Research Paper

Relationship between climate change risk perception, mental health, and differences in urban environments

Ang QU, School of Architecture and Design, Harbin Institute of Technology;Key Laboratory of National Territory Spatial Planning and Ecological Restoration in Cold Regions, Ministry of Natural Resources, China

Abstract

As climate change intensifies, the risks associated with climate change are increasingly affecting the mental health of residents through their perceptions. Understanding the relationship between climate change risk perception and residents' mental health, as well as the differentiation of this relationship in different built environments, can help reduce the negative impacts of climate change risks on urban residents, improve their mental health, and encourage them to take positive bottom-up adaptation behaviors to reduce the health risks posed by climate change. In this paper, we used a questionnaire survey to collect data, and geostatistical methods to discuss the relationship between residents' climate change risk perceptions and mental health in different urban built environments. The results show that each dimension of the CCRP has a different degree of influence on different aspects of residents' mental health, which is mainly manifested in the differences between old and new urban areas and between urban centries and suburbs. It was also found that higher green space coverage, lower sky view factor (SVF), and building density were associated with lower mental health, and that there were regional differences in the mental health of residents living in different urban built areas.

Keywords

Climate change risk perception, Mental health, Urban environments

1. Instruction

1.1. Background

The impact of climate change on residents' health is a topic of great concern, and the main scope of discussion is the impact of climate change on residents' physical health and physical activity, with relatively little discussion of the impact on mental health, while the impact of climate change on residents' mental health is mainly obtained through the residents' perception of climate change risk, which includes direct impacts, indirect impacts, and substitution impacts and other pathways. The impacts of climate change on mental health are mainly obtained through residents' perception of climate change risks, including direct, indirect, and vicarious impacts.

The direct impacts of climate change phenomena, such as increasing precipitation, rising temperatures, and extreme weather events, which are experienced by residents living in urban areas, can have a direct impact on mental health, mainly in the form of post-traumatic stress disorder, anxiety, and depression. Studies have shown that psychological stress following extreme weather events is associated with increased rates of suicide and mental health problems.[1][3][5]

Indirect impacts are caused by unequal access to resources for combating the adverse effects of climate change due to unbalanced development and gentrification of living environments, which means that lower socio-economic groups, women, and the elderly are more likely to be affected by the adverse effects of climate change. Alternative impacts are those in which urban residents do not feel the impacts of climate change, but through community organisations, the internet, and communication with friends and family, they learn about the experiences and attitudes of others towards the adverse impacts of climate change, and in the process form their own judgements about the risks of climate change.[2][4][6]

According to existing research, climate change risk perception is an important factor in urban residents' perception of the impacts of climate change, and climate change risk perception is also an important perceptual component of climate change impacts on residents' mental health, and climate change risk perception is affected by a variety of factors, including the individual's level of education, level of income, worldview, access to climate change-related information and the amount of climate change-related information, and even affected by Race, geography, and political affiliation. Environmentalists and those with higher levels of education and access to information are more likely to believe in climate change and feel the impacts of climate change, and studies have shown that people who live in cities longer are less likely to be affected by climate change, and that older people have lower levels of climate change risk perceptions than younger people. In general, people with higher levels of climate change risk perception are more likely to take proactive adaptation measures. [9][10][11] [12][13]

1.2. Literature Review

Differences in geographic location and socio-economic level not only result in significant differences in the spatial scale of climate change risk, but also in the perception of climate change risk by people of different socio-economic status in different urban spaces. Due to the rapid development of cities, their internal spaces have become gentrified, e.g. newly built high-grade neighbourhoods tend to have a higher quality built environment, a higher proportion of green and permeable areas, and more convenient access to infrastructure. The inhabitants of these neighbourhoods are mainly high-income and well-educated, and are relatively more capable of coping with the impacts of climate change. Older neighbourhoods, on the other hand, tend to have lower quality built environments, more crowded living environments, a higher proportion of hardened land, a lack of access to nature and outdoor space, and poorer accessibility to various types of infrastructure. However, residents tend to have lived there for a longer period of time, and are mostly low-income and elderly people, who are also more vulnerable to the risks posed by climate change. Spatial heterogeneity in geographic space can lead to climate injustice in cities, making vulnerable populations more susceptible to the impacts of climate change. [7][14] In addition, while there is still a gap in understanding between urban dwellers and climate-related experts, this gap is now narrowing as a result of easier access to information. [15][16]

Urban residents' perception of climate change risk can have an impact on residents' mental health in the following ways. Affective response play a critical role in shaping perceptions of climate change risk, which is the first reaction of residents to climate change risk, with fear of climate change dominating. Affective response can lead to positive adaptive actions based on the experiences that residents have gained from experiencing climate change. Residents whose means of production are closely linked to climate change tend to be more vulnerable to the effects of climate change on their mental health. [17]

Adaptation intentions is another important aspect of climate change risk perception. Adaptation intentions refers to an individual's willingness and behaviour to take measures to mitigate the effects of climate change risks. People who are more likely to be willing to undertake positive adaptation tend to have higher levels of income to afford their adaptation behaviour and higher levels of climate change awareness.

