

Article

Effects of Perceptions of Climate Change and Flood Risk on Coping Behavior: A Case Study of Taipei, Taiwan

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Abstract: Globalization and population growth have put great pressure on the environment over the last few decades, and climate change has increased associated negative effects. Researchers examine the interactions between human and the environment. Among them, the relationship between place attachment and pro-environmental behavior has attracted particular research attention. However, few studies have addressed the relationships among flood risk perceptions, place attachment, and climate change coping behavior in a densely populated urban area. This study examines the effects of perceptions of climate change and flood risk on coping behavioral intention, and determines whether place attachment plays a mediating or moderating role therein in Taipei, the flood-prone capital city of Taiwan. A total of 1208 questionnaires were collected. An analysis of the mediation effects based on a three-level regression model (Phase I) suggested that place attachment is not a mediator. Adjustment of the model and analysis of moderation effects using structural equation modeling (Phase II) suggested no moderation effect. In Phase III, the mediation effect was reexamined, with the replacement of dependent variables (adaptation/mitigation) with high-effort/low-effort coping behaviors, and one dimension of place attachment was replaced with four dimensions thereof (place dependence and place identity, place satisfaction, place affect, place social bonding). The results thus obtained reveal that the paths of place satisfaction exhibit significant mediating effects between attitudes and high-effort coping behavior. Some paths exhibit significant mediating effects between perceptions and low-effort coping behavior through place satisfaction. Another four paths exhibit partial significant mediating effects through place dependence and place identity and place social bonding. These results suggest that affective attachment of people to local places results in a behavioral tendency to protect or improve those places. The main contribution of this study is its support of meta-analyses of the effects of each dimension of place attachment to provide a better understanding of the effects of place attachment on flood risk perception and coping behavior.



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Keywords: place attachment; mediation effect; moderation effect; climate change perception; flood risk perception; coping behavior

1. Introduction

Globalization and the pressure of population growth on the environment have led to natural hazards and man-made disasters [1], and climate change has increased the negative effects of disasters [2]. Associated threats have had a great impact on countries globally [3], and particularly on Taiwan, which is an island state and is prone to flooding [4–6]. Many people believe that environmental problems are caused by human activities [7,8]. The relationship between place attachment and pro-environmental behavior has attracted considerable attention as it relates to the interaction between people and the environment [9–13]. However, studies have yielded inconsistent findings concerning the effects of place attachment [9], and few have examined their multidimensional nature [10,14].

Throughout history, humans have been exposed to a range of natural hazards. The coupling of a high risk of natural hazards with inadequate coping measures frequently

leads to man-made disasters [15], including flash flooding, river flooding, and coastal flooding, all of which cause people to be displaced. The emotional connection between people and their new location after displacement varies among cultures. For example, in the western Himalayas, villagers who left dangerous areas under the Bhakra Nangal program returned to their original settlement, even when they were aware that they were at risk [16]. In the urbanized settlement of Faro Beach in southern Portugal, residents were exposed to coastal hazards, and houses and roads were destroyed by a storm. However, residents felt safe there and did not plan to relocate [17]. In a case study of the responses of residents to an earthquake in the Netherlands, despite the perception of risks and emotional responses to earthquake hazards, strong place attachment reduced the likelihood of moving out [18]. A study of earthquake-stricken areas of Sichuan, China, yielded similar findings [13]. Studies in India, the USA, and Australia have shown that highly committed people are reluctant to be displaced, even if they have experienced flooding [19]. The villagers of Shenmu Village, Taiwan, who include indigenous people, have suffered from flooding as a result of 16 consecutive years of landslides and debris flows. After repeated forced evictions, they have nevertheless insisted on returning to their village, even facing the risk of further flooding [20].

These findings reveal a relationship between place attachment and perceived risk. However, the literature provides no clear consensus about this relationship. For example, Bonaiuto et al. [19] reviewed eight studies and found that increased place attachment is associated with a greater perceived frequency of natural disasters, such as volcanic eruptions, hurricanes, earthquakes, and landslides. They also found that negative correlations between place attachment and perceived seismic risk, volcanic risk, and risk associated with beach pollution. Bonaiuto et al. [19] reported both positive and negative relationships between place attachment and coping activities. De Dominicis et al. [21] suggested that, when a high risk is perceived, place attachment can inhibit preventive behavior in response to risks of flooding.

The relationships among place attachment, risk perception, and coping strategies may be more complex than that between place attachment and pro-environmental behavior. Scientific knowledge of systematic aspects of the relationship among these concepts is lacking [19,21,22]. The results of relevant studies vary with the socio-demographic structure of the place of interest, and a comparison of their results can elucidate factors that shed light on the relationship [18]. Place attachment, perceived risk, and coping behavior depend on location [23]. For example, Domingues et al. [17] found that the relationship among place attachment, perceived risk, and other variables are location- and population-specific, such that other contextual and individual variables have direct, moderating, and/or mediating effects. Bonaiuto et al. [19] also noted that place attachment has both moderating and mediating roles in the relationship between perceived risk and coping behavior. The present work also seeks to determine whether place attachment moderates or mediates this relationship.

In this work, the analyzed natural hazard is flooding. According to 2020 statistics from the Taipei Fire Department [24], flooding is an important hazard in all 12 districts of Taipei. Since natural hazards, such as floods, landslides, and debris flows, that are caused by extreme rainfall have a high probability of repeated occurrence, disaster research must be increased [21]. Based on a literature review, this work proposes causal relationships among attitudes to climate change, perceived flood risk, and behavioral intention and examines the role of place attachment in these relationships. An empirical study of Taipei residents was performed using stratified random sampling surveys, with a view to improving our understanding of the interactions between humans and nature in highly urbanized areas, and especially the relationships among place attachment, perceived risk, and coping behavior.

2. Literature Review

2.1. Place Attachment

Place attachment can be broadly defined as the emotional, perceptive, and behavioral bond that develops between people and a place [10,11,25]. It refers to the overall feelings, sense of connection, thoughts, and behavioral intentions that people develop over time in relation to the social and physical environment [26]. People are willing to stay in a place that gives them peace and security [27] and creates place attachment that further promotes freedom of exploration, comfort and emotional responses within the local community [28]. People with a high degree of attachment tend to live in the same place for a long time, while those who are unable to establish strong links to their place of residence are more likely to leave [29].

Place attachment can be developed on various geographic scales (such as home, neighborhood, city, region, and country) [30]. As a complex and multidimensional concept [11,13,30], place attachment includes other concepts, such as place dependence, place identity, place social bonding (a sense of belonging or identity of a place), and place affect (an individual's feelings or "love" for a place) [9,14,25,31]. People can be attached to a place for many reasons, so place attachment can be distinguished by emotional bonds (place identity) and functional bonds to a place (place dependence) [18]. Residents' attitudes toward a place to which they are attached depend on the "meaning" of the place, which refers to whether the place is taken for granted or needs to be consciously discovered [25]. However, numerous studies have examined the relationships among place attachment, place satisfaction, and pro-environmental behavior, but few have examined their multidimensional nature [14].

Place attachment was originally identified in studies of environmental psychology that were concerned with an individual's connection to a house and home and, later, to neighborhoods and places that are associated with the individual's connection to a particular environment [32]. Psychological literature suggests that place attachment is associated with the belief that a place is a good place to live, and that individuals who feel more attached to their local environment are those who express a more positive view of it [33]. Place attachment is conceptualized as a sense of place [17,34]; it involves urban attachment [10,35], community attachment, neighborhood attachment [10,19,21], family attachment [22,36], and links to nature [37], although the term place attachment is the most widely used.

Additionally, place attachment is a broad area of research that, while maturing in theory, methodology, and application, will benefit from the contributions of geographers [38]. For example, Yi-Fu Tuan, a distinguished human geographer and pioneer in the study of place attachment, coined the term "topophilia" to indicate people's love for a particular place [39,40]. Place attachment is inherent in the human condition, and geographers and relevant scholars are particularly interested in place attachment and how it shapes everyday lives (e.g., going to work, shopping, and social interactions), important life choices (e.g., place of residence, education, and vacation), and identity (e.g., religion, citizenship, and state) [41].

Daryanto and Song [9] believed that place attachment can create a personal sense of responsibility for the local environment, thereby encouraging activities that contribute to environmental sustainability. Jansen [18] confirmed the "greater threat—stronger place attachment" link, possibly because the threat of losing a place reminds residents of their attachment to it [22]. Stancu et al. [26] considered that strong attachment to a place may have a negative impact on coping with or the perception of a threat. A possible explanation may depend on the fact that place attachment may have a direct effect not on coping behavior but on the relationship between perception and coping behavior.

No consensus exists on the causal relationships among environmental attitudes, perceived risk, and coping behavior nor on whether place attachments on different scales have different effects on coping behavior. Numerous studies attribute this lack of consensus to the diverse conceptualization or unclear measurement of place attachment. For

example, Walker and Chapman [42] and Williams and Vaske [43] treated place attachment as a two-dimensional concept that involved only place identity and place dependence. Bailey et al. [44] investigated five types of relationship of a resident to place, which were traditional attachment, active attachment, place alienation, place relativity, and placelessness. Halpenny [45] and Stedman [46] argued that the conceptualization of place attachment reflects place dependence, place identity, and affective components, while Kyle et al. [47] suggested that place attachment includes place identity, place dependence, and place social bonding. In contrast, Daryanto and Song [9], Ramkissoon et al. [14], Ramkissoon and Mavondo [31], and Wnuk and Oleksy [25] found that place attachment incorporates four concepts, which are place dependence, place identity, place social bonding (a sense of belonging to or a membership identity with a place), and place influence (an individual's feelings about, or "love" for a place).

