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Research article

Flood disaster mitigation modeling through participation community based on the land conversion and disaster resilience

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ABSTRACT

The objective of this research is to determine the relationship between non-structural flood disaster mitigation models to reduce the impact of floods. The analysis is carried out on the basis of community participation, land conversion, and community resilience. The 1398 household was conducted at 2019 is used as the sample of this research. This research is focused on the mitigation modeling by adopting three models (CLEAR model, CLUE-S model, DROP model) as variables, 15 indicators and 65 sub-indicators. Three hypotheses were formulated to effectively carry out the research. Structural equation model is used to investigate the close relationship between the three models. The relation between CLEAR and CLUE-S models have a positive correlation is about 14.806, CLEAR and DROP models have a close relation is about 4598, and CLUE-S and DROP models have a close positive relation is about 4.004. The results of these three models are very valuable to the central and local governments for formulating the policies programs in designing sustainable non-structural flood mitigation and subsequent policies with references to the three models above which are effective to reduce the flood events.

1. Introduction

Floods, which frequently take place due to climate change, have become the most common natural disaster and pose a major threat to human societies [1, 2]. Floods occurring in Indonesia are generally caused by five factors includings of heavy rain, land conversion, river channel construction error, river silting, and coastal flooding [3, 4, 5]. The intensity of rain in Indonesia is high in each year experiencely. Hence, the frequency of floods is high [6]. Compared to the other countries, Indonesia encounters floods frequently [7, 8]. In reality, the floods occur almost in every year [7, 9] and it also has the affects to 12 million people in Indonesia [10]. Special for the country, the average of the floods, which spread all over it, within about 2010 until 2019 was 747 events in a year [11]. The population growth, worsened by the effects of climate change, significantly contributes to flooding. Additionally, Cultural and geographical components also affect people's adaptability to climate change [12].

Rainfall change results in the increase of the number of hydrometeorological disasters, which in turn, causes flooding. One of the areas was Lampung, Indonesia (Figure 1) [13]. Based on data from the National Disaster Management Agency (BNPB), there were approximately 42 incidents from 2010 to 2019. Relating to the data above, the areas of Lampung such as Pringsewu, Tanggamus, Bandar Lampung, East Lampung, South Lampung district, Pesawaran, Mesuji, and West Tulang Bawang districts. Based on the data, one of the areas in Lampung regencies which is often occurred of the floods almost in every year was Pesawaran.

Pesawaran is an area of 1,173.73 m^2 and comprises 11 sub-districts (Figure 1). Based on the data from the Region Disaster Management Agency (BPBD), Floods taking place in Pesawaran is a type of inundation floods with inundation heights between between 0.5 and more than 1.5 m, because based on field findings, the height of flood inundation that often occurs in Pesawaran Regency ranges from 0.5 to more than 1.5 m. Referring to the data of the floods occurring from 2010 to 2019, Pesawaran's floods were caused by high intensity of rainfall [14] with the average of 50 mm/h in three days' time in a month and also the overflow from the shallow watersheds of the rivers resulted in damage to infrastructure along the rivers and crashed into people's houses.

In addition, there are 27 watersheds in Pesawaran with the Bulok Karto catchment area as the widest, which is an area of 463.6 ha. The morphometry confirmed that small, less wide, less long, and less deep rivers have large volumes of water (silting of the rivers). The narrow

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bodies of the rivers, intensity of the constant rainfall, the transformation of the rivers' upstream into plantations, and also between siltation and blockage are due to surficial landslides and eroded water [15, 16]. If a river is unable to hold any more water, the water will then find lower inundated areas and can in turn be a major cause of flooding [17]. Nevertheless, flooding can be minimized if it is not too big. Consequently, it is based on the principle, flooding is among those infeasible to avoid or eliminate fully [18].

Referring to Figure 1 above, it can be seen that if there are totally several efforts which is given from the government, the risk of flood's event more shrinks quickly. The activities of disaster management are generally limited to three main elements, i.e. mitigation and preparedness, response, and recovery [19, 20]. Disaster mitigation is a series of efforts to reduce disaster risk through physical development, awareness and the increase in the ability to encounter the threats [21, 22, 23].

In a fact, by indentifictating the aforementioned problems, the community demands effective and optimal non-structural flood mitigation. Typically, non-structural measures are those not only involving physical construction but also using knowledge, practice, or agreement to minimize the risks and impacts, policies and laws, public awareness, training, and education in particular [24]. The non-structural approach is on the basis of the adjustment of human activities and societies intended to mitigate the flood damages. It consists of insurance, land use management, awareness, environmentally sensitive area protection, and other emergency and recovery policies for decent management of flood damages.

Based on the explanation above, the researchers offer a compilation efforts in the form of a model. The four main reasons why the disaster models are expected to be useful are as follows: 1) a model helps to simplify the complex events by distinguishing critical elements. It is even more significantly beneficial when responding to disasters with grave time constraints. 2) Comparing an actual condition with a theoretical model leads to a better understanding of the current situation, facilitates the planning process, and comprehensive completion of disaster management plans. 3) The availability of a disaster management model is an essential element in quantifying disaster events. 4) A documented disaster management model helps to establish a common base of understanding all involved [25].

The integrated disaster management model was involved in this research. It means, the organizing has a relation activities to ensure their effective implementation. The advantage of this model is that it provides a balance between preparedness and flexibility in order to respond fluidly to specific post-disaster needs since it provides the link between actions and disastrous events, which can be tight or loose.

The model's integration of this research was adapted from the CLEAR, CLUE-S, and DROP models. The CLEAR model (can do, like to, enable to, asked to, respond to) is a model of community participation adopted from the basic theory proposed by [26]. While, the CLUE-S model (conversion of land use and it effects-small location) has been specifically developed for an explicit spatial simulation of land use change based on the empirical analysis of site suitability combined with a dynamic simulation of competition and interaction between the spatial and temporal dynamics of the system as well as the driving aspects of the change, which are socio-economic aspects [27]. Besides that, the DROP model (Disaster Resilience of Place Model) focuses on the resilience at the community, social, and environmental levels in the face of natural disasters [28].

In a fact, there are several researchs and flood studies have been conducted, but they are mostly non-structural management-oriented [29], innovation of non-structural disaster mitigation models on the basis

