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Climate Change Risk Perception among Agriculture Students: the Role of Knowledge, Environmental Attitude, and Belief in Happening

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ABSTRACT

Climate change has arisen due to "enhanced greenhouse effect", as a result of human activities and lifestyle. Mitigation of greenhouse gases is dependent on climate change risk perception. Therefore, the present study aimed to provide a conceptual model to determine risk perception and explore whether knowledge about causes and consequences of climate change influence individuals' environmental attitudes, beliefs in the happening of climate change, and risk perception. The study was designed as a cross-sectional survey. The study sample consisted of 320 undergraduate students who were selected through random sampling. Structural Equation modeling showed that the relationship between knowledge of causes and consequences and risk perception was mediated by environmental attitude and beliefs. Respondents with higher knowledge about the causes and consequences of climate change are significantly more likely to consider climate change as a risk. Knowledge of causes and consequences has a direct effect on the belief that climate change is happening and on environmental attitude, and indirect effect on risk perception. Environmental attitude and belief have a significantly positive effect on risk perception. The suggested model could account for about half of the variance (49%) in risk perception. The results showed that the suggested framework is an effective tool for the prediction of risk perception.

Keywords: Beliefs in happening, Environmental attitude, Global warming, Greenhouse gas mitigation, Knowledge of causes.

INTRODUCTION

Mounting evidences have confirmed that climate is changing globally and will be worse in the future (Adger *et al*., 2003). These changes likely have severe adverse impacts on natural ecosystems and human societies (Bijani *et al*., 2017; IPCC, 2007; Granderson, 2014; Whitmarsh, 2009; Smith *et al*., 2017; Lee *et al*., 2015). In particular, climate change raises the frequency and/or intensity of droughts, heavy downpours, and floods, hurricanes and, hence, it poses severe threats to agriculture (Boazar *et al*., 2019; Bakhtiyari *et al*., 2017; Azadi *et al*., 2019ab; Heath and Gifford, 2006; Karl, 2009; Kilinc *et al*., 2013; Rickard *et al*., 2016; Zobeidi *et al*., 2016). Smith *et al*., (2017) have placed climate change near the top of the long list of environmental and other challenges that humans are facing now and in the future and have argued that it is a key factor preventing sustainable social and economic development across the world. Extensive evidence suggests that human behaviors are the root of many environmental problems

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(Mohammadi-Mehr *et al*., 2018), especially climate change (IPCC, 2014; Shepardson *et al*., 2009; Princiotta, 2009). It is due to 'enhanced greenhouse effect', arising as a result of human activities and lifestyle (Brody *et al*., 2012). These activities emit GreenHouse Gases (GHGs) such as carbon dioxide, methane, and nitrous oxide (Jamshidi *et al*., 2018; Gifford *et al*., 2011). As such, it is essential that activities that contribute to GHGs, be urgently eliminated or reduced by nations, which, in the literature of climate change, is called mitigation (reducing GHGs) (O'Neill *et al*., 2013, Arbuckle *et al*., 2013; Duguma *et al*., 2014; Ambusaidi *et al*., 2012; Aitken *et al*., 2011). Mitigation includes measures to decrease the emission of GHGs by reducing reliance mostly on fossil fuels (coal, oil and gas) (Carrico *et al*., 2015; Sánchez *et al*., 2014; Whitmarsh, 2009; Bozorgparvar *et al*., 2018) Although government and policy makers have a great role in mitigation through their supports and policy decisions, mitigation of GHGs emissions is dependent on voluntary operations by people through adopting lower-carbon life-style (Semenza *et al*., 2008; van Sluisveld *et al*., 2016; Lorenzoni *et al*., 2007; Aitken *et al*., 2011; Kim *et al*., 2013; Gifford *et al*., 2011). An individual can have multiple roles to improve a low-carbon living, including being a low-carbon consumer (Schanes *et al*., 2016) (e.g. through buying organic and local food products), a low-carbon employee (e.g. through occupational decisions) (Whitmarsh *et al*., 2011).

