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# Decoding Land Use Conflicts: Spatiotemporal Analysis and Constraint Diagnosis from the Perspectives of Production–Living–Ecological Functions

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**Abstract:** Exploring the intensity and constraint factors of land use conflicts provides essential insights for efficient land use planning. Currently, China's spatial development is gradually transitioning towards the coordinated development of production, living, and ecological functions (PLEFs). Previous studies have typically focused on land use conflicts from a micro perspective, examining conflicts between production, living, and ecological land uses at a fine scale. There is limited research from a macro perspective that conducts a theoretical analysis based on the production, living, and ecological functions of land use conflicts themselves. In addition, existing studies primarily analyze the influencing factors of land use conflicts, with limited literature directly addressing the constraint factors of land use conflicts. This study focuses on 12 prefecture-level cities in Hubei Province, China, using data from 2010 to 2020. It categorizes land use conflicts at the macro level into production perspective, living perspective, and ecological perspective conflicts. For each of these conflict perspectives, different pressure, state, and response indicators are introduced. This approach leads to the development of a theoretical framework for analyzing land use conflicts at the macro level. On this basis, a spatiotemporal evolution analysis of land use conflicts was conducted. Additionally, using a constraint factor diagnosis model, the study analyzed the constraint factors of land use conflicts at the macro level across cities, leading to the following research conclusions: (1) the land use conflicts from the production and living perspectives in the 12 prefecture-level cities of Hubei showed an upward trend from 2010 to 2020, while the land use conflicts from the ecological perspective exhibited a downward trend; (2) during the study period, Wuhan exhibited the highest intensity of land use conflicts from both the production and living perspectives, while Ezhou experienced the highest intensity of land use conflicts from the ecological perspective for most of the study period; (3) the main constraining factors of land use conflicts from the production perspective in the 12 prefecture-level cities of Hubei are population density, average land GDP, and effective irrigation rate. The primary constraining factors of land use conflicts from the living perspective are population density, urbanization rate, and average land real estate development investment. The main constraining factors of land use conflicts from the ecological perspective are population density, average land fertilizer input, and effective irrigation rate. This study constructs a new theoretical framework for land use conflict assessment at the macro level, providing a novel approach for studying land use conflicts at the macro scale.

**Keywords:** land use conflicts; production–living–ecological functions (PLEFs); perspectives; pressure–state–response model (PSR); constraint factor diagnosis model; Hubei Province

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## 1. Introduction

Since the reform and opening up, China's urbanization process has rapidly accelerated, leading to an increasing demand for construction land [1]. According to statistics, China's urban population surged from 460 million in 2000 to 920 million in 2022, and the urbanization rate rose from 36.22% to 65.22% [2]. During this process, agricultural land, forest land, water bodies, and other types of land have been extensively occupied for construction purposes [3]. This has not only led to substantial resource waste, but has also intensified the issue of land use conflicts [4], and resulted in severe environmental pollution and ecological imbalance [5,6]. Therefore, balancing the relationship between economic development and ecological conservation [7], particularly in addressing land use conflicts arising from the occupation of land for construction purposes, is crucial for the sustainable development of land in the future.

The increase in urban construction land not only intensifies conflicts with agricultural production land [8], but also has a significant impact on the quality of life of the population and the ecological environment within the conflict areas [9,10]. The resulting conflicts over land demand, viewed through the perspectives of production–living–ecological functions (PLEFs), significantly hinder the sustainable development of regional socio-economies [11,12]. Currently, China's land spatial development model has shifted from being primarily focused on the production function to emphasizing the coordinated development of PLEFs [13,14]. Against this backdrop, conducting research on land use conflicts based on the perspectives of PLEFs is of great practical significance for mitigating regional land use conflicts and resolving land use contradictions.

Land use conflict is a prominent issue that exists globally [15,16]; its essence lies in the game of choice regarding land values among stakeholders [17]. Different scholars have provided different definitions for the specific connotations of land use conflicts. Some scholars consider land use conflict to be the manifestation of mismatched and unbalanced tensions between limited land resources and the increasingly diverse demands for land [18,19]. Additionally, they note that the intensity of land use conflicts and their resulting negative effects vary at different stages due to variations in demands for land resources [9]. Other scholars define and categorize land use conflicts based on game theory [20], social conflict theory [21], and land use conflict cycle theory [22].

Building upon relevant studies [23,24], this study defines land use conflict as follows: Land use conflict arises from the contradiction between the scarcity of land resources and the diversity of land uses, which exacerbates the excessive utilization of land resources, ultimately leading to land use conflicts.

Existing research on land use conflicts primarily focuses on conflict identification methods and influencing factors. Different studies are generally conducted at various scales of analysis [25]. Overall, the existing literature mainly addresses land use conflicts at the national [26], urban agglomeration [27], watershed [28], provincial [29], city [30], rural [31], and county scales [32].

In their study of land use conflict identification methods, Jiang et al. [5] used the ecological risk assessment model to identify the level of land use conflicts in the Chinese mainland. Other studies have examined land use conflict levels in Denmark, Botswana, the Beijing-Tianjin-Hebei region, and the urban agglomeration around Hangzhou Bay through methods such as media content analysis [33], desktop surveys [34], weighted scoring methods [22], and the land use spatial conflicts index [27], respectively.

In the study of factors influencing land use conflicts, Cruz-Daraviña and Bocarejo Suescún [35] identified tax benefits as the primary factor affecting land use conflicts in Cali, Colombia. Additionally, the participation of various actors [36], ecological security patterns [29], urbanization rate [31], detailed division of functional zones [32], territorial spatial zoning control [18], social-ecological associations [8], and the number of stakeholders [25] were found to be key factors influencing land use conflicts in local communities in the European Arctic, Shandong Province in China, rural areas in Poland, Yanchi County in China, the Rao River Basin in China, the Baffle Basin in Australia, and the Greater Mapungubwe Transfrontier Conservation Area in South Africa, respectively.

As research on land use conflicts continues to deepen, an increasing number of studies have begun to emphasize the production–living–ecological functions (PLEFs) of land use [37–41], often focusing on fine-scale analyses of the conflict relationships between production land, living land, and ecological land at the micro level.

In the research on land use conflict identification methods and influencing factors between production land, living land, and ecological land, scholars have made significant contributions. Liang et al. [42] used a landscape ecological risk assessment model and found that population agglomeration and regional economic development positioning are the main factors influencing land use conflicts between production land and living land in Chongqing. Meanwhile, Cui et al. [28] focused on the Yangtze River Economic Belt and conducted research using a coupling assessment model, identifying total population, GDP per capita, and road network density as the primary factors influencing land use conflicts among production land, living land, and ecological land. Additionally, a study on the Bohai Rim coastal zone, employing a multi-criteria evaluation system, found that the land reclamation index and economic density are the key factors affecting land use conflicts between production, living, and ecological lands in this region [43].

Table 1 summarizes the existing literature on land use conflicts, including the study scales, areas, methods, and influencing factors.

**Table 1.** Studies on land use conflicts in the existing literature.

| Study Scales | Areas | Methods | Influencing Factors | Literature |
|---|---|---|---|---|
| Nation | China | Ecological risk assessment | Population density and altitude | [5] |
| | Denmark | Systematic Literature review | Potential benefits of stakeholders | [26] |
| | Botswana | Media content analysis | Infrastructure alteration and landscape modification | [33] |
| | Sweden | Desktop surveys | Land tenure reforms | [34] |
| Urban agglomeration | Beijing-Tianjin-Hebei region, China | Weighted scoring method | Public participation and new type of urbanization | [22] |
| | Urban agglomeration around Hangzhou Bay, China | Land use spatial conflicts index | Per capita GDP and distances to urban centers | [27] |
| Province | Shandong, China | Spatial overlay analysis of arable land and construction land | Ecological security pattern | [29] |
| | Chongqing, China | Landscape ecological risk assessment | The population agglomeration and regional economic development positioning | [42] |

**Table 1.** *Cont.*

| Study Scales | Areas | Methods | Influencing Factors | Literature |
|---|---|---|---|---|
| City | Shiraz, Iran | Qualitative methodology | Pervasive influence of neoliberal urban planning and management discourse | [7] |
| | Jinan, China | Linear weighted sum model | Land resource scarcity and diversity of human needs | [9] |
| | Enshi, China | Land use conflicts strength model | Future land use changes | [30] |
| | Cali, Colombia | Multi-actor multi-criteria analysis | Tax benefits and logistic land use implementation | [35] |
| | Ningbo, China | PLES suitability evaluation | Urban expansion | [39] |
| Rural Area | Rural Ethiopia | Variable assignment | Rangeland scarcity and insecure land tenure | [19] |
| | Rural Poland | Multiple criteria decision-making methods | Urbanization rate | [31] |
| Country | Jiangjin, China | Coupled evaluation model of production–living–ecological functions | Coordinated spatial development | [12] |
| | Yanchi, China | Pole–Field–Zone–Network | Detailed division of functional zones | [32] |
| Watersheds | Rao River Basin, China | Multi-objective land use suitability evaluation method | Territorial spatial zoning control | [18] |
| | Yangtze River Economic Belt, China | Combined calculation of land conflicts in ecology and construction, ecology and agriculture, and agriculture and construction | Total population, per capita GDP, number of mobile phone users, and road density | [28] |

**Table 1.** *Cont.*

| Study Scales | Areas | Methods | Influencing Factors | Literature |
|---|---|---|---|---|
| Basin | Baffle Basin, Australia | Combined value and preference method | Social-ecological associations | [8] |
| Conservation Area | Greater Mapungubwe Transfrontier Conservation Area, South African | Field Interview method | Number of Stakeholders | [25] |
| Coastal Zone | Bohai Rim coastal zone, China | Multi-criteria evaluation system | Land reclamation index and economic density | [43] |
| Communities | Local communities in the European Arctic | Semi-structured interviews | Participation of various actors | [36] |

It can be observed that existing research has made substantial contributions to the identification methods and influencing factors of land use conflicts, as well as to the study of the production–living–ecological functions of land use. However, most of the existing studies focus on the micro-level, analyzing land use conflicts by classifying land into specific categories such as production land, living land, and ecological land at a fine scale, and examining the conflicts between these land use types. There is a lack of research from a macro-level viewpoint that considers land use conflicts from the production, living, and ecological perspectives. Moreover, while much of the existing research analyzes the influencing factors of land use conflicts, there is a noticeable gap in studies addressing the constraint factors of land use conflicts.

Unlike previous studies, this research does not analyze land use conflicts at the micro level by classifying land into production, living, and ecological categories based on a fine scale. Instead, it adopts a macro-level perspective grounded in the theory of land use multifunctionality, using prefecture-level city data as the research object. The study classifies land use conflicts into three distinct perspectives: land use conflicts from the production perspective; land use conflicts from the living perspective; and land use conflicts from the ecological perspective, thereby constructing a theoretical framework for analyzing land use conflicts. Building on this framework, the study further integrates the pressure–state–response (PSR) model with land use conflicts from the production, living, and ecological perspectives. For each perspective, pressure, state, and response indicators are introduced, enriching the theoretical framework of land use conflicts and establishing a macro-level theoretical system for evaluating such conflicts. Additionally, this study conducts a spatiotemporal evolution analysis of land use conflicts from the three perspectives. Moreover, unlike previous research that primarily focuses on the factors influencing land use conflicts, this study shifts the focus to the constraint factors of land use conflicts, using the constraint factor diagnosis model to diagnose the constraint degrees for each of the three perspectives, thus extending the findings of previous research.

This paper is organized as follows: The first section serves as the introduction, while the second section focuses on the methodology, including an overview of the study area and data sources, as well as an explanation of the theoretical framework and research methods employed. In terms of methodology, the pressure–state–response (PSR) model is first used to construct a theoretical evaluation system for land use conflicts from the perspectives of production, living, and ecology, respectively. The following section explains the land use conflict evaluation model and the constraint factor diagnosis model. The third section presents a detailed account of the research results, analyzing the spatiotemporal evolution of land use conflicts from the perspectives of production, living, and ecology across 12 prefecture-level cities in Hubei Province from 2010 to 2020. Building on this analysis, the study further employs a constraint factor diagnosis model to examine the mitigation effects of various constraint factors on land use conflicts from these three perspectives. The fourth section consists of a discussion which addresses the theoretical contributions of the study, comparisons with similar research, policy implications, limitations of the research, and directions for future research. Finally, the fifth section concludes the paper with a summary of the research findings.

## 2. Methodology

### 2.1. Study Area

The study area is Hubei Province in China, located between latitudes 29°01′53″ N and 33°06′47″ N and longitudes 108°21′42″ E and 116°07′50″ E (see Figure 1). The total land area of Hubei Province is approximately 185,900 square kilometers, accounting for about 1.94% of China's total land area. The province is characterized by mountainous terrain surrounding a relatively low central area, forming an incomplete basin that opens slightly to the south [30]. Geographically, Hubei consists of 56% mountainous land, 24% hilly terrain, and the remaining 20% consists is composed of plains and lakes, which provide a favorable natural environment and excellent conditions for agricultural production [6]. The province experiences a subtropical monsoon climate with distinct seasons: cold winters, hot summers, mild springs, and cool autumns, accompanied by rainfall that coincides with high temperatures [10].

Hubei Province is economically advanced and experiencing rapid growth, characterized by high levels of industrialization and urbanization, making it a leading province in economic development in central China. Its capital, Wuhan, is the only sub-provincial city in the central region. However, with population growth and rapid urban expansion, the spatial patterns of land use in Hubei have undergone significant changes, leading to conflicts between land supply and demand, such as land reclamation from lakes and the disorderly occupation of arable land. These issues highlight the tension between insufficient natural resource endowment and the increasing demand for land resources.

Hubei is administratively divided into 12 prefecture-level cities (Wuhan, Huangshi, Shiyan, Yichang, Xiangyang, Ezhou, Jingmen, Xiaogan, Jingzhou, Huanggang, Xian-ning, and Suizhou), one autonomous prefecture (Enshi Tujia and Miao Autonomous Prefecture), and four provincial directly-administered county-level cities (Xiantao, Qianjiang, Tianmen, and Shennongjia Forestry District). The Enshi Tujia and Miao Autonomous Prefecture is one of China's ethnic minority autonomous prefectures. Although it covers a large geographical area, its population is relatively sparse, and its level of economic development is comparatively lower. Therefore, it is not included in the scope of this study. Xiantao, Qianjiang, Tianmen, and Shennongjia Forestry District exhibit administrative and economic development disparities when compared to the 12 prefecture-level cities; thus, they are also excluded from this study. Consequently, this study focuses solely on the 12 prefecture-level cities of Hubei Province.

