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Climate Disasters and Subjective Well-Being among Urban and Rural Residents in Indonesia

Moh Shadiqur Rahman [1,*], Novil Dedy Andriatmoko [2,*], Moh Saeri [3], Herman Subagio [3], Afrizal Malik [4], Joko Triastono [4], Renie Oelviani [4], Juliana C. Kilmanun [5], Helena da Silva [6], Marietje Pesireron [7], Rein Estefanus Senewe [7] and Yusuf Yusuf [8]

1 Department of Tropical Agriculture and International Cooperation, National Pingtung University of Science and Technology, Pingtung 912, Taiwan
2 Department of Socio-Economics, Faculty of Agriculture, University of Brawijaya, Jl. Veteran, Malang 65145, Indonesia
3 Assessment Institute for Agricultural Technology East Java, Malang 65152, Indonesia; saeri@pertanian.go.id (M.S.); hermansubagio@pertanian.go.id (H.S.)
4 Assessment Institute for Agricultural Technology Central Java, Semarang 50552, Indonesia; afrizalmalik@pertanian.go.id (A.M.); jokotriastono@pertanian.go.id (J.T.); renieoelviani@pertanian.go.id (R.O.)
5 Assessment Institute for Agricultural Technology West Kalimantan, Pontianak 78241, Indonesia; julianacarolina@pertanian.go.id
6 Assessment Institute for Agricultural Technology East Nusa Tenggara, Kupang 85362, Indonesia; helenadasilva@pertanian.go.id
7 Assessment Institute for Agricultural Technology Maluku, Ambon 97233, Indonesia; marietje.p@pertanian.go.id (M.P.); reinsenewe@pertanian.go.id (R.E.S.)
8 Indonesian Center for Horticulture Research and Development (ICHORD), Bogor 16111, Indonesia; yusufdarsa@pertanian.go.id
* Correspondence: mohsodiqurrahman@gmail.com (M.S.R.); novildedy@ub.ac.id (N.D.A.)

Abstract: Climate disasters pose a risk to residents' well-being globally. However, information about the impact of climate disasters among urban and rural residents remains lacking, especially in Indonesia. This study aims to fill the gap by investigating the impact of climate disaster on subjective well-being based on urban and rural typology model. The data were cross-sectional, involving 7110 Indonesian residents who had experienced climate disasters, 3813 from urban areas and 3297 from rural areas. An ordered probit model was employed to estimate the impact of climate disasters on subjective well-being (i.e., happiness and life satisfaction). In general, the empirical results show that climate disasters do not significantly affect the happiness of Indonesian residents, but they significantly and negatively impact their life satisfaction. Further analysis reveals that climate disasters impact urban and rural residents differently. The subjective well-being of rural residents is more severely affected than those living in urban areas. Further estimation also indicated that climate disaster significantly reduces residents' subjective well-being at the lowest income level for both rural and urban residents. Our finding confirms that rural residents remain the most vulnerable to the impacts of climate change.

Keywords: climate disaster; ordered probit; happiness; life satisfaction; subjective well-being; Indonesia

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1. Introduction

Climate change has impacted the environment and various aspects of human life in recent decades. Its immediate indicator is the change in global temperature [1], which has risen by nearly 1.8 degrees Fahrenheit since 1880 [2]. Floods, droughts, tropical cyclones, and earthquakes are some of the catastrophic impacts, which have happened more frequently across the globe. Fang et al. [3] reported that there have been 13,386 climate disasters globally since 1970, resulting in 3.6 million deaths, 7.7 billion casualties, and

USD 3.3 trillion economic losses. In the future, the occurrences of climate disasters are anticipated to increase in intensity and frequency [4]. For instance, Lenderink and Van Meijgaard [5] predicted that extreme rain events would become more frequent in the future. Similarly, Taherkhani et al. [6] projected that extreme weather phenomena would continue to increase due to the sea-level rise. Indonesia has been impacted by extreme weather severely. From 1815 to 2019, there were 10,438 floods, 6050 landslides, 2124 droughts, and 1914 forest fires [7]. Aside from fatality, climate disasters such as these cause significant ecological, economic, social, and physiological losses [8].

Literature has extensively documented the impacts of climate disasters with various social indicators. There are two strands of research on the nexus between climate disasters and society. The first focuses on the association with economic losses [9–12]. For example, Dasgupta, Laplante, Murray, and Wheeler [9] examined the economic impact of sea-level rise in 84 developing countries, claiming that increasing sea level per meter can reduce agricultural land by 7%, which means 10% of GDP losses in the agricultural sectors. Ullah, Shah, Saqib, Yaseen, and Haider [12] assessed the households' vulnerability to floods in Pakistan, highlighting the vulnerability of the daily wagers as they lost their primary source of income. Due to their financial limitations, these residents living in poverty were also unable to mitigate the impact of floods, i.e., reconstruct their house or move to a safer place. Similarly, Nguyen, Le, and Vo [11] compared the households in flood-prone areas and safer areas and found that the former earned less income and had a higher expenditure. They also reported that climate disasters caused 57% of economic losses in Vietnam, and 37.3% were affected by the floods. In Indonesia, Djalante, Garschagen, Thomalla, and Shaw [10] estimated that between 1900 to 2015, the total economic losses due to climate disasters were at approximately USD 44 million, and the death toll was 238,000.

