个人展示

罗婷瑜 | 2019 - 2023 武汉大学

地理信息科学（数字地图与空间信息工程）

TINGYU LUO

interest in Spatial analysis and data analysis

学科背景

专业背景

武汉大学地理信息科学（数字地图与空间信息工程）＋ 计算机科学与技术

总GPA **3.87/4**，均分**91.12**, 大三学年综合素质测评专业**第一**

核心课程

地理信息系统原理　地图设计与编制　空间数据库原理

数据结构　空间分析　地图艺术设计　计算机网络

图形图像软件应用　空间信息可视化　面向对象的软件开发

数理基础好，专业课扎实

高等数学B1	高等数学B2	线性代数	概率论与数理统计	大学物理	数据统计分析SPSS
91	99	96	93	97	94
网络GIS与位置服务	地图投影与空间变换	数字摄影测量	地理信息系统实践	GIS+行业创新应用	地理信息科学研究进展
95	95	96	95	99	93

CPGIS2022论文发表

国际地理信息与技术大会（EI国际会议）

Comprehensive Evaluation of Emergency Shelters in Wuhan City Based on GIS（第一作者）

Comprehensive Evaluation of Emergency Shelters in Wuhan City Based on GIS

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***Abstract*—Emergency shelters, which reflect the city's ability to respond to and deal with major public emergencies to a certain extent, are essential to a modern urban emergency management system. This paper is based on spatial analysis methods, using Analytic Hierarchy Process to analyze the suitability of the 28 emergency shelters in Wuhan City. The Technique for Order Preference by Similarity to an Ideal Solution is further used to evaluate the accommodation capacity of emergency shelters in central urban areas, which provides a reference for the optimization of existing shelters and the site selection of new shelters, and provides a basis for improving the service capacity of shelters. The results show that the overall situation of emergency shelters in Wuhan is good, with 96% of the places reaching the medium level or above, but the suitability level needs to be further improved, especially the effectiveness and accessibility. Among the seven central urban areas in Wuhan, Hongshan District has the strongest accommodation capacity while Jianghan District has the weakest, with noticeable differences.**

***Keywords*—Wuhan City; Emergency shelter; Spatial analysis; Analytic Hierarchy Process**

I. Introduction

With the rapid development of cities and the continuous improvement of city governance systems, urban emergency management has become the focus of work. Emergency shelter is significant as it is a major component of city emergency resources and the important guarantee of people's life safety. Nowadays, emergency shelters are required to be distributed evenly, safe and reliable, adaptive to local conditions, useful both in normal times and in an emergency as well as planned in the long term. However, at present, the construction of large emergency shelters has the problems of insufficient scale, uneven distribution, and incomplete functions.

Many current evaluations of emergency shelters focus on site selection and optimization, planning and design, spatial pattern, and serviceability. For instance, Japanese scholars Tetsuya and Kayoko [1] use Geographic Information Systems(GIS) and apply statistical methods and public open data related to population and emergency shelters. The present research aims to conduct a suitability analysis for the emergency shelter allocation quantitatively. Gu et al. [2] evaluated the rationality of the spatial layout of emergency shelters in the central urban area of Heyuan City from four aspects: accessibility, service area ratio, per capita accessible refuge area ratio, and population allocation gap, but did not combine the four aspects and conduct an overall evaluation. Xiong et al. [3] used AHP to evaluate the disaster reduction capability of the earthquake emergency shelters in Chaoyang District, Beijing, but did not evaluate the service capacity of the emergency places. Yin et al. [4] used AHP to evaluate the site selection of emergency shelters in Tianjin, combined with GIS spatial analysis methods to evaluate the satisfaction of 14 shelters in the central urban area. However, they did not establish a complete satisfaction evaluation system and did not compare and analyze the service capacity of the emergency shelters in each district.

Based on GIS spatial analysis methods, in this paper, we use AHP and Technique for Order Preference by Similarity to an Ideal Solution(TOPSIS) methods to evaluate the site selection and accommodation capacity of emergency shelters. The factors considered are relatively complete, and the analysis of population data is also combined. We clearly and intuitively demonstrated the current construction's shortcomings, thus facilitating future planning and layout of emergency shelters.