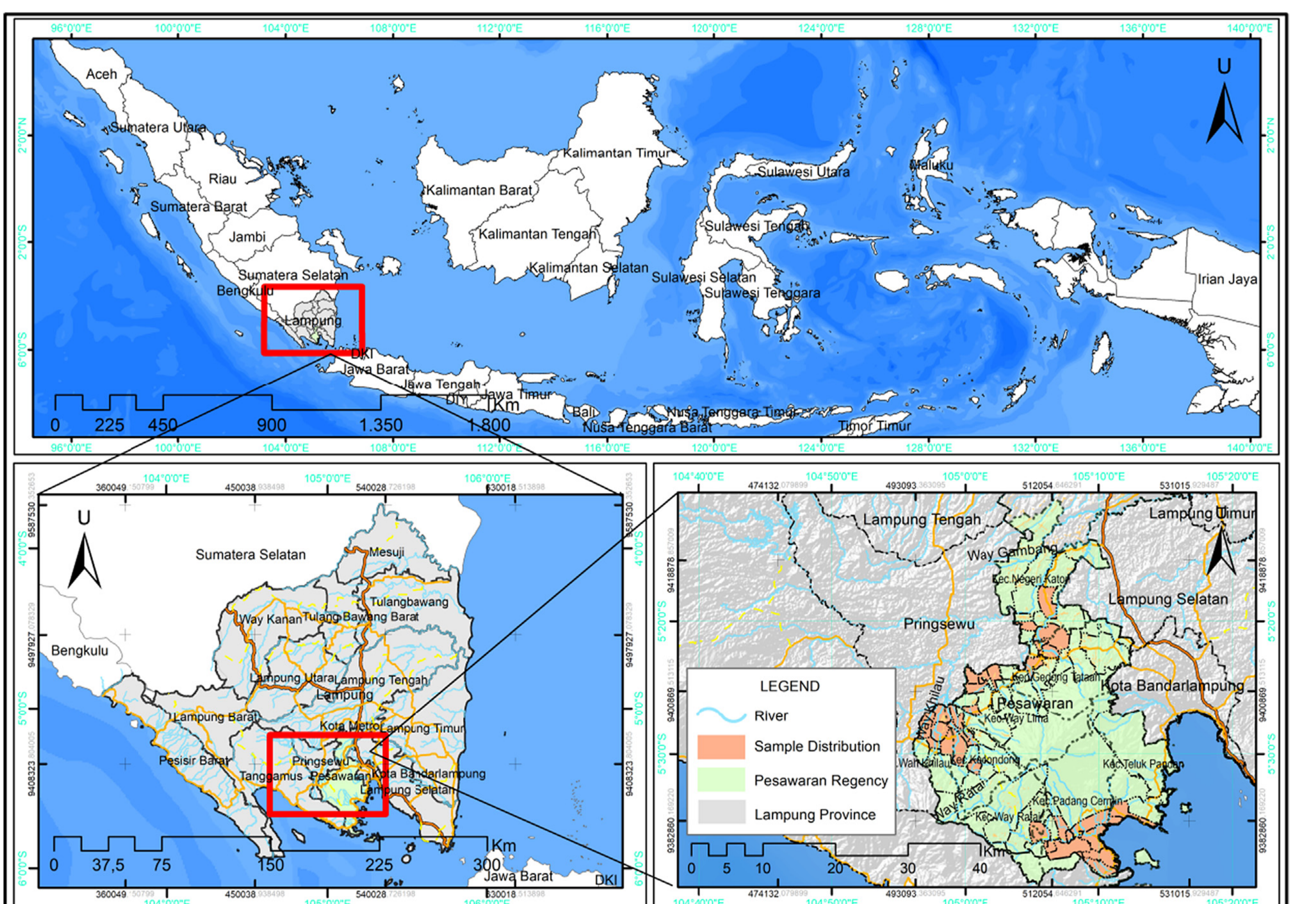

Figure 1. Locations: a) Indonesia (Country), b) Lampung (Province) on Sumatra Island c) Pesawaran (Regency).

of communication, information, coordination, and cooperation [30], KINFIL models [31], mitigation measures [32], integration of the scenario modeling of land use and flood risk assessment [33]. The first objective of this study was the model itself, which combined three independent modeling variables (community participation, land conversion, and disaster resilience) for the flood mitigation control. The researcher perceived the development of a participatory community integration model, land use conversion, and community resilience as an essential. The previous research by [18] only examined the effect of community participation on land use change in its relationship with flooding, while the community's resilience to flooding is merely judged from land use change there is no direct attention to community participation [34]. The second objective of this study at the generation of an integrated flood mitigation model for the attenuation of floods and the optimization of the community participation in Pesawaran, Lampung.

2. Literature review and methods

2.1. Area of study

Geographically, Pesawaran is located at the coordinates of 5°10′–5°50′ East Longitude and 105°–105º20′ South Latitude. The regency is a large as 117,377 hectares. It consists of 11 districts (Tegineneng, Negerikaton, Way Lima, Way Khilau, Kedondong, Padang Cermin, Way Ratai, Teluk Pandan, Marga Punduh, Punduh Pidada, and Gedongtataan) with a total of 133 sub-districts. Pesawaran is a result of South Lampung's expansion. The research data was taken in areas prone to flooding, i.e. Kedondong, Gedongtaaan, Padang Cermin, Way Lima, Way Khilau, Way Ratai, and Teluk Pandan, which are red and yellow color in Figure 2.

2.2. Theoretical model

2.2.1. Community participation

Public participation is a key factor of the response to the disaster [35]. Community participation is the main key to the effectiveness of flood management efforts [7]. Participation is the involvement of the community in the planning and decision-making processes with regard to what to do, program implementation, contribution to resources, cooperation of specific organizations or activities, sharing the benefits of constructional programs, and the evaluation of such programs [36]. Early community involvement is the best means of easing the impact of a disaster as they will be aware of every step towards the diminishment of the fallout and better prepared for such a threat. Therefore, it is more probable that they will be able to save themselves, recover from, and repair the damage from the calamity. They will in turn be a safe and independent community that is resilient to disastrous events.

2.2.2. Conversion of land use exchange

Rather than natural change, the important factor in the modification and conversion of land covers is actually the involvement of humans [37]. Land conversion in general involves the change in the allocation of land resources from one use to another. It prevents the conversion of natural and agricultural areas in flood plains into residences at the parcel level and shows that avoided loss mostly offsets missed development opportunities [38]. The effectiveness of a wetland for flood abatement may vary depending on the size of the area, type and condition of the vegetation, slope, and location of the wetland in the flood path along with the saturation of the wetland soil before flooding. Trees and other wetland vegetation help to slow down the speed of a flood. This action

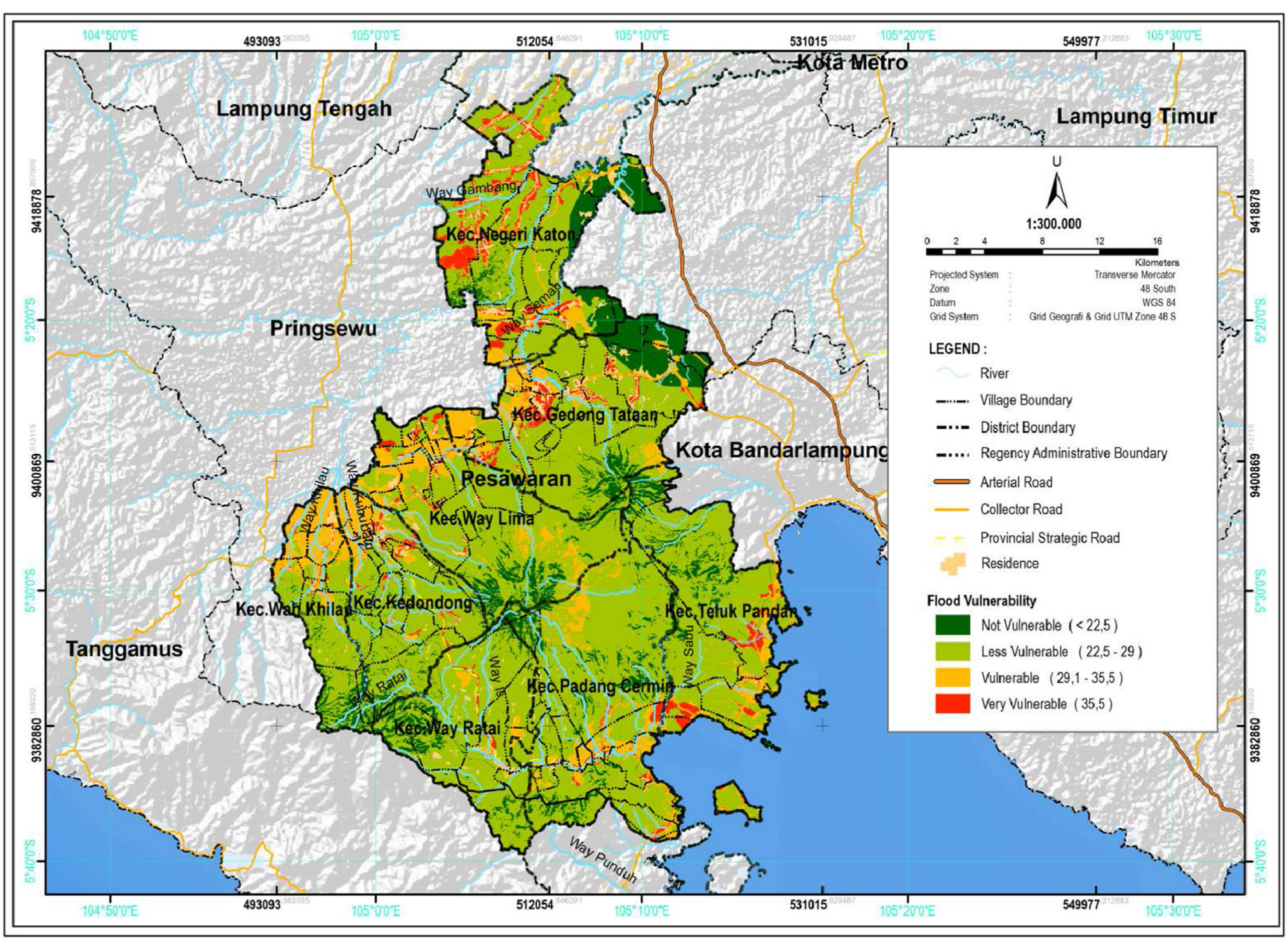

Figure 2. . Flood-prone and very vulnerable areas in Pesawaran.

combined with water storage can actually lower the height of a flood [39].

