water

MDPI

Article

Factors Affecting Farmers' Adoption of Flood Adaptation Strategies Using Structural Equation Modeling

Md Omar Faruk [1,2,*] and Keshav Lall Maharjan [1]

[1] International Economic Development Program, Graduate School of Humanities and Social Sciences, Hiroshima University, Higashi-Hiroshima 739-8529, Japan
[2] Department of Agricultural Extension, Ministry of Agriculture, Dhaka 1215, Bangladesh
* Correspondence: m202435@hiroshima-u.ac.jp; Tel.: +81-090-97596620

Abstract: Floods are a frequent disaster in Bangladesh, and farmers are the most at risk. Understanding how to improve the farmers' flood adaption is important to reduce flood effects. Protection motivation theory (PMT) has been widely used to examine flood adaptation behavior, but there is still debate regarding the quantitative effect of PMT factors on flood adaption behavior, particularly in a geographically vulnerable context. This study integrates psychological aspects based on PMT to assess farmers' flood adaptability. A cross-sectional survey was conducted to collect data from 359 farmers. We employed structural equation modeling to test a PMT model with mediation analysis. The results showed that farmers who perceive a higher flood risk and feel more fear of floods are more likely to implement flood adaptation measures. Similarly, farmers adopt more adaptive actions if they have higher self-efficacy and response efficacy. However, they are less likely to take adaptive actions if they are subject to maladaptation. Maladaptation plays a significant role as a mediating variable. These findings will act as recommendations for government agencies to design policy measures to strengthen flood risk management. The study supports the theory of protection motivation to understand farmers' flood adaptation behavior. However, further study is required to enhance and generalize the existing model.

Keywords: farmers; flood adaptation strategies; protection motivation theory; structural equation modeling

check for updates

Citation: Faruk, M.O.; Maharjan, K.L. Factors Affecting Farmers' Adoption of Flood Adaptation Strategies Using Structural Equation Modeling. *Water* **2022**, *14*, 3080. https://doi.org/10.3390/w14193080

Academic Editor: Piotr Matczak

Received: 12 August 2022
Accepted: 28 September 2022
Published: 30 September 2022

1. Introduction

Bangladesh is a country suffering from extreme geographic vulnerability and subject to regular flooding. With the Ganges, Brahmaputra, and Meghna River systems, and their tributaries, Bangladesh has the world's biggest delta plain. The country has a total area of 14,7570 km^2, of which rivers and island waters account for 6.7% [1]. Between 1954 and 2017, Bangladesh was devastated by at least 58 major floods, killing 20,039 people and displacing millions more [2]. The 1966, 1987, 1988, 1998, and 2007 floods were the most devastating floods in Bangladesh, affecting millions of people [3]. Similarly, with high water levels, this country experienced one of the most devastating river floods since records began in 2017 [3], and the Ministry of Disaster Management and Relief (MoDMR) assessed the floods to be the worst in at least 40 years [4]. The latest catastrophic floods in Bangladesh in June 2020 affected 5.4 million people in the country's northern, central, and northeastern regions. Around 37% of the country's total territory was flooded, affecting 33 districts, and it was the country's longest flooding period in 22 years [5].

Despite Bangladesh's being severely prone to flooding, few studies have focused on the flood adaptation behavior of Bangladeshi people, especially the farmers' community in the remote char-lands. The riverine sand and silt landmasses are commonly known as "char-lands" in Bengali [6]. The char areas, which comprise almost 7200 km^2, are believed to accommodate 4–5% of the Bangladeshi population [6–8]. There are 56 major and

226 small char in this country [9]. Among the flood-prone regions of Bangladesh, char regions are primarily vulnerable to flooding, drought, and river erosion regardless of their physical connection to the mainland or distance from growth centers [10]. Growth centers are the growing points of char-lands development. Flooding is the greatest natural hazard in char-lands, wreaking havoc on residents, especially farmers. Farmers and fishermen make up more than 70% of the char population. Sharecropping, agricultural day labor, and livestock farming are all poor predictors of these families' income [11]. Floods and riverbank erosion, on the other hand, ruin their crops, their lands, and their homes. As a result, protecting livelihoods from flood events has become a major concern for flood-prone char communities in recent years.

To protect against flood hazards, the world is moving to risk-focused flood management, which necessitates a complete understanding of flood adaptation behavior [12]. For social systems, one can distinguish between administrative and private adaptation as well as preemptive adaptation before a flood and responsive adaptation after a flood [13]. Flood adaptation measures are a crucial aspect of the shift from a top-down institutional approach to community-based flood risk management. Globally, government representatives highlight the necessity of people's self-defense and believe that shared responsibility is the right approach [14–17]. It seems to be ambiguous whether this represents people's capacity to enhance their protection level [17]. These studies indicate a gap that we address with this study, where we assessed the farmers' perceived risk and their coping capacities like self-efficacy, response efficacy, and response cost; we also explored their actual flood adaptation behaviors. Several studies showed that early adoption of flood adaptation strategies by individuals or families can significantly reduce flood damage [13,18,19]. However, most people living in flood-prone areas do not take proactive flood prevention measures [20,21]. Despite the fact that several studies have demonstrated that adopting flood adaptation measures is cost-effective in many circumstances [22], even those who live in floodplains are not sufficiently prepared for probable flood disasters. Meyer et al. [23] conducted a survey of coastal inhabitants in numerous US states and found that only one-fourth of the residents had taken precautionary measures before the arrival of Hurricane Sandy. Schmuck [24] found that although people in the flood-prone areas of Bangladesh are aware of coming floods, they are reluctant to prepare for them and accept their fate as helpless flood victims. This raises the question, for Grothmann and Reuswig [13], of why some people in flood-prone regions take adaptation measures for floods while many others do not.

In order to determine the factors that affect individual decisions about flood adaptation, this study aimed to examine the implementation of flood adaptation measures by farmers who reside in flood-prone char-land regions. For this purpose, we conducted a survey with 359 farmers to gather information. The survey was conducted after the 2020 flood, and we included 21 flood adaptation measures that farmers were asked whether or not they had implemented them to prevent damage from the 2020 flood. This flood affected 1.06 million households and caused USD 42 million worth of crop loss [5]. Since char-lands are more vulnerable than other regions, farmers incurred huge losses in crops and property damage. These high damages caused by the 2020 flood highlight the importance of improving individual flood adaptation in char-lands to minimize future flood damages. It is also crucial to comprehend why some char-land farmers chose to employ flood adaptation measures while others did not. This was the key question of this study, which aimed to explain how different factors affect farmers' flood adaptation behavior based on protection motivation theory. This study tested different hypotheses to show relationship between PMT components and flood adaptation considering the above question.

Many researchers have performed behavioral or cognitive studies based on a theoretical framework to evaluate the influence of individual actions on flood adaptation strategy adoption [25,26]. The detailed investigation of private flood adaptation behavior benefits from theoretical frameworks that are consistent and that allow for the comparison and generalization of results across studies contrary to nontheoretical and exploratory methodologies [27]. In light of this, Grothmann and Reusswig [13] applied the protection motivation theory (PMT) in flood risk research more than fifteen years ago. PMT is one of the four major theories in the field of health behavioral psychology. Though Rogers first presented the concept in relation to health risks, it now appears to have a broader application, including with natural and technological hazards [28,29]. In several studies, the PMT has been utilized as a theoretical foundation to describe how individuals adapt when they are under threat of flooding. [30]. PMT takes into account psychological factors such as threat appraisals and coping appraisals.

Although various studies have been conducted showing factors influencing individuals' decisions to implement flood adaptation measures in different countries, there is little research on the determinants influencing the adoption of flood adaptation measures in Bangladesh. Importantly, for the farmers' contexts in Bangladesh, no studies were found linking psychological factors to flood adaptation. Mallick et al. [31] applied PMT to assess how threat perceptions and coping assessments influence migration decisions in farming communities suffering from farmland salinity. Ansari [32] performed a correlation analysis of only the threat assessment components of protection motivation theory (PMT) with flood prevention measures in the north central region of Bangladesh. In contrast, this article specifically used structural equation modeling to construct PMT factors (both threat assessments and coping assessments) as well as to analyze direct and indirect effects on farmers' flood adaptation through maladaptive or nonprotective responses. Structural equation modeling (SEM) is effective for capturing the PMT components properly and critically appraising their expected interrelations, which develops on the methodology used in prior studies.

Therefore, this study used a conceptual model based on PMT to examine psychological aspects. The goals of this research are twofold. First, this study identified the flood adaptation strategies used by farmers in response to the 2020 flood; second, SEM was used to analyze the factors associated with the use of flood adaptation strategies. This study suggests that certain of the decision routes underpinning the PMT are consistently better than others based on both a review of previous articles and the results of a substantial survey with char-land farmers in Bangladesh. Understanding the farmers' decisions on flood adaptation can assist governments in developing policies to improve communication and flood risk management. The rest of the study is organized as follows: Section 2 describes the theory and hypothesis. Section 3 consists of materials and methods, while Section 4 contains the main findings. Section 5 presents the discussion of the paper, and finally, Section 6 presents our conclusions and policy recommendations.

