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Requisition–Compensation Balance Relief for Hydraulic Projects Based on Cultivated Land Quality Improvement

Bo Liu [1,*], Huatong Zhou [1], Minjing Qi [2], Menglei Pan [1] and Liang Tang [3,*]

[1] Ginling College, Nanjing Normal University, Nanjing 210000, China
[2] Business School, Beijing Normal University, Nanjing 210000, China
[3] School of Business, Fuyang Normal University, Fuyang 236037, China
* Correspondence: 45242@njnu.edu.cn (B.L.); 1120821013@hhu.edu.cn (L.T.)

Abstract: Requisition–compensation balance is a type of cultivated land protection system in China. The implementation of hydraulic projects has changed the natural conditions unfavorable to the development of agricultural production and effectively improved the quality of cultivated land. This means that the requisition–compensation balance of cultivated land policies for hydraulic projects should be treated differently. Starting from the example of the requisition–compensation balance of hydraulic projects, this paper analyzes the four major factors of cultivated land quality, namely nature, space, ecology, and economy, from the perspective of cultivated land quality. The productivity of cultivated land is selected as the main index. Based on the principle of ensuring the balance of total grain output value, a corresponding quantitative system is constructed. The measurement of cultivated land quality change and that change's impact on the requisition–compensation balance of cultivated land are explored. In this paper, the constructed quantitative system is tested by taking the local reinforcement projects of Pizhou Luoma Lake and Zhongyun River as examples. Through an analysis and calculation of the selected cases, the quality of cultivated land in Pizhou City was found to have increased by 92.87%, in keeping with the balance of total grain output value. A relief strategy involving the requisition–compensation balance of cultivated land for hydraulic projects is put forward. This strategy provides the theoretical basis for the revision of the policy of requisition–compensation balance of cultivated land for hydraulic projects.

Keywords: hydraulic projects; requisition–compensation balance; cultivated land quality; relief strategy

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1. Introduction

Requisition–compensation balance is a kind of cultivated land protection system in China. Simply understood, as the name implies, the requisition–compensation balance is designed to achieve the requisition–compensation balance of cultivated land. That is, relevant departments should convert and supplement the same amount of cultivated land, based on the quantity and quality of the cultivated land occupied for investment and development purposes, housing construction, water conservancy construction, etc. As the main way to ensure grain production, solve the problem of cultivated land, and realize the government's expected public goals, the requisition–compensation balance of cultivated land policy is an important cultivated land protection strategy that has been selected and applied by the government. After introducing the current policy, the requisition–compensation balance of cultivated land begins with paying attention to quantity protection in the initial stages, then moves to the stage of development, where quantity and quality are combined. There is also an in-depth stage under the new situation of rapid urbanization. This is followed by research into the "trinity" of quantity, quality, and ecology, as proposed and implemented so far (since 2018), and finally the prospect stage, which would push the "trinity" stage forward, to encompass quantity, quality, ecology, and humanity. The

compensation mechanism of the requisition–compensation balance of cultivated land system will also be continuously improved.

At present, China has high legal requirements in the area of the requisition–compensation balance of cultivated land. At the same time, the government is putting forward a scientific implementation of the requisition-compensation balance. In addition, stricter requirements have been implemented for China's cultivated land protection. If non-agricultural construction needs to occupy cultivated land, upon approval, the unit occupying the cultivated land shall be responsible for reclaiming an amount of cultivated land equivalent in quantity and quality to the cultivated land occupied. These steps are taken according to the principle of "how much is occupied and how much is reclaimed". This requirement also provides the latest legal basis for the implementation of the requisition–compensation balance of the cultivated land policy. At its essence, the requisition–compensation balance of cultivated land policy is a cultivated land protection measure designed to ensure cultivated land quality. Hydraulic projects can improve the quality of cultivated land, something that is difficult to achieve when compared with general non-agricultural construction supplementary cultivated land projects. From a microscopic point of view, the construction of hydraulic projects is undertaken for special purposes, such as flood control, irrigation, and water diversion. From a macro point of view, hydraulic projects can achieve social and economic benefits, as well as ecological and environmental benefits. The multiple benefits that hydraulic projects can achieve represent the requisition–compensation balance of cultivated land for hydraulic projects, which is different from the requisition–compensation balance of cultivated land typically associated with general engineering construction projects.

