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DISASTER AND RESILIENCE FOR THE 2007 FLOOD EVENT IN PART OF SUKOHARJO REGENCY

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ABSTRACT

Community resilience has become an important factor in a disaster mitigation plan. Resilience is related to the ability to recover from a disaster and is for every person different. This research intends to assess community resilience for flood disaster. Factors for quantifying community resilience were asked to respondents by giving questionnaire and interviewing them, and FGD was also done in order to generate flood map based on the community knowledge. The FGD result shows that the flood depth in the study area varies from 0 until 300 cm, and the duration of inundation varies from 1-7 days. Flood also caused losses, and the distribution of the losses was Rp. 0 - 100,000,000,- although, in general, the losses was merely below Rp. 2,000,000,-. Based on the weighting result, the resilience value of the respondent is distributed from 0.113 until 0.700. The average resilience value of Laban village is 0.403, and 0.368 for Kadokan village. The resilience value was mostly influenced by human capital. In order to increase the community resilience, government has established flood control devices and rehabilitated the dike along the river.

Keywords : interviews, focus group discussion, flood characteristics, community resilience

ABSTRAK

Ketahanan masyarakat merupakan faktor penting dalam rencana mitigasi bencana. Ketahanan berkaitan dengan kemampuan untuk pulih dari bencana dan berbeda untuk setiap orang. Penelitian ini bertujuan untuk menilai ketahanan masyarakat terhadap bencana banjir. Faktor-faktor untuk mengukur ketahanan masyarakat ditanyakan kepada responden melalui kuesioner dan wawancara. Selain itu, peta banjir dihasilkan berdasarkan pengetahuan yang dimiliki oleh masyarakat. Hasil FGD menunjukkan bahwa kedalaman banjir di daerah penelitian bervariasi dari 0 hingga 300 cm, sedangkan durasi genangan bervariasi dari 1-7 hari. Banjir juga menyebabkan kerugian dengan distribusi kerugian sebesar Rp. 0 - 100,000,000,00. Namun, pada umumnya kerugian yang ditimbulkan masih lebih kecil dari Rp. 2.000.000,-. Distribusi nilai ketahanan responden berdasarkan hasil pembobotan berkisar antara 0,113 hingga 0,700. Nilai rata-rata ketahanan desa Laban adalah 0,403, dan 0,368 untuk desa Kadokan. Nilai ketahanan sebagian besar dipengaruhi oleh modal manusia. Dalam rangka, meningkatkan ketahanan masyarakat, pemerintah telah membentuk perangkat pengendalian banjir dan merehabilitasi tanggul di sepanjang sungai.

Kata kunci: wawancara, diskusi kelompok, karakteristik banjir, ketahanan masyarakat

INTRODUCTION

Flood has caused a big impact in terms of disruption and destruction to livelihood and the changes in the live of affected people. The characteristic of flood in each area is different in its duration, intensity, and frequency. Based on the geographical and geological characteristics, Indonesia is generally prone to flood [Marfai et al. 2008] Sukoharjo is one of the regencies in Central Java Province that has frequently been struck by flood in recent years. In the last three years, Sukoharjo has frequently experienced flooding.

The knowledge of the community affected by flood is important to be integrated in flood risk assessment [Wigati, 2008; Marfai and Hisbaron, 2008; Suryanti, Marfai 2008 and Marfai et al. 2008]. Their understanding of flood as part of their environment is an important factor that should be considered by local government in establishing flood risk management [Febrianty, 2010]. Hence, community resilience becomes an important factor in a disaster mitigation plan [Marfai, 2011]. Unfortunately, information related to resilience is inadequate. For this reason, this research intends to assess the community resilience for flood disaster.

Objectively, this research aims to:

1. Identify the Flood Characteristic in the study area including Flood Distribution, Flood Depth and Flood Duration.
2. Identify the Flood Impact to Community.
3. Identify the community Resilience due to the flood event.

The research location consists of two kelurahan / villages in Sukoharjo that were affected by flood in 2007. These areas are located in the south part of Surakarta municipality. Geographically, Suko harjo is located on 7^{o} 42' S and 110^{o} 50' E. Some parts of this regency are crossed by the Bengawan Solo River, the main river of the Solo basin.

The two villages in Sukoharjo regency that were inundated in 2007 are desa Laban and desa Kadokan [www.tempointeraktif.com, 2007]. Although located in different sub-districts, these two villages are geographically located close to each other. Both villages are naturally prone to flood. The overflow of the Bengawan Solo River and Samin River caused flooding in those villages in the end of 2007. Figure 1 shows the location of the study area.