2. Theory and Hypothesis

People who live in disaster-prone areas have long been reported as doing nothing or relatively little to reduce their risk of mortality, damage, or loss of property [33,34]. Some individuals may be prepared to accept effort and accountability to lessen their flood risk, whereas others take a different perspective. As a result, an individual's preparedness against a threat can be affected by different levels of preparation [35]. To explain the diversity in farmers' flood adaptation measures to minimize flood damage in char-lands, the authors developed a cognitive model based on protection motivation theory [13,36].

This study concentrates on the most widely used version of PMT, as shown in Figure 1, in which the main two cognitive processes, threat appraisals (risk perception and flood fear) and coping appraisals (self-efficacy, response efficacy, and response cost), are used to determine the effects of PMT components on farmers' flood adaptation strategy adoption. The first process, threat appraisals, describes how a person evaluates the likelihood of a risk and the potential damage to items he or she assesses. Risk perception can be defined as the perception of risk probability and consequences [30]. People have a high risk perception when they feel a flood is extremely probable (high perceived probability) and the flood's possible effects are severe (high perceived consequences). Flood fear is another component of threat appraisals that is thought to be a strong predictor of adaptation behavior [30,37]. The second process, coping appraisal, on the other hand, evaluates a person's capacity to adapt to flood and the effectiveness of adaptation measures, as well as the cost of adapting. People have high coping assessments when they believe an adaptive intervention is effective (high response efficacy), easy to execute (high self-efficacy), and economical to undertake (low response costs) [19,38]. As a result, we anticipate that individuals' threat and coping appraisals will improve if they are better informed about flood risk and necessary preventive actions. While communicating information about the likelihood, consequences, and level of fear associated with a flood aims to change people's threat perceptions, communicating information about the ability, effectiveness, and affordability of specific adaptation strategies aims to change people's adaptive perspectives [39].

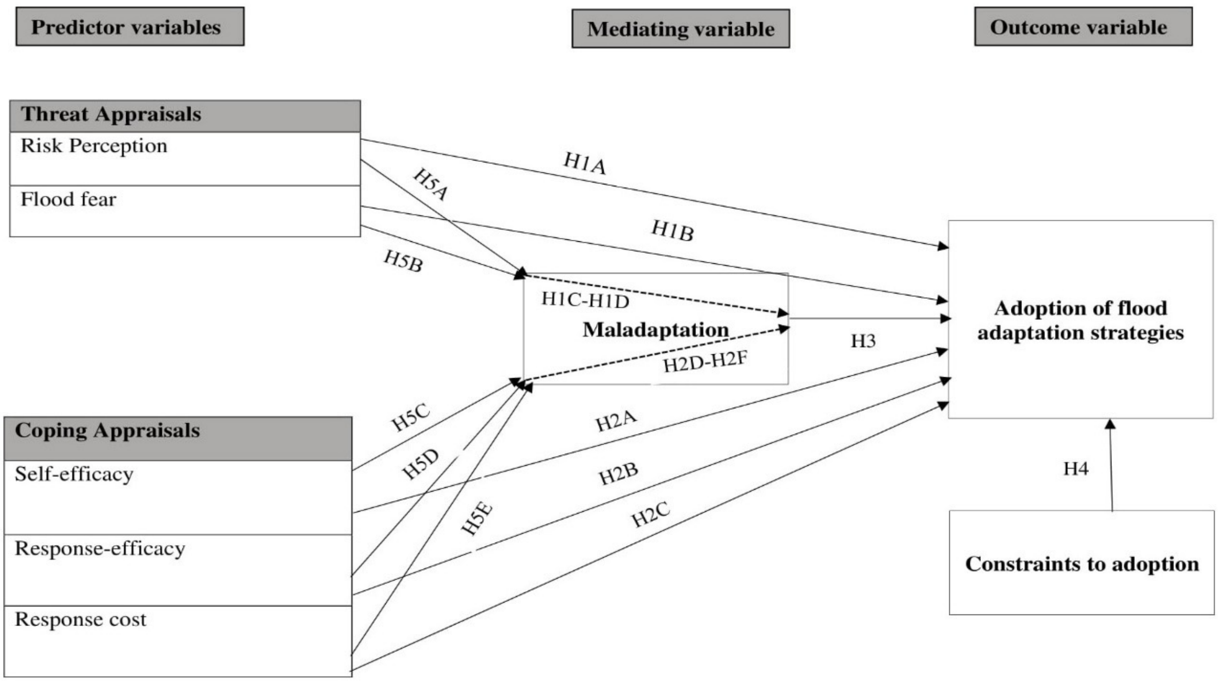

Figure 1. Model of flood risk adaptation behavior and hypotheses. Straight and dashed arrows depict predicted direct effects and mediation (indirect) effects respectively.

In addition to the basic PMT, an additional variable, constraints to adoption, was taken into account according to the extended version of PMT [13] to highlight the influence of constraints faced by farmers to their adoption of flood adaptation strategies. The PMT model proposed in this study is shown in Figure 1.

Previous research has shown little evidence that better risk mitigation behavior is influenced by risk perception [12,18]. However, Wang et al. [40] identified the effect of risk perception on flood prevention intention. As a result, the effect of risk perception is contradictory. Fear of future flooding [13,37,41] is a consistently effective predictor of flood adaptation behavior. This study also explores the influence of farmers' maladaptive behavior as a mediator. A mediating variable is expected to be influenced by predictor variables and should have effects on dependent variables. Based on PMT, maladaptation is expected to be influenced by explanatory factors such as threat appraisals and coping appraisals, and maladaptation should have a relationship with flood adaptation behaviors. As maladaptation is a nonprotective psychological response, it is reasonable to consider maladaptation to show how farmers' perceived flood risk and coping assessment affect their flood protection behavior through maladaptation or nonprotective responses in the context of char-lands as the literacy level among char-dwellers is quite low.

Three major domains of maladaptation such as, denial, fatalism, and wishful thinking, were considered in this maladaptation assessment. Previous studies on the association between risk perception and maladaptation found consistent negative associations [30,37]. Based on the above discussion, we can propose the following hypotheses:

H1A: *Risk perception has a direct effect on the adoption of flood adaptation strategies.*

H1B: *Flood fear has a direct effect on the adoption of flood adaptation strategies.*

H1C: *Maladaptation mediates the effects of risk perception on the adoption of flood adaptation strategies.*

H1D: *Maladaptation mediates the effect of flood fear on the adoption of flood adaptation strategies.*

Once a certain level of threat is perceived, individuals typically seek out adaptive ways to deal with the situation. People usually consider the benefits of different strategies and evaluate their ability to implement them before taking action. The motivation for implementing flood adaptation measures is associated with a belief in strong self-efficacy, response efficacy, and low response costs [27,42]. Previous studies [12,13,18,19,37] showed a consistent relationship between coping appraisals and flood adaptation. In a focus group discussion with residents of flood-prone cities in High River, Alberta, McDonald-Harker [43] assessed respondents' limited coping capacity and lack of resources for flood risk mitigation efforts, resulting in inaction in flood risk reduction. In general, under the PMT, coping appraisal has a negative effect on maladaptation responses [29], indicating that strong coping concepts are linked to a reduction in maladaptive behavior. Only a few studies [13,44] have investigated this connection in private flood protection. The following hypotheses are presented based on the findings of the preceding research:

H2A–H2C: *Self-efficacy, response efficacy, and response cost have direct effects on the adoption of flood adaptation strategies.*

H2D–H2F: *Maladaptation mediates the effects of self-efficacy, response efficacy, and response cost on the adoption of flood adaptation strategies.*

Maladaptation does not reduce the risk of flood events, but it does assist individuals in "ignoring or repressing the bad feelings that come with it" [18]. This type of response, per PMT, lowers protection incentives and so hinders adaptive behavior [29]. However, the influence of maladaptation reactions on protection motivation is unclear. Maladaptation intention has been shown to impair protection motivation in past studies [13,45]. The negative link between the PMT and maladaptation responses could only be validated for a small subset of these responses, and it does not seem to have major effects on all flood adaptation strategies. Considering these studies, the following hypothesis can be drawn:

H3: *Maladaptation intention has direct effects on the adoption of flood adaptation strategies.*

Farmers face many constraints or challenges in adopting adequate flood adaptation measures, and constraints to adoption are expected to have a negative relationship with flood adaptation measures [13]. For this, we propose the hypothesis as follows:

H4: *Constraints to adoption have direct effects on the adoption of flood adaptation strategies.*

According to Grothmann and Reusswig [13], both threat appraisals and coping appraisals had negative correlation with maladaptation or nonprotective responses. We propose the following hypothesis:

H5A–H5E : *Both threat appraisals (risk perception and flood fear) and coping appraisals (self-efficacy, response efficacy, and response cost) have direct effects on maladaptation.*

3. Materials and Methods

3.1. Study Locale, Sampling and Data Collection

Sirajganj is a flood-prone district in northern Bangladesh comprising largely char areas. The Brahmaputra River, sometimes known as the Jamuna River, passes through this region. The Jamuna's monsoon flow is so high that it often breaches its banks, drowning much of Sirajganj. Since it is located on the Jamuna River's bank, the Chowhali subdistrict of Sirajganj district floods severely. The Chowhali subdistrict was chosen for this study as shown in Figure 2 based on flood intensity. The Jamuna River splits the Chowhali subdistrict into two parts. The biggest calamities in this area are riverbank erosion and repeated flooding. Due to riverbank erosion at various times, the land of this subdistrict is frequently lost to the river. The majority of this subdistrict is composed of riverine island habitats known as char-lands.