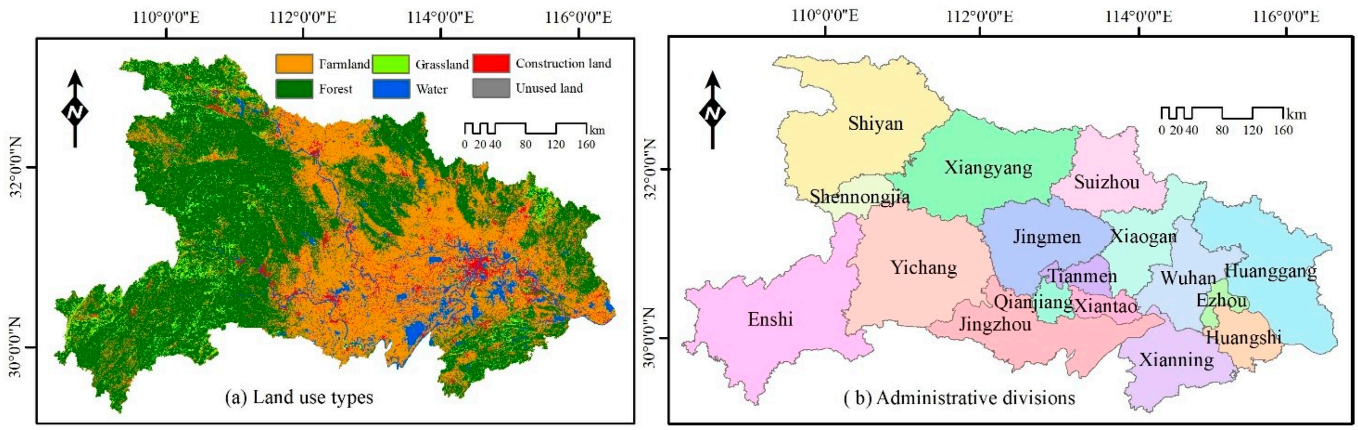


**Figure 1.** The map of Hubei.

## *2.2. Data Sources*

The research period of this study spans from 2010 to 2020, a time characterized by rapid economic development in China and significant land use conflicts. Specifically, this study compares data from the years 2010, 2015, and 2020 for comparative analysis. Hubei Province, like many others, experienced both rapid economic growth and severe land use conflict issues during this period. This study draws upon relevant literature [16] and constructs an evaluation system for land use conflict using 17 relevant indicators, including population density, urbanization rate, average land GDP, the proportion of secondary industry output value, the proportion of tertiary industry output value, total grain yield, the level of agricultural mechanization per unit of arable land area, land reclamation rate, effective irrigation rate [35], average land real estate development investment, per capita GDP, per capita urban residential area, per capita disposable income of urban residents, per capita disposable income of rural residents, fiscal expenditure, average land fertilizer input, and forest coverage rate [36].

The data mentioned above are sourced from the Hubei Statistical Yearbook and China City Statistical Yearbook as well as statistical yearbooks and national economic and social development statistical bulletins from various prefecture-level cities. In collecting these data, this study utilized 2010 as the base year for adjusting the statistical data related to economic indicators. In addition, for certain outliers and missing values, this study employed methods such as data fitting and linear interpolation to ensure the validity, scientific accuracy, and consistency of the data.

## *2.3. Theoretical Framework*

The theoretical foundation of this study is based on the theory of land multifunctionality, which posits that land in a given area serves multiple functions [14]. For instance, land designated for urban development simultaneously serves both production and living functions, while agricultural land encompasses production, living, and ecological functions [41]. Therefore, land use in the same area inevitably involves the perspectives of production, living, and ecological functions. Based on this, the study constructs the theoretical framework shown in Figure 2.

As shown in Figure 2, this study categorizes land use conflicts in the 12 prefecture-level cities of Hubei Province into three macro-level perspectives: land use conflicts from the production perspective; land use conflicts from the living perspective; and land use conflicts from the ecological perspective. According to the theory of land multifunctionality, within the same prefecture-level city, conflicts from all three perspectives—production, living, and ecology—are inevitably present. Building on relevant research findings [38–40], this study defines land use conflicts from the three perspectives as follows:

(1) Production perspective: These conflicts arise during the process of land resource utilization due to the discrepancies between different land use patterns and structures.

They involve contradictions and conflicts between human-driven land functions, such as economic activities and food production, and the land's provision of functions for other organisms and resources. (2) Living perspective: These conflicts emerge from the varying land use practices and structures during the process of land resource utilization. They involve contradictions and conflicts between human living needs, such as daily life and residential environments, and the land's provision of functions for other organisms and resources. (3) Ecological perspective: These conflicts stem from the competition for benefits and land resources, leading to contradictions between land development and ecological environments. Such conflicts result in spatial disharmony, such as imbalances in land use patterns and a decline in ecological quality, and trigger a range of ecological issues that affect the harmony of human–land relations.

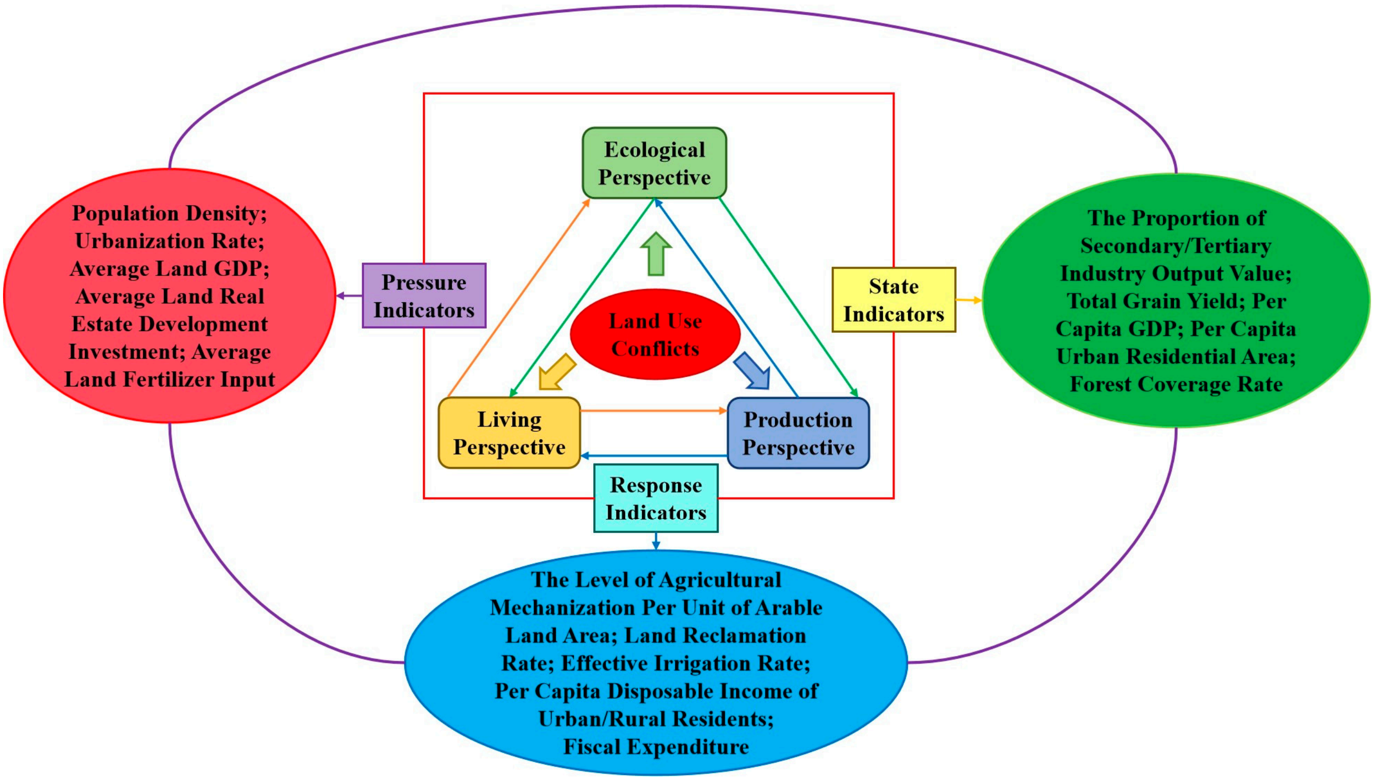


**Figure 2.** PSR theoretical analysis framework for land use conflicts from production–living–ecological perspectives.

Subsequently, this study introduces the pressure–state–response (PSR) model to further enrich the theoretical analysis framework of land use conflicts. Specifically, building on the theoretical framework of land use conflicts from the production, living, and ecological perspectives, the study introduces pressure, state, and response indicators for each of these perspectives. This approach aims to clarify the theoretical framework system of land use conflicts in the 12 prefecture-level cities of Hubei Province at the macro level, addressing the production, living, and ecological perspectives.

Specifically, the pressure indicators include factors such as population density, urbanization rate, average land GDP, average land real estate development investment, and average land fertilizer input [38]. The state indicators encompass factors like the proportion of secondary industry output value, the proportion of tertiary industry output value, total grain yield, per capita GDP, per capita urban residential area, and forest coverage rate [44]. The response indicators include factors such as the level of agricultural mechanization per unit of arable land area, land reclamation rate, effective irrigation rate, per capita disposable income of urban and rural residents, and fiscal expenditure [45].

It is evident that this study does not adopt a micro-level perspective to analyze land use conflicts between production land, living land, and ecological land in the study area, nor does it focus on the analysis of the three types of land use. Instead, it approaches land use conflicts from a macro-level perspective, analyzing the production, living, and ecological perspectives of land use conflicts. This constitutes an innovative contribution to the theoretical framework of existing research on land use conflicts. Furthermore, based on this macro-level framework, the study further introduces pressure, state, and response indicators for each of the three perspectives, namely, production, living, and ecology, thus expanding the evaluation system of land use conflicts.

### *2.4. Methods*

#### 2.4.1. Evaluation Framework of Land Use Conflict

This study constructs an evaluation framework for land use conflict based on the PSR model. The PSR model considers pressure (P), state (S), and response (R) as the criteria layers for the indicator system [4,38,46] and has become a commonly used analytical tool for studying land use conflicts [44]. Based on this, this study constructs evaluation indicator systems from three perspectives: production, living, and ecological [22]. Details regarding the specific indicators selected and their attributes are provided in Table 2.

**Table 2.** Land use conflict evaluation framework from the perspective of PLEFs.

| Target Level | Criterion Level | Indicators | Units | Factor Attributes | Weights |
|---|---|---|---|---|---|
| Production Perspective | Pressure Indicators (0.539) | Population Density (A1) | People/km$^2$ | + | 0.156 |
| | | Urbanization Rate (A2) | % | + | 0.072 |
| | | Average Land GDP (A3) | Ten Thousand RMB/km$^2$ | + | 0.311 |
| | State Indicators (0.179) | The Proportion of Secondary Industry Output Value (A4) | % | + | 0.054 |
| | | The Proportion of Tertiary Industry Output Value (A5) | % | + | 0.072 |
| | | Total Grain Yield (A6) | Ten Thousand Tons | − | 0.053 |
| | Response Indicators (0.282) | The Level of Agricultural Mechaniza-tion Per Unit of Arable Land Area (A7) | Ten Thousand Kilowatts/km$^2$ | − | 0.043 |
| | | Land Reclamation Rate (A8) | % | − | 0.088 |
| | | Effective Irrigation Rate (A9) | % | − | 0.151 |

**Table 2.** *Cont.*

| Target Level | Criterion Level | Indicators | Units | Factor Attributes | Weights |
|---|---|---|---|---|---|
| Living Perspective | Pressure Indicators (0.595) | Population Density (B1) | People/km$^2$ | + | 0.284 |
| | | Urbanization Rate (B2) | % | + | 0.130 |
| | | Average Land Real Estate Development Investment (B3) | Ten Thousand RMB/km$^2$ | + | 0.181 |
| | State Indicators (0.234) | Per Capita GDP (B4) | Ten Thousand RMB Per Person | − | 0.065 |
| | | The Proportion of Tertiary Industry Output Value (B5) | % | − | 0.058 |
| | | Per Capita Urban Residential Area (B6) | Square Meters Per Person | − | 0.111 |
| | Response Indicators (0.171) | Per Capita Disposable Income of Urban Residents (B7) | RMB | − | 0.063 |
| | | Per Capita Disposable Income of Rural Residents (B8) | RMB | − | 0.082 |
| | | Fiscal Expenditure (B9) | One Hundred Million RMB | − | 0.026 |
| Ecological Perspective | Pressure Indicators (0.467) | Population Density (C1) | People/km$^2$ | + | 0.194 |
| | | Urbanization Rate (C2) | % | + | 0.089 |
| | | Average Land Fertilizer Input (C3) | t/km$^2$ | + | 0.184 |
| | State Indicators (0.219) | The Proportion of Secondary Industry Output Value (C4) | % | + | 0.066 |
| | | The Proportion of Tertiary Industry Output Value (C5) | % | − | 0.039 |
| | | Forest Coverage Rate (C6) | % | − | 0.114 |
| | Response Indicators (0.314) | Land Reclamation Rate (C7) | % | − | 0.109 |
| | | Effective Irrigation Rate (C8) | % | − | 0.187 |
| | | Fiscal Expenditure (C9) | One Hundred Million RMB | − | 0.018 |

#### 2.4.2. Land Use Conflict Evaluation Model

(1) Min–Max Scaling

Before quantitatively evaluating the relevant indicators, it is necessary to standardize each indicator. In this study, we draw on the research of Zhang et al. [47] and use min–max scaling to standardize the data. Although this method is relatively traditional, it remains effective in addressing such issues [18]. Based on the discussion in the preceding section regarding the impact of various indicators on land use conflict, we further classify the indicators into positive and negative indicators. The specific processing method is as follows:

Formula for calculating positive indicators:

$$X'_{ij} = \frac{Xij - min(Xj)}{max(Xj) - min(Xj)} \tag{1}$$

Formula for calculating negative indicators:

$$X'_{ij} = \frac{max(Xj) - Xij}{max(Xj) - min(Xj)} \tag{2}$$

where: $X_{ij}'$ and $X_{ij}$ represent the standardized value and original value of the $j$-th indicator in the $i$-th year, respectively, and $max(X_j)$ and $min(X_j)$ are the maximum and minimum values of the $j$-th indicator across all years.