II. Study area and data sources

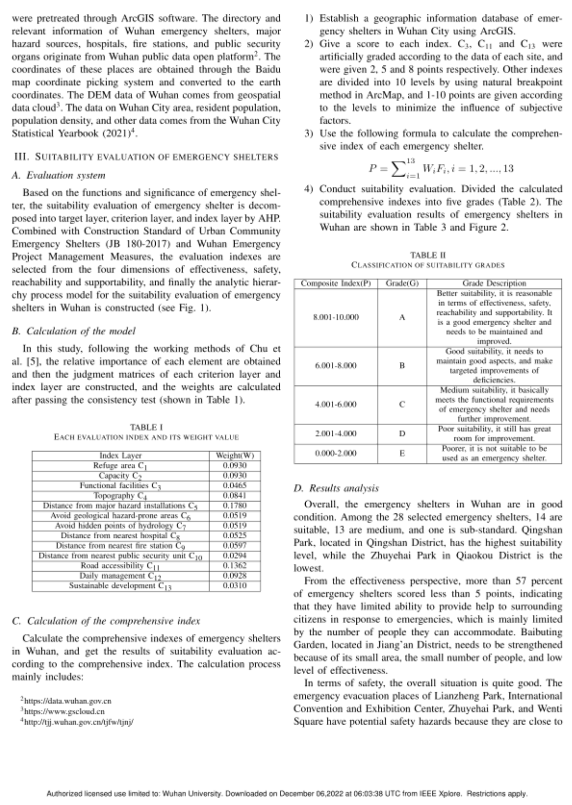
A. Overview of the study area

In this work, we study the emergency shelters in Wuhan City, Hubei Province, an important scientific and educational base, industrial base, and comprehensive transportation hub. It is located at the intersection of the golden waterway of the Yangtze River and the main artery of the Beijing-Guangzhou Railway and is known as the Nine Provinces Passage. Wuhan is also in an advantageous position in the economic geography circle of China and is the core city of the Yangtze River Economic Belt. Wuhan has a total area of 8,569 square kilometers, with a permanent population of about 11.45 million in 2021. Up to now, Wuhan has jurisdiction over 13 districts, including Jiang'an District, Jianghan District, Qiaokou District, Hanyang District, Wuchang District, Qingshan District, Hongshan District, Caidian District, Jiangxia District, Huangpi District, Xinzhou District, Dongxihu District, and Hannan District.

B. Data sources

The data of Wuhan's administrative divisions, traffic network, water system, etc., are from OpenStreetMap[1] and

[1]https://www.openhistoricalmap.org



were pretreated through ArcGIS software. The directory and relevant information of Wuhan emergency shelters, major hazard sources, hospitals, fire stations, and public security organs originate from Wuhan public data open platform[2]. The coordinates of these places are obtained through the Baidu map coordinate picking system and converted to the earth coordinates. The DEM data of Wuhan comes from geospatial data cloud[3]. The data on Wuhan City area, resident population, population density, and other data comes from the Wuhan City Statistical Yearbook (2021)[4].

III. Suitability evaluation of emergency shelters

A. Evaluation system

Based on the functions and significance of emergency shelter, the suitability evaluation of emergency shelter is decomposed into target layer, criterion layer, and index layer by AHP. Combined with Construction Standard of Urban Community Emergency Shelters (JB 180-2017) and Wuhan Emergency Project Management Measures, the evaluation indexes are selected from the four dimensions of effectiveness, safety, reachability and supportability, and finally the analytic hierarchy process model for the suitability evaluation of emergency shelters in Wuhan is constructed (see Fig. 1).

B. Calculation of the model

In this study, following the working methods of Chu et al. [5], the relative importance of each element are obtained and then the judgment matrices of each criterion layer and index layer are constructed, and the weights are calculated after passing the consistency test (shown in Table 1).

TABLE I
Each evaluation index and its weight value

Index Layer	Weight(W)
Refuge area C_1	0.0930
Capacity C_2	0.0930
Functional facilities C_3	0.0465
Topography C_4	0.0841
Distance from major hazard installations C_5	0.1780
Avoid geological hazard-prone areas C_6	0.0519
Avoid hidden points of hydrology C_7	0.0519
Distance from nearest hospital C_8	0.0525
Distance from nearest fire station C_9	0.0597
Distance from nearest public security unit C_{10}	0.0294
Road accessibility C_{11}	0.1362
Daily management C_{12}	0.0928
Sustainable development C_{13}	0.0310

C. Calculation of the comprehensive index

Calculate the comprehensive indexes of emergency shelters in Wuhan, and get the results of suitability evaluation according to the comprehensive index. The calculation process mainly includes:

1) Establish a geographic information database of emergency shelters in Wuhan City using ArcGIS.
2) Give a score to each index. C_3, C_{11} and C_{13} were artificially graded according to the data of each site, and were given 2, 5 and 8 points respectively. Other indexes are divided into 10 levels by using natural breakpoint method in ArcMap, and 1-10 points are given according to the levels to minimize the influence of subjective factors.
3) Use the following formula to calculate the comprehensive index of each emergency shelter.

$$P = \sum_{i=1}^{13} W_i F_i, i = 1, 2, ..., 13$$

4) Conduct suitability evaluation. Divided the calculated comprehensive indexes into five grades (Table 2). The suitability evaluation results of emergency shelters in Wuhan are shown in Table 3 and Figure 2.

TABLE II
Classification of suitability grades

Composite Index(P)	Grade(G)	Grade Description
8.001-10.000	A	Better suitability, it is reasonable in terms of effectiveness, safety, reachability and supportability. It is a good emergency shelter and needs to be maintained and improved.
6.001-8.000	B	Good suitability, it needs to maintain good aspects, and make targeted improvements of deficiencies.
4.001-6.000	C	Medium suitability, it basically meets the functional requirements of emergency shelter and needs further improvement.
2.001-4.000	D	Poor suitability, it still has great room for improvement.
0.000-2.000	E	Poorer, it is not suitable to be used as an emergency shelter.

