The impact of psychological distance to climate change and urban informality on adaptation planning

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Abstract

Climate change adaptation planning involves adjusting to the impacts of climate change and taking action to mitigate its adverse effects. Psychological distance, the separation between one's self-perception and actual events, can play a significant role in an individual's readiness to adapt to climate change impacts. This study aims to investigate the socioeconomic factors associated with psychological distance to climate change in formal and informal settlements of Lahore, Pakistan. Using a literature review, data indicators were selected and grouped into the psychological distance dimensions of spatial, temporal, social, and hypothetical. A questionnaire survey was conducted in the study area, resulting in a total of 400 responses. Descriptive statistics and sampled paired t-tests were used to measure differences between responses from formal and informal communities, and multivariate regression models were developed to identify socioeconomic factors associated with psychological distance to climate change. The results of the study indicate a significant difference between formal and informal settlements in spatial distance and hypothetical dimensions. Additionally, household size, average household income, number of children, and past experiences with extreme weather conditions were found to be significant factors. The study recommends that these factors be taken into account when

engaging with the public, communicating risks, and devising relevant policies for effective adaptation planning.

1. Introduction

Climate change poses a significant threat to humanity, with changing climatic conditions and associated natural hazards causing significant damage to global human and environmental systems (IPCC, 2018, 2021). In the past 50 years, climatic events and natural hazards have resulted in the loss of 3.7 million lives, affected 8 billion people, and caused damages of US$ 3.6 trillion. According to a recent report by the Intergovernmental Panel on Climate Change (IPCC), 3.3 to 3.6 billion people live in contexts that are highly vulnerable to the impacts of climate change (Birkmann, Liwenga, et al., 2022; Pörtner et al., 2022). Furthermore, the report suggests that mortality due to climate hazards is 15 times higher in highly vulnerable countries compared to very low vulnerable countries (Birkmann, Jamshed, et al., 2022; Birkmann, Liwenga, et al., 2022). Given the severity and increasing risk of climate change, it is essential to develop resilience and coping mechanisms, including communities' behavior and attitude towards climate change. The actions and practices that a community chooses to adopt are closely linked to their perceptions and understanding of climate change, which are crucial to explore. The increasing perils posed by climate change present a multifaceted challenge that encompasses existential, physical, and psychological dimensions (Maiella et al., 2020). In light of this, the phenomenon of "psychological distancing" has emerged as a crucial area of inquiry within the field of climate change research. Psychological distancing refers to the tendency for individuals to unconsciously perceive environmental threats, such as climate change, as being psychologically remote, despite their real-world impact (Liberman et al., 2007). The concept of psychological distancing has gained significant importance in the

study of climate change due to its implications for public perception and behavior (Brügger, 2020; de Guttry et al., 2019; Jones et al., 2017; McDonald et al., 2015; Spence et al., 2012).

The Construal Level Theory (CLT) is a psychological framework that explains how individuals make sense of events or objects that are not directly experienced (Trope & Liberman, 2010). The theory is grounded in the concept of psychological distance, which refers to the degree to which an event or object is removed from an individual's direct experience. CLT posits that as psychological distance increases, individuals tend to re-imagine and construct or reconstruct the mental representation of the event or object at different levels of construal (Armstrong et al., 2019; de Guttry et al., 2019).

The Construal Level Theory (CLT) is a widely-utilized framework that explains psychological distancing in terms of different dimensions, including temporal, spatial, social, and hypothetical (Maiella et al., 2020). This theory recognizes that psychological distancing is intertwined with a range of factors related to climate change, including individual perceptions, beliefs, behaviors, and aspects of social life (de Guttry et al., 2019; McDonald et al., 2015). However, despite its widespread usage, CLT has been criticized for several reasons, including a lack of clarity in its definition and application, limited generalizability, and a dearth of empirical evidence to support its claims (see details in Brügger 2020)(Keller et al., 2022). In light of these criticisms, McDonald et al. (2015) have recommended a more comprehensive examination of all dimensions of psychological distancing in the context of climate change. A more systematic investigation of psychological distancing is therefore needed to better understand its role in shaping public attitudes and behaviors related to climate change (Jones et al., 2017; Spence et al., 2012).

Research has shown that direct experience of climate change-related events (proximity) can increase concern and action on climate change. Conversely, psychological distance acts as a significant barrier to public engagement with climate change issues (Jones et al., 2017). As a result, it is suggested that

reducing the public's psychological distance to climate change by increasing awareness and sensitivity to the issue through improved communication can lead to more positive attitudes and behaviors towards climate change (McDonald et al., 2015). Therefore, it is crucial to study psychological distance to climate change and the factors that influence it in order to better understand public perceptions of climate change and adaptation behaviors.