The literature is unclear on whether place attachment promotes environmentally friendly behavior, possibly because of differences in the designs of relevant studies. Owing to the existence of various cultural contexts and groups, place attachment and pro-environmental behavior should be measured on different scales [9]. Understanding whether or how cultural and personal factors affect the bond between place attachment and pro-environmental behavior is important. People with a stronger attachment to a place are more likely to exhibit pro-environmental behavior [31,34]. However, some empirical studies have claimed that no, or even a negative, link exists between place attachment and pro-environmental behavior. For example, Junot et al. [48] and Tonge et al. [49] found that place attachment had a negative or no effect on pro-environmental behavior. Individuals with a strong attachment to a particular place tend to be satisfied with the environment there and, thus, have no or a low tendency to exhibit pro-environmental behavior. Daryanto and Song [9] suggested that studies of place attachment should consider its multidimensional nature and the potentially different roles associated with those dimensions in promoting pro-environmental behavior.

2.2. Risk Perception

Risk perception is an emotional structure that is driven by unconscious emotional processes [50] and is affected by perceptive heuristics, which can generate bias in decision-making. For example, environmental risks are often associated with the view, "I will be unaffected", and inaccurate views may be reached about how environmental risks affect individuals and their communities [13,19,21], resulting in inaction [51]. Therefore, risk perception is not rational nor analytical but, rather, a subjective judgment of risk characteristics and severity [52]. Risk perception is the basic predictor of the psychological and behavioral coping strategies that individuals use in dealing with risk [17,52]. Numerous variables affect how individuals perceive and respond to risks, such as their situation and personal characteristics [18], previous experience of hazards [13,17,18,50], attachment to places and communities, and the degree of understanding of hazards [17].

A risky situation may increase the strength of the bond between residents and place [18], and people tend to match their perceptions to those of the people with whom they identify [53], leading to socio-cultural, historical, and group-specific risk-coping performance [54]. Raaijmakers et al. [55] identified three aspects of risk perception: awareness (of hazardous situations), worries about one's situation, and preparation for potential outcomes. In the literature, findings concerning the relationships between intensity of place attachment and coping with risk and between place attachment and perceived risk are inconsistent [14,17]. Some studies have found no correlation between perceived risk and preparedness [56], while others have found such a correlation [13,17,57].

Bonaiuto et al. [19] noted that, with respect to exposure to seismic risk, volcanic risk, and beach pollution, greater place attachment is associated with lower risk perceptions. Their results reveal that residents with strong attachments may feel safe at home, potentially leading to neglect or denial of potential hazards, and a consequent underestimation of potential risks [19,21]. A study of Faro Beach in southern Portugal found that stronger place

attachment is associated with lower risk perceptions, as residents tend to accept risk as an aspect of their environment [17]. However, in a study of responses to a Dutch earthquake, individuals with strong attachment did recognize the risk and feel emotional pain but were reluctant to take action as a result [18].

Risk perception, and especially flood risk perception [21], is closely related to individual adaptive intention [58]. While communities at risk of extreme rainfall are more aware than others of the effects of climate change, communities with low exposure to potential danger are less aware of the benefits of adapting to climate change. Some studies have suggested that place attachment may negatively moderate this positive relationship. This obstruction effect is stronger in areas where subjective risk is greater [21].

Domingues et al. [17] suggested that the effect of place attachment on risk perception is not simple and may depend on other variables, especially perceived risk probability and experience with risk. Under condition of high risk, place attachment may increase risk perception, while, under conditions of low risk, it reduces risk perception [59]. In considering the relationship between risk perception and place attachment, the latter is often conceptualized as a predictor or an antecedent variable in that it affects individual perception risk, but the nature of this relationship is unclear [17].

2.3. Prevention Coping Behavior

“Coping” can be defined as a person’s perception of and his or her behavioral efforts to manage the needs that arise from a stressed relationship with the environment [60]. For example, effective disaster preparedness can increase the hazard preparedness capacity of families at risk of disasters and reduce the impact of such disasters on those families [61,62]. Evacuations and relocations are effective means of reducing the impact of disasters on residents [13]. In the theory of reasoned action [63], to change a person’s behavior, one must first change his or her beliefs, which underpin a person’s will to control his or her behavior. Restated, the generation of behavior is the behavior that the individual takes through thinking, experience, and after choices are made; the theoretical context includes attitudes, intention, and that the intention of behavior will be influenced by attitudes and external environmental norms.

According to Tournoisa and Rollero [64], place attachment and place identity are both useful in estimating local conservation activities in theoretical discussions of the NIMBY (Not-In-My-Backyard) phenomenon. Local opposition to new developments is conceived as a means of local protection that occurs when these new developments undermine pre-existing emotional attachments and threaten place identity. Ramkissoon et al. [14] found no certain rules concerning whether the relationship between place attachment and behavioral intention has direct, indirect, or no effects. Dlamini et al. [8] suggested that the link between attitudes and behavior is indirect, but that attitudes affect behavioral intention, which, in turn, shapes behavior. Intention is affected not only by attitudes but also by normative pressures. Thus, behavior ultimately depends on beliefs, possible consequences, and social norms [63]. Positive environmental behavior may arise from a sense of attachment to the place, whereas blatantly negative behavior may reflect passivity or indifference to the local environment.

The concept of preparedness is increasingly used to describe natural behavioral responses to potential environmental risks, which are effective measures to reduce significantly disaster risk [50,61,62]. Disaster preparedness is defined as the knowledge and capabilities that are developed by individuals to predict, respond to, and recover from the impacts of hazards [65]. Risk perception, whether high or low, consistent or inconsistent with actual risk, is the variable that has been most considered in studies of disaster preparedness.

The relationships among place attachment, risk perception, and preparedness are increasingly being addressed in the context of natural hazards, and a need exists to promote adequate adaptation and response behaviors in disaster-prone populations [17]. While most relevant studies focus on location and risk, they have found only weak and inconsistent

relationships among variables, possibly owing to the various types of disaster and social, economic and cultural environments they have involved [50]. However, a strong sense of place may be an important potential factor in the risk perception and low preparedness levels of beach dwellers [66].

Place attachment is negatively correlated with intention to migrate, so stronger place attachment is related to lower migration intention [13,18,19,21,67]. Statistical evidence indicates that respondents with strong place attachment are often reluctant to accept this fact. This result seems surprising, as these respondents are also reluctant to move, perhaps because of “survivor bias” [13]. They use other coping strategies to respond to earthquakes, such as participating in protests against further gas extraction (collective action) [68] or seeking social support [18].

Risk perception may have no causal effect on coping behavior and may depend on the urgency of a threat [57]. More information can result in risk normalization, which is a way to respond psychologically to threats by reducing the subjectively assessed degree of risk. However, attachment to a place does not automatically ensure that people improve the place to which they are attached, and strong attachment may even be an obstacle to change [21,69]. Domingues et al. [17] found that the relationships among place attachment, perceived risk, and other variables may be location-specific. Other contextual and individual variables have a direct, moderating, and/or mediating effect. The purpose of this paper is to determine whether the place attachment of residents of Taipei has a mediating or moderating effect on the relationship between their perceived flood risk and coping behavioral intention.

3. Research Methods and Research Design

3.1. Study Area

From Taipei’s integrated vulnerability and ecological footprint [6], four quadrants of vulnerability were identified. Quadrant I represents “high social vulnerability/high biophysical vulnerability”; Quadrant II represents “low social vulnerability/high biophysical vulnerability”; Quadrant III represents “low social vulnerability/low biophysical vulnerability”; and Quadrant IV represents “high social vulnerability/low biophysical vulnerability”.

This work focuses on flood disasters. According to Taiwan’s National Science and Technology Center for Disaster Reduction (NCDR) [70], a map of flood potential was generated by simulating various conditions of rainfalls. Simulations with rainfall of 350 mm, 500 mm, and 650 mm in 24 h were run. Various accumulated rainfalls yielded different flooding depths. As accumulated rainfall increased, flooding range and depth increased. Poor drainage may promote flooding. Based on Taipei’s 600 mm Flooding Potential Map and related research, more than half of the areas in the Datong, Wanhua, Wenshan, and Zhongshan districts are areas of potential flooding [6,34]. The study areas in this work are the Datong and Wanhua districts (Quadrant I, with more than half of the area flooded) and the Zhongshan and Wenshan districts (Quadrant III, also with more than half of the area flooded).

3.2. Mediating Effects of Place Attachment

Based on the literature review, the theoretical structure shown in Figure 1 is proposed. Risk perceptions and attitudes toward flood risk are assumed to have direct effects on coping behavior, while place attachment acts as a mediator. At this stage, three-step regression models are used.

The three-step regression model of Raudenbush and Bryk [71] and Singer and Willett [72] is used herein. First, the relationship between perceived risk of flooding and coping behavioral intention is studied; second, the relationship between place attachment and coping behavioral intention is discussed; and third, the relationship between the interaction between place attachment and perceived flood risk (place attachment \times perceived risk) and coping behavioral intention is examined.

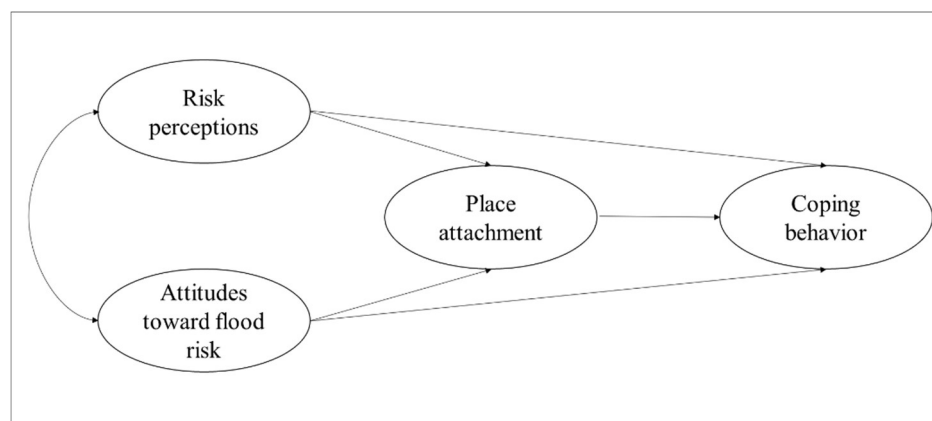


Figure 1. Theoretical structure of this research.

