International Journal of New Developments in Engineering and Society
ISSN 2522-3488 Vol. 7, Issue 8: 47-53, DOI: 10.25236/IJNDES.2023.070808

Research on Low Efficiency Land Use Identification Method in Baiyun District, Guangzhou City Based on Multisource Data

Haoran Gui[1,2], Jing Chen[1,*], Fan Yu[2]

[1]*Guangdong University of Technology, Guangzhou, Guangdong, 510006, China*
[2]*Beijing University of Civil Engineering and Architecture, Beijing, China*
[*]*Corresponding author*

Abstract: *In the context of rapid urban development, the development of construction land has become the main form of urban land use. While urban space is being developed, the unreasonable use of construction land has generated a large amount of inefficient land, which poses obstacles to the future development of the city. The relevant staff should construct a locally adapted urban inefficient land identification and evaluation index system, and use multisource data to conduct spatial overlay analysis on construction land. The results show that the city where the research area is located is in the late stage of urbanization, with an urbanization level above 70% and a relatively slow urbanization speed. However, the economic development level is on the rise, and inefficient land is mainly distributed in the central, western, and northern regions of the research area.*

Keywords: *Multi-source Data, Spatial Analysis, Evaluation Index System, Identification of Inefficient Land Use*

1. Introduction

Against the backdrop of socio-economic development, the expansion of urban construction land has led to a clear trend of urban spatial extension, which has also become one of the important ways of land use during this period. Although the level of development and performance varies among countries and regions, the trend and occurrence time of urban sprawl are basically consistent under the influence of economic globalization. Since the 1950s (1950-1980), the trend of urban expansion in the Western world has been evident. The development of the automotive industry has brought the time distance within cities closer, which has expanded the range of options for consumers to purchase houses and properties, while also driving the spread of urban boundaries towards suburban villages. In China, the stage of urban expansion corresponds to the period of reform and opening up in the Western world (1978-2008). The level of urbanization in China increased from 17.91% to 45.67% at an average annual growth rate of 1.048%. The overall level of national economic development, production conditions, and people's quality of life have been improved to some extent. Among them, the urbanization level in the southeast coastal areas is higher than that in inland areas, and the speed of urbanization has certain advantages. The scope of urban space utilization is larger, in the absence of organized planning and corresponding policy restrictions at that time, the expansion of the edges of large cities showed a trend of blind spread, and the situation was relatively serious. The rapid advancement of urbanization has led to the rapid expansion of construction land and the emergence of a large number of inefficient lands [1, 2].

At present, there are still some shortcomings in research: inefficient urban land has regional and multifunctional characteristics, and the identification of inefficient urban land varies between urban and rural areas, economically developed and underdeveloped areas due to differences in natural geographical environment, social conditions, economic conditions, and other factors. Secondly, the differences in land use functions among different land use types result in typical characteristics of land use attributes, and therefore the factors that affect the formation of inefficient urban land use are also different. Zheng Rongbao (2014) used a combination of remote sensing images and field survey analysis methods to extract inefficient land use recognition research; Mao Yulong (2018) used object-oriented classification to extract inefficient land use information in Jinjiang City. However, in the analysis and discrimination of inefficient land use using big data and multisource remote sensing data, the research on the former has not yet formed a complete knowledge system. In addition, these

ISSN 2522-3488 Vol. 7, Issue 8: 47-53, DOI: 10.25236/IJNDES.2023.070808

studies are mainly based on clustering methods of remote sensing images, and further improvement is needed for pattern recognition and analysis based on socio-economic data. As a fundamental work, the identification of urban inefficient land directly affects the overall effectiveness of urban inefficient land redevelopment. However, throughout existing research on how to construct urban inefficient land identification based on local conditions and types, there has not yet been a systematic theoretical explanation, and in practice, the phenomenon of "one size -fits-all" is also prone to occur. Studying the issue of urban inefficient land redevelopment is not only conducive to the smooth implementation of urban inefficient land redevelopment work, but also plays a promoting role in the construction of new rural areas and the realization of a comprehensive well-of society. For the current practice of inefficient land use in underdeveloped, cities and towns, the evaluation criteria are mainly based on the "Guiding Opinions on Deepening the Redevelopment of Low Utility Land in Cities and Towns (Trial)" (hereinafter referred to as "Guiding Opinions") issued by the former Ministry of Land and Resources in 2016. However, through on-site research, it has been found that the industrial and commercial industries in underdeveloped areas are mainly low-end industries, with small scale and low output, poor agglomeration, and severe environmental pollution, residential land showing scattered layout and extensive utilization, and blindly applying "Guiding Opinions" cannot effectively identify inefficient urban land use in underdeveloped areas [3].