2.2.3. Disaster resilience

Resilience reflects the extent to which complex adaptive systems self-regulate and build the capacity to learn and adapt [28, 40]. Resilience is a tendency to survive and develop. Moreover, it can be interpreted as the capacity to move individuals or groups to maintain, tolerate, produce, and even improve the experience of an event by controlling the conditions in the community.

2.3. Development of models and hypotheses

2.3.1. CLEAR model

The CLEAR model in this research adopted the clear public communication model by Lowndes Vivien et al [26]. The CLEAR model participation is a participation model effective if the community performs five factors, i.e. can do (able), which means having the resources and knowledge to participate, Like to (want), which is having a sense of attachment that strengthens the participation, enabled to (possible), which means being given the opportunity to participate, asked to (voluntary group), which means they see that their views have been considered or responded to.

2.3.2. CLUE-S model

The modified modeling approach for a regional application, called CLUE-S (the Conversion of Land Use and its Effects at a Small regional level) [27]. CLUE-S according to Verburg [41] consists of four categories: 1) spatial policies and restrictions, which encompass areas in which land use change is restricted through the policies or ownership status. Some spatial policies restrict every change in land use in certain areas, for instance, prohibition of logging in forest reserves. 2) Land use requirements (demands), which change trends of extrapolation of past and near-future land use, which is a common technique for the calculation of land use requirements. 3) Special conversion arrangements for the types of land use. Conversion elasticity is related to the reversibility of land use change. The types of land use with high-capital investments will not be easily converted to other types of use as long as sufficient demand still stands. 4) Location characteristics, most of which are directly related to the location, such as soil characteristics and elevation. However, land management decisions concerning particular locations are not always on the basis of site-specific characteristics alone. Conditions at certain other levels, for instance, household, community, and administrative levels, can influence the decisions. These factors are represented by accessibility measures, which indicate the location's position relative to important regional facilities.

2.3.3. DROP model

The ecology, social, economic competence, institutions, infrastructure, and society are the six dimensions of the DROP indicators [28]. Each dimension has a detailed variable that become the focus of the discussion. Biodiversity and wetland areas are such variables contained in the ecological dimension. The discussion related to the quantity of religions based totally on groups, demography, and social networks describe the social dimension. The employment extent and asset values are the key measurement in representing the economic dimension. The emergency control characteristics as mitigation, preparedness, response, recovery plans, and emergency reaction abilities are included in the institutional dimension. The infrastructure dimension issues vital infrastructure, lifelines, and transportation networks. The last dimension, the society, is detailed by indicators that related to the high-quality of existence, health, and existence of numerous social packages. The indicators and sub-indicators of the three models are presented in Table 1.

Based on the literature review and selecting the indicators, the hypotheses of this study the following are:

The hypotheses development can be seen in Figure 3.

Table 1. Indicators and sub-indicators of three models.

Model	Basic theory	Indicators	Sub indicators
Variabile X			
CLEAR Participation (Can do, Like to, Enable to, Asked to, Respond to)	[26]	Can do (able) the resources and knowledge to participate	resources, education, economy, social status
		Like to (want); a sense of attachment that strengthens participation	Identification, equality in society, and citizenship
		Enable to (possible) given the opportunity to participate	Types of civic organizations, activities, and access for participation.
		Asked to (voluntary group)	Forms of participation and strategies.
		Respond to (responding); see the evidence that their views are considered	Listening, prioritizing, and positive and negative feedback.
CLUE-S (Conversion Land Use Exchange-Small region)	[27]	Policy and spatial restrictions	Availability of spatial policies, limiting policies, a series of specific conversions of land use, and zonal agricultural development.
		Requirements land use (request)	trends in land use change, scenario conditions linking policy targets with land use change requirements
		Conversion settings special type land use	Reversibility of land use change, conversion, and sequences of land use transition
		Location characteristics	Location position relative to important regional facilities, location factors, suitability of the location for certain forms of land use.
DROP (Disaster Resilience of Place)	[42]	Social	Productive age, the number of dependents, education, population density, poverty, and unemployment.
		Economy	Income, daily total income, the number of sources, livelihood, savings, availability of emergency funds, the number of working family members, women's jobs, women's income level, expenses, ownership of houses, ownership of gardens/rice fields, capital sources, and market access
		Institutional	Becoming a member of a disaster-resilient village group, cooperatives, financial institutions, religious institutions, managers of conservation areas, and roles of the government.
		Infrastructure	Availability of funds for infrastructure management, health facilities, educational

(continued on next page)

Table 1 (*continued*)

Model	Basic theory	Indicators	Sub indicators
			facilities, markets, availability of electricity, and availability of clean water
		Ecological	Widths of wetland areas, lost wetland areas, erosion, impermeable surface water, and biodiversity.
		Ability community	Local understanding of risks, counseling services, health and fitness, and the quality of life.

Hypothesis 1 (H1) Community participation (CLEAR model) is positively associated with conversion land use exchange (CLUE-S model).A community's mitigation strategy is a creative combination of coordinated choices in several areas. Public participation activities take part in community visioning. The linkage between land use exchange and emergency management efforts. Land use plans help communities change their approach to the mitigation of a hazard from the focus on post-disaster recovery and re-development into the focus on pre-disaster mitigation integrated with usage planning [43].

Hypothesis 2 (H2) Community participation (CLEAR model) is positively related to disaster resilience (DROP model).Community participation refers to the two-way regular exchange regarding flood risk and information on preparedness in the community. In this context, information sufficiency entails the assessment of additional information by at-risk individuals to handle disaster risk [44]. Resilience is a more strategic than normative concept, because, to be effective, resilience must be explicitly based on, and informed by, the environmental, ecological, social, and economic drivers and dynamics of a particular place, and it must be integrated across a range of linked scales such as community participation [45].

Hypothesis 3 (H3) Conversion land use exchange (CLUE-S model) is positively related with disaster resilience (DROP model).Resilience assessment helps land use planners understand which sectors, regions, and communities are the least resilient, and how they can improve the adaptive capacity to respond to hazards and disturbances while sustaining a functional state of resilience [46].

2.4. Methodology

This study was employed survey, mapping, literature review, and quantitative research method. The survey was conducted to observe the flood-prone areas. The researchers interviewed the district and sub-district chiefs (32 persons) also the flood-affected communities about

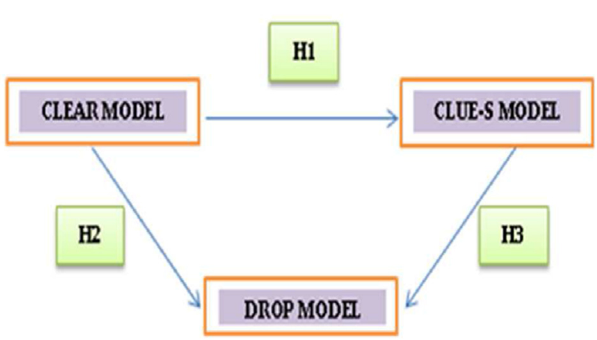

Figure 3. Hypothesis development.

the flood mitigation efforts that had been performed there. The employed interview and survey methods were intended to confirm or disconfirm a range of plausible hypotheses. Additionally, Mapping was performed to identify the physical conditions of the flood-affected areas using Arcgis 10.6. This study also implemented the literature review through field exploration by reading books, journals, secondary data (Table 2).