Hydraulic projects is a general term for the construction of various projects for the control, utilization, and protection of surface and underground water resources and the environment. To a certain extent, hydraulic projects have helped to ensure agricultural production, increase grain output, and ensure national food security, all of which is consistent with the original intention of the requisition–compensation balance policy. The benefits of hydraulic projects are not only reflected in the improvement of the external conditions for agricultural production, such as water conservancy, transportation, electricity, and safety in the surrounding areas; these projects also offer benefits by way of the great improvement of the quality of cultivated land in the location where the project is located. Therefore, the requisition–compensation balance of cultivated land involved in the construction of hydraulic projects should be reduced or exempted. However, these benefits are not reflected in the current requisition–compensation balance of hydraulic projects. That is, China currently lacks a relief strategy for the requisition–compensation balance of hydraulic projects based on the improvement of cultivated land quality. Therefore, this paper attempts to explore the measurement of cultivated land quality change, and the impact on the requisition–compensation balance of cultivated land, from the perspective of cultivated land quality. What is more, this study puts forward a relief strategy regarding the requisition–compensation balance of cultivated land for hydraulic projects. The strategy is intended to provide a basis for the management of the requisition–compensation balance of cultivated land for hydraulic projects, as well as for the formulation of subsequent relief policies.

2. Literature Review

From the perspective of cultivated land quality, since the 1980s, soil problems have been an issue of great concern for the international community. To date, a large number of scholars, both at home and abroad, have been committed to exploring and solving soil quality problems. Domestic research on cultivated land quality, one of the main research directions, lies in the construction of a cultivated land quality evaluation index system [1] and the division of cultivated land into quality grades [2]. In addition, these cultivated land quality evaluation systems are constantly improving. At the same time, for different research purposes, the selected cultivated land quality evaluation methods will also be different. Some researchers have constructed cultivated land quality evaluation index

systems from the perspectives of climate, landform, soil, infrastructure, ownership, and utilization [3]. Others have developed a cultivated land quality evaluation system based on the perspective of sustainable development needs [4]. In the meantime, there is also a provincial cultivated land quality evaluation system that is based on multi-level indicators [5]. This latter system provides the basis for China's requisition–compensation balance of cultivated land, basic cultivated land protection, land consolidation, and other related land management work. Foreign scholars have also summed up various methods in the evaluation of cultivated land quality. A large number of researchers have focused on the application of geographic information systems (GIS). Some scholars have made rice suitability images from the perspective of cultivated land quality evaluation, by using remote sensing images combined with GIS [6]. The research direction of soil quality abroad is roughly the same as that of domestic research. Foreign researchers tend to pay more attention to the sustainability of soil [7] and the biological factors in soil quality [8]. In addition, the current research on the quality of cultivated land for hydraulic projects in China tends to focus on the construction of an evaluation index system for the implementation effect of the requisition–compensation balance of cultivated land for hydraulic projects [9], as well as the impact of the construction of hydraulic projects on investment benefits [10].

From the perspective of the requisition–compensation balance of cultivated land, China's policy system is being continuously enriched, thus providing a more perfect legal basis for the formulation of requisition–compensation balance of cultivated land policy. After collecting the existing literature, this study found that a large number of research works at present have mostly focused on the extension of the scope of the requisition–compensation balance of cultivated land. The focus is on the continuous improvement of quality [11] and ecology [12]; research on the construction of an ecological civilization is also being undertaken [13]. In addition, many researchers are committed to exploring the current situation of China's present requisition–compensation balance of cultivated land policy [14], as well as examining the implementation difficulties and providing suggestions [15,16]. This paper summarizes the research on the quality performance of the requisition–compensation balance of cultivated land [13] and finds that many scholars have linked the quality of supplementary cultivated land with the quality of occupied cultivated land. They have also converted the grades of supplementary cultivated land and occupied cultivated land as methods or measures to ensure the quality of cultivated land in the requisition–compensation balance of cultivated land.

From the perspective of land protection, the issue of agricultural land protection has resonated in many scientific fields [17]. In recent years, the European Union has also discussed protecting agricultural land [18]. Based on the literature review of cultivated land protection policies in developed countries, the sustainable development of land is clearly an important area being discussed by foreign scholars at present. Land policies, to a certain extent, do not take into account the needs of agriculture [19]. Formulating feasible land use policies is one of the key challenges of sustainable development [20]. That is, land policy is still a research hotspot for scholars, both at home and abroad.

The construction of hydraulic projects usually involves a comprehensive livelihood project; one which will play an important role in increasing the grain output and ensuring food security. For example, small-scale irrigation and hydraulic projects are closely related to agricultural production and are an important basic guarantee for the development of modern agriculture [21,22]. At the same time, the impact of hydraulic projects on the surrounding ecological environment [23,24] is also a research direction followed by many scholars.