(2) Entropy Method

Although the entropy method is a relatively traditional approach for assigning weights, its objective weighting properties and simplicity of implementation lend it a certain degree of representativeness in studies addressing similar issues [48]. Therefore, this study employs the entropy method for the objective weighting of indicators, following the procedural framework outlined by Yu et al. [49]. The specific calculation steps are as follows:

1. Calculate the proportion of the $j$-th indicator value in the $i$-th year:

$$Yij = X'_{ij} / \sum_{i=1}^{m} X'_{ij} \tag{3}$$

where: $Y_{ij}$ represents the proportion of the $j$-th indicator value in the $i$-th year, and $m$ represents the number of evaluation years.

2. Calculate the entropy values of each indicator:

$$ej = -k\sum_{i=1}^{m} (Yij \times lnYij) \tag{4}$$

where: $k = 1/ln(q)$, $e_j$ represents the entropy of the $j$-th indicator, with $0 \leq e_j \leq 1$, when $Y_{ij} = 0$, $Y_{ij} \times lnY_{ij} = 0$. Here, $q$ represents the product of the number of evaluation years and the number of cities studied, i.e., $q = 3 \times 12 = 36$.

3. Calculate the information entropy redundancy:

$$dj = 1 - ej \tag{5}$$

where: $d_j$ represents the redundancy of the indicator's information entropy.

4. Calculate the weights of each indicator:

$$wj = \frac{dj}{\sum_{j=1}^{n} dj} \tag{6}$$

where $n$ represents the number of indicators, and $w_j$ represents the weight of the $j$-th indicator.

The weights of relevant indicators calculated based on the above formula are shown in Table 2.

(3) Comprehensive Index of Land Use Conflict

The comprehensive index of land use conflict is an important indicator used to assess the level of land use conflict at the macro level. It primarily calculates the land use conflict level through a weighted combination of the pressure index (TP), state index

(TS), and response index (TR). Drawing on relevant research [9], this study constructs the comprehensive index of land use conflict as follows:

$$ILU = r_1 T_P + r_2 T_S + r_3 T_R \quad (7)$$

where $r_1$, $r_2$, and $r_3$ represent the weights of the factors in each factor group. The formulae for the land use conflict pressure index ($T_P$), state index ($T_S$), and response index ($T_R$) are as follows:

$$T_P = \sum_{i=1}^{n} [U(x_i) \times w_i] \quad (8)$$

$$T_S = \sum_{j=1}^{m} [U(x_j) \times w_j] \quad (9)$$

$$T_R = \sum_{k=1}^{q} [U(x_k) \times w_k] \quad (10)$$

where $w$ is the weight of a single factor; $U(x)$ is the standardized value of a single indicator $x$; $i$, $j$, and $k$ represent the factor indices; and $n$, $m$, and $q$ represent the number of indicators for the pressure index, state index, and response index, respectively.

#### 2.4.3. Constraint Factor Diagnosis Model

The constraint factor diagnosis model is a powerful tool for constraint diagnosis [48,50]. After analyzing and calculating the comprehensive index of land use conflict, it is essential to further utilize the constraint factor diagnosis model to identify the constraint factors of land use conflict. In this study, this model is applied to calculate the constraint degrees of various indicators for 12 prefecture-level cities in Hubei at three time points (2010, 2015, and 2020).

This study first calculates the deviation degree of indicators, then combines the weights to calculate the constraint degree of indicators, and conducts a constraint diagnosis for the study area. Below are the relevant calculation formulae.

1. Formula for calculating the deviation degree of indicators $D_j$:

$$D_j = 1 - X'_{ij} \quad (11)$$

where $X_{ij}'$ is the same as Formulas (1) and (2).

2. Indicator weight ($w_j$): see Formula (6).

3. Calculation of indicator constraint degree ($h_j$):

$$h_j = [(D_j \times w_j) / \sum_{j=1}^{n} (w_j \times D_j)] \times 100\% \quad (12)$$

where $n$ is the number of indicators, and $j$ represents the $j$-th indicator.

## 3. Results

### *3.1. Spatiotemporal Evolution Analysis of Land Use Conflicts in Hubei*

According to Equations (7)–(10), the intensity of land use conflicts is calculated from production, living, and ecological perspectives for the 12 prefecture-level cities in Hubei in the years 2010, 2015, and 2020 (see Tables 3–5). Subsequently, ArcGIS 10.8 is employed for mapping purposes, utilizing the natural breaks method to classify the intensity of land use conflicts into five categories: low-level area, lower-level area, moderate-level area, higher-level area, and high-level area, with white areas representing non-research zones (see Figures 2–4).

### 3.1.1. Production Perspective

Table 3 reflects the intensity of land use conflicts from a production perspective across the 12 prefecture-level cities in Hubei from 2010 to 2020.

**Table 3.** Intensity of land use conflicts in Hubei from a production perspective (2010–2020).

| City | 2010 | 2015 | 2020 |
|---|---|---|---|
| Wuhan | 0.185 | 0.239 | 0.316 |
| Huangshi | 0.124 | 0.131 | 0.135 |
| Shiyan | 0.105 | 0.106 | 0.110 |
| Yichang | 0.094 | 0.101 | 0.105 |
| Xiangyang | 0.079 | 0.081 | 0.082 |
| Ezhou | 0.123 | 0.135 | 0.144 |
| Jingmen | 0.067 | 0.064 | 0.059 |
| Xiaogan | 0.077 | 0.087 | 0.095 |
| Jingzhou | 0.053 | 0.057 | 0.060 |
| Huanggang | 0.074 | 0.073 | 0.070 |
| Xianning | 0.082 | 0.088 | 0.091 |
| Suizhou | 0.060 | 0.059 | 0.057 |

From Table 3, it is evident that, from a production perspective, apart from Jingmen, Huanggang, and Suizhou, the intensity of land use conflicts in other parts of Hubei has significantly increased. Particularly notable is Wuhan, which serves as the political, economic, and cultural center of Hubei. The intensity of land use conflicts in Wuhan rose from 0.185 in 2010 to 0.239 in 201, and further to 0.316 in 2020, marking increases of 29.19% and 32.22%, respectively.

As the only sub-provincial city in Hubei Province, Wuhan experienced rapid economic development from 2010 to 2020. However, this swift economic growth exacerbated the production perspective of land use conflicts. Consequently, the level of land use conflicts in Wuhan has continued to rise. In contrast, Jingmen, Huanggang, and Suizhou experienced a decrease in the intensity of land use conflicts during the study period due to factors such as population outflow and urban shrinkage.

Based on Table 3, the planar heat map of land use conflicts in Hubei from 2010 to 2020, viewed from a production perspective, is depicted in Figure 3a.

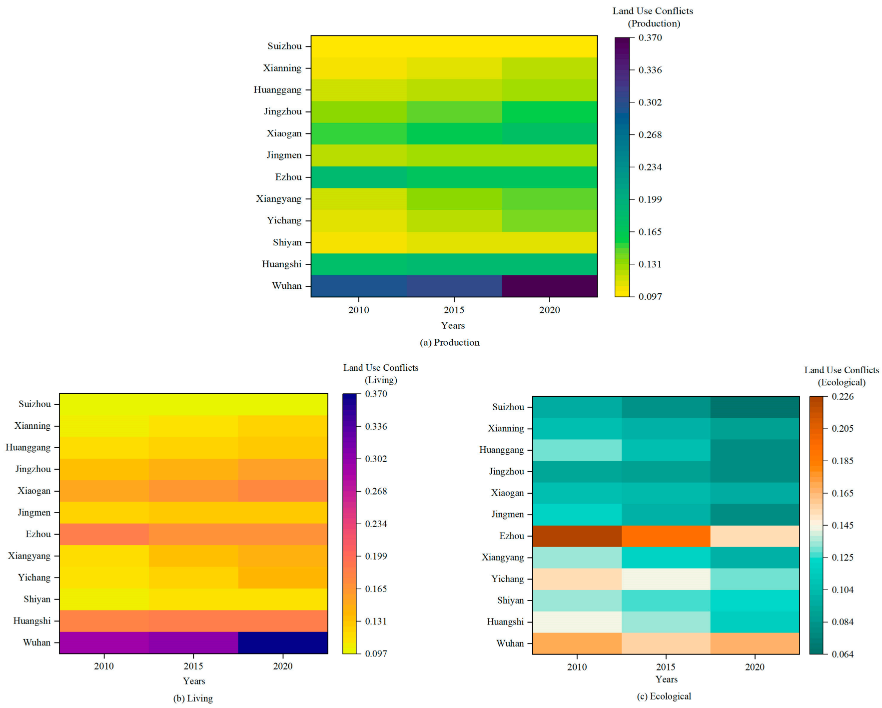


**Figure 3.** The spatiotemporal evolution of three perspectives of land use conflicts in Hubei from 2010 to 2020.

Figure 3a is a heat map illustrating the spatiotemporal evolution of land use conflict intensity from a production perspective in the 12 prefecture-level cities of Hubei from 2010 to 2020. It is evident that the level of land use conflicts in Wuhan is significantly higher compared to other cities during the study period. Based on Table 3 and Figure 3a, Figure 4 was generated using ArcGIS 10.8. This figure illustrates the changes in the intensity of land use conflicts from a production perspective across the 12 prefecture-level cities in Hubei in 2010, 2015, and 2020.

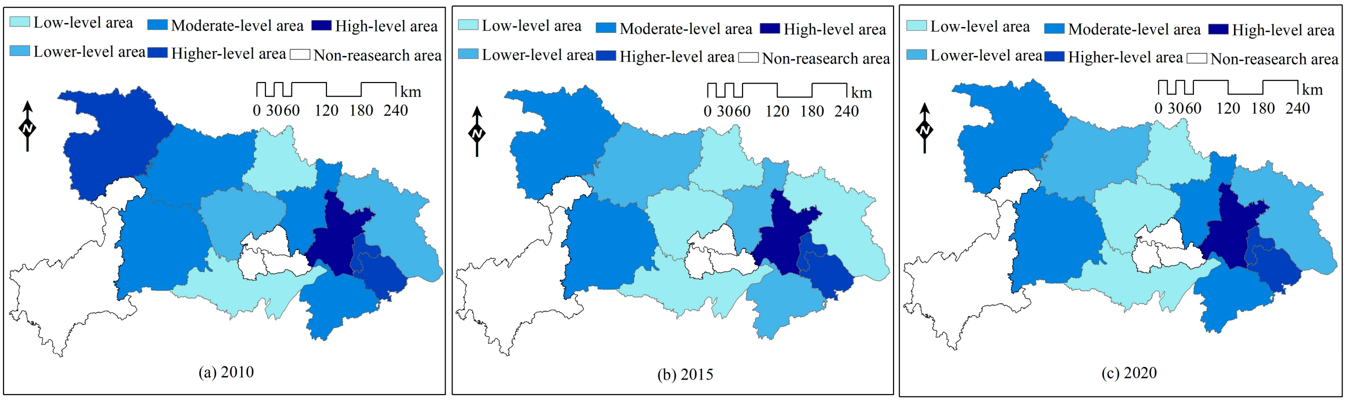


**Figure 4.** Level of land use conflicts from a production perspective.

According to Figure 4, Wuhan emerged as the sole area with a high level of land use conflict from 2010 to 2020 in Hubei. This can be attributed to Wuhan's dominant position in Hubei's development, exerting a "suction" effect that continually escalated land use conflict. In contrast, regions experiencing higher levels of land use conflicts include Huangshi and Ezhou. Huangshi, primarily driven by heavy industries such as steel production, demonstrated a heightened demand for productive land throughout the study period. Meanwhile, Ezhou, situated adjacent to Wuhan, faced significant developmental influence from Wuhan, thereby similarly intensifying the demands on production land and consequently escalating land use conflicts during the research timeframe.

The moderate-level areas of land use conflicts primarily include Shiyan, Yichang, Xiaogan, and Xianning. Shiyan was classified as a region with a higher level of land use conflict in 2010 but transitioned to a moderate-level area in both 2015 and 2020, indicating a relative easing of its land use conflict levels. This may be attributed to Shiyan's location in the Qinba mountainous region, where economic development is less pronounced and the demand for production land is moderate. Yichang consistently remained in the moderate-level area of land use conflict across the three time points studied. As a provincial sub-center city with relatively high economic development, Yichang's extensive area contributes to its moderate level of land use conflict. Although Xiaogan and Xianning have moderate levels of economic development, their proximity to Wuhan exposes them to significant demand for production land influenced by Wuhan's development.

The areas with lower levels of land use conflicts primarily include Xiangyang and Huanggang. Xiangyang was categorized as a region with a moderate level of land use conflict in 2010 but transitioned to a lower level of land use conflict in both 2015 and 2020, indicating a relative decrease in the intensity of land use conflict. This can be attributed to Xiangyang's status as a provincial sub-center city in Hubei, with a relatively developed economy. Moreover, Xiangyang's extensive area and favorable agricultural production conditions contribute to its overall lower level of land use conflict. Huanggang, despite its proximity to Wuhan, features a large area and is situated in the Dabie mountainous region, where economic development is less pronounced. As a result, there is lower demand for production land, leading to a lower level of land use conflict.

The regions characterized by low levels of land use conflicts primarily include Jingmen, Jingzhou, and Suizhou. Jingmen was classified as having low land use conflict in 2010, and this designation remained consistent in both 2015 and 2020. This may be attributed to Jingmen's favorable agricultural production environment, relatively advantageous economic development conditions, and comparatively well-developed policies for the utilization of production land. These factors collectively contribute to the reduction in land use conflicts related to production land in Jingmen. Jingzhou exhibits a relatively high level of economic development and is renowned as a fertile area in the Jianghan Plain, recognized for its historical and cultural significance. Consequently, local government efforts to preserve its agricultural productivity have effectively restrained land use conflict to a low level. Suizhou, despite having relatively lower economic development, boasts substantial grain production, contributing to a low level of land use conflict.