Cognition can also have a significant impact on climate change risk perception. Cognition includes understanding of climate change knowledge, risk assessment and awareness of its causes. Differences in the level of awareness come mainly from individual residents, including their ideology, political stance, etc., which mainly influences whether residents can adopt rational adaptive behaviours to cope with climate change, and to a certain extent affects their psychological expectations of climate change, and influences the mental health of the residents. [18][19]

Self-efficacy is also an important aspect of climate change risk perception; self-efficacy refers to an individual's confidence in his or her ability to perform a specific task or achieve a specific goal. It determines whether individuals are able to adopt adaptive behaviours that are within their capabilities, and is more of a practical guide, and is therefore often regarded as one of the key psychological factors in the response to climate change by individual residents. [20]

The above studies show that climate change risk perception is affected by the built environment and social support, which are highly sensitive to spatial changes in the city, and that socioeconomic status also influences residents' choice of residence to a certain extent. Existing research on climate change risk perception is mainly at the mathematical level, which is different from the reality and does not reflect the real perception of residents, and fails to discuss the impact of climate change risk perception on mental health. The lack of in-depth discussion of the relationship between climate change risk perception and mental health in terms of geographic distribution and differences between built environments in different cities also makes it difficult to plan and guide policy.

This study examines the relationship between climate change risk perception (CCRP) and residents' mental health, and the differences in the role of the urban environment in this relationship. The risks posed by climate change are not just objective risks, but also health risks to the human body, including psychological trauma. And the spatial differences in this affective relationship are elaborated, providing a theoretical basis for more in-depth research in the future, and a new perspective for improving the research on climate change risk perception.

The objectives of this research are as follows: 1) To analyze the impact of affective responses, adaptation intentions, and cognition within climate change risk perception on different dimensions of residents' mental health; 2) To explore how factors such as urban green coverage, Sky View Factor (SVF), and building density mitigate mental health issues among residents; 3) To investigate regional differences in mental health levels among residents in various urban built areas and examine the potential causes of these disparities.

2. Materials and Methods

2.1. Research Area

Harbin is a representative of China's cold cities, in the past two decades, Harbin's annual average temperature, seasonal average temperature, and monthly maximum temperature have shown an upward trend, and the annual average temperature increase is, per decade, 0.37 ℃, due to the influence of rapid urbanisation, the city centre tends to warm up more seriously.

The study area is selected as the main built area of Harbin, including Daoli District, Nangang District, Daowai District, Xiangfang District, which includes the old city centre and the newly developed city centre, and covers the main types of built environment and architectural characteristics of Harbin. To ensure the accuracy of the experimental results, data collection was conducted at the community level to improve precision.

The study's methodology and approach are illustrated in Figure 1.

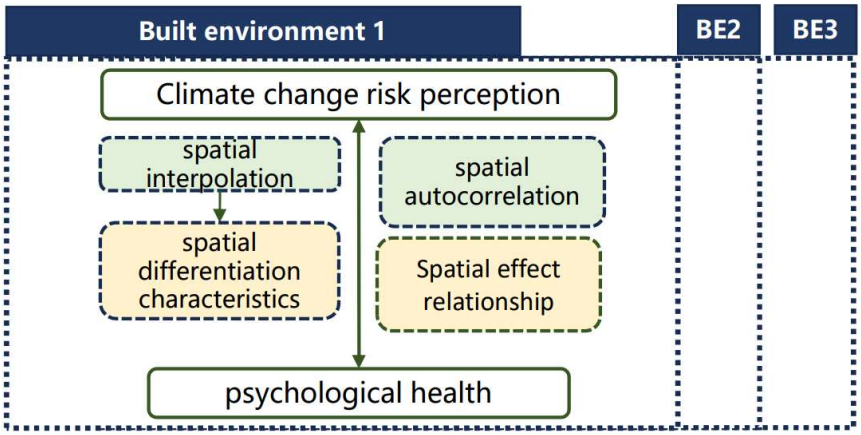


Figure 1. The spatial distribution of various dimensions of climate change risk perception. Source: drawn by the author.

2.2. Data Sources

In conducting the dimensional screening process, the indicators used in this study were identified and categorised under each dimension by using the previous research literature as a basis and by selecting their recurrent indicators in conjunction with the existing research questions. The four dimensions of climate change risk perception are Affective Response (3 indicators), Adaptation Intentions (4 indicators), Cognizance (3 indicators), and Self-efficacy (2 indicators). Socioeconomic data collected included age, educational attainment, income (in RMB), gender (male = 1, female = 2), past experience, and occupation. A 1-4 Likert scale was used to measure all indicators of climate change risk perception, with scale points ranging from very low (1), low (2), high (3), to very high (4). After finalizing the indicators, a survey questionnaire was developed. The first part of the questionnaire covers basic socioeconomic factors, including age, income, gender, and educational level.

The survey data used in this study was collected from March to November 2023 through a climate change risk perception survey using a mixed-method approach of online and offline research. Respondents were recruited from 134 communities across the main urban areas of Harbin, including Daoli District, Daowai District, Nangang District, and Xiangfang District, resulting in a total of 752 participants. After excluding incomplete responses, individuals under the age of 12, and those who did not acknowledge the existence of climate change, 551 valid respondents remained. To ensure the geographical representativeness of the sample, a stratified multi-stage sampling method was employed. The geographical location of respondents was determined based on the community name they provided.

Regarding mental health, the WHO-5 Well-Being Index (1998 version) was used, which measures five dimensions: active and vigorous, calm and relaxed, fresh and rested, cheerful and in good spirits, and filled with things that interest. These dimensions were used to assess different aspects of residents' mental health.

Finally, the main urban areas of Harbin were divided into 500m fishnet grid cells, and spatial connections were established with the respective data for further analysis.