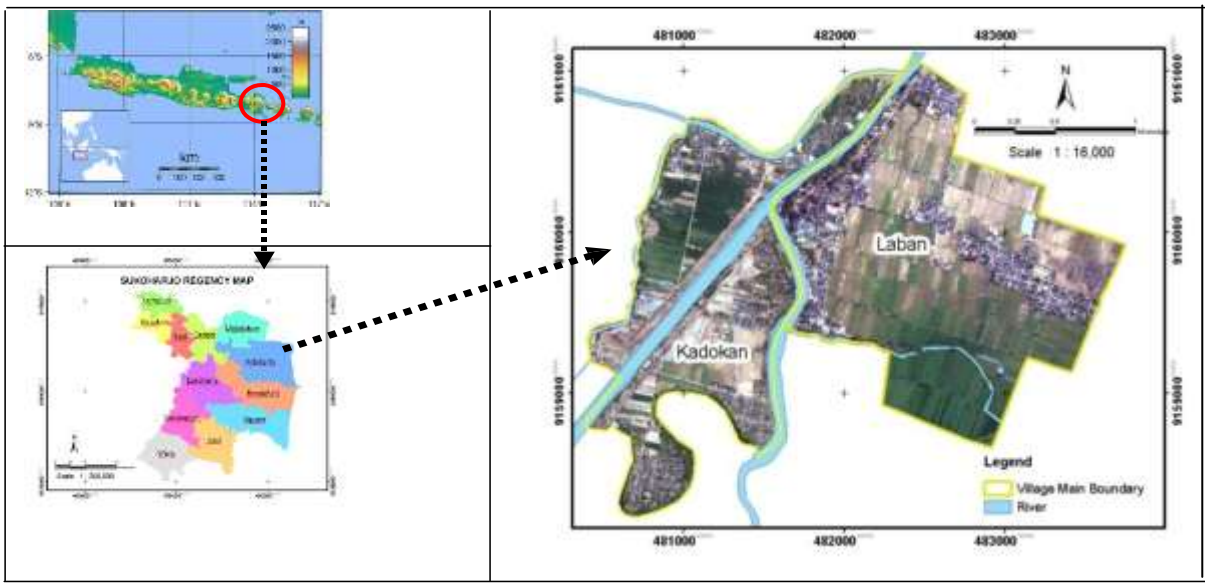

Figure 1. Overview of Study Area

THE METHODS

This research focused on two activities i.e.: 1) generating a flood map based on the community knowledge, and 2) determining and analyzing variables of community resilience. Along with the Focus Group Discussion (*FGD*), giving questionnaire and interviewing respondents are the main methods used in this research.

Some people are involved in *FGD* in order to describe the flood event in their village. Flood characteristics, such as flood depth, flood distribution, and flood duration were described by the participants. In order to make it easier for them to describe flood characteristics, every element has been categorized into 3 levels i.e. low/quick; moderate; and deep/long.

Questionnaire was used to acquire the community resilience data, and interview was also done to obtain further information. In obtaining the resilience data, 80 respondents were selected and interviewed. The respondents were randomly selected from the area which was inundated during the 2007 flood event. According to *Islam et al.* [2010], there are 5 major forms of capital in building community resilience i.e. natural capital, economic capital, physical capital, social capital, and human capital. This research focuses on human capital and economic capital, which describs each respondent's resilience condition.

RESULT AND DISCUSSION

Flood Characteristic

Flood Extent/ Distribution

The interview with both respondents and local government, and the *FGD* provided some information that the flood in *desa* Laban is unevenly distributed. During the big flood, there was only 1 *dusun* that was not inundated because, compared to the other 2 *dusun,* it is situated on a higher elevation.