Pakistan is particularly vulnerable to disasters and climate change impacts (Abdul & Yu, 2020; Rana & Routray, 2018). The country has experienced a range of climatic events, including large-scale flooding, extreme temperatures, drought conditions, and limited capacities for coping and adapting to these events. This has revealed the vulnerability of socio-ecological systems in Pakistan (Abid et al., 2016; Jamshed et al., 2020). Rapid urbanization and a lack of corrective measures for risk reduction have also increased urban risks (Rana et al., 2021). As a result, Pakistan is ranked 5th on the long-term climate risk index (Eckstein et al., 2019). Despite the abundance of literature on risk perception in the field of climate change (Abid et al., 2016; A. B. Aslam et al., 2022; A. Aslam & Rana, 2022; Saqib et al., 2016), little attention has been paid to the concept of psychological distancing in relation to the different types of settlements within urban areas, specifically formal and informal settlements[1]. These two types of settlements possess distinct social, economic, physical, environmental, and spatial characteristics (Graesser et al., 2012; Ono & Kidokoro, 2020; Snyder et al., 2014; Zhang et al., 2020), and it is likely that their inhabitants' perceptions of climate change-related risks also differ (Rana et al., 2020; Ullah et al., 2015). In light of this gap in research, it is crucial to investigate the perception of dwellers living in formal and informal settlements

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[1] UN HABITAT defined informal settlements as "…areas where inhabitants are deemed by the authorities to have no legal claim to the land they occupy and the system of occupation ranges from squatting to informal rental housing. In most cases, the housing is insecure and poor quality and does not comply with current planning and building regulations. Informal settlements are also often situated in the most precarious urban areas where basic services and infrastructure including public or green space are limited". (UNHABITAT, 2017)

towards climate change, with a specific focus on psychological distancing. This information is crucial for the effective prioritization of actions, engagement of the public, communication of risk, and reduction of climate change impacts. Thus, this research aims to: (1) quantify psychological distancing to climate change in formal and informal settlements in Lahore, Pakistan; and (2) identify the determinants of psychological distancing to climate change in these settlements. This study contributes by answering the following research questions:

RQ1: How much is the psychological distance to climate change between formal and informal settlements?

H1: Psychological distance to climate change varies between formal and formal settlements.

RQ2: What socioeconomic factors are associated with psychological distance in formal and informal settlements?

H2: Different socioeconomic factors are associated psychological distance in formal and informal settlements

2. Psychological distance to climate change and urban formality

Globally, people may or may not attribute climate change as something that will happen within a distance in terms of temporality or geography (de Guttry et al., 2019). The public sometimes does not believe that climate change can be experienced directly or indirectly in the present or the future (McDonald et al., 2015). Such prevailing and ever-growing perception directed the scientific community towards Construal Level Theory (CLT). Baltatescu (2014) explained psychological distance as *"A cognitive separation between the self and other instances such as persons, events, or times"* (Baltatescu, 2014). First, the theory was limited to temporal distance; however, later, the theory was extended and included three other dimensions, i.e., social, spatial, temporal, and hypothetical (Figure 1). The dimension of 'spatial distance' comprehends the individual to his judgment; 'social distance' looks into

the linkage of individuals with the rest of the world, while 'hypothetical distance' is between specific and hypothetical events (Baltatescu, 2014). The scientific community also proposed other dimensions, such as informational distance (Fiedler, 2007).

The concept of psychological distance, as contextualized within the framework of the CLT, has been applied to the study of individuals' perceptions of climate change and the potential impacts it may have on their adaptation measures (Bar-Anan et al., 2006; Brügger, 2020). However, the relationship between psychological distance dimensions and climate change perceptions remains an area in need of further empirical verification (McDonald et al., 2015). Leiserowitz et al. (2013) found that individuals tend to perceive climate change as happening in distant locations and in the distant future, rather than in their immediate vicinity (Leiserowitz et al., 2013). Furthermore, Spence and Pidgeon (2010) found that individuals and communities tend to perceive the potential impacts of climate change as being less severe than the actual impacts on society as a whole (Spence & Pidgeon, 2010). Additionally, Spence et al. (2011) found that personal experiences with natural disasters have a significant impact on an individual's perceptions of climate change. For instance, those who have experienced floods are more likely to believe in climate change than those who have not.

Recent studies have also suggested that rare extreme events, unless they happened recently, had limited influence on beliefs and decisions but recent events have limited impacts on people with pre-existing beliefs rejecting climate change (Sambrook et al., 2021). A study found that flood events in Colorado did not change existing climate change beliefs but created awareness of risks and vulnerabilities to climate change (Shepard et al., 2018). Another study highlighted the importance of geographic location and hazard experience as factors influencing risk perception (Allan et al., 2020). Moreover, most studies investigating the linkage of CLT, psychological distance, and climate change impact were conducted in western/developed countries like the USA and UK.

Currently, the global urban population stands at 4.4 billion individuals, with approximately 1 billion residing in informal settlements (Satterthwaite et al., 2020). Informal settlements are defined as urban areas that do not fall under legal systems of land ownership and tenure. These settlements often lack compliance with building, health, and safety standards and essential utilities such as clean drinking water and proper sanitation. Due to their informal status, city governments are often unable or unwilling to provide necessary infrastructure and services, such as paved roads, piped water, sewerage, drainage, healthcare, emergency services, and legal protections (Satterthwaite et al., 2020).

Climate change affects all communities, regardless of whether they are rural or urban, belong to any socioeconomic group, or live in formal or informal settlements. However, the impacts of climate change are disproportionately concentrated in informal settlements ((Mitlin & Satterthwaite, 2013). The residents of these areas are often more exposed to climate-related events, particularly children, women, those with health vulnerabilities, and the elderly (Revi et al., 2014). Factors such as low income, limited resources, inadequate infrastructure, and dangerous locations increase their vulnerability to climate and disaster risks (Moser & Satterthwaite, 2009).

