ISSN 0024-9521
IJG Vol. 45, No.2, December 2013 (171 - 186)

INDONESIAN JOURNAL OF GEOGRAPHY

THE EFFECT OF LAND USE AND COMMUNITY PARTICIPATION ON FLOOD CONTROL AT NORTH ACEH DISTRICT

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ABSTRACT

This study is intended to answer the effect of land use, community participation and their relationship to flooding. The result states that land use has a direct effect to flooding with value of about -0.323, all of the land use does not have an indirect effect, therefore the total score is -0.323. Community participation for flood control has a direct effect of about 1.640. The participation does not have an indirect effect, therefore the total effect is 1.640. Community participation has a direct effect to flooding with score of -0.416. The indirect effect is 2.322, while the total effect is 1.906. Land use for flood control has no direct effect and indirect effect. Land use has a direct effect to flood with score of a bout -0.323. It does not have an indirect effect, while the total effect is -0.323. Flood control effect on flooding has a direct effect of 1.416. It does not have indirect effect, thus the total effect is 1.416. The study reveals that the land use and community participation related to flood variables have significant effect. Moreover, flood control effort also has significant effect to reduce flooding.

Keywords: Land use, community participation, flood, flood control

ABSTRAK

Penelitian ini bertujuan untuk menjawab besarnya pengaruh tataguna lahan, partisipasi masyarakat dan hubungan keduanya terhadap banjir. Hasil penelitian menyatakan bahwa tataguna lahan terhadap banjir berpengaruh langsung -0.323, tidak ada pengaruh tak langsung, efek total -0.323, Partisipasi masyarakat terhadap pengendalian banjir berpengaruh langsung 1.640, tidak ada pengaruh tak langsung, efek total 1,640. Partisipasi masyarakat terhadap banjir berpengaruh langsung -0.416, pengaruh tak langsung 2,322, efek total 1,906. Tataguna lahan terhadap pengendalian banjir tidak berpengaruh langsung maupun tak langsung. Tataguna lahan terhadap banjir berpengaruh langsung -0.323, tidak ada pengaruh tak langsung, efek total -0,323. Pengendalian banjir terhadap banjir berpengaruh langsung 1.416, tidak ada pengaruh tak langsung, efek total 1,416. Hasil penelitian menyatakan bahwa tataguna lahan dan partisipasi masyarakat berpengaruh signifikan terhadap banjir. Pengendalian banjir berpengaruh signifikan terhadap banjir.

Kata kunci: Tataguna lahan, Partisipasi masyarakat, Banjir, Pengendalian banjir

INTRODUCTION

North Aceh district is very susceptible to flood hazard. Based on flood risk mapping by *Badan Nasional Penanggulangan Bencana Pusat (BNPB)* [2010], the area as has higher flood risk compared to other districts in Aceh Province. Krueng Keu-reuto is one of the rivers in North Aceh which is currently not able to accommodate the flowing water from the upstream. Economic losses due to the flooding in the area are estimated to about Rp 60-70 billion per year [*Bappeda Aceh Utara*, 2011]. High frequency of flooding mainly occurs in sub Matangkuli, Lhoksukon, Baktiya, Tanah Pasir and Baktiya Barat. The flood inundation are ranged from 7 -15 days and with the water level of about 60-100 cm. Changes in catchment hydrologic conditions also occurred in addition to high rainfall intensity. These changes are generated due to uncontrolled deforestation and inappropriate land use, especially by regarding to its function. Besides spatial planning by the local governments, there is still no regulation (*Perda/Qanun*) functioned as a legal basis for land use management. The land use changes in the study area therefore are not planned and become main contributor to the flooding.

Land use can affect flooding especially due to its function as water storage. According to *Chow et al.*, [1988], type of land use and land cover will affect runoff coefficient. Runoff coefficient is one of the variables that affect flooding in addition to rainfall and catchment area. According to *He-Fei* [2006], Changes in land use, especially increasing urban land use will lead to higher river flow, and makes the risk flooding is also increasing.

Land use of the district based on reports from North Aceh in Figures (2011) are mainly used for rice field 40.905 Ha (12.41%), building 34,848 Ha (10.57%), cropland 37,702 Ha (11.44%), dry farming area 21,155 Ha (6.42%), grassland 4,497 Ha (1.36%), Land that is not cultivated 10,395 Ha (3.15%), community forest 36,552 Ha, state forest 46,394 Ha (14.07%), plantation 54,764 Ha (16.61%), Other land use 28,689 Ha (8.70%), fishpond 8,591 Ha (2.61%), pond 639 Ha (0.-19%), and swamp 4,555 Ha (1.38%). Land use conditions in North Aceh changes from year to year, as shown in Table 1, indicates that the flood discharge will be in accordance with the land use changes.