The impact of climate disasters on well-being and intangible assets can also be severe [13]. The death toll and physical damages leave residents traumatized, and the environmental destruction causes biodiversity loss and disturbed ecosystems [14]. Therefore, the second strand of research focuses on the association between climate disasters and residents' well-being [15–17], which can either be physiological, i.e., health problems or psychological, i.e., stress and anxiety [18]. A study involving 422 respondents from France, Hudson, Botzen, Poussin, and Aerts [17] found that climate disasters, especially floods, reduced residents' subjective well-being. Calvo, Arcaya, Baum, Lowe, and Waters [15] compared the happiness level of the Americans before and after Hurricane Katrina and found a significant decrease even after a year had passed. Hamama-Raz, Palgi, Leshem, Ben-Ezra, and Lavenda [16] revealed that the subjective well-being of the Filipinos was negatively impacted because they lost their home and resources and experienced disturbances to their physical health.

The severity of the impact may depend on socio-economic and demographic profiles, according to Sam et al. [19], and the difference is usually stark between urban and rural areas. The urban infrastructure is often more developed, and residents have more stable income sources. Meanwhile, the rural infrastructure is not as advanced, and most residents depend on natural resources for income [20] as they primarily work in the agriculture, fisheries, and forestry sectors. Therefore, climate disasters may affect rural and urban dwellers in different magnitudes. Although previous literature has documented the impact of climate disasters on subjective well-being, research has not compared how the effect may be different between the urban and rural areas. Therefore, this study seeks to address the gaps and is motivated to support the United Nations' Sustainable Development Goal of "no one must be left behind" by calling for the reduction of urban–rural inequality and the improvement of mental health and wellness for all humanity.

This study contributes to the literature from two essential aspects. First, this study provides the comparison impact of climate disaster subjectively between urban and rural residents. Second, we investigate the disaggregated impact of climate disaster on the subjective well-being by household income level. The existing literature mainly examined the homogenous impact of climate disaster [17,18,21,22]. Residents from different income

levels, on the other hand, may behave differently when impacted by a climate disaster. The current study aims to investigate the impact of climate disaster on subjective well-being based on the urban and rural typology model. The finding will have a practical implication on urban and rural development policy making and climate change mitigation.

2. Materials and Methods

2.1. Research Data

This study employs open-access data from the Indonesian Life Survey Family 5 (IFLS-5), and it can be accessed on http://www.rand.org/labor/FLS/IFLS.html (accessed on 2 November 2021). The survey was conducted from 2014 to 2015 and was firstly initiated by RAND Corporation, which collaborated with METRE Survey and Gadjah Mada University. The IFLS is a national survey collecting detailed data from about 23,776 individuals from 15,067 households. The survey was ethically reviewed and approved by Institutional Review Boards in the United States and Gadjah Mada University in Indonesia.

The respondents had previously experienced a climate disaster. The exclusion criteria of the IFLS data were those who had never experienced a climate disaster and those with missing information. As such, we included 7110 respondents, with 3813 living in urban areas and 3297 living in rural areas. The questionnaire was divided into three parts. The first was about a climate disaster. The respondents were asked how many times they had experienced climate disasters in the last five years. The second was about the socio-demographic profiles, including age, gender, marital status, family members, education, health condition, income, and assets. The third was about subjective well-being.

2.2. The Measurement of Key Variables

Climate disaster is the first key variable. This variable is measured by the respondents' intensity of disasters experienced in the last five years, including flood, landslide, volcanic eruption, earthquake, windstorm, forest fire, and drought. The second key variable is subjective well-being, which is one of the most significant current discussions to understand people's well-being conditions. The importance of non-monetary components has become more acknowledged in the last decade, which is now recognized as a multidimensional concept spanning multiple aspects of life [23]. Classic well-being indicators, such as income, have also been criticized for being too one-sided and incapable of accounting for non-monetary components of life, such as happiness and life satisfaction. Easterlin [24] argues that wealth cannot increase happiness significantly [20,25,26]. As a result, researchers in disciplines such as economics and political science were attracted to the idea of subjective well-being [27,28]. Personal cognition and emotional judgment of life quality are both considered to constitute subjective well-being. [29,30]. According to Diener et al. [31], subjective well-being is "a broad category of phenomena that include people's emotional responses, domain satisfactions and global judgments of life satisfaction". To assess subjective well-being, international literature has traditionally utilized two indicators, namely happiness and life satisfaction Happiness is a sort run measure to symbolize the emotional quality of everyday experience, whereas life satisfaction refers to long-term ideas and sentiments about life [20,32]. To measure the happiness variable, the respondents were asked: "After everything you have gone through, would you say you were very happy, happy, unhappy, or very unhappy"? The responses' scoring is 1 for very unhappy, 2 for unhappy, 3 for happy, and 4 for very happy. Meanwhile, for life satisfaction, the respondents were asked: "In general, how satisfied are you with your life"? There were five scale options to choose from 1 for not satisfied at all, 2 for not very satisfied, 3 for somewhat satisfied, 4 for very satisfied, and 5 for completely satisfied.