Figure 1: Psychological distancing to climate change and its dimensions

Several studies have examined the relationship between psychological distancing and flood risk perception in relation to different built environments. For example, Aslam & Rana, (2022) investigated the impact of various urban built environments on public perception and its relationship with psychological distance to climate change. The study found that different risk perceptions and psychological distances are associated with different physical settings, and a strong negative correlation was found between risk perception and psychological distance to climate change. Similarly, Rasool, Rana, & Ahmad, (2022) studied flood risk perception and psychological distance to climate change in rural communities in Pakistan and found that high flood risk areas had moderate levels of risk perception and psychological distance to climate change. It was reported that willingness to practice mitigation measures is negatively associated with psychological distance and positively linked with risk perception (Carmi & Kimhi, 2015). Therefore, this study aims to quantify the psychological distance to climate change and identify socioeconomic factors that influence it in the context of formal and informal settlements in Lahore, Pakistan. It is recommended that efforts be made to reduce psychological distance to climate change through improved risk communication for effective adaptation planning.

3. Methods and data

3.1 Study area selection

Lahore is one of the most populous cities in Pakistan, with a population of over 11 million people. As the administrative capital of the Punjab province, Lahore has experienced significant growth and expansion in recent years (Rana & Bhatti, 2018). The city is expanding along key corridors such as Grand Trunk Road and Burki Road towards the north and northeast and Multan Road and Ferozepur Road towards the south. This growth has led to the development of both formal and informal settlements. Lahore is bordered by the international border with India on the east and the northeast, while the River Ravi flows

from north to south along the western edge of the city. The district of Kasur is located to the south of Lahore (Figure 2).

Faisal Town is a formal settlement that has been recognized and approved by the Lahore Development Authority. It is a low to medium-density neighborhood located in the middle of the city, well-connected and situated between Model Town and Johar Town. With a population of over 51,000, the town is easily accessible via Maulana Shaukat Ali Road, which is lined with eateries on both sides. The neighborhood is close to commercial areas, educational institutes, and hospitals, and is well-connected to local transport, including the Metro Bus and Orange Line Metro Train, making it a centrally-located area within the city (Figure 3).