Different from the condition in *desa* Laban, flood is more evenly distributed in *desa* Kadokan. Most of the area in this village was inundated. The flooding in both villages was mainly caused by the broken dike. The distribution of the flood coverage in both villages is displayed in Figure 2

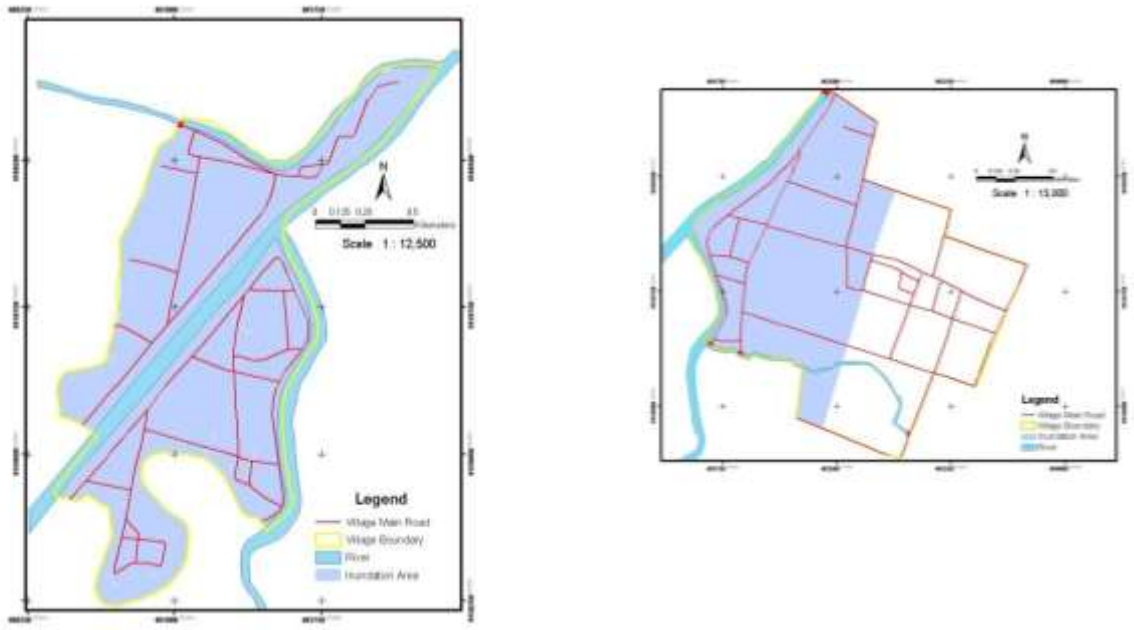

Figure 2. Left: Flood Distribution In Kadokan; Right: Flood Distribution in Laban

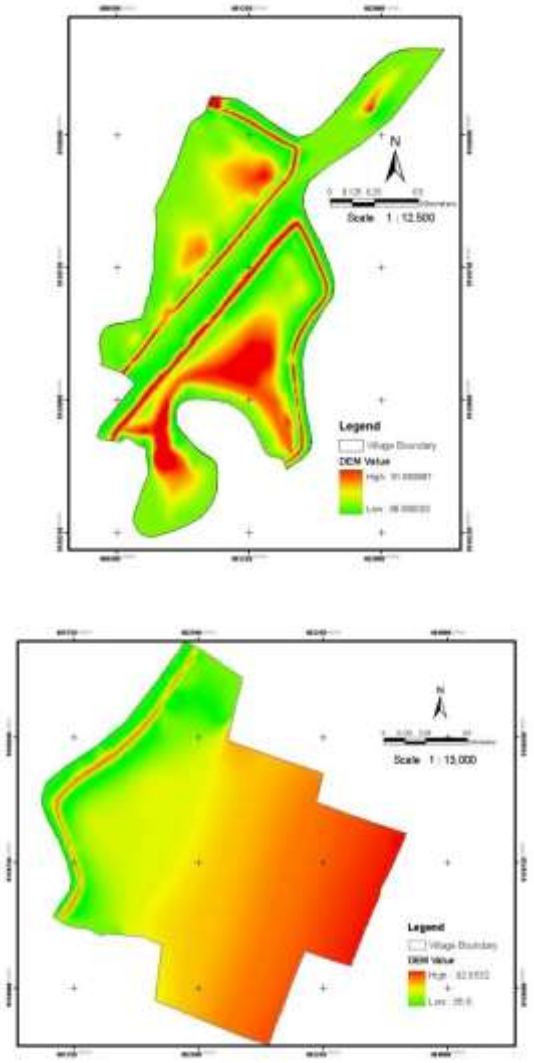

Figure 3. Left: *DEM* map of Kadokan; Right: *DEM* map of Laban

Flood Depth

The 2007 flood event inundated *desa* Laban and *desa* Kadokan in different depth. The Focus Group Discussion has generated three classes of flood depth i.e. deep (> 100 cm), moderate (50 – 100 cm), and shallow (< 50 cm). The depth was estimated from the village main road and, therefore, it represents the general flood depth in both villages. Figure 3 shows the flood depth distribution in both villages acquired from the overlay of *FGD* result and flood depth inside the respondent's houses.