In the beginning of 2012 to August 2012 there were 6 times of flood inundation, with the average of 50 to 100 cm. There were inundations for 4 times in Matangkuli, 3 times in Lhoksukon, 3 times in Baktiya, and 2 times in Baktiya Barat. The cause is mainly due to the capacity of the river to flow the water which is much smaller than the magnitude the discharge. Additionally, meanders in Krueng Keureuto River produce a relatively low flow rate to drain the flood. In terms of land use, the flooding also partly caused by changes of forest into agricultural land and housing. This condition causing the absorption of rain into the ground (infiltration) becomes smaller, and in return the runoff becomes greater. Flood mitigation by local government generally conducted through structural approach. The result is still inadequate when compared with the increasing flooding problem which generally require large budget. This condition is in contrast with local government ability of to provide those measures since the local governments have to build various aspects, not only flood control infrastructures. An effort to reduce flooding through non-structural aspects from spatial planning through optimal land use regulation and community participation is required. These efforts can help reduce the impact of flooding. Discharge of an area is affected by the runoff coefficient, rainfall intensity, and cacthment area. Runoff coefficient depends on the type of land use or land cover affecting infiltration into the soil. Rainfall intensity is the amount of rainfall over an area. Catchment area is an area that will drain the water. If the discharge area of the existing channels is streamed by either river or drainage channel, there will be runoff that causes flooding. Flood problem can only be reduced, so that the impact can be minimized. Thus, in principle, the problem of flooding can not be removed or eliminated altogether. It requires the responsibility of multi stakeholders for monitoring and controling through provision of facilities and infrastructures, so that negative impacts can be reduced as much as possible.

An integrated regional planning is required in solving problem related flood hazard. Regional planning that is more focused on economic development planning will go hand in hand with the implementation of community planning and participatory planning. Thus the planning is based on applications of scientific methods in making public policy and attempts to link scientific and technical knowledge into actions inside the community domain to achieve higher social welfare [*Sirojuzilam*, 2010]. Formulation of the reseach problem in this study is based on the contradiction of the requirements for regional development and the effort to minimize the discharge during high-intensity rainfall. To overcome this problem, land use planning optimization is required so that both of them can be linked to reduce flooding. Besides, an effort in community participation is necessary as one of the input to stakeholders, especially in conducting preventive measures against floods and community involvement in water resources management. The objectives of this research is to explore the effect of land use and community participation on flooding in North Aceh, and measures its effect as a flood control efforts through non-structural approach in regulating land use and to increase community participation, either individually or in groups that can bring recommendations for local governments in implementing regional development.

Hypothesis of the research are:

1. Land use change has a negative impact and is significant to flooding
2. Community participation has a negative impact and is significant to flooding
3. Land use and community participation have a negative impact and are significant to flooding
4. Community participation has a positive impact and is significant to flood control
5. Community participation and flood control have a negative impact andare significant to flood
6. Flood control has a negative impact and is significant to flooding

Table 1. Land use Changes at Aceh Utara

No	Land Use	2010	2009	2008	2007	2006	2005
1.	Rice field	40.905	40.711	40.024	39.773	39.748	39.748
2.	Building	34.848	31.896	40.518	34.753	35.258	35.258
3.	Cropland	37.702	38.386	36.459	38.838	40.151	42.589
4.	Dry farming	21.155	21.576	25.768	30.142	31.427	31.033
5.	Grassland	4.497	4.497	5.712	7.862	7.662	7.657
6.	Not cultivated	10.395	10.395	9.163	12.713	13.753	13.897
7.	Community forest	36.552	35.512	40.771	34.738	34.481	33.225
8.	State forest	46.394	49.346	51.129	58.275	64.295	64.250
9.	Plantation	54.764	55.153	50.116	43.537	37.534	38.444
10.	Other land	28.689	27.694	16.446	15.625	12.097	10.511
11.	Fishpond	8.591	9.290	9.456	9.540	9.624	9.624
12.	Pond	639	675	714	748	782	782
13.	Swamp	4.555	4.555	3.410	3.142	3.142	2.668
	Total	329.686	329.686	329.686	329.686	329.954	329.686

Reference: North Aceh in Figures [2011]

THE METHODS

Very complex relationship found from varius factors that generate flooding since it involves natural phenomena that often beyond human control. Various types of physical and non-physical mitigation efforts, either alone or combined only serves to suppress or minimize the magnitude of the flooding damage. Therefore, it can not eliminate the problem completely or freeing floodplain from flooding absolutely. Approach to overcome flooding problem with structural mitigation are still required, but must be supported with a non-structural approach in an integrated manner to reduce the impact.

This study merges two variables of land use and community participation combined with civil engineering based research using river conditions, channel and hydrology of the region to compare each variable. The variables are integrated in a formulated model, which is comprehensively countermeasures one to other. Empirical data are used to analyze the civil engineering based data, and the observed variables are integrated to both empirical data. The data is analyzed based on latent variables (unobserved) through questionnaire. The analysis is conducted using structural equation model (*SEM*) in Amos software. Technical empirical data become the basis for determining the extent of forest which then compared with public perception. This study aims to identify the effect of land use and community participation to flooding. The results are expected to minimize the impact of floods, which can be done by preparing a variety of strategies, especially structural approach synergized with non-structural approach. It therefore can provide an opportunity to community participation, so that optimal results are obtained.

Based on above description, the reduction in structural approach has a tendency towards required high costs. It is in contrast with local government budget that are constraints on those aspects. It therefore needs to be done through non-structural strategies involving community approach by relying on the concept of social capital which focusing on trust, networking and social institutions.

This study uses latent variables (unobserved) consists of latent exogenous variables as independent variables and endogenous latent variables as dependent variable. The independent variables are namely land use and community participation. Each variable is measured through indicators manifest with the notation x. Endogenous latent variables as the dependent variable are namely floods and flood control. Each variables measured through indicators manifest variables y. The conceptual framework can be described as shown in Figure 1, where x_{11} is the land area, x_{12} is land conversion, x_{13} is land regulation (Qanun), x_{14} is illegal logging, x_{21} is participation of maintained infrastructure, x_{22} is money participation, x_{23} is participation in planning, x_{24} is participation in the implementation, y_{11} is water level inundation, y_{12} is duration of flood, y_{13} is coverage of flood, y_{14} is loss rate, y_{21} is floodplain management, y_{22} is institution coordination, y_{23} is disaster flooding and y_{24} is infrastructure maintenance.