Kotha Pind is an informal settlement located within Faisal Town and linked to the major circulation of Faisal Town via Abul Hassan Isfahani Road and Qazi Muhammad Isa Road. It is surrounded by the planned development of Faisal Town. The internal network of Kotha Pind is inefficient with narrow, congested streets and it has grown informally, without following any urban planning or space standards. The settlement offers low-quality living for its residents, with insufficient sewerage and sanitation facilities (Figure 3).
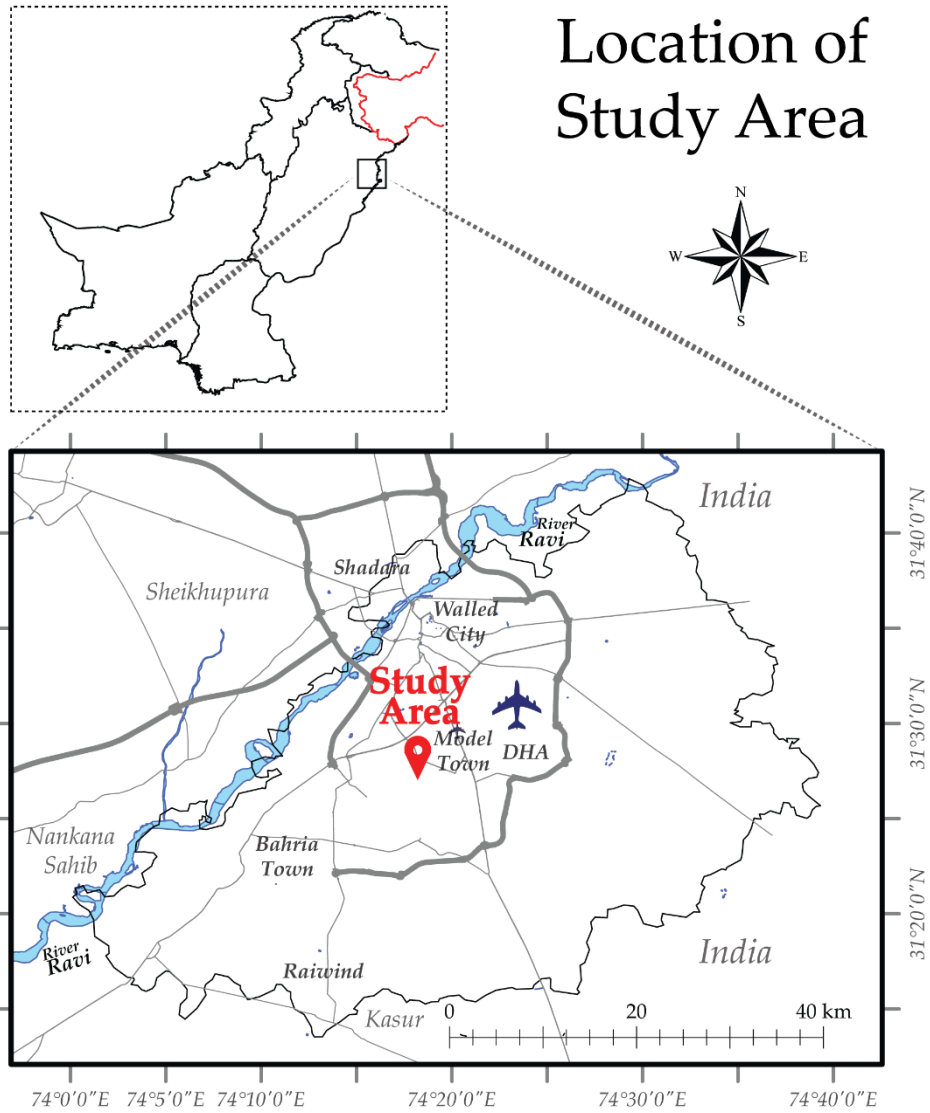
Figure 2 Location of the study area in the Lahore Metropolitan, Pakistan
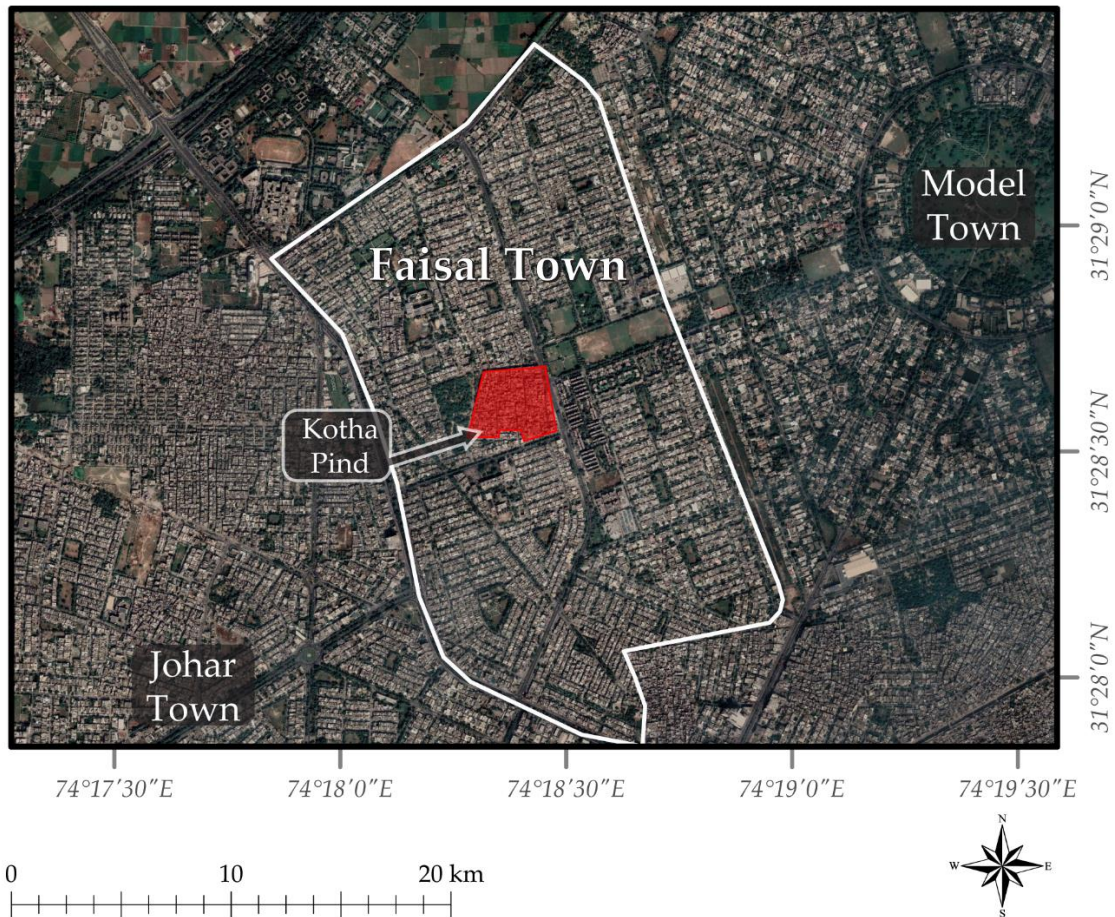
Figure 3 Location and boundary of Faisal Town (formal settlement) and Kotha Pind (informal settlement)

3.2 Research design, sampling, and data collection

This study employs a quantitative and descriptive research approach to quantify psychological distance to climate change, as well as an explanatory research design to identify socioeconomic indicators that influence psychological distance to climate change. The data was collected in four dimensions: spatial/geographic, temporal, social, and hypothetical (Table 1). A questionnaire was developed to gather data from individual respondents through a set of questions for each of these dimensions. The concepts of climate change risk perceptions and psychological distance are commonly measured on a 1-5 Likert scale, thus, all indicators were extracted from literature and measured on a 1-5 Likert scale (A.

Aslam & Rana, 2022; McDonald et al., 2015; Rasool et al., 2022; Spence et al., 2012). The questionnaire

also captures data on the socioeconomic conditions (age, gender, income, etc.) of the respondents.

Cochran's sampling technique was applied to determine the sample size, with a confidence level of 95%

and a 5% margin of error.

A total of 400 questionnaires were collected, with 200 responses from the formal settlement (Faisal

Town) and 200 responses from the informal settlement (Kotha Pind). A random sampling method was

used to collect responses from the settlements. The respondents were briefed about the purpose of the

study and provided informed consent prior to the survey. Fieldwork was conducted in February 2020,

and six undergraduate students from a local university were trained in data collection. The survey team

was thoroughly briefed and the questionnaire was discussed in detail to ensure clarity.