The result of the Focus Group Discussion in both villages shows a different pattern of flood depth. The pattern in *desa* Laban shows that the flood depth decreases gradually from west to east, whereas in *desa* Kadokan, it is more varied. A unique result can be seen from the overlay of the flood depth resulted from the *FGD* and interview. The depth pattern resulted from the *FGD* shows a gradual increase which is in line with the general elevation. On the other hand, the depth pattern of the respondents' houses is distributed randomly. Although the *FGD* result shows that some houses are located in the same flood depth zone, each house, in fact, has a different flood depth.

Coping mechanism that people did by raising the floor foundation had caused the varied flood depth inside the respondents' houses.

Flood Duration

The duration difference of inundation was generally described by the participants in the *FGD*. There are three classes of flood duration, i.e. long (>2 days), moderate (1–2 days), and quick (<1 day). Different results are generated from the overlay of the *FGD* based flood duration and the flood duration inside the respondents' houses. Figure 4 shows the overlay of the flood duration based on the *FGD* and the flood duration inside the house of the respondents.

The differences were caused by different standardization of inundation height. Sometimes people did not consider an inundation event as inundation when they could pass the road easily, althoughugh the water was already several cm high. On the contrary, when the same water height inundated houses, they would consider the event as an inundation event. Furthermore, the flooding events occurred three times in 2007 with a different duration also influenced the calculation of the flood duration.

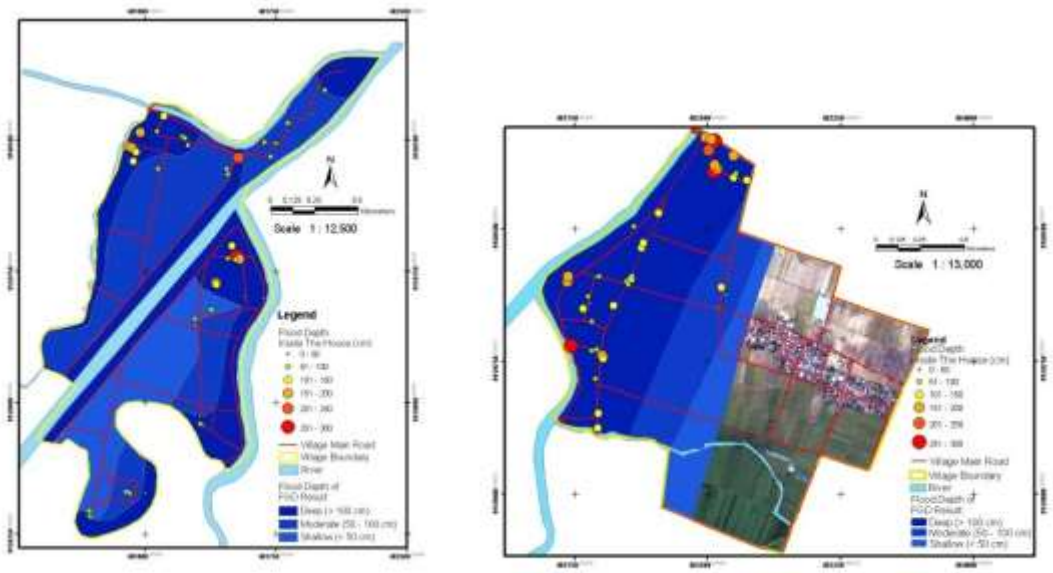

Figure 4. Left: The distribution of Flood Depth in Kadokan; Top: The distribution of Flood Depth In Laban

