

SUSTAINABLE CITIES AND SOCIETY

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Thermal environment disparities across 11 cities in the greater bay area: Nonlinear relationships and urban greening-based solutions

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ABSTRACT

Urbanization intensifies urban thermal environment (UTE) degradation. While urban morphology affects UTE, its nonlinear, cross-city contributions under shared climatic conditions remain understudied. We analyze 11 cities in China's Greater Bay Area (GBA) using LightGBM and SHapley Additive exPlanations (SHAP) to reveal nonlinear relationships between urban form and daytime/nighttime summer land surface temperatures. Results show NDVI is the strongest cooling factor, with peak effectiveness at 0.6–0.8, beyond which benefits diminish. Water cools during the day but loses efficacy at night, except in Hong Kong and Guangzhou, revealing intra-regional heterogeneity. Landscape Shape Index (LSI) increases daytime warming but saturates at high values—Foshan and Dongguan shift to cooling at $LSI > 1.2$, while Macao shows amplified warming. Building heights > 20 m exacerbate nighttime heat, especially at 20–40 m. High floor area ratio (FAR) generally worsens UTE, yet Hong Kong and Zhuhai exhibit anomalous daytime cooling. We propose a novel classification method based on the nonlinear response patterns of urban morphologies to UTE, enabling data-driven city clustering. Using this approach, cities are grouped into four UTE-behavior clusters: (1) balanced forms (Dongguan, Foshan, Zhongshan), (2) extensive green spaces (Guangzhou, Huizhou, Zhaoqing), (3) complex environments (Hong Kong, Macao, Zhuhai), and (4) diverse green spaces (Shenzhen, Jiangmen). This typology captures morphological-thermal synergies. By isolating morphological drivers in a climatically homogeneous region, our study reveals critical thresholds and divergent thermal responses, underscoring the need for city-specific mitigation. The framework advances nonlinear UTE analysis and supports climate-resilient urban design in rapidly urbanizing regions.

1. Introduction

The deterioration of the Urban Thermal Environment (UTE) is a byproduct of urbanization (Ji et al., 2023), further exacerbated by the concentration of industrial and recreational activities in cities. In rapidly growing regions such as East and Southeast Asia, urbanization is inevitable and is accompanied by UTE-related issues, including urban (Feinberg, 2023) heat islands, CO₂ emissions, land degradation, public health deterioration, and social inequality. According to the IPCC 2022 assessment report (Shukla et al., 2022), global temperatures are projected to rise by 0.2 °C per decade, which further intensify both ecological and economic losses in the Anthropocene (Feng et al., 2021). Against the backdrop of global warming, the influence of environmental factors on UTE has become increasingly pronounced, as urban morphology and green spaces are closely correlated (S. Wang et al., 2024). Therefore, understanding the environmental factors contributing

to UTE is critical for designing sustainable cities capable of addressing the challenges posed by urban heat.

The lives and health of urban residents are increasingly affected by the prolonged deterioration of UTE (Buchin et al., 2016), and the duration of this effect continues to increase. Research on urbanization effects indicates that local climate is susceptible to the compounded influences of factors such as heat generated by urban development, urban dynamic characteristics, and industrial emissions, leading to the deterioration of not only the daytime thermal environment but also the nighttime one (Qiao et al., 2024; Y. Wang et al., 2024). The deterioration of the daytime thermal environment, which is directly related to public health and urban production activities, has been thoroughly investigated in previous research (Tehrani et al., 2024; Yang & Zhao, 2024). These studies have identified key drivers, including intense solar radiation during the day, urban canopy morphology, and changes in surface energy budgets due to various types of human activities (Coutts et al.,