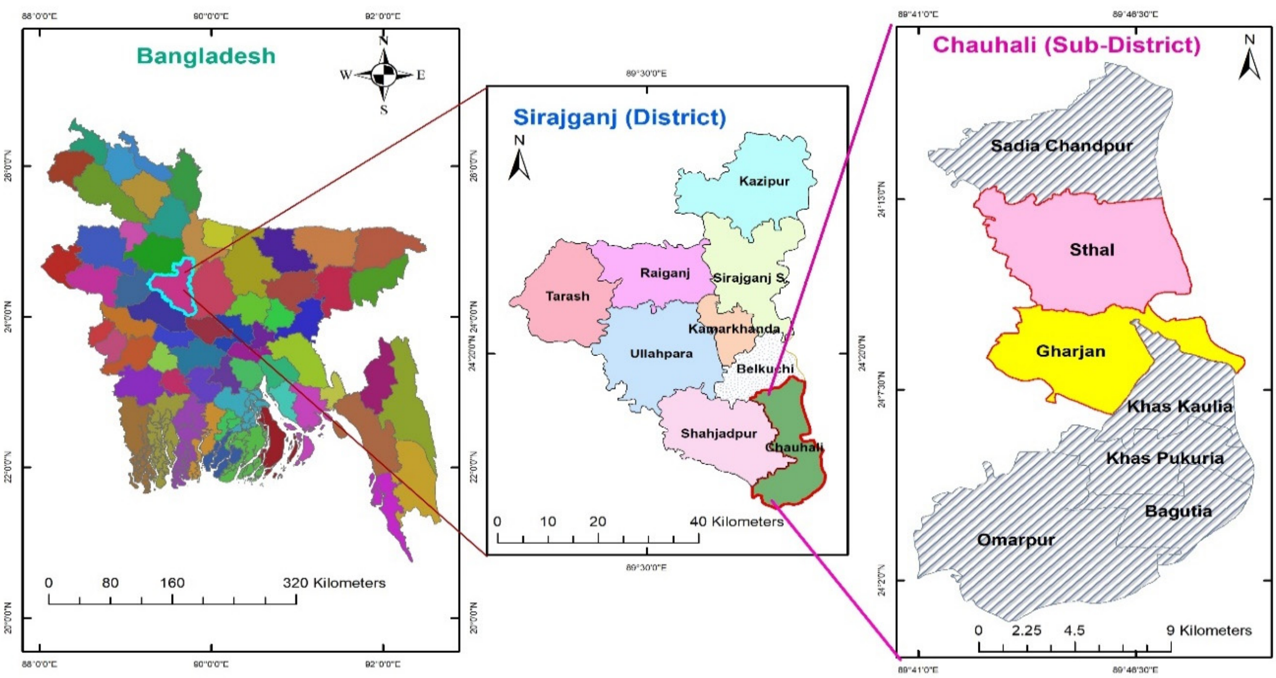

Figure 2. Map of surveyed location. Source: Faruk and Maharjan [46].

A cross-sectional survey was conducted using a qualitative and quantitative mixed approach. To obtain the primary data, farmers were interviewed using a semi-structured questionnaire. The questionnaire was constructed to collect data on the farmers' sociodemographic and PMT factors, as well as their flood adaptation strategies adopted in the 2020 flood. To determine sample size, two unions, Ghorjan and Sthal, under the Chowhali subdistrict, were purposively chosen based on flood severity. Within each union, three villages (Har Ghorjan, Boro Ghorjan, and Muradpur) from the Ghorjan union and three villages (South Nouhata, North Nouhata, and Chaluhara) from the Sthal union were randomly selected. The subdistrict agricultural office provided a detailed list of the farmers.

From the list of 1793 farmers from 6 villages (Har Ghorjan, 300; Boro Ghorjan, 250; Muradpur, 500; South Nouhata, 295; North Nouhata, 223; and Chaluhara, 225), 60 respondents were selected by simple random sampling from each village. Using these approaches, the sample size of the population was 360 (on an average, 60 farmers per village); the final sample size was 359 because one farmer was missing. The survey was conducted in August 2021. Prior to conducting the final survey, the research ethics committee of the Graduate School of Humanities and Social Sciences at Hiroshima University approved the questionnaire for compliance with ethical concerns such as basic human rights, the protection of personal information, and data security.

3.2. Measurement of Variables

In recent studies, a range of methodologies have been employed to measure individual flood adaptation in various regions. Bradford et al. [47] utilized a simple Likert-scale survey to analyze six European countries' self-evaluated levels of personal preparedness. Miceli et al. [48] used a multi-item variable to assess how successfully residents in an Italian alpine region mitigated flood damage. Poussin et al. [19] investigated the extent of the use of different types of measures such as structural, avoidance, and emergency measures by local residents in three flood-prone locations in France. Grothmann and Reusswig [13] used a 5-point Likert scale ranging from 0 ('not at all') to 4 ('to a great extent') to identify flood protective behaviors in the past. Papagiannaki et al. [49] estimated the total weight of eight dichotomous questions asking about respondents' recently adopted flood-preparedness measures. The items were weighted based on importance and implementation cost. Botzen et al. [50] used binary questions for the estimation of three flood damage mitigation measures separately. Based on this research, we proposed a checklist of 21 flood adaptation strategies adopted by farmers in the 2020 flood. A score of 1 was given for each strategy for a total possible score of 21.

The adaptation strategies were structural (eight items), livelihood (six items), emergency (four items), and financial (three items) in nature. The total score of flood adaptation strategies, comprising all categories, was the dependent variable in this study. A list of variables and their descriptions is provided in Table 1.

Table 1. Variables that are part of the protection motivation theory.

Variables	Description	Measuring Unit	α Value
Total flood adaptation score	The adoption of flood adaptation strategies in 2020 flood (21 items)	1 if farmers adopted each adaptation strategies, 0 otherwise.	0.92
Risk perception	There are a total of eight components in this personal evaluation of the probability of a future occurrence (a) and the consequent damage (b)	(a) 1–very unlikely, 2–rather unlikely, 3–neutral, 4–rather likely, 5–very likely (b) 1–not bad at all; 2–rather not bad; 3–neutral; 4–rather bad; 5–very bad;	0.93
Flood fear	Worry about flood occurrences and consequences.	1–not at all; 2–a bit; 3–neutral; 4–somewhat; 5–very much;	0.94
Self-efficacy	The respondent thinks that he/she is capable of following the described 21 measures.	1–Very unable, 2–Rather unable, 3–Neutral, 4–Rather able, 5–Very able	0.93
Response efficacy	Effectiveness of the described 21 flood adaptation strategies	1–Very ineffective, 2–Rather Ineffective, 3–Neutral, 4–Rather effective, 5–Very effective	0.93
Response cost	To what extent the adaptation measures are costly (21 items)	1–very costly, 2–rather costly, 3–neutral, 4–rather not costly, 5–very not costly;	0.94
Maladaptation	Denial, fatalism, and wishful thinking (3 items)	1–strongly disagree; 2–disagree; 3–neutral; 4–agree; 5–strongly agree.	0.93
Constraints to adoption	Constraints faced by the farmers in flood adaptation strategy adoption (12 items)	0–No constraint, 1–low, 2–medium, 3–high	0.95

According to Miceli et al. [48], the major two aspects of risk perception (risk probability and consequences) should be brought together into a single, more holistic model. Based on this, we considered risk perception a single variable in the PMT construct. Risk perception consisted of eight questions about risk probability and consequences, and we averaged the eight scores to get the risk perception score. When compared with the set thresholds, the risk perception and flood fear indicators exhibit high reliability with Cronbach's alphas of 0.93 and 0.94, respectively. In this study, farmers were asked to assess the efficacy of each adaptation strategy, their own capacity to execute each measure, and the expense required for each specific measure on a five-point scale [19,38]. Cronbach's alphas for all coping appraisal items were greater than 0.9, indicating high scale reliability.

On 5-point Likert scales, farmers were asked to assess how much they agreed with statements regarding maladaptation responses like denial of flood adaptation, wishful thinking, and fatalism [51]. Maladaptation was measured by the average of three components in this study. In case of self-efficacy (SE), response efficacy (RE) and response cost (RC), respondents were asked to rate their perceptions of 21 flood adaptation measures using a 5-point Likert scale, and average scores were compiled for each. Farmers' constraints to flood adaptation, e.g., lack of resources (information, money, knowledge, infrastructure, and social support) were considered in this model using a 4-point Likert scale [52] and the average for each constraint.

3.3. Analytical Method

Path analysis, a structural equation modeling (SEM) tool, was used to evaluate the PMT model hypotheses in previous studies [40,49,51,53,54]. There are several models can be applied in structural equation modeling such as path analysis, factor analysis, latent variable structural models, and growth curve models. In this study, a mediation model was established using path analysis through SEM. For mediation analysis, SEM models are best represented by path diagrams. SEM in the context of mediation analysis has advantages when a model contains latent variables. SEM provides for the assessment of linkages in a proposed mediation process (Figure 1), as well as the direct effect of the predictor variables on the outcome and the mediation effect, which describes how an exogenous variable affects the outcome variable through the mediator [55]. The indirect effect refers to the extent of mediation. The two forms of mediation effects are full and partial. Full mediation can be demonstrated when predictor variable X shows significant influence on mediating variable M that in turn significantly influences dependent variable Y without having any direct effect on the dependent variable. However, if predictor X shows a direct effect on dependent variable Y in addition to a mediation or indirect effect, it is called partial mediation. No mediation effect is found when the predictor variable has no significant relationship with the mediation variable.