#### 3.1.2. Living Perspective

Table 4 reflects the intensity of land use conflicts from a living perspective across the 12 prefecture-level cities in Hubei from 2010 to 2020.

**Table 4.** Intensity of land use conflicts in Hubei from a living perspective (2010–2020).

| City | 2010 | 2015 | 2020 |
|---|---|---|---|
| Wuhan | 0.295 | 0.302 | 0.369 |
| Huangshi | 0.181 | 0.187 | 0.183 |
| Shiyan | 0.105 | 0.112 | 0.109 |
| Yichang | 0.114 | 0.123 | 0.142 |
| Xiangyang | 0.116 | 0.132 | 0.147 |
| Ezhou | 0.183 | 0.169 | 0.171 |
| Jingmen | 0.123 | 0.128 | 0.128 |
| Xiaogan | 0.152 | 0.162 | 0.176 |
| Jingzhou | 0.133 | 0.144 | 0.156 |
| Huanggang | 0.115 | 0.122 | 0.127 |
| Xianning | 0.107 | 0.113 | 0.125 |
| Suizhou | 0.097 | 0.100 | 0.098 |

According to Table 4, from a living perspective, the intensity of land use conflict has increased in all areas of Hubei except for Ezhou. Taking Wuhan as an example, its land use conflict intensity rose from 0.295 in 2010 to 0.302 in 2015, and further to 0.369 in 2020, which represents increases of 2.37% and 22.19%, respectively. Notably, the significant rise observed during the period from 2015 to 2020 is particularly striking.

During the period from 2010 to 2020, Wuhan experienced rapid economic growth, particularly accelerating between 2015 and 2020. This swift economic development significantly enhanced Wuhan's level of urbanization but concurrently exacerbated land use conflicts. Consequently, Wuhan witnessed a sharp increase in land use conflict intensity from 2015 to 2020. In contrast, Ezhou was the sole city in the study period in which the overall land use conflict intensity decreased, albeit marginally, from 0.183 in 2010 to 0.171 in 2020, marking a reduction of 6.56% over the decade. However, Ezhou's overall land use conflict level remains relatively high. Therefore, collectively, the twelve prefecture-level cities in Hubei exhibit elevated levels of land use conflict from a living perspective.

Based on Table 4, the planar heat map of land use conflicts in Hubei from 2010 to 2020, from a living perspective, is depicted in Figure 3b. Figure 3b is a heat map illustrating the spatiotemporal evolution of land use conflict intensity from a living perspective in the twelve prefecture-level cities of Hubei from 2010 to 2020. It is evident that the level of land use conflicts in Wuhan, similar to the production perspective, is significantly higher compared to other cities during the study period. Based on Table 4 and Figure 3b, Figure 5 was created using ArcGIS 10.8. Figure 5 illustrates the changes in land use conflict levels from a living perspective among the twelve prefecture-level cities in Hubei in 2010, 2015, and 2020.

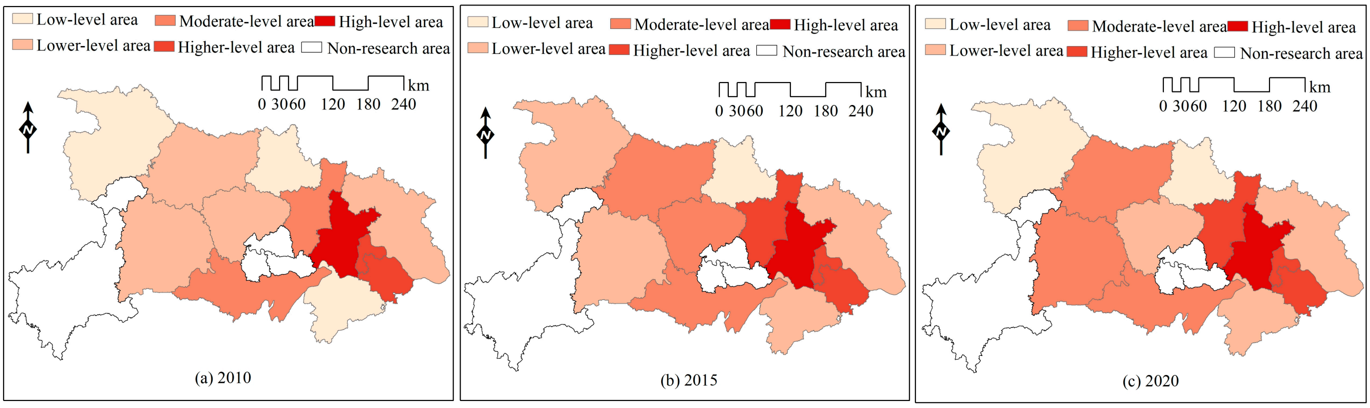


**Figure 5.** Level of land use conflicts from a living perspective.

As illustrated in Figure 5, from a living perspective, Wuhan was the only area with a high level of land use conflict between 2010 and 2020. This is attributed to Wuhan being the sole city in Hubei experiencing a net influx of population. As urbanization rates continued to rise, the significant influx of people inevitably intensified land use conflict. The regions characterized by higher levels of land use conflicts include Huangshi, Ezhou, and Xiaogan. These three cities are all adjacent to Wuhan, and individuals unable to purchase homes in Wuhan often opt to buy properties in these areas. With convenient commuting options to Wuhan, these cities experience heightened demand for living land, resulting in higher levels of land use conflicts.

The areas with moderate levels of land use conflicts are primarily Jingzhou and Xiangyang. Jingzhou is situated in the Jianghan Plain, with a dense population and a relatively high level of economic development, meaning that residents have a big demand for living land. Xiangyang, as a sub-central city of Hubei, ranks second to Wuhan in terms of economic development, with a relatively large population and significant demand for residential land among its residents.

The regions with lower levels of land use conflicts include Jingmen, Huanggang, Yichang, and Xianning. Jingmen has a moderate level of economic development and a smaller population, resulting in lower demand for living land. Huanggang, located extensively in the Dabie Mountains region, has a relatively lower level of economic development. It also experiences the highest net outflow of population in Hubei. Yichang, despite its economic advancement, features large areas of mountainous terrain, leading to lower demand for living land among residents. Xianning has a relatively lower level of economic development and is characterized by its mountainous and lake-rich landscape, contributing to lower demand for living land.

The regions with low levels of land use conflict are primarily Shiyan and Suizhou. Shiyan is situated in the Qinba mountainous region with a relatively underdeveloped economy and a smaller population. Suizhou is located in the northern hilly area of Hubei, characterized by a sparse population and a lower level of economic development. Residents exhibit minimal demand for living land, leading to a low level of land use conflict.

### 3.1.3. Ecological Perspective

Table 5 reflects the intensity of land use conflicts from an ecological perspective across the 12 prefecture-level cities in Hubei from 2010 to 2020.

**Table 5.** Intensity of land use conflicts in Hubei from an ecological perspective (2010–2020).

| City | 2010 | 2015 | 2020 |
|---|---|---|---|
| Wuhan | 0.170 | 0.156 | 0.167 |
| Huangshi | 0.144 | 0.134 | 0.117 |
| Shiyan | 0.132 | 0.127 | 0.122 |
| Yichang | 0.153 | 0.143 | 0.128 |
| Xiangyang | 0.132 | 0.119 | 0.100 |
| Ezhou | 0.225 | 0.192 | 0.153 |
| Jingmen | 0.120 | 0.101 | 0.079 |
| Xiaogan | 0.107 | 0.104 | 0.095 |
| Jingzhou | 0.092 | 0.089 | 0.079 |
| Huanggang | 0.130 | 0.106 | 0.078 |
| Xianning | 0.107 | 0.100 | 0.089 |
| Suizhou | 0.097 | 0.081 | 0.064 |

From Table 5, it can be observed that, from an ecological perspective, the level of land use conflict across various regions in Hubei has generally decreased. Taking Ezhou as an example, its intensity of land use conflict decreased from 0.225 in 2010 to 0.192 in 2015, and further to 0.153 in 2020, marking reductions of 14.67% and 20.31%, respectively. This indicates an overall improvement in the level of land use conflict among the 12 prefecture-level cities in Hubei.

In contrast to the perspectives of production and living, from an ecological standpoint, the city with the highest level of land use conflict was Ezhou in both 2010 and 2015, while in 2020, this title shifted to Wuhan. Ezhou's rapid economic development has primarily relied on heavy industry, which has caused some environmental damage, resulting in a higher level of land use conflict from the ecological perspective. However, the outbreak of COVID-19 led to a decline in industrial production in Ezhou, which, in turn, improved the city's ecological environment. As a result, by 2020, Ezhou's land use conflict level from an ecological perspective decreased, falling below that of Wuhan.

According to Table 5, the planar heat map of land use conflicts in Hubei from 2010 to 2020, presented from an ecological perspective, is illustrated in Figure 3c. Figure 3c is a heat map illustrating the spatiotemporal evolution of land use conflict intensity from an ecological perspective in the 12 prefecture-level cities of Hubei from 2010 to 2020. It is evident that the level of land use conflicts in Wuhan and Ezhou is significantly higher compared to other cities during the study period. Based on Table 5 and Figure 3c, Figure 6 was created using ArcGIS 10.8. Figure 6 illustrates the changes in the level of land use conflict from an ecological perspective among the 12 prefecture-level cities in Hubei in 2010, 2015, and 2020.

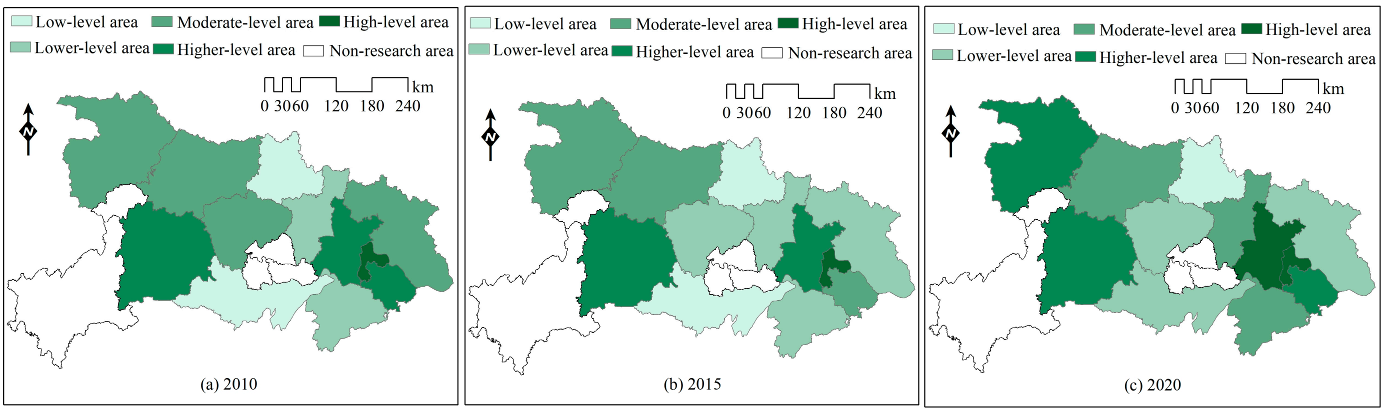


**Figure 6.** Level of land use conflicts from an ecological perspective.

Figure 6 illustrates that Ezhou is identified as a region with a high level of land use conflict, while Wuhan, Huangshi, and Yichang are classified as areas with higher-level areas. This classification is attributed to Ezhou's economic development, which is primarily driven by heavy industry, leading to ecological degradation; consequently, Ezhou exhibits a high level of land use conflict. Conversely, Wuhan places a greater emphasis on environmental conservation efforts, including projects like the Huangpi Mulan Cultural Ecotourism Zone. Despite industrial and urban development posing certain environmental challenges, Wuhan's overall level of land use conflict is lower compared to Ezhou. Huangshi, centered around steel industry development, inevitably impacts the environment, contributing to its higher level of land use conflict. Yichang, characterized by higher economic development, also faces ecological challenges due to economic growth, resulting in a higher level of land use conflict.

In general, Shiyan and Xiangyang are classified as areas with moderate levels of land use conflicts. Shiyan is located in the Qinba Mountain region, characterized by a relatively favorable ecological environment. However, its economic development is primarily driven by the automotive industry, and insufficient attention has been paid to ecological conservation during industrial growth, resulting in some environmental degradation. Xiangyang, while benefiting from favorable agricultural production conditions, has experienced certain ecological pollution issues as a result of its rapid economic development.

In contrast, regions with lower levels of land use conflicts include Jingmen, Xiaogan, Xianning, and Huanggang. Jingmen exhibits moderate economic development, with a high grain-production yield and strong environmental protection measures. Xiaogan benefits from a favorable agricultural production environment and scenic natural surroundings. Xianning, known as the "hometown of hot springs" in Hubei, features numerous mountains and lakes and emphasizes effective ecological conservation practices. Similarly, Huanggang, situated in the Dabie Mountains region, prioritizes environmental protection efforts, leading to a lower level of land use conflict.

Finally, the regions with low levels of land use conflicts primarily include Suizhou and Jingzhou. Suizhou exhibits lower economic development and a smaller population, resulting in minimal environmental impact. Jingzhou, known for its rich historical and cultural heritage, is situated in the heartland of the Jianghan Plain. The local government places significant emphasis on environmental preservation, contributing to a low level of land use conflict in the region.