3. Result

3.1. The spatial distribution of climate change risk perception

There are clear spatial differences in perceptions of climate change risk within cities, which are closely linked to gentrification of urban development. Residents' socio-economic status and income influence their choice of place of residence, and areas with higher quality built environments tend to have more favourable climatic conditions. As a result, residents in these areas are relatively less exposed to unfavourable urban environmental conditions, and conversely, those in more vulnerable cities are rather more exposed to unfavourable urban environmental conditions.

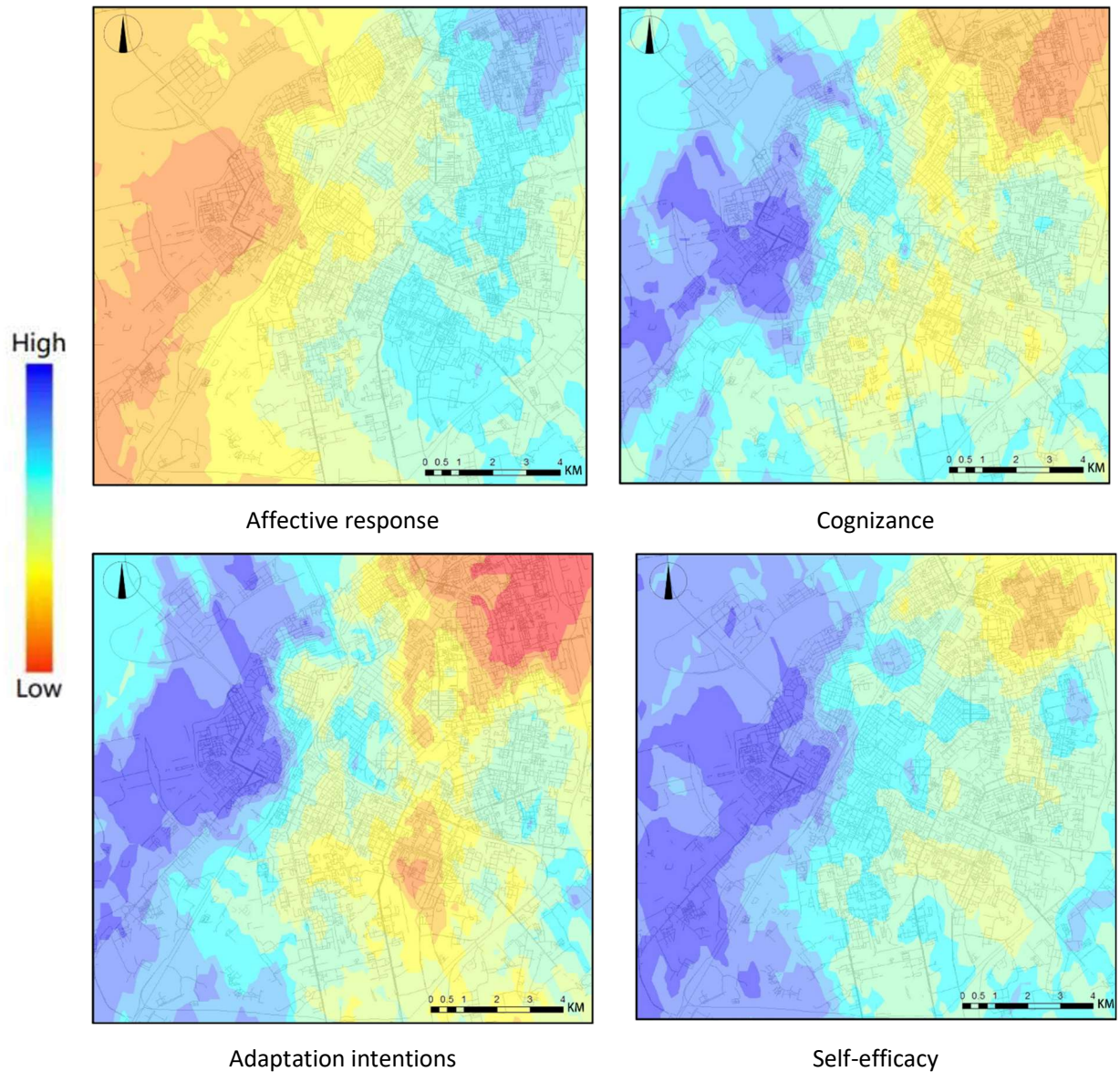


Figure 2. The spatial distribution of various dimensions of climate change risk perception. Source: drawn by the author.

In Figure 2, the distribution of CCRP varies across different dimensions. The low-value point for Affective Response is located in Daoli District, a built area of Harbin known for its relatively high economic status,

high construction quality, and higher housing prices. Residents in this area generally have higher income levels, giving them more time and resources to cope with the risks associated with climate change. Consequently, their Affective Response is relatively low. In contrast, in the older parts of Harbin, where infrastructure is poor, buildings are aging, and residents have lower income levels, the ability to cope with climate change is weaker, and the fear of climate risks is greater.

In the dimensions of Cognizance, Adaptation Intentions, and Self-Efficacy, the distribution is the opposite of Affective Response, with low values mostly appearing in outlying areas and high values concentrated in the central areas. Although there are some variations in hotspot distribution, the overall trends are similar. This suggests that individuals with higher socioeconomic status have greater access to climate change knowledge, are more willing and able to take action, and possess a deeper understanding of climate change.