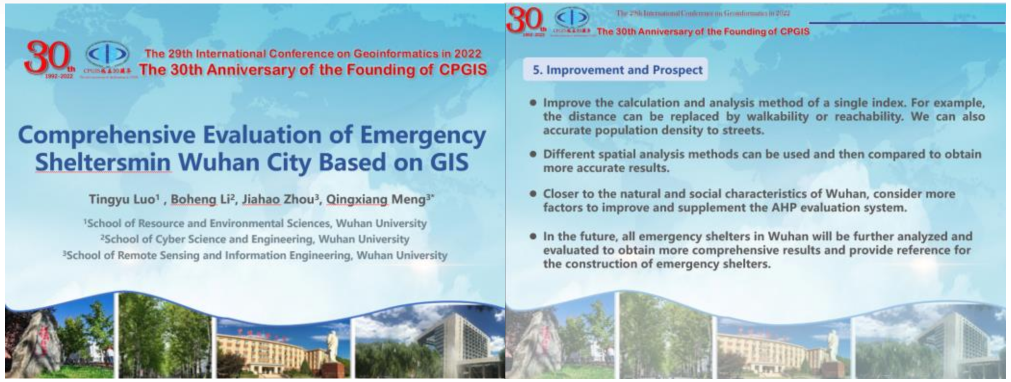
D. Results analysis

Overall, the emergency shelters in Wuhan are in good condition. Among the 28 selected emergency shelters, 14 are suitable, 13 are medium, and one is sub-standard. Qingshan Park, located in Qingshan District, has the highest suitability level, while the Zhuyehai Park in Qiaokou District is the lowest.

From the effectiveness perspective, more than 57 percent of emergency shelters scored less than 5 points, indicating that they have limited ability to provide help to surrounding citizens in response to emergencies, which is mainly limited by the number of people they can accommodate. Baibuting Garden, located in Jiang'an District, needs to be strengthened because of its small area, the small number of people, and low level of effectiveness.

In terms of safety, the overall situation is quite good. The emergency evacuation places of Lianzheng Park, International Convention and Exhibition Center, Zhuyehai Park, and Wenti Square have potential safety hazards because they are close to

[2]https://data.wuhan.gov.cn
[3]https://www.gscloud.cn
[4]http://tjj.wuhan.gov.cn/tjfw/tjnj/