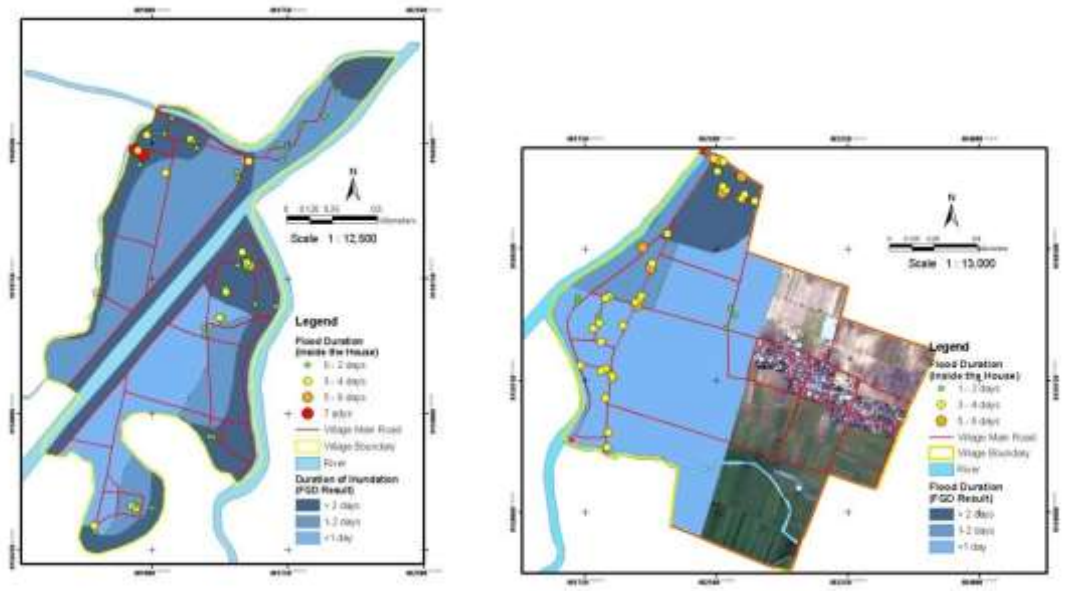

Figure 5. Left: The distribution of Flood Duration in Kadokan; Top: The distribution of Flood Duration in Laban

Impact of Floods to the Community

Trauma

The interview result indicates that most of the respondents are traumatized. They seem to be frightened whenever it rains hard. About 56% of the respondents still have this kind of psychological condition. Unlike the male respondents, most female respondents still feel traumatized. Table 1 shows the psychological condition of the respondents based on their gender in both villages.

Table 1. Psychological Condition of Respondents Based on Gender

Gender	Traumatized (percent)	Not Traumatized (percent)
Male	18.75	36.25
Female	37.5	7.5

The traumatized respondents are distributed randomly in the study area. The traumatic circumstance is caused more by the gender factor than other factors such as flood depth and flood experiences. A psychology study in America reveals that women are more sensitive to the emergence of stress hormones, *corticotropinreleasing factor* (*CRF*), than men [*Dewi*, 2010]. Therefore, women are more prone to depression, trauma, and other psychological problems.

Losses

Losses that are caused by the 2007 flood event vary among the community. The variation depends on the goods that the people had before the flood event and the flood preparedness. Some people that have more flood experiences seem to be more prepared than those that do not, such as having *ranggon* inside the house. *Ranggon* is a place bellow the roof that is used for keeping goods during the flooding. Sudden flood events also influenced the losses level. The losses reported by the people varied between Rp. 0, - until Rp. 100,000,000,-. In average, the respondents' losses are less than Rp. 2.000.000,-.

The respondents' losses as the impact of the 2007 flood event can be seen in Table 2.

Table 2. Respondents' Losses

Losses	Frequency	Percent
0 – 2.000.000	51	63.75
2.000.000 – 4.000.000	7	8.75
4.000.000 – 6.000.000	7	8.75
8.000.000 – 10.000.000	3	3.75
>10.000.000	6	7.5

Impact of Floods to Income

Flood also influenced most of the respondents' income although some people's income in the area remains uninfluenced. The percentage of this group is about 28 percent. Table 3 shows the influence of flood to respondents' income.

Table 3. Flood Influence to the Income of Respondents

Influence to Income	Frequency	Percent (%)
Yes	57	71.3
No	23	28.8

The types of occupation that were influenced by flood in the study area are traders, factory workers/laborers, farmers, entrepreneurs, and *gamelan* craftsmen. Workers' absence in the factory affects the salary because these workers are paid daily. Flood also damages agricultural crops and merchandises which affects the farmer and trader's income as a consequence. Some craftsmen also suffered losses since their *gamelan* was damaged by flood. Types of occupations that were not influenced by the flood events are civil servants, teachers, and retired people because they are paid monthly.

Community Resilience

Human Capital

Sullivan and Sheffrin, 2003 in (*Islam* et al. 2010)mentioned that skills and knowledge are human capital in building community resilience. Skills and knowledge can be gained through education and experiences. Education and experiences can increase understanding or perception of community risk and also increase the ability in developing and implementing risk reduction strategies. Therefore, this research investigated both factors in determining community resilience in the study area.