In conclusion, this paper collates the existing papers that examined the quality of cultivated land, the policy of requisition–compensation balance of cultivated land, and land protection. It was found that, at present, a large number of research works by scholars at home and abroad focus on the exploration of various factors influencing cultivated land quality. Alternatively, they examine the influence of land-related factors on certain specific agricultural types, ecology, and climate fields. Meanwhile, research into land protection

mainly focuses on the influence of land on agriculture, which is similar to the research direction of this article.

At the same time, some weak points have also been found in the current research, after sorting through a large number of documents. For example, very little discussion exists on the combination of cultivated land quality and cultivated land policy. Cultivated land quality determines the grain output to a great extent and is of vital importance to human survival. Relevant cultivated land policies should be formulated, and the current comprehensive system of cultivated land quality should be improved, using this policy for guidance. At the same time, in China, we found that research on the relief strategy of the requisition–compensation balance of cultivated land, due to the improvement of cultivated land quality, is also virtually non-existent.

3. Method

3.1. Analysis Framework

Under the current environment of a shortage of resources and the continuous increase of construction land, if the requisition–compensation balance of cultivated land policy only pursues an absolute quantitative balance, drawbacks may soon emerge. In addition, the quality balance is the core essence of the requisition–compensation balance of cultivated land.

When the construction of a hydraulic project is complete, this will have a very favorable impact on the surrounding cultivated land. Such projects not only meet the needs of flood control, but they also improve the surrounding environment and maintain the quality of water and soil, thus greatly promoting the development of grain output and forestry, animal husbandry, and fisheries in the surrounding areas. It is generally difficult to realize the balance of cultivated land quality in non-agricultural construction supplementary cultivated land projects. Improving cultivated land quality through hydraulic project construction is also impossible for general non-agricultural construction at present. Zhou Yongen [25] pointed out in a evaluation of hydraulic projects that hydraulic projects are conducive to improving the surrounding environment and maintaining the quality of soil and water. Hydraulic projects are different from general projects. The services they provide have the same typical characteristics as public goods: non-competitiveness, non-exclusiveness, and indivisibility. These characteristics can effectively improve the natural environment of the areas covered by hydraulic projects and greatly improve the quality of land. Assuming that the land quality in non-water conservancy construction areas is Q_0, the land quality in hydraulic project areas can achieve Q_1, and beyond doubt $Q_1 > Q_0$. Therefore, the quality of cultivated land around hydraulic projects is greatly improved.

Another example of these benefits is the contribution of China's hydraulic projects to flood control and waterlogging elimination. During both the long- and short-term since the project was established, great contributions have been made to agriculture in the surrounding areas. Hydraulic projects have enhanced the safety of residents' lives and property, and the stability of the country. Hydraulic projects also play an important role in contributing to the grain production capacity in the irrigation areas of such projects [26]. Assuming that the per mu output value of cultivated land in a certain area before the construction of a hydraulic project is P_0, and the total cultivated land is C_0; and assuming that other conditions are stable, after the completion of a hydraulic project, the output value per mu of cultivated land in this area is P_t. Under normal circumstances, the project must appear $P_t > P_0$, before and after. If the project-occupied cultivated land amount is C_t, the output value of the cultivated land increased by the construction of hydraulic projects is $(P_t - P_0) \times (C_0 - C_t)$. When the requisition–compensation balance of cultivated land policy for hydraulic projects is implemented, the portion of increasing output value is often not considered. This also shows that the current requisition–compensation balance of cultivated land policy, to a certain extent, does not embody the principle of fairness and justice.

After the completion of a hydraulic project, in addition to bringing direct impacts such as flood control, waterlogging prevention, and improvement of cultivated land quality, some indirect benefits may also be included. These include benefits such as an increased employment rate in the surrounding areas, water conservancy, tourism benefits, etc. Such projects can also stimulate the development of the real estate industry in regional cities, as well as the development of industry and commerce. From the very beginning of a project, given the large scale and long cycle of hydraulic projects, the employment rate in the surrounding areas will be increased within a given period. After the completion of the project, certain shipping benefits may be generated, directly due to the hydraulic project. The benefits brought about by the increase in traffic volume, including freight and passenger transportation, due to the improvement of navigation conditions may also bring about the development of tourism in the surrounding areas, thus further stimulating the development of the employment rate, consumption, and the real estate industry, and improving social factors.

3.2. Research Method

In the process of evaluating cultivated land quality, existing research on the connotation of cultivated land quality and the evaluation index system provides an important context and connections [27]. This provides a theoretical basis for the formulation of relief strategies for the requisition–compensation balance of cultivated land for hydraulic projects.