Data were analyzed using SEM (structural equation model) in *AMOS* software. *Wijaya* [2009] stated that *SEM* analysis requires samples at least 5 times the number of indicator variables. Maximum likelihood estimation techniques require samples ranged 100-200 samples. Another opinion suggests that the maximum likelihood estimation technique is effective for 150-400 samples. To obtain high precision analysis, sample is taken proportionaly, consisted of 355 people and 15 sample groups (Tuha Peut, Tuha Lapan, and other villages respectively). For single person, 5 districts accounted for 15 people, so the total sample is 370 people. In addition, 30 samples were taken as informants from the government officials involved in flood management problem (*Bappeda, Dinas Pengairan,* and *Badan Penanggulangan Bencana Daerah*/*BPBD*). Ten people were selected for each institution so the number is 30 samples. Information from the institution will be used as additional information on institution perceptual aspects. Hydrologic data used are rainfall, river hydraulic, climatology and land use. An analysis of the ability of rivers and channels to flow the water is also conducted. The analysis results are later used as a comparison against the questionnaire analysis.

Necessary technical data, public perception both individually and in community institutions, perceptions of government officials who have responsibility for the management of water resources were used as informants. The data is required in accordance with the characteristics of the data:

a. Primary data, data collection was done by field observations, through questionnaires and searched documentation
b. Secondary data, data collection was done through compilation of relevant agencies in accordance with the requirements of data

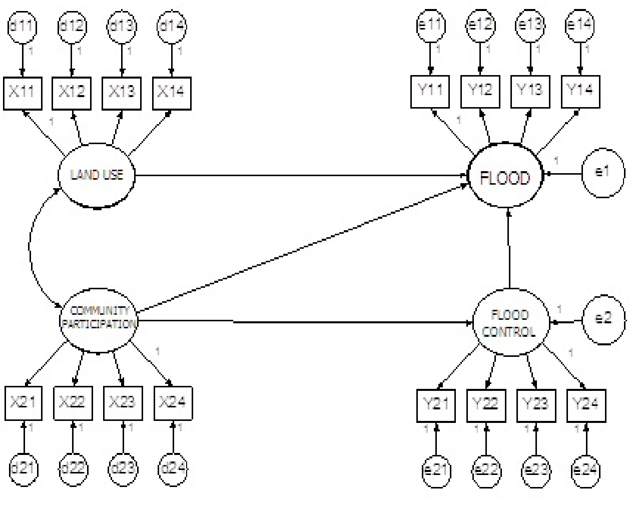

Figure 1. Conceptual Framework Research

Hydrologic analysis is conducted based on data taken from Badan Meteorologi, Klimatologi, dan Geofisika (*BMKG*) Lhokseumawe. Based on the history of rainfall data for 10 years, the maximum discharge capacity will be compared with capacity of the river catchment. Moreover, the discharge runoff that causes flooding will be known. Data analysis was performed with rational methods based on the land use change data. The analysis ran for each year so that the condition of land use for all of the year can be known. It is subsequently assumed that the discharge area can reduce flooding based linear programming optimization, which intended to obtain proper land use according to plaaned discharge area. Besides, the analysis was also used to convert buffer land water indicator (public & private forestry and cropland) in the questionnaire to facilitate the respondents in answering open-ended questions. Analysis is performed by calculating the discharge based on rainfall history by calculating the percentage of water in the buffer lands, existing land use conditions, and the discharge that occurs. The river capacity to flow the water called the balanced condition was then calculated. Calculation was then taken to identify the percentage of land area to reach the balance. The balance obtained under a condition that the amount of discharges that occurs is at or near the river capacity to flowing the water. Questionnaire data were used to the respondents, either individually or in community institutions. The questionnaire conducted to formulate a model that resembles existing conditions by testing its validity and reliability. The perception of the government institutions is used as additional information that will be compared with the results of the respondent data analysis using Structural Equation Modeling (*SEM*). The analysis is conducted based on the hypotheses that have been formulated. Path diagram in Structural Equation Modeling is used to describe the specification of the model more clearly and easily as well as describing the path diagram equations appropriately. Relationships among the model outlined in the structural equation model and measurement model. Variables in Structural Equation Modeling consist of latent variables as an abstract concept that can only be observed indirectly and imperfectly through its effect on the observed variables. Latent variables distinguished the exogenous and endogenous variables. Exogenous variables equivalent to the independent variable, while the equivalent endogenous variables with the dependent variable. Observed variables or measured variable is the variable that can be observed or measured empirically and is often referred as an indicator. This variable is a measure of the effects or latent variables.

RESULT AND DISCUSSION

According to *Chow et al.,* [1988] land use is directly proportional to flooding. Land use is converted through runoff coefficient whose magnitude depends on the type of land use. The result of the calculation indicates that the existing land use produce flood discharge 1686.16 m^3/sec based on rational methods, while the capacity of the river catchment and drainage based on the hydraulic channel is 946.74 m^3/sec. This case illustrates that the Krueng Keureuto River in this condition is no longer able to drain so that the flood will occur. Discharge runoff of 139.42 m^3/sec is shown in Table 2.