2.3. Econometric Analysis

This study employs an ordinal probit model to estimate the impact of climate disasters since the dependent variables are ordinal, i.e., subjective well-being (happiness and life

satisfaction). Therefore, we assumed that subjective well-being is the function of the climate disaster and socio-demographic variables. Specifically, the model can be written as follows:

$$S_i^* = \varphi C_i + \beta X_i + e_i, \; with \; S_i = \begin{cases} 1 \; if \; S_i^* \leq C_1 \\ 1 \; if \; C_1 < S_i^* \leq C_2 \\ z \; if \; C_{z-1} \leq S_i^* \end{cases}$$

where S_i^*. denotes subjective well-being (i.e., happiness and life satisfaction), determined with ordinal variables S_i and unknown cut-offs C_1, C_2, ... C_{z-1}; X_i is explanatory variables, i.e., age, gender, marital status, family members, education, health condition, income, and assets; φ and β represent the parameters to be estimated; and e_i is a random error term.

3. Results

3.1. Descriptive Statistics

Table 1 presents the descriptive statistics of the variables used in this study. The results show that the average natural frequency by the respondent is 2.4042, revealing that the respondents have experienced climate disasters approximately two to four times in the last five years. The average values of subjective well-being indicators are 2.9809 for happiness and 3.2446 for life satisfaction. This finding suggests that the well-being of Indonesian residents who had experienced climate disasters was relatively good. Regarding the socio-demographic profiles, the average age of the respondents was 37.1716 years old, with 52.28% female and 72.53% married. In addition, the average family member in a household is approximately four to five, and 45.14% of them have a child under 15 years old. The majority of the respondents graduated from primary school (32.41%), and only 3.16% graduated from university. The mean value of self-report health status was 2.8964, suggesting a good condition. The average income earned by the respondent was about IDR1,047,927 per month. Almost 93% owned a television set, 72.02% owned a mobile phone, and 75.19% owned a private vehicle, i.e., a motorcycle or car. Finally, only 25.82% of the respondents owned financial savings.

Table 1. Descriptive statistics.

Variables	Definition and Measurement	Mean	Std. Dev
Climate disaster	The number of disasters experienced in the last five years (time)	2.4042	5.3389
Happiness	Self-reported happiness from 1 = very happy to 5 = very unhappy	2.9809	0.5421
Life satisfaction	Self-reported life satisfaction from 1 = very unsatisfied to 5 = very satisfied	3.2446	0.8403
Age	Age of respondent (years)	37.1716	14.5600
Gender	1 for female; 0 for male	0.5228	0.4995
Marital status	1 for married; 0 otherwise	0.7253	0.4464
Child	1 if the respondent has a child under 15; 0 for otherwise	0.5414	0.4983
Family members	The number of family members (person)	4.4336	1.9474
No education	1 if the respondent has no formal education; 0 for otherwise	0.0281	0.1654
Primary education	1 if the last formal education level is primary; 0 otherwise	0.3241	0.4681
Junior education	1 if the last formal education level is junior high; 0 otherwise	0.2097	0.4071
Senior education	1 if the last formal education level is secondary (senior high); 0 otherwise	0.1904	0.3927
Associate's degree	1 if the last formal education level is associate's degree; 0 otherwise	0.0316	0.1751
University education	1 if the last formal education level is a bachelor, master or PhD; 0 otherwise	0.0726	0.2595
Health report	Self-reported personal health from 1 = unhealthy to 4 very healthy	2.8964	0.6743
Income	Total household income (IDR/month)	1,047,927	1,042,036
Television	1 if the respondent owns a TV; 0 otherwise	0.9257	0.2622
Mobile phone	1 if the respondent owns a mobile phone; 0 otherwise	0.7202	0.4489
Private transportation	1 if the respondent owns a private vehicle; 0 otherwise	0.7519	0.4319
Saving	1 if the respondent has financial savings; 0 otherwise	0.2582	0.4377
Observation	7110		

Table 2 presents the mean differences of the study variables between the urban and rural residents in Indonesia. There is no significant difference between urban and rural residents' experience in climate change, suggesting that both urban and rural residents have experienced similar climate disasters. The subjective well-being indicators show different results. There is no significant difference in the happiness level, but the residents' life satisfaction is significantly higher in urban areas. Those living in urban areas are more satisfied with their life than those living in rural areas.

Table 2. Mean difference of selected variables between urban and rural residents.

Variables	Urban (3813)	Rural (3297)	Mean Differences
Climate disaster	2.4427	2.3597	0.0830
Happiness	2.9982	2.9609	0.0373
Life satisfaction	3.2662	3.2196	0.0466 **
Age	36.5125	37.9339	−1.4214 ***
Gender	0.5313	0.5129	0.0184
Marital status	0.6892	0.7671	−0.0778 ***
Child	0.5266	0.5584	−0.0318 ***
Family members	4.5083	4.3473	0.1610 ***
No education	0.0181	0.0397	−0.0216 ***
Primary education	0.2547	0.4043	−0.1497 ***
Junior education	0.1922	0.2299	−0.0377 ***
Senior education	0.2177	0.1589	0.0587 ***
Associate's degree	0.0422	0.0194	0.0228 ***
University education	0.0981	0.0431	0.0550 ***
Health report	2.8870	2.9072	−0.0203
Income	1,176,854	90,0186	27,6668 ***
Television	0.9504	0.8972	0.0533 ***
Mobile phone	0.7712	0.6612	0.1100 ***
Private transportation	0.7776	0.7222	0.0554 ***
Saving	0.2985	0.2117	0.0867 ***

Note: ** $\leq$ 0.05, *** $\leq$ 0.01.