The literature review was performed in February 2021. It was a review of empirical studies which is describing flood mitigation and flood mitigation modelling using Web of Science and Google Scholar. Quantitative research deals with quantifying and analyzing variables in order to get the results [47]. The analysis methods applied in this research were the quantitative methods employing the software is named SEM(Figure 4).

Besides that, the sample of this research used random sampling of the heads of the families living in flood-prone and highly flood-prone areas. The data collecting technique conducted by applying the questionnaire on each variables; CLEAR, CLUE-S, and DROP. As many as 112 items were distributed to respondents in 8 districts. The research unit involves 32 sub-districts. In this study, there are three exogenous (independent) variables, i.e. community participation, land use conversion, and community resilience. An exogenous (independent) variable is a variable which is not influenced by an antecedent (prior) variable. The variables of this study are illustrated by Table 1.

The data analysis of the instrument of this research was a likert scale with five choices, i.e. strongly agree, agree, neutral, disagree, strongly disagree. The score on each items are ranged from 5 to 1. 5 is the highest and 1 is lowest. Then, the scores were processed in order to obtain the data analysis.

The data analysis of the questionnaire was performed with a quantitative multivariate method through the analysis of SEM (Structural Equation Model). SEM was selected in this study because of its reliability and ability to measure a model comprehensive. Besides that, SEM too used to confirm variable and the factors that influence it. In general, SEM is a combining of confirmatory theory factor analysis and regression analysis. SEM can solve cases with many variables, both exogenous and endogenous variables. SEM is a statistical analysis technique for estimating and evaluating models that consist of linear relationships between variables, which are usually mostly variables that cannot be observed directly (latent variables). SEM is a multivariate method allowing the concurrent assessment of multiple equations [48]. It is employed for statistical investigations for two reasons. First, it is a multivariate method that allows the assessment of the equations of several equations. Second, it performs factor and regression analyses in one step. This study used IBM spss amos 22 SEM Software for statistical determinations [49].

The first step, the structural equation models (SEM) is to find out a path analysis. The second step is to determine the validity and reliability of the data by using a measurement model through Confirmatory Factor Analysis (CFA). CFA is frequently implemented to confirm the data structure based on the measurement model obtained from the theory [50, 51]. The application of CFA in this study was performed using the second-order CFA. Second order CFA latent variables are not measured directly through assessment indicators. Meanwhile, the CFA of CLEAR, the variable comprised 5 dimensions, i.e. can do, like to, enable to, asked to, and response to. The application of CFA in CLUE-S, the variable consisted of 4 dimensions, i.e. policies, requirements, settings, and characteristics. Lastly, the CFA of DROP, the variable was composed of 6 dimensions, i.e. institutional, ecological, capability, infrastructure, economic, and social. Measurement testing is employed to examine the goodness of fit. On the others hands, it examines how well the sample data fit a distribution from a population with a normal distribution.

In other words, the three stages are the measurement model to identify the direction of the influence of each exogenous latent variable on the endogenous latent variable and each construct. Before looking at the interaction between constructs, it is of the essence to first make sure

Table 2. Primary literature review, website journals, secondary data, book.

No	Literature review	Journal	Secondary data	book
1	Lowndes.Vivien; Pratchett.Lawrence; and Stoker.Gerry; "Diagnosing and Remedying the Failings of Official Participation Schemes: The CLEAR Framework."	*Soc. Policy Soc.*, vol. 5, no. 2, pp. 281–291, https://doi.org/10.1017/s1474746405002988.	BNPB, "Indonesia National Disaster Management Plan 2010–2020," no. 24. 2009.	Byrne.Barbara;*Structural Equational Modeling with AMOS*, Second Edi. routledge Taylor and Francis Group, 2010.
2	Verburg.Peter; Veldkamp., Limpiada.Ramil; and Mastura.Sharifah; "Modeling the spatial dynamics of regional land use: The CLUE-S model,"	*Environ. Manage., vol. 30, no. 3, pp. 391–405, 2002,* https://doi.org/10.1007/s00267-002-2630-x.	BPS Pesawaran, "Profil Kabupaten Pesawaran," *Badan Pus. Stat. Kabupaten Pesawaran*, pp. 8–25, 2019.	Scumacker.E., *A Beginner's Guide to Structural Equation Modeling*, Third Edit., vol. 175, no. 3. Taylor & Francis, 2010.
3	T. Cutter, Susan L: Burton, G; Emrich, "Disaster resilience indicators for benchmarking baseline conditions,"	*J. Homel. Secur. Emerg. Manag., vol. 7, no.1,2010,* https://doi.org/10.2202/1547-7355.1732.	BPBD, Maps	Kline.Rex; *Principles and practices of structural equation modelling.* The Guilford Press, 2015.
4	Chih.Hung.Hung; Yi.Yang.Ching; C. C. Yi; and L. Y. Chung, "Building Resilience: Mainstreaming Community Participation into Integrated Assessment of Resilience to Climatic Hazards in Metropolitan Land Use Management,"	*Land use policy, vol. 50, pp. 48–58, 2016,* https://doi.org/10.1016/j.landusepol.2015.08.029.		Carri.A; *Definitions of Community Resilience: an Analysis.*Community and Regional Resilience Institute, 2013.

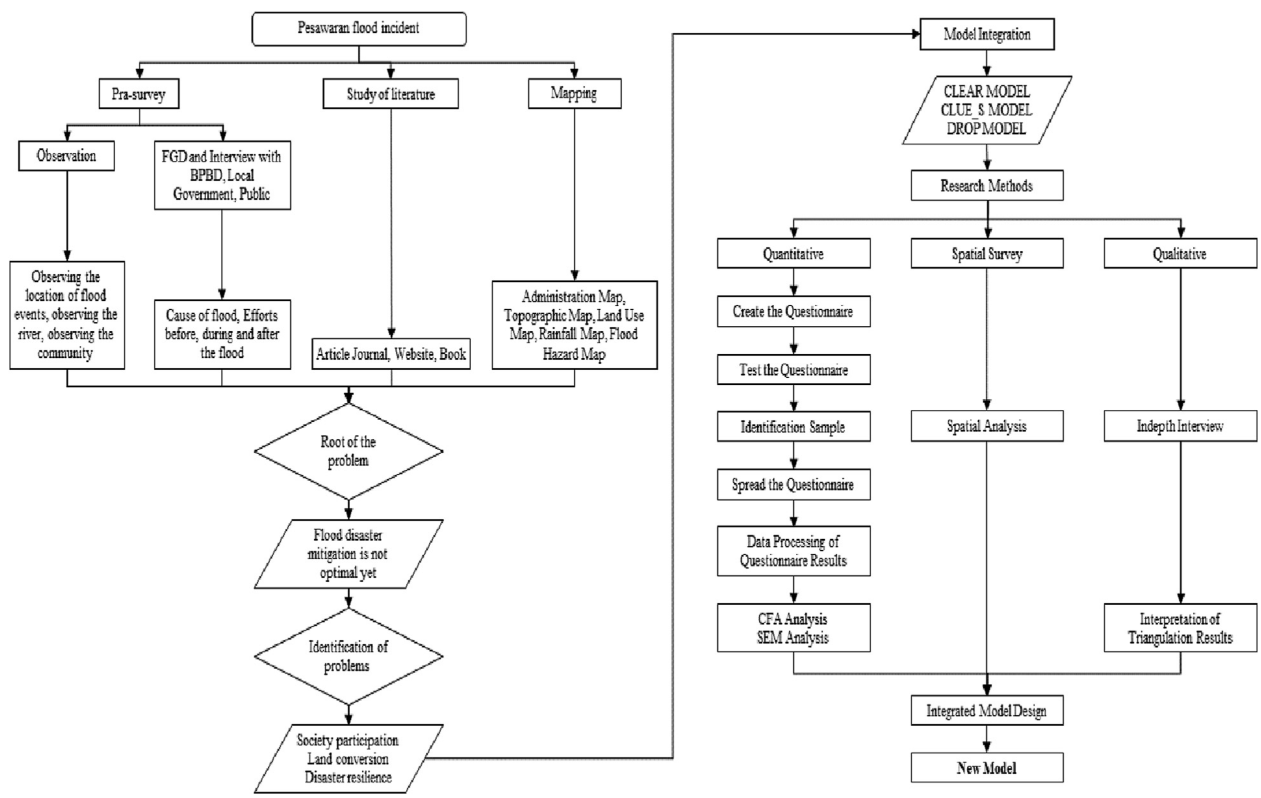

Figure 4. Flowchart.