Table 1. Questions asking individuals about the different dimensions and indicators of psychological

distance (Each question was measured on a 5-point Likert scale[1]. Additionally, some questions were

scored inversely[2])

Sr. No.	Dimensions, Indicators, and Questions
Spatial/Geographic Distance	
S1	How much is your local community likely to be affected? (local level)
S2	How much is your region likely to be affected? (city/regional level)
S3	In your view, how much will climate change impact your country? (national level)
S4	In your view, how much will climate change impact the world? (global level)
Temporal Distance	
T1	How much do you agree that the country is facing the impacts of climate change now?
T2	How much are you convinced that climate change will impact future generations?

Social Distance	
SOC1	How much will you and your household be likely to be affected due to climate change?
SOC2	How much do you believe humans are causing climate change?
Hypothetical distance	
U1	How certain are you that climate change is happening?
U2	How certain are you that climate change is threatening the world?
U3	How much do you think that the urgency of climate change is exaggerated?[2]
U4	How certain are you that climate change will damage humans in the future?

[1] Scale: 5- Very low/strongly disagree to 1-very high/strongly agree

[2] Inversed in scale for analysis

Source of items: (A. Aslam & Rana, 2022; McDonald et al., 2015; Rasool et al., 2022; Spence et al., 2012).

Table 2. Socioeconomic factors

Sr. No.	Factors	Data type
1	Age	Numeric
2	Gender	Binary
3	Education	Numeric
4	Household income	Numeric
5	Number of children in the household	Numeric
6	Past experience with an extreme event	Binary

3.3 Data analytical techniques

3.3.1 Index construction

An index is a commonly used method to measure risk perceptions in climate change adaptation and disaster risk reduction (Birkmann, 2006; Rana et al., 2020). In this study, the weighted average index method was used to develop the index to quantify the psychological distance to climate change and its dimensions. The index is developed by weighting the different indicators and dimensions of psychological distance to climate change, and then calculating the average score for each respondent. (Eq 1).

$$CI = (W_1 + W_2 + W_3 + \ldots W_n)/n \tag{1}$$

$$= \sum_{i=1}^{n} Wi /n$$

Where CI is the composite index, W_1 to W_n are respective values assigned to indicators, and n is the total number of indicators used for computing the composite index.

Following this general equation, the spatial distance, temporal distance, social distance, and hypothetical distance indices were formulated. The overall psychological distance to climate change was developed by averaging all the indices, as shown in Eq. 2

Spatial distance	$= \sum_{i=1}^{4} SW_i/n$	(n = 4)
Temporal distance	$= \sum_{i=1}^{2} EW_i/n$	(n = 2)
Social distance	$= \sum_{i=1}^{2} PW_i/n$	(n = 2)
Hypothetical distance	$= \sum_{i=1}^{4} IW_i/n$	(n = 4)

$$Psychological\ distance\ to\ climate\ change = \frac{Spatial + Temporal + Social + Uncertainty}{4} \qquad (2)$$

3.3.2 Statistical tests and multivariate regression model

Descriptive statistics were used to determine differences between formal and informal settlements in terms of psychological distance to climate change. Chi-square tests, mean, and standard deviation were performed to compare socioeconomic characteristics and individual indicators of psychological distance to climate change. Multiple regression analysis was conducted to gain a deeper understanding of the socioeconomic factors associated with psychological distance to climate change. The independent variables were socioeconomic factors such as age, education, household size, household income, the number of children in the house, and past experience with extreme events. Psychological distance to climate change was taken as the dependent variable. Three models were run separately, one for formal settlements, one for informal settlements, and one for overall formal and informal settlements combined.

The study also performed several diagnostic tests to ensure the robustness of the results. These included the Breusch and Pagan test of heteroskedasticity (Hatekar, 2010), which found no heteroskedasticity in the data; the variance inflation factor (VIF) test, which found no multicollinearity in the variables (Stock, H & Watson, W, 2019); and the Jarque Bera test, which confirmed that the residuals were normally distributed. The p-value of the test (p= 0.62) was insignificant, which confirms that residuals are normally distributed (Choi & Nam, 2008). Additionally, the study checked the reliability of the instruments through the Cronbach's alpha test, which found that the instruments of the population were acceptable and reliable, with a range of values between 0.6 to 0.90 (Taber, 2018). STATA software was used for data analysis and robustness tests.

4. Results

4.1 Socioeconomic profile of respondents

The socioeconomic characteristics of respondents residing in formal and informal settlements differ significantly (Table 3). The results show that 48% of respondents in the informal settlement were below the age of 35 years, compared to 55% in formal settlements. However, the mean age was similar in both settlements. Due to sociocultural restrictions, the number of female respondents was limited. The household size was slightly larger in the informal settlement (7.2) compared to formal settlements (6.9). A significant difference was found in the income levels of respondents in formal and informal settlements (χ^2 = 344.45; p-value = 0.000). The majority of respondents in the formal settlement had a monthly income of more than PKR 75,000, while none of the respondents in the informal settlement fell in that category. All the respondents in the informal settlement had a monthly income below PKR 75,000.

Furthermore, there was a significant difference in education attainment between formal and informal settlements (χ^2 = 226.80; p-value = 0.000). Most respondents in the informal settlement had a high school education or below, while in formal settlements, 95% of respondents had a university education. In terms of occupation, most respondents in the formal settlement were employed in the government and commerce sectors, while in the informal settlement, a considerable proportion of respondents were daily wagers, indicating a more fragile income source in the context of climate stress. Chi-square statistics also suggested that occupation structure was significantly different between formal and informal settlements (χ^2 = 73.13; p-value = 0.000). Overall, it can be concluded that respondents in the informal settlement were socioeconomically disadvantaged compared to respondents in the formal settlement.