To get a balanced condition between land use 42% of the area is required. Table 3 illustrates the condition that the discharge will be balanced.

Goodness of Fit Test

Conformance testing of the used to test how well the level of goodness of fit of the research model. Based on the test results shown in Table 4, it can be seen that all of the existing criteria are in good condition. It can be said that the overall research model has a good level of goodness of fit. Measurement result of goodness-of-fit test indicates that the model proposed in this study can be accepted. It can be seen from the Chi Square and probability value of 112.882 and 0.161 respectively. The value explains that the overall fit of the model can be said to be moderate. However, the analysis can still be conducted, because the size of a model is not only seen from the probability value, but also seen from other fitting criteria, for example *GFI*, *AGFI*, *CFI*, *TLI*, and *RMSEA* [*Kusnendi*, 2008].

Table 2. Comparison of Land Area Against Discharge Runoff

No	LAND USE	EXISTING CONDITION							
		Land Area	%	Rainfall	runoff coefficient	Avarage	Debit	Debit Optimum	Deviation
1.	Rice field	1.147	19,65	8,80	0,40	459	118	109,44	8,17
2.	Building	1.145	19,62		0,70	802			
3.	Cropland	566	9,70		0,55	312			
4.	Dry farming	135	2,31		0,60	81			
5.	Grassland	84	1,44		0,40	34			
6.	Not cultivated	199	3,41		0,70	139			
7.	Community forest	713	12,22		0,30	214			
8.	State forest	117	2,01		0,30	35			
9.	Plantation	996	17,06		0,30	299			
10.	Other land	288	4,93		0,65	187			
11.	Fishpond	302	5,18		0,55	166			
12.	Pond	13	0,21		0,55	7			
13.	Swamp	131	2,25		0,55	72			
Total		5.837	100			2.806			
Area runoff coefficient						0,48			
Comparison of the land area of Area					31%				

Table 3. Comparison of Land Area Ballance Condition

No	LAND USE	BALLANCE CONDITION							
		Land Area	%	Rainfall	runoff coefficient	Avarage	Debit	Debit Optimum	Deviation
1.	Rice field	1.147	19,65	8,80	0,40	459	109	109,44	(0,76)
2.	Building	1.145	19,62		0,70	802			
3.	Cropland	566	9,70		0,55	312			
4.	Dry farming	135	2,31		0,60	81			
5.	Grassland	84	1,44		0,40	34			
6.	Not cultivated		-		0,70	-			
7.	Community forest	912	15,63		0,30	274			
8.	State forest	405	6,94		0,30	122			
9.	Plantation	1.127	19,31		0,30	338			
10.	Other land		-		0,65	-			
11.	Fishpond	302	5,18		0,55	166			
12.	Pond	13	0,21		0,55	7			
13.	Swamp		-		0,55	-			
	Total	5.837	100			2.593			
	Area runoff coefficient					0,44			
	Comparison of the land area of Area				42%				

Normed Chi-square (*CMIN/DF*) used to measure the suitable indices for relative parsimony goodness-of-fit model. Moreover, the coefficients estimated amount is expected to reach the level of conformance. Value of *CMIN/DF* in this model is 1.140, indicates that the model fulfilled both the criteria. Goodness-of-Fit Index (*GFI*), which indicates the level of overall model, was calculated from predicted squared residuals compared to the actual data. Value close to 1 implies that tested model has good agreement. With the acceptance of the recommended level> 0.9, it can be concluded that the research model has a good level of compliance with GFI of 0.962.

Adjusted Goodness-of-Fit Index (*AGFI*) is the *GFI* that is adjusted by the ratio between the degree of freedom of the proposed model and the degree of freedom of the null models. *AGFI* value in our model is 0.948, indicates that the model is considered good. Tucker Lewis Index (*TLI*) is an index that compares the incremental conformance tested model with baseline model. *TLI* is a suitability index model that is less affected by sample size, with recommended value > 0.9. It can be concluded that the proposed model shows a good level of compliance with TLI value of 0.973. Comparative Fit Index (*CFI*) is an index that compares the incremental model with null tested model. The scale of this index ranges from 0 to 1. A value close to 1 indicates that the model has a good level of fitness. This index is highly recommended to use since the index is relatively insensitive to sample size and less effectd by the complexity of the model. Regarding to the recommended resultof > 0.9, the *CFI* of 0.978 indicates that the model had a good agreement. The Root Mean Square Error of Approximation (RMSEA) is an index used to compensate the value of Chi-Square in a larger sample. Acceptance of the recommended value is < 0.08, *RMSEA* of 0.020 in this model showed a good level of fitness. Thus it can be said that the overall research model has good goodness-of-fit, so it can be used as an accurate model.