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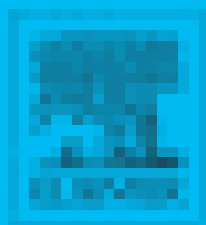
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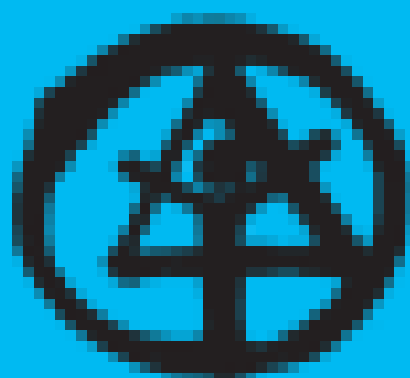
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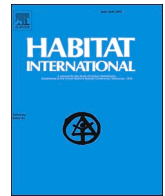
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Uncovering the activity-based gender segregation and its association with crime

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Gender equity
Human mobility big data

ABSTRACT

Building gender-inclusive cities is important for gender equity. However, women face challenges in using urban spaces equally as men do, which limits women's access to economic opportunities and life chances. Gender segregation in urban spaces reflects such gender inequality, while previous studies have insufficiently quantified it. This paper addressed this gap using a human mobility big data approach to gender segregation that unfolds in residential, workplace, daytime and nighttime activities. It further examined the role of crime in shaping gender segregation because women's fear of crime is an invisible constraint on their activities when using urban spaces. The mobility trajectory of 16,574,877 mobile phone users in Guangzhou, China were examined for this end. We found a more salient gender segregation of daytime and nighttime activities than residential and workplace activities, and a positive association between crime rate and gender segregation that is stronger in the suburbs. In particular, violent and property crimes are significantly associated with residential gender segregation, while robbery crimes influence workplace gender segregation. Notably, sex assaults have significantly increased nighttime activity gender segregation. Overall, this paper advances the understanding of gendered urban spaces and social segregation, offering critical insights for policy and planning aimed at building more gender-inclusive cities.

1. Introduction

Driven by the “New Urban Agenda” from the United Nations Human Settlement Programme (UN-Habitat), urban planning is increasingly prioritizing gender inclusivity and the needs of women, aiming to create cities that serve all individuals equitably (Mostofa et al., 2024). This objective aligns directly with the United Nations Sustainable Development Goals (SDGs), particularly those focused on achieving gender equity and fostering sustainable cities (United Nations UN, 2015). Concurrently, a growing number of global organizations are addressing how to make cities more accommodating for women through research, policy advocacy, and improved public transportation design (UN-Habitat, 2012a,b). Historically, urban spaces were designed in ways that favored men, creating spatially fixed opportunities for political and social engagement. For women, these opportunities are further constrained by a pervasive fear of crime, which ultimately limits their rights (Beebejaun, 2017). Therefore, achieving gender inclusivity is crucial for significantly enhancing women's access to employment,

services, and opportunities, thereby improving their overall well-being. However, transforming gendered urban spaces to ensure equitable use remains a considerable challenge, necessitating sustained and collaborative efforts to effectively integrate gender perspectives into urban development strategies.

The general manifestation of gendered urban spaces is the gender segregation in daily activities. Currently, there are multiple dimensions of gender segregation issues, especially in China, such as gender differences in employment among migrant workers, gender income inequality caused by occupational segregation, and the division of labor within households (Zhang & Wu, 2017; Zhang, 2020). However, in recent years, individuals and other elements of urban life are no longer bound to localized production and exchange but instead engage in daily activities through mobility (Nilforoshan et al., 2023; Wang et al., 2018; Cai et al., 2024). A new academic trend has emerged, redirecting focus toward activity patterns closely tied to space use and exposure disparities. The core of this shift lies in the evolution of the research paradigm, moving from an emphasis on static residential segregation to a more