Meanwhile, the socio-demographic variables show that the urban residents are more educated, earn more, and own a television and/or mobile phone, a vehicle, and financial capital (savings). For instance, the urban residents' education level is tertiary. In rural areas, most residents graduated from junior high school or primary school. Many of them receive no education at all. Those in urban areas also earn more, IDR276,668 higher than those in rural areas. Overall, with such significant differences between urban and urban residents, it is likely that the climate disasters will impact them differently, especially in terms of their well-being.

As we mentioned earlier, there were seven types of natural disaster that were reported by the respondents, namely flood, landslide, volcanic eruption, earthquake, windstorm, forest fire, and drought. Some respondents could have experienced several climate disasters. Figures 1 and 2 present the percentage of climate disasters experienced by urban and rural residents respectively. In general, flood was the most common natural disaster experienced by rural and urban residents, followed by volcanic eruption, earthquake, drought, and windstorm. In contrast, the climate disasters that were experienced the least by the respondents were landslides and forest fires. Interestingly, based on urban and rural typology, relative with rural area, floods were climate disasters that occurred more frequently in urban areas. In fact, we found 22.5% of our respondents who live in urban areas have experienced flooding but only 11% for the rural respondents. Chen et al., 2015 claimed that rapid urbanization has a negative influence on urban hydrological systems, notably in terms of increasing the danger of urban floods and creating significant losses due to flooding. On the other hand, the most common disasters experienced by rural communities compared to cities are drought and landslides.

3.2. The Impact of Climate Disasters on Subjective Well-Being: A Pooled Model

The impact of climate disasters on subjective well-being indicators (happiness and life satisfaction) was estimated by an ordered probit model and presented in Table 3 specifically in the third row, column two for happiness, and column three for life satisfaction. The estimation result indicates that climate disasters have an insignificant effect on residents' happiness, but it has a negative impact on life satisfaction with statistical significance at 5% level.