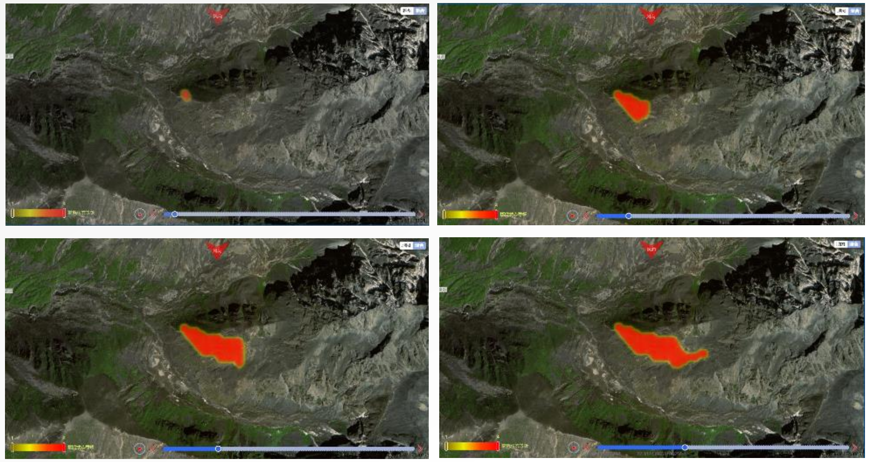
大致内容

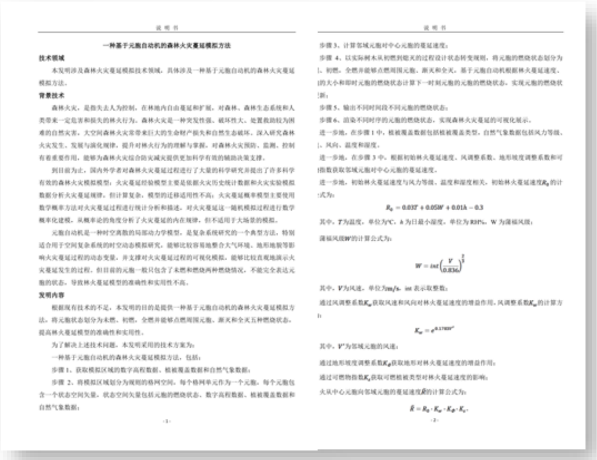
采用 AHP 模型对选取的28个武汉市应急避难场所进行适宜性分析

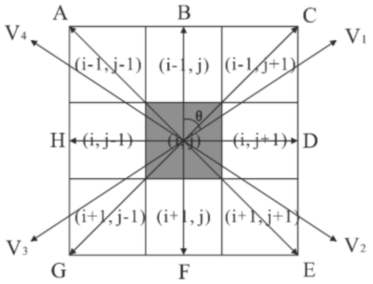
采用 TOPSIS 模型对武汉市中心城区应急避难场所的容纳能力进行评价

发明专利申请

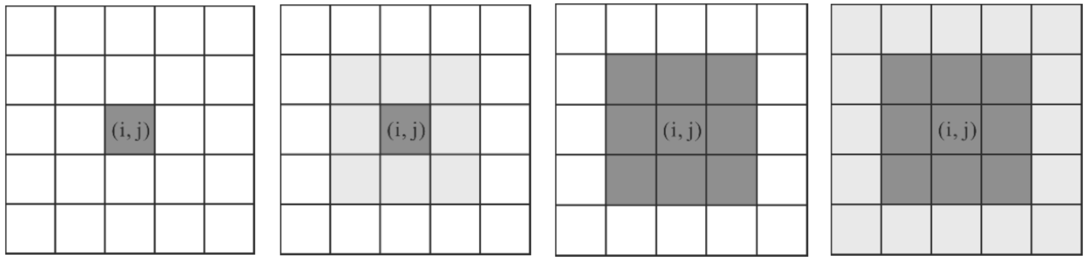
一种基于元胞自动机的森火蔓延模拟方法（第一发明人）







元胞八邻域示意图



元胞自动机模拟林火蔓延示意图

主要思路

获取高程数据、植被覆盖数据、自然气象数据

将划分为规则格网，每个格网单元作为一个元胞

计算中心元胞向邻域元胞的蔓延速度

$$R_0 = 0.03T + 0.05W + 0.01h - 0.3$$

$$R = R_0 \cdot K_w \cdot K_\varphi \cdot K_s$$

设计**状态转变规则**，计算下一时刻元胞状态，实现元胞状态的更新

发明专利申请

核心改进点一

风、地形调整系数 $K_w = e^{0.1783V}$ $K_\varphi = e^{0.355(\tan\varphi)^{1.2}}$

考虑风向和元胞邻域

$$\tilde{R} = R_0 K_s \begin{bmatrix} (K_w K_\varphi)_{i-1,j-1} \\ (K_w K_\varphi)_{i-1,j} \\ (K_w K_\varphi)_{i-1,j+1} \\ (K_w K_\varphi)_{i,j+1} \\ (K_w K_\varphi)_{i+1,j+1} \\ (K_w K_\varphi)_{i+1,j} \\ (K_w K_\varphi)_{i+1,j-1} \\ (K_w K_\varphi)_{i,j-1} \end{bmatrix}。$$

$$R_{i-1,j-1} = R_0 \cdot K_S \cdot e^{0.1783V\cos(315°-\theta)} \cdot e^{3.533(-1)^G\left|\frac{h_{k,l}-h_{i,j}}{\sqrt{2}a}\right|^{1.2}}$$

$$R_{i-1,j} = R_0 \cdot K_S \cdot e^{0.1783V\cos\theta} \cdot e^{3.533(-1)^G\left|\frac{h_{k,l}-h_{i,j}}{a}\right|^{1.2}}$$

$$R_{i-1,j+1} = R_0 \cdot K_S \cdot e^{0.1783V\cos(45°-\theta)} \cdot e^{3.533(-1)^G\left|\frac{h_{k,l}-h_{i,j}}{\sqrt{2}a}\right|^{1.2}}$$

$$R_{i,j+1} = R_0 \cdot K_S \cdot e^{0.1783V\cos(90°-\theta)} \cdot e^{3.533(-1)^G\left|\frac{h_{k,l}-h_{i,j}}{a}\right|^{1.2}}$$

$$R_{i+1,j+1} = R_0 \cdot K_S \cdot e^{0.1783V\cos(135°-\theta)} \cdot e^{3.533(-1)^G\left|\frac{h_{k,l}-h_{i,j}}{\sqrt{2}a}\right|^{1.2}}$$

$$R_{i+1,j} = R_0 \cdot K_S \cdot e^{0.1783V\cos(180°-\theta)} \cdot e^{3.533(-1)^G\left|\frac{h_{k,l}-h_{i,j}}{a}\right|^{1.2}}$$

$$R_{i+1,j-1} = R_0 \cdot K_S \cdot e^{0.1783V\cos(225°-\theta)} \cdot e^{3.533(-1)^G\left|\frac{h_{k,l}-h_{i,j}}{\sqrt{2}a}\right|^{1.2}}$$

$$R_{i,j-1} = R_0 \cdot K_S \cdot e^{0.1783V\cos(270°-\theta)} \cdot e^{3.533(-1)^G\left|\frac{h_{k,l}-h_{i,j}}{a}\right|^{1.2}}$$