that the goodness-of-fit criteria have been fulfilled. Before looking at the interaction of the constructs, it is necessary to fulfill the criteria for goodness of fit. The goodness of the model is determined by the strength of each structural path [52]. Goodness of fit is grouped into three, namely absolute fit measures, incremental fit measures and parsimony fit measures. The maximum likelihood technique was preferred for the analysis of the parameters in the SEM. To find out whether the model made is based on observational data in accordance with the model theory or no model fit index reference is needed. As a result of the analysis, the fit indices used of chi-square, significant probability, RMSEA, GFI CMIN/DF, RMR, NFI, AGFI, IFI, CFI, PGFI, PNFI, AIC, CAIC, used in evaluating the model fit. The following are the model fit index values that are often used in SEM. The level of fit and interpretation of the fit indices as a result of the analyzes [53, 54, 55, 56], were given in Table 3.

3. Results

3.1. Demographic data

A number of 1398 household heads, who were valid respondents, filled out the questionnaire. The collecting data was conducted in 32 sub-districts across 8 districts. The distribution of the data respondent can be seen in Table 4.

Detail information regarding to the respondents' ages, genders, and education is presented by Table 5.

Relating to the data above, it can be seen that the respondents were as laborers, traders, teachers, honorary teachers, construction workers, chicken collectors, retired teachers, farmers, government employees, soldiers, masseuses, entrepreneurs, businessmen, private sector

Table 3. Fit indices for structural equation modelling (SEM).

Type Measure	Measure	Name	Description	Cut Off For Good Fit
Absolute Fit Measure	X^2	Chi-Square	Measures how close the covariance matrix of the model's prediction results and the covariance matrix of the sample data.	p-value > 0.05
	(A)GFI	(Adjusted)Goodness of Fit	Measures how close the covariance matrix of the model's prediction results and the covariance matrix of the sample data.	GFI ≥0,90 AGFI ≥0,90
	RMSEA	Root Mean Square Error of Approximation	Measure that describes the tendency of the chi-square to reject models with large sample sizes.	RMSEA ≤0,08
	CMIN/DF	The minimum sample discrepancy function) divided by the degree of freedom (df)	significant difference between the observed and estimated covariance matrices	CMIN/DF ≤ 2,00
	RMR	Root Mean Square Residual	Residual based. The mean squared difference between the sample covariance residual and the estimated covariance residual. Unstandardised	RMR ≤0,05
Incremental Fit Measures	NFI	Normed Fix Index	size comparison with the proposed model and the null model.	NFI ≥0,90
	AGFI		development of the GFI that has been adjusted to the ratio of the degree of freedom.	AGFI ≥0,90
	IFI		used to overcome parsimony and sample size problems, which are related to NFI.	IFI ≥0,90
	CFI	Comparative Fit Index	incremental fit index. This index is relatively insensitive to the sample size	CFI ≥.90
Parsimonious Goodness of Fit	PGFI	Parsimonious Goodness of Fit Index	compare better fit to alternative models.	PGFI < GFI
	PNFI	Parsimonious Normed Fit Index	Used to compare better fit on alternative models.	PNFI < NFI
	AIC	Akaike Information Criterion	Index that describes the suitability of comparisons between models.	Positive and smaller
	CAIC	Akaike Information Criterion		

employees, housewives, fishermen, managers, steam workers, farm laborers, taxi drivers, security guards, mayors, retired civil servants, police officers, chicken farmers, and fish farmers. Most respondents were farmers (62%). The respondents' monthly earnings were 1,650,000 to 2,000,000 rupiahs.

Table 4. Amount respondent in village research location.

No	District	Sub-districts	Numbers of Respondents
1	Gedong Tataan	Bagelen	132
		Gedung Tataan	55
		Karang Anyar	115
2	Negeri Katon	Negeri Katon	49
		Kagungan Ratu	24
		Karang Rejo	27
3	Way Lima	Batu Raja	24
		Pekondoh Gedung	16
		Cimanuk	42
		Paguyuban	30
		Sidodadi	67
		Sindang Garut	37
4	Way Ratai	Bunut	41
5	Teluk Pandan	Batu Menyan	29
6	Padang Cermin	Sanggi	42
		Padang Cermin	163
		Trimulyo	14
		Tambangan	16
		Hanau Brak	37
		Banjaran	24
		Durian	22
		Hepong Jaya	21
		Gayau	22
7	Kedondong	Kertasana	24
		Way Kepayang	36
		Kedondong	54
8	Way khilau	Kubu Batu	38
		Mada Jaya	59
		Tanjung Rejo	25
		Tanjung Kerta	32
		Gunung Sari	6
		Kota Jawa	75
		Amount	1398

3.2. Instrument validity and reliability

The validity and reliability of the data were calculated through Confirmatory Factor Analysis (CFA). CFA is frequently conducted for confirming the data structure based on the measurement model obtained from the theory [50, 51]. In the CFA, the researchers have a theory about the structure of the data, which in this case is called as a measurement model [57]. The measurement model is based on theory and conditions in the field [54]. Conditions for the comparison between the theoretical basis and the empirical data are then proposed to be a hypothesis in CFA. Validity is the extent to which a test measures what it is really supposed to measure. In other words, the validity of the items built in a construct is measured. Whereas, the reliability is the extent to which the measurement of the items of each construct has been consistent for a certain period of time and across various instruments [58].

The analysis of the measurement model comprises the loading factor value and the Construct Reliability (CR) value. A loading factor value of ±0.3 to 0.4 accepts the minimum of a Construct Reliability (CR) ≥ 0.60–0,70 [49, 52, 59, 60]. In this study, the Confirmatory Factor Analysis (CFA) for each construct (variable) was conducted with the second-order CFA.

3.2.1. Confirmatory Factor Analysis (CFA) of the CLEAR model

The five dimensions forming the CLEAR model in this study were *can do*, *like to*, *enable to*, *asked to*, and *response to*. Two dimensions, i.e.

Table 5. Respondents' characteristics.

Respondents' Characteristics	Frequencies	Percentages (%)
Ages		
25–30	64	5
31–36	132	9
37–42	360	26
43–48	325	23
49–54	261	19
55–60	200	14
61–66	41	3
67–72	15	1
Genders		
Man	1217	87
Female	181	13
Education		
Elementary School	192	14
Junior High School	451	32
Senior High School	662	47
Vocational School	40	3
Undergraduate	47	3
Level Three-Diploma	2	0,4
College of Teacher Education	4	0,6

response to and *enable to*, were removed as the item values were below 0.30, which were low. The number of dimensions was shrunk to 3, i.e. *can do*, *like to*, and *asked to*. This implies that each items proven the validity that could explain or strengthen its indicator or dimension to reinforce each of the variables above 0.30, while the items below the minimum of 0.30 did not need to be taken into account at the next stage. The results of the reliability test (Construct Reliability) of the CLEAR model are presented in Table 6.