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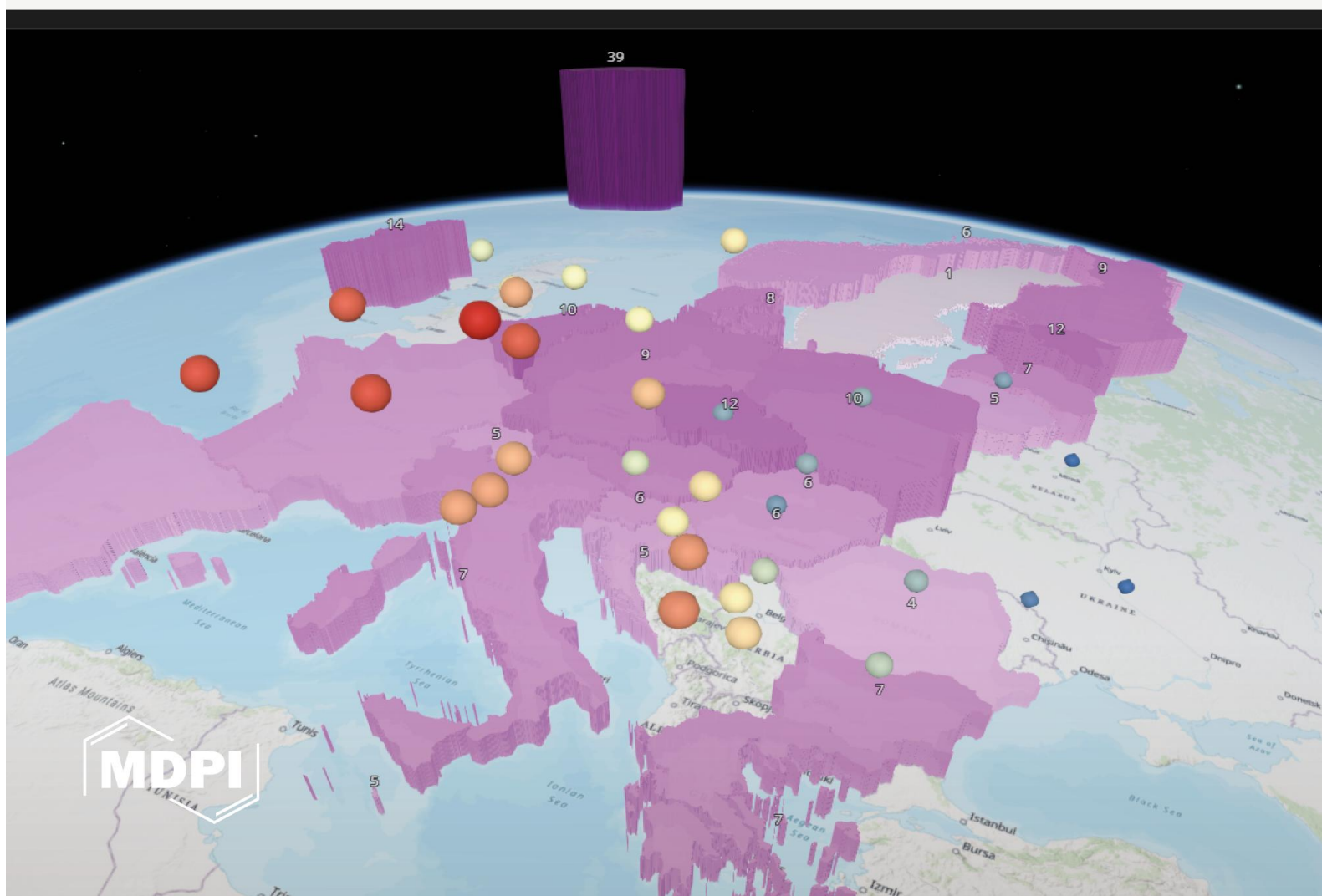
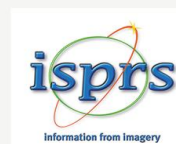
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3D-Geo-Vis: Interactive 3D Geovisualisation & Usability Evaluation

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Article

Analyzing the Non-Linear Correlation Between Streetscape Accessibility Elements and Urban Restorativeness Using Explainable Machine Learning Models