Table 4. Good of Fit Test

Criteria Index Size	Reference	Result	Conclution
Chi Square	approach 0	112,882	Marginal
P-Value	≥ 0,05	0,161	Good
CMIN/df	≤ 2,00	1,140	Good
RMSEA	≤ 0,08	0,020	Good
GFI	≥ 0,90	0,962	Good
AGFI	≥ 0,90	0,948	Good
TLI	≥ 0,90	0,973	Good
CFI	≥ 0,90	0,978	Good

Table 5.Weights Regression on Factors

Variable			Estimate	S.E.	C.R	P
X11	<---	Land Use	1,000			
X12	<---	Land Use	1,815	0,319	5,684	***
X13	<---	Land Use	1,249	0,251	4,971	***
X14	<---	Land Use	1,132	0,233	4,864	***
Y11	<---	Flood	1,000			
Y12	<---	Flood	1,967	0,416	4,735	***
Y13	<---	Flood	1,213	0,283	4,282	***
Y14	<---	Flood	1,088	0,280	3,891	***
X24	<---	Community Participation	1,000			
X23	<---	Community Participation	0,601	0,124	4,853	***
X22	<---	Community Participation	1,241	0,187	6,633	***
X21	<---	Community Participation	0,478	0,102	4,701	***
Y24	<---	Flood Control	1,000			
Y23	<---	Flood Control	0,695	0,118	5,884	***
Y22	<---	Flood Control	1,041	0,140	7,409	***
Y21	<---	Flood Control	0,277	0,111	2,505	0,012

Table 6. Causality test models

Variable			Estimate	S.E	C.R	P
Flood Control	<---	Community Participation	3,108	1,083	2,870	0,004
Flood	<---	Land Use	-0,259	0,120	2,169	0,030
Flood	<---	Community Participation	-0,435	0,216	2,011	0,044
Flood	<---	Flood Control	-0,782	0,222	3,519	***

Convergent validity test

Based on the measurement results of Table 5, the regression weights for all indicators critical ratio is greater than two times standard errors. That means all points in the research studies are applicable to each variable.

Causality test models

Regression weights from causality test result or effect between variables can be analyzed and calculated through *AMOS* statistical program. In addition to the degree of freedom (df), the value of *t* or *cr* can also be known, based on the significance of *t* with probability value (p) = 0.05

Further explanation of regression weights evaluation analysis can be described and explained as follows:

a. Community participation variables significantly affect flood control because of the significance is 0.004, less than the probability value of 0.05.
b. Variables significantly affect land use variables with significance of 0,030, smaller than the 0.05 probability.
c. Variables significantly affect participation because the significance of 0.044 is smaller than the 0.05 probability.
d. Variables significantly affect flood control variables with significance of 0.00, smaller than smaller than the 0.05 probability.

Hypothesis Testing

Hypothesis testing result of the negative effect of the land use to flooding is shown from the critical ratio value (cr). The value is 2.169, greater than *t* table of 1.96. The probability value (P) is 0.030, smaller than 0.05 probability, thus research hypothesis can be acceptable. Loading factors of land use to flooding is -0.259. Land requirement for housing in northern Aceh increased annually in accordance with the needs of the community. To meet the needs of the community, sometimes conversion of rice field to residential or shop/commercial purposes occurred. This change was also made by the increasing to selling price of land, especially for agricultural area located on the roadside. The change of runoff coefficient and reducing water infiltration into the soil is one of the factors that causing flooding. Building permit (*IMB*) rules implementation related to the conversion from rice fields to houses or shops illustrates that 20% is not good, 53% is poor, 0% is quite good, 20% good and only 7% very good as shown in Figure 2. This information is in line with the results of the hypothesis testing that the conversion of rice fields into residential or shop/commercial is common in North Aceh.

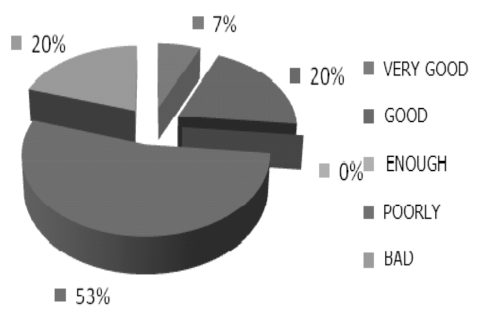

Figure 2. Graph of Building Permit (*IMB*)

Forest land that is not reaching the optimal ratio in North Aceh occurred because of many illegal logging. Based on the results of the questionnaire, 19% is stated that many illegal logging occurred, 41% stated a lot of them are going on, 38% stated they were quite a lot going on and only 2% statetd that they were less. Incidence of illegal logging according to the respondents in North Aceh is shown in Figure 3.

The regulation of the district as of local regulations in theAceh province is called Qanun. It regulate in detail about the land use including planning permissions that are not disturbing the development. In line with the study by *He-Fei* [2006] in Shenzhen, China, there is a real relationship between the impact of changes in land use policies against the risk of flooding to some extent. It stated that changes in land use, particularly the use of urban land, causing an increase in river flow which makes the risk of flooding increases. Other research by *Wesli* [2007], states that the flood is stronglyeffected by rainfall and land use regulation. In this study, land use variables have a direct effect of -0.323 to flooding and not have an indirect effect to the flood variables, therefore the total effects is -0.323. Ability of ground water buffer area (community forests, state forests and plantations) indicates that the ratio of the buffer in the existing condition is 31%. Thus it will generate 118 m^3/sec temporary discharge, while the river's capacity and drainage water flow is only 109.44 m^3/sec. This shows that the capacity of the river is not able to drain flood which still going at 8.17m^3/sec. To obtain the equilibrium flow rate based on of rainfall at or near capacity and river draining the ratio of ground water buffer lands (private forests, state forests and plantations) it must have an area approximately 42% of the total area. Based on the above calculation, it can be stated that the ability of forest land as a water buffer, the ratio of land use, regulations governing land use, and indicator of illegal logging contribute in influencing the flood occurrence of 0.259, while the rest is affected by other variables