Quality management is one of the core contents of land management, and cultivated land quality is the foundation of land management [28]. Therefore, understanding the connotation of cultivated land quality is of great significance in improving cultivated land productivity and ensuring food security. Cultivated land quality is a multi-level comprehensive concept that includes natural quality, environmental quality, ecological quality, and economic quality. Specifically, natural quality refers to the ability to maintain biological productivity, protect environmental quality, and promote the health of animals, plants, and human beings within the scope of the natural system. The natural quality of cultivated land is the basis, therefore, of cultivated land quality. The environmental quality of cultivated land refers to the spatial location, geology, climate, and other environmental conditions of the location of cultivated land. The ecological quality of cultivated land refers to the environmental conditions that affect the growth, development, and distribution characteristics of organisms, including climatic conditions, soil conditions, biological conditions, etc. The economic quality of cultivated land is the most important factor reflecting the quality of cultivated land. Economic quality is the result of the comprehensive effects of the natural quality, spatial quality, and ecological quality of cultivated land, and also reflects the comprehensive output capacity and efficiency of cultivated land.

3.2.1. Cultivated Land Quality Change Index

Measuring the index of changes in cultivated land quality should follow the principles of system synthesis [29], a minimum data set, and operability. On the premise that the quality of cultivated land can be fully reflected, existing research results should be fully utilized. This will not only control costs within a reasonable range, but will also facilitate the comparative evaluation of the project results and existing relevant results. The unity of a land sustainable use index system in the national social and economic system will be improved by selecting available statistical indicators or other indicators selected with relevant detection systems.

The quality of cultivated land is mainly affected by natural factors, economic factors, environmental factors, and ecological factors. At present, the evaluation of cultivated land quality is mainly divided into three types. The first is the evaluation of various elements contained in cultivated land, i.e., its own physical and chemical properties. The second involves evaluating the land's production capacity. The third type is the evaluation of the suitability of crops. These evaluations all analyze the use value of cultivated land, but they often ignore the evaluation of the value of the cultivated land itself. Cultivated land has the

function of nurturing plants and can give economic value to human beings. The economic value of cultivated land can be directly reflected through the output of agricultural products. The output of cultivated land is directly related to the quality of cultivated land. Therefore, the productivity of cultivated land can be taken as the main index in the evaluation index system of cultivated land quality. Production capacity is the foundation chosen to maintain the production capacity of cultivated land. The requisition–compensation balance of cultivated land policy should emphasize the balance of production capacity. In order to ensure the balance of total grain output value, it is proposed that grain yield per unit area (including by-products) and the associated price (income) are the most direct indicators that can be used to reflect the quality of cultivated land. Therefore, these two indicators are taken as monitoring indicators for the impact of hydraulic projects on the quality of cultivated land. It is also assumed that other indicators used to monitor the quality of cultivated land will not change before or after the construction of hydraulic projects.

3.2.2. Hypothetical Model

The purpose of implementing a requisition–compensation balance of cultivated land is to maintain national food security. On the basis of ensuring the total output value of grain, the quantity of supplementary cultivated land can be reasonably reduced, based on the improvement of cultivated land quality, and a corresponding quantitative system being constructed. A relief strategy of the requisition–compensation balance of cultivated land for hydraulic projects is put forward.

Therefore, according to the general principle of the requisition–compensation balance of cultivated land in hydraulic projects, which is to ensure the balance of total grain output value, a relevant hypothesis model is constructed:

(a) Assume that there are n project protection areas for hydraulic projects, which are respectively recorded as $Z1, Z2, \ldots, Zn$.

(b) Assume that there are m kinds of grain and cash crops in the project protection area constructed by the hydraulic project. Before the construction of hydraulic projects, the planting area of grain and cash crops in each year in each protected area is $S_{j_0^1 t}, S_{j_0^2 t}, \ldots, S_{j_0^m t}$ ($j = 1, 2, \ldots, n$; t is the year); the yield of grain and cash crops in each year in each protected area before the construction of hydraulic projects is $Q_{j_0^1 t}, Q_{j_0^2 t}, \ldots, Q_{j_0^m t}$ ($j = 1, 2, \ldots, n$; t is the year), and the price is $P_{j_0^1 t}, P_{j_0^2 t}, \ldots, P_{j_0^m t}$ ($j = 1, 2, \ldots, n$; t is the year). After the completion of the hydraulic project, the planting area of grain and cash crops in each protected area is $S_{j_1^1 t}, S_{j_1^2 t}, \ldots, S_{j_1^m t}$ ($j = 1, 2, \ldots, n$; t is the year); the yield of grain and cash crops in each protected area before the construction of the hydraulic project is $Q_{j_1^1 t}, Q_{j_1^2 t}, \ldots, Q_{j_1^m t}$ ($j = 1, 2, \ldots, n$; t is the year), and the price is $P_{j_1^1 t}, P_{j_1^2 t}, \ldots, P_{j_1^m t}$ ($j = 1, 2, \ldots, n$; t is the year).