$R_0 K_s (K_w K_\varphi)_{k,l}$ 表示火从元胞（i，j）向元胞（k，l）蔓延的速度分量

核心改进点二

元胞状态的划分：

将森林元胞的状态划分为：S=0未燃，S=1初燃，S=2全燃并具有点燃周围元胞的能力，S=3渐灭，S=4全灭

遍历火场中燃烧状态可能改变的元胞，即满足：

$$\left(S = 0 \,\&\&\, \exists S_{邻} = 2\right) || 0 < S < 4$$

元胞状态转变规则：

若此时 S=0，可燃且邻域存在状态为 S=1 的初燃元胞，则计算得到下一时刻该元胞值；

若此时 S=1 恰好初燃，则下一时刻 S=2，全燃；

若此时 S=2 且邻域 S≥2 或不可燃，则 S=3，逐渐熄灭；

若此时 S=3，则下一时刻 S=4，完全熄灭。

开发能力

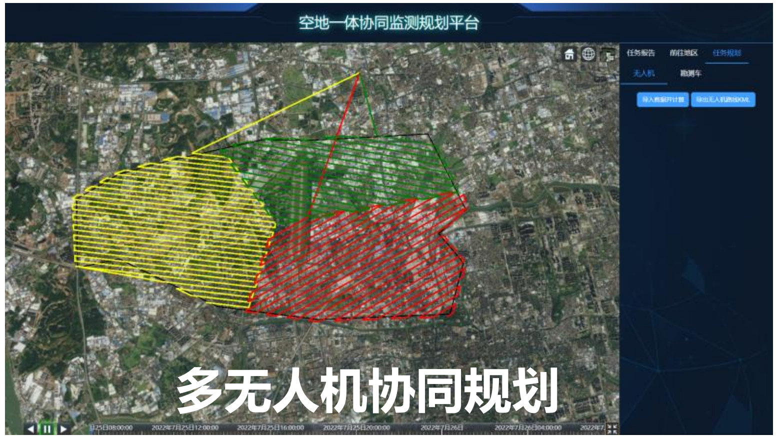
重大危险源态势感知

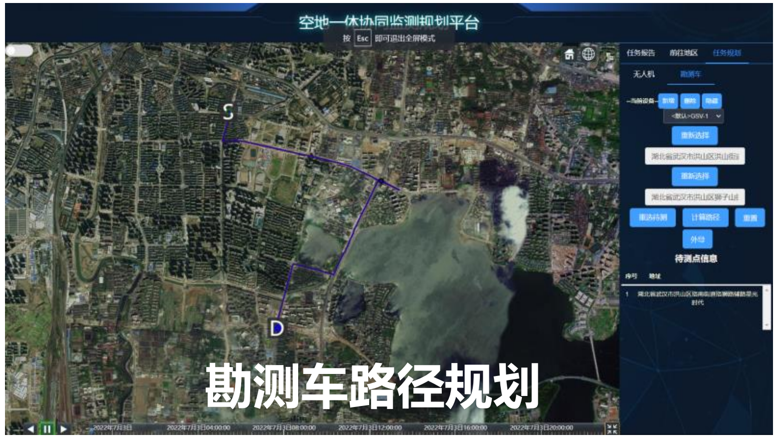
人防工程缓冲区态势感知

应急资源的分析与评价

应急资源可视化平台的开发

空天地一体监测平台的开发





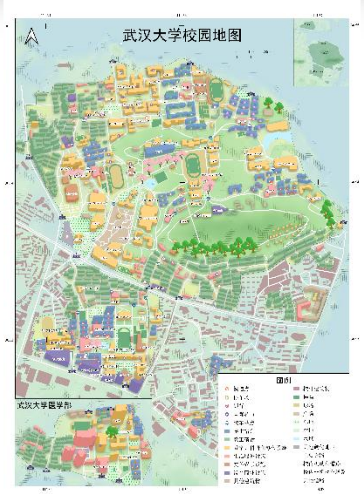
智慧城市与应急管理

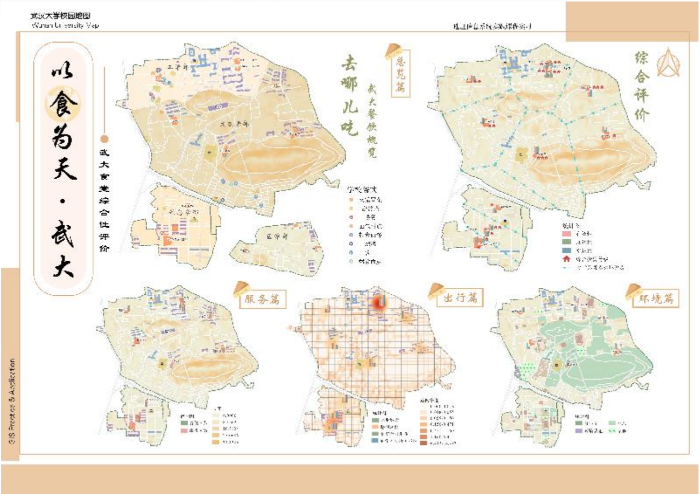
应急避难场所可视化

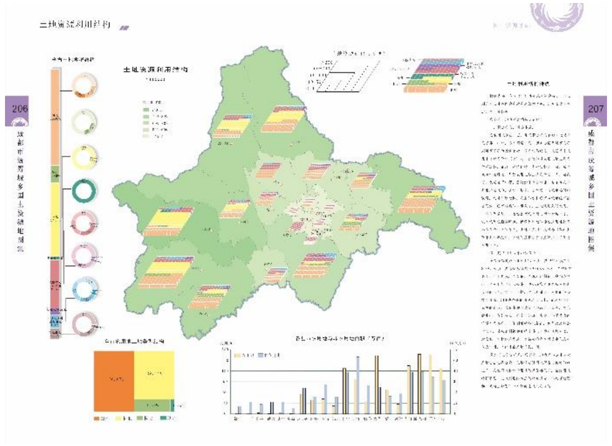
地图设计制作能力

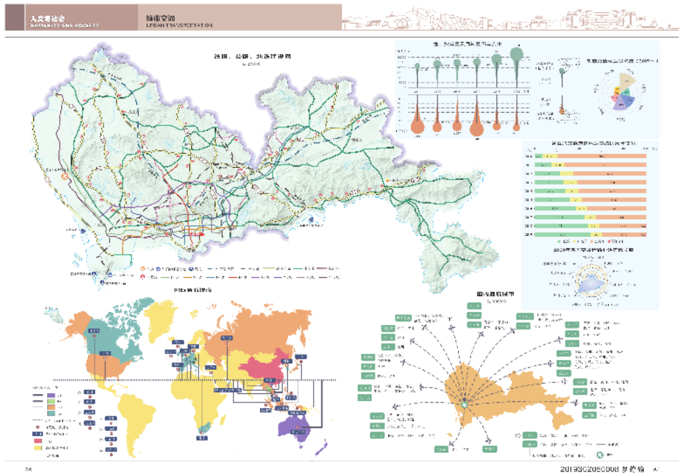
“兹游奇绝处，烟雨任平生”

地理与历史的结合，**文化地图**编制的探索









课程作业中的地图设计、专题图编制