Hypothesis of community participation has a significant effect for flood was given by the critical ratio value (*cr*) 2.011. This is greater than *t* table value of 1.96. Moreover the probability (P) of 0.044 is smaller than 0.05 probability. It can be said the research hypothesis can be accepted. Loading factor participation to flooding is negative -0.435. It describes that the community participation can reduce flooding. Based on field observations, the opportunity of the community in to be involved in maintenancing the flood infrastructures in the North Aceh was not sufficiently given by the local government, it is seen from the respondents' answers that 1% is very involved, 1% were included, 29% is quite involved, 55% and 14% of the less involved were excluded. Community participation in maintaining flood infrastructures causing ignorance of the people, which assume that the task of keeping the flood infrastructures is government's duty. Community involvement in the maintenance of flood infrastructures in North Aceh based on respondent data is shown in Figure 4.

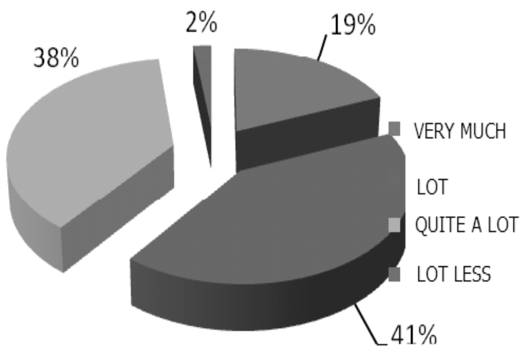

Figure 3. Illegal logging in North Aceh Based on respondents

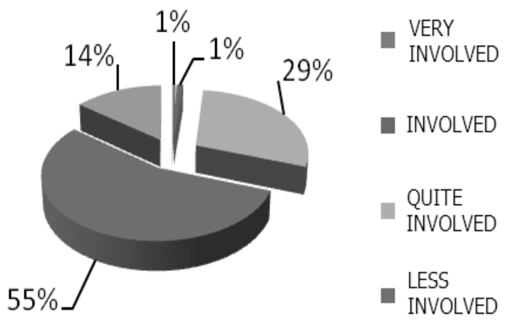

Figure 4. Involvement of communities in flood infrastructure maintenance

Community participation is one of the factors lacked by stakeholders. The role of the government is still very dominant. Community participation in the pre-disaster phase is very small, especially in the process and policy implementation. The participation rate is only in the level of consultation. In some activities, there are still at the level of information in which the civil society still as objects. In this study, it stated that community participation has a direct effect of -0.416 and indirect effect of 2.322 to flooding, so the total effect is 1.906. Based on this condition, the community involvement to maintain flood infrastructure, such as by not throwing waste into the river or channel, cleaning channels, community involvement in flood management planning, community involvement in overseeing the implementation on such infrastructure development contributes to 0.435, while the rest is affected by other variables.

Hypothesis that land use and community participation has a significant effect on the flooding was given by the critical ratio value (*cr*) 2.103, greater than the *t* table value of 1.9. P value of 0.036 is less than 0.05 so it can be said that the hypothesis is acceptable. Loading factors of land use variables with the participation is 0.020. Flood prevention in North Aceh is still oriented in infrastructure by building dikes and improve the condition of the river or drainage channel. However, it can not be done completely because of the limitations of the local government budget. Therefore the efforts should be coupled with non-structural effort to involve the community. Various studies on the role of the community, as expressed by *Murdiono Benni* [2008], give conclusion that structural flood control are only short term solutions. Structural efforts should be coupled with efforts that are non-structural, long-term, such as watershed management, public education about flood, rescue planning from floods and so on. The study of land use to flood risk by *Wheatera Howard et. al.,* [2009], lead to the conclusion that a long-term approach to flood management through land use in the *UK* is focused on how to use the land in a balanced manner, both against economic, environmental and social needs. Therefore it is conducted in order not to create the legacy of flood risk. How does the government manage the balance between state and market forces in decisions about land use, including the structural flood management are likely to require high cost. From a variety of the above description it can be stated that the ability of forest land as a water buffer, the ratio of land use, regulations governing land use, and the occurrence of illegal together with community involvement in maintaining the flood infrastructures. Community involvement by not throwing waste into the river or canal, community involvement in implementing river cleaning, community involvement in planning or anticipation of flood mitigation, and public involvement in the implementation of development such as overseeing the construction of flood indrastructure contribute to influencing the flood occurrence of floods by 0.020, while the remaining are affected by other variables.

Hypothesis that participation affect flood control is significant and gives positive effect was given by critical ratio (*cr*) 2.870 which is greater than *t* table value 1.96 and a P value 0.004 or less 0.05. It can be said that hypothesis acceptable. Loading factor participation to flood control is 3.108, so it can be interpreted that any addition or increase in the value of the participation variable of one unit will increase the value of flood control variable from 3.108. Community involvement in maintaining flood infrastructure need to be given sufficient space, especially in the flood control program, such as floodplain management as well as in preventing floods by using communal work (*gotong royong*), keeping the environment and so forth. Besides, people also need to be involved in the planning and implementation of development related to flood control. In this study, the community participation variables have a direct effect 1.640 and did not have an indirect effect on flood control variable, so the total effect is 1.640. Community involvement in maintaining the flood infrastructure by not throwing waste into the river or canal, the involvement of the community in providing assistance to perform mutual cooperation, community involvement in the planning or anticipation of flood mitigation, public involvement in the implementation of development such as overseeing the infrastucture development will affect flood control.