In the dimension of Adaptation Intentions, there is also a low-value hotspot in Xiangfang District, which is near several universities. This may be linked to the activity habits of university students, who often study or engage in entertainment indoors, relying on the cool spaces provided by buildings to avoid extreme weather. Their adaptation behaviors tend to be passive, influenced by factors beyond their control, such as university regulations. For instance, students cannot install air conditioning in dormitories without permission, even in extreme heat. Additionally, studies suggest that while many students have a basic understanding of climate change, they lack knowledge of specific adaptation measures and the concrete impacts of climate change. In addition, it has been shown that as age decreases, more and more college students are more inclined to be less active outdoors, especially in the winter and summer months, even though college students have some level of knowledge about their climate change situation.

3.2. The spatial distribution of climate change risk perception

In Figure 3, the spatial distribution pattern of the impact mechanism of climate change risk perception and built environments appears generally stable. Similar trends were observed in the dimensions of Adaptation Intentions, Self-Efficacy, and Cognizance. The high-value (H-H) areas for each dimension of climate change risk perception are primarily concentrated in Daoli District. This indicates that residents with higher socioeconomic status possess a better understanding of climate change and are more willing to invest time and resources in responding to climate-related situations, leading to a higher level of climate change risk perception. Consequently, residents in this area are less affected by the mental health impacts of climate change.

Conversely, the low-value (L-L) areas are mainly found in Daowai District, Nangang District, and parts of Xiangfang District (near the city suburbs). This suggests that residents with lower socioeconomic status often lack the time or awareness to consider climate change, resulting in a lower level of climate change risk perception and greater vulnerability to the mental health impacts of climate change.

Mental Health and Adaptation Intentions

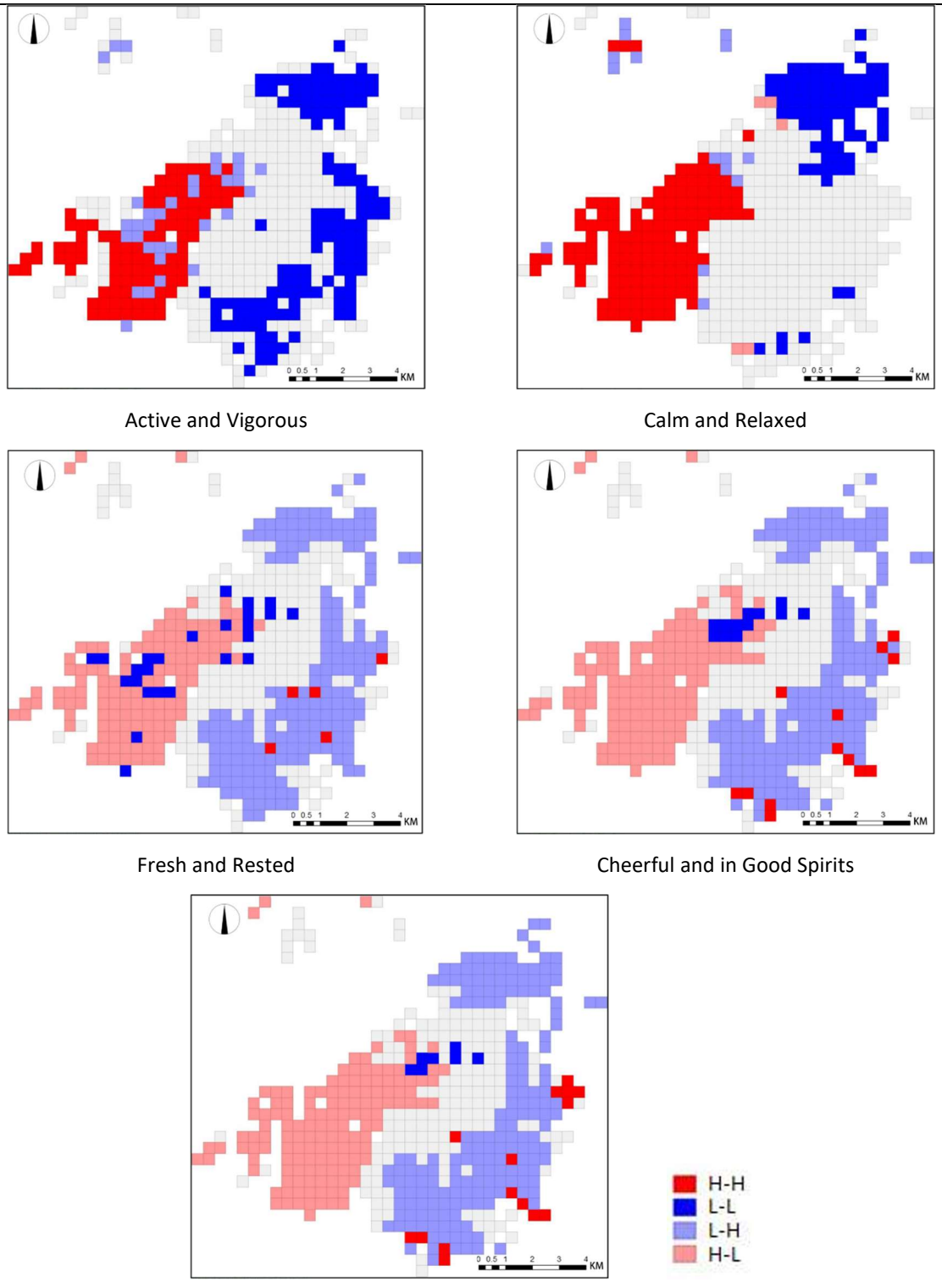


Figure 3.1 Spatial autocorrelation between Adaptation Intentions and residents' mental health. Source: drawn by the author.