After the three-step regression model is used to test the interaction between place attachment and perceived flood risk, hierarchical multiple regression analyses are conducted for two types of district (high integrated vulnerability and low integrated vulnerability) to determine whether the coefficients of the paths increases when place attachment and its interaction with risk perceptions are added to the simple linear regression model (whether perceived risk predicts coping behavioral intention).

3.3. Questionnaire Design

Questionnaire surveys were used to assess the effect of place attachment on the relationship between perceived risk and coping behavior. The questionnaire items were based on the statements adopted from the past research [5,6,10,21,27]. Questions on flood risk perceptions elicited whether respondents were aware of the flood risk in the area where they lived. Questions on place attachment targeted each respondent's feelings about his or her relationship with the city/district/neighborhood (different spatial scales) in which he or she resides. Questions on attitudes elicit respondents' attitudes toward flooding risk, whether they exhibit an optimistic bias in their perceived risk of flooding, and their attitudes toward coping behavior. Questions regarding respondents' intentions to exhibit preventive behavior were also asked. The questionnaire was in Chinese, and an English version of the questionnaire can be found in the Supplementary Material (I).

With regard to flood risk perception, this work examines respondents' risk perceptions through questions about risk perceptions and attitudes. Questionnaire items included the following statements. "Flood risk will continue to increase due to climate change", "Although rapid urban development has increased the area of impermeable water, I do not think the incidence of flooding will increase", "I think floods have inherently unpredictable characteristics that make their impacts mostly underestimated", "When I think of floods, I feel anxious", and "I feel powerless in the face of floods; I am not sure that I can protect my life against floods". A five-point Likert scale was used to evaluate risk perception, where 1 indicates "strongly disagree", and 5 indicates "strongly agree".

Questionnaire items regarding place attachment included 16 statements, such as: "The current living environment makes me feel safe", "I feel like I am not part of Taipei City", "I will take the initiative to care for the Taipei City environment", "It is difficult for me to leave Taipei City", and "Taipei City is an ideal place". Questionnaire items concerning coping behavior (adaptation behavior) included the following four statements. "Participating in disaster prevention and rescue work (such as disaster prevention drills) in my area of residence is very valuable", "Taiwan will face an increasing flood risk in the future", "I am interested in information about flood risk and flooding", and "I think storing supplies in case of flooding is pointless."

Questionnaire items regarding coping behavior (mitigation behavior) included the following eight statements. "I will participate in disaster prevention and rescue work

(such as disaster prevention drills)", "I will try to learn more about flood risk", "I will store supplies and rescue kits at home", "I will work to understand the content of the government's disaster prevention plan, and become familiar with disaster prevention and relief preparations", "When shopping or ordering food, I will consider my actual needs to avoid waste", "In order to reduce air pollution and carbon dioxide emissions, I will take more public transportation", "When I leave the room for more than three minutes, I will turn off the lights to reduce waste", and "When I buy home appliances, I will choose those with energy-saving labels".

3.4. Questionnaire Survey

A two-stage stratified random sampling method was used. The first stage was carried out from 1 December 2018, to 31 March 2019, and involved face-to-face surveys in the Wanhua, Zhongshan, Datong, and Wenshan districts, yielding a total of 600 valid samples. The second stage was conducted from 13 June to 1 August 2020, and 608 valid samples were collected. During the two periods in which the surveys were undertaken, no flooding event which may have affected the survey results occurred. Although the two surveys were conducted at different times, the sociodemographic characteristics of Taipei residents surveyed in those two periods were assumed not to differ significantly, and the probabilities that respondents were sampled were assumed to be equal [73].

The descriptive statistics are as follows. Of the respondents, 46.9% were male, and 53.1% were female. There were 2,602,418 residents in Taipei by the end of 2020. Of the total population, 47.3% were male, and 52.7% were female [74], similar to the sample of our study. With respect to their education levels, 45.6% had at least a college education; and 27.3% had completed high school/vocational school. Comparatively, 36.6% of Taipei residents have an education level of colleges and universities and above, followed by master (13.7%) and senior high school (9.1%) [75]. With respect to occupations, the largest group were involved in business (40.0%), followed by housekeepers (14.0%) and others (11.7%). Comparatively, the largest group were involved in technical staff (28.4%), followed by professionals (22.4%) and service staff and sales clerk (16.4%) [76]. With respect to personal annual income, 23.8% of the respondents reported an annual income of below NTD 250,000, and 7.1% reported income of over NTD 700,000. Comparatively, 20.7% of Taipei residents (the largest group) reported their annual income as over NTD 700,000, and the smallest group (5.7%) reported their income as NTD 250,000–349,999 [77].

The descriptive statistics of the questionnaire survey of this study show that the ratio of gender and education is roughly similar to the population of Taipei. However, there are differences regarding occupation and income. It is suspected that the respondents may worry about the income tax issue and, thus, did not declare their real income level. Relevant research pointed out that the information obtained by respondents in the questionnaire survey and the results of government surveys have a certain degree of non-random error and may lead to research bias [78–80]. Therefore, there is possibly a non-random error of the information provided by the respondents of this research.

4. Results

4.1. Phase I: Three-Step Mediated Regression Model

Analyses of the three-step mediated regression model are performed to determine the relationship between perceived flood risk, attitudes to climate change, and coping behavioral intention, in the first step; between place attachment and coping behavioral intention, in the second step; and among place attachment, the interaction between perceived flood risk and attitudes to climate change, and coping behavioral intention, in the third step. The results concerning the mediation effect in four districts are as follows.

4.1.1. Datong District

As shown in Table 1, the path coefficient of "attitudes→place attachment", referring to a direct effect, is significant and negative ($\beta = -0.293$, $p < 0.05$), indicating that more positive

attitudes of respondents in the Datong district are correlated with weaker place attachment. This finding is consistent with that of De Dominicis et al. [21] and Domingues et al. [17], who found that place attachment negatively mediates attitudes and behavioral intention. The path coefficient of “place attachment→coping behavior” is significant and positive ($\beta = 0.291, p < 0.05$), indicating that a stronger place attachment of respondents is correlated with more coping behavior. The other path coefficients do not reach significance, indicating that no other direct effects obtain.

Table 1. Three-step mediated regression model for Datong, Wanhua, Zhongshan, and Wenshan districts.

Path	B	SE	t	p	β
Datong District					
Direct effect					
Perceptions→Place attachment	0.071	0.058	1.225	0.221	0.172
Attitudes→Place attachment	−0.119	0.057	−2.097	0.036 *	−0.293
Perceptions→Coping behavior	0.094	0.070	1.341	0.180	0.179
Attitudes→Coping behavior	0.119	0.064	1.851	0.064	0.230
Place attachment→Coping behavior	0.370	0.169	2.193	0.028 *	0.291
Indirect effect					
Perceptions→Place attachment→Coping behavior	0.026	0.025	1.069	0.285	0.050
Attitudes→Place attachment→Coping behavior	−0.044	0.029	1.516	0.130	−0.085
Wanhua District					
Direct effect					
Perceptions→Place attachment	−0.023	0.026	−0.859	0.390	−0.132
Attitude→Place attachment	0.006	0.015	0.412	0.681	0.047
Perceptions→Coping behavior	0.281	0.091	3.097	0.002 **	0.422
Attitudes→Coping behavior	0.094	0.053	1.778	0.075	0.187
Place attachment→Coping behavior	0.940	0.764	1.231	0.218	0.241
Indirect effect					
Perceptions→Place attachment→Coping behavior	−0.021	0.030	−0.705	0.481	−0.032
Attitudes→Place attachment→Coping behavior	0.006	0.015	0.390	0.696	0.011
Zhongshan District					
Direct effect					
Perceptions→Place attachment	0.057	0.042	1.366	0.172	0.199
Attitudes→Place attachment	0.015	0.018	0.807	0.420	0.081
Perceptions→Coping behavior	0.338	0.110	3.061	0.002 **	0.416
Attitudes→Coping behavior	0.093	0.047	1.977	0.048 *	0.180
Place attachment→Coping behavior	0.565	0.372	1.518	0.129	0.199
Indirect effect					
Perceptions→Place attachment→Coping behavior	0.032	0.032	1.015	0.310	0.040
Attitudes→Place attachment→Coping behavior	0.008	0.012	0.712	0.476	0.016
Wenshan District					
Direct effect					
Perceptions→Place attachment	0.006	0.014	−0.444	0.657	−0.070
Attitudes→Place attachment	0.000	0.010	−0.019	0.985	−0.002
Perceptions→Coping behavior	0.148	0.069	2.139	0.032 *	0.330
Attitudes→Coping behavior	−0.007	0.050	−0.138	0.890	−0.017
Place attachment→Coping behavior	1.875	2.471	0.759	0.448	0.365
Indirect effect					
Perceptions→Place attachment→Coping behavior	−0.012	0.030	−0.383	0.702	−0.026
Attitudes→Place attachment→Coping behavior	0.000	0.019	−0.019	0.985	−0.001

* $p < 0.05$; ** $p < 0.01$

With respect to indirect effects, the Sobel test revealed that neither mediation path reaches significance ($p > 0.05$), so the perception or attitudes of respondents in the Datong

district do not have a significant effect on their coping behavior through place attachment (Figure 2).