The parameters estimated from SEM define the type and magnitude of the relationship between variables in a model, as well as data on the model's overall fit with different indices. Fit indices are a useful tool for evaluating how well a model reflects the observed data. The comparative fit index (CFI), normed fit index (NFI), root mean square error of approximation (RMSEA), and standardized root-mean-square residual (SRMR) were the model fit indices considered in this study with maximum likelihood estimation. This method is preferred to handle the missing data [56]. As maximum likelihood estimation considers all observations, the model reported in the study refers to the whole sample of 359 farmers. In addition to SEM analysis, the Sobel test and the Baron Kenny approach were employed to check the robustness of the mediation effect of the proposed hypotheses. Furthermore, bootstrapping was also used to check the robustness of the results of the former models. STATA statistical software was used for all data analysis.

4. Results

4.1. Descriptive Results

4.1.1. Sociodemographic Characteristics

In the Chowhali subdistrict of Sirajganj, 359 valid survey questionnaires from 6 villages in 2 unions were analyzed in depth for this study. The sociodemographic characteristics of age, gender, year of schooling, and annual income in the study area are summarized in Table 2.

From Table 2, we find that the respondents were largely between the ages of 31 and 60 (65.74%), which may be explained by the fact that that age group (31–60) is the most active in farming in char-lands. Only 8.08% of respondents involved in agriculture are between ages of 0 and 30, while older people above 60 equal 17.83%. Male farmers account for more than two-thirds of the respondents (70.47%), while female farmers account for 29.53%, indicating that men are more involved in agriculture than women. A large percentage of farmers (39.83%) have no formal education, while almost as many (42.34%) have only primary education, indicating that education levels among farmers are extremely low. This statistic is also consistent with the findings of [57], who reported that the average years of schooling in the char-lands was 1.9 years, and another study that revealed that 45% of people in the floodplain had only had primary education [58].

This could be attributed to living in remote char areas with little educational resources. About three-quarters of the respondents (71.31%) earn between 0 and 50,000 BDT per year.

However, 26.46% of respondents have an annual income of 51,000–100,000 BDT, while only 2.79% have an annual income of more than 100,000 BDT.

Table 2. Sociodemographic information of respondents (n = 359).

Variables	Category	Frequency	Percentage
Age	Up to 30 years	29	8.08
	31–60 years	236	65.74
	Above 60 years	64	17.83
Gender	Male	253	70.47
	Female	106	29.53
Education	No schooling	143	39.83
	Primary (1–5)	152	42.34
	Secondary (6–10)	59	16.43
	Higher secondary and above >10	5	1.39
Annual Income (BDT)	Up to 50,000	256	71.31
	51,000–100,000	95	26.46
	Above 100,000	10	2.79

4.1.2. Farmers' Adoption of Flood Adaptation Strategies

Table 3 shows the farmers' adoption of flood adaptation strategies, which are divided into four categories: structural, livelihood, emergency, and financial measures. A descriptive analysis was performed to show the farmers' adoption of flood adaptation strategies. A high percentage of farmers (84.40%) set up a portable cooking stove before the flood. This is because most houses' yards with fixed cooking stoves are inundated during floods in the char-lands, and a portable cooking stove can be carried anywhere during an emergency. Even if farmers are forced to relocate due to flooding, they must supply food for their families. Another key structural precaution is raising livestock place, which more than three-quarters of farmers did prior to the flood since livestock are equally as susceptible to flooding as farmers. In most cases, livestock habitats in the yard are more likely to be flooded, making livestock more vulnerable. It can be difficult to move cattle to another location, which makes farmers more concerned about livestock safety. Another essential structural strategy adopted by most farmers is macha preparation (72.42%). Macha is a high stage or bed with low-cost material mainly composed of bamboo. Farmers stay on macha and keep their essential belongings when floods enter their homes. Other structural measures, such as rising tubewel (45.68%), flood-proof sanitation (45.13%), and constructing or raising the house plinth (41.78%), had lower adoption rates since they are more expensive.

Among the livelihood strategies, farmers arranged fodder for livestock at a higher percentage (81.89%) than other strategies since most grazing fields are drowned during floods, causing farmers to collect straw for their cows and goats. Farmers (57.60%) were observed to preserve some dry foods for their families during the flood because cooking was difficult owing to a lack of fuel and cooking arrangements. Mixed cropping is another significant livelihood option. More than half of the respondents practiced mixed cropping like sesame with Aman paddy for crop diversification to minimize flood effects. Just above half of the respondents adjusted planting and harvesting times in response to the 2020 flood, as it is very crucial to reduce the crop damage, although sometimes farmers cannot predict the actual time of flooding due to a lack of effective flood early warning. About 40.39% of farmers changed their crop varieties, such as flood-tolerant rice varieties, to continue their livelihood during a flood. Farmers (38.16%) also practiced growing seedlings in sandbags, pots, etc. When their fields are flooded and they are unable to plant vegetables, farmers gather early-growing vegetable seeds and grow them in pots, sandbags, and other containers. They extend the crop duration in this way by transplanting the seedlings onto the main field after floods.

Table 3. Farmers' adoption of flood adaptation strategies.

Variables	Adoption of Flood Adaptation Strategies (*n* = 359)	
	Frequency	Percentage
Structural strategies score		
Construction/raising plinth of house	150	41.78
Fencing house	137	38.16
Raising of livestock place	278	77.44
Raising tube well	164	45.68
Flood-proof sanitation	162	45.13
Portable stove	303	84.40
Arrangement of boat	135	37.60
Macha preparation	260	72.42
Livelihood strategies score		
Changing crop variety	145	40.39
Mixed cropping	202	56.27
Growing seedling in pot or sandbag	137	38.16
Adjustment of planting and harvesting time	190	52.92
Fodder arrangement	294	81.89
Dry food collection	207	57.60
Emergency strategies score		
Shifting family	209	58.22
Shifting livestock	166	46.24
Shifting valuable goods	212	59.05
Alternative occupation during flood	160	44.57
Financial strategies score		
Money savings	180	50.14
Informal credit	222	61.84
Formal credit	187	52.09

Farmers were less likely to take emergency measures because they did not want to leave their homes, livestock, or other necessities behind. Farmers transferred family members (58.22%) when an emergency arose, particularly children and the elderly, who are the most vulnerable to flooding. They also relocated their essential goods (59.05%) and livestock (46.25%). Another factor responsible for the lower adoption of emergency strategies is the scarcity of shelter centers in the char-lands.

Farmers lose their jobs when their lands are flooded. Farmers try to find alternate occupations such as fishing, boating, weaving, rickshaw pulling, and so on, but it is difficult to find alternative jobs during floods. During the flood of 2020, 44.57% of farmers were engaged in alternate occupations. Farmers who lose their crops and are unable to obtain adequate aid to maintain their livelihoods seek loans from various sources, both formal (banks, nongovernmental organizations, other financial institutions) and informal (friends, family, and others). In terms of financial strategy, 61.84% of farmers used informal sources for credit, while 52.09% used formal sources. Considering future flood events, about half of the respondents saved money for emergency needs.

A mean comparison among the total of different flood adaptation strategies is shown in Figure 3. Overall, the average score for adaptation strategies was 11.88, with higher averages of structural measures (4.43) and livelihood strategies (3.27) compared with emergency (2.08) and financial measures (1.64). However, this study considered total flood adaptation strategies score as a dependent variable to see the relationship with PMT explanatory variables.

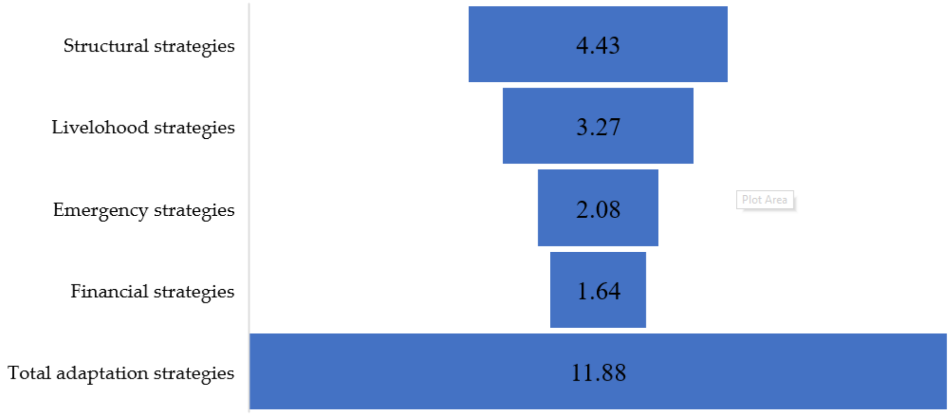

Figure 3. Mean of different flood adaptation strategies.

4.2. Path Analysis Results

4.2.1. Model Fitting Results

Before conducting path analysis using structural equation modeling, we performed multicollinearity testing. Table 4 shows the multicollinearity test. The variance inflation factor (VIF) was employed in the SEM model to assess multicollinearity among the latent variables. According to [59], if the VIF exceeds 10, that variable is said to be highly collinear and can be excluded from the model. The variance inflation factor (VIF) for all latent variables was less than 5, indicating that there were no multicollinearity issues [51].