Some studies (Hu and Chen, 2016; Arbuckle *et al*., 2013) have revealed that individuals' daily decisions and their responses to the hazards of climate change are often influenced by their understanding and perception about the problem itself. It is confirmed that tackling climate change will be a success only if the causes and impacts of risk are extensively understood by the public and especially by those who have to undertake mitigation practices (Malandrakis *et al*., 2011; Brody *et al*., 2008). Furthermore, Brody *et al.* (2012) also found that perceived risk to self and family trigger a greater willingness to behavioral change for climate change mitigation. Spence et al. (2011) have found that individuals' perceptual differences regarding that climate change is less uncertain and feel more confident that their actions will have an effect on climate change translate into a greater willingness to save energy to mitigate climate change. Yazdanpanah *et al*. (2015) also found that positive perceptions of renewable energy sources are determinants of greater willingness to use renewable energy sources. Therefore, understanding individual perception of the negative impact of climate change is a very important issue and the first step toward an effective policy making for mitigation. Through this understanding, policy makers will know what's happened on the ground and can design policy and initiatives that are supported by public for climate-change mitigation (Lujala *et al*., 2015). In this regard, Shi (2016) points out that public perception can influence the decisions of public policymakers. These reasons caused researchers to pay plenty of attention to the importance of public perception in the combating against climate change (Semenza *et al*., 2008; Spence *et al*., 2011; Arbuckle *et al*., 2013). In addition, despite the fact that global warming has become an increasingly important environmental issue for Iran, very little research has been focused on the risk perception of Iranian public in this regard. According to statistical report of Iran's Environmental Protection Agency, in 2016, Iran was the 9th biggest producer of greenhouse gases in the world.

Considering the impact of perceived risk on the implementation of mitigation behaviors, this study aimed to identify factors influencing the perceived risk of climate change. In addition, this research was undertaken to evaluate university students' risk perception about climate change in Iran. This specific group was selected because students will have to make complex policy responses to GHGs

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mitigation (Wachholz *et al*., 2014). In this regard, it was confirmed that students, through participation in cross-disciplinary groups, would be able to perceive climate change problems and collectively solve them (Lyth *et al*., 2007).

Risk perception relates to the perceptions about undesirable impacts for valued objects (Hylan *et al*., 2016; Arbuckle *et al*., 2013) and it refers to the belief that one is vulnerable to a disease or risk factor (Mead *et al*., 2012) which often concerns the future events (Linden, 2014). Therefore, it has commonly been evaluated as an individual's appraisal of the climate change impacts on health, economic, and environment (Arbucle *et al*., 2013). In the context of this study, it is about college students' subjective appraisal of the undesirable impacts of climate change including reduction of life quality and standards, reduction of water availability in the community, and possibility of getting a dangerous disease.

There is considerable research that beliefs about climate change have positive relation to risk perception. Beliefs are usually defined as perception of the state of things in the world (Arbuckle, *et al.*, 2013). For example, Reser *et al*. (2012), Bradley and Reser (2017), and Arbuckle *et al*. (2013) have shown that belief in happening of climate change is a determinant of perceived risk.

Furthermore, previous researches (Stoutenborough and Vedlitz 2014; Carlton and Jacobson, 2013) have stated that environmental attitude is highly correlated with risk perceptions. Environmental attitude is degree of favorable or unfavorable evaluation of the natural environment (Hawcroft and Milfont, 2010). For instance, O'Connor *et al.* (1999) found that those with pro-environmental attitudes have more willingness to act for reduction of risks related to high greenhouse gas emissions. Stoutenborough and Vedlitz (2014) found that persons with high ecological values have more risk perception of climate change. They argued that those who have greater ecological values are more likely to attempt to do something in order to perceive climate change because of their concerns for the environment. Environmental attitudes influence environmental attitudes can predict environmental risk perceptions. (Carlton and Jacobson, 2013).