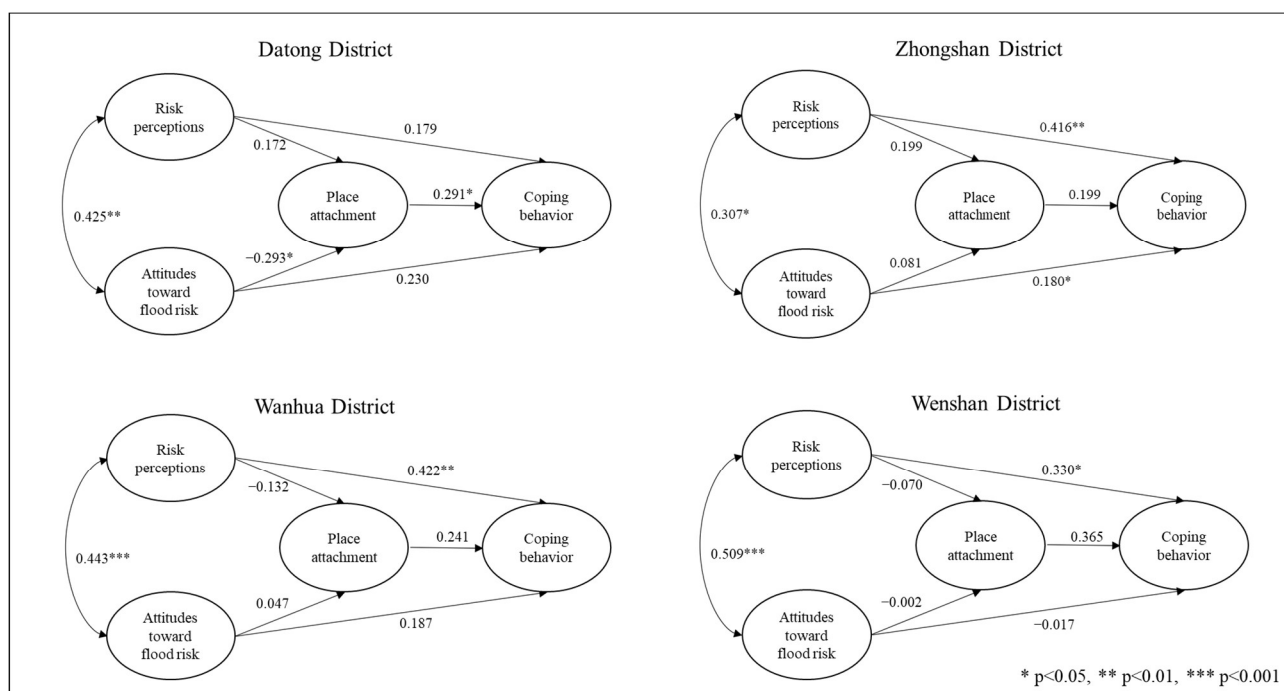


Figure 2. Three-step mediated regression model for Datong, Wanhua, Zhongshan, and Wenshan districts.

4.1.2. Wanhua District

As shown in Table 1, with respect to direct effects, the path coefficient of “perceptions→ coping behavior” is significant and positive ($\beta = 0.422$, $p < 0.01$), showing that higher risk perceptions of the respondents in the Wanhua district are correlated with stronger coping behavior. The other path coefficients do not reach significance, indicating the absence of other direct effects.

With respect to indirect effects, the Sobel test reveals that neither mediation path reaches significance ($p > 0.05$), so the perception or attitudes of respondents in the Wanhua district do not have a significant effect on coping behavior through place attachment (Figure 2).

4.1.3. Zhongshan District

As shown in Table 1, with respect to direct effects, the path coefficient of “perceptions→ coping behavior” is significant and positive ($\beta = 0.416$, $p < 0.01$), indicating that better perceptions are associated with more coping behavior. The path coefficient of “attitudes→coping behavior” is significant and positive ($\beta = 0.180$, $p < 0.05$), revealing that more positive attitudes of Zhongshan respondents are associated with a higher degree of coping behavior. Other path coefficients do not reach significance, indicating that no other direct effects pertain.

With respect to indirect effects, the Sobel test indicates that neither mediation path reaches significance ($p > 0.05$), so neither the perception nor the attitudes of respondents in the Zhongshan district do not have a significant effect on coping behavior through place attachment (Figure 2).

4.1.4. Wenshan District

As shown in Table 1, with respect to direct effects, the path coefficient of “Perceptions→ Coping behavior” is significant and positive ($\beta = 0.330$, $p < 0.05$), showing that higher risk perceptions of respondents from the Wenshan district perform is associated with more

coping behavior. The other path coefficients do not reach significance, indicating no other direct effects.

With respect to indirect effects, the Sobel test indicates that neither mediation path reaches significance ($p > 0.05$), so the perception and attitudes of respondents in the Wenshan district do not have a significant effect on coping behavior through place attachment (Figure 2).

4.1.5. Summary

The analyzed mediation effects in the four districts include the paths “perceptions→place attachment→coping behavior” and “attitudes→place attachment→coping behavior.” Place attachment does not have a statistically significant mediating role. The original model (phase I) was reviewed herein, and the role of place attachment was changed to “moderator”, as suggested by Bernardo [59], De Dominicis et al. [21], and Jansen [18]; coping behavior is replaced by “mitigation behavior” and “adaptation behavior”, and structural equation modeling (SEM) is used in subsequent analyses. The above analyses suggest that the causal relationships for a particular area may vary among constituent locales. For example, a single district may include some areas (such as neighborhoods) with high disaster risks and other areas that are relatively safe. Therefore, the scale of place attachment was revised. In addition to “district”, the larger-scale “city” and the smaller-scale “neighborhood” are included. Analyses of place attachment on these three scales will yield more detailed results.

4.2. Phase II: Moderation Effect of Place Attachment in Structural Equation Modeling

In phase II, structural equation modeling (SEM) is used to examine the moderating effect of place attachment to attitudes/perceptions and behavioral intention. The original SEM (Figure 3IIa) is shown on the left-hand side of Figure 3, with four paths among perceptions, attitudes, and two coping behaviors. Adding place attachment (high and low, as shown on the right-hand side of Figure 3IIb) yielded four more paths. Finally, structural equation multi-group analysis was conducted to compare the two groups of path coefficients to determine whether the two SEMs differed in any way. Accordingly, the strength of the moderation effect was determined [42]. Differences imply that place attachment has a moderating effect; their absence implies a lack thereof. Moreover, in order to increase the explanatory power of SEM, the scale of place attachment and the corresponding variables are reviewed, and the SEM is revised accordingly. In phase II, the dependent variables are divided into those associated with mitigation and adaptation behaviors, and place attachment is identified on the three scales of city, district, and neighborhood.

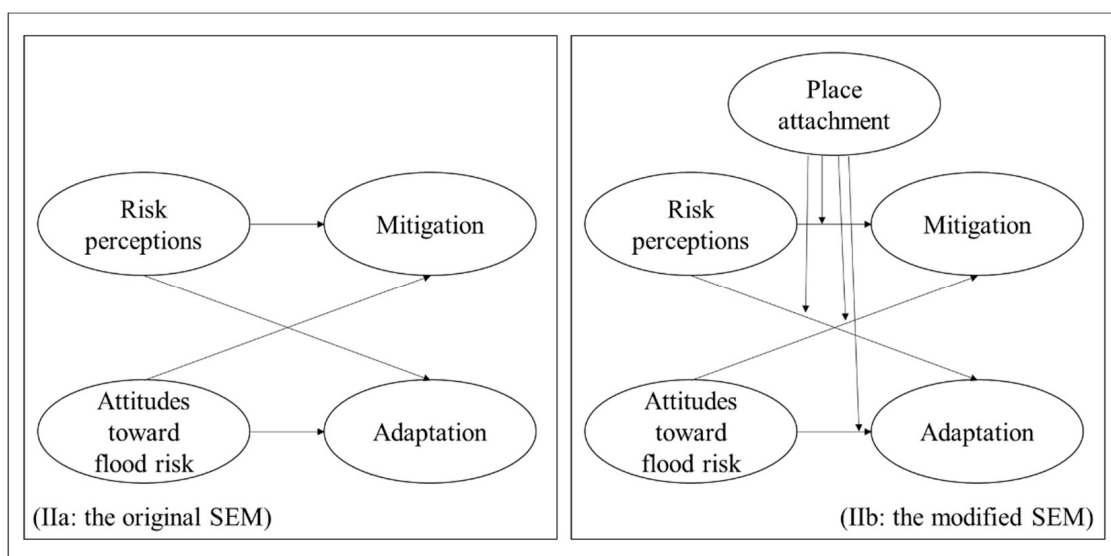


Figure 3. Phase II: Place attachment as a moderator in SEM.

4.2.1. Datong District

The sample size for the Datong district is 158. In Figure 3IIa (no place attachment), the four paths are as shown in Table 2. The hypothesis “perceptions→mitigation” (standardized coefficient = 0.296, $p = 0.255$) does not reach significance, indicating that perceptions do not have a direct effect on mitigation. The hypothesis “attitudes→mitigation” does not reach significance (standardized coefficient = -0.232 , $p = 0.232$), indicating that attitudes do not have a direct effect on mitigation. The hypothesis “perceptions→adaptation” (standardized coefficient = 0.085, $p = 0.596$) does not reach significance, indicating that perceived risk has no direct effect on adaptation. The hypothesis “attitudes→adaptation” (standardized coefficient = -0.015 , $p = 0.898$) does not reach significance, indicating that attitudes do not have a direct effect on adaptation.

Table 2. Results obtained using SEM for the Datong district (no place attachment).

Hypothesis	Path	Std Err	<i>p</i>	Std Coef
H1	Perceptions→Mitigation	0.059	0.255	0.296
H2	Attitudes→Mitigation	0.043	0.232	−0.232
H3	Perceptions→Adaptation	0.067	0.596	0.085
H4	Attitudes→Adaptation	0.046	0.898	−0.015

A. City Attachment

After “city attachment” was added to the SEM, the multi-group model comparison revealed no significant difference between the eight paths without high/low place attachment (Figure 3IIa) and the “eight paths with high/low place attachment” (Figure 3IIb) ($\Delta\chi^2$ (df = 4) = 3.533, $p = 0.473$), indicating that the structures of the two groups did not differ significantly. This result suggests that place attachment is not a moderator in the path from perceptions/attitudes to mitigation/adaptation.

B. District Attachment

After “district attachment” was added to the SEM, no significant difference was found between the eight paths without high/low place attachment and the eight paths with high/low place attachment ($\Delta\chi^2$ (df = 4) = 9.434, $p = 0.051$), indicating that the structures of the two groups did not differ significantly. This result suggests that place attachment is not a moderator in the path from perceptions/attitudes to mitigation/adaptation.