Table 4. Results of multicollinearity testing.

Variables	VIF	1/VIF
Self-efficacy	4.95	0.20
Response efficacy	2.60	0.38
Response cost	2.79	0.36
Risk perception	3.22	0.31
Flood fear	2.13	0.47
Maladaptation	2.89	0.35
Constraints to adoption	1.46	0.68
Mean VIF	2.86	

We also found several fit indices from SEM estimates (Table 5), which assess the validity of a model. Following [54], different model fit indices like the chi square to df ratio (χ^2/df), the root means square error of approximation (RMSEA), the standardized root-mean-square residual (SRMR), the comparative fit index (CFI), and the Tucker–Lewis index (TLI) were all used to evaluate the model fit. Table 5 shows that the value of χ^2/df was 2.88, which is less than 3.00, satisfying the condition of good model fit.

Table 5. Results of different model fit indices for SEM.

Index	Assessment Criteria	Final Model	Requirements
χ^2/df	<3.00	2.88	Satisfied
RMSEA	0.03–0.08	0.07	Satisfied
CFI	>0.90	0.99	Satisfied
TLI	>0.90	0.98	Satisfied
SRMR	<0.05	0.01	Satisfied

Both the values of the standardized root-mean-square residual and the root mean square error of approximation are below the threshold. The comparative fit index (CFI) and the Tucker–Lewis index (TLI) are also above the threshold of 0.9. These findings show that the models fit the data well.

4.2.2. Analysis of the Model Effects

Different paths, according to the correlations shown in Figure 1, were tested for rationality. The final path model shown in Figure 4 shows that all hypotheses are confirmed except H2F compared with the initial hypothesis shown in Figure 1. The SEM estimates (standardized coefficients) shown in Figure 4 depict the direct effects of the predictor variables on farmers' flood adaptation strategies. The mediated effects linked to threat appraisals (risk perception and flood fear) and maladaptation and those between coping appraisals (self-efficacy, response efficacy, and response cost) and maladaptation make up the overall indirect effect (Table 6). The total effect of the predictors on the outcome variable is equal to the sum of the direct and indirect effects.

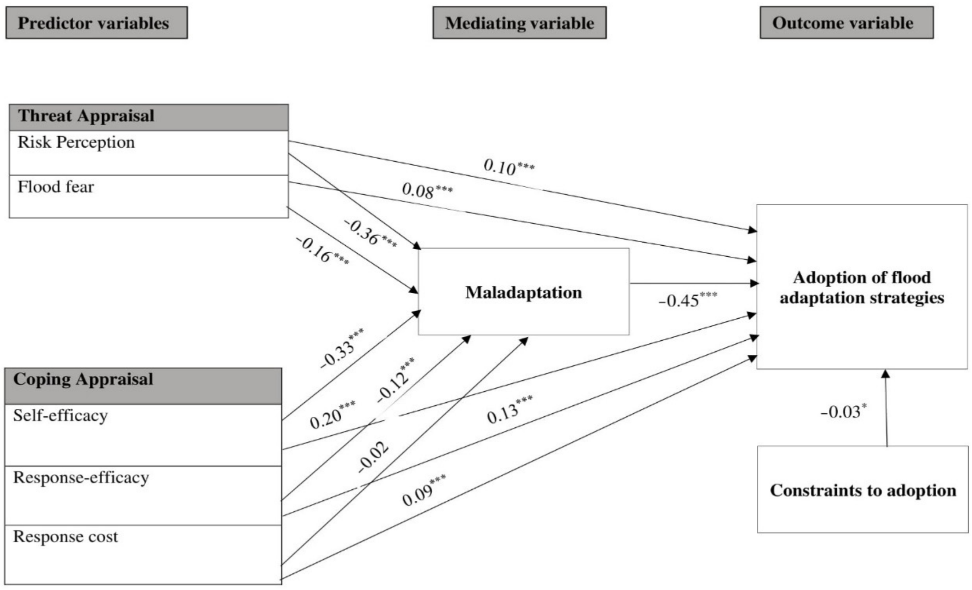

Figure 4. Path modeling results (SEM standardized coefficients). Only the direct effects are reported. Indirect or mediation effects are reported in Table 6. Note: * $p < 0.1$ and, *** $p < 0.001$.

Table 6. Direct, indirect (mediation), and total effects of predictors on flood adaptation strategies.

Hypothesis and Path	Direct Effects	Indirect or Mediating Path	Mediation Effect	Total Effect
H1A: RP→TAS	0.10 ***	H1C: RP→MA→TAS	0.16 ***	0.26 ***
H1B: FF→TAS	0.08 ***	H1D: FF→MA→TAS	0.07 ***	0.15 ***
H2A: SE→TAS	0.20 ***	H2D: SE→MA→TAS	0.15 ***	0.35 ***
H2B: RE→TAS	0.13 ***	H2E: RE→MA→TAS	0.05 ***	0.18 ***
H2C: RC→TAS	0.09 ***	H2: SE→MA→TAS	0.01	0.10 ***
H3: MA→TAS	−0.45 ***			
H4: CFA→TAS	−0.03 *			
H5A: RP→MA	−0.36 ***			
H5B: FF→MA	−0.16 ***			
H5C: SE→MA	−0.33 ***			
H5D: RE→MA	−0.12 ***			
H5E: RC→MA	−0.02			

Note: Significance at * $p < 0.1$, and *** $p < 0.001$. Standardized coefficients are used in SEM estimation. Here, TAS—Total adaptation score, RP—Risk perception, FF—Flood fear, SE—Self-efficacy, RE—Response efficacy, RC—Response cost, MA—Maladaptation, CFA—Constraints to flood adaptation.

(1) Direct effects

The path modeling findings are shown in Figure 4, with a focus on the direct effects (standardized SEM coefficients). All of the hypothesized direct effects of predictor factors on farmers' flood adaptation were confirmed by the findings (Table 6). The SEM parameter estimates for the routes that are directly connected between threat appraisals and flood adaptation strategy adoption, such as risk perception, H1A (0.10, $p < 0.001$), and flood fear, H1B (0.08, $p < 0.001$), are statistically significant. With respect to the effect of predictor variables related to coping appraisals on flood adaptation strategy adoption, the effects of self-efficacy, H2A (0.20, $p < 0.001$), response efficacy, H2B (0.13, $p < 0.001$), and response cost, H2C (0.09, $p < 0.001$), are statistically significant. The results also show significant estimates for the effect of maladaptation, H3 (−0.45, $p < 0.001$), and constraints to adoption, H4 (−0.03, $p < 0.1$), on the adoption of flood adaptation strategies. Therefore, all hypotheses are accepted for the direct correlation of predictors with the outcome variable.

Most of the hypothesized direct effects of explanatory factors (H5A–H5D) on maladaptation were confirmed by the findings except response cost (H5E). Risk perception had the highest influence (−0.36, $p < 0.001$), implying that farmers with higher risk perception have less maladaptation, such as wishful thinking, fatalism, or denials of flood risk, and vice versa. Flood fear (−0.16, $p < 0.001$) is likewise linked to maladaptive behavior, suggesting that farmers who are afraid of flooding are less maladaptive. That is, threat appraisals are a strong predictor of maladaptation. Coping appraisals like self-efficacy (−0.33, $p < 0.001$) and response efficacy (−0.12, $p < 0.001$) have significant negative effects on maladaptation, whereas response cost has no significant effect on maladaptation.

(2) Indirect or mediation effects

Structural equation models have the benefit of allowing for indirect effects between variables to be evaluated. Threat appraisal characteristics are found to have indirect effects on flood adaptation strategy adoption, as indicated in Table 6. Maladaptation, on the other hand, is found to mediate the impacts of two threat appraisal predictors, particularly risk perception, H1C (0:16, $p < 0.001$), and flood fear, H1D (0:07, $p < 0.001$), on farmers' adoption of flood adaptation strategies.

In the case of the coping appraisals (H2D–H2F), the results show that maladaptation (0.15, $p < 0.001$) mediates the effect of self-efficacy (H2E) on flood adaptation strategy adoption. Maladaptation is also observed to mediate the effect of response efficacy (H2F) on flood adaptation (0.05, $p < 0.001$), while maladaptation provides no mediating effect on flood adaptation for response cost (H2F). Constraints to adoption are not mediated in the above SEM model. Figure 5 shows the direct, indirect, and total effects of PMT factors on farmers' adoption of flood adaptation strategies.