### *3.2. Constraint Diagnosis of Land Use Conflict in Hubei*

The constraint diagnosis model is utilized to diagnose the relevant constraint factors of land use conflicts, aiming to assess the effectiveness of different factors in mitigating these conflicts. Generally, a higher constraint degree indicates a stronger mitigating effect of a factor on land use conflicts, while a lower constraint degree suggests a weaker mitigating effect of that factor on land use conflicts. To analyze the constraint factors of land use conflicts in the 12 prefecture-level cities of Hubei Province, Formulas (11) and (12) are used to calculate the constraint factors for land use conflict from the production perspective, which primarily include the population density (A1), urbanization rate (A2), average land GDP (A3), proportion of secondary industry output value (A4), proportion of tertiary industry output value (A5), total grain yield (A6), level of agricultural mechanization per unit of arable land (A7), land reclamation rate (A8), and effective irrigation rate (A9). For land use conflict from the living perspective, the constraint factors primarily comprise population density (B1), urbanization rate (B2), average land real estate development investment (B3), per capita GDP (B4), the proportion of tertiary industry output value (B5), per capita urban residential area (B6), per capita disposable income of urban residents (B7), per capita disposable income of rural residents (B8), and fiscal expenditure (B9). Regarding land use conflict from the ecological perspective, the key constraint factors include population density (C1), urbanization rate (C2), average land fertilizer input (C3), the proportion of secondary industry output value (C4), the proportion of tertiary industry output value (C5), forest coverage rate (C6), land reclamation rate (C7), effective irrigation rate (C8), and fiscal expenditure (C9).

### 3.2.1. Production Perspective

Based on Formulas (11) and (12), the constraint factors of land use conflict from the production perspective in 12 prefecture-level cities of Hubei from 2010 to 2020 (specifically in the years 2010, 2015, and 2020) were diagnosed, and a planar heat map was created using Origin Pro 2021, with the results presented in Figure 7a.

Specifically, the degree of deviation of each constraint factor is first calculated using Formula (11). Then, this degree of deviation is combined with the weights of each factor determined by the entropy method and substituted into Formula (12) to calculate the constraint degree of each constraint factor. Similarly, the calculation methods for the constraint degrees of land use conflicts between the living perspective and the ecological perspective are the same, with Formulas (11) and (12) applied to obtain Figures 7b and 7c, respectively.

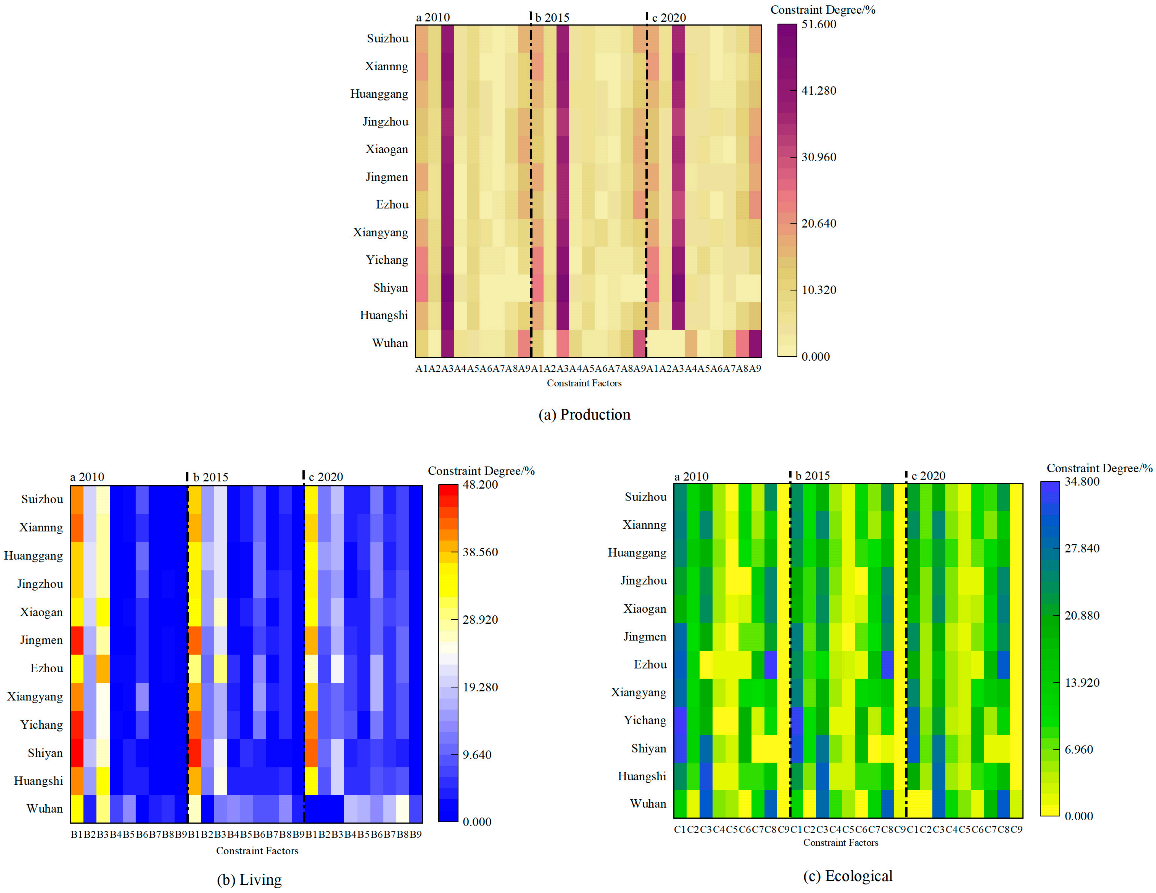


**Figure 7.** Diagnosis of constraint degrees on land use conflicts in Hubei from 2010 to 2020.

Figure 7a clearly illustrates the constraint degrees of various constraint factors of land use conflicts from the production perspective across the twelve prefecture-level cities in Hubei for the years 2010, 2015, and 2020. It is evident that the average land GDP (A3) exhibits the highest constraint degree on land use conflicts in nearly all the cities throughout the study period, meaning that the average land GDP has the strongest mitigating effect on land use conflicts. Based on this, Table 6 has been developed as follows.

Table 6 presents the top three factors exhibiting the highest constraint degrees on land use conflicts from the production perspective across the twelve prefecture-level cities in Hubei for the years 2010, 2015, and 2020. These three factors are also the ones with the strongest mitigating effects on land use conflicts from the production perspective. As mentioned earlier, indicators of land use conflict from the production perspective include the following: pressure indicators including population density (A1), urbanization rate (A2), and average land GDP (A3); state indicators, including the proportion of secondary industry output value (A4), the proportion of tertiary industry output value (A5), and total grain yield (A6); and response indicators including the level of agricultural mechanization per unit of arable land area (A7), land reclamation rate (A8), and effective irrigation rate (A9).

**Table 6.** Top three constraint factors of land use conflicts from the production perspective in the 12 prefecture-level cities of Hubei (2010–2020).

| **City** | **2010** | | | **2015** | | | **2020** | | |
|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **1** | **2** | **3** | **1** | **2** | **3** |
| Wuhan | average land GDP (A3) 41.407 | effective irrigation rate (A9) 23.040 | population density (A1) 10.803 | effective irrigation rate (A9) 30.704 | average land GDP (A3) 24.515 | land reclamation rate (A8) 12.757 | effective irrigation rate (A9) 44.213 | land reclamation rate (A8) 24.879 | proportion of secondary industry output value (A4) 15.527 |
| Huangshi | average land GDP (A3) 48.094 | population density (A1) 16.955 | effective irrigation rate (A9) 11.152 | average land GDP (A3) 44.096 | population density (A1) 17.426 | effective irrigation rate (A9) 12.750 | average land GDP (A3) 41.097 | population density (A1) 17.562 | effective irrigation rate (A9) 14.860 |
| Shiyan | average land GDP (A3) 51.448 | population density (A1) 25.520 | urbanization rate (A2) 9.484 | average land GDP (A3) 49.805 | population density (A1) 25.198 | urbanization rate (A2) 7.645 | average land GDP (A3) 49.434 | population density (A1) 25.598 | urbanization rate (A2) 6.610 |
| Yichang | average land GDP (A3) 46.125 | population density (A1) 22.620 | the proportion of tertiary industry output value (A5) 9.928 | average land GDP (A3) 44.078 | population density (A1) 22.822 | the proportion of tertiary industry output value (A5) 8.827 | average land GDP (A3) 42.644 | population density (A1) 22.850 | effective irrigation rate (A9) 8.856 |
| Xiangyang | average land GDP (A3) 41.050 | population density (A1) 18.362 | effective irrigation rate (A9) 9.643 | average land GDP (A3) 37.972 | population density (A1) 18.191 | effective irrigation rate (A9) 11.192 | average land GDP (A3) 35.687 | population density (A1) 18.236 | effective irrigation rate (A9) 12.406 |
| Ezhou | average land GDP (A3) 42.849 | effective irrigation rate (A9) 16.122 | population density (A1) 13.502 | average land GDP (A3) 37.656 | effective irrigation rate (A9) 19.425 | population density (A1) 14.101 | average land GDP (A3) 31.999 | effective irrigation rate (A9) 22.303 | population density (A1) 14.263 |
| Jingmen | average land GDP (A3) 39.681 | population density (A1) 18.531 | effective irrigation rate (A9) 14.066 | average land GDP (A3) 37.379 | population density (A1) 18.345 | effective irrigation rate (A9) 16.174 | average land GDP (A3) 35.004 | effective irrigation rate (A9) 17.914 | population density (A1) 17.857 |

**Table 6.** *Cont.*

| City | 2010 | | | 2015 | | | 2020 | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| Xiaogan | average land GDP (A3) 39.259 | effective irrigation rate (A9) 17.326 | population density (A1) 13.221 | average land GDP (A3) 38.266 | effective irrigation rate (A9) 18.631 | population density (A1) 13.688 | average land GDP (A3) 36.605 | effective irrigation rate (A9) 20.162 | population density (A1) 14.043 |
| Jingzhou | average land GDP (A3) 36.435 | effective irrigation rate (A9) 16.355 | population density (A1) 13.873 | average land GDP (A3) 35.215 | effective irrigation rate (A9) 16.971 | population density (A1) 14.120 | average land GDP (A3) 33.721 | effective irrigation rate (A9) 17.803 | population density (A1) 14.397 |
| Huanggang | average land GDP (A3) 40.798 | population density (A1) 16.127 | effective irrigation rate (A9) 11.481 | average land GDP (A3) 39.077 | population density (A1) 16.199 | effective irrigation rate (A9) 13.062 | average land GDP (A3) 37.486 | population density (A1) 16.198 | effective irrigation rate (A9) 14.687 |
| Xianning | average land GDP (A3) 43.562 | population density (A1) 19.247 | average land GDP (A3) 10.502 | average land GDP (A3) 42.674 | population density (A1) 19.597 | effective irrigation rate (A9) 11.924 | average land GDP (A3) 40.936 | population density (A1) 19.684 | effective irrigation rate (A9) 13.121 |
| Suizhou | average land GDP (A3) 39.674 | population density (A1) 18.016 | effective irrigation rate (A9) 17.047 | average land GDP (A3) 38.100 | population density (A1) 17.853 | effective irrigation rate (A9) 17.477 | average land GDP (A3) 36.436 | effective irrigation rate (A9) 18.007 | population density (A1) 17.665 |

Table 6 indicates that there are significant differences in the top three constraint factors related to land use conflicts from the production perspective among the twelve prefecture-level cities in Hubei. In Wuhan, the constraint degree of average land GDP (A3) ranked first in 2010 at 41.407%. However, by 2015 and 2020, the constraint degree of effective irrigation rate (A9) became the highest, at 30.704% and 44.213%, respectively, indicating the most significant mitigating effect on land use conflicts from the production perspective. This shift is likely due to the continuous improvement in effective irrigation rates during the study period, which has, to some extent, mitigated land use conflicts in Wuhan's agricultural production areas. Furthermore, the increase in the effective irrigation rate has eased the pressures resulting from rapid urbanization and the conversion of agricultural land to construction land. Therefore, the mitigating effect of the effective irrigation rate on land use conflicts has gradually increased.

In contrast, for cities other than Wuhan, the average land GDP (A3) consistently ranked as the foremost constraint factor in 2010, 2015, and 2020, with its constraint degree significantly surpassing that of other factors. Taking Huangshi as an example, the average land GDP (A3) accounted for 48.094%, 44.096%, and 41.097% of the constraint degree on land use conflicts at the three time points of the study, significantly surpassing the subsequent factors by 31.139, 26.670, and 23.535 percentage points, respectively. This may be because the average land GDP is the most direct indicator reflecting the urban production activities and economic development level. This indicator can directly reflect the land use conflicts from the production perspective, and has the greatest impact on land use conflicts, resulting in the strongest constraint degree.

In addition to average land GDP (A3) and effective irrigation rate (A9), another significant constraint factor is population density (A1). As shown in Table 6, population density (A1) has consistently emerged as a primary constraint factor across various time periods in most cities. Taking Shiyan as an example, population density (A1) ranked second in 2010, 2015, and 2020, accounting for 25.520%, 25.198%, and 25.598% of the constraint degree on land use conflicts, respectively. These constraint degrees were higher than those of the third-ranked factor by 16.036, 17.553, and 18.988 percentage points, respectively. This may be because population density directly reflects the production demands of a city. A larger population inevitably leads to higher production demands that need to be met, and such demands significantly influence the level of land use conflicts from the production perspective. As a result, population density has a relatively strong constraint degree on land use conflicts from the production perspective.

Based on the analysis of the results from different time periods and cities, it is evident that, despite significant variations in the primary constraint factors of land use conflicts from the production perspective among different cities, population density (A1), average land GDP (A3), and effective irrigation rate (A9) are the main constraint factors on land use conflicts across the twelve prefecture-level cities in Hubei. Therefore, when formulating differentiated policies to mitigate land use conflicts according to local conditions, particular attention should be given to population density, average land GDP, and effective irrigation rate. By moderately promoting the reasonable development of average land GDP, maintaining an appropriate population density, and improving the effective irrigation rate in agriculture, the level of land use conflicts from the production perspective can be mitigated across various prefecture-level cities in Hubei.

### 3.2.2. Living Perspective

Based on Formulas (11) and (12), the constraint factors of land use conflicts from the living perspective for 12 prefecture-level cities in Hubei from 2010 to 2020 were diagnosed, and a planar heat map was created using Origin Pro 2021. The results are shown in Figure 7b.

Figure 7b clearly illustrates the constraint degrees of various constraint factors on the intensity of land use conflicts from the living perspective in the 12 prefecture-level cities of Hubei Province for the years 2010, 2015, and 2020. It is evident that population density (B1) has the highest constraint degree on land use conflicts from the living perspective across nearly all cities during the study period. Based on this analysis, Table 7 has been created.