Knowledge is a part of public perceptions of climate change, and an essential factor in enhancing public concern about climate change dangers and motivating mitigative behaviors (Reser *et al*., 2012). Indeed, awareness and knowledge are important factors in the formation of environmental beliefs and risk perceptions (O'connor *et al*., 2002). Climate change knowledge could comprise many things such as knowledge about science of climate change, information about the reasons and its impacts, and also knowledge about the process and trend of climate change and what actions one can take (Reser *et al*., 2012; Tobler *et al*., 2012). For example, in this regard, researches demonstrated that knowledge of the causes and impacts of climate change are key determinants of environmental beliefs (O'Connor *et al*., 2002; O'Connor *et al*., 1999). Heath and Gifford (2006) demonstrated that perceived knowledge that measured an individuals' subjective appraisal of technical knowledge about the causes of climate change was a strong determinant of beliefs in happening of climate change, and that its consequences were negative. Hidalgo and Pisano, (2010) also found that knowledge of the climate change causes significantly influences the perception that climate change poses a real and imminent risk. Tobler *et al*. (2012) suggested that knowledge about climate change causes and consequences were related to greater concern and lesser skepticism about climate change. Indeed, environmental knowledge can raise or decline perceptions of risk and, so, indirectly associate to environmental behaviors (O'Connor *et al*., 1999). Study of Sundblad *et al*. (2007) showed that both cognitive risk judgments of serious undesirable impacts and emotional risk judgments (worry) were

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determined by knowledge about the climate change causes and consequences.

Direct/personal experience an object and second-hand (mediated) information/knowledge about it shapes attitudes toward it (Upham *et al*., 2009). For example, Kollmuss and Agyeman (2002) and Kellstedt *et al*. (2008) note that environmental knowledge has positive relation to formation of positive environmental attitude.

Based on the research conceptual framework following hypotheses present:

- Beliefs in happening of climate change will positively affect risk perception Hypothesis (H1).
- Environmental attitude will positively affect risk perception (H2).
- Knowledge about causes of climate change will positively affect beliefs in happening of climate change (H3).
- Knowledge about consequences of climate change will positively affect beliefs in happening of climate change (H4).
- Knowledge of causes of climate change will positively affect environmental attitude (H5)
- Knowledge of consequences of climate change will positively affect environmental attitude (H6) (see Figure 1).

Design and Participant

The study was designed as a cross-sectional survey. The population of interest consisted of the undergraduate students of Agricultural Science and Natural Resources University in Khuzestan Province, in Southwest Iran. It is important to note that based on the population size (N= 1200) and the Table of Krejcie and Morgan, our study sample consisted of 320 undergraduate students. The study sample was selected through a random sampling. The research conceptual model was quantitatively tested using the survey methodology. Also, to assess the student's knowledge and perception of climate change, a closed or structured questionnaire was designed and the validity of the questionnaire was approved by a panel of experts.

The suggested model sought to predict the strength of risk perception as the endogenous variable by way of two exogenous and two mediating variables. The exogenous variables were knowledge of causes and knowledge of consequences. The mediating variables were environmental attitude and belief in happening of climate change. Structural Equation Modeling (SEM) procedure was used to test our suggested model. SEM have been effective in tackling many issues in the social and behavioral sciences (Jöreskog and Sörbom, 1982) and can be used to investigate complex models (Cangur and Ercan, 2015), The analysis was conducted with the Maximum Likelihood Estimation (MLE) algorithm and using the AMOS program. A SEM process consists of Confirmatory Factor Analysis (CFA) and regression to allow structural relationships among latent constructs (Arbucle