Mental Health and Self-efficacy

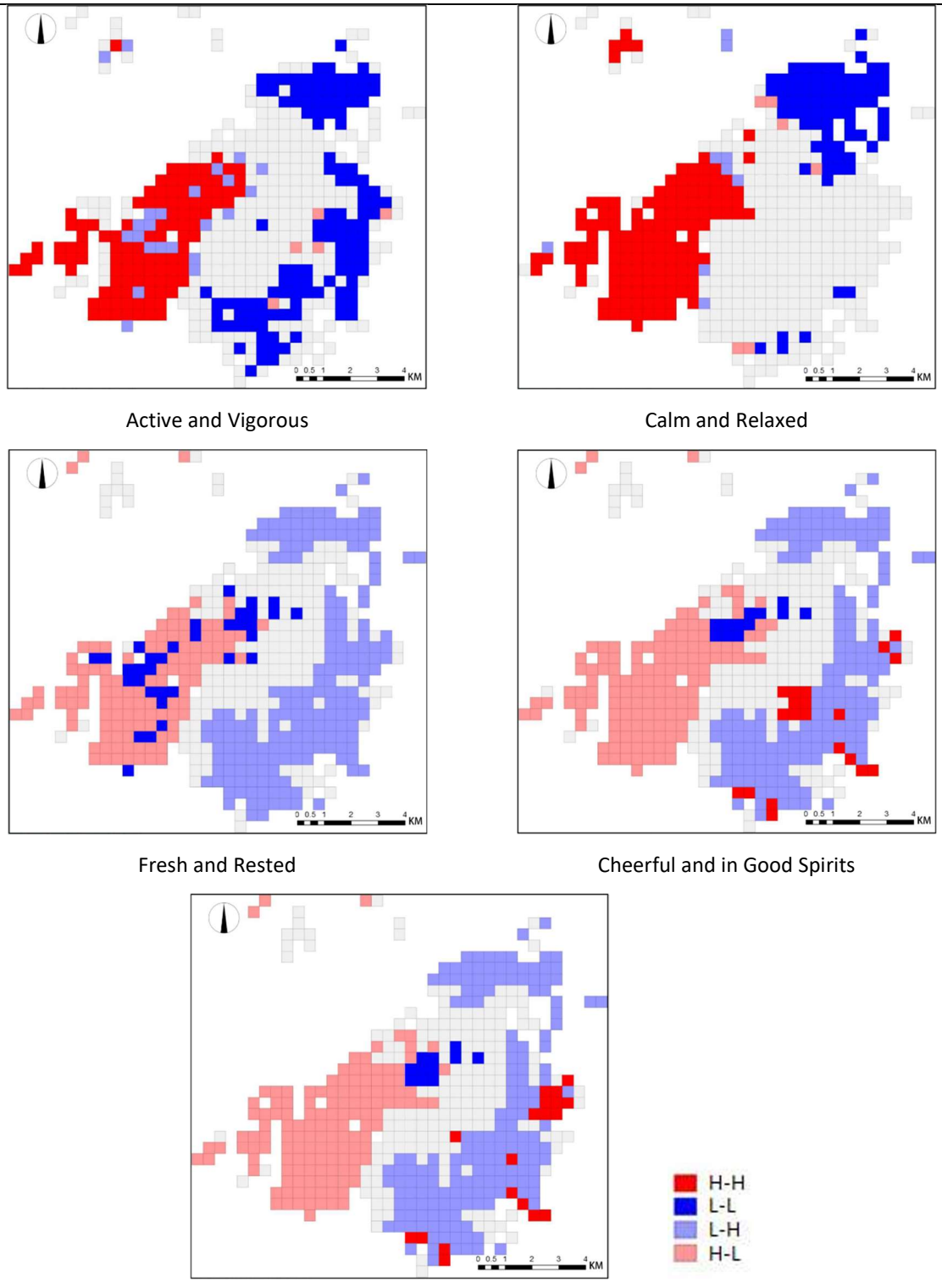


Figure 3.2 Spatial autocorrelation between Self-efficacy and residents' mental health. Source: drawn by the author.