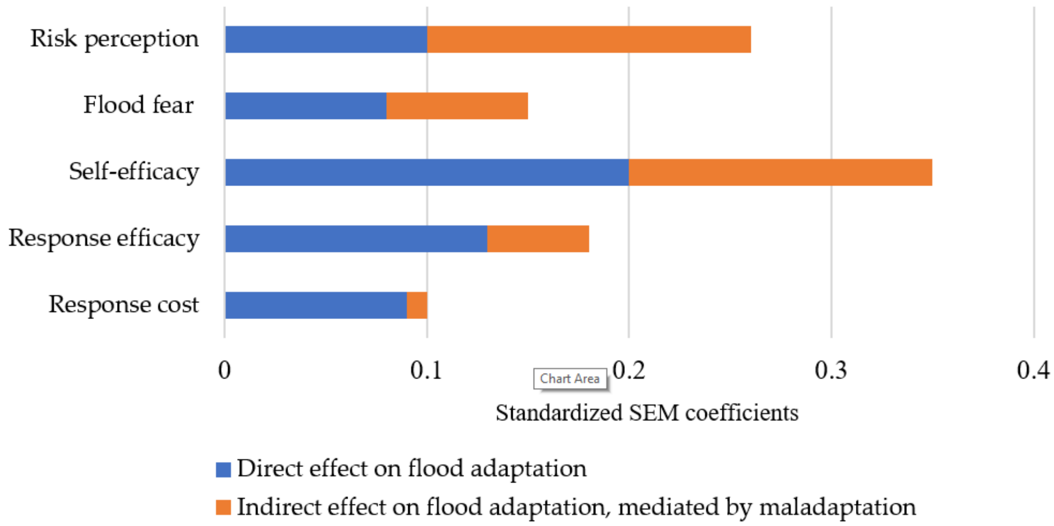

Figure 5. Total effects (SEM standardized coefficients) of the model's predictor variables on the farmers' flood adaptation.

(3) Total effects

The total effect represents the degree to which several factors interact. Flood risk perception, flood fear, self-efficacy, response efficacy, and response cost all influence flood adaptation behaviors, as shown in Table 6, but different factors have different degrees of influence. Among the coping appraisal variables, self-efficacy has the largest total effect (0.35, $p < 0.001$) on flood adaptation strategy adoption, followed by response efficacy (0.18, $p < 0.001$) and response cost (0.10, $p < 0.001$). The total effects of flood risk perception (0.26, $p < 0.001$) and flood fear (0.17, $p < 0.001$) on flood adaptation are also significant.

4.2.3. Robustness Check with Sobel Test and Baron Kenny Approach

Recent studies [60–62] have used the Sobel test as a supplemental tool to examine mediation effects to reinforce the robustness of their findings. We utilized the Sobel test in accordance with this research and obtained similar results to those from the SEM (path analysis). The findings of the Sobel test for the mediation effect are shown in Table 7.

Table 7. Significance testing of mediation effects (standardized).

Path	Coefficient	Standard Error	Z Value	*p* Value
RP→MA→TAS	0.16 ***	0.02	7.67	0.000
FF→MA→TAS	0.07 ***	0.02	4.30	0.000
SE→MA→TAS	0.15 ***	0.03	5.83	0.000
RE→MA→TAS	0.05 ***	0.02	2.98	0.003
RC→MA→TAS	0.01	0.02	0.525	0.599

Note: Level of significance at *** $p < 0.001$.

The Baron Kenny approach also confirmed the nearly identical mediation effects of risk perception, flood fear, self-efficacy, and response efficacy. If step 1 (X → M), step 2 (M → Y), and step 3 (X → Y) are significant, there must be a mediation effect, and if either step 1 or step 2 is insignificant, there is no mediation. The Baron Kenny approach was also used to summarize the findings of mediation effects shown in Table 8. In our study, risk perception, flood fear, self-efficacy, and response efficacy had partial mediation effects on flood adaptation strategy adoption.

Table 8. Mediation effect according to the Baron Kenny approach.

Path	Step 1 (X → M)	Step 2 (M → Y)	Step 3 (X → Y)	Mediation Type	%RIT (Indirect/Total)
RP→MA→TAS	−0.36 ***	−0.45 ***	0.11 ***	Partial	61
FF→MA→TAS	−0.16 ***	−0.45 ***	0.09 ***	Partial	48
SE→MA→TAS	−0.33 ***	−0.45 ***	0.19 ***	Partial	43
RE→MA→TAS	−0.12 ***	−0.45 ***	0.13 ***	Partial	30
RC→MA→TAS	−0.02	−0.45 ***	-	No mediation	10

Note: Statistical significance, *p* value at *** $p < 0.001$.

About 61% of the effects of risk perception on flood adaptation were mediated by maladaptation. The effects of flood fear, self-efficacy, and response efficacy were mediated by maladaptation at 48%, 43%, and 30%, respectively. In contrast, response cost had no mediation effect.

In addition to the two traditional approaches (Sobel test and Baron Kenny), we also employed bootstrapping as a modern tool of mediation analysis. The results of bootstrapping for indirect effects are shown in Table 9.

From the bootstrapping test, we found almost the same coefficients as from the SEM and the Sobel test. However, the z values were lower than the results of Sobel test.

Table 9. Indirect or mediation effects by bootstrapping.

Path	Coefficient	Bootstrap Standard Error	Z Value	*p* Value
RP→MA→TAS	0.16 ***	0.21	5.77	0.000
FF→MA→TAS	0.07 ***	0.07	4.10	0.000
SE→MA→TAS	0.15 ***	0.27	4.79	0.000
RE→MA→TAS	0.05 ***	0.26	2.60	0.009
RC→MA→TAS	0.01	0.20	0.49	0.621

Note: Statistical significance, *p* value at *** $p < 0.001$. Standardized coefficients are used.

5. Discussion

This study established a comprehensive theoretical framework based on PMT with a sample of char-land farmers in flood-prone regions of Sirajganj district, Bangladesh, in order to better understand the farmers' incentive to adapt to floods. Prior to the survey, these areas were severely affected by a riverine flooding event in 2020. The findings demonstrated that there was a good overall fit of the model proposed in the study, supporting the applicability of PMT in the context of flood-prone char-lands. The results indicated that the framework is helpful in evaluating farmers' perceptions of flood risk and their flood adaptation behaviors. This study demonstrated a consistent direct link between threat appraisal (risk perception and flood fear) and flood adaptation adoption. Farmers' adoption of flood adaptation strategies was strongly correlated with their perception of risk: Farmers with higher perceived risk and consequences adopted more adaptation strategies, which is in line with the findings of Wang et al. [40] but contradicts the findings of others [12,30]. As char-land farmers are less educated and they have less knowledge to perceive the risk, farmers with a low level of perceived risk were less likely to adopt adaptation measures. Flood fear was also found as a positive and significant predictor of flood adaptation in this study. Flood fear can motivate individuals to act, especially in relation to only last-minute safety precautions [30]. We also identified strong evidence for the direct effect of coping appraisals on flood adaptation. Self-efficacy is the greatest predictor of flood adaptation adoption among the three components of coping assessment studied here. Response efficacy is also a significant predictor of flood adaptation strategy adoption. There was a positive and significant correlation of response cost with farmers' flood adaptation, which indicates that farmers adopt strategies that are more affordable for them since response cost was scaled from very costly to very not costly (1–5). From the descriptive analysis, it was found that char-land farmers have a low annual income; therefore, they do not have adequate financial capacity to adopt necessary flood adaptation measures. These results of coping appraisals were predicted, as coping assessments have been shown to have a significant effect on flood adaption behavior in previous studies [12,13,22].

In structural equation modeling, maladaptation was employed as a mediating variable. Maladaptive behavior was found to be negatively linked to all explanatory variables related to PMT. Farmers who perceived a higher flood risk were less likely to exhibit maladaptive behaviors such as wishful thinking, fatalism, or denials of flood risk. In a meta-analysis of PMT research, threat appraisal and maladaptation were shown to be positively associated [29]. However, the negative result in our models is consistent with other research on individual flood mitigation behavior [13,37]. Flood fear showed a similar negative relationship to maladaptation as risk perception did. We also found a significantly negative relationship with maladaptation for coping appraisals such as self-efficacy and response efficacy. These findings indicate that farmers' high coping beliefs limit maladaptive behavior, which is supported by the original PMT framework [29].

This study also examined the hypotheses that maladaptation mediates the effects of threat appraisals and coping appraisals of related variables on individual adoption of flood adaptation strategies. Risk perception showed significant mediation or indirect effects on farmers' flood adaptation adoption mediated by maladaptation. Dang et al. [51] also found that risk perception is strongly mediated by maladaptation, influencing climate change adaptation. Flood fear was also significantly mediated by maladaptation to flood adaptation. Among the variables of coping appraisals, self-efficacy and response efficacy showed significant mediation or indirect effects through maladaptation on flood adaptation adoption, while response cost was found not to be mediated significantly by maladaptation. Like the SEM estimates, the Sobel test and the Baron Kenny approach showed similar mediation effects on farmers' adoption of flood adaptation strategies for threat appraisals (risk perception and flood fear) and coping appraisals (self-efficacy and response efficacy). Bootstrapping method also confirmed the similar findings as former methods used in this study.

6. Conclusions and Policy Recommendations

In previous studies, socioeconomic factors were frequently highlighted as determinants of farmers' adoption of flood adaptation strategies. Meanwhile, psychological issues related to protection motivation theory (PMT) have received little attention, particularly in Bangladesh. As a result, several psychological aspects are incorporated into this study to analyze their influence on farmers' flood adaptation using structural equation modeling (SEM). From the SEM analysis, we find that farmers are more inclined to adopt flood adaptation strategies if they believe the risks of flooding are higher and their fear of flooding is greater. Farmers are also seen to have more flood adaptation measures when they are more capable of adapting and their perception regarding the effectiveness of flood adaptation measures is higher. In contrast, maladaptive behavior makes them less likely to adopt flood adaptation strategies. Another concern of this study was to show the applicability of PMT, which was developed for and is usually utilized in health-risk research, to flood adaptation in the context of char-lands.