(c) Assume that the planting area, yield, and the price of grain and cash crops in each protected area before the construction of the hydraulic project are expressed by the average value of r years before the construction of the project, respectively, $S_{j_0^i}$, $Q_{j_0^i}$, and $P_{j_0^i}$ ($i = 1, 2, \ldots, m$; $j = 1, 2, \ldots, n$). After the completion of the hydraulic project, the planting area, yield, and price of grain and cash crops in each protected area are respectively expressed by the average value of r years after the completion of the project, which is $S_{j_1^i}$, $Q_{j_1^i}$, and $P_{j_1^i}$ ($i = 1, 2, \ldots, m$; $j = 1, 2, \ldots, n$), and then there are:

$$\begin{cases} S_{j_0^i} = \dfrac{\sum_{v=1}^{r} S_{j_0^i t_v}}{r} \\ Q_{j_0^i} = \dfrac{\sum_{v=1}^{r} Q_{j_0^i t_v}}{r} \\ P_{j_0^i} = \dfrac{\sum_{v=1}^{r} P_{j_0^i t_v}}{r} \end{cases}; \quad (1)$$

$$\begin{cases} S_{j_1^i} = \frac{\sum_{v=1}^{r} S_{j_1^i t_v}}{r} \\ Q_{j_1^i} = \frac{\sum_{v=1}^{r} Q_{j_1^i t_v}}{r} \\ P_{j_1^i} = \frac{\sum_{v=1}^{r} P_{j_1^i t_v}}{r} \end{cases}; \tag{2}$$

(d) Assume that the total output value of grain and cash crops in each year of a certain protected area is Y_{jt_v}, and the unit yield of grain and cash crops in each year of a certain protected area is y_{jt_v}; then:

$$\begin{cases} Y_{jt_v} = \sum_{w=1}^{m} Q_{j^w t_v} P_{j^w t_v} \\ y_{jt_v} = \frac{Y_{jt_v}}{S_{jt_v}} = \frac{\sum_{w=1}^{m} Q_{j^w t_v} P_{j^w t_v}}{\sum_{w=1}^{m} S_{j^w t_v}} \end{cases} \tag{3}$$

(e) According to Assumption 3, the output value of the grain and cash crops in each protected area, before and after the construction of the hydraulic project, is expressed by the average value of r years before the construction of the project and after the completion of the project, respectively. It is assumed that the output value of the grain and cash crops in a protected area before the construction of the hydraulic project is Y_{j_0}, and the output value per unit area yield of grain and cash crops is y_{j_0}. Assuming that the output value of grain and cash crops in a protected area after the completion of the hydraulic project is Y_{j_1}, and the output value per unit area yield of grain and cash crops is y_{j_1}; then:

$$\begin{cases} Y_{j_0} = \frac{\sum_{v=1}^{r} \sum_{w=1}^{m} Q_{j_0^w t_v} P_{j_0^w t_v}}{r} \\ y_{j_0} = \frac{Y_{j_0}}{S_{j_0}} = \frac{\sum_{v=1}^{r} \sum_{w=1}^{m} Q_{j_0^w t_v} P_{j_0^w t_v}}{r \sum_{v=1}^{r} \sum_{w=1}^{m} S_{j_0^w t_v}} \end{cases} \tag{4}$$

$$\begin{cases} Y_{j_1} = \frac{\sum_{v=1}^{r} \sum_{w=1}^{m} Q_{j_1^w t_v} P_{j_1^w t_v}}{r} \\ y_{j_1} = \frac{Y_{j_1}}{S_{j_1}} = \frac{\sum_{v=1}^{r} \sum_{w=1}^{m} Q_{j_1^w t_v} P_{j_1^w t_v}}{r \sum_{v=1}^{r} \sum_{w=1}^{m} S_{j_1^w t_v}} \end{cases} \tag{5}$$

According to the general principle of the requisition–compensation balance of cultivated land in hydraulic projects, which is to ensure the balance of total grain output value, it is necessary to analyze the construction of hydraulic projects. For the degree of improvement of the total grain output value, assuming that the improvement degree of hydraulic projects to total grain output value is IL, for a protected area,

$$IL = \frac{Y_{j_1} - Y_{j_0}}{Y_{j_0}} \tag{6}$$

According to the principle of ensuring the balance of total grain output value, the construction of hydraulic projects can improve the quality of cultivated land of IL. Moreover, due to the promotion effect of hydraulic projects on the total grain output value, the improvements are not limited to just the cultivated land involved in the construction of the hydraulic projects, but include the whole protected area. Therefore, when considering the requisition–compensation balance of cultivated land, the coefficient ε should be considered.