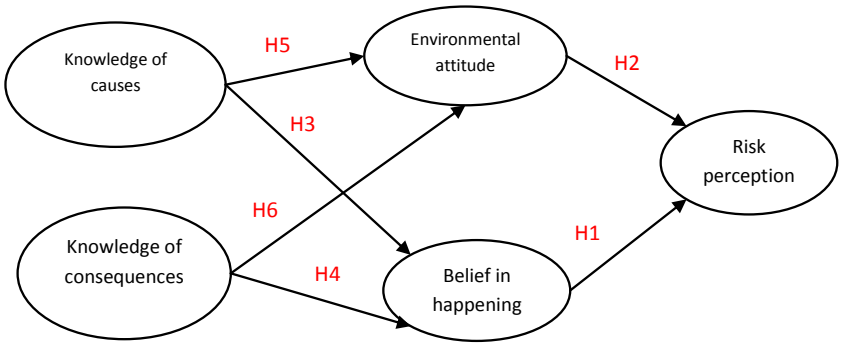

Figure 1. Conceptual framework of climate change risk perception and hypotheses of the research.

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et al., 2013). In addition, because the chi-square statistic is dependent on the sample size, the adequacy of the model was examined using various other goodness-of-fit indices (Joreskog & Sorbom, 1982).

In our sample, 72.18 percent (n= 231) were woman and the remaining 27.18 percent (n= 87) were male, 0.62 percent (n= 2) did not state their sex. The mean age of the respondents was 21.08 years (SD= 1.57). The education level ranged from first-year entry to university (27.2%, n= 87), second entry (21.3%, n= 75), third entry (23.8%, n= 76) and fourth entry (27.8%, n= 89).

Variables studied

The questionnaires included measures of a dependent variable (risk perception), moderating independent variables (environmental attitude and beliefs associated with climate change existence or happening) and independent variables (knowledge of causes and knowledge of consequences of climate change). All variables were measured as latent variables using multiple-items scales (Table 1), and all items of the present study were scored or measured on the 5-point Likert-type scale (1= Strongly disagree, 5= Strongly agree). The means, standard deviations, and Cronbach's Alpha of the scales are shown in Table 1. The Cronbach's Alpha coefficient was used as a measure to represent the reliability and refine the statements to finalize the questionnaire. All variables indicated an acceptable reliability coefficient (0.66-0.77).

RESULTS

All goodness-of-fit indices are shown in Table 2. Therefore, all variables of the structural model had a satisfactory fit, while as shown in Table 2, for RMSEA (Root Mean Square Error of Approximation) index, values smaller than 0.10 is acceptable (Henry and Stone, 1994). In addition, according to Cangur and Ercan (2015), RMSEA value smaller than 0.05 represents a good convergence criterion for the analyzed data. Therefore, the model had an excellent fit in terms of RMSEA. SRMR (Standardized Root Mean Square Residual) is another index that is presented in Table 2. SRMR represents the acceptable and good fit indicator when it produces a value smaller than 0.05 (Cangur and Ercan, 2015). Hence, SRMR index is also acceptable in the conceptual model.

Figure 2 presents the standardized parameter estimates and variances explained in the endogenous variables. As expected, knowledge (causes/consequences) significantly predicted all mediating and endogenous variables (environmental attitude, belief and risk perception). Knowledge of causes has a direct effect on belief in climate change ($\beta= 0.26$, $P< 0.01$) and environmental attitude ($\beta= 0.52$, $P< 0.001$) and an indirect effect on risk perception ($\beta= 0.34$, $P< 0.001$). Knowledge of consequences has a direct effect on belief in climate change ($\beta= 0.53$, $P< 0.001$) and environmental attitude ($\beta= 0.51$, $P< 0.001$) and an indirect effect on risk perception ($\beta= 0.39$, $P< 0.001$). Environmental attitude has a significantly positive effect on the risk perception ($\beta= 0.56$, $P> 0.001$). Belief has a significantly positive effect on risk perception ($\beta= 0.18$, $P> 0.05$).