This determination of contributing factors can assist concerned authorities in developing policy for flood adaptation. The knowledge of why some people in flood-prone regions prepare effectively for floods while many others remain unprepared can enhance effective policy formulation. Since farmers' flood adaptation is influenced by their perceptions of flood risk, coping appraisals like self-efficacy and response efficacy, and maladaptive behavior, more policy implications must be considered to improve farmers' flood adaptation behavior. The information farmers receive about flood risk and adaptation strategies is important for threat appraisals and coping appraisals. As a result, ensuring the dissemination of the right information at the right time is crucial. Moreover, the importance of information accuracy and sources of information can also be emphasized because maladaptation includes wishful thinking, denying the risk of floods, and fatalism, which are all potential barriers to flood adaptation, and religious or cultural beliefs can include such views. Furthermore, necessary campaigns and programs should be increased to create flood awareness among farmers over existing beliefs. The present flood regulatory framework of Bangladesh is mostly effective for providing relief and responding to emergencies during times of flooding, but there is still room to improve communities' ability to adapt and their resilience to deal with future floods.

The current study has a number of methodological limitations that need to be highlighted. First, the study employed perceptions and beliefs obtained from a survey to explain flood adaptation strategies that have already been implemented in the past. This is plausible, as the perceptions and beliefs that were expressed during the survey were mostly constant over time and would have anticipated and contributed to the adaptive responses [13]. Second, although the study was intended to test a causal model of flood adaptation, it is improper to infer causality due to the non-experimental design of the study. For instance, it is unclear whether or not risk perception impacts self-adaptive behavior against flooding. Third, the sample was constrained to a particular geographic area.

Despite these limitations, the results of the structural equation model imply that PMT is an effective framework for assessing farmers' flood adaptation adoption. In particular, combining PMT with structural equation modeling provides useful results and explanations. However, further research is needed to increase the construct validity of the measurement model and to incorporate more constructs that can contribute to increasing the use of PMT in flood adaptation research beyond its traditional uses. However, this study opens avenues of study to further analyze these PMT factors affecting farmers' ability to reduce their flood losses in flood-prone areas like char-lands.

Author Contributions: Conceptualization, M.O.F. and K.L.M.; methodology, M.O.F.; validation, M.O.F. and K.L.M.; software, M.O.F.; formal analysis, investigation, resources, data curation, M.O.F.; writing original draft preparation, M.O.F.; writing review and editing, M.O.F. and K.L.M.; visualization, M.O.F.; supervision, K.L.M. All authors have read and agreed to the published version of the manuscript.

Funding: There was no external funding for this research.

Institutional Review Board Statement: The study was conducted according to the guidelines and approved by the Ethics Committee of Graduate School for International Development and Cooperation (IDEC), Hiroshima University, Japan, on 31 August 2021.

Informed Consent Statement: All farmers who took part in this study provided their informed consent.

Data Availability Statement: The data presented in this study are available on request from the corresponding author.

Acknowledgments: The APC of this paper is partially funded by the Association for Regional Agricultural and Forestry Economics (ARAFE). This paper is based on a draft previously presented at the 6th International ARAFE Workshop, which was held virtually on 26 June 2022. The paper was then revised by incorporating feedback from the conference. The authors would like to thank ARAFE for this. The authors and funding agency have no conflicts of interest. The authors are also thankful for a Project for Human Resource Development Scholarship (JDS) organized by Japan International Cooperation Center (JICE), which facilitated the master's study of M.O.F. at Hiroshima University, Japan.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Islam, M.A.; Solaiman; Islam, M.S.; Tusher, T.R.; Kabir, M.H. Impacts of flood on Char livelihoods and its adaptation techniques by the local people. *Bangladesh J. Sci. Res.* **2015**, *28*, 123–135. [CrossRef]
2. Relief MODMA. Disaster Report Dhaka: Department of Disaster Management 2013. Available online: https://reliefweb.int/report/bangladesh/disaster-report-2013 (accessed on 18 June 2022).
3. Hossain, B. Role of organizations in preparedness and emergency response to flood disaster in Bangladesh. *Geoenviron. Disasters* **2020**, *7*, 33. [CrossRef]
4. Philip, S.; Sparrow, S.; Kew, S.F.; van der Wiel, K.; Wanders, N.; Singh, R.; Hassan, A.; Mohammed, K.; Javid, H.; Haustein, K.; et al. Attributing the 2017 Bangladesh floods from meteorological and hydrological perspectives. *Hydrol. Earth Syst. Sci.* **2019**, *23*, 1409–1429. [CrossRef]
5. International Federation of Red Cross and Red Crescent Societies (IFRC). Bangladesh: Monsoon Floods. 2021. Available online: https://reliefweb.int/report/bangladesh/bangladesh-monsoon-floods-final-report-n-mdrbd025 (accessed on 10 July 2022).
6. Kelly, C.; Chowdhury, M.H.K. *Poverty, Disasters and the Environment in Bangladesh: A Quantitative and Qualitative Assessment of Causal Linkages*; Bangladesh Issues Paper; UK Department for International Development: Dhaka, Bangladesh, 2002.
7. Mondal, M.S.; Rahman, M.A.; Mukherjee, N.; Huq, H.; Rahman, R. Hydro-climatic hazards for crops and cropping system in the chars of the Jamuna River and potential adaptation options. *Nat. Hazards* **2015**, *76*, 1431–1455. [CrossRef]
8. Paul, S.; Islam, M.R. Ultra-poor char people's rights to development and accessibility to public services: A case of Bangladesh. *Habitat Int.* **2015**, *48*, 113–121. [CrossRef]
9. Banglapedia. Char. Available online: https://en.banglapedia.org/index.php/char (accessed on 15 July 2022).
10. Irrigation Support Project for Asia and Near East (ISPAN). *Char-Land Study Overview: Summary Report (Draft)*; Flood Plain Coordination Organization, Ministry of Irrigation, Water Development and Flood Control: Dhaka, Bangladesh, 2003.
11. Hossain, B.; Sohel, M.S.; Ryakitimbo, C.M. Climate change induced extreme flood disaster in Bangladesh: Implications on people's livelihoods in the Char Village and their coping mechanisms. *Prog. Disaster Sci.* **2020**, *6*, 100079. [CrossRef]
12. Bubeck, P.; Botzen, W.J.W.; Kreibich, H.; Aerts, J.C.J.H. Detailed insights into the influence of flood-coping appraisals on mitigation behaviour. *Glob. Environ. Chang.* **2013**, *23*, 1327–1338. [CrossRef]
13. Grothmann, T.; Reusswig, F. People at risk of flooding: Why some residents take precautionary action while others do not. *Nat. Hazards* **2006**, *38*, 101–120. [CrossRef]