C. Neighborhood Attachment

After “neighborhood attachment” was added to the SEM, no significant difference was found between the eight paths without high/low place attachment and the eight paths with high/low place attachment ($\Delta\chi^2$ (df = 4) = 7.953, $p = 0.093$), indicating that the structures of the two groups did not differ significantly. This result suggests that place attachment is not a moderator in the path from perceptions/attitudes to mitigation/adaptation.

D. Summary for Datong District

The above analyses suggest that, regardless of scale, place attachment is not a moderator of the structural relationship between perceptions/attitudes and mitigation/adaptation (Table 3).

Table 3. Moderating effect of place attachment on different scales for the Datong district.

District	Moderator Effect of City Attachment	Moderator Effect of District Attachment	Moderator Effect of Neighborhood Attachment
Datong	—	—	—

Note: “—”, not a moderator

4.2.2. Wanhua District

The sample size for the Wanhua district is 150. In Figure 3IIa (no place attachment), the four paths are as shown in Table 4. The hypothesis “perceptions→mitigation” (standardized coefficient = -0.064 , $p = 0.752$) does not reach significance, indicating that perceptions do not have a direct effect on mitigation. The hypothesis “attitudes→mitigation” does not reach significance (standardized coefficient = 0.255 , $p = 0.187$), indicating that attitudes do not have a direct effect on mitigation. The hypothesis “perceptions→adaptation” (standardized coefficient = -0.016 , $p = 0.926$) does not reach significance, indicating that perceived risk has no direct effect on adaptation. The hypothesis “attitudes→adaptation” (standardized coefficient = 0.225 , $p = 0.178$) does not reach significance level, indicating that attitudes do not have a direct effect on adaptation.

Table 4. Results obtained using SEM for the Wanhua district (no place attachment).

Hypothesis	Path	Std Err	<i>p</i>	Std Coef
H1	Perceptions→Mitigation	0.164	0.752	−0.064
H2	Attitudes→Mitigation	0.145	0.187	0.255
H3	Perceptions→Adaptation	0.132	0.926	−0.016
H4	Attitudes→Adaptation	0.116	0.178	0.225

As for the Wanhua district, regardless of scale (city/district/neighborhood), place attachment is not a moderator of the structural relationship between perceptions/attitudes and mitigation/adaptation.

4.2.3. Zhongshan District

The sample size for the Wanhua district is 150. In Figure 3IIa (no place attachment), the four paths are as shown in Table 5. The hypothesis “perceptions→mitigation” (standardized coefficient = 0.195 , $p = 0.221$) does not reach significance, indicating that perceptions do not have a direct effect on mitigation. The hypothesis “attitudes→mitigation” does not reach significance (standardized coefficient = -0.003 , $p = 0.981$), indicating that attitudes do not have a direct effect on mitigation. The hypothesis “perceptions→adaptation” (standardized coefficient = 0.194 , $p = 0.092$) does not reach significance, indicating that perceived risk has no direct effect on adaptation. The hypothesis “attitudes→adaptation” (standardized coefficient = 0.262 , $p = 0.016$) is significantly positive, indicating that more positive attitudes toward flood risk are associated with greater adaptation.

Table 5. Results obtained using SEM for the Zhongshan district (no place attachment).

Hypothesis	Path	Std Err	<i>p</i>	Std Coef
H1	Perceptions→Mitigation	0.137	0.221	0.195
H2	Attitudes→Mitigation	0.096	0.981	−0.003
H3	Perceptions→Adaptation	0.164	0.092	0.194
H4	Attitudes→Adaptation	0.129	0.016 *	0.262

* $p < 0.05$

Regardless of scale (city/district/neighborhood), place attachment is not a moderator of the structural relationship between perceptions/attitudes and mitigation/adaptation for the Zhongshan district.

4.2.4. Wenshan District

The sample size for the Wenshan district is 150. In IIa (no place attachment), the four paths are as shown in Table 6. The hypothesis “perceptions→mitigation” (standardized coefficient = 0.060 , $p = 0.592$) does not reach significance, indicating that perceptions do not have a direct effect on mitigation. The hypothesis “attitudes→mitigation” does not reach significance (standardized coefficient = -0.001 , $p = 0.991$), indicating that attitudes do not have a direct effect on mitigation. The hypothesis “perceptions→adaptation” (standardized coefficient = -0.178 , $p = 0.108$) does not reach significance, indicating that perceptions

have no direct effect on adaptation. The hypothesis “attitudes→adaptation” (standardized coefficient = -0.171 , $p = 0.107$) does not reach significance, indicating that attitudes have no direct effect on adaptation.

Table 6. Results obtained using SEM for the Wenshan district (no place attachment).

Hypothesis	Path	Std Err	<i>p</i>	Std Coef
H1	Perceptions→Mitigation	0.105	0.592	0.060
H2	Attitudes→Mitigation	0.145	0.991	−0.001
H3	Perceptions→Adaptation	0.045	0.108	−0.178
H4	Attitudes→Adaptation	0.066	0.107	0.171

For the Wenshan district, on the city level, place attachment moderates the structural relationship between perceptions/attitudes and mitigation/adaptation. On the district and neighborhood scales, however, place attachment is not a moderator of the structural relationship between perceptions/attitudes and mitigation/adaptation.

4.2.5. Summary

Based on the relevant results, most of the paths of interest exhibit no significant variation in the moderating effect of place attachment on the causal relationships on three scales in the four districts; the exception involves city attachment in the Wenshan district. From the results for the Wenshan district, results vary with respect to the moderating effect of place attachment on the three scales; no moderating effect is found on the district or neighborhood level, but a moderator effect is identified on the city level.

4.3. Phase III: Mediating Effect Readjusted in Structural Equation Modeling

4.3.1. Adjustment of Dependent Variables

In the questionnaire, one of the items regarding place attachment was, “It is difficult for me to leave the place where I currently live.” About 80% of the respondents agreed with this statement, indicating that they have no intention to move. Of this 80% of respondents, about 30% believed that the neighborhood where they live is at risk of flooding, but they are not willing to move.

Since the mediator and moderator analyses yielded no significant results, the structure of the causal relationships is revised accordingly. Since most Taipei residents did not understand the difference between adaptation and mitigation, based on the literature review, the first step in readjusting the structural model was to change the dependent variables. Mitigation and adaptation were changed to as “high-effort” and “low-effort” coping behaviors based on factor analyses. For example, Daryanto and Song [9] consolidated various classification criteria in the literature, and Ramkissoon et al. [80] and Song and Soopramanien [12] distinguished between high- and low-effort behaviors. With this modification, the mediation analysis herein was carried out to determine whether the explanatory power of the model could be improved. Daryanto and Song [9] categorized pro-environmental behavior as general versus place-specific. General behaviors are not specific to place, and myriad such pro-environmental behaviors are possible. (They include, for example, “talking to others about environmental issues” and “making financial contributions to environmental organizations”). Place-specific behavior is pro-environmental behavior that is targeted at a particular place (as in “signing a petition in support of the protection of coral reefs at an industrial development site”) or that evokes place-related ideas (as in “I take environmental action to improve the image of the city in which I live”).

Eight questions concerned coping behavior. Factor analyses were performed to simplify the data and statistical analyses were then performed. The KMO Measure of Sampling Adequacy is 0.659, which exceeds 0.50 and so indicates that a factor analysis of the data is effective. Moreover, the significance level indicates the usefulness of a factor analysis with the data herein.

Based on the rotated component matrix, the factors that are considered in coping behavior-related questions 1, 2, 6 can be collapsed into a single factor, “high-effort coping

behavior”, and those considered in coping behavior-related questions 3, 4, 5, 7, 8, can be collapsed into a single factor, “low-effort coping behavior”. The detailed results of KMO and Bartlett’s Test and the rotated composition matrix can be found in the Supplementary Material (II).

4.3.2. Adjustment of Place Attachment

Issues concerning the measurement of place attachment and the variability of research findings regarding place attachment, place satisfaction, and pro-environmental behavior [11] make further research necessary [52]. Previous research findings do not clearly reveal whether all dimensions of place attachment are related to environmental behavioral intention. Therefore, a holistic approach to examining place attachment should be taken [50]. The multidimensional consideration of place attachment differs from that of general place attachment and can better predict place satisfaction and environmental behavioral intentions. For example, studies of earthquake-stricken areas of Sichuan, China, have established that place identity is significantly negatively correlated with residents’ willingness to move, whereas place dependency and the severity of disasters are positively correlated with residents’ willingness to move [13].

Sixteen questions regarding place attachment were asked. Factor analyses were carried out to simplify the data thus obtained, and then statistical analyses were performed. The KMO Measure of Sampling Adequacy was 0.732, exceeding 0.500, so a factor analysis of the data in this work is useful. The statistical significance also indicates the effectiveness of factor analysis. Of the rotated component matrix, the first component includes questions 1, 11, 12, 13, 14, 15, and 16; the second component includes questions 5, 6, and 7; the third component includes questions 2, 3, and 4; and the fourth component includes questions 8, 9, and 10. The detailed results of KMO and Bartlett’s Test, the total variance explained and the rotated composition matrix can be found in the Supplementary Material (III).

4.3.3. Phase III: Mediating Effect of Place Attachment in Structural Equation Modeling

In Phase I, a Three-step Mediated Regression Model was used to elucidate the mediating effect of place attachment on the relationship between perceptions and coping behavior. In Phase II, SEM was used to determine the moderating effect of place attachment on the relationship between perceptions and coping behavior. The mediating effect and moderating effect were mostly insignificant. Therefore, the multidimensionality of place attachment, suggested by Daryanto and Song [9], Ramkissoon et al. [14], Ramkissoon and Mavondo [81], and Wnuk and Oleksy [25], as well as high- and low-effort coping behaviors, suggested by AlQahtany and Abubakar [82], Blöschl et al. [83], and Thorup-Binger and Charania [84], are used to revise the original causal model of perceived risk and coping behavior and, thus, provide a plausible model that is consistent with relevant theoretical discourses. The dependent variables (adaptation/mitigation) are replaced with “high-effort coping behavior” and “low-effort coping behavior”, and one dimension of place attachment is replaced with four dimensions thereof (place dependence and place identity, place satisfaction, place affect, place social bonding), in the mediation relationship in SEM. Thus, the results obtained are as follows.