Assume that the amount of cultivated land occupied by the hydraulic project (i.e., the amount of cultivated land that needs to be balanced) is A mu, and the flood control protection area of the hydraulic project is B mu, then:

$$\varepsilon = \frac{A}{B} \tag{7}$$

According to the principle of an equal output value, in order to ensure that the output value remains unchanged, the amount of cultivated land needed becomes $\frac{A}{1+IL}\varepsilon$. The

amount by which the requisition–compensation balance of cultivated land can be reduced or exempted is

$$A - \frac{A}{1 + IL}\varepsilon \tag{8}$$

When carrying out the requisition–compensation balance of cultivated land, under the condition of ensuring food security, the requisition–compensation balance of cultivated land can be reduced or exempted according to the improvement effect of hydraulic projects on the land quality.

4. Case Study

This project was implemented in Pizhou City, in order to give full play to the overall benefits of the East-to-South Transfer Project. The goals of the project were to ensure people's safety and to sustain economic and social development in the project area, improve flood control standards, and ensure the safety of levee flood discharges. The project attaches equal importance to construction and management, and strengthens the existing flood control infrastructure. The central canal is 54 km in length. The case study area is the central canal passing through Pizhou City. The upstream area of the central canal starts from Pizhou City, the river runs through Pizhou City, and downstream to Luoma Lake. In the 15 km from Dawangmiao to Sulu, the Huai Committee is responsible for implementation; and the 39 km from Dawangmiao to Pixin junction is implemented by the Water Resources Department of Jiangsu Province. Construction of the project started at the end of 2015, the work was fully completed in early-2018. All work has been completed and accepted. The project included the requisitioning of a total of 3049.041 mu of cultivated land. Pizhou City is to undertake the task of requisition–compensation balancing of the 554.6575 mu of cultivated land that was requisitioned during the implementation of the project. (see Figure 1).

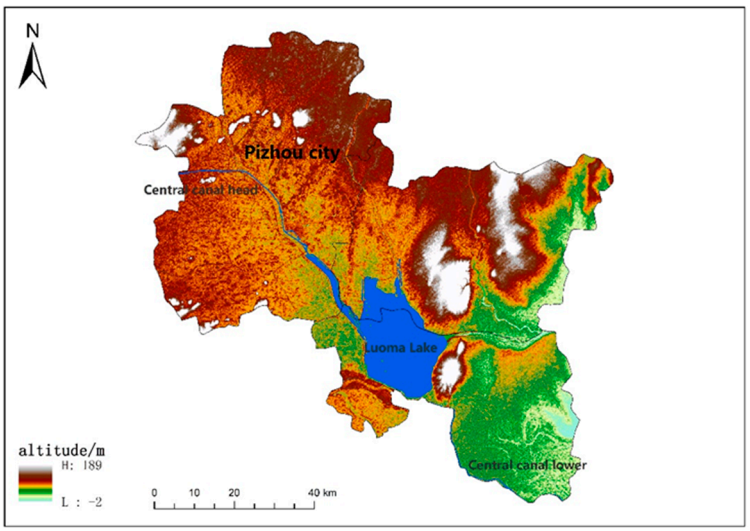

Figure 1. Geographical schematic diagram of Luoma Lake and Zhongyun River.

4.1. Data Processing

Construction of the project started at the end of 2015, and the full construction was completed at the beginning of 2018. In this study, 2014 and 2015 are selected as the cultivated land quality before the project construction, 2018 and 2019 are selected as the cultivated land quality after the project construction was completed, and the total grain output value of the whole year is selected as the index used to measure the cultivated land quality. The data in Pizhou's 2014, 2015, 2018, and 2019 National Economic and Social Development Statistics Bulletins is presented in Table 1:

Table 1. Quality indicators of cultivated land in Pizhou City over the years.