Most of the respondents do not have any experiences with flood. About 41.3% of respondent said that the 2007 flood event was their first flood experience. These respondents mostly did not experience the 1966 flood event which is worse (in the context of the flood depth and flood duration) than the 2007 flood event. On the other hand, the elderly respondents experienced the 1966 flood event. Flood experiences of respondents in both villages can be seen in Table 4.

Table 4. Flood Experiences of Respondents in Study Area

Flood Experiences	Frequency	Percent
1 time	31	38.75
2-5 times	20	250
6-10 times	2	2.50
>10 times	27	33.75
Total	80	100.00

The second element in human capital is education. The level of education was distributed based on the age which ranges from 20 to 74 years old. The level of education in *desa* Laban and *desa* Kadokan can be seen in Table 5.

Table 5. Education Level of Respondents in Study Area

Education Level	Frequency	Percent
No Education	12	15.00
Elementary School	32	40.00
Junior High School	13	16.25
Senior High School	18	22.50
College	5	6.25

Most of the respondents, both in *desa* Laban and *desa* Kadokan only attended elementary school. The age of respondents in this group is between 51 to 60 years old. On the other hand, only 5 respondents from both villages received their college education.

People with a low level of education, mostly elderly, accept flood as their risk since they live in the area along the river. Coping mechanism that they did before, during and after the flooding is based on the knowledge that has been passed from generation to generation. On the other hand, younger people with a higher level of education are generally more aware of this type of hazard. They are more active in updating information related to flood by using telecommunication tools, such as cell phones. The updated information concerning the flood among the community before, during, and after disaster were flood depth, flood coverage, evacuation route, evacuation places, assistance center, and aid.

Economic Capital

Economic capital means financial resources that people use in recovery. It includes saving, income, investment, and other fund sources. Economic resilience can increase people's ability and capacity

to reduce disaster impact and speed up recovery.

People need financial resource for the recovery, and their main source for the recovery is their income. The income of the household or people who work in non formal sectors was usually influenced by the flood. On the other hand, the income of people who work in formal sectors such as civil servants or teachers remains uninfluenced by the flooding event. However, income alone is sometimes not enough and, therefore, other financial resources to support the recovery are needed. The availability of more financial resources will make the recovery process faster. Table 6 shows the number of people who used other financial resources besides their income.

Table 6. Community Financial Resources for Recovery toward the 2007 Flood Impact

Financial Resources	Yes		No	
	Frequency	Percent	Frequency	Percent
Saving	17	21.3	63	78.8
Selling things	8	10.0	72	90.0
Relations Help	16	20.00	64	80.0
Loan	18	22.5	62	77.5

Having used one or more financial resources does not necessarily mean that they can restore the condition back to the condition before the disaster. Even some people in the area cannot recover at all. Yet, they can accept the condition and live normally. The acceptance attitude among the people is influenced by factors such as culture and religion. In the religion view, disaster is an ordeal from God to measure one's level of faith. Furthermore, disaster is also an admonition from God so that human can utilize natural resources more wisely. Besides, Javanese culture also has a strong influence to people's daily life. Such influence is reflected from a belief among Javanese people which says that every occurrence is the way of nature in balancing the ecosystem. Another popular teaching in Javanese culture is a saying that says *"nrimo ing pandum"*. This saying teaches people to accept every challenge in their life with a sincere heart, face the challenge with hard work, then let God determine the result

Table 9. Resilience Factor Score for Economic Capital in *desa* Kadokan

Factor	Sub-Factor	Sub-sub-factor	Sub-sub-sub-factor
Economic Capital (0.50)	Financial Sources (1.00)	Income (0.30)	Not influenced (1.00)
			Influenced by Flooding (0.00)
		Loan	(0.25)
		Relations Help	(0.20)
		Saving	(0.15)
		Selling Things	(0.10)

Based on the above table, the resilience value for each respondent in both villages can be calculated. The distribution of resilience value in *desa* Laban is ranging from 0.163 until 0.600,

[Kompasiana, 2010]. Both factors have, indeed, helped people recover psychologically.

Weighting Value for Community Resilience

Three factors of resilience were discussed with the community to determine the score. These factors are flood experiences, financial resources, and levels of education. The score and weighting value of the community resilience based on the *FGD* result can be seen in Table 7, 8 and 9.