Mental Health and Cognizance

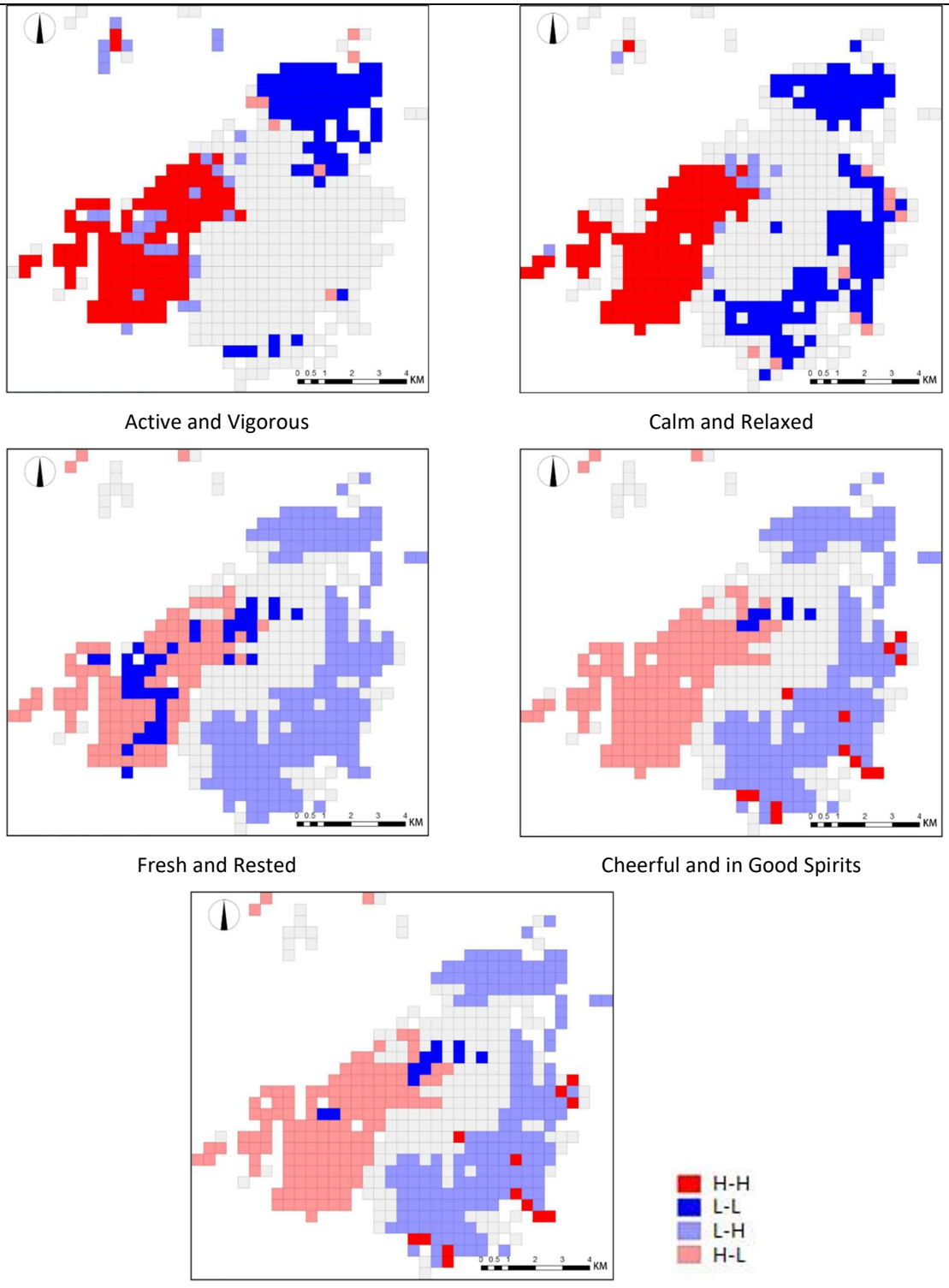
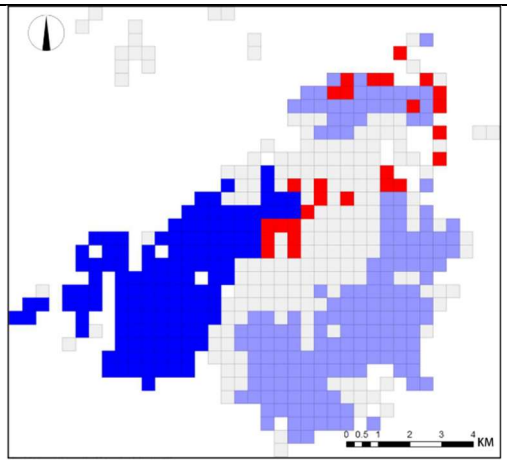
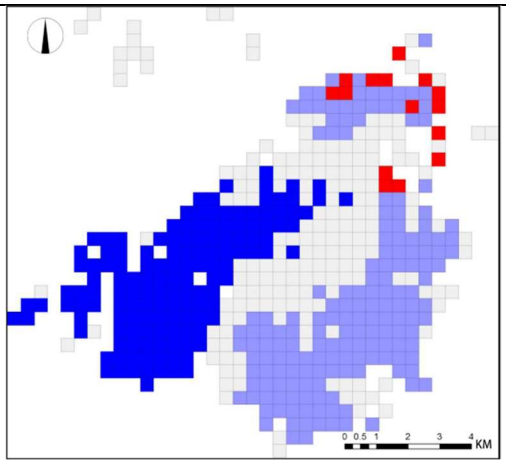


Figure 3.3 Spatial autocorrelation between Cognizance and residents' mental health. Source: drawn by the author.