Year	Total Annual Grain Output (10,000 tons)
2014	88.60
2015	91.99
2018	127.77
2019	136.41

The average value of the total grain output in 2014 and 2015 as the cultivated land quality before the project construction commenced was selected. The average value of the total grain output in 2018 and 2019 and the total output value of forest and fishery in 2018 and 2019 are taken as the cultivated land quality after the project construction was completed. In December 2014, the national average price of third-class white wheat in the domestic wheat market was 1572 yuan/ton (train board price); this price was taken as the average price of grain in Pizhou City before the construction of the project began. In December 2018, the national average price of third-class white wheat in the domestic wheat market was 2120 yuan/ton (train board price), and this price was taken as the average price of grain in Pizhou City after the completion of the project.

4.2. Index Calculation

According to the data in Table 1, the output value of grain and cash crops before and after the project construction can be estimated as Y_{j_0} and Y_{j_1}, respectively.

According to the calculation, Y_{j_0} = 3.534 billion yuan; Y_{j_1} = 6.816 billion yuan.

The improvement degree IL of hydraulic projects to the total grain output value is calculated, and the calculation results are as follows:

$$IL = 92.87\%$$

Calculation coefficient ε: As the amount of cultivated land A occupied by this project is 2106.561 mu, and the protected area B of this project is 2390 square kilometers, i.e., 3,585,000 mu, the calculation is conducted as follows:

$$\varepsilon = \frac{A}{B} = 5.88 \times 10^{-4} \tag{9}$$

The construction of this project caused the quality of cultivated land in Pizhou City to improve by 92.87%. When carrying out the requisition–compensation balance of cultivated land, under the condition of ensuring food security and after the requisition–compensation balance of cultivated land of the project was determined and shared, the quantity of 554.6575 mu of the requisition–compensation balance of cultivated land requisitioned by Pizhou City during the project implementation period can be reduced or exempted accordingly.

According to the formula analyzed with the above model, Pizhou City undertook the task of the requisition-compensation balance of 554.6575 mu of cultivated land that was requisitioned in the project implementation stage. According to the principle of equal output value, in order to ensure that the output value remains unchanged, the amount of cultivated land needed was

$$\frac{554.6575}{1+0.9287} \times 5.88 \times 10^{-4} = 0.169 \text{ mu} \tag{10}$$

5. Discussion

5.1. Measurement of Cultivated Land Quality Change

The topic of cultivated land quality has received extensive attention since it was first put forward. Scholars at home and abroad are constantly improving their exploration of its connotations. The summary of cultivated land quality in this paper is a multi-level

comprehensive concept that includes natural quality, environmental quality, ecological quality, and economic quality, all of which can comprehensively reflect the cultivated land quality. Various research on the evaluation index system of cultivated land quality has been conducted. At present, different departments have different systems and evaluation methods to carry out the investigation and evaluation of cultivated land quality [30]. Based on the impact of the factors that affect cultivated land quality in terms of grain productivity, cultivated land quality is currently a hot and difficult research topic in the field of cultivated land protection. Based on the principle of ensuring the balance of total grain output value, it is proposed that grain yield (including by-products) and grain price (income) should be used as direct indicators of cultivated land quality. It is relatively reasonable to explore the promotion effect of hydraulic projects on total grain output value and to explore feasible strategies of cultivated land occupation, compensation, and relief. However, due to the inherent differences in hydraulic projects, the results of different hydraulic projects will also be different. The specific methods should be based on the principle of reality and determined according to the characteristics of each region. This paper proposes that the grain yield per unit area (including by-products) and the grain price (income) are the most direct indicators that can be used to reflect the quality of cultivated land. Therefore, these two indicators are taken as monitoring indicators to determine the impact of hydraulic projects on the quality of cultivated land. It is also assumed that the other indicators that could be used to monitor the quality of cultivated land will not change before and after the construction of hydraulic projects.

By comparing the changes of grain output value before and after the construction of hydraulic projects, this paper reflects the changes of cultivated land quality. Then the quantitative relationship between the occupation of cultivated land and the supplementation of cultivated land is constructed, and relief strategy of the requisition–compensation balance of cultivated land in hydraulic projects is explored. Through an analysis and calculation of the selected cases, it was found that the quality of cultivated land in Pizhou City increased by 92.87%, in keeping with the balance of the total grain output value. Therefore, the burden of 554.6575 mu of cultivated land requisitioned by Pizhou City in the project implementation section can be ignored. One can also see that the impact of hydraulic projects on the improvement of cultivated land quality is especially significant. Therefore, relevant relief strategies should be formulated to reduce the pressure of such projects on the requisition–compensation balance of cultivated land.