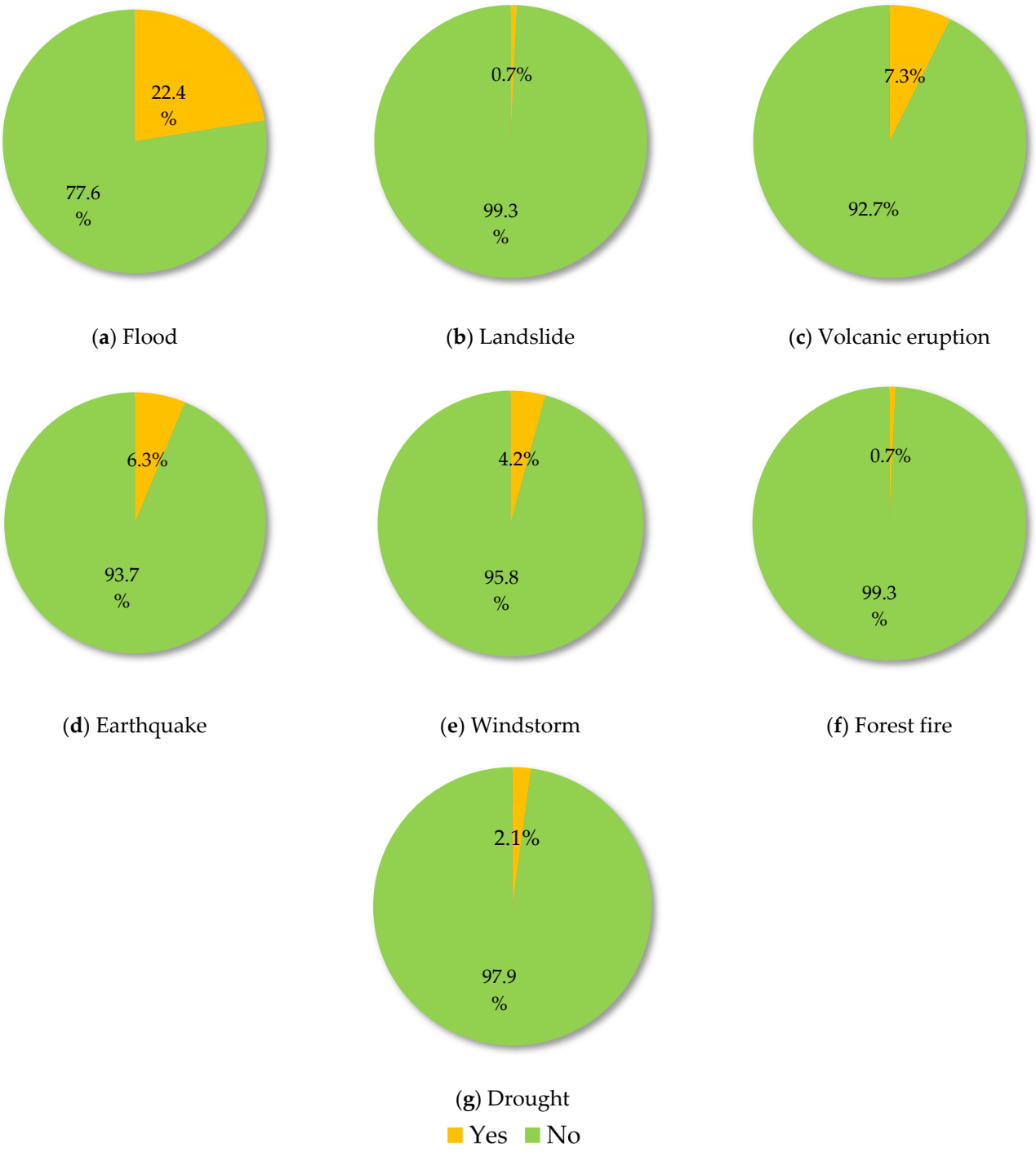

Figure 1. Respondents' experience of climate disasters in urban areas.

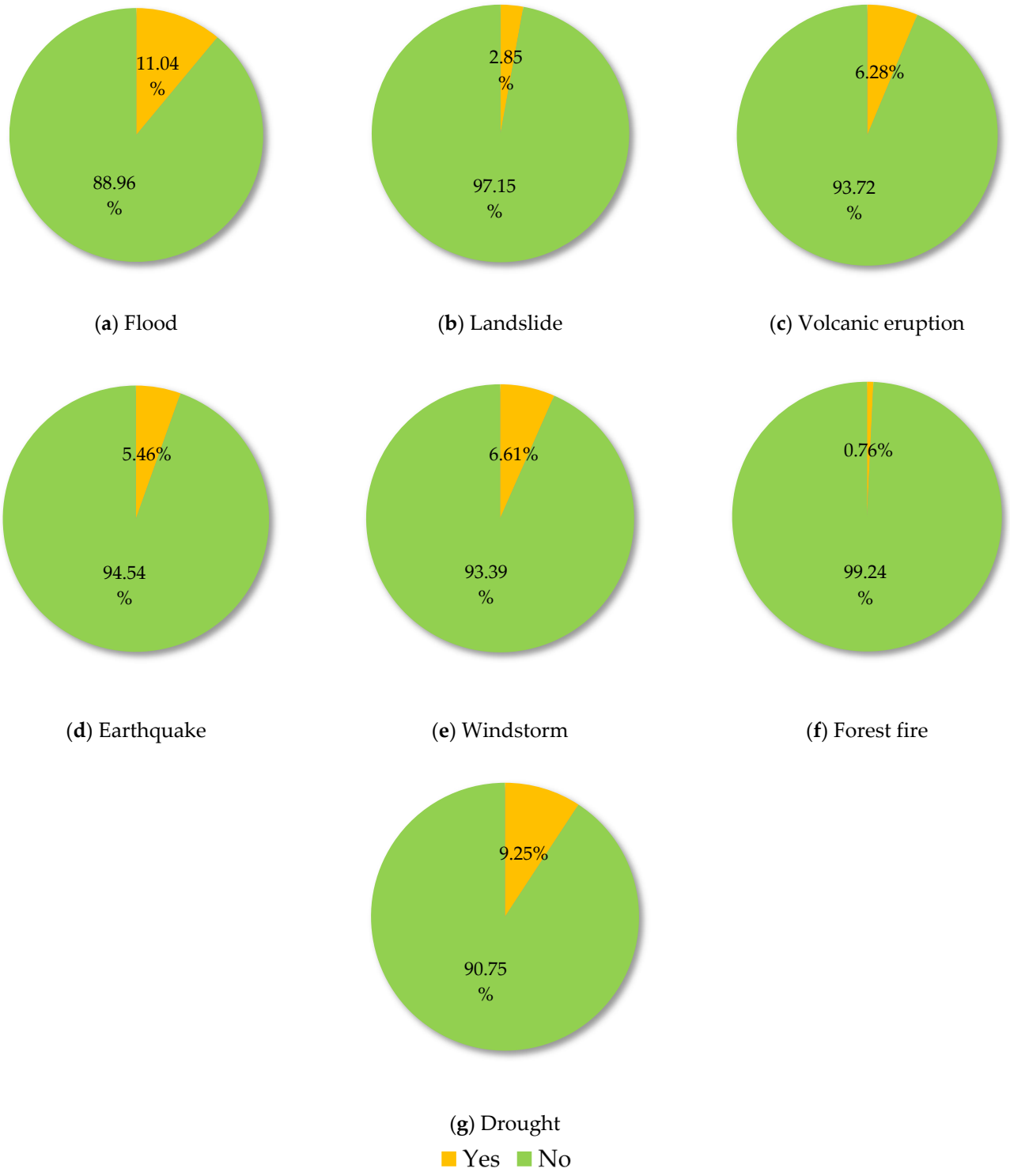

Figure 2. Respondents' experience of climate disasters in rural areas.