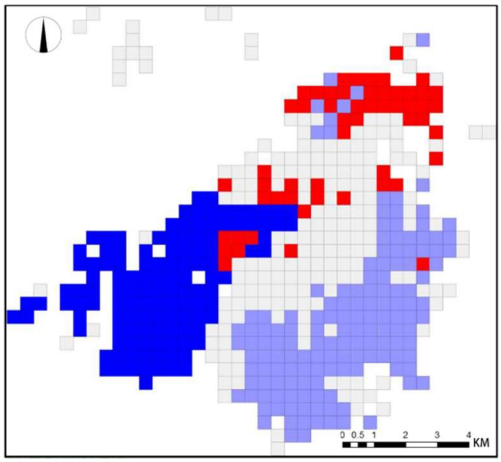
Mental Health and Affective Response



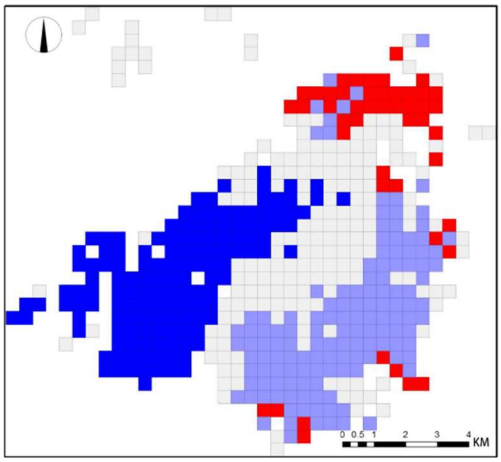
Active and Vigorous



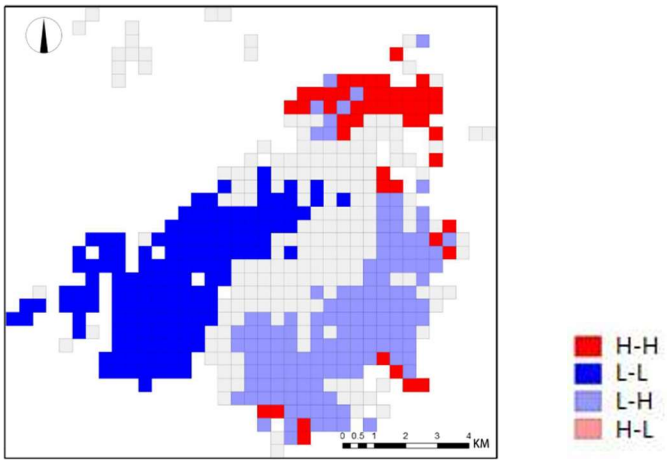
Calm and Relaxed



Fresh and Rested



Cheerful and in Good Spirits



Mental Health and Affective Response

Figure 3.4 Spatial autocorrelation between Affective Response and residents' mental health. Source: drawn by the author.

The Affective Response dimension is the opposite of the first three dimensions, as it reflects the negative experiences of urban residents in response to climate change. The Sky View Factor (SVF) and building height exhibit low-high (L-H) value aggregation in certain areas of Daowai, Nangang, and Xiangfang, while high-low (H-L) value aggregation is observed in Daoli District.

In Figure 3, it is evident that, due to the impact of climate change, the dimensions of mental health—specifically "Active and Vigorous" and "Calm and Relaxed"—in Daoli and Daowai Districts of Harbin City are generally positively correlated with climate change risk perception. In contrast, other dimensions of mental health also show positive correlations with climate change risk perception. However, in Nangang District, Xiangfang District, and other areas, most dimensions exhibit negative correlations in the Affective Response dimension, although a few dimensions are not statistically significant. The distribution characteristics of these areas are generally consistent with those of Daoli and Daowai Districts.

This indicates a significant relationship between climate change risk perception and residents' mental health, characterized by high spatial autocorrelation. The degree of this correlation varies across different regions of the city, highlighting the need for further research tailored to the characteristics of the populations in these areas. Such research could help identify the impact patterns for different groups of urban residents and propose targeted strategies.

3.3. Strategy

The impact of climate change risk on urban residents has not been fully clarified, and at this stage, most of the relevant studies have used climate change risk perception as a moderator variable to express the impact of climate change risk on residents, to explore its impact on the physical, psychological, and behavioural aspects of the residents, which has not yet been established, and there is not a set of standard paradigm based on a set of effective, and the current research are The current research is based on the selection of indicators according to the focus of the research. In this paper we focus on the impact of climate change risk perceptions on the mental health of the population and the differentiation of this impact across built environments, but physical health and adaptive behaviours, for example, can be characterised in the same way, and there may be spatial differences in impacts between them. Such differences and support are often created through differences in built environments within communities as well as community support, which may be significantly related to an individual's social network as well as social interaction activities, but unfortunately none of the above conjectures were tested in this paper.

Future research that explores the pathways of climate change risk perceptions on urban residents in a relatively complete manner will allow for the development and implementation of comprehensive policies and targeted programmes, with the necessary assessment and monitoring, and the regulation of the allocation of needed resources, which could be of great significance for climate justice in urban areas, thus further reducing the overall climate health risks of the population.

Special support should be given to vulnerable groups in cities, such as women, outdoor workers, low-income groups, etc., to protect women and vulnerable groups, who are often more susceptible to the risks posed by climate change than the rest of the population, causing deeper psychological stress. Public awareness-raising and knowledge dissemination should also be carried out to estimate, through publicity and education, that urban residents will respond positively to climate change and actively prepare for long-term climate change events in order to alleviate climate anxiety.

4. References

[1]Alibudbud, R. (2023) 'Mental health service, training, promotion, and research during typhoons: Climate change experiences from the Philippines', *Asian Journal of Psychiatry*, 86. Available at: https://doi.org/10.1016/j.ajp.2023.103673.

[2]Ansah, E.W. *et al.* (2024) 'Climate change, urban vulnerabilities and adaptation in Africa: a scoping review', *Climatic Change*. Springer Science and Business Media B.V. Available at: https://doi.org/10.1007/s10584-024-03711-8.

[3]Arya, B. and Kumar, H. (2023) 'An Investigation of Climate Change, Eco-Anxiety and Risk Perception in The Context of Theory of Planned Behaviour', in *IOP Conference Series: Earth and Environmental Science*. Institute of Physics. Available at: https://doi.org/10.1088/1755-1315/1279/1/012020.