In view of this, this article introduces the combination of remote sensing and multisource data into the micro research of urban inefficient land use and constructs an indicator system for the identification and evaluation of urban inefficient land use. This study aims to use Baiyun District, Guangzhou City, as an application area for the identification method of inefficient land use, to verify the feasibility and stability of the identification scheme, and to analyze the identification results, to address the issue of remote sensing data being unable to obtain socio-economic attributes during inefficient land feature extraction, we combine remote sensing data with open data and use spatial analysis methods to obtain socio-economic attributes of land features. This addresses the shortcomings of remote sensing data in feature extraction and solves the problem of remote sensing data being unable to obtain socio-economic attributes, providing scientific decision-making support for land management departments [4, 5].

2. Data and the Research Area

2.1. Overview of the Research Area

Guangzhou is a national comprehensive gateway city, a famous historical and cultural city, and one of China's major foreign trade ports. Guangzhou is located in the central southern part of Guangdong Province and the northern part of the Pearl River Delta. It is the confluence of the Xijiang, Beijiang, and Dongjiang rivers and is bordered by the South China Sea. The longitude and latitude range from 112.57 ° E to 114.3 ° E, and from 22.26 ° N to 23.56 ° N; The city center is located at 23.06 ° N and 113.15 ° E. The location and administrative divisions of Guangzhou in China are shown in the following figure. This study will use Baiyun District, Guangzhou City, as an example for identifying inefficient land use and verifying its accuracy [6].

2.2. Data Sources

(1) Remote sensing data

This article uses remote sensing image data from the sky map on December 7, 2022. Tiantu "is a comprehensive geographic information service website built by the National Bureau of Surveying and Mapping Geographic Information. Integrating geographic information public service resources from surveying and mapping departments at all levels of the country, province, cities (counties), as well as relevant government departments, enterprises and institutions, social organizations, and the public, providing authoritative, standardized, and unified online geographic information comprehensive services to various users. This study selected high-resolution image data with a spatial resolution of 0.6m [7].

(2) Multiple source data

The multisource data of this study is mainly used to extract the socio-economic attribute information of the construction land object based on the object. The open data used mainly includes POI data, population density data, GDP data, and OSM data. Among them, the data type of POI (Point of Interest) is vector points, mainly used to reflect the distribution of regional socio-economic service

ISSN 2522-3488 Vol. 7, Issue 8: 47-53, DOI: 10.25236/IJNDES.2023.070808

points. Based on this, kernel density analysis and interpolation analysis can be carried out to further obtain surface socio-economic attribute information; OSM (Open Street Map) data is open-source map data that contains rich road traffic information, used for network analysis and processing of road network data. The road traffic data type is a vector line, including road type, vehicle speed, road name, and other information, used for extracting time cost calculation and analysis of construction land [8].

3. Research Methods

3.1. Extraction of Built-up Areas

This article uses SVM method to achieve the classification of built-up areas in remote sensing images. The principle of SVM method is to establish an optimal decision hyperplane, which maximizes the distance between the two classes of samples closest to the plane on both sides of the plane, thereby providing good generalization ability for classification problems. This method does not require a large number of samples, has low structural risk, low noise, and high classification accuracy, making it one of the most widely used classification methods at present. The principle of sample selection is to fully consider the spectra, structure, texture, and distribution patterns of different types of land objects, and to distribute them evenly. This sample selection mainly divides the types of land objects in urban built-up areas into two types: construction land and non construction land. Construction land is mainly located in the central area of the city, with dense internal distribution and blocks composed of various color covers, as well as the urban edge, low density built-up areas with relatively scattered distribution and high-density built-up areas in urban centers and built-up areas, as well as bare land with low utilization and undeveloped land; Non construction land refers to widely distributed forest land, urban fringe areas, concentrated cultivated land, as well as widely distributed rivers and irregularly shaped reservoirs. This classification sample selects 300 sample points for construction land and 300 sample points for construction land. Select 200 sample points for construction land and 200 sample points for construction land for validation samples. The extraction result uses Kappa coefficient (a method used to measure classification accuracy), and the Kappa coefficient for this accuracy evaluation is 0.8140. Mask processing was performed in ArcGIS to obtain the classification of construction land, as shown in the following Figure 1:

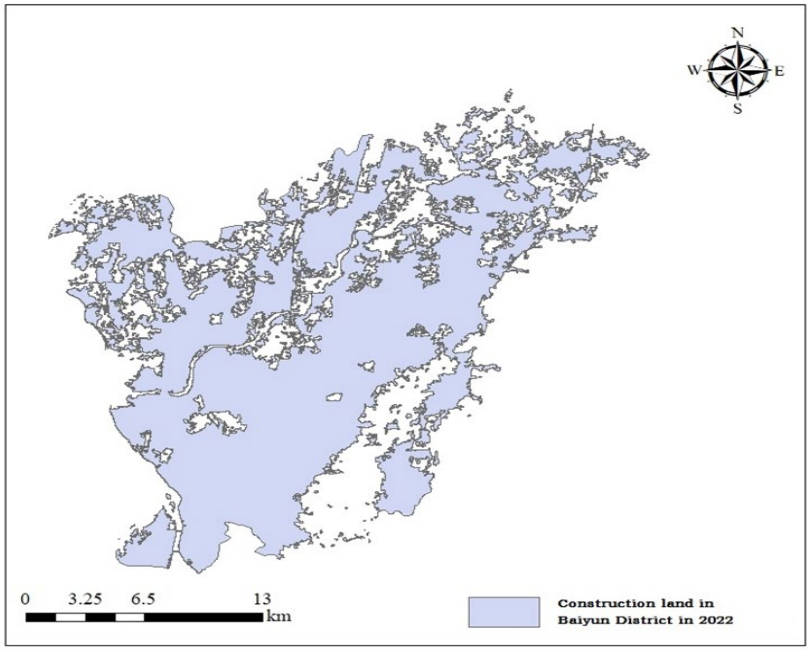

Figure 1: Classification of Construction Land in Baiyun District

3.2. GIS Spatial Overlay Analysis

The managers will select six main socioeconomic types from multiple sources of data, and cut the POI points of catering services, public facilities, living services, commercial residences, sports and leisure services, technology and cultural services, shopping services, and healthcare services in

ISSN 2522-3488 Vol. 7, Issue 8: 47-53, DOI: 10.25236/IJNDES.2023.070808

Guangzhou separately. Finally, the multi-source data was combined at the POI points in each section of Baiyun District, and a buffer zone analysis was performed with a distance radius of 150 m from the merged POI points to obtain a schematic picture of the POI buffer. By analyzing the buffer zone, the changes in urban construction land can be accurately calculated, thereby determining the distribution of inefficient land. It can easily find the "buffer zone" of inefficient urban land and provide a basis for decision-making by urban planning and management departments. On this basis, a new buffer analysis method is proposed, which has the following advantages: firstly, it utilizes the core density method for buffer analysis; secondly, this method is based on the natural refractive index; finally, it not only considers the influence of spatial structure, but also considers time factors. However, it is very sensitive to manual intervention. It is more suitable for the analysis of continuous data.

The population density map of Baiyun District uses a value of 176 people per hectare as the boundary point. Below this boundary point, it is determined as a low population density area. The low population density and construction land are overlaid and analyzed to obtain the construction land with low population density, as shown in figure 2:

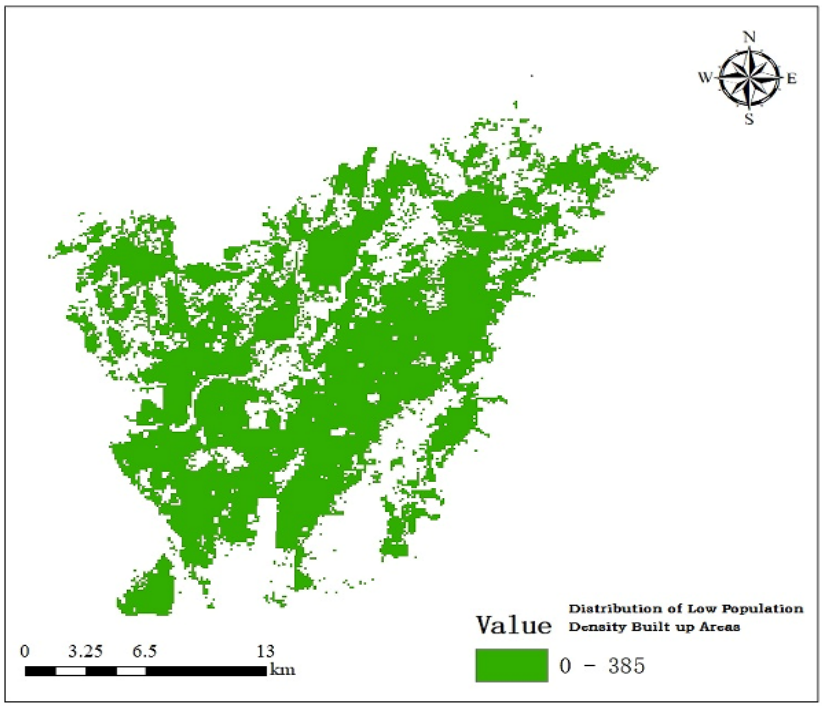

Figure 2: Distribution of Low Population Density Built up Areas in Baiyun District

3.3. Evaluation System Indicators and Weights

The evaluation index system for the efficiency level of construction land use incorporates independently analyzed indicators into the same system for comprehensive evaluation, and calculates the land use efficiency level of each construction land is shown in Table 1.

This article uses the Analytic Hierarchy Process to determine the weight of meso-analysis and combines expert opinions to obtain the indicator judgment

The broken matrix is shown in Table 2.

Table 1: Index System of Construction Land Use Efficiency Level

	Indicator	Index attribute
The efficiency level of construction land use	Positive comprehensive plot ratio	Positive
	Positive population density	Positive
	Positive infrastructure completeness	Positive
	The building density	Positive
	GDP	Positive
	Slope	Negative

ISSN 2522-3488 Vol. 7, Issue 8: 47-53, DOI: 10.25236/IJNDES.2023.070808

Table 2: Indicator Analysis and Judgment Matrix

Judgment matrix							
	Q1	Q2	Q3	Q4	Q5	Q6	W
Q1	1	2	3	4	5	6	0.38
Q2	0.5	1	2	3	4	5	0.25
Q3	0.2	0.5	1	2	2	3	0.15
Q4	0.2	0.3333	0.5	1	2	3	0.05
Q5	0.16	0.25	0.5	0.5	1	2	0.07
Q6	0.3	0.2	0.3333	0.333	0.5	1	0.10

After calculation, the weights of comprehensive plot ratio, population density, infrastructure completeness, building density, GDP, and slope on the land use level of residential land functional areas are 0.38, 0.25, 0.15, 0.05, 0.07, and 0.10, respectively.

Each indicator shows varying degrees of regional differences. In terms of comprehensive plot ratio and building density, the overall land use level of old residential areas is relatively high, but there are also some cases where the above ground construction indicators exceed the ideal or planned values. The population density and basic completeness are more prominent in the differences between the center and edge of the urban area. The old urban area has sound infrastructure, reflecting strong population adsorption capacity. However, in the residential areas around the urban area, there are many newly developed residential areas, with relatively poor transportation convenience, incomplete supporting facilities such as water supply, power supply, gas supply, and communication, and low concentration of residential population. Uneven population distribution also leads to differences in regional living conditions. New residential areas have a large building area and a small population, with some residential areas having a large per capita building area and a certain degree of idle space. However, some old residential areas exhibit a situation of low per capita building area and small living space. The level of land price realization shows the differences in economic benefits in urban areas. The location advantage of the old urban area is obvious, and the overall level of land price realization is relatively high. Based on the specific situation of each indicator, although the residential areas in the central area of the urban area are more fully and intensively reflected in the comprehensive results of the indicators, the analysis of their plot ratio, building density, and per capita building area indicators shows that some old urban areas have problems of construction exceeding the plan, building density being too dense, and population being too concentrated. However, there are significant differences in the new urban areas, and the degree and efficiency of residential land use still need to be further improved [9].

By judging the results of the matrix, combining the results of Figure 2 and the buffer zone of POI points, a weighted overlay analysis is conducted in ArcGIS to obtain inefficient land use. The degree of inefficient land use is divided into three levels: heavy, medium, and mild [10].