Table 7. Resilience Factor Score for Human Capital in Study Area

Factor	Sub-Factor	Sub-sub-factor	
Human Capital (0.50)	Education Level (0.50)	College	(1.00)
		Senior High School	(0.80)
		Junior High School	(0.60)
		Elementary school	(0.40)
		No Education	(0.20)
	Flood Experiences (0.50)	>10 times	(1.00)
		6-10 times	(0.75)
		2-5 times	(0.50)
		1time	(0.25)

Table 8. Resilience Factor Score for Economic Capital in *desa* Laban

Factor	Sub-Factor	Sub-sub-factor	Sub-sub-sub-factor
Economic Capital (0.50)	Financial Sources (1.00)	Income (0.30)	Not influenced (1.00)
			Influenced by Flooding (0.00)
		Relations	(0.25)
		Help	
		Saving	(0.20)
		Loan	(0.15)
		Selling Things	(0.10)

Table 9. Resilience Factor Score for Economic Capital in *desa* Kadokan

Factor	Sub-Factor	Sub-sub-factor	Sub-sub-sub-factor
Economic Capital (0.50)	Financial Sources (1.00)	Income (0.30)	Not influenced (1.00)
			Influenced by Flooding (0.00)
		Loan	(0.25)
		Relations	(0.20)
		Help	
		Saving	(0.15)
		Selling Things	(0.10)

Based on the above table, the resilience value for each respondent in both villages can be calculated. The distribution of resilience value in *desa* Laban is ranging from 0.163 until 0.600, whereas the distribution of resilience value in *desa* Kadokan is more varied, from 0.113 until 0.700. The average resilience value of the respondents in *desa* Laban is 0.368. About 28.74% of the value came from the economic capital factor, whereas the other 71.26% came from the human capital factor. The average resilience value of the respondents in *desa* Kadokan is 0.403, with the 28.57% of the value came from the economic capital factor and the rest 71.43% came from the human capital factor. This research shows that human capital gave bigger influence than economic capital in determining the resilience value of the community in study area. Figure 5 and 6 show the spatial distribution of the respondents' resilience in both villages and its relation with flood depth and flood duration based on the *FGD* result

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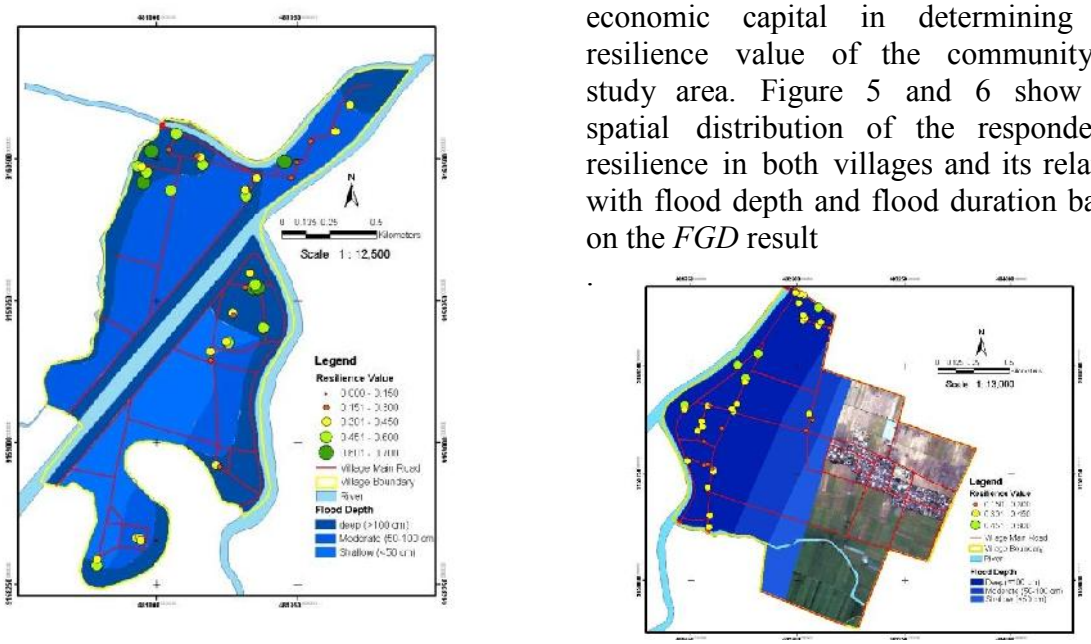

Figure 6. Left : Distribution of Respondents' Resilience and Flood Depth in Kadokan; Right : Distribution of Respondents' Resilience and Flood Depth in Laban