14. Bostrom, A.; Morss, R.E.; Lazo, J.K.; Demuth, J.L.; Lazrus, H.; Hudson, R. A mental models study of hurricane forecast and warning production, communication, and decision-making. *Weather. Clim. Soc.* **2016**, *8*, 111–129. [CrossRef]
15. Box, P.; Thomalla, F.; Van den Honert, R. Flood Risk in Australia: Whose Responsibility Is It, Anyway? *Water* **2013**, *5*, 1580–1597. [CrossRef]
16. Morss, R.E.; Demuth, J.L.; Bostrom, A.; Lazo, J.K.; Lazrus, H. Flash Flood Risks and Warning Decisions: A Mental Models Study of Forecasters, Public Officials, and Media Broadcasters in Boulder, Colorado. *Risk Anal.* **2015**, *35*, 2009–2028. [CrossRef]
17. Scolobig, A.; Prior, T.; Schrter, D.; Jrin, J.; Patt, A. Towards people-centred approaches for effective disaster risk management: Balancing rhetoric with reality. *Int. J. Disaster Risk Reduct.* **2015**, *12*, 202–212. [CrossRef]
18. Bubeck, P.; Botzen, W.J.W.; Aerts, J.C.J.H. A Review of Risk Perceptions and Other Factors that Influence Flood Mitigation Behavior. *Risk Anal.* **2012**, *32*, 1481–1495. [CrossRef] [PubMed]
19. Poussin, J.K.; Botzen, W.J.W.; Aerts, J.C.J.H. Factors of influence on flood damage mitigation behaviour by households. *Environ. Sci. Policy* **2014**, *40*, 69–77. [CrossRef]
20. Aerts, J.C.J.H.; Botzen, W.J. Flood-resilient waterfront development in New York City: Bridging flood insurance, building codes, and flood zoning. *Ann. N. Y. Acad. Sci.* **2011**, *1227*, 1–82. [CrossRef]
21. Lo, A. The role of social norms in climate adaptation: Mediating risk perception and flood insurance purchase. *Glob. Environ. Chang.* **2013**, *23*, 1249–1257. [CrossRef]
22. Kreibich, H.; Christenberger, S.; Schwarze, R. Economic motivation of households to undertake private precautionary measures against floods. *Nat. Hazards Earth Syst. Sci.* **2011**, *11*, 309–321. [CrossRef]
23. Meyer, R.J.; Baker, J.; Broad, K.; Czajkowski, J.; Orlove, B. The Dynamics of Hurricane Risk Perception: Real-Time Evidence from the 2012 Atlantic Hurricane Season. *Bull. Am. Meteorol. Soc.* **2014**, *95*, 1389–1404. [CrossRef]
24. Schmuck, H. "An Act of Allah": Religious Explanations for Floods in Bangladesh as Survival Strategy. *Int. J. Mass Emergencies Disasters* **2000**, *18*, 85–96.
25. Owusu, S.; Wright, G.; Arthur, S. Public attitudes towards flooding and property-level flood protection measures. *Nat. Hazards* **2015**, *77*, 1963–1978. [CrossRef]
26. Liu, D.; Li, Y.; Shen, X.; Xie, Y.; Zhang, Y. Flood risk perception of rural households in western mountainous regions of Henan Province, China. *Int. J. Disaster Risk Reduct.* **2018**, *27*, 155–160. [CrossRef]
27. Kellens, W.; Terpstra, T.; De Maeyer, P. Perception and Communication of Flood Risks: A Systematic Review of Empirical Research. *Risk Anal.* **2013**, *33*, 24–49. [CrossRef] [PubMed]
28. Floyd, D.L.; Prentice-Dunn, S.; Rogers, R.W. A Meta-Analysis of Research on Protection Motivation Theory. *J. Appl. Soc. Psychol.* **2000**, *30*, 407–429. [CrossRef]
29. Milne, S.; Sheeran, P.; Orbell, S. Prediction and Intervention in Health-Related Behavior: A Meta-Analytic Review of Protection Motivation Theory. *J. Appl. Soc. Psychol.* **2000**, *30*, 106–143. [CrossRef]
30. Babcicky, P.; Seebauer, S. Unpacking Protection Motivation Theory: Evidence for a separate protective and non-protective route in private flood mitigation behavior. *J. Risk Res.* **2019**, *22*, 1503–1521. [CrossRef] [PubMed]
31. Mallick, B.; Rogers, K.G.; Sultana, Z. In harm's way: Non-migration decisions of people at risk of slow-onset coastal hazards in Bangladesh. *Ambio* **2022**, *51*, 114–134. [CrossRef]
32. Ansari, M.S. *Protection Motivation of Flood Prone Households in North-Central Bangladesh*; Wageningen University: Wageningen, The Netherlands, 2018.
33. Kunreuther, H.; Ginsberg, R.; Miller, L.; Sagi, P.; Slovic, P.; Borkan, B.; Katz, N. *Disaster Insurance Protection: Public Policy Lessons*; Wiley New York: Hoboken, NJ, USA, 1978.
34. Peek, L.A.; Mileti, D.S. *The History and Future of Disaster Research*; John Wiley & Sons, Inc.: Hoboken, NJ, USA, 2002.
35. Horwath, C.C. Applying the transtheoretical model to eating behaviour change: Challenges and opportunities. *Nutr. Res. Rev.* **1999**, *12*, 281–317. [CrossRef]
36. Rogers, R.W. Cognitive and psychological processes in fear appeals and attitude change: A revised theory of protection motivation. In *Social Psychophysiology: A Sourcebook*; Guilford Press: New York, NY, USA, 1983; pp. 153–176.
37. Zaalberg, R.; Midden, C.; Meijnders, A.; McCalley, T. Prevention, Adaptation, and Threat Denial: Flooding Experiences in the Netherlands. *Risk Anal.* **2009**, *29*, 1759–1778. [CrossRef]
38. Binh, P.T.; Zhu, X.; Groeneveld, R.A.; Van Erland, E.C. Risk communication, women's participation and flood mitigation in Vietnam: An experimental study. *Land Use Policy* **2020**, *95*, 104436. [CrossRef]
39. Haer, T.; Botzen, W.J.W.; Aerts, J.C.J.H. The effectiveness of flood risk communication strategies and the influence of social networks—Insights from an agent-based model. *Environ. Sci. Policy* **2016**, *60*, 44–52. [CrossRef]
40. Wang, T.; Lu, Y.; Liu, T.; Zhang, Y.; Yan, X.; Liu, Y. The determinants affecting the intention of urban residents to prevent flooding in China. *Nat. Hazards Earth Syst. Sci. Discuss.* **2021**, *2021*, 1–23. [CrossRef]
41. Keller, C.; Siegrist, M.; Gutscher, H. The Role of the Affect and Availability Heuristics in Risk Communication. *Risk Anal.* **2006**, *26*, 631–639. [CrossRef]
42. Parker, D.J.; Priest, S.J.; Tapsell, S.M. Understanding and enhancing the public's behavioural response to flood warning information. *Meteorol. Appl.* **2009**, *16*, 103–114. [CrossRef]
43. Haney, T.J.; McDonald-Harker, C. "The River Is Not the Same Anymore": Environmental Risk and Uncertainty in the Aftermath of the High River, Alberta, Flood. *Soc. Curr.* **2016**, *4*, 594–612. [CrossRef]

44. Richert, C.; Erdlenbruch, K.; Figuières, C. The determinants of households' flood mitigation decisions in France—On the possibility of feedback effects from past investments. *Ecol. Econ.* **2017**, *131*, 342–352. [CrossRef]
45. Siegrist, M.; Gutscher, H. Natural Hazards and Motivation for Mitigation Behavior: People Cannot Predict the Affect Evoked by a Severe Flood. *Risk Anal.* **2008**, *28*, 771–778. [CrossRef]
46. Faruk, M.O.; Maharjan, K.L. Impact of Farmers' Participation in Community-Based Organizations on Adoption of Flood Adaptation Strategies: A Case Study in a Char-Land Area of Sirajganj District Bangladesh. *Sustainability* **2022**, *14*, 8959. [CrossRef]
47. Bradford, R.A.; O'Sullivan, J.J.; van der Craats, I.M.; Krywkow, J.; Rotko, P.; Aaltonen, J.; Bonaiuto, M.; De Dominicis, S.; Waylen, K.; Schelfaut, K. Risk perception—Issues for flood management in Europe. *Nat. Hazards Earth Syst. Sci.* **2012**, *12*, 2299–2309. [CrossRef]
48. Miceli, R.; Sotgiu, I.; Settanni, M. Disaster preparedness and perception of flood risk: A study in an alpine valley in Italy. *J. Environ. Psychol.* **2008**, *28*, 164–173. [CrossRef]
49. Papagiannaki, K.; Kotroni, V.; Lagouvardos, K.; Papagiannakis, G. How awareness and confidence affect flood-risk precautionary behavior of Greek citizens: The role of perceptual and emotional mechanisms. *Nat. Hazards Earth Syst. Sci.* **2019**, *19*, 1329–1346. [CrossRef]
50. Botzen, W.J.W.; Kunreuther, H.; Czajkowski, J.; de Moel, H. Adoption of Individual Flood Damage Mitigation Measures in New York City: An Extension of Protection Motivation Theory. *Risk Anal.* **2019**, *39*, 2143–2159. [CrossRef]
51. Dang, H.L.; Li, E.; Nuberg, I.; Bruwer, J. Understanding farmers' adaptation intention to climate change: A structural equation modelling study in the Mekong Delta, Vietnam. *Environ. Sci. Policy* **2014**, *41*, 11–22. [CrossRef]
52. Uddin, M.N.; Bokelmann, W.; Entsminger, J.S. Factors Affecting Farmers' Adaptation Strategies to Environmental Degradation and Climate Change Effects: A Farm Level Study in Bangladesh. *Climate* **2014**, *2*, 223–241. [CrossRef]
53. Hayes, A.F. *Introduction to Mediation, Moderation, and Conditional Process Analysis: A Regression-Based Approach*; Guilford Publications: New York, NY, USA, 2017.
54. Huang, J.; Cao, W.; Wang, H.; Wang, Z. Affect Path to Flood Protective Coping Behaviors Using SEM Based on a Survey in Shenzhen, China. *Int. J. Environ. Res. Public Health* **2020**, *17*, 940. [CrossRef]
55. Iacobucci, D. Structural equations modeling: Fit Indices, sample size, and advanced topics. *J. Consum. Psychol.* **2010**, *20*, 90–98. [CrossRef]
56. Enders, C.K.; Bandalos, D.L. The Relative Performance of Full Information Maximum Likelihood Estimation for Missing Data in Structural Equation Models. *Struct. Equ. Modeling A Multidiscip. J.* **2001**, *8*, 430–457. [CrossRef]
57. Islam, M.N. Flood risks for the char community on the Ganges-Padma floodplain in Bangladesh. *Int. J. Environ.* **2012**, *2*, 106–116.
58. Rahman, M.; Siddik, M. Livelihood Analysis of the Char Dwellers Using Capital Asset Framework. *J. Environ. Sci. Nat. Resour.* **2018**, *11*, 27–36. [CrossRef]
59. Kehinde, A.D.; Ogundeji, A.A. The simultaneous impact of access to credit and cooperative services on cocoa productivity in South-western Nigeria. *Agric. Food Secur.* **2022**, *11*, 11. [CrossRef]
60. Holcomb, T.R.; Holmes, R.M., Jr.; Connelly, B.L. Making the most of what you have: Managerial ability as a source of resource value creation. *Strateg. Manag. J.* **2009**, *30*, 457–485. [CrossRef]
61. Ndofor, H.A.; Sirmon, D.G.; He, X. Firm resources, competitive actions and performance: Investigating a mediated model with evidence from the in-vitro diagnostics industry. *Strateg. Manag. J.* **2011**, *32*, 640–657. [CrossRef]
62. Boxall, P.; Ang, S.H.; Bartram, T. Analysing the 'Black Box' of HRM: Uncovering HR Goals, Mediators, and Outcomes in a Standardized Service Environment. *J. Manag. Stud.* **2011**, *48*, 1504–1532. [CrossRef]