Table 3 also presents the influence of the control variables on residents' subjective well-being. Generally, the results show that subjective well-being is positively and significantly influenced by gender, marital status, health condition, income, and the ownership of a television, private vehicle, and financial savings, but it is negatively and significantly influenced by age. The older the person, the lower the happiness and life satisfaction levels are, consistent with a previous study about age and subjective well-being [33–35]. Female residents are associated with higher subjective well-being than male residents. The gender

variable shows a negative and significant coefficient, which is different from the finding by Stevenson and Wolfers [36], stating that men tend to have higher happiness levels than women. However, Brereton et al. [37] and Fujita et al. [38] claimed that there is a negative association between men and subjective well-being. The inconsistency in the findings might be due to the different socio-economic conditions of research locations.

Table 3. The impact of climate disasters on subjective well-being: pooled model.

Variable	Happiness (Coefficient)		Life Satisfaction (Coefficient)	
Climate disaster	−0.0039	(0.0030)	−0.0058	(0.0026) **
Age	−0.0088	(0.0013) ***	−0.0042	(0.0012) ***
Gender	0.0634	(0.0311) **	0.1745	(0.0272) ***
Marital status	0.3454	(0.0449) ***	0.0125	(0.0395)
Child	−0.0087	(0.0396)	−0.0815	(0.0347) **
Family members	0.0169	(0.0085) **	0.0136	(0.0075) *
No education	−0.0267	(0.1042)	0.1606	(0.0921) *
Primary education	−0.0452	(0.0534)	0.0128	(0.0463)
Junior education	−0.0629	(0.0531)	0.0898	(0.0458) **
Senior education	0.0247	(0.0538)	−0.0073	(0.0464)
Associate's degree	0.0718	(0.0971)	−0.0648	(0.0838)
University education	0.0679	(0.0724)	0.0089	(0.0626)
Health report	0.2952	(0.0228) ***	0.2515	(0.0200) ***
Income	3.93×10^{-8}	(1.63×10^{-8}) **	4.60×10^{-8}	(1.43×10^{-8}) ***
Television	0.1428	(0.0574) **	0.1690	(0.0510) ***
Mobile phone	0.1085	(0.0403) ***	0.0413	(0.0352)
Private transportation	0.1638	(0.0365) ***	0.1292	(0.0320) ***
Saving	0.2061	(0.0364) ***	0.1336	(0.0315) ***
Cut 1	−0.9955	(0.1257)	−0.9960	(0.1107)
Cut 2	0.0511	(0.1225)	0.1046	(0.1079)
Cut 3	2.5202	(0.1263)	1.3259	(0.1088)
Cut 4			2.8559	(0.1125)
Log likelihood	−4879.9547		−8035.1091	
LR chi2(18)	527.4700		358.0100	
Prob > chi2	0.0000		0.0000	
Pseudo R2	0.0513		0.0218	

Note: * ≤ 0.10, ** ≤ 0.05, *** ≤ 0.01. Standard errors are presented in parentheses.

Marital status has a positive effect on happiness and is statistically significant at a 1% level, suggesting that marriage increases residents' happiness level. Using national surveys, Stack and Eshleman [39] found a strong association between marital status and happiness, through increasing financial satisfaction and health status. Having a child under 15 significantly reduces life satisfaction. The main reason is that residents need time and effort to take care of their children, and they must juggle with other responsibilities. Meanwhile, the number of family members has a positive and significant impact on both subjective well-being indicators. This finding implies that residents with more family members are happier and more satisfied. According to Zhu et al. [40], the number of family members influences family functionality, which helps residents deal with stress better and offers them emotional and financial support, hence making them happier.

Self-reported health indicates positive coefficients on happiness and life satisfaction with statistical significance at a 1% level. This result suggests that better health conditions lead to higher happiness and life satisfaction levels. This finding is not surprising because health is essential to achieving well-being. For instance, being ill becomes a barrier for residents to fulfil their needs such as earning income and affording entertainment [41,42]. Income is positively associated with happiness and life satisfaction, statistically significant at a 1% level, suggesting that those with a higher income are generally happier and more satisfied with their lives. A study conducted by Sohn [43] investigating the determinant

of happiness in Indonesia produces a similar finding, highlighting the positive effect of income on happiness. Mobile phone ownership increases subjective well-being significantly because it can connect residents. Television ownership also has a positive and significant effect on happiness and life satisfaction as it is a source of entertainment or information, including weather forecasts. Private vehicle ownership has a positive and significant coefficient on subjective well-being because it allows residents to be mobile and active. Lastly, the variable cut 1 to cut 4 given at the bottom of the empirical results of the ordered probit model illustrates where the latent variables are cut in order to create the three groups based on the ordinal value of our dependent variable, namely happiness and life satisfaction.

3.3. The Impact of Climate Disasters on Subjective Well-Being: An Urban and Rural Model

This section provides the impact of climate disasters on subjective well-being among urban and rural residents. The result is presented in Tables 4 and 5 for urban and rural residents, specifically in the second rows. The results indicate that the climate disasters do not significantly affect urban residents' happiness and life satisfaction. However, the results show a negative effect on happiness and life satisfaction among the rural residents with statistical significance at 10% and 5% for happiness and life satisfaction respectively. Furthermore, Tables 4 and 5 also provide the influence of control variables on subjective well-being. The finding is similar to the pool model in Table 3. However, the interesting result is that education level is strongly associated with happiness and life satisfaction in urban areas. This is because, in urban areas, residents with higher levels of education are in a fiercer competition to get better jobs. In rural areas, education has no significant effect on subjective well-being. This is because most rural residents are farmers or fishers, so they do not necessarily reach a higher education level.