Table 7 presents the top three factors with the highest constraint degrees on land use conflicts from the living perspective in the 12 prefecture-level cities of Hubei for the years 2010, 2015, and 2020. As mentioned earlier, the indicators of land use conflicts from the living perspective include the following: pressure indicators, including population density (B1), urbanization rate (B2), and average land real estate development investment (B3); state indicators, including per capita GDP (B4), the proportion of tertiary industry output value (B5), and per capita urban residential area (B6); and response indicators, including per capita disposable income of urban residents (B7), per capita disposable income of rural residents (B8), and fiscal expenditure (B9).

**Table 7.** Top three constraint factors of land use conflicts from the living perspective in the 12 prefecture-level cities of Hubei (2010–2020).

| **City** | **2010** | | | **2015** | | | **2020** | | |
|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **1** | **2** | **3** | **1** | **2** | **3** |
| Wuhan | population density<br>(B1)<br>35.041 | average land real estate development investment<br>(B3)<br>30.505 | the proportion of tertiary industry output value<br>(B5)<br>13.110 | population density<br>(B1)<br>26.659 | per capita GDP<br>(B4)<br>13.060 | per capita disposable income of rural residents<br>(B8)<br>13.047 | per capita disposable income of rural residents<br>(B8)<br>24.141 | per capita GDP<br>(B4)<br>19.278 | per capita disposable income of urban residents<br>(B7)<br>18.557 |

**Table 7.** *Cont.*

| City | 2010 | | | 2015 | | | 2020 | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| Huang shi | population density (B1) 40.870 | average land real estate development investment (B3) 33.294 | urbanization rate (B2) 15.702 | population density (B1) 38.682 | average land real estate development investment (B3) 25.336 | urbanization rate (B2) 11.968 | population density (B1) 34.879 | average land real estate development investment (B3) 19.635 | per capita GDP (B8) 8.998 |
| Shiyan | population density (B1) 48.082 | average land real estate development investment (B3) 27.290 | urbanization rate (B2) 17.868 | population density (B1) 45.941 | average land real estate development investment (B3) 23.373 | urbanization rate (B2) 13.939 | population density (B1) 42.399 | average land real estate development investment (B3) 19.762 | Urbanization rate (B2) 10.948 |
| Yichang | population density (B1) 45.662 | average land real estate development investment (B3) 25.449 | urbanization rate (B2) 15.711 | population density (B1) 42.219 | average land real estate development investment (B3) 17.076 | urbanization rate (B2) 12.639 | population density (B1) 40.969 | per capita urban residential area (B6) 11.994 | average land real estate development investment (B3) 10.154 |
| Xiang yang | population density (B1) 40.513 | average land real estate development investment (B3) 25.449 | urbanization rate (B2) 15.196 | population density (B1) 38.710 | average land real estate development investment (B3) 17.216 | per capita urban residential area (B6) 15.771 | population density (B1) 37.671 | per capita urban residential area (B6) 16.316 | average land real estate development investment (B3) 10.740 |
| Ezhou | average land real estate development investment (B3) 39.032 | population density (B1) 34.426 | urbanization rate (B2) 14.873 | average land real estate development investment (B3) 29.329 | population density (B1) 28.991 | per capita urban residential area (B6) 13.690 | population density (B1) 26.774 | average land real estate development investment (B3) 22.615 | per capita urban residential area (B6) 16.239 |
| Jingmen | population density (B1) 46.500 | average land real estate development investment (B3) 28.145 | urbanization rate (B2) 16.339 | population density (B1) 43.112 | average land real estate development investment (B3) 21.548 | urbanization rate (B2) 12.158 | population density (B1) 39.756 | average land real estate development investment (B3) 16.234 | per capita GDP (B8) 9.811 |
| Xiaogan | population density (B1) 36.134 | average land real estate development investment (B3) 33.174 | urbanization rate (B2) 20.561 | population density (B1) 34.216 | average land real estate development investment (B3) 26.039 | urbanization rate (B2) 15.697 | population density (B1) 32.992 | average land real estate development investment (B3) 19.139 | Urbanization rate (B2) 11.753 |

**Table 7.** *Cont.*

| City | 2010 | | | 2015 | | | 2020 | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| Jingzhou | population density | average land real estate development investment | urbanization rate | population density | average land real estate development investment | urbanization rate | population density | average land real estate development investment | per capita urban residential area |
| | (B1) 38.446 | (B3) 28.813 | (B2) 21.029 | (B1) 36.436 | (B3) 21.674 | (B2) 15.917 | (B1) 35.488 | (B3) 15.464 | (B6) 13.742 |
| Huang gang | population density | average land real estate development investment | urbanization rate | population density | average land real estate development investment | urbanization rate | population density | average land real estate development investment | Urbanization rate |
| | (B1) 37.926 | (B3) 28.161 | (B2) 22.329 | (B1) 36.484 | (B3) 22.452 | (B2) 18.272 | (B1) 34.869 | (B3) 17.548 | (B2) 14.885 |
| Xianning | population density | average land real estate development investment | urbanization rate | population density | average land real estate development investment | urbanization rate | population density | average land real estate development investment | Urbanization rate |
| | (B1) 41.855 | (B3) 28.852 | (B2) 19.521 | (B1) 38.604 | (B3) 22.161 | (B2) 15.034 | (B1) 37.693 | (B3) 17.455 | (B2) 11.915 |
| Suizhou | population density | average land real estate development investment | urbanization rate | population density | average land real estate development investment | urbanization rate | population density | average land real estate development investment | per capita urban residential area |
| | (B1) 41.176 | (B3) 26.612 | (B2) 19.815 | (B1) 38.406 | (B3) 22.351 | (B2) 15.475 | (B1) 36.091 | (B3) 19.022 | (B6) 12.772 |

From Table 7, it can be observed that the constraint factors for land use conflicts from the living perspective among the 12 prefecture-level cities in Hubei exhibited certain variations over the study period, with significant differences across cities. Taking Yichang as an example, during the years 2010, 2015, and 2020, the primary constraint factor for land use conflicts from the living perspective was population density (B1), which accounted for 45.662%, 42.219%, and 40.969% of the constraint degrees, respectively. This was higher than the second-ranked factor by 20.213, 25.143, and 28.975 percentage points, respectively. Moreover, population density consistently ranked first in constraint factors on land use conflicts in most cities during the majority of the time periods studied. This may be because population density most directly reflects the living demands of a city; the higher the population density, the greater the living demands. As a result, population density has the greatest impact on land use conflicts from the living perspective, making it the primary constraint factor for such conflicts.

Furthermore, in most cities and during the majority of the time periods studied, average land real estate development investment (B3) emerged as the second-ranking constraint factor on land use conflicts from the living perspective. Taking Xiangyang and Ezhou as examples, in Xiangyang, average land real estate development investment (B3) ranked as the second most significant constraint factor on land use conflicts in both 2010 and 2015, surpassing the third-ranking constraint factor by 10.253 and 1.445 percentage points, respectively. In Ezhou, average land real estate development investment (B3) consistently ranked second in terms of its constraint degree on land use conflicts in 2010, 2015, and 2020, exceeding the third-ranking constraint factor by 19.553, 15.301, and 6.376 percentage points, respectively. This may be attributed to the fact that average land real estate development investment stimulates urban economic growth, which not only drives urban development but also impacts residents' housing needs and other living requirements. As a result, it has a significant effect on land use conflicts from a living perspective, leading to a higher degree of constraint on such conflicts.

Further analysis reveals that the urbanization rate (B2) is a primary constraint factor on land use conflicts in the other 11 prefecture-level cities, excluding Wuhan. Taking Jingmen and Xiaogan as examples, the urbanization rate (B2) ranked third as a constraint factor for land use conflicts in Jingmen in both 2010 and 2015, while it consistently ranked third in Xiaogan during 2010, 2015, and 2020. This may be attributed to the fact that the urbanization rate reflects the level of economic development and population concentration in a city. Cities with higher urbanization rates typically have greater living demands, which consequently leads to a more significant impact of the urbanization rate on land use conflicts from a living perspective, resulting in a higher degree of constraint on such conflicts.

The constraint factors influencing land use conflicts from a living perspective in Wuhan exhibit significant differences compared to other cities. In 2020, the highest-ranking constraint factor for mitigating land use conflicts in Wuhan was the per capita disposable income of rural residents (B8), indicating that this factor had the greatest mitigating effect on land use conflicts from a living perspective in Wuhan. This may be attributed to the continuous increase in income levels among rural residents in Wuhan, which has narrowed the income gap with urban residents. The rise in income has substantially improved living conditions, thereby greatly mitigating the level of land use conflicts in Wuhan from a living perspective.

Analysis of different time periods and cities reveals that while there are significant differences in the primary constraint factors on land use conflicts among various cities, overall, population density (B1), urbanization rate (B2), and average land real estate development investment (B3) are the main constraint factors on land use conflicts from the living perspective in the 12 prefecture-level cities of Hubei. Therefore, when formulating differentiated policies to address land use conflicts from the living perspective, it is particularly important to consider factors such as population density, urbanization rate, and average land real estate development investment. For example, it is essential to maintain a reasonable level of urbanization, while ensuring an appropriate population size and the average land real estate development investment. These measures will effectively mitigate the intensity of land use conflicts from a living perspective in cities across Hubei.

### 3.2.3. Ecological Perspective

Based on Formulas (11) and (12), the constraint factors of land use conflicts from the ecological perspective for twelve prefecture-level cities in Hubei from 2010 to 2020 were analyzed, and a planar heat map was created using Origin Pro 2021. The results are shown in Figure 7c.

Figure 7c clearly illustrates the degrees of constraint factors related to land use conflicts from the ecological perspective in the twelve prefecture-level cities of Hubei in 2010, 2015, and 2020. It is evident that population density (C1) and effective irrigation rate (C8) exhibit the highest constraint degrees across nearly all cities throughout the study period. Based on this observation, Table 8 has been developed.

Table 8 presents the top three constraint factors on land use conflicts from the ecological perspective in the twelve prefecture-level cities of Hubei for the years 2010, 2015, and 2020. As mentioned earlier, the indicators under the ecological perspective include the pressure indicators of population density (C1), urbanization rate (C2), and average land fertilizer input (C3); the state indicators of the proportion of secondary industry output value (C4), the proportion of tertiary industry output value (C5), and forest coverage rate (C6); and the response indicators of land reclamation rate (C7), effective irrigation rate (C8), and fiscal expenditure (C9).

**Table 8.** Top three constraint factors of land use conflicts from the ecological perspective in the 12 prefecture-level cities of Hubei (2010–2020).

| **City** | **2010** | | | **2015** | | | **2020** | | |
|---|---|---|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **1** | **2** | **3** | **1** | **2** | **3** |
| Wuhan | average land fertilizer input (C3) 30.749 | effective irrigation rate (C8) 29.151 | population density (C1) 13.669 | effective irrigation rate (C8) 29.686 | average land fertilizer input (C3) 28.769 | land reclamation rate (C7) 12.334 | effective irrigation rate (C8) 31.090 | average land fertilizer input (C3) 29.306 | land reclamation rate (C7) 17.493 |
| Huangshi | average land fertilizer input (C3) 31.592 | population density (C1) 23.354 | effective irrigation rate (C8) 15.360 | average land fertilizer input (C3) 30.104 | population density (C1) 22.428 | effective irrigation rate (C8) 16.410 | average land fertilizer input (C3) 28.264 | population density (C1) 20.683 | effective irrigation rate (C8) 17.501 |
| Shiyan | population density (C1) 33.049 | average land fertilizer input (C3) 28.171 | forest coverage rate (C6) 18.981 | population density (C1) 31.840 | average land fertilizer input (C3) 27.709 | forest coverage rate (C6) 18.454 | population density (C1) 30.745 | average land fertilizer input (C3) 26.856 | forest coverage rate (C6) 18.162 |
| Yichang | population density (C1) 34.642 | forest coverage rate (C6) 19.231 | Urbanization rate (C2) 11.920 | population density (C1) 32.656 | average land fertilizer input (C3) 20.260 | forest coverage rate (C6) 18.724 | population density (C1) 30.023 | average land fertilizer input (C3) 21.188 | forest coverage rate (C6) 17.891 |
| Xiangyang | population density (C1) 28.393 | average land fertilizer input (C3) 20.351 | effective irrigation rate (C8) 14.911 | population density (C1) 26.387 | average land fertilizer input (C3) 19.398 | effective irrigation rate (C8) 16.236 | population density (C1) 24.491 | average land fertilizer input (C3) 19.160 | effective irrigation rate (C8) 16.661 |
| Ezhou | effective irrigation rate (C8) 34.737 | population density (C1) 29.092 | land reclamation rate (C7) 18.244 | effective irrigation rate (C8) 33.355 | population density (C1) 24.213 | land reclamation rate (C7) 16.276 | effective irrigation rate (C8) 31.141 | population density (C1) 19.913 | land reclamation rate (C7) 17.911 |
| Jingmen | population density (C1) 28.777 | effective irrigation rate (C8) 21.845 | average land fertilizer input (C3) 20.687 | population density (C1) 26.549 | effective irrigation rate (C8) 23.406 | average land fertilizer input (C3) 20.954 | effective irrigation rate (C8) 24.350 | population density (C1) 24.272 | average land fertilizer input (C3) 20.593 |
| Xiaogan | effective irrigation rate (C8) 24.911 | average land fertilizer input (C3) 23.637 | population density (C1) 19.010 | effective irrigation rate (C8) 25.628 | average land fertilizer input (C3) 23.589 | population density (C1) 18.828 | effective irrigation rate (C8) 26.040 | average land fertilizer input (C3) 24.113 | population density (C1) 18.137 |

**Table 8.** *Cont.*

| City | 2010 | | | 2015 | | | 2020 | | |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 |
| Jingzhou | effective irrigation rate (C8) 24.636 | average land fertilizer input (C3) 22.947 | population density (C1) 20.896 | effective irrigation rate (C8) 24.991 | average land fertilizer input (C3) 22.957 | population density (C1) 20.794 | effective irrigation rate (C8) 24.997 | average land fertilizer input (C3) 22.948 | population density (C1) 20.215 |
| Huanggang | population density (C1) 25.011 | average land fertilizer input (C3) 18.698 | effective irrigation rate (C8) 17.808 | population density (C1) 22.572 | average land fertilizer input (C3) 19.346 | effective irrigation rate (C8) 18.201 | average land fertilizer input (C3) 20.963 | population density (C1) 20.450 | effective irrigation rate (C8) 18.543 |
| Xianning | population density (C1) 25.834 | average land fertilizer input (C3) 25.433 | effective irrigation rate (C8) 14.097 | average land fertilizer input (C3) 25.259 | population density (C1) 24.937 | effective irrigation rate (C8) 15.173 | average land fertilizer input (C3) 24.711 | population density (C1) 23.667 | effective irrigation rate (C8) 15.775 |
| Suizhou | population density (C1) 24.930 | effective irrigation rate (C8) 23.588 | average land fertilizer input (C3) 18.765 | population density (C1) 23.294 | effective irrigation rate (C8) 22.803 | average land fertilizer input (C3) 19.259 | effective irrigation rate (C8) 22.421 | population density (C1) 21.995 | average land fertilizer input (C3) 19.835 |

Table 8 indicates that there are significant differences in the constraint factors on land use conflicts from the ecological perspective among the 12 prefecture-level cities in Hubei during the study period. For instance, the effective irrigation rate (C8) is a key constraint factor for land use conflicts from an ecological perspective in most cities, playing a significant role in mitigating these conflicts. However, in Yichang, the mitigating effect of the effective irrigation rate does not rank among the top three, whereas the forest coverage rate (C6) consistently ranks among the top three factors throughout the study period. This may be attributed to Yichang's mountainous terrain, which results in a lower effective irrigation rate and thus a weaker mitigating effect on land use conflicts from an ecological perspective. Nevertheless, due to its high forest coverage rate and effective environmental protection measures in the mountainous areas, the forest coverage rate exerts a stronger mitigating effect on land use conflicts in Yichang.