According to the results of the testing of the CFA model after the re-reduction, it is inferable that *enable to* and *respond to* could not be included as their CR values were lower than 0.6, while the CR values of the other three dimensions, i.e. *like to, can do,* and *asked to,* were 0.757, 0.690, and 0.676 respectively. These three dimensions have a very good level of reliability because they have exceeded the limit value of CR 0.6. It means that the three dimensions are reliable for measuring the CLEAR variable. Items in each dimension have a loading factor value of 0.30 (feasible). Thus, it can be concluded that the acquisition of the CFA model for the CLEAR variable is feasible/valid to be used in further analysis consisting of 3 main dimensions with their respective items. The total of the obtained construct reliability values was 0.881. In reference to the results, the CLEAR model had a CR value of 0.6, which means that the valid items were reliable to measure the CLEAR model right.

3.2.2. Confirmatory Factor Analysis (CFA) of the CLUE-S model

The CLUES model in this study comprised four dimensions, i.e. policies, requirements, settings, and location characteristics. None of the four dimensions was removed as they were all valid and could explain or strengthen its indicators or dimensions to reinforce each of the variables above 0.30. The results of the reliability test (Construct Reliability) of the CLUE-S model are presented by Table 7.

Referring to the table above, the combined total of the construct reliability values was 0.853. From the results, it is known that the CLUE-S model had a CR value of 0.6, meaning that the valid items were reliable to measure the CLUE-S model right.

3.2.3. Confirmatory Factor Analysis (CFA) DROP model

The DROP model in this study was composed of 6 dimensions, i.e. institutional, ecological, capability, infrastructure, economic, and social. The obtained of CFA model after the reduction is shown in Table 8.

Table 6. Validity and reliability of the CLEAR model.

Dimensions			Loading Factor Values	Error Values	Composite/Construct Reliability Values
X11.10	<—	Can_do	0,604	0,792	0,690
X11.9	<—	Can_do	0,587	0,785	
X11.8	<—	Can_do	0,577	0,765	
X11.7	<—	Can_do	0,385	1,041	
X11.6	<—	Can_do	0,551	0,792	
X11.5	<—	Can_do	0,409	1,075	
X11.4	<—	Can_do	0,420	1,010	
X11.2	<—	Can_do	0,361	1,167	
X11.1	<—	Can_do	0,456	1,061	
Total			4,350	8,488	
X12.9	<—	Like_to	0,466	1,147	0,757
X12.8	<—	Like_to	0,623	0,960	
X12.7	<—	Like_to	0,595	0,771	
X12.6	<—	Like_to	0,571	0,967	
X12.5	<—	Like_to	0,630	0,979	
X12.4	<—	Like_to	0,565	1,058	
X12.3	<—	Like_to	0,525	1,060	
X12.2	<—	Like_to	0,609	0,790	
X12.1	<—	Like_to	0,577	0,808	
Total			5,161	8,540	
X14.12	<—	Asked_to	0,434	0,974	0,676
X14.10	<—	Asked_to	0,391	1,070	
X14.9	<—	Asked_to	0,653	0,847	
X14.8	<—	Asked_to	0,635	0,780	
X14.7	<—	Asked_to	0,589	0,796	
X14.6	<—	Asked_to	0,481	0,910	
X14.2	<—	Asked_to	0,305	1,141	
X14.1	<—	Asked_to	0,501	1,094	
Total			3,989	7,612	
Combined Total			13,500	24,640	0,881

Based on the table above, the average of the construct reliability values was 0.850. From the results, it is known that the DROP variable had a CR value of 0.6, it means that the valid items were reliable enough to serve as the measure of the DROP model. The speaking of the CR values of the dimensions, the highest (0.698) belonged to the economic dimension, followed by the infrastructure (0.647), then the social dimension (0.601).). The three dimensions' reliability values were high enough as they exceeded the minimum CR value, which was 0.6.

3.3. Measurement model

The analysis techniques applied to prove the hypotheses was the structural equation modeling analysis. Before using the structural equation modeling analysis, there were several pre-conditions to meet for the fulfillment of the goodness-of-fit (Table 9).

The suitability test of the research model is used to put to the test how high the level of goodness of fit of the research model is. According to Table 9, all the three measures, i.e. Absolute Fit Measures, Incremental Fit Measures, and Parsimonious Fit Measures, indicate that the goodness-of-fit was fulfilled. Chi-square = 23.380, probability = 0.271 $>$ 0.05. Criteria of Incremental Fit Measures is in fit condition. GFI = 0.997 $>$ 0.90, CFI = 1.000 $>$ 0.90 (Figure 5). Figure 5 indexes the degree of discrepancy (0.997) as follows:

The Incremental Fit Measures were considered the best. The goodness of fit was fulfilled (PGFI = 0.302 and PNFI = 0.362). Based on the three measures above, it is obvious that the improvement of the model in this study was very good. The R-squared was determined to show the

Table 7. Validity and reliability of the CLUE-S model.

Indicators			Loading Factor Values	Error Values	Composite/ Construct Reliability Values
X21.6	<—	Land policy	0.523	0.934	0.65861
X21.5	<—	Land policy	0.598	0.663	
X21.4	<—	Land policy	0.451	0.861	
X21.3	<—	Land policy	0.513	0.9	
X21.2	<—	Land policy	0.526	0.722	
X21.1	<—	Land policy	0.451	0.78	
Total			3.062	4.86	
X22.5	<—	Land conversion requirements	0.439	0.997	0.65578
X22.4	<—	Land conversion requirements	0.494	0.965	
X22.3	<—	Land conversion requirements	0.581	0.775	
Total			1.514	2.737	
X23.3	<—	Land conversion arrangement	0.508	0.943	0.62122
X23.2	<—	Land conversion arrangement	0.469	0.99	
X23.1	<—	Land conversion arrangement	0.472	0.952	
Total			1.449	2.885	
X24.4	<—	Location characteristics	0.682	0.696	0.73761
X24.3	<—	Location characteristics	0.708	0.556	
X24.2	<—	Location characteristics	0.651	0.646	
X24.1	<—	Location characteristics	0.629	0.638	
Total			2.67	2.536	
Combined Total			8.695	13.018	0.8531

measure of the goodness of fit of the linear regression models and to measure the strength of the relationship between the models.

Thus, the hypothesis of the relationships between variables were afterwards put to the test. The obtained results are as follows (Table 10):

The Critical Ratio (C.R) value describes the statistics formed by dividing an estimate by its standard error. With a sufficient sample size, the critical ratio resembles a normal distribution. In that case, a value of 1.96 indicates two-sided significance at the "standard" 5% level. Simply put, when the critical ratio (CR) is >1.96 for a regression weight, that path is significant at the .05 level or better (that is, the estimated path parameter is significant). How strong is the relationship which exists then the criteria used. If the CR value > 1.96 then the covariance of the factor has a significant relationship. Hypothesis testing was administered by analyzing the value (CR) compared to the required statistical limit, which is above 1.96 [53].

Three hypothesis were proposed, which were further discussed in the following sections:

Hypothesis 1. **(H1)** There is a positive relation between community participation (CLEAR) and land use conversion (CLUE-S).

Based on the data, the t-value was 14.806. It signifies that there is a positive relationship between community participation (CLEAR) and conversion of use land (CLUE-S) since the value met the requirement, t-value > t-table (14.806 > 1.96), and the R value was 0.581. Futhermore, it can be said that hypothesis 1 (H1) is accepted.

Hypothesis 2. **(H2)** There is a positive relation between participation in disaster mitigation (CLEAR) and flood resilience (DROP).

It is in line with the data, it is known that the t-value was 4.598, which indicates that there is a positive relationship between participation in disaster mitigation (CLEAR) and disaster resilience flood (DROP) as the value fulfilled the required condition, t-value > t-table (4.598 > 1.96) and the R value was 0.149, it means that the hypothesis 2 (H2) is accepted.

Table 8. Validity and reliability of the DROP model.