Hypothesis that community participation and flood control for flood affected community participation variables were analyzed based on the variable with the critical ratio value (cr) is 2.870, greater than the t table value 1.96 and P value 0.004 is significantly smaller 0.05. The result of the effect flood control variable to flood variable the critical ratio value (cr) is 3.519, greater than 1.96. P value of 0.00 is significantly smaller 0.05, so the hypothesis is significant. The effect can be seen through the loading factor of each where community participation for flood control has loading factor 2.108 and flood control variable to flooding variable -0.782 so that it can be stated that the variables directly affect community participation 1.640 for flood control variable while the effect 1.416 to flooding and both amounted to 3.065. Of several studies conducted illustrates that there is effect between community participation in flood, society basically have a great desire to participate in community-based activities such as disaster preparedness floods when given the opportunity to get involved in it [*Motoyoshi*, 2006]. On research *Masahiko et al.,* [2010] in Switzerland, research on community participation in flood control is integrated with research methods using the Integrated Water Resources Management (*IWRM*) and Integrated Flood Management (*IFM*). The results state that community participation is fundamental and essential for each phase of the flood management preparedness, response and recovery. It can maximize community participation through the development of related activities in the basin as a whole. Results of this study can be stated that community participation variables directly affect flood control 3.065. It can be stated that the involvement of the community in keeping with the flood infrastructure not throw waste into rivers or channels, community involvement in providing assistance through mutual aid duct cleaning, community involvement in planning or anticipation of flood mitigation, public involvement in the implementation of development such as overseeing the construction of flood infrastructure along with variable water level, duration of inundation, widespread inundation and loss contribute to affect flood control at 3.065, while the rest is affected by other variables.

Hypothesis that flood control and flood has a significant positive effect was given by critical ratio value (*cr*) of 3.519, greater than *t* table of 1.96. The Probability (P) is 0.000, smaller than 0.05, so the hypothesis can be accepted. Loading factor flood for flood control is -0.782. Based on the research by *Tsinda et al.,* [2010] in the city of Kigali (Rwanda), the result indicates that the city of Kigali is effectd by multiple disasters that caused some damage. From Kigali case, it is implied that the ongoing disaster mitigation is hindered by a separate policy and disfunction among stakeholders involved in disaster management. The government must make practical policy regarding to flood control as in land-use planning, thus it can prevent the encroachment of the land vulnerable to flooding. This can not be done if people are not empowered with knowledge related to flood, because the community participation in the planning stage by positioning the community as beneficiaries is sometimes limited. In the context of Kigali, interests of grassroots communities should be given a key role in the planning and implementation together with public institutions. From the results of a study by *Motoyoshi* [2006], research on the issue of community participation in flood risk management methods using questionnaires and *SEM* analysis (structural equaition model) indicates that the flood control is not related to the community participation and society. Society is basically has a greater desire to participate in community-based activities such as disaster preparedness when they given space to get involved in it. In this study, flood control variables have a direct effect to flood variable of 1.416 and did not have an indirect effect for flood variable. Thus it has a total effect -1.416. Based on the description, it is stated that the importance of an integrated flood control by involving all stakeholders in anticipation of flooding either on pre-disaster, disaster and post-disaster conditions must conducted through flood plains management (flood management).

Novelty

Research and study of flooding has been done by many researchers, but mostly oriented towards technical studies based on empirical data using manifest variables such as rainfall, river cross section (channel), land use and other technical variables. Research related to community participation as one of the flood variables in this study illustrate that there is a relationship and effect of each variable to flooding. A finding of the novelty in this study is the model used, that combine two independent variables as land use variables and community participation variable for flood control. All of the variables together were analyzed related to flooding as dependent variable. In addition, this study is the first study in North Aceh and Aceh Province which intended to answer the effects of the non-structural efforts in flood control. The model used in this study as shown in Figure 5.

Previous studies tend to focus on technical study that uses one independent variable and one dependent variable, such as study related to the effects of land use change on flood discharge in Banjaran catcment area. The conclusion indicates that changes in land use is the most influential to flood discharge, mainly by wetland changes, settlement, and followed by dry land [*Suroso et al.,* 2006] as shown in Figure 6.

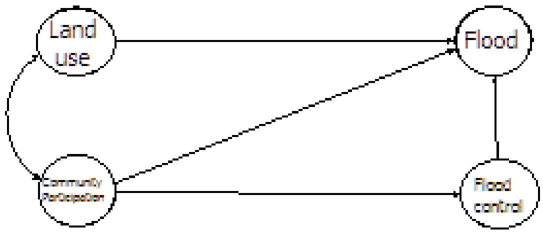

Figure 5. Model in this study [*Wesli*, 2013]

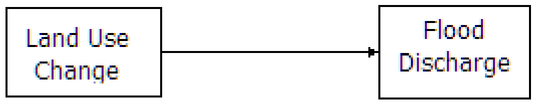

Figure 6. Research Model by *Suroso et al.,* [2006]

In the above model, land-use variable is independent variable and flood discharge variable is the dependent variable. Other studies related to the conclusion is that the change of land use from wetlands to residential and industrial area in Kaligarang cactment area causing increasing discharge and sedimentation, flooding, lower crop area and agricultural production in the lower reaches of the cactment area [*Kurnia et al.*, 2006]. The land use change variables as independent variables and the flood discharge as the dependent variable to the model as shown in Figure 7.