Despite certain variations in the constraint factors of land use conflicts from an ecological perspective across different cities and study periods, overall, population density (C1), average land fertilizer input (C3), and effective irrigation rate (C8) are the primary constraint factors for land use conflicts from an ecological perspective in most cities. Taking Jingzhou as an example, the effective irrigation rate (C8) consistently serves as the key constraint factor for land use conflicts, playing a significant role in mitigating such conflicts. Its contributions to mitigating land use conflicts were 24.636%, 24.991%, and 24.997% in 2010, 2015, and 2020, respectively. This may be because the effective irrigation rate reflects the overall agricultural production conditions in a region and objectively indicates the local state of environmental protection. An increase in the effective irrigation rate generally signifies better ecological conservation, thus playing a crucial role in mitigating land use conflicts from an ecological perspective.

Taking Huanggang and Xianning as examples, the average land fertilizer input (C3) was the second-ranking constraint factor for land use conflicts in Huanggang in 2010 and 2015, and the first-ranking constraint factor in 2020. In Xianning, average land fertilizer input (C3) was the second-ranking constraint factor in 2010, and the first-ranking constraint factor in both 2015 and 2020. This may be attributed to the fact that average land fertilizer input is a key indicator of agricultural ecological land use development, directly influencing the level of land use conflicts from an ecological perspective. Therefore, average land fertilizer input is a major constraint factor for land use conflicts from an ecological perspective.

To further analyze the question, with Suizhou as an example, population density (C1) ranked as the first constraint factor for land use conflicts from an ecological perspective in both 2010 and 2015, while it ranked second in 2020, accounting for 24.930%, 23.294%, and 21.995% of the constraint degree on land use conflicts, respectively. These percentages were higher than those of the subsequent constraint factors by 1.342, 0.491, and 2.160 percentage points, respectively. This may be attributed to the strong relationship between population density and ecological environmental protection. In general, an increase in population density tends to have a certain level of impact on the ecological environment, thus leading to a greater influence of population density on land use conflicts from an ecological perspective, and a higher constraint degree in this regard.

In summary, it is evident that while there are variations in constraint factors on land use conflicts from the ecological perspective among different cities and time periods, the effective irrigation rate (C8), average land fertilizer input (C3), and population density (C1) are the primary constraint factors on land use conflicts from the ecological perspective across the 12 prefecture-level cities in Hubei. Therefore, when formulating targeted policies to mitigate these conflicts, particular attention should be given to the population density, average land fertilizer input, and effective irrigation rate. Measures should be implemented to maintain an appropriate urban population size, reduce land fertilizer inputs, and improve the effective irrigation rate. These actions could effectively mitigate the level of land use conflicts from an ecological perspective in Hubei.

## 4. Discussion

### *4.1. Theoretical Contributions*

First, this study focuses on the 12 prefecture-level cities in Hubei, constructing a land use conflict evaluation system at the macro level based on the production, living, and ecological perspectives in land use conflicts. This approach expands the theoretical framework for analyzing land use conflicts. Unlike previous studies, which primarily adopt a micro-level perspective on land use conflicts, this research does not categorize land into production, living, and ecological land types [14,28], nor does it focus on conflicts between these land types. Instead, based on the theory of land use multifunctionality, this study categorizes land use conflicts at the urban macro level into perspectives of production, living, and ecological conflicts. This analytical framework offers a more effective means of addressing land use conflicts from a policy-oriented perspective at the macro level, facilitating a deeper understanding of urban land use issues and the development of targeted urban policies.

Second, building on the categorization of land use conflicts into production, living, and ecological perspectives, this study further introduces pressure indicators, state indicators, and response indicators for each of these three perspectives of land use conflict. This approach enriches the theoretical framework of the land use conflict evaluation system at the macro level. Although previous studies have applied the pressure–state–response (PSR) model to land use issues [38], few studies have directly integrated this model with the analysis of perspectives of production, living, and ecological land use conflicts.

Third, this study employs a constraint factor diagnosis model to analyze the constraint degrees of various factors on land use conflicts from the production, living, and ecological perspectives in 12 prefecture-level cities of Hubei, thereby enhancing the existing theoretical contents. Previous studies have primarily focused on analyzing the influencing factors of land use conflicts, typically examining isolated factors such as terrain [2], potential benefits of stakeholders [26], and land tenure reforms [34], with a lack of research directly addressing the multiple constraint factors on land use conflicts.

*4.2. Comparisons of Related Studies*

Based on the above research results, the following similarities and differences have been identified compared to existing studies.

First, this study finds that although the levels of land use conflicts vary among the 12 prefecture-level cities in Hubei, their trends of change are highly consistent. Similar conclusions were also drawn by Bao et al. [2] and Zhou [27], who, respectively, studied the urban areas of Beijing and the City of Hangzhou Bay Group. Therefore, unified measures can be adopted to mitigate land use conflicts within these large-scale urban clusters.

Second, the study found that, during the research period, the levels of land use conflicts from production and living perspectives in the 12 prefecture-level cities of Hubei both exhibited an increasing trend, while the level of land use conflict from the ecological perspective decreased. However, a study by Xiao et al. [45], focusing on Qianjiang City, a county-level city under the direct jurisdiction of Hubei Province, found that land use conflict in Qianjiang was rapidly increasing across three land use types. This discrepancy may be partly due to differences in the study subjects. This study is based on macro-level prefecture-level city data, while Xiao et al. [45] conducted their research using fine-scale, micro-level land classification data. Additionally, it may also be attributed to the energy structure in Qianjiang, which is coal-dependent, and its industrial structure, which is oriented towards chemical industries, thereby exerting a certain negative impact on ecological land use.

Third, this study finds that factors such as the average land GDP, population density, effective irrigation rate, urbanization rate, average land real estate development investment, and average land fertilizer input are key constraint factors on land use conflicts in the 12 prefecture-level cities of Hubei. This is consistent with the findings of Ye et al. [51], who conducted land use conflict research at the county level in Hubei and identified similar influencing factors. However, other studies have drawn different conclusions. For instance, Wan et al. [52], based on case studies and qualitative analysis conducted in certain counties of Hubei, argue that policies and legal systems are the primary factors influencing land use conflicts in the region. Other quantitative studies have found that factors such as transportation conditions [53] and climate change [54] are the major influences on land use conflicts at the county and city levels in Hubei, respectively. These discrepancies may be attributed to differences in research methodologies, such as the use of qualitative versus quantitative analysis, as well as variations in the measurement approaches for land use conflict. The differences in spatial scales—with some studies focusing on the city level, while others concentrate on the county level—could also account for the divergent findings. Furthermore, this study primarily analyzes constraint factors, whereas the aforementioned studies focus on influencing factors, which may also contribute to the variation in results.

*4.3. Policy Implications*

Based on the results of this study, the following policy recommendations are proposed:

First, government departments need to further develop relevant policies and legal provisions to mitigate the land use conflict issues in Hubei Province, with a particular emphasis on mitigating the land use conflicts from the production and living perspectives. For instance, it is essential to develop rational land use plans that legally define and regulate the usage boundaries of production and living land use. Additionally, the provincial government and local governments at all levels should establish a more stringent punitive mechanism aimed at addressing violations that harm reasonable production and living land use.

Second, from the perspectives of production, living, and ecology in the context of land use conflicts, cities in Hubei Province need to develop specific reform measures tailored to the primary perspectives of the land use conflicts they face. For instance, Wuhan, in particular, needs to adopt measures to mitigate land use conflicts from both the production and living perspectives. This can be achieved by further developing rational land use plans to curb unreasonable land occupation, while simultaneously protecting agricultural and other productive lands and providing a more comfortable living environment for urban and rural residents, alongside improved public service facilities. In contrast, Ezhou should focus on addressing land use conflicts from an ecological perspective by gradually adjusting its industrial structure, prioritizing the development of emerging industries, and reducing its over-reliance on heavy industry. This strategy will help strengthen the protection of both urban and rural ecological environments and mitigate land use conflicts from the ecological perspective arising from the limited availability of natural resources and the growing demand for construction land.

Third, targeted policies should be formulated based on primary constraint factors. For land use conflict from the production perspective, measures should be implemented to maintain high-quality development in average land GDP, while promoting the construction of new urbanization to mitigate the intensified land use conflicts caused by urban population influx and improving irrigation conditions for agricultural production. Regarding land use conflict from the living perspective, it is important to steadily promote the healthy development of per capita real estate investment. Furthermore, efforts should be made to enhance the reform of the household registration system by relaxing policy restrictions on non-registered population regarding housing purchases and enhance the balance of public services in order to further facilitate the integration of urban and rural areas. For land use conflict from the ecological perspective, measures should encourage rural populations to seek local employment, easing the pressure of land use conflicts from the ecological perspective caused by excessive urban population concentration and prioritizing the implementation of a zero-growth action plan for chemical fertilizers while enhancing effective irrigation rates.

### *4.4. Research Limitations and Future Research Directions*

First, this study analyzed land use conflicts solely using quantitative methods, lacking case study analyses from field visits to the relevant regions. Future research could benefit from engaging with local stakeholders, such as government officials and residents, to combine case studies with quantitative analyses, thereby enhancing the reliability of the findings. Moreover, while the entropy weight method used to construct the evaluation framework for land use conflicts is reasonable, it is still a relatively traditional objective weighting method that overlooks the subjective preferences of stakeholders, such as decision-makers. Future studies could employ a combined weighting method that integrates both subjective and objective approaches, ensuring a more comprehensive and unified assessment.

Second, this study solely utilized data at the prefecture-level city scale to examine the level of land use conflicts, lacking research at the fine-scale land use conflict level. Research at the fine scale would facilitate a more accurate identification and assessment of land use conflicts, while also better capturing the legitimate interests and demands of stakeholders involved in land use processes. Future research could further explore land use conflicts at the fine-scale level, thereby providing a deeper understanding of the economic, social, and ecological contexts in which these conflicts occur and offering more scientifically informed and effective governance strategies for achieving regional sustainable development.

## 5. Conclusions

This study focuses on 12 prefecture-level cities in Hubei Province and assesses the levels of land use conflicts in the study area from 2010 to 2020 by integrating perspectives of land use conflicts from production, living, and ecological perspectives with the pressure–state–response model. Building upon the analysis of spatiotemporal evolution, this study further introduces a constraint factor diagnosis model to investigate the primary constraint factors of land use conflicts in Hubei, thereby providing guidance for efficient land use planning in the province. The following research conclusions are drawn:

(1) Between 2010 and 2020, the levels of land use conflicts from the production and living perspectives generally increased across cities in Hubei, while the levels of land use conflicts from the ecological perspective decreased in most cities. This may be attributed to the rapid economic development in Hubei's cities during the study period, which led to increased pressure on production demand and rising living costs, thereby exacerbating land use conflicts from the production and living perspectives. Concurrently, municipal governments effectively implemented environmental protection policies, which mitigated the level of land use conflicts from the ecological perspective.

(2) At the city level, the intensity of land use conflicts from the production and living perspectives in Wuhan is significantly higher compared to other cities, while Ezhou exhibits a markedly higher intensity of land use conflicts from the ecological perspective. This disparity may be attributed to Wuhan's substantial siphoning effect within Hubei and the central region of China, which attracts a large influx of production sectors and population, thereby exacerbating its land use conflicts from the production and living perspectives. Ezhou, due to its proximity to Wuhan, smaller population, and limited area, has developed its economy with steel and pellet plants as key pillars, resulting in a higher level of land use conflicts from the ecological perspective.

(3) In terms of constraint factors, although there are certain variations across different cities and time periods, overall, the top three constraint factors on land use conflicts from the production perspective are population density, average land GDP, and effective irrigation rate. For land use conflicts from the living perspective, the top three constraint factors are population density, urbanization rate, and average land real estate development investment. Regarding land use conflicts from the ecological perspective, the top three constraint factors are population density, average land fertilizer input, and effective irrigation rate.