Based on the SEM results, the study confirmed that belief positively affects students' risk perception, supporting H1. The findings indicated that environmental attitude has a significantly positive influence on risk perception and support H2. The study also confirmed that knowledge of causes and consequences of climate change did affect overall beliefs in happening of climate change, supporting H3 and H4. H5 was supported by showing that the higher the level of knowledge about anthropogenic climate change, the higher environmental attitude. Lastly, H6 predicted that the higher knowledge of consequences, the higher the level of environmental attitude and support H6 (Table 4).

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Table 1. Mean, standard deviations (SD), and reliability coefficient (alpha) of scales.

Variables	Mean	SD	References
Knowledge of causes (Cronbach's Alpha= 0.70)			Shi *et al*. (2015); Arbuckle *et al*. (2013); Rejesus *et al*., 2013; Heath and Gifford (2006)
climate change is caused mostly by human activities	3.97	0.88	
climate change is caused more or less equally by natural changes in the environment and human activities. (Negative statement)	3.92	0.93	
Knowledge of consequences (Cronbach's Alpha= 0.70)			Shi *et al.* (2015); Tobler *et al.* (2012)
Climate change will increase the Negative public health impacts.	4.07	0.88	
Climate change will decrease the see level.	4.22	0.87	
Climate change will increase the droughts.	4.27	0.89	
Climate change will increase the insects.	3.92	1.04	
Environmental Attitude (Cronbach's Alpha= 0.66)			Hawcroft and Milfont, (2010)
The earth is like a spaceship with limited resources.	3.95	0.87	
Plants and animals have as much right to exist as humans.	3.96	0.93	
The Balance of nature is delicate.	4.04	0.89	
Beliefs in happening climate change(Cronbach's Alpha= 0.70)			Heath and Gifford, (2006); Whitmarsh, (2005)
It seems to me that precipitation patterns had changed compared to when I was a child.	4.09	0.77	
I think recent winter wasn't as cold as last years.	3.83	1.03	
I think the current summer is warmer than last years.	4.09	0.91	
I am quite sure that global warming is occurring now	4.10	0.92	
It seems to me that temperature is warmer now than in years before.	4.01	0.98	
Risk perception (Cronbach's Alpha= 0.77)			O'Connor *et al.* (1999); Leiserowitz (2006)
How likely do you think it is that each of the following will occur during the next 25 years due to global warming?			
Worldwide, many people's standard of living will decrease.	3.89	0.90	
Worldwide water shortages will occur.	4.32	0.77	
Increased rates of serious disease worldwide.	4.17	0.91	
My standard of living will decrease.	4.00	0.94	
My chance of getting a serious disease will increase	3.94	0.96	

Table 2. Fit indices of conceptual framework.

	$\chi 2$	$\chi 2$/df	GFI	AGFI	CFI	SRMR	RMSEA
Recommended values	-	< 3	> 0.9	> 0.9	> 0.9	< 0.10	< 0.08
SEM	246.136	1.697	0.930	0.908	0.935	0.046	0.047