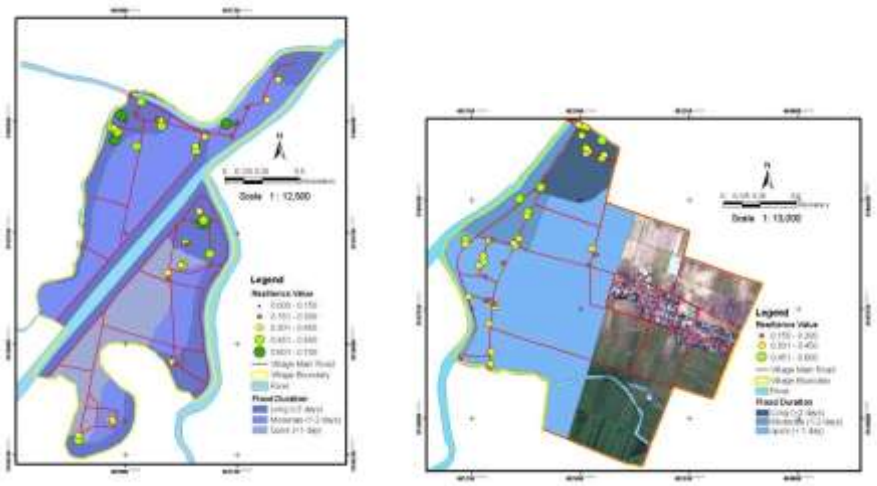

Figure 7. Left: Distribution of Respondents' Resilience and Flood Duration in Kadokan; Right : Distribution of Respondents' Resilience and flood Duration in Laban

Resilience value of both villages is distributed randomly, both in flood depth and flood duration patterns. Respondents with a lower resilience value will theoretically be more vulnerable than respondents with a higher resilience value. This condition will be worsened by the flood depth and duration. Therefore, respondents with the lowest resilience value which are located in a deep flood zone and/or in a zone with long flood duration are most vulnerable to flood. On the other hand, respondents with a highest resilience value and are located in the shallow zone of the flood depth classes and/or in a zone with short flood duration are least vulnerable to flood.

CONCLUSION

The distribution of flood depth and duration in *desa* Laban is different from the distribution of flood depth and duration in *desa* Kadokan. The pattern of flood depth and duration was influenced by factors such as distance from river, general elevation, and location of broken dikes. Three classes of flood depth, i.e. deep (> 100 cm), moderate (50 – 100 cm), and shallow (< 50 cm), as well as three classes of flood duration, i.e. long (> 2 days), moderate (1 – 2 days), and quick (< 1 day), were generated based on the result of the Focus Group Discussion. In this case, not all the deep flood zones were also the long duration flood zones.

The 2007 flood event also gave a considerable impact to people's life. Most respondents that were interviewed are traumatized. The traumatic circumstance is caused more by gender factor than other factors such as flood depth and flood experiences. The disaster also caused significant losses which varied between Rp. 0, - until Rp. 100,000,000,-. In average, the respondents' losses are less than Rp. 2.000.000,-. The flooding event also greatly influenced the income of the people. About 71.3% of respondents who mostly work in non formal sectors claimed that their income was influenced by flood. On the other hand, respondents working in formal sectors reported that their income was not influenced by the disaster at all.

The resilience value of both villages is distributed randomly in terms of both the flood depth and flood duration patterns. The distribution of resilience value in *desa* Laban is ranging from 0.163 until 0.600, whereas in *desa* Kadokan, the distribution of the resilience value is more varied, from 0.113 until 0.700. The average resilience value of the respondents in *desa* Laban is 0.368, whereas in *desa* Kadokan the average resilience value is 0.403. More than 70% of the resilience value is influenced by the human capital factor, while the rest is

influenced by the economic capital factor.

This research indicates that human capital has a bigger influence than economic capital in determining the community resilience value, especially in the study area.

RECOMMENDATION

Based on the result and conclusion, the following recommendations can be proposed:

1. A further study on the relation between resilience and flood characteristic will be valuable to provide information related to community resilience in risk assessment.
2. Concerning the resilience assessment, more capital indicators in building community resilience will provide better result in describing community resilience. Therefore, a deeper investigation concerning each capital will be valuable in obtaining some information related to community resilience
3. Focus Group Discussion based on the community knowledge is an effective way to obtain some information in a wide scope. As this low-cost method can easily be adopted and implemented, FGD can be used by government in order to gain some information in a wide scope.
4. Comparing detailed DEM maps to flood maps generated by the community, especially in the flat area, should be considered as important. Therefore, very detail contours of the study area are needed in order to analyze flood more accurately.

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