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## References

1. Han, B.; Jin, X.; Zhao, Q.; Chen, H. Spatiotemporal Patterns and Mechanisms of Land-Use Conflicts Affecting High-Quality Development in China. *Appl. Geogr.* **2023**, *155*, 102972. [CrossRef]
2. Bao, W.; Yang, Y.; Zou, L. How to Reconcile Land Use Conflicts in Mega Urban Agglomeration? A Scenario-Based Study in the Beijing-Tianjin-Hebei Region, China. *J. Environ. Manag.* **2021**, *296*, 113168. [CrossRef] [PubMed]
3. Li, J.; Bai, Y.; Alatalo, J.M. Impacts of Rural Tourism-Driven Land Use Change on Ecosystems Services Provision in Erhai Lake Basin, China. *Ecosyst. Serv.* **2020**, *42*, 101081. [CrossRef]
4. Xu, D.; Deng, X.; Guo, S.; Liu, S. Labor Migration and Farmland Abandonment in Rural China: Empirical Results and Policy Implications. *J. Environ. Manag.* **2019**, *232*, 738–750. [CrossRef]
5. Jiang, S.; Meng, J.; Zhu, L.; Cheng, H. Spatial-Temporal Pattern of Land Use Conflict in China and Its Multilevel Driving Mechanisms. *Sci. Total Environ.* **2021**, *801*, 149697. [CrossRef]
6. Cui, X.; Deng, W.; Yang, J.; Huang, W.; de Vries, W.T. Construction and Optimization of Ecological Security Patterns Based on Social Equity Perspective: A Case Study in Wuhan, China. *Ecol. Indic.* **2022**, *136*, 108714. [CrossRef]
7. Ahmad, Y.; Zahra, R.; Ali, C. Transformations in Urban Gardens: Neoliberal Influences and Land Use Conflicts in Shiraz's Qasr al-Dasht Gardens. *Land Use Policy* **2024**, *146*, 107311. [CrossRef]
8. Karimi, A.; Hockings, M. A Social-Ecological Approach to Land-Use Conflict to Inform Regional and Conservation Planning and Management. *Landsc. Ecol.* **2018**, *33*, 691–710. [CrossRef]
9. Dong, G.; Ge, Y.; Jia, H.; Sun, C.; Pan, S. Land Use Multi-Suitability, Land Resource Scarcity and Diversity of Human Needs: A New Framework for Land Use Conflict Identification. *Land* **2021**, *10*, 1003. [CrossRef]

10. Cui, X.; Huang, L. Integrating Ecosystem Services and Ecological Risks for Urban Ecological Zoning: A Case Study of Wuhan City, China. *Hum. Ecol. Risk Assess. Int. J.* **2023**, *29*, 1299–1317. [CrossRef]
11. Peng, H.; Zhang, X.; Ren, W.; He, J. Spatial Pattern and Driving Factors of Cropland Ecosystem Services in a Major Grain-Producing Region: A Production-Living-Ecology Perspective. *Ecol. Indic.* **2023**, *155*, 111024. [CrossRef]
12. Chen, H.; Yang, Q.; Su, K.; Zhang, H.; Lu, D.; Xiang, H.; Zhou, L. Identification and Optimization of Production-Living-Ecological Space in an Ecological Foundation Area in the Upper Reaches of the Yangtze River: A Case Study of Jiangjin District of Chongqing, China. *Land* **2021**, *10*, 863. [CrossRef]
13. Deng, Y.; Yang, R. Influence Mechanism of Production-Living-Ecological Space Changes in the Urbanization Process of Guangdong Province, China. *Land* **2021**, *10*, 1357. [CrossRef]
14. Zou, L.; Liu, Y.; Wang, J.; Yang, Y. An Analysis of Land Use Conflict Potentials Based on Ecological-Production-Living Function in the Southeast Coastal Area of China. *Ecol. Indic.* **2021**, *122*, 107297. [CrossRef]
15. Stepanova, O.; Polk, M.; Saldert, H. Understanding Mechanisms of Conflict Resolution beyond Collaboration: An Interdisciplinary Typology of Knowledge Types and Their Integration in Practice. *Sustain. Sci.* **2020**, *15*, 263–279. [CrossRef]
16. Lu, X.; Ke, S. Evaluating the Effectiveness of Sustainable Urban Land Use in China from the Perspective of Sustainable Urbanization. *Habitat Int.* **2018**, *77*, 90–98. [CrossRef]
17. Milczarek-Andrzejewska, D.; Zawalińska, K.; Czarnecki, A. Land-Use Conflicts and the Common Agricultural Policy: Evidence from Poland. *Land Use Policy* **2018**, *73*, 423–433. [CrossRef]
18. Chen, L.; Cai, H. Study on Land Use Conflict Identification and Territorial Spatial Zoning Control in Rao River Basin, Jiangxi Province, China. *Ecol. Indic.* **2022**, *145*, 109594. [CrossRef]
19. Bekele, A.E.; Drabik, D.; Dries, L.; Heijman, W. Large-Scale Land Investments and Land-Use Conflicts in the Agro-Pastoral Areas of Ethiopia. *Land Use Policy* **2022**, *119*, 106166. [CrossRef]
20. Adhami, M.; Sadeghi, S.H.; Sheikhmohammady, M. Making Competent Land Use Policy Using a Co-Management Framework. *Land Use Policy* **2018**, *72*, 171–180. [CrossRef]
21. Dietz, K.; Engels, B. Analysing Land Conflicts in Times of Global Crises. *Geoforum* **2020**, *111*, 208–217. [CrossRef]
22. Ma, W.; Jiang, G.; Chen, Y.; Qu, Y.; Zhou, T.; Li, W. How Feasible Is Regional Integration for Reconciling Land Use Conflicts across the Urban–Rural Interface? Evidence from Beijing–Tianjin–Hebei Metropolitan Region in China. *Land Use Policy* **2020**, *92*, 104433. [CrossRef]
23. You, H.; Zhang, J.; Song, Y. Assessing Conflict of Farmland Institutions Using Credibility Theory: Implications for Socially Acceptable Land Use. *Land Use Policy* **2022**, *112*, 105817. [CrossRef]
24. Aghmashhadi, A.H.; Zahedi, S.; Kazemi, A.; Fürst, C.; Cirella, G.T. Conflict Analysis of Physical Industrial Land Development Policy Using Game Theory and Graph Model for Conflict Resolution in Markazi Province. *Land* **2022**, *11*, 501. [CrossRef]
25. Sinthumule, N.I.; Ratshivhadelo, T.; Nelwamondo, T. Stakeholder Perspectives on Land-Use Conflicts in the South African Section of the Greater Mapungubwe Transfrontier Conservation Area. *J. Land Use Sci.* **2020**, *15*, 11–24. [CrossRef]
26. Elomina, J.; Živojinović, I. Systematic Literature Review of Land Use Conflicts in Northern Sweden—Lessons Learned and Ways Forward. *Resources* **2024**, *13*, 77. [CrossRef]
27. Zhou, D.; Lin, Z.; Lim, S.H. Spatial Characteristics and Risk Factor Identification for Land Use Spatial Conflicts in a Rapid Urbanization Region in China. *Environ. Monit. Assess.* **2019**, *191*, 677. [CrossRef]
28. Cui, J.; Kong, X.; Chen, J.; Sun, J.; Zhu, Y. Spatially Explicit Evaluation and Driving Factor Identification of Land Use Conflict in Yangtze River Economic Belt. *Land* **2021**, *10*, 43. [CrossRef]
29. Dong, G.; Liu, Z.; Niu, Y.; Jiang, W. Identification of Land Use Conflicts in Shandong Province from an Ecological Security Perspective. *Land* **2022**, *11*, 2196. [CrossRef]
30. Zuo, Q.; Zhou, Y.; Wang, L.; Li, Q.; Liu, J. Impacts of Future Land Use Changes on Land Use Conflicts Based on Multiple Scenarios in the Central Mountain Region, China. *Ecol. Indic.* **2022**, *137*, 108743. [CrossRef]
31. Cieślak, I. Identification of Areas Exposed to Land Use Conflict with the Use of Multiple-Criteria Decision-Making Methods. *Land Use Policy* **2019**, *89*, 104225. [CrossRef]
32. Wang, J.; Qu, L.; Li, Y.; Feng, W. Identifying the Structure of Rural Regional System and Implications for Rural Revitalization: A Case Study of Yanchi County in Northern China. *Land Use Policy* **2023**, *124*, 106436. [CrossRef]
33. Hjalager, A.-M. Land-Use Conflicts in Coastal Tourism and the Quest for Governance Innovations. *Land Use Policy* **2020**, *94*, 104566. [CrossRef]
34. Kalabamu, F.T. Land Tenure Reforms and Persistence of Land Conflicts in Sub-Saharan Africa—The Case of Botswana. *Land Use Policy* **2019**, *81*, 337–345. [CrossRef]
35. Cruz-Daraviña, P.A.; Bocarejo Suescún, J.P. Freight Operations in City Centers: A Land Use Conflict in Urban Planning. *Land Use Policy* **2021**, *108*, 105575. [CrossRef]
36. Živojinović, I.; Elomina, J.; Pülzl, H.; Calanasan, K.; Dabić, I.; Ólafsdóttir, R.; Siikavuopio, S.; Iversen, A.; Robertsen, R.; Bjerke, J.; et al. Exploring Land Use Conflicts Arising from Economic Activities and Their Impacts on Local Communities in the European Arctic. *J. Land Use Sci.* **2024**, *19*, 186–210. [CrossRef]
37. Yang, Y.; Bao, W.; Liu, Y. Coupling Coordination Analysis of Rural Production-Living-Ecological Space in the Beijing-Tianjin-Hebei Region. *Ecol. Indic.* **2020**, *117*, 106512. [CrossRef]

38. Wang, D.; Li, Y.; Yang, X.; Zhang, Z.; Gao, S.; Zhou, Q.; Zhuo, Y.; Wen, X.; Guo, Z. Evaluating Urban Ecological Civilization and Its Obstacle Factors Based on Integrated Model of PSR-EVW-TOPSIS: A Case Study of 13 Cities in Jiangsu Province, China. *Ecol. Indic.* **2021**, *133*, 108431. [CrossRef]
39. Lin, G.; Fu, J.; Jiang, D. Production–Living–Ecological Conflict Identification Using a Multiscale Integration Model Based on Spatial Suitability Analysis and Sustainable Development Evaluation: A Case Study of Ningbo, China. *Land* **2021**, *10*, 383. [CrossRef]
40. Chen, Z.; Tang, C.; Liu, B.; Liu, P.; Zhang, X. Can Socialized Services Reduce Agricultural Carbon Emissions in the Context of Appropriate Scale Land Management? *Front. Environ. Sci.* **2022**, *10*, 1039760. [CrossRef]
41. Xue, Z.; Zhen, L.; Miah, M.G.; Shoyama, K. Impact Assessment of Land Use Functions on the Sustainable Regional Development of Representative Asian Countries—A Comparative Study in Bangladesh, China and Japan. *Sci. Total Environ.* **2019**, *694*, 133689. [CrossRef] [PubMed]
42. Liang, T.; Du, P.; Yang, F.; Su, Y.; Luo, Y.; Wu, Y.; Wen, C. Potential Land-Use Conflicts in the Urban Center of Chongqing Based on the "Production–Living–Ecological Space" Perspective. *Land* **2022**, *11*, 1415. [CrossRef]
43. Zong, S.; Hu, Y.; Bai, Y.; Guo, Z.; Wang, J. Analysis of the Distribution Characteristics and Driving Factors of Land Use Conflict Potentials in the Bohai Rim Coastal Zone. *Ocean Coast. Manag.* **2022**, *226*, 106260. [CrossRef]
44. Zhao, Y.W.; Zhou, L.Q.; Dong, B.Q.; Dai, C. Health Assessment for Urban Rivers Based on the Pressure, State and Response Framework—A Case Study of the Shiwuli River. *Ecol. Indic.* **2019**, *99*, 324–331. [CrossRef]
45. Xiao, P.; Xu, J.; Zhao, C. Conflict Identification and Zoning Optimization of "Production-Living-Ecological" Space. *Int. J. Environ. Res. Public Health* **2022**, *19*, 7990. [CrossRef]
46. Xi, F.; Wang, R.; Shi, J.; Zhang, J.; Yu, Y.; Wang, N.; Wang, Z. Spatio-Temporal Pattern and Conflict Identification of Production–Living–Ecological Space in the Yellow River Basin. *Land* **2022**, *11*, 744. [CrossRef]
47. Zhang, Y.; Long, H.; Tu, S.; Ge, D.; Ma, L.; Wang, L. Spatial Identification of Land Use Functions and Their Tradeoffs/Synergies in China: Implications for Sustainable Land Management. *Ecol. Indic.* **2019**, *107*, 105550. [CrossRef]
48. Chen, Y.; Zhu, M.; Lu, J.; Zhou, Q.; Ma, W. Evaluation of Ecological City and Analysis of Obstacle Factors under the Background of High-Quality Development: Taking Cities in the Yellow River Basin as Examples. *Ecol. Indic.* **2020**, *118*, 106771. [CrossRef]
49. Yu, Z.; Xu, E.; Zhang, H.; Shang, E. Spatio-Temporal Coordination and Conflict of Production-Living-Ecology Land Functions in the Beijing-Tianjin-Hebei Region, China. *Land* **2020**, *9*, 170. [CrossRef]
50. Yang, S.; Song, S.; Li, F.; Yu, G.; He, G.; Cui, H.; Wang, R.; Sun, B.; Du, D.; Chen, G.; et al. Evaluating Farmland Ecosystem Resilience and Its Obstacle Factors in Ethiopia. *Ecol. Indic.* **2023**, *146*, 109900. [CrossRef]
51. Ye, Q.Q.; Wei, R.; Zhang, P.P. A Conflict Identification Method of Urban, Agricultural and Ecological Spaces Based on the Space Conversion Matrix. *Sustainability* **2018**, *10*, 3502. [CrossRef]
52. Wan, J.L.; Liu, Y.F.; Zhang, X.L. Conflict in informal rural construction land transfer practices in China: A case of Hubei. *Land Use Policy* **2021**, *109*, 105573.
53. Zhou, H.; Chen, Y.; Tian, R.Y. Land-Use Conflict Identification from the Perspective of Construction Space Expansion: An Evaluation Method Based on 'Likelihood-Exposure-Consequence'. *ISPRS Int. J. Geo-Inf.* **2021**, *10*, 433. [CrossRef]
54. He, N.; Zhou, Y.; Wang, L.; Li, Q.; Zuo, Q.; Liu, J.Y. Spatiotemporal differentiation and the coupling analysis of ecosystem service value with land use change in Hubei Province, China. *Ecol. Indic.* **2022**, *145*, 109693. [CrossRef]