Table 4. The impact of climate disasters on subjective well-being: urban model.

Variables	Happiness (Coefficient)		Life Satisfaction (Coefficient)	
Climate disaster	−0.0002	(0.0042)	−0.0044	(0.0035)
Age	−0.0069	(0.0018) ***	−0.0020	(0.0016)
Gender	0.0603	(0.0421)	0.1673	(0.0372) ***
Marital status	0.3109	(0.0594) ***	−0.0295	(0.0529)
Child	−0.0361	(0.0540)	−0.0828	(0.0478) *
Family members	0.0187	(0.0114) *	0.0231	(0.0101) **
No education	−0.0009	(0.1656)	0.1621	(0.1471)
Primary education	−0.0674	(0.0711)	0.0741	(0.0626)
Junior education	−0.0906	(0.0691)	0.1510	(0.0605) **
Senior education	0.0341	(0.0668)	−0.0553	(0.0582)
Associate's degree	0.0191	(0.1167)	−0.1149	(0.1014)
University education	0.1444	(0.0860) *	−0.0313	(0.0752)
Health report	0.2715	(0.0312) ***	0.2587	(0.0276) ***
Income	8.04×10^{-9}	(1.88×10^{-8})	3.39×10^{-8}	(1.65×10^{-8}) **
Television	0.1196	(0.0943)	0.1039	(0.0838)
Mobile phone	0.1330	(0.0575) *	0.1134	(0.0511) **
Private transportation	0.1889	(0.0515) ***	0.1474	(0.0457) **
Saving	0.1638	(0.0470) ***	0.1573	(0.0412) ***
Cut 1	−0.9958	(0.1738)	−0.9339	(0.1553)
Cut 2	0.0103	(0.1695)	0.2347	(0.1507)
Cut 3	2.4125	(0.1741)	1.4479	(0.1522)
Cut 4			2.9770	(0.1571)
Log likelihood	−2677.6730		−4261.0885	
LR chi2(18)	243.8400		187.1400	
Prob > chi2	0.0000		0.0000	
Pseudo R2	0.0435		0.0215	

Note: * ≤ 0.10, ** ≤ 0.05, *** ≤ 0.01. Standard errors are presented in parentheses.

Table 5. The impact of climate disasters on subjective well-being: rural model.

Variables	Happiness (Coefficient)		Life Satisfaction (Coefficient)	
Climate disaster	−0.0080	(0.0043) *	−0.0079	(0.0038) **
Age	−0.0111	(0.0020) ***	−0.0070	(0.0018) ***
Gender	0.0574	(0.0466)	0.1769	(0.0401) ***
Marital status	0.3970	(0.0693) ***	0.0725	(0.0603)
Child	0.0223	(0.0592)	−0.0792	(0.0511)
Family members	0.0155	(0.0132)	0.0002	(0.0114)
No education	0.0193	(0.1425)	0.1764	(0.1241)
Primary education	0.0006	(0.0851)	−0.0306	(0.0724)
Junior education	−0.0143	(0.0857)	0.0286	(0.0726)
Senior education	0.0190	(0.0911)	0.0731	(0.0771)
Associate's degree	0.2164	(0.1742)	0.0454	(0.1498)
University education	−0.1232	(0.1345)	0.1161	(0.1144)
Health report	0.3305	(0.0338) ***	0.2446	(0.0292) ***
Income	1.42×10^{-7}	(3.51×10^{-8}) ***	9.25×10^{-8}	(3.02×10^{-8}) ***
Television	0.1415	(0.0737) *	0.1980	(0.0650) ***
Mobile phone	0.0729	(0.0571)	−0.0314	(0.0491)
Private transportation	0.1413	(0.0522) ***	0.1191	(0.0450) ***
Saving	0.2600	(0.0580) ***	0.1057	(0.0493) **
Cut 1	−0.9386	(0.1901)	−1.0898	(0.1643)
Cut 2	0.1603	(0.1856)	−0.0481	(0.1610)
Cut 3	2.7301	(0.1922)	1.1901	(0.1619)
Cut 4			2.7287	(0.1672)
Log likelihood	−2184.4583		−3756.8766	
LR chi2(18)	307.3400		197.2600	
Prob > chi2	0.0000		0.0000	
Pseudo R2	0.0657		0.0256	

Note: * ≤ 0.10, ** ≤ 0.05, *** ≤ 0.01. Standard errors are presented in parentheses.

3.4. Disaggregate Analysis

Given the results of pool model and urban–rural model, only showing the homogenous estimates of climate disaster effect on residents' subjective well-being, this study further investigates a disaggregate analysis to understand the heterogeneous effect of climate disaster by considering the household income level. Table 6 provides the empirical estimation for the happiness model; it was indicated that the climate disaster significantly and negatively impacted rural residents' happiness at the middle income level (household income quantile 2) but not for residents at the household income tertile 1 and 3. For the urban residents, it has not significantly affected their happiness for all household income levels (household income quantile 1, 2, and 3). For the life satisfaction measure, it was negatively and significantly affected by climate disaster only at the lowest level (household income quantile 1) for both urban and rural model, and it did not significantly affected the households at the middle and highest income level (household income quantile 2 and 3).