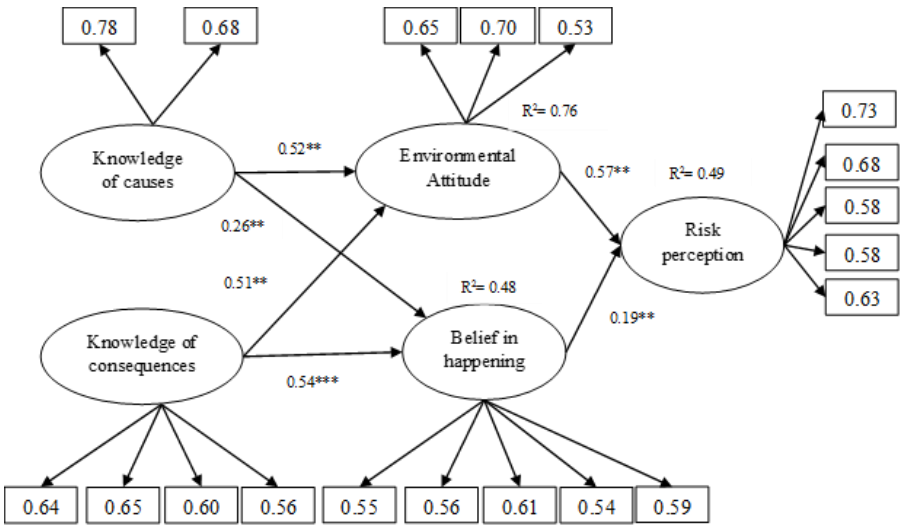

Figure 2. Causal analysis model derived from the path analysis.

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Table 3. Standardized Total, direct and indirect effects of the variables on environmental attitude, belief in happening and risk perception.

	Knowledge of causes	Knowledge of consequences	Environmental attitude	Belief
		Standardized total effects		
Environmental attitude	0.52	0.51	–	–
Belief	0.26	0.53	–	–
Risk perception	0.34	0.39	0.56	0.18
		Standardized direct effects		
Environmental attitude	0.52	0.51	–	–
Belief	0.26	0.53	–	–
Risk perception	–	–	0.56	0.18
		Standardized indirect effects		
Risk perception	0.34	0.39	–	–

Table 4. The results of Hypothesis test variables of the research.

	Hypothesis	β value	Conclusion
H1	Belief→Risk perception	0.45**	Supported
H2	Environmental attitude→Risk perception	0.42**	Supported
H3	Knowledge of cause→Belief	0.27**	Supported
H4	Knowledge of consequence→Belief	0.53**	Supported
H5	Knowledge of cause→Environmental Attitude	0.22*	Supported
H6	Knowledge of consequence→Environmental attitude	0.30**	Supported

**: 0.01 level, *: 0.05 level.

DISCUSSION

Several conclusions can be drawn from our findings:

(a) The first and foremost, our finding revealed that knowledge is a key factor in shaping students' belief about climate change and their environmental attitude. Knowledge about causes and consequences of climate change can predict 76% variance in environmental attitude. Indeed, if students are aware that human actions are the cause of climate change and have enough information about impacts of climate change on ecosystem and human health, they will be more likely to believe that environment is delicate and vulnerable, the earth has limited resources, and all plants and animals have the same right to life as the human. In line with this finding, Bradley *et al*. (1999) and Kollmuss and Agyeman (2002) demonstrated that environmental knowledge has a positive influence on environmental attitudes. Furthermore, knowledge about causes and consequences of climate change can explain 48% of variance in students' belief about climate change. Students with the greater knowledge about causes and effects of climate change are more likely to believe it is occurring and real.

The impacts of climate change are divided into consequences for the human health and environment ecosystem including undesirable change in sea level, and drought. In this regard, Tobler *et al*. (2012) found that a greater knowledge about climate change and its causes were associated with more concern about climate change and less skepticism about climate change. Whereas in their study skepticism refers to unbelief in happening climate change, both knowledge

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of causes and knowledge of consequences have positive effects on belief that climate change is occurring.

Based on these results, increasing knowledge about climate change among young adults through curriculum, seminars, and workshop can help to improve student attitudes and beliefs about climate change. Moreover, we propose that to have climate change education efficacy and effectiveness, it is better that the climate change curriculum focuses on causes and consequences of this phenomenon. Shepardson *et al*. (2014) noted that education is the main part of the response to climate change around the world because education helps students perceive and investigate the climate change consequences, motivates attitude and behavior change, and improves their adaptation to climate change.