Table 3 Socioeconomic characteristics of the sampled population

Socioeconomic characteristics		Faisal town (Formal) n = 200		Kotha Pind (Informal) n = 200		Chi-square test	
		Freq	%age	Freq	%age	χ^2	p-value
Age	<26	36	18.0	26	13.0		
	26-35	59	29.5	83	41.5		
	36-45	75	37.5	74	37.0		
	>45	30	15.0	17	8.5	9.272	0.026
	Min	15		15			
	Max	63		57			
	Mean	35.00		34.51			
	Std Dev	10.246		8.356			
Household size (number of family members)	<6	49	24.5	41	20.5		
	6-7	88	44.0	81	40.5		
	8-9	29	14.5	31	15.5		
	>9	34	17.0	47	23.5	3.154	0.368
	Min	3		4			
	Max	14		14			
	Mean	6.86		7.23			
	Std Dev	1.849		1.945			
Monthly income (in PKR)*	<25,000	0	0.0	13	6.5		
	25001-75000	15	7.5	187	93.5		
	75001-125000	112	56.0	0	0.0		
	>125000	73	36.5	0	0.0	344.455	<0.001
	Min	45,000		20,000			
	Max	280,000		60,000			
	Mean	121,950		36147			
	Std Dev	45042.66		9075.31			
Educational Attainment	Not attended	0	0.0	14	7.0		
	Primary	1	0.5	53	26.5		
	High	2	1.0	68	34.0	226.804	<0.001
	College	7	3.5	22	11.0		
	University	190	95.0	43	21.5		
Occupation of the household head	Unemployed	0	0.0	8	4.0		
	Daily wage earners	0	0.0	45	22.5		
	Agriculture	2	1.0	1	0.5	73.128	<0.001
	Government	90	45.0	43	21.5		
	Trade & Commerce	104	52.0	93	46.5		
	Private work	4	2.0	14	3.5		

*1 USD = 156.85 PKR (20th June 2021)

4.2 Psychological distance to climate change

4.2.1 Spatial distance

The results show that people in informal settlements perceived their communities and households to be at a higher risk than those in formal settlements, despite being geographically located next to each other. Similarly, their responses for country-level impact showed that they believed Pakistan is threatened by climate change, but the perception was found to be higher in formal settlements. This may be due to the fact that media outlets often project the events of natural hazards and disasters as impacts of climate change, and people in formal settlements have access to such news. However, only the perceived impact of climate change on local and national levels was found to be significantly different for formal and informal settlements.

Table 4 Mean and standard deviation values of each indicator of the psychological distance to climate change

Sr. No.	Dimensions, indicators, and questions	Faisal Town (Formal) n = 200		Kotha Pind (Informal) n = 200		Chi-square test	
		Mean	Std Dev	Mean	Std Dev	χ^2	p-value
Spatial/geographic distance							
S1	How much is your local community likely to be affected? (at the local level)	2.51	0.862	2.27	0.728	15.786	0.001
S2	How much is your region likely to be affected? (at the city/regional level)	2.21	0.778	2.19	0.779	1.284	0.864
S3	In your view, how much will climate change impact your country? (at the national level)	2.04	0.844	1.99	0.726	7.245	0.064
S4	In your view, how much will climate change impact the world? (at the global level)	2.06	0.822	1.87	0.755	5.924	0.205
Temporal distance							
T1	How much do you agree that the country is feeling the effects of climate change now?	1.83	0.661	1.75	0.687	2.571	0.277
T2	How much do you agree that climate change will impact future generations?	1.93	0.567	1.98	0.630	1.792	0.617
Social distance							
SOC1	How much will you and your household be likely to be affected due to climate change?	2.58	0.882	2.29	0.767	16.284	0.003

SOC2	How much do you believe humans are causing climate change?	2.08	0.770	2.22	0.809	3.550	0.314
Hypothetical distance							
U1	How certain are you that climate change is happening?	2.31	1.145	1.85	0.650	30.078	0.000
U2	How much are you certain that climate change is threatening the world?	1.89	0.728	1.86	0.790	2.941	0.401
U3	How much do you think that the seriousness of climate change is exaggerated? *	3.44	1.010	3.34	1.183	19.808	0.001
U4	How certain are you that climate change will affect humans in the future?	2.34	0.893	2.61	0.950	9.120	0.028

High mean values show higher risk perception and lower psychological distance

*Reversed in scale

4.2.2 Temporal distance

The temporal distance was attributed to time, and the perception of climate change in terms of time is quantified using two indicators: the effects of climate change today compared to yesteryears, and the likely impacts on future generations. However, no significant difference was found between indicators of temporal distance with climate change in both formal and informal settlements. In both localities, low average values imply that people believed climate change impacts were more prominent than in previous years and would impact future generations. However, in the sampled population, very few respondents (6%) reported facing extreme events in the past several years.

4.2.3 Social distance

The two indicators used to measure the social distance dimension showed opposite yet interesting results. There was a significant difference in responses from formal and informal settlements regarding the adverse impact of climate change on their families (p-value = 0.003), with respondents in the informal settlements perceiving a greater impact on their families. However, there was no statistical difference between respondents regarding the belief that humans are accountable for climate change. The low average values imply that the majority of respondents in both formal and informal settlements

believe that humans are responsible for climate change, indicating that they consider it an anthropogenic phenomenon.