Table 6. Disaggregate analysis.

Category	Urban				Rural			
	Happiness (Coefficient)		Life Satisfaction (Coefficient)		Happiness (Coefficient)		Life Satisfaction (Coefficient)	
Household income quantile 1	0.002	(0.009)	−0.021	(0.008) ***	−0.004	(0.005)	−0.009	(0.004) **
Household income quantile 2	0.002	(0.006)	−0.002	(0.005)	−0.033	(0.014) **	−0.002	(0.012)
Household income quantile 3	−0.012	(0.009)	−0.009	(0.008)	−0.007	(0.009)	−0.009	(0.008)

Note: ** ≤ 0.05, *** ≤ 0.01. Standard errors are presented in parentheses.

4. Discussion

This section begins by discussing the subjective well-being impact of climate disaster on Indonesian residents, specifically comparing the subjective impact of climate disaster between rural and urban residents. In general, this study revealed that climate disaster reduced overall life satisfaction of Indonesian residents. Residents who have experienced more climate disasters tend to have lower life satisfaction than those who have experienced fewer disasters. This is because life satisfaction is a long-term indicator of subjective well-being [20], influenced by infrastructure damages, the grief for death, income reduction, and health issues [15–17]. This finding is in line with previous studies that show a negative association between climate disasters and life satisfaction in Ukraine [44], Japan [45], and America [46], although these studies did not investigate the effect of climate disasters on specific groups such as urban and rural.

Furthermore, this study also makes the first attempt by investigating the different impact of climate disaster on subjective well-being among rural and urban residents. The finding indicated that climate related disasters do not play an essential role in urban residents' subjective well-being. However, they significantly reduce rural residents' subjective well-being, including their happiness and life satisfaction. This finding suggests that rural residents are more vulnerable to climate disasters. There are two tentative explanations. First, the infrastructure in the rural areas is not well developed, such as roads, electricity, and education facilities. Second, rural residents usually depend on natural resources as the primary source of their income, such as agriculture, livestock, forestry, and fisheries sectors. Hence, when these sectors are affected by climate disasters, most rural residents lose their income, and it is difficult to recover from the climate disaster's damage. Meanwhile, urban residents have more stable jobs, so it is easier to recover from the climate disaster's damage.

Research often attributes the increasing frequency of natural disasters to climate change [47,48]. These disasters are considered imminent threats to human life, causing infrastructure damage, losses in productive assets, death tolls, and casualties [49]. In Pakistan, for example, households lost their livelihoods because they depended on the agricultural sector, which was severely impacted by a flooding disaster since 2010 [12]. Empirical evidence from past research shows how climate disasters have caused many casualties. For example, heatwaves in 1981–2010 resulted in deaths by respiratory diseases in Europe [50]. In France, the heatwave in 2003 caused 70,000 deaths; this subsequently prompted the French authorities to establish the Health Watch Warning System [51]. Natural disasters like these cause not only physical health problems but also induce stress and anxiety [17]. This study confirms that climate disasters negatively impact subjective well-being in the long term, measured by perceived life satisfaction.

Identifying vulnerable people and locations at risk of natural disasters is still debatable in the international literature. Our study claims that natural disasters have a higher impact on rural (as opposed to urban) areas and low-income communities (Table 6). This may be caused by poor development plans in vulnerable areas such as the rural and remote areas, indicating that the losses and damages should not solely be attributed to climate change. Raju and da Costa [52] also claimed that 'climate' or 'natural' losses and casualties are also closely linked to vulnerability, which is often man-made through unplanned urbanization, structural inequality, and marginalization based on religion, caste, class, ethnicity, gender, or age. Vulnerability is thus a result of social and political processes, including poor governance. Raju et al. [53] also argue that blaming nature or climate change absolves people's responsibility and could be treated as a political narrative. In other words, city administrations need to evaluate the social and physical vulnerabilities before drawing any conclusions as to what causes the severe losses and damages.

5. Conclusions

Based on the cross-sectional data from 7110 Indonesian residents with climate disaster experience, we used an ordered probit model to estimate the subjective well-being between urban and rural residents. In general, the finding indicates that climate disasters do

not significantly affect happiness, but they negatively affect life satisfaction substantially. Interestingly, the disaggregate estimation from urban and rural residents shows that climate disasters do not significantly affect the urban residents. However, they significantly impact the rural residents. This result confirmed that residents living in rural areas are more vulnerable to climate disasters than residents in urban areas. We also found that subjective well-being is significantly influenced by gender, marital status, health condition, income, and possession of a television, private vehicle, and financial savings, and it is negatively and significantly influenced by age.

Given the strong impact of climate disasters on rural residents' subjective well-being, this study suggests developing targeted climate disasters adaptation and mitigation policy, including developing resilient rural infrastructure, upskilling rural workers, and improving the education facility, including natural information warning systems so that residents can anticipate and mitigate the damage.

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