in the production process is also larger, and in the short term, irrigation, chemical fertilizers, pesticides, mulch as

an important means of ensuring yields, the expansion of the area also means that it may have an increase in negative impacts on the environment, resulting in an increase in the negative value of ecosystem services of farmland, how to ensure and improve the productivity of the existing area of farmland is a problem that deserves further investigation. further exploration. From the perspective of sustainable development of ecosystem services in Fujian Province, the promotion of organic fertiliser measurement, soil-formulated fertiliser, biodegradable mulch film, and biological control of pests and diseases is conducive to the reduction of impacts caused by chemical agriculture, and further promotes the enhancement of farmland ecosystem services. At the same time, farmland irrigation as an important influence factor, facing both the coverage area affects the ecosystem service problem, but also face the problem of excessive evaporation of irrigation water, in recent years the background of the increase in extreme weather, Fujian as a water-abundant areas of farmland water resources are also facing certain challenges. With the popularity of information technology in rural areas in recent years, the full use of information technology means of fine management of farmland, rational regulation of water resources, fertiliser and pesticide dosage is an important means of solving the sustainable development of agriculture.

(4) In the grey correlation analysis, it can be seen that the per capita net income of farmers ranked fourth among the 12 secondary influencing factors, which indicates that it has a great influence on the value of farmland ecosystem services, but due to the differences in the area of arable land and the population of farmers in each region, it is difficult to judge the extent of the influence of the state of economic development of the various regions of Fujian Province on the value of farmland ecosystem services. Therefore, in further research, the relationship between society and the value of farmland ecosystem services in each region of Fujian Province can be deeply explored from the perspective of social development.

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