Items Indicators/Dimensions			Loading Factor Values	Error Values	CR Values
X31.6	<—	Social	0.573	0.852	0.60092
X31.5	<—	Social	0.586	0.804	
X31.4	<—	Social	0.663	0.751	
X31.3	<—	Social	0.435	0.976	
Total			2.257	3.383	
X32.13	<—	Economic	0.434	0.972	0.69841
X32.12	<—	Economic	0.377	1	
X32.11	<—	Economic	0.365	1.106	
X32.10	<—	Economic	0.333	1.241	
X32.8	<—	Economic	0.582	0.752	
X32.7	<—	Economic	0.452	0.996	
X32.6	<—	Economic	0.388	1.088	
X32.5	<—	Economic	0.479	1.012	
X32.4	<—	Economic	0.515	1.067	
X32.3	<—	Economic	0.325	1.34	
X32.2	<—	Economic	0.591	0.881	
X32.1	<—	Economic	0.519	0.951	
Total			5.36	12.406	
X33.9	<—	Infrastructure	0.56	0.77	0.64744
X33.8	<—	Infrastructure	0.658	0.764	
X33.7	<—	Infrastructure	0.519	0.999	
X33.6	<—	Infrastructure	0.509	0.874	
X33.2	<—	Infrastructure	0.483	0.985	
X33.1	<—	Infrastructure	0.411	0.977	
Total			3.14	5.369	
X35.2	<—	Ecologic	0.364	0.985	0.62119
X35.3	<—	Ecologic	0.305	0.792	
Total			0.669	1.777	
Combined Total			11.426	22.935	0.85058

Table 9. Structural equation modeling analysis.

Fit Indice	*Absolute Fit Measures*	*Cuts of Value*	Descriptions
Chi-square	Must be smaller	23.380	Fit
Significant Probability	≥0.05	0.271	Fit
RMSEA	≤0.08	0.011	Fit
GFI	≥0.90	0.997	Fit
CMIN/DF	≤2.00	1.169	Fit
RMR	≤0.05	0.010	Fit
Incremental Fit Measures			
NFI	≥0.90	0.997	Fit
AGFI	≥0.90	0.990	Fit
IFI	≥0.90	1.000	Fit
CFI	≥0.90	1.000	Fit
Parsimonious Fit Measures			
PGFI	PGFI < GFI	0.302	Fit
PNFI	PNFI < NFI	0.362	Fit
AIC	Value must be ≤ AIC *Independent models* and *saturated models*	115.380 (IM:7026.979; SM:132.00)	Fit
CAIC	Value must be ≤ CAIC *Independent Models* and *saturated models*	402.548 (IM:7095.649; SM:544.025)	Fit

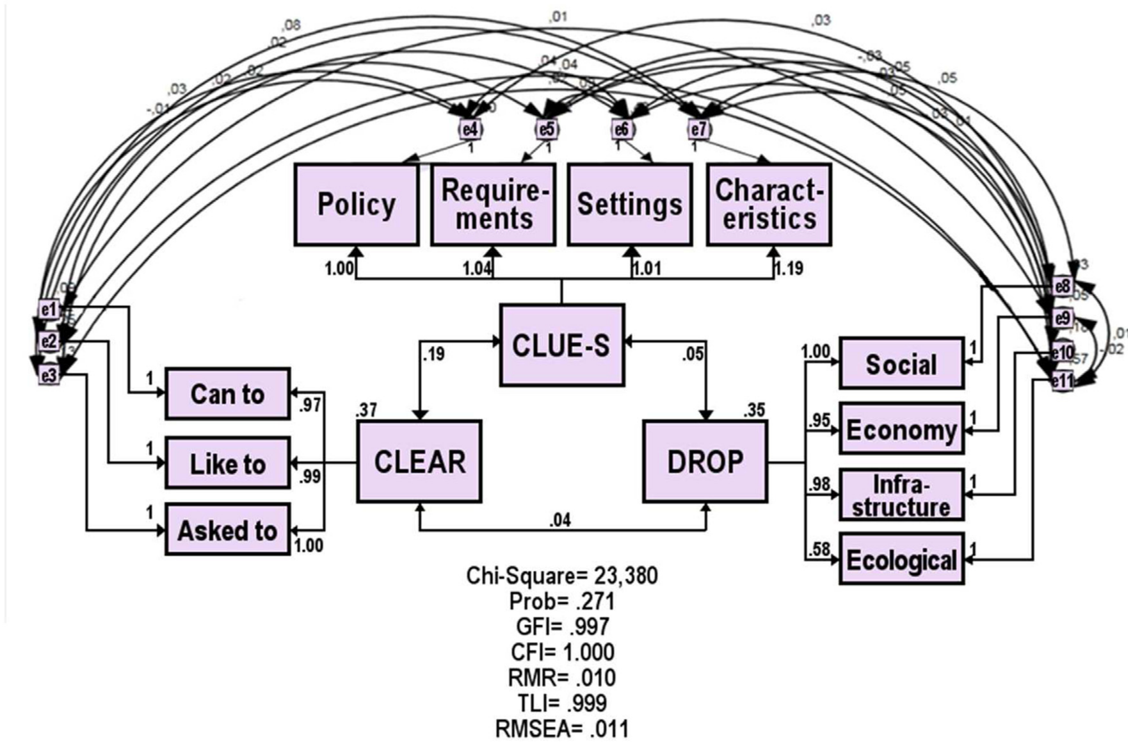

Figure 5. The results of the structural equation modeling of the research model.

Table 10. Relationship between variables.

			C.R.	P	R Value
Clear	<—>	Clue_S	14,806	***	0,581
Clear	<—>	Drop	4,598	***	0,149
Clue_S	<—>	Drop	4,004	***	0,121

Hypothesis 3. **(H3)** There is a positive relation between land conversion (CLUE-S) and flood resilience (DROP).

It is related t the data, the t-value was 4.004. So, with the fulfillment of the requisite, t-value > t-table (4.004 > 1.96), and the R value was 0.121, it is a right inference that the positive relation between land conversion (CLUE-S) and flood resilience (DROP) is proven. It can be concluded that the hypothesis 3 (H3) is accepted.

4. Discussion

4.1. There is a positive relationship between community participation (CLEAR model) and land conversion (CLUE-S model)

Based on the result discussion, the critical ratio value was 14.806 (14.806 > 1.96), which means a positive and significant relationship stands between community participation (CLEAR) and land use conversion (CLUE-S). Hypothesis 1 can therefore be declared accepted. The magnitude of the relationship between community participation (CLEAR) with land use conversion (CLUE-S) was 0.581 or 58.1%, which falls into the *high* category. This finding is different from Wesli's finding [18]. Wesli's result presented a smaller critical ratio (2.103), and the loading factor value of the land use variables with the participation was 0.020. It means that the finding of this research is better. It might be attributable to the fact that the location of the previous research, Aceh, Indonesia, prioritized the structure aspect over community involvement in flood mitigation. Contrasty with the people of Pesawaran, Lampung, Indonesia, who participated in mitigation programs as an attempt to form mutual cooperation in cleaning drainage channels (Figure 6) and raise a strong collective desire to create or improve their flood-free areas.

The strategy of changing the functions of agricultural land in Pesawaran relied on the community (community-based management plan) as the community is the foundation in the form of participation in controlling the agricultural land conversion [61]. Communities comply with local government policies not to cut trees in community forest areas. Assist the village government with land control and restoration of an area's water system as part of the reversibility of land change to prevent flooding. Community participation (local communities or stakeholders) serves as the key to the success of ecosystem restoration [62].

4.2. There is a positive relationship between community participation (CLEAR model) and flood resilience (DROP model)

The positive relationship between participation in disaster mitigation (CLEAR) and flood resilience (DROP) has been proven with the magnitude being 0.121 or 12.1% and being categorized as low. Flood mitigation-related activities were performed in an organized fashion at the community level. Vulnerabilities and risks arising from floods can be reduced substantially this way [36, 37].

A high degree of interdependence degrades resilience as disturbance (either upstream or downstream) in one sector impacts another [28]. If they do not take part in participatory programs, their disaster resilience will not shrink as the community has to survive the flood no matter what as disaster resilience is a human instinct to survive. Resilience is the ability of a community to recover on its own [29, 63].