4. Identification Results and Analysis

The urban population structure reflects the distribution and proportion of different urban areas, serving as an indicator of regional economic development. In the formula: U is the urban population, P is the total population, and PU is the urbanization rate:

$$PU=U/P \tag{1}$$

As shown in Figure 3, severe and inefficient land use is mainly concentrated in the northern part of Baiyun District, while moderate and inefficient land use is distributed in the western part of Baiyun District. According to the visual discrimination from remote sensing satellite images, the development of the central and southern parts of towns in Baiyun District is relatively complete compared to other regions, and it is more in line with the distribution of mild and inefficient land use in this study.

The city where the study area is located is located in the the Pearl River Delta urban agglomeration, which is an advanced stage of development. Its role in economic development is quite significant, mainly connotative development, and the development is mainly manifested in qualitative improvement. From the perspective of the development of urbanization process, the city where the study area is located is in the late stage of urbanization. The urbanization level is higher than 70%, and the urbanization speed is relatively slow, but the economic development level is on the rise, therefore, the technological level of urban land use is constantly improving, and in such a situation, the original land use level will not be able to meet the standards after technological innovation, which is the main

ISSN 2522-3488 Vol. 7, Issue 8: 47-53, DOI: 10.25236/IJNDES.2023.070808

reason for the formation of inefficient land use. Regarding the inefficient land use situation in the research area, the suggestions summarized in this study are as follows:

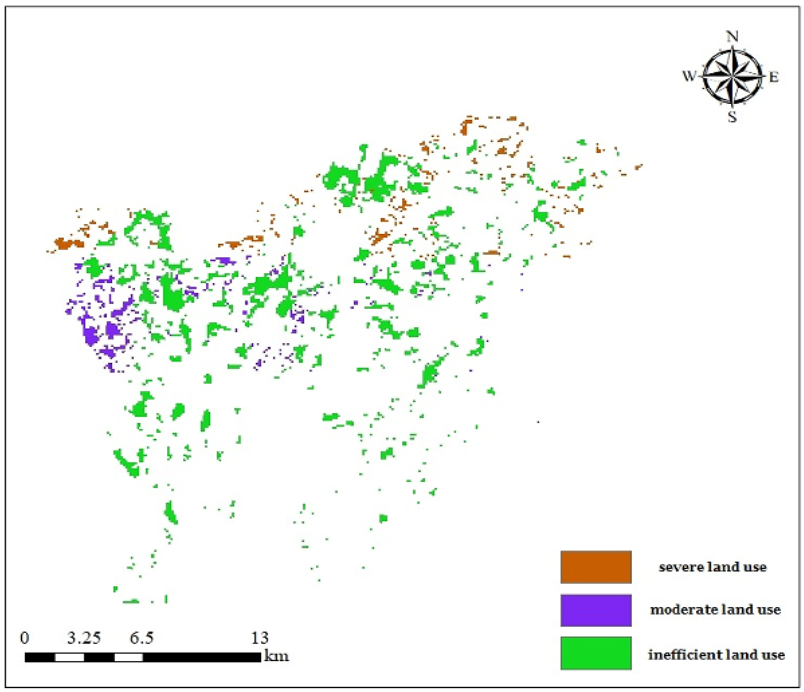

Figure 3: Distribution of Inefficient Land in Baiyun District, Guangzhou City, 2022

Overall renovation. When the buildings on inefficient land are in disrepair for a long time and cannot perform their original functions, they need to be demolished as a whole. Based on the functional rating results, the land nature should be changed and re-planned and constructed according to new requirements. Involving dual changes in purpose and structure functional replacement. For buildings that have good quality, appearance, and use value but do not meet the requirements for urban functional enhancement, the overall image can be improved through redecoration to create new functions that conform to regional positioning. The land use can be determined according to its functional change requirements and can be changed or unchanged. The overall framework of the building remains unchanged, and the internal and external forms mostly change significantly renovation and upgrading. In order to adapt to the requirements of new functional upgrades, significant renovations have been made to the buildings, and the possibility of output reconstruction is not ruled out, but the land use remains unchanged repair and maintenance. While maintaining the same land use and architectural form and structures, carrying out renovation and maintenance is mainly applicable to the protection of ancient scenic spots and buildings, with a focus on configuring infrastructure and improving the environment.