As seen in Figure 4, one path exhibits significant mediation effects between attitudes and factors related to high-effort coping behavior; it is “Attitudes→Place Affect→High-effort Coping Behavior”. Another path exhibits significant mediation effects between low-effort coping behavior and place attachment factors; it is “Perceptions→Place Satisfaction→Low-effort Coping Behavior”. Other paths exhibit partial significant mediation effects; they are “Attitudes→Place Dependence and Place Identity”, “Attitudes→High-effort Coping Behavior”, “Perceptions→Place Dependence and Place Identity”, “Place Satisfaction→Low-effort Coping Behavior”, “Place social bonding→High-effort Coping Behavior”, and “Place Social Bonding→Low-effort Coping Behavior”.

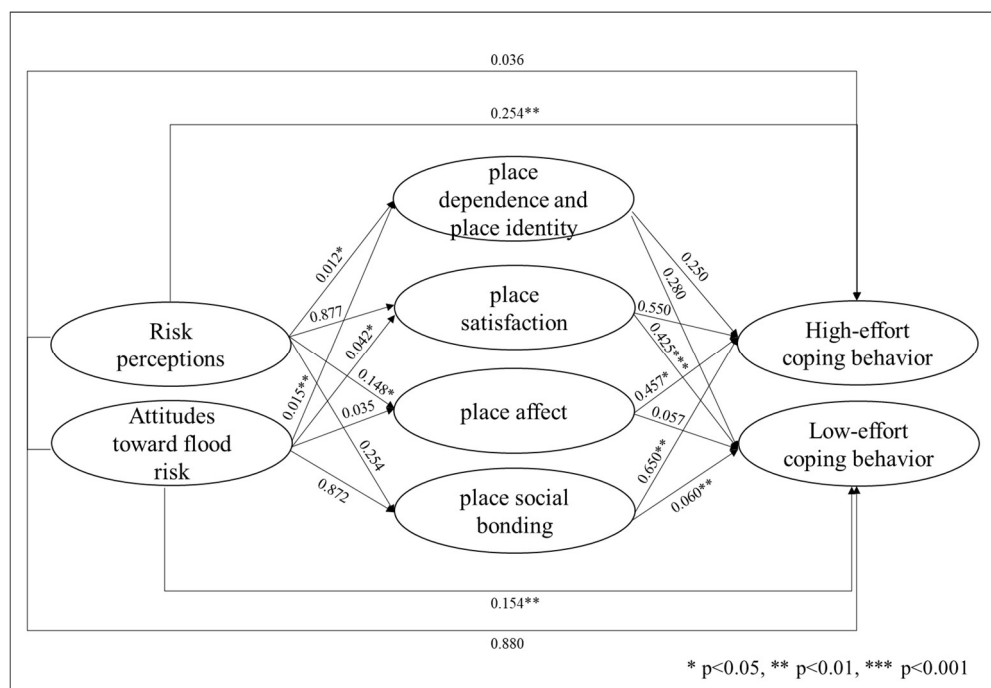


Figure 4. Mediating relationship between high/low-effort coping behavior and factors associated with place attachment.

Since the interpretative power of the revised model is better than those of the previous two models (Phase I and Phase II), and more significant mediation paths are thus obtained, coping behavior should be revised, and the place attachment factors should be introduced into the causal relationship between perceived risk and coping behavior. Accordingly, subsequent studies will be able to confirm and validate the revised model. Additionally, the relevant literature reveals that, owing to the diversity of place attachments, detailed results can be obtained by disassembling place attachment into various dimensions [13,14,18,84].

5. Conclusions and Suggestions

In Phase I (Three-step Mediated Regression Model), the role of place attachment as a mediator of two causal relationships, “perceptions→place attachment→coping behavior” and “attitudes→place attachment→coping behavior” was examined. The results reveal that place attachment was not a mediator. Since Domingues et al. [17] suggested that the relationships among place attachment, perceived risk, and other variables may depend on location and population, other contextual and individual variables may have direct, moderating, and/or mediating roles. Therefore, in Phase II (Moderating Effect in Structural Equation Modeling), the structural model was adjusted, and the role of place attachment was changed from mediating to moderating; the dependent variable was changed from “coping behavior” to “mitigation” and “adaptation”, and SEM was used for analysis.

The results of surveys that were performed within a single district varied geographically within the district; for example, one district (such as a neighborhood) may include areas with a high risk of disaster and areas with a low risk of disaster. Therefore, the concept of place attachment should be revised and may be specified as attachment to city, district, and neighborhood, for example, to examine the role of place attachment on different geographical scales. Place attachment is a cognitive and emotional connection between people and places [10,11]. This people-place connection arises from people’s bonds with a place and the social interactions they have in that particular place [85]. However, Daryanto and Song [9] posited that, when a person lives in a place, social bonding may be important. Accordingly, the original model in Phase I was adjusted herein. However, according to analyses of the moderating effects of place attachment in SEM on different scales in the

four districts, in all of the model paths, place attachment, except for “city attachment” in the Wenshan district, had no significant moderating effect.

Based on relevant research findings, a factor analysis of place attachment was conducted and the original model in Phase II was revised for consistency with the relevant theoretical discourses. In the readjusted model (Phase III: Mediating Effect in SEM), the dependent variables were changed from “mitigation/adaptation” to “high-effort coping behavior/low-effort coping behavior”, and a single dimension of place attachment was replaced with four dimensions of place attachment (place dependence and place identity, place satisfaction, place affect, place social bonding). The results thus obtained reveal that four paths include statistically significant mediation effects; they are “attitudes→place affect→high-effort coping behavior”, attitudes→place social bonding→high-effort coping behavior”, “perceptions→place satisfaction→low-effort coping behavior”, and “perceptions→place social bonding→low-effort coping behavior”.

The results of this study may be consistent with the claim of Daryanto and Song [9] that people-place affective attachment generates a behavioral tendency to protect or improve the local environment. Focusing on attachment to, and the meaning of, place helps to clarify opportunities for, and barriers to, collaboration among interests, affecting their stewardship and transformative capability [69]. Therefore, the public sector should strive to create, sustain, and strengthen people’s attachment to place. Additionally, individuals who are attached to a place may be satisfied with the environment there and, thus, feel no need to protect or improve it, and they may be reluctant to evacuate and relocate because of “survivor bias”, which reduces the perceived likelihood and severity of disasters [13]. Decision-makers can design messages that highlight the severity of environmental problems and communicate to individuals that their beloved places require them to act in a more environmentally friendly or disaster-avoiding manner.

Follow-up recommendations are made to analyze separately various areas of vulnerability to determine whether they associated with different effects of place attachment. According to the results for the Datong district and the Zhongshan district, the moderating effect of place attachment is evident in the relationship between perceived risk and coping behavior, so place attachment is more likely to moderate the relationship between perceived risk and coping behavior than to moderate relationships between other variables, such as attitudes or perceptions.

The natural hazard that was considered in this study is flooding that is caused by climate change. According to 2020 statistics from the Taipei Fire Department, flooding is a major hazard in all 12 districts of Taipei. The most important application of this research is that its results can be applied to other disasters that are caused by climate change, such as debris flow that is caused by extreme rainfall. If it is to be applied to disasters that are not associated with climate change, such as earthquakes, different perspectives must be taken and different data used. More cross-boundary and transdisciplinary studies are needed.

The main contribution of this study is that it supports future meta-analyses of the effects of each dimension of place attachment to provide a better understanding of the effects of place attachment on perceived risk and coping behavior. Moreover, owing to the poor interpretative power of mediation and moderation in the original model, the structure of that model was adjusted based on a review of the literature and the societal context of Taipei City. In the readjusted model, the scale of place attachment was specified (city, district, neighborhood); coping behavior was changed from mitigation/adaptation to high-effort/low-effort coping behavior, and place attachment was further specified using four dimensions (place dependence and place identity, place satisfaction, place affect, place social bonding), ultimately improving the interpretative power of the model. This research method can be used in various geographical locations and cultural contexts to yield more compelling causal relationships among perceived flood risk, place attachment, and coping behavior.

Supplementary Materials: The following supporting information can be downloaded at: <https://www.mdpi.com/article/10.3390/su14010289/s1>. “Supplementary Material (I): The Questionnaire; Supplementary Material (II): Factor Analyses for the Eight Questions Regarding Coping Behavior; Supplementary Material (III): Factor Analyses for the Sixteen Questions Regarding Place Attachment.”

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Informed Consent Statement: When the face-to-face survey was carried out, we provided the following statement at the top of the questionnaire: “The questionnaire is designed primarily to examine the effects of perceptions of climate change and flood risk on coping behavior, and will be used for research purposes only. Your personal data will not be disclosed so you can complete it with peace of mind.”

Data Availability Statement: The datasets used and analyzed during the current study are available from the corresponding author on reasonable request.