5.2. Measures to Improve Land Management Policies

In order to better implement the requisition–compensation balance of cultivated land, realize the fairness and justice of interval benefits, and the responsibility for distribution, a number of suggestions are put forward with regards to the current land management policies: (1) Formulate differentiated cultivated land protection strategies for cultivated land in different regions. For example, in areas where land resources are scarce, the amount and layout of cultivated land should be stabilized. In addition, the balance of quantity should be strictly controlled, and the utilization efficiency of land resources should be improved to the greatest extent possible. (2) Formulate scientific land management strategies, implement comprehensive land improvement, and increase monitoring of the whole process. The requisition–compensation balance of cultivated land is not only the pursuit of quantitative balance; the balance of quality has also become the focus of current research. The implementation of comprehensive land management will improve the spatial planning of China's land to the greatest extent. At the same time, a scientific monitoring system for the protection of global land resources will be constructed to improve the post-supervision system of the requisition–compensation balance of cultivated land. (3) Formulate an accurate "responsible person" mechanism. At present, the responsibility for the requisition–compensation balance of cultivated land is divided into two categories: "who occupies" and "who supplements". Under this system, the responsibility for distribution is obviously unfair; the impact of construction projects on the land quality and society in

the occupied areas is also often not considered. A relevant responsible-person mechanism should be designed and implemented, in order to give full play to the principles of fairness and justice.

5.3. Inadequacy

In view of the authors' research level and data availability, some deficiencies exist in this paper. First, the cultivated land quality evaluation index refers to the selected cultivated land quality influencing factors that have a significant impact on cultivated land quality. This index is based on the four factors of nature, space, ecology, and economy. However, the influence of various factors on the selected grain yield index (including by-products) and the grain price (income) has not been discussed or subjected to quantitative data analysis. At the same time, the selected case data are not rich enough, and the quantitative analysis of cultivated land quality changes may not be accurate enough. In future studies, we can conduct more in-depth and accurate research on the changes of cultivated land quality, from the perspective of the various factors of cultivated land quality, so as to obtain more practical results.

6. Conclusions

Based on the application analysis and calculation of the above models and data, the change rate of cultivated land quality and the quantity of cultivated land quality relief are obtained. The following conclusions are drawn:

(1) The hydraulic project has had an obvious improvement effect on the cultivated land quality in the construction area. Hydraulic projects can greatly improve the quality of cultivated land in a broad sense, by improving the ecological environment and agricultural development in the region.

(2) Judging by the amount of relief in the requisition–compensation balance, the land needed to undertake the task of the requisition–compensation balance of cultivated land is only 0.169 mu. In addition, the task of the requisition–compensation balance of cultivated land in this city can be ignored after considering the relief of quality improvement. Based on the results of Table 1 and the results of the calculation of the cultivated land quality change index, we can also see that the impact of hydraulic projects on the improvement of cultivated land quality is especially significant. Relevant relief strategies should be formulated to reduce the pressure of requisition–compensation balance of cultivated land requirements for such projects.

At present, under the general cultivated land environment, the amounts of reserve resources of cultivated land are decreasing day by day. However, the requirements for the quality and ecology of supplementary cultivated land are continuously improving. The pressure on the party responsible for the supplementary cultivated land to achieve the requisition–compensation balance of cultivated land will further increase. That is, the difficulty associated with adjusting the coordinated promotion of economic development and cultivated land protection with the requisition–compensation balance will further increase. Based on the improvement of cultivated land quality, this paper explored the relief strategy of requisition–compensation balance for hydraulic projects. This strategy fully embodies the principle of fairness and justice in the responsibility for distribution and interval benefits. Under the requisition–compensation balance of cultivated land policy, the status of cultivated land quality in the requisition–compensation balance of cultivated land is continuously increasing; this is in line with the role of hydraulic projects. Therefore, the formulation of a requisition–compensation balance of cultivated land relief strategy for hydraulic projects is of great significance.

Under the guidance of the new development concept, requisition–compensation balance of cultivated land policy will focus on the impact of cultivated land on quality, ecology, and humanity. Researchers are also guided to carry out more in-depth comprehensive research of the requisition–compensation balance of cultivated land from the perspective of "quantity, quality, ecology, and humanity". Future cultivated land research will continue to

broaden the scope and extend "ecological balance" and "human impact"; to construct a more scientific and reasonable quantitative model, and this will model be integrated into empirical research. It is expected that a more comprehensive and objective relief strategy will be formulated. This strategy will conform to the requisition–compensation balance of the cultivated land of hydraulic projects under different real conditions.

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