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Abstract

Previous research has primarily focused on the restorative effects of environments on the general population, often overlooking the specific restorative capacity of urban settings for the disabled population. There is a lack of comprehensive investigation into the interaction between accessibility elements and urban restorativeness. This study, conducted in Shenzhen, Guangdong Province, China, categorizes streetscape accessibility elements for the disabled population and develops a recognition system based on an enhanced DeeplabV3+ framework. Semantic segmentation of streetscape accessibility elements was performed using 201,860 sampling points and 807,440 street view images. This study employed a combination of TrueSkill scoring, sentiment semantic analysis, LDA topic modeling, and LAB color clustering to quantify and visualize urban restorativeness. The impact of accessibility elements on urban restorativeness was explored using the XGBoost-SHAP model. Results indicate significant effects of architectural space constraints and high-density motor vehicle distribution on the safety of the disabled population's mobility. The low pixel ratio of accessibility facilities and signs indicates insufficient infrastructure, while high landscape recognition rates exhibit significant spatial coverage heterogeneity. Detection rates for the disabled population in street views are nearly zero, highlighting a severe lack of inclusivity in pedestrian environments. Urban restorativeness exhibited a pattern of being higher in the south and east, and lower in the north and west. Among the accessibility elements, public green spaces (PGS) contributed the most to urban restorativeness, accounting for 25% of the impact, and the study elucidates the mechanisms through which various elements affect urban restorativeness. This absence stems from spatial competition, missing co-design, threshold effect conflicts, and color interference mechanisms. This research breaks away from traditional linear analytical frameworks and reveals the complex non-linear relationship between accessibility elements and urban restorativeness through the XGBoost-SHAP model, providing a quantitative decision-making tool for planning accessible environments in high-density cities.

Keywords: streetscape accessibility elements; urban restorativeness; deep learning recognition system; explainable machine learning models; shenzhen



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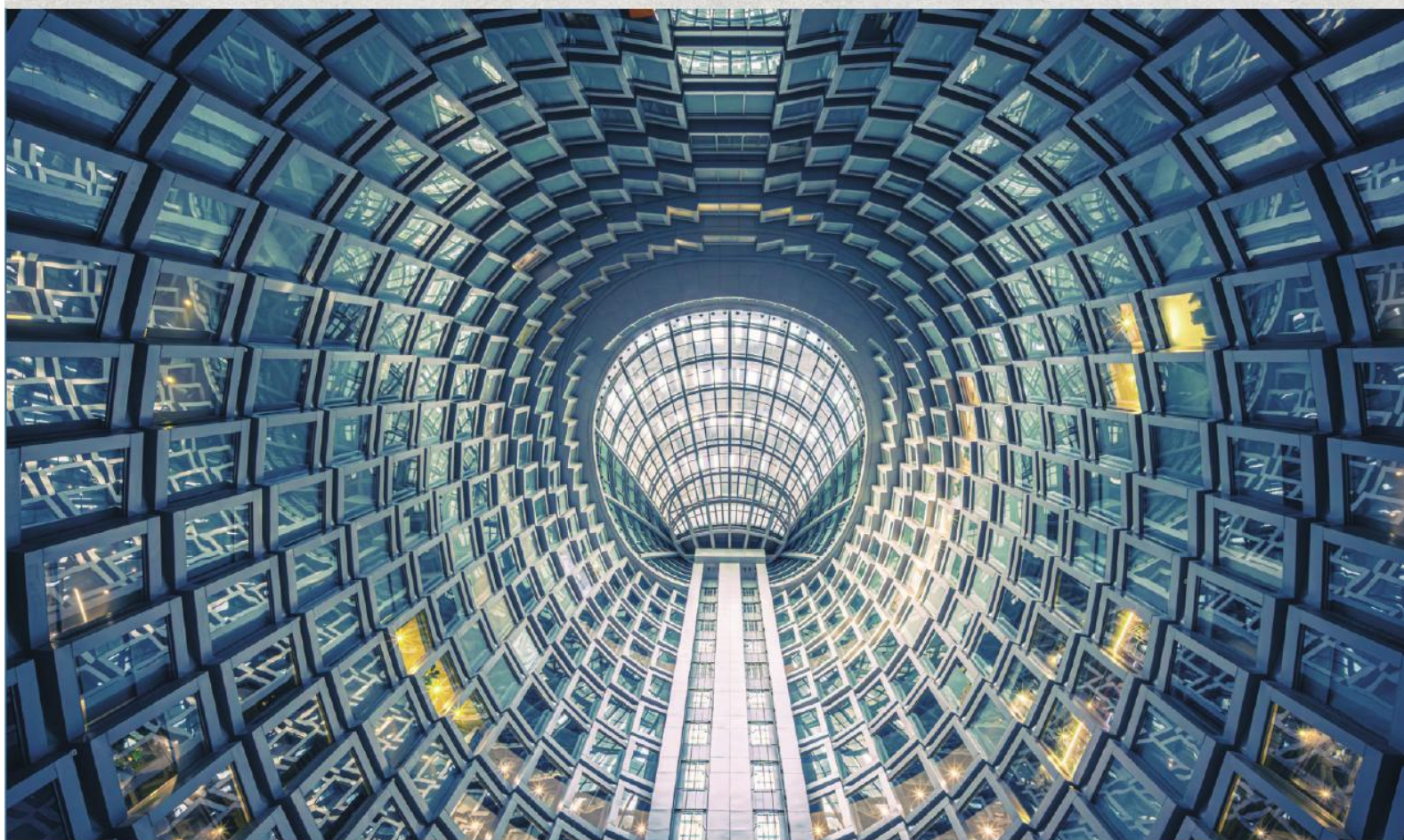
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城市 学报