4.2.4 Hypothetical distance

The results showed that the respondents from both formal and informal settlements had a mixed level of certainty regarding the climate change impacts on large spatial and future temporal scales. There was a significant difference between the certainty of the climate change phenomenon in formal and informal settlements (p-value < 0.01), with respondents in formal settlements showing a higher level of uncertainty. A cross-question on the level of seriousness also showed a significant difference between formal and informal settlements (p-value = 0.001). These results suggest that the absence of direct encounters with climate change-related events and lack of participation in any climate change-relevant platform may have prompted these opposing views among the respondents. It also indicates that experience, exposure, and relevant interaction supersede basic demographic factors such as education, social, and economic classes.

4.2.5 Psychological distance to climate change

Initially, a correlation was run among the dimensions of psychological distance to find the internal dynamics and interactions with each other. The spatial distance was found to have a moderate correlation with social distance (0.632), while a weak correlation with temporal distance (0.477) and hypothetical (0.195). Temporal distance had a weak correlation with social distance and hypothetical (0.456 and 0.277). The correlation between social distance and hypothetical was not significant. These correlation tests can provide evidence to link them together to understand better the construal level of theory in the context of climate change, as proposed by some researchers (McDonald et al., 2015).

T-tests were conducted for individual dimensions first and overall psychological distance to understand the difference between formal and informal settlements regarding climate change perceptions. The t-test for spatial distance was significant (at p-value <0.05), and a higher average value implies that formal settlements perceive themselves as spatially more distant from climate change than informal settlements. However, the t-test for temporal distance was not significant, showing no difference in temporal distance between the two settlements. Both communities have similar perceptions of the relationship between humans and climate change, as a t-test for social distance to climate change was also not found significant. Furthermore, people living in formal settlements are more uncertain about climate change than those in informal settlements, as the t-test stands significant (p-value<0.05). Lastly, all four dimensions were combined, and a t-test was conducted for the overall psychological distance. The first hypothesis was confirmed, i.e., null hypothesis (H_0) = both formal and informal settlements had no difference, while alternative hypothesis (H_1) = both formal and informal settlements had a difference in psychological distance. As the p-value was found significant, therefore null hypothesis was rejected, and alternative hypothesis was accepted. Thus, the study answers the first research question, that psychological distance to climate change varies significantly between the selected settlements. However, it is important to note that the observed differences in psychological distancing should be approached with caution due to the limited sample size effect (Cohen's d = 0.20).

Table 5: Statistical differences among formal and informal settlements

Dimension	Faisal town (Formal) n = 200		Kotha Pind (Informal) n = 200		t-test	
	Mean	Std Dev	Mean	Std Dev	t-value	p-value
Spatial	2.202	0.545	2.077	0.538	2.602	**0.010**

Temporal	1.875	0.490	1.860	0.521	0.300	0.764
Social	2.327	0.611	2.225	0.651	1.119	0.265
Hypothetical	2.492	0.406	2.412	0.323	2.155	**0.032**
Psychological distance*	2.224	0.348	2.151	0.404	2.025	**0.044**

* Cronbach's alpha for psychological distance to climate change was 0.611

Note: Positive t-value implies that former (formal settlements) are psychologically more distant from climate change than later (informal settlements)

4.3 Determinants of psychological distance to climate change

Multivariate regression models were employed to investigate the socioeconomic factors associated with the psychological distance to climate change in both formal and informal settlements, as reported in Table 6. The results of Model 1 revealed that household income and size were significantly associated with psychological distance to climate change in formal settlements. This finding is consistent with the results of the previous t-test, which revealed that formal settlements were more psychologically distant from climate change, thereby confirming the hypothesis that comparatively high household income and small household size may contribute to this distance.

Model 2 provided further insight into the socioeconomic factors associated with psychological distance to climate change in informal settlements (Table 6). Results indicated that household size, number of children, and past experiences with climate change events were all significant predictors. Given that a single source of income often characterizes informal settlements, a larger family size may indicate a weaker socioeconomic situation and increased vulnerability to climate change events. Additionally, past experiences with climate change events may reduce uncertainty about the phenomenon.

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Overall, these findings support the second hypothesis that different socioeconomic factors are associated with psychological distance to climate change in formal and informal settlements. The two models effectively answered the second research question by identifying specific socioeconomic factors that influence psychological distance to climate change.

Table 6: Results of multivariate regression models

Socioeconomic factors	Model 1	Model 2
	Faisal Town (Formal)	**Kotha Pind (Informal)**
	n = 200	n = 200
Age	0.00196	0.00432
	(0.00244)	(0.00335)
Education	-0.00954	-0.0146
	(0.0297)	(0.0231)
Household income	0.00000153**	0.00000617
	(0.000000552)	(0.00000335)
Household Size	0.0350*	-0.0367*
	(0.0143)	(0.0179)
Number of children in the household	0.0411	0.101***
	(0.0211)	(0.0198)
Past experience with an extreme event	0.135	-0.261**
	(0.127)	(0.0984)
Constant	1.689***	1.844***
	(0.151)	(0.176)
R-squared	0.167	0.182
Adj R-squared	0.143	0.169
F-Stat	0.000	0.000
Breusch-Pagan test	0.5479	0.0424
VIF	1.21	1.36

Note: Standard errors are in parenthesis; significant at *p<.05, **p < .01, ***p < .001, and F-Statistics show the overall significance of the model.