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References

- Chen, X.; Peterson, M.N.; Hull, V.; Lu, C.; Lee, G.D.; Hong, D.; Liu, J. Effects of attitudinal and sociodemographic factors on pro-environmental behaviour in urban China. *Environ. Conserv.* **2013**, *38*, 45–52. [\[CrossRef\]](#)
- IPCC. Summary for Policymakers. An IPCC Special Report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. In *Global Warming of 1.5 °C*; Masson-Delmotte, V., Zhai, P., Pörtner, H.-O., Roberts, D., Skea, J., Shukla, P.R., Pirani, A., Moufouma-Okia, W., Péan, C., Pidcock, R., Eds.; World Meteorological Organization: Geneva, Switzerland, 2018; p. 32.
- WWF. *Living Planet Report 2020—Bending the Curve of Biodiversity Loss*; World Wide Fund for Nature International: Gland, Switzerland, 2020. Available online: <https://www.worldwildlife.org/publications/living-planet-report-2020> (accessed on 6 November 2021).
- Lai, C.-H.; Liao, P.-C.; Chen, S.-H.; Wang, Y.-C.; Cheng, C.; Wu, C.-F. Risk perception and adaptation of climate change: An assessment of community resilience in rural Taiwan. *Sustainability* **2021**, *13*, 3651. [\[CrossRef\]](#)
- Lee, Y.-J. Relationships among environmental attitudes, risk perceptions, and coping behavior: A case study of four environmentally sensitive townships in Yunlin County, Taiwan. *Sustainability* **2018**, *10*, 2663. [\[CrossRef\]](#)
- Lee, Y.-J.; Lin, S.-Y. A study on the relationships of place attachment and individual attributes of residents in different vulnerable districts in Taipei, Taiwan. *Environ. Sci. Pollut. Res.* **2021**, *28*, 46247–46265. [\[CrossRef\]](#) [\[PubMed\]](#)
- Cheng, T.M.; Wu, H.C. How do environmental knowledge, environmental sensitivity, and place attachment affect environmentally responsible behaviour? An integrated approach for sustainable island tourism. *J. Sustain. Tour.* **2015**, *23*, 557–576. [\[CrossRef\]](#)
- Dlamini, S.; Tesfamichael, S.G.; Mokhele, T. Socio-demographic determinants of environmental attitudes, perceptions, place attachment, and environmentally responsible behaviour in Gauteng province, South Africa. *Sci. Afr.* **2021**, *12*, e00772. [\[CrossRef\]](#)
- Daryanto, A.; Song, Z. A meta-analysis of the relationship between place attachment and pro-environmental behaviour. *J. Bus. Res.* **2021**, *123*, 208–219. [\[CrossRef\]](#)
- Lewicka, M. On the varieties of people’s relationships with places: Hummon’s typology revisited. *Environ. Behav.* **2011**, *3*, 676–709. [\[CrossRef\]](#)
- Scannell, L.; Gifford, R. Defining place attachment: A tripartite organizing framework. *J. Environ. Psychol.* **2010**, *30*, 289–297. [\[CrossRef\]](#)
- Song, Z.; Soopramanien, D. Types of place attachment and pro-environmental behaviors of urban residents in Beijing. *Cities* **2019**, *84*, 112–120. [\[CrossRef\]](#)

13. Xu, D.; Qing, C.; Deng, X.; Yong, Z.; Zhou, W.; Ma, Z. Disaster risk perception, sense of place, evacuation willingness, and relocation willingness of rural households in earthquake-stricken areas: Evidence from Sichuan province, China. *Int. J. Environ. Res. Public Health* **2020**, *17*, 602. [\[CrossRef\]](#)
14. Ramkissoon, H.; Smith, L.D.G.; Weiler, B. Testing the dimensionality of place attachment and its relationships with place satisfaction and pro-environmental behaviours: A structural equation modelling approach. *Tour. Manage.* **2013**, *36*, 552–566.
15. World Bank. *Natural Hazards, UnNatural Disasters: The Economics of Effective Prevention*; The World Bank: Washington, DC, USA, 2010.
16. Pirta, R.S.; Chandel, N.; Pirta, C. Loss of home at early age: Retrieval of memories among the displaced of Bhakra Dam after fifty years. *J. Indian Acad. Appl. Psychol.* **2014**, *40*, 78–85.
17. Domingues, R.B.; Neves de Jesus, S.; Ferreira, O. Place attachment, risk perception, and preparedness in a population exposed to coastal hazards: A case study in Faro Beach, southern Portugal. *Int. J. Disaster Risk Reduct.* **2021**, *60*, 102288. [\[CrossRef\]](#)
18. Jansen, S.J.Y. Place attachment, distress, risk perception and coping in a case of earthquakes in the Netherlands. *J. Hous. Built Environ.* **2020**, *35*, 407–427. [\[CrossRef\]](#)
19. Bonaiuto, M.; Alves, S.; De Dominicis, S.; Petrucci, I. Place attachment and natural environmental risk: Research review and agenda. *J. Environ. Psychol.* **2016**, *48*, 33–53. [\[CrossRef\]](#)
20. Chan, S.E.; Huang, P. When disasters are a part of home: The Hakka community's rootedness and resilience to periodic landslides in Shennu Village. *Landsc. Rev.* **2012**, *14*, 34–47.
21. De Dominicis, S.; Fornara, F.; Cancellieri, U.G.; Twigger-Ross, C.; Bonaiuto, M. We are at risk, and so what? Place attachment, environmental risk perceptions and preventive coping behaviours. *J. Environ. Psychol.* **2015**, *43*, 66–78. [\[CrossRef\]](#)
22. Anton, C.E.; Lawrence, C. Home is where the heart is: The effect of place of residence on place attachment and community participation. *J. Environ. Psychol.* **2014**, *40*, 451–461. [\[CrossRef\]](#)
23. Casakin, H.; Hernández, B.; Ruiz, C. Place attachment and place identity in Israeli cities: The influence of city size. *Cities* **2015**, *42*, 224–230. [\[CrossRef\]](#)
24. Taipei City Government. *A Simulation of Rainfall and Flooding in Taipei City*; Government Information Open Platform: Taipei, Taiwan, 2021. Available online: <https://data.gov.tw/dataset/121550> (accessed on 6 November 2021). (In Chinese)
25. Wnuk, A.; Oleksy, T. Too attached to let others in? The role of different types of place attachment in predicting intergroup attitudes in a conflict setting. *J. Environ. Psychol.* **2021**, *75*, 101615. [\[CrossRef\]](#)
26. Stancu, A.; Ariccio, S.; De Dominicis, S.; Cancellieri, U.G.; Petrucci, I.; Ilin, C.; Bonaiuto, M. The better the bond, the better we cope. The effects of place attachment intensity and place attachment styles on the link between perception of risk and emotional and behavioral coping. *Int. J. Disaster Risk Reduct.* **2020**, *51*, 101771. [\[CrossRef\]](#)
27. Hidalgo, M.C.; Hernández, B. Place attachment: Conceptual and empirical questions. *J. Environ. Psychol.* **2001**, *21*, 273–281. [\[CrossRef\]](#)
28. Scannell, L.; Gifford, R. The experienced psychological benefits of place attachment. *J. Environ. Psychol.* **2017**, *51*, 256–269. [\[CrossRef\]](#)
29. Hernández, B.; Hidalgo, M.C.; Salazar-Laplace, M.E.; Hess, S. Place attachment and place identity in natives and non-natives. *J. Environ. Psychol.* **2007**, *27*, 310–319. [\[CrossRef\]](#)
30. Shaykh-Baygloo, R. A multifaceted study of place attachment and its influences on civic involvement and place loyalty in Baharestan new town, Iran. *Cities* **2020**, *96*, 102473. [\[CrossRef\]](#)
31. Ramkissoon, H.; Mavondo, F.T. Proenvironmental behavior: Critical link between satisfaction and place attachment in Australia and Canada. *Tour. Anal.* **2017**, *22*, 59–73. [\[CrossRef\]](#)
32. McAndrew, F.T. *Environmental Psychology*; Indo-American Books: New Delhi, India, 2015.
33. Rollero, C.; De Piccoli, N. Place attachment, identification and environment perception: An empirical study. *J. Environ. Psychol.* **2010**, *30*, 198–205. [\[CrossRef\]](#)
34. Jorgensen, B.; Stedman, R. Sense of place as an attitude: Lakeshore owners' attitudes toward their properties. *J. Environ. Psychol.* **2001**, *21*, 233–248. [\[CrossRef\]](#)
35. von Wirth, T.; Gret-Regamey, A.; Moser, C.; Stauffacher, M. Exploring the influence of perceived urban change on residents' place attachment. *J. Environ. Psychol.* **2016**, *46*, 67–82. [\[CrossRef\]](#)
36. Brown, B.; Perkins, D.D.; Brown, G. Place attachment in a revitalizing neighborhood: Individual and block levels of analysis. *J. Environ. Psychol.* **2003**, *23*, 259–271. [\[CrossRef\]](#)
37. Gosling, E.; Williams, K. Connectedness to nature, place attachment and conservation behavior: Testing connectedness theory among farmers. *J. Environ. Psychol.* **2010**, *30*, 298–304. [\[CrossRef\]](#)
38. Diener, A.C.; Hagen, J. The power of place in place attachment. *Geogr. Rev.* **2021**. [\[CrossRef\]](#)
39. Seamon, D.; Sowers, J. Place and placelessness, Edward Relph. In *Key Texts in Human Geography*; Hubbard, P., Kitchen, P., Vallentine, G., Eds.; Sage: London, UK, 2008; pp. 43–51.
40. Tuan, Y.-F. *Topophilia: A Study of Environmental Perception, Attitudes, and Values*; Prentice-Hall: Englewood Cliffs, NJ, USA, 1974.
41. Diener, A.C.; Hagen, J. Geographies of place attachment: A place-based model of materiality, performance, and narration. *Geogr. Rev.* **2020**. [\[CrossRef\]](#)
42. Walker, G.J.; Chapman, R. Thinking like a park: The effects of sense of place, perspective-taking, and empathy on pro-environmental intentions. *J. Park. Recreat. Admin.* **2003**, *21*, 71–86.