双月刊

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JOURNAL OF URBAN SCIENCES

本期主题：城市三新——新技术·新空间·新治理

基于多智能体协同下城市老年人就医出行街景友好度评估 | 董禹 肖思懿 孙世德 王芳宇 董慰
大语言模型驱动的人居环境特征智能识别——以武夷山建成环境文献分析为例 | 李凤娇 马悦 龙瀛
以人为本的城市更新价值范式 | 李昊

主管单位 中华人民共和国教育部
主办单位 天津大学

基于大模型的城市街道感知评价

Urban Street Perception Assessment Based on Large Language Models

仇华龙 姜宇逍 陈 杰 杨伊扬 杨林川

QIU Hualong, JIANG Yuxiao, CHEN Jie, YANG Yiyang, YANG Linchuan

摘 要: 传统街道感知评价方法普遍存在成本较高、覆盖范围有限等局限,而常规视觉分析模型又难以精准刻画居民对街道空间的情绪体验。为此,文章构建了融合大语言模型的街道感知评价框架,形成“街景图像-文本描述-情绪标签”的一体化分析流程。基于深圳市约 12 万张街景图像数据,利用微调后的大语言模型生成街道描述文本,将其映射为愉悦、舒适、烦躁三类情绪,并揭示其空间分布特征;利用语义分割模型提取绿视率、天空率等空间要素,通过回归模型分析街道感知分布与空间要素之间的关联关系。结果表明:深圳市街道感知水平表现出显著的空间异质性;连续绿荫遮蔽和视野开阔通透等空间特征有助于提升积极情绪,而界面过度围合、视觉环境杂乱则易引发负面情绪;绿视率与天空率是提高情绪积极性的关键影响要素。研究证实,大语言模型在支持街道感知大规模、精细化评价的同时,能够提供具有叙事性的深度解读,可为街道品质提升与以人为本化城市设计提供科学依据和技术支撑。