[4]Bourque, F. and Cunsolo Willox, A. (2014) 'Climate change: The next challenge for public mental health?', *International Review of Psychiatry*, 26(4), pp. 415–422. Available at: https://doi.org/10.3109/09540261.2014.925851.

[5]Brody, S.D. *et al.* (2008) 'Examining the relationship between physical vulnerability and public perceptions of global climate change in the United States', *Environment and Behavior*, 40(1), pp. 72–95. Available at: https://doi.org/10.1177/0013916506298800.

[6]Charlson, F. *et al.* (2021) 'Climate Change and Mental Health: A Scoping Review', *Public Health*, 18, p. 4486. Available at: https://doi.org/10.3390/ijerph.

[7]Cianconi, P., Betrò, S. and Janiri, L. (2020) 'The Impact of Climate Change on Mental Health: A Systematic Descriptive Review', *Frontiers in Psychiatry*, 11. Available at: https://doi.org/10.3389/fpsyt.2020.00074.

[8]Deng, X. *et al.* (2023) 'Spatiotemporal evolution patterns of urban heat island and its relationship with urbanization in Guangdong-Hong Kong-Macao greater bay area of China from 2000 to 2020', *Ecological Indicators*, 146. Available at: https://doi.org/10.1016/j.ecolind.2022.109817.

[9]Doherty, T.J. and Clayton, S. (2011) 'The Psychological Impacts of Global Climate Change', *American Psychologist*, 66(4), pp. 265–276. Available at: https://doi.org/10.1037/a0023141.

[10]Ebi, K.L. *et al.* (2025) 'Extreme Weather and Climate Change: Population Health and Health System Implications', *Annual Review of Public Health Downloaded from www.annualreviews.org. Guest (guest* [Preprint]. Available at: https://doi.org/10.1146/annurev-publhealth.

[11]Evans, G.W. (2018) 'Projected Behavioral Impacts of Global Climate Change', *Review in Advance first posted on* [Preprint]. Available at: https://doi.org/10.1146/annurev-psych-010418.

[12]Gao, Y., Zhao, J. and Han, L. (2022) 'Exploring the spatial heterogeneity of urban heat island effect and its relationship to block morphology with the geographically weighted regression model', *Sustainable Cities and Society*, 76. Available at: https://doi.org/10.1016/j.scs.2021.103431.

[13]Hayes, K. *et al.* (2018) 'Climate change and mental health: Risks, impacts and priority actions', *International Journal of Mental Health Systems*, 12(1). Available at: https://doi.org/10.1186/s13033-018-0210-6.

[14]Hussein, A.K., Dosh, R.J. and Abojassim, A.A. (2023) 'Using of a Moran's I and Hot Spot Analysis to Identify of Thoron in Najaf City using GIS Software', *Pollution*, 9(3), pp. 1140–1149. Available at: https://doi.org/10.22059/poll.2023.354568.1768.

[15]Kabisch, N. *et al.* (2024) 'Monitoring and perception of allergenic pollen in urban park environments', *Landscape and Urban Planning*, 250. Available at: https://doi.org/10.1016/j.landurbplan.2024.105133.

[16]Kjellstrom, T. and McMichael, A.J. (2013) 'Climate change threats to population health and well-being: The imperative of protective solutions that will last', *Global Health Action*, 6(1). Available at: https://doi.org/10.3402/gha.v6i0.20816.

[17]Majumder, S. *et al.* (2023) 'Multiscale GIS based-model to assess urban social vulnerability and associated risk: Evidence from 146 urban centers of Eastern India', *Sustainable Cities and Society*, 96. Available at: https://doi.org/10.1016/j.scs.2023.104692.

[18]Newberry Le Vay, J. *et al.* (2023) 'Integrating mental health into climate change education to inspire climate action while safeguarding mental health', *Frontiers in Psychology*, 14. Available at: https://doi.org/10.3389/fpsyg.2023.1298623.

[19]Obradovich, N. *et al.* (no date) 'Empirical evidence of mental health risks posed by climate change'. Available at: https://doi.org/10.7910/DVN/OVQY76.

[20]Reyes-Riveros, R. *et al.* (2021) 'Linking public urban green spaces and human well-being: A systematic review', *Urban Forestry and Urban Greening*. Elsevier GmbH. Available at: https://doi.org/10.1016/j.ufug.2021.127105.

[21]Salas Reyes, R. *et al.* (2021) 'A Research Agenda for Affective Dimensions in Climate Change Risk Perception and Risk Communication', *Frontiers in Climate*, 3. Available at: https://doi.org/10.3389/fclim.2021.751310.

[22]Villacis, A.H., Alwang, J.R. and Barrera, V. (2021) 'Linking risk preferences and risk perceptions of climate change: A prospect theory approach', *Agricultural Economics (United Kingdom)*, 52(5), pp. 863–877. Available at: https://doi.org/10.1111/agec.12659.

[23]Zeren Cetin, I., Varol, T. and Ozel, H.B. (2023) 'A geographic information systems and remote sensing–based approach to assess urban micro-climate change and its impact on human health in Bartin, Turkey', *Environmental Monitoring and Assessment*, 195(5). Available at: https://doi.org/10.1007/s10661-023-11105-z.

[24]Zhou, M., Wang, R. and Guo, Y. (2024) 'How urban spatial characteristics impact surface urban heat island in subtropical high-density cities based on LCZs: A case study of Macau', *Sustainable Cities and Society*, 112. Available at: https://doi.org/10.1016/j.scs.2024.105587.