43. Williams, D.; Vaske, J.J. The measurement of place attachment: Validity and generalizability of a psychometric approach. *For. Sci.* **2003**, *49*, 830–840.
44. Bailey, E.; Devine-Wright, P.; Batel, S. Emplacing linked lives: A qualitative approach to understanding the co-evolution of residential mobility and place attachment formation. *J. Community Appl. Soc. Psychol.* **2021**, *31*, 515–529. [\[CrossRef\]](#)
45. Halpenny, E. Pro-environmental behaviors and park visitors: The effect of place attachment. *J. Environ. Psychol.* **2003**, *30*, 409–421. [\[CrossRef\]](#)
46. Stedman, R.C. Toward a social psychology of place—predicting behavior from place-based cognitions, attitude, and identity. *Environ. Behav.* **2002**, *34*, 561–581. [\[CrossRef\]](#)
47. Kyle, G.; Grafe, A.; Manning, R. Testing the dimensionality of place attachment in recreational settings. *Environ. Behav.* **2005**, *37*, 153–177. [\[CrossRef\]](#)
48. Junot, A.; Paquet, Y.; Fenouillet, F. Place attachment influence on human well-being and general pro-environmental behaviors. *J. Theor. Soc. Psychol.* **2018**, *2*, 49–57. [\[CrossRef\]](#)
49. Tonge, J.; Ryan, M.M.; Moore, S.A.; Beckley, L.E. The effect of place attachment on pro-environment behavioral intentions of visitors to coastal natural area tourist destinations. *J. Travel Res.* **2015**, *54*, 730–743. [\[CrossRef\]](#)
50. Xu, D.D.; Peng, L.; Liu, S.Q.; Wang, X.X. Influences of risk perception and sense of place on landslide disaster preparedness in southwestern China. *J. Disaster Risk Sci.* **2018**, *9*, 167–180. [\[CrossRef\]](#)
51. Gifford, R. The dragons of inaction: Psychological barriers that limit climate change mitigation and adaptation. *Am. Psychol.* **2011**, *66*, 290–302. [\[CrossRef\]](#)
52. Slovic, P. Perception of risk. *Science* **1987**, *236*, 280–285. [\[CrossRef\]](#)
53. Brown, V.J. Risk perception: It's personal. *Environ. Health Perspect.* **2014**, *122*, A276–A279. [\[CrossRef\]](#) [\[PubMed\]](#)
54. Joffe, H. Risk: From perception to social representation. *Br. J. Soc. Psychol.* **2003**, *42*, 55–73. [\[CrossRef\]](#) [\[PubMed\]](#)
55. Raaijmakers, R.; Krywkow, J.; van der Veen, A. Flood risk perceptions and spatial multi-criteria analysis: An exploratory research for hazard mitigation. *Nat. Hazards* **2008**, *46*, 307–322. [\[CrossRef\]](#)
56. Rego, L.E.; Pereira, S.M.; Morro, J.; Pacheco, M.P. Perceptions of seismic and volcanic risk and preparedness at São Miguel Island (Azores, Portugal). *Int. J. Disaster Risk Reduct.* **2018**, *31*, 498–503. [\[CrossRef\]](#)
57. Martins, V.N.; Nigg, J.; Louis-Charles, H.M.; Kendra, J.M. Household preparedness in an imminent disaster threat scenario: The case of superstorm sandy in New York City. *Int. J. Disaster Risk Reduct.* **2019**, *34*, 316–325. [\[CrossRef\]](#)
58. van Valkengoed, A.M.; Steg, L. Meta-analyses of factors motivating climate change adaptation behaviour. *Nat. Clim. Change* **2019**, *9*, 158–163. [\[CrossRef\]](#)
59. Bernardo, F. Impact of place attachment on risk perception: Exploring the multidimensionality of risk and its magnitude. *Estud. Psicol.* **2013**, *34*, 323–329. [\[CrossRef\]](#)
60. Folkman, S.; Lazarus, R.S.; Gruen, R.J.; DeLongis, A. Appraisal, coping, health status and psychological symptoms. *J. Pers. Soc. Psychol.* **1986**, *50*, 571–579. [\[CrossRef\]](#)
61. Peng, L.; Tan, J.; Lin, L.; Xu, D.D. Understanding sustainable disaster mitigation of stakeholder engagement: Risk perception, trust in public institutions, and disaster insurance. *Sustain. Dev.* **2019**, *27*, 885–897. [\[CrossRef\]](#)
62. Peng, L.; Xu, D.D.; Wang, X.X. Vulnerability of rural household livelihood to climate variability and adaptive strategies in landslide-threatened western mountainous regions of the Three Gorges Reservoir area, China. *Clim. Dev.* **2019**, *11*, 469–484. [\[CrossRef\]](#)
63. Ajzen, I.; Fishbein, M. *Understanding Attitudes and Predicting Social Behavior*; Prentice Hall: Englewood Cliffs, NJ, USA, 1980.
64. Tournois, L.; Rollero, C. Should I stay or should I go? Exploring the influence of individual factors on attachment, identity and commitment in a post-socialist city. *Cities* **2020**, *102*, 102740. [\[CrossRef\]](#)
65. UNISDR. Terminology on Disaster Risk Reduction. 2009. Available online: https://www.unisdr.org/files/7817_UNISDRTerminologyEnglish.pdf (accessed on 6 May 2019).
66. Domingues, R.B.; Costas, S.; Jesus, S.N.; Ferreira, Ó. Sense of place, risk perceptions and preparedness of a coastal population at risk: The case of Faro Beach. *J. Spat. Organ. Dyn.* **2017**, *3*, 163–175.
67. Swapan, M.S.H.; Sadeque, S. Place attachment in natural hazard-prone areas and decision to relocate: Research review and agenda for developing countries. *Int. J. Disaster Risk Reduct.* **2021**, *52*, 101937. [\[CrossRef\]](#)
68. Kutlaca, M.; van Zomeren, M.; Epstude, K. Our right to a steady ground: Perceived rights violations motivate collective action against human-caused earthquakes. *Environ. Behav.* **2019**, *51*, 315–344. [\[CrossRef\]](#)
69. Masterson, V.A.; Stedman, R.C.; Enqvist, J.; Tengö, M.; Giusti, M.; Wahl, D.; Svedin, U. The contribution of sense of place to social-ecological systems research: A review and research agenda. *Ecol. Soc.* **2017**, *22*, 49. [\[CrossRef\]](#)
70. NCDR. *Potential Flooding Maps in Taiwan (Taipei City)*; NCDR: Taipei, China, 2021. Available online: <https://dmap.ncdr.nat.gov.tw/%e4%b8%bb%e9%81%b8%e5%96%ae/%e5%9c%b0%e5%9c%96%e6%9f%a5%e8%a9%a2/gis%e6%9f%a5%e8%a9%a2/> (accessed on 6 November 2021). (In Chinese)
71. Raudenbush, S.W.; Bryk, A.S. *Hierarchical Linear Models: Applications and Data Analysis Methods*; Sage: Thousand Oaks, CA, USA, 2002.
72. Singer, J.D.; Willett, J.B. *Applied Longitudinal Data Analysis: Modeling Change and Event Occurrence*; Oxford University Press: Oxford, UK, 2003.

73. Easton, V.J.; McColl, J.H. Online Statistics Glossary, Version 1.1. (n.d.). Available online: <http://www.stats.gla.ac.uk/steps/glossary/alphabet.html> (accessed on 25 December 2021).
74. Department of Civil Affairs, Taipei City Government, Government Information Open Platform, Population, Taipei, Taiwan. 2021. Available online: https://ca.gov.taipei/News_Content.aspx?n=8693DC9620A1AABF&sms=D19E9582624D83CB&s=EE7D5719108F4026 (accessed on 18 December 2021). (In Chinese)
75. Department of Civil Affairs, Taipei City Government, Government Information Open Platform, Education, Taipei, Taiwan. 2021. Available online: https://ca.gov.taipei/News_Content.aspx?n=8693DC9620A1AABF&sms=D19E9582624D83CB&s=49EE949EED38EF73 (accessed on 18 December 2021). (In Chinese)
76. Department of Budget, Accounting and Statistics, Labor and Employment, Taipei City Government. 2021. Available online: https://dbas.gov.taipei/News_Content.aspx?n=72EB69FFAC3565DF&sms=96C0B436A542605B&s=0EE1734BF15D2DCD (accessed on 18 December 2021). (In Chinese)
77. Department of Budget, Accounting and Statistics, Income, Taipei City Government. 2021. Available online: https://dbas.gov.taipei/News.aspx?n=1A92853853322CF6&sms=AC3003A760CEDBAC&_CSN=98675A908DC49E21 (accessed on 18 December 2021). (In Chinese)
78. Angel, S.; Disslbacher, F.; Humer, S. What did you really earn last year? Explaining measurement error in survey income data. *J. Royal Statist. Soc. Ser. A (Stat. Soc.)* **2019**, *182*, 1411–1437. [[CrossRef](#)]
79. Angel, S.; Heuberger, R.; Lamei, N. Differences between household income from surveys and registers and how these affect the poverty headcount: Evidence from the Austrian SILC. *Soc. Indic. Res.* **2018**, *138*, 575–603. [[CrossRef](#)]
80. Cabral, A.C.G.; Gemmell, N.; Alinaghi, N. Are survey-based self-employment income underreporting estimates biased? New evidence from matched register and survey data. *Int. Tax Public Financ.* **2020**, *28*, 284–322. [[CrossRef](#)]
81. Ramkissoon, H.; Mavondo, F.T. The satisfaction–place attachment relationship: Potential mediators and moderators. *J. Bus. Res.* **2015**, *68*, 2593–2602. [[CrossRef](#)]
82. AlQahtany, A.M.; Abubakar, I.R. Public perception and attitudes to disaster risks in a coastal metropolis of Saudi Arabia. *Int. J. Disaster Risk Reduct.* **2020**, *44*, 101422. [[CrossRef](#)] [[PubMed](#)]
83. Blöschl, G.; Hall, J.; Parajka, J.; Perdigão, R.A.; Merz, B.; Arheimer, B.; Aronica, G.T.; Bilibashi, A.; Bonacci, O.; Borga, M.; et al. Changing climate shifts timing of European floods. *Science* **2017**, *357*, 588–590. [[CrossRef](#)]
84. Thorup-Binger, C.; Charania, N.A. Vulnerability and capacities of international students in the face of disasters in Auckland, New Zealand: A qualitative descriptive study. *Int. J. Disaster Risk Reduct.* **2019**, *39*, 101136. [[CrossRef](#)]
85. Scannell, L.; Gifford, R. The psychology of place attachment. In *Environmental Psychology: Principles and Practice*, 5th ed.; Gifford, R., Ed.; Optimal Books (open library): Colville, WA, USA, 2014; Available online: https://www.researchgate.net/publication/279718543_The_psychology_of_place_attachment (accessed on 6 November 2021).