空间分析能力

地区社会弱势性空间格局分析

区域醉酒空间格局及其影响因素分析

社区生活圈可步性测度

公园绿地可达性及其优化选址

区域多中心性测度

耕地破碎化空间格局及其影响因素分析

校园食堂分布适宜性评价与选址规划（右图）

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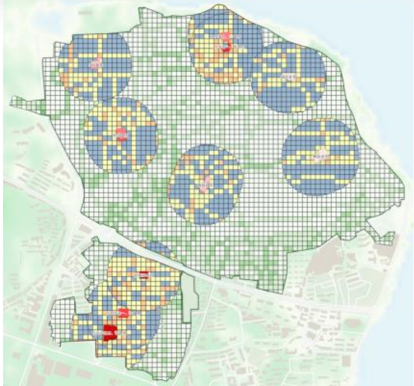
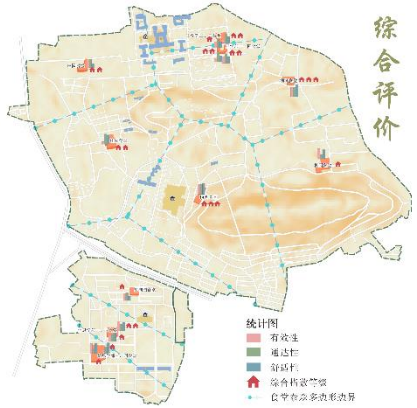
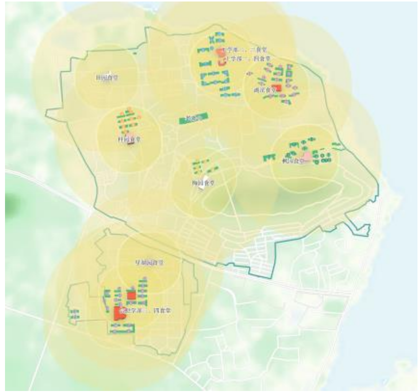
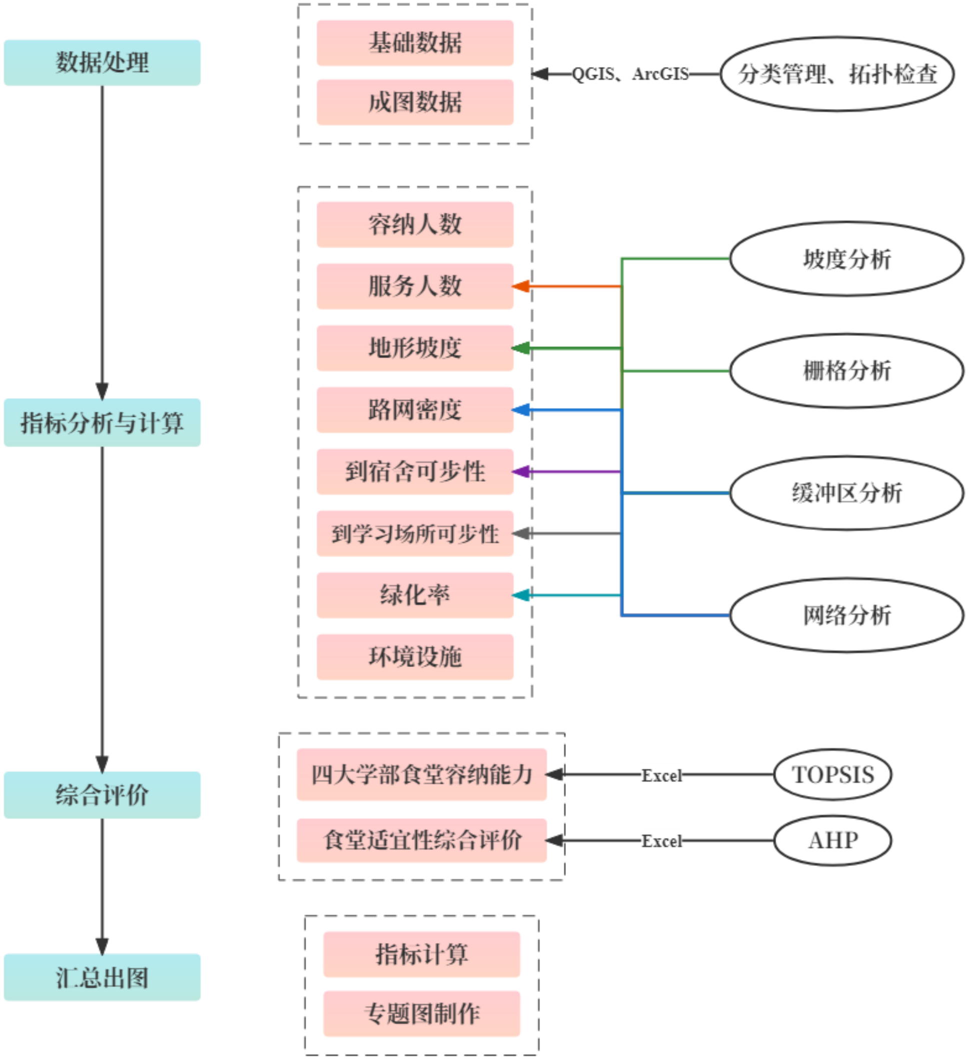
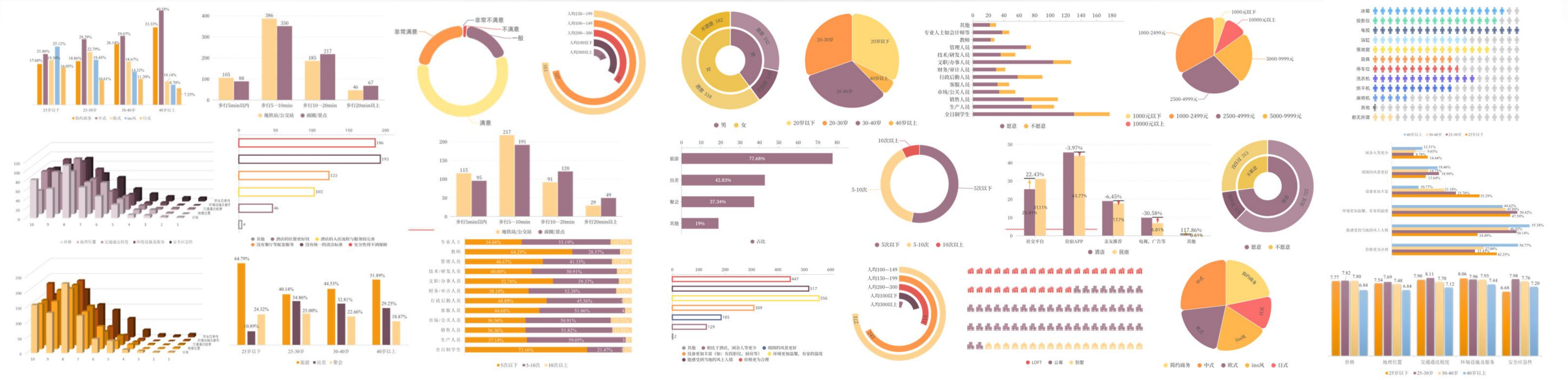