关键词: 大语言模型;街道感知;建成环境;街景图像;生成式人工智能

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【文献标志码】A

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Abstract: Traditional street perception evaluation methods are generally limited by high costs and limited coverage, while conventional computer vision models struggle to accurately characterize residents' emotions in street spaces. To address these limitations, this study establishes a street perception evaluation framework based on large language models (LLMs) and an integrated analytical process of street view images, text descriptions, and emotion classification. Using approximately 120 000 street view images collected in Shenzhen, this study employs a fine-tuned LLM to generate street perception descriptions, which are further mapped into three emotional dimensions (i.e., pleasure, comfort, and irritation), and their spatial distributions are then mapped. Spatial environmental indicators such as the green view index and sky view index are extracted via semantic segmentation models, and regression models are employed to reveal the association between street perception and spatial environmental indicators. The results show that street perception in Shenzhen exhibits significant spatial heterogeneity. Continuous tree canopy and open, visually permeable streetscapes contribute to positive emotions, whereas excessive enclosure and cluttered visual environments induce negative emotions. The green view index and sky view index are key factors for enhancing positive emotions. This study confirms that LLMs enable large-scale and fine-grained evaluation of street perception while providing in-depth narrative insights. It offers empirical evidence and technical support for street quality improvement and people-oriented urban design.

Keywords: large language model; street perception; built environment; street view image; GenAI

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四川省哲学社会科学“十四五”规划 2025 年度 项目立项通知书

杨林川 同志：

经省社科联党组批准，您主持的四川省哲学社会科学研究“十四五”规划 2025 年度课题：四川城乡消费基础设施均等化测度研究(研究报告)，已获准立项。项目类别：四川统计发展专项(重点项目)，项目批准号：SC25TJ004，完成时间：2026 年 8 月。资助经费总额 5 万元，一次性拨付。

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2025 年 8 月 29 日



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项目编号:2025-RK00-00042-ZF

验收评价结论:合格

2026年04月29日



成都市科学技术局制
The Science and Technology Bureau of Chengdu Program

四川省第五次全国经济普查资料开发应用课题 结项证书

立项编号：SCJP02

项目名称：新质生产力赋能四川省国家战略腹地建设：现实挑战
与实现路径

项目类别：重 大

负责人：杨林川

主要参加人：王冰、彭迎澳、韩磊、彭一升、仇华龙、严琪胜

本项目经审核准予结项，等级**合格**，特发此证。

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2025年12月25日

附件

2026 年成都市哲学社会科学规划年度项目立项名单

一、一般项目				
序号	课题名称	成果形式	课题负责人	责任单位
1	习近平党建思想引领成都基层党建高质量发展研究	研究报告	郭玥	中共四川省委党校
2	全过程人民民主在成都基层治理中的实践形态与运行机制研究	研究报告	杨雨林	中共四川省委党校
3	新时代党建引领成都新型农村集体经济高质量发展的实践逻辑及优化路径	论文	王贝	西华大学
4	党史短视频赋能成都大中小学思政课的内在逻辑与实践路径研究	论文	李春梅	西南交通大学
5	中国共产党人精神谱系的成都印记研究	论文	储连伟	中共四川省委党校
6	红军长征成都足迹的历史挖掘及长征文化传承创新路径研究	研究报告	蔚建鹏	四川师范大学
7	党建引领成都社会组织参与超大城市基层治理的机制研究	论文	张仁枫	四川大学
8	大熊猫文化赋能成都城市形象对外传播研究	研究报告	席珍彦	四川大学
9	成都微短剧出海东南亚的跨文化传播研究	论文	袁海涛	西南石油大学
10	成都新就业群体参与全过程人民民主的现实困境及优化路径研究	研究报告	李鑫诚	西南石油大学

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72	公园城市背景下成都全域城乡养老服务体系协同构建与分类治理研究	研究报告	万将军	四川农业大学
二、青年项目				
序号	课题名称	成果形式	课题负责人	责任单位
1	成渝地区双城经济圈与泛中亚区域合作的路径研究	研究报告	王琳	四川大学
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3	西方汉学视域下成都道教文化融入国际旅游目的地形象建构研究	研究报告	王晓玲	四川旅游学院
4	发展与安全视域下成渝地区双城经济圈新型能源体系协同建设研究	论文	李乔楚	西南石油大学