The abovementioned idea is in accordance with the perception of [64], that a resilient community must be able to demonstrate the capability to deal with disasters, self-regulate before, during, and after the ordeals, and adapt to and learn from them (Figure 7). For human beings, mitigation is innate as an instinct for survival, but it will better if it is supported by mitigation program activities and the community is actively involved in them. People leave their homes only when their lives are threatened. They even prefer staying at home to evacuating if it has not

Figure 6. Clean the drainage's activity.

been a severe flood. On the other hand, not everyone is willing to participate and collaborate in programs requiring long-term involvement and commitment.

The DROP framework focuses on conditions associated with inherent resilience [42]. In the case of flooding, community resilience looks for ways to improve by focusing on community knowledge about floods. Their views on flood management, potential collaboration, and partnerships between fellow community members and disaster management hold a significant role. In addition, not all of the residents in Pesawaran was involved and the knowledge of the community (as the majority was those with the educational level of secondary high school or below) was not enough to fully strengthen disaster resilience, not to mention the weakening level of public trust in government institutions, whereas, raising community resilience is the key to reducing vulnerability of natural hazards [65]. Not to mention the weakening level of public trust in government institutions.

Additionally, education and training on environmental conservation and disaster have a risk reduction, including flooding, must be organized since it is the community's right to participate in them, at least to be offered with them. According to [55], a strong capacity to deal with disaster threats is related to the community's capability building programs or activities. The main targets are those who are able to anticipate disasters, handle emergencies, and recover from disasters [66]. Ultimately, social learning and designing strategies for the improvement of flood resilience require the development of effective relationships and partnerships, which in turn require time and constant commitment to negotiate priorities. Resilience is about how ecosystems and humans get together as integrated social–ecological systems in which they are recognized as coupled, interdependent, and co-evolving [40, 67].

4.3. There is a positive relationship between land conversion (CLUE-S model) and flood resilience (DROP model)

The positive relationship between land conversion (CLUE-S) and flood resilience (DROP) exists with the magnitude of the relationship between land conversion (CLUE-S) and flood resilience (DROP) being 0.149 or 14.9% and belongs to the *low* category.

In relation to special conversion settings for types of land use, land conversion in the village did exist. As a result of the damage most of the land suffered from flooding, farming there was infeasible. In other words, the land was no longer productive. As in Figure 7, it was then converted into a plantation.

Paddy field is usually a critical area close to the river, when a flood occurs, the river water overflows and inundates the wetland paddy field (Figure 8). This condition causes farmers to fail and lose their crops. Therefore, to cover losses and so that the land can still be used as part of food security, the land is converted into other crops that are more resistant to flooding and are more economically profitable for the

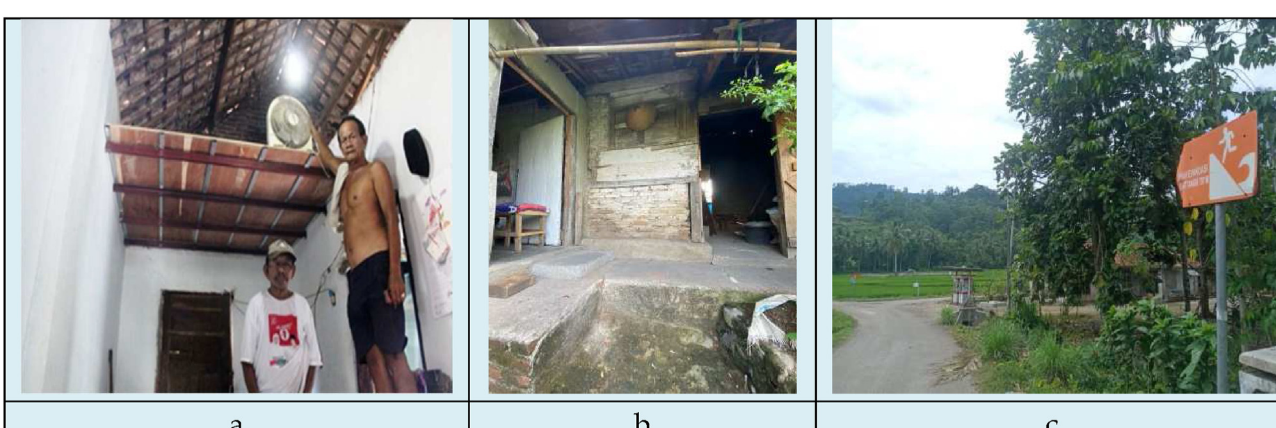

Figure 7. a) People make boards at the top of the house to store valuables, b) People's houses in Gedongtaaan Village where the front of the house is raised as a flood barrier, c). Construction of flood evacuation routes in collaboration with the community and local government.

Figure 8. (a) Flood River. (b–d) flooded rice paddy wetlands.

community (cassava, oil palm, coconut plantations). So that, when there is a flood they can still survive on the money from the cultivation of these plants. The land-use conversion in this study has a positive impact because the converted land is critical land that is converted into plantations (Figure 9, Figure 10).

The process of converting rice fields into plantations is a condition difficult to avoid as a result of flooding. The limited availability of land contradicts the demand for it. This fact calls for other choices in terms of land use and land relocation in the most economically profitable direction.

5. Limitations and future research

The limitation of this study is that it was conducted during the COVID-19 pandemic. So the field data collection of respondents and interviews with expert sources was limited due to the regulation of minimum direct interaction with other people. The difficulty of collecting the data from those who did not have any smartphones, laptops, or internet networks was also a considerable obstacle. For the next future research, it will be better to conduct a research related to this matter in a different

Figure 9. a) Rice fields having turned into grasslands and rainfed rice fields due to flooding; b) Land converted into a cassava plantation due to flooding.

Figure 10. Wetland paddy fields are converted into oil palm plantations (right side) in Sukaraja village, Pesawaran district.

geographical location with strong internet networks, so that the findings will be more accurate and can serve as a supplement of or, at least, be compared with these research findings. Second, although the model proposed in this research was acceptable, especially the flood resilience model, it might also be better for the next future research to combine the positive and negative effects of the theoretical findings of this research to improve the inclusiveness of the model.

6. Conclusions

According to the research results of this paper, hypothesis 1. hypothesis 2, hypothesis 3, were established, have a positive impact on each other. Encouraged by these results, the researchers gave the conclusion that community participation has a positive relationship with land conversion and disaster resilience as part of nonstructural flood mitigation efforts. The community participated with their ability and desire to convert flood-affected rice fields into plantations that produce high economic value (oil palm). The ability and willingness to participate in flooding is a part of the community's efforts to survive in their area. Socially, they do not want to change their place of residence. The land conversion carried out by the community as part of non-structural flood mitigation efforts is able to make them survive, especially from an economic perspective, where rice fields that have lost due to flooding become profitable again after being replaced by plantation land. Poor community participation hinders the effective implementation of disaster mitigation policies and emergency response programs. In fact, there are still several factors of community participation and flood resistance neglected by the people in Pesawaran. This is without a shade of doubt something of paramount importance for the Pesawaran regional government to note when addressing the flood problems.

The results also led to the awareness that some scientists have seen disaster mitigation only from the perspectives of two double-dimensional models, i.e. community participation-land change and community participation-disaster resilience models. Additionally, the triple-dimensional model of this research, it is hoped that flood mitigation management will be more efficient and comprehensive. Last but not least, the proposed model can be an alternative to the models applied in numerous phases in various disaster inflicted locations.

Declarations

Author contribution statement

Irma Lusi Nugraheni: Conceived and designed the experiments; Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Agus Suyatna: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Agus Setiawan: Analyzed and interpreted the data; Wrote the paper.

Abdurrahman: Performed the experiments; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Data availability statement

Data will be made available on request.

Declaration of interest's statement

The authors declare no conflict of interest.

Additional information

No additional information is available for this paper.

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