学科交叉+数据分析

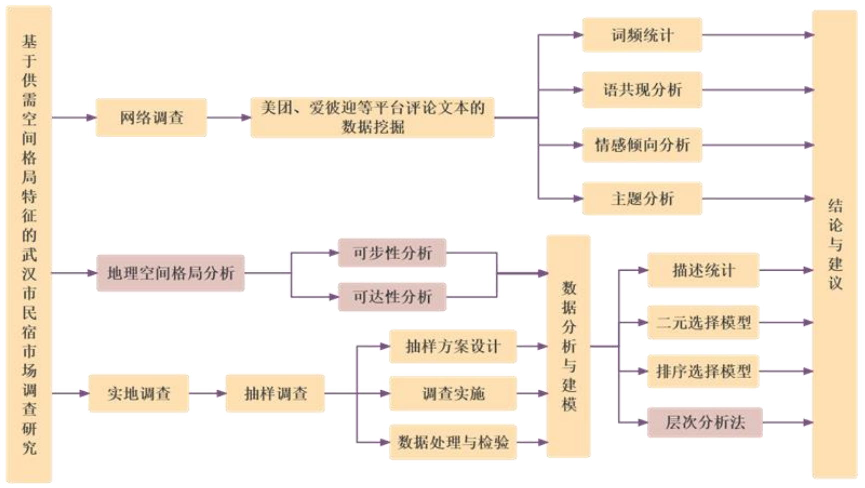


何曾住处限西东

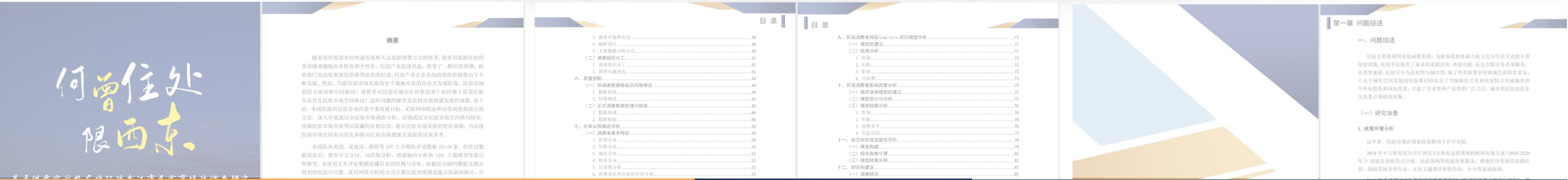
——基于供需空间格局特征的武汉市民宿市场调查研究

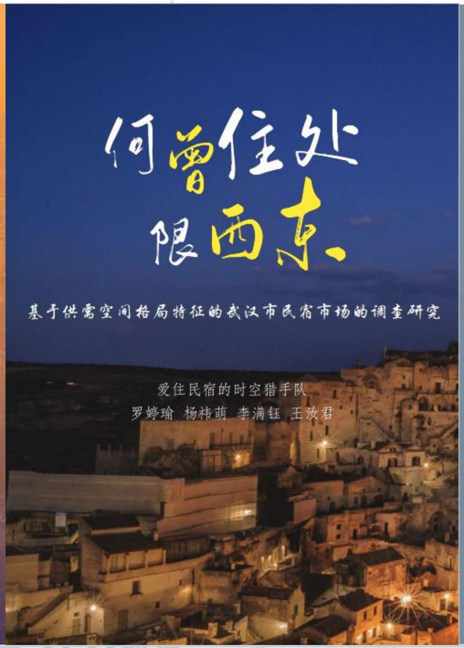
面向民宿市场供需平衡发展的目标，采取网络爬虫和问卷调查相结合的方法，利用GIS方法识别武汉市民宿市场空间格局特征，挖掘民宿市场发展背后隐藏的价值信息，提出民宿市场发展的优化策略。

“GIS+”一次学科交叉的探索



学科交叉+数据分析





整体思路+进度规划

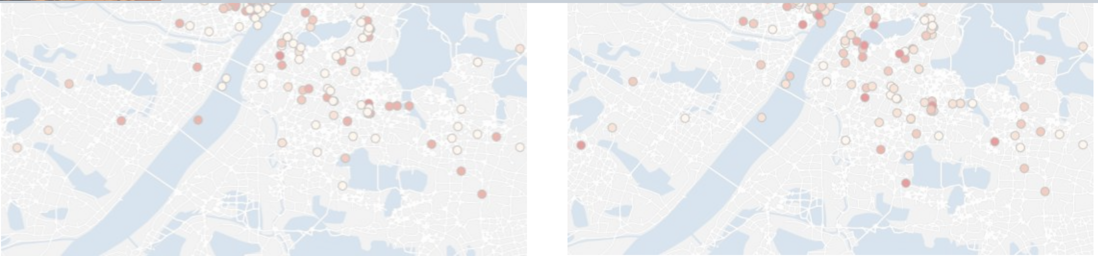
评论文本数据的挖掘与分析

问卷数据的挖掘与分析

排序选择模型的运用

AHP模型的结合

利用SPSS、R、Python等分析处理数据



创新思维训练

武汉城市圈开放数据应用大赛二等奖
2022.01

市场调查与分析大赛湖北赛区三等奖
2022.5

“挑战杯”创业计划大赛湖北省**金奖**
2022.6

- 全国大学生测绘学科创新创业智能大赛 **国家特等奖**
- 互联网+大学生创新创业大赛湖北省**金奖**

2022.7

互联网+大学生创新创业大赛**全国总决赛金奖**
2022.10

- “挑战杯”创业计划大赛全国总决赛铜奖
- 雄安新区“科技•人才•创新周”交流学习

2023.3

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作为团队核心成员（3/15）参加创新创业比赛，在其中不断培养互联网创新思维，锻炼发现并解决社会中的实际问题的能力

未来目标

从自身学科与专业出发 → 交叉融合，实践探索

“赛”为重 → “创”为重，不断创新

学习交流

参加雄安新区首届科技•人才•创新周活动，与清北等高校优秀团队交流学习

个人荣誉

荣誉称号

武汉大学第七届十大自强之星
武汉大学三好学生
武汉大学优秀毕业生
武汉大学社会活动积极分子
武汉大学优秀学生干部
于刚-宋晓奖学金
国家励志奖学金
武汉大学甲等奖学金
武汉大学乙等奖学金

竞赛奖项

“互联网+”大学生创新创业大赛全国金奖
“挑战杯”中国大学生创业计划竞赛全国铜奖
全国大学生测绘学科创新创业智能大赛特等奖
“正大杯”市场调查与分析大赛湖北省三等奖
SuperMap杯高校GIS大赛开发组二等奖
SuperMap杯高校GIS大赛制图组三等奖
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地理信息科学（数字地图与空间信息工程）

TINGYU LUO

interest in Spatial analysis and data analysis