5. Conclusions and Discussion

This article studies from the perspective of promoting high-quality urban development in the country, focusing on social and demographic attributes, applying multisource data to identify inefficient construction land in Baiyun District, supplementing dynamic feature evaluation, which can accurately grasp the urban renewal needs more comprehensively, and improve the accuracy and reliability of identifying and evaluating new areas. Simultaneously combining population data, economic data, and social data, we construct an evaluation of the development potential of inefficient land use. Combining urban policy guidance, planning requirements, and technical standards, it has strong operability. This method is applicable to the identification of urban renewal areas at the medium to macro level, mainly targeting three types of land use: industrial, residential, and commercial. Specific evaluation indicators are also mainly constructed for these three functions. Therefore, for the update and evaluation of specific functional units with three main functions at the meso macro scale, reference and identification can be made.

There are certain shortcomings and limitations in this study. For example, in the selection of evaluation indicators for the development potential level of construction land, although this article

ISSN 2522-3488 Vol. 7, Issue 8: 47-53, DOI: 10.25236/IJNDES.2023.070808

refers to the existing relevant research and selects 6 indicators from four aspects of economic function and social life to construct an evaluation system, due to the multidimensional and complex nature of urban functions, their functions in the region and within are far more than that. The evaluation of each sub function only selected some representative indicators as much as possible, and the evaluation results have certain limitations; In future research of this kind, further refinement of urban sub functions and improvement and expansion of the evaluation index system can be carried out. For some projects, which specific function within the unit needs to be identified, the applicability of the technical methods studied in this study still needs further research.

At present, research on the identification, development, and utilization of inefficient urban land in China is still in its infancy. The judgment system and evaluation system for inefficient land use, as well as the planning and construction of urban land use, are still in the exploratory stage. How to effectively and quickly promote research and development in this area still requires a lot of practical work.

Acknowledgements

This work is jointly supported by General Project of Humanities and Social Science Research of the Ministry of Education (20YJAZH008, Research on the Mechanism of Accurate Identification and Launch of Rural Idle Homesteads Based on the Synergistic Utilization of High Score and Luminous Remote Sensing Data) and R&D Program of Beijing Municipal Education Commission (KM202010016010, Research on the quality detection method of ground cover classification based on deep confidence neural network).

References

[1] Cao Kaiyu. A Study on the Path of Redevelopment of Inefficient Urban Land under the Background of New Urbanization. Northwestern University, 2016
[2] Huang Xiaodi. Research on the Evaluation of Intensive Utilization of Construction Land in Jinjiang City under the Background of New Urbanization. Fujian Normal University, 2016
[3] Jiang Liwu, Zhao Xiaomin. Evaluation of Land Intensive Use in Development Zones Based on GIS Spatial Model. Development Research, 2010 (02): 10-12
[4] Tang Shiqing, Zhou Zhenju, Lei Fengchun. Investigation and Reflection on the Redevelopment of Inefficient Urban Land. Land in China, 2018 (08): 38-40
[5] Kone, T. and Kanko, T. Necessity of Minimum Floor Area Ratio Regulation in a Growing City Regional Science and Urban Economics, 2009, 39 (4): 502-511
[6] Lewis, GM, Brabec, E Regional land pattern assessment: Development of Area Source Efficiency Measurement Method Landscape and Urban Planning, 2005 (4)
[7] Ming, Y.s.and Hin, H.k. Planned Urban Industrialization and its Effect on Urban Industrial Real Estate Value: The Singapore Experience. Habitat International, 2006, 30 (3): 509-539
[8] Long Ying, Suizi Xin, Mao Mingrui. Progress in the Application of New Data Storage in Urban Planning and Research. Urban and Regional Planning Research, 2018, 10 (3): 85-103
[9] Zheng Rongbao, Zhang Chunhui, Chen Meizhao. Research on Target Identification and Secondary Development Strategy of Inefficient Industrial Land. Land and Natural Resources Research, 2014, (4): 20-24
[10] Zeng Siyan, Xue Yaya, Xu Chunpeng, et al. Multi criteria evaluation of urban inefficient land use based on subject function: Taking Xuzhou City as an example. Land and Natural Resources Research, 2018, (3): 24-28