5. Discussion

The concept of psychological distance is crucial to comprehend, particularly in less developed or developing nations where the majority of climate change impacts have occurred or are projected to occur. It is essential to investigate the psychological distance in various urban contexts. This study has made a significant contribution by quantifying the psychological distance to climate change and identifying socioeconomic indicators that may play a role in both formal and informal settlements.

The results related to spatial distance reveal that residents of both formal and informal settlements perceive that climate change will impact their immediate surroundings at the local or city level. These findings are consistent with previous studies, such as Jamieson, (2015), which reported that individuals tend to anticipate more impacts of climate change in developing nations. Furthermore, residents of less developed or remote areas tend to perceive more degrading environmental conditions (Gifford et al., 2009). However, respondents from both settlements believed more in global climate change than regional or local level impacts.

It is widely acknowledged that climate change is occurring, but individuals often perceive it as psychologically distant or expect consequences to occur in the distant future (Maiella et al., 2020). Leiserowitz (2005) found a different tendency among individuals to perceive that climate change impacts are currently occurring. The perception of the timeline of climate change impacts, known as temporal distance, revealed that people perceived that the impacts of climate change in the past and future would be similar. The varying temporal distances among different communities can be linked to

past experiences. As the settlements in this study did not have significant experiences with severe climate change events in recent years, they did not make any temporal connections to climate change.

Social distance explains how individuals perceive the relationship between climate change and humans. The level of self-identification with an event defines how socially distant a community perceives itself from it. A common perception is that families living in developing countries or remote areas would be the most affected by climate events (Jamieson, 2015; Reser et al., 2014). In this case, both formal and informal settlements were found to have a similar social distance to climate change.

The level of (un)certainty defines the perceived probability of climate change and its impacts, i.e., the level of confidence in whether an event can occur (McDonald et al., 2015). Results of this study indicate that individuals residing in formal and informal settlements show similar levels of certainty towards climate change despite the different demographic contexts. Additionally, as psychological distance is associated with whether an event is perceived as abstract or concrete (Wang et al., 2019), it can lead individuals to misinterpret climate predictions and analyze them incorrectly (Budescu et al., 2012).

Well-informed policy measures that aim to transform community behavior through risk perception and psychological distance are crucial for effective risk management. In this regard, assessing psychological distance and managing it may have significant policy implications related to mitigation and adaptation behaviors. This study measures the psychological distance to climate change in formal and informal urban settings, and investigates the socioeconomic factors that predict psychological distance and, in turn, affect the community's risk perception. Specific factors that have been highlighted separately for both scenarios include household income and size in formal settlements, and household size, number of children, and past experience of climate change events in informal settlements. The study found that the role of household size was negatively associated with psychological distance in the informal

settlement. This may be because informal settlements had a relatively larger household size and were more concerned about climate change.

The study uses the Construal Level Theory (CLT) as a framework to explain human perception and behavior, and supports the argument that reducing psychological distance to climate change may increase concern about climate change and promote mitigation behaviors (Jones et al., 2017). Furthermore, this framework also helps to understand that individuals accept climate change more concretely when they perceive it as less distant (McDonald et al., 2015). Therefore, the socioeconomic factors that play a vital role in affecting psychological distance are critical in developing risk perception. Planners and policymakers, through the integrated framework of CLT and psychological distance, should understand the association of socioeconomic conditions and perceptions of formal and informal settlements before proposing climate resilience and adaptation solutions.

6. Conclusion

Climate change represents a significant threat to humanity and has a profound impact on human-environment interactions. As such, it is crucial to understand the public's perception of the risks associated with climate change in order to design effective adaptation planning, mitigation, and risk management strategies. This study aimed to measure the factors associated with psychological distance to climate change in the settlements of Lahore, Pakistan. The findings of the study revealed that formal settlements perceive themselves as spatially more distant from the effects of climate change than informal settlements. However, no differences were observed in temporal and social distance dimensions for both communities. Additionally, the study found that household income and size were important factors in formal settlements, while household size, number of children, and past experience of extreme events were associated with psychological distance to climate change in informal settlements. These results provide valuable insights for policymakers and stakeholders in terms of

understanding perceptions and devising risk management strategies. The study emphasizes the importance of enhancing community resilience and capacity by reducing psychological distance to climate change.

This study has several limitations that should be acknowledged. Firstly, a larger and more representative sample size may have been useful in obtaining more generalizable and accurate results. Although a large sample was collected in the study, representative sampling was not possible due to the lack of disaggregated population data at a neighborhood scale. Additionally, due to sociocultural restrictions, responses from female participants were not obtained during the survey. This highlights the need for future studies to incorporate a gender perspective.

It is also important to note that perception is a complex phenomenon that can be influenced by a variety of factors, therefore, more indicators may be necessary to accurately measure the psychological distance to climate change. Additionally, all dimensions were equally weighted in the study, which is another limitation that should be addressed in future studies. Finally, this study only approached perceptions from a social aspect, whereas institutional, political, religious, media, and cultural underpinnings were not explored. Therefore, for future studies, it is suggested to explore behavioral intentions for mitigation, risk perception and communication, social and cultural factors, and trust in institutions, in relation to the psychological distance to climate change and its various dimensions.

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