b) The analysis has revealed that students with higher environmental attitude and more positive attitude tend to have significantly higher risk perceptions. Smith *et al*. (2017) believed that education is a key factor in the formation of attitude about climate change in comparison to other environmental problems. They noted that global climate change has complicated causes and consequences that may not be easily understandable. Thus, it needs some educational background to comprehensive the causes and risks of climate change. We suggest that mass media can provide information background for young adults. In line with this finding, Chokriensukchai and Tamang (2010) noted that the media connect climate research coverage to individual behavior such as power consumption. Individuals need to be knowledgeable about the link of their behavior to climate change, as well as the necessity of addressing climate change as a global environmental problem. Studies show that people tend to change their attitudes toward an issue in accordance with the information they receive from the media (Chokriensukchai and Tamang, 2010).

c) In addition, belief in happening of climate change has shown to be a determinant of climate change risk perceptions. In other word, students who believe that climate change is occurring express significantly more risk perception. Our results were confirmed by previous studies. For example, according to the results of Arbuckle *et al*., 2013 belief have significant and positive effect on perceived risk. They showed that those who believe climate is changing and associated with human causes have higher concern. Lee *et al*., (2015) have revealed that perception of local temperature change is the strong determinant of risk perception in many African and Asian countries. Reser *et al*. (2012) also found that respondents who more strongly believed that climate change was occurring had more risk perception in their living area.

d) The relationship between knowledge and climate change risk perception is indirect and mediated by environmental attitude and belief.

CONCLUSION

Our framework can predict about half of the variance (49%) in risk perception. We think that the suggested framework is an effective tool for prediction of risk perception. In this regard, teaching student about the causes and consequences of climate change will eventually increase risk perception. One of the most important limitations of this research is the research sample. In other words, this research only involved students and could not be generalized to the whole country. It is also a descriptive research type and does not investigate causality. The most important lesson learned from this study is the discovery of the importance of different types of knowledge in understanding the risk perception of climate change. In other words, while risk perception is a keyword in literature and policy of climate change, increasing people's knowledge about climate

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change will have a significant impact on improving the perceived risk of individuals and, as a result, increasing adaptive behavior and mitigation action.

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درک خطر تغییرات آب و هوایی در میان دانشجویان کشاورزی: نقش دانش، نگرش محیطی و اعتقاد به وقوع

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چکیده

تغییرات اقلیمی ناشی از "اثر فزاینده گلخانه‌ای" است که به علت فعالیت‌ها و شیوه زندگی انسان رخ داده است. کاهش گازهای گلخانه‌ای بستگی به درک خطر تغییرات آب و هوایی دارد. از این رو، مطالعه حاضر، به ارائه یک مدل مفهومی برای تعیین درک خطر پرداخته است و به بررسی این می پردازد که آیا آگاهی درباره علل و پیامدهای تغییرات آب و هوایی می‌تواند نگرش‌های زیست محیطی افراد، باور به وقوع تغییرات آب و هوایی و درک خطر را تحت تاثیر قرار دهد یا خیر. این مطالعه در قالب یک پیمایش مقطعی انجام شد. نمونه پژوهش شامل ۳۲۰ دانشجوی کارشناسی بودند که از طریق نمونه گیری تصادفی انتخاب شدند. مدل سازی معادلات ساختاری نشان داد که رابطه بین آگاهی از علل و پیامدها و درک خطر به واسطه‌ی نگرش و باورهای زیست محیطی می باشد. پاسخ دهندگان با دانش بیشتر در مورد علل و پیامدهای تغییر آب و هوایی به احتمال زیاد تغییرات آب و هوایی را به عنوان یک خطر در نظر می‌گیرند. دانشِ علل و عواقب ناشی از تغییرات اقلیمی تاثیر مستقیمی بر باور به در حال وقوع بودن تغییرات آب و هوایی و نگرش محیطی و تأثیر غیر مستقیمی بر درک خطر دارد. نگرش زیست محیطی و باور به وقوع نیز تاثیر مثبت معناداری بر درک ریسک خطر داشتند. مدل پیشنهادی تحقیق می‌تواند تقریبا نیمی از واریانس (۴۹٪) درک خطر را برآورد کند و یک ابزار موثر برای پیش بینی درک خطر باشد.

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