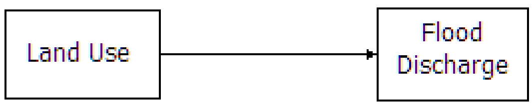

Figure 7. Research Model by *Kurnia et. al.* [2006]

Other studies of community participation to flooding in the Semarang Lama city related to the conclusion is that the presence of community participation in the financing of operations and maintenance activities at the implementation of the flood control program can be resolved if the implementation can give maximum benefit and impact on economic growth, which is not only in the region but around the area of the Semarang city [*Yudho*, 2002]. Research using one dependent variable and one independent variable in which community participation as an independent variable is a latent variable. It is measured by manifest variables, namely participation in maintenance, dues and participation in giving force participation. Flood control as the dependent variable is a latent variable that is measured by manifest variables including flooding duration and frequency of floods. Difference of this study is related to the number of independent variables used, which is only one variable as the participation variable alone. The research model is shown in Figure 8

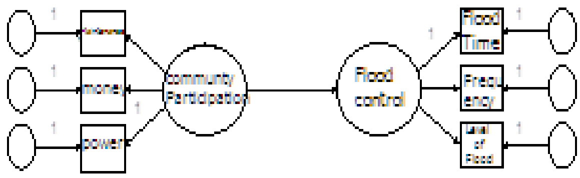

Figure 8. Research Model by *Yudho et. al.* [2002]

Another novelty in this research is the use of latent variables that can not be measured directly but through a dimension of indicator variable [*Kusnendi*, 2008]. In this study, land use variables become independent variables as latent variable that is measured with manifesting variable, x_{11}, x_{12}, x_{13} and x_{14} and community participation variable taken as latent variable, measured by manifesting variables x_{21}, x_{22}, x_{23} and x_{24}. Floods and flood control as the dependent variavel is a latent variable that is measured by manifesting variable y_{11}, y_{12}, y_{13} and y_{14} for flooding, and y_{21}, y_{22}, y_{23} and y_{24} for flood control. Previous empirical studies using only manifest variables declared in the type of land use and land area which then converted into numerical drainage coefficients. Theoretically, it is stated that the function of the magnitude of the flood discharge is directly proportional to changes of land use, rainfall intensity and the river drainage area. Thus, the results of this study are relatively comprehensive, in which the next research can be developed in an effort to cope with floods in Aceh Province. Other novelty that can be used practically regarding flood prevention models in North Aceh district is that it can later be replicated in other areas, as well in the Aceh Province or in Indonesia, or even in other areas where flood control efforts are required in a comprehensive manner through structural and non-structural approach.

CONCLUSION

Government of the district should make local regulation (*Qanun*) which regulates the land use and its derivatives as well as the rules governing the use of land, including rules on land use change and water buffer, planting efforts through community forestry program in order to expand the area of forest, and close monitoring of the illegal logging through firmly law enforcement. In the preparation, it should pay attention to forest area as a water buffer system which is important as an effort to reduce runoff. By maintaining sufficient forest area, it does not necessarily eliminate flooding, but at least it can reduce the water that becomes runoff

To reduce flood through non-structural approach, community participation both in maintaining the function of flood infrastructure, involved in the planning, and implementation of development in the field flooded is indispensable. To maximize the efforts of non-structural approach, North Aceh District Government must proactively engage the community, especially by considering the communities as subjects and not as objects in flood infrastructure maintenance, flood mitigation planning, implementation of infrastructure, and promotion of the integrated management. Those actions are important in facing floods, so that they feel owning the infrastructure and wants to maintain it. Non-structural effort by the communities is including setting up disaster aware community by forming groups in every village and conduct training simulations in disaster preparedness. Given the regular floods every year, local authority is expected to build an early warning infrastructure which is important to reduce the impact of flood, especially casualty losses, evacuation of the casualties, and material losses.

Flood prevention programs through non-structural activities involving the community and regulate the land use to reduce flooding. Government of the district should prepare ‘Qanun’ regulation governing the use of land and to prevent the occurrence of illegal logging. This is supported with the involvement of the community together to supervise and facilitate in maintaining the infrastructure. This is possibly conductd by not throwing waste into the river or channels, community involvement in providing assistance such as cleaning rivers and channels. Besides, people should be given a space to engage in planning or mitigation of floods and public involvement in the implementation of development such as overseeing flood infrastructure construction. To prevent flooding, the government should make land use regulations, which covering prevention of land conversion, especially water buffer areas such as forests, gardens, fields and other.

In addition to the structural measures, the district government should make non-structural efforts through community programs that are more extensive, involving civil society organizations (*NGOs*), and universities. Involvement in flood control efforts must cover the pre-flood conditions, floods, and the aftermath. The combinations of structural and non-structural efforts have been started due to its efficiency.

Local government should immediately prepare integrated flood management. The overall effort should be an integral part or should be integrated with the management of water resources in the river basin system (integrated water resources management/*IWRM*). River basin management involves stakeholders including community involvement, both individually and institutionally.

Local government should immediately develop effective floodplain management and applicable strategy, and routine maintenance to flood infrastructures. Management by strengthening inter sectoral coordination in accordance with their respective is also required. Badan Penanggulangan Bencana Daerah (*BPBD*) should be pointed as proactive coordinator partnering with various parties. Besides *BPBD* must keep records and evaluate any disasters, including losses due to disasters in order to become a powerful database to resolve problems in the future disasters.

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