Implementation of Climate and Disaster Resilience Initiative (CDRI) in Kampung Sewu, Surakarta, Central Java, Indonesia

Suryanto1,2, Pradiptya Arrasyid3, Amelia Choya TR2
1 Department of Economics and Business, Sebelas Maret University, Sebelas Maret University, Jl. Ir. Sutami 36 A, Kentingan, Surakarta, 57126, Indonesia
2 Alumnae Department of Economics and Business, Sebelas Maret University, Sebelas Maret University, Jl. Ir. Sutami 36 A, Kentingan, Surakarta, 57126, Indonesia
3 Corresponding author: Suryanto_feb@staff.uns.ac.id

Abstract. Global climate change causes the occurrence of natural disasters like floods. Disaster causes a loss or other negative impacts on the community. Community resilience is necessary to increase the capability to cope with the negative impacts. Besides the local wisdom, many aspects should be improved to reduce the disaster risk. This study aimed to determine the level of community resilience facing floods in Kampung Sewu and to find out the variables that cause the level of resilience of Kampung Sewu community low. This research was conducted in Kampung Sewu, Jebres Subdistrict, Surakarta City, precisely in Neighborhood Association (RT) and Citizen Association (RW), namely: RT 02/RW I, RT 03/RW I, RT 01/RW II, RT 02/RW II, RT 01/RW II, RT 01/RW IV, RT 01/RW VIII and RT 01/RW IX. The method used in this research was descriptive quantitative. The analysis used was Climate and Disaster Resilience Initiative (CDRI). The sampling technique was purposive sampling. The results of this study indicated that the area that had the highest level of community resilience was RT03/RW I because the location had low risk and rare from intervention of Sibat Community to anticipate of flooding. Location that had the lowest resistance level was RT01/RW IX because the location had never been flooded and there was no interference in Sibat Sewu in anticipation of flooding. Sibat Sewu educates people actively improving capacity building for community in Kampung Sewu. The variables causing low endurance were sanitation and waste disposal, education and awareness variables, disaster preparedness variables, income variables, financial and savings variables, budgetary and subsidy variables and land-use.

1. Introduction

Global climate change is an environmental issue that is widely discussed in various countries. Climate is the average weather conditions over a long period of time, whereas weather is the atmospheric state in a short period of time [1]. Furthermore, climate is a statistic of various atmospheric conditions, including temperature, pressure, wind, and humidity in an area during a certain period [2]. Three main factors related to global climate change, which impact the agricultural sector, are changes in rainfall patterns, increased extreme climate events (floods and droughts), air temperature and sea level [3].

Climate change will bring some negative effects, in Runinuwu [4] research shows that changes in rain patterns will affect agricultural production. Global climate change occurs due to the greenhouse effect caused by increased greenhouse gas emissions and reduced green forest areas, increased industrial and vehicle exhaust gas pollution. Global climate change can cause natural disasters such as
drought, floods, landslides and storms. Environmental, technological, and social interventions need to be implemented to facilitate farmers’ mitigation and adaptation to threats caused by climate [5]. Reducing the risk of loss can be done by carrying out responsive behavior due to environmental changes that occur by developing a strategy and certain decisions to deal with subsequent situations [6]. It is important to understand how resilience initiatives that are implemented at the local level [7].

Comparing practitioner perspectives with scientific and policy-oriented goals is criticism of resilience in the disaster and development space [8]. The researchers found that practitioners viewed the resilience paradigm is a driver of real change towards better programming. This is a form of initiative in dealing with climate change. Flood disaster is a common phenomenon that occurs every year in various regions in Indonesia. Every year the number of victims of floods in Indonesia continues to increase. Table 1 consist of data on flood victims in Indonesia from 2017-2019 as follows:

Table 1. Number of victims and impacts of Flood Disaster in Central Java 2017 - 2019

| Category                          | 2017  | 2018  | 2019  |
|-----------------------------------|-------|-------|-------|
| Number of Flood Disaster Events   | 192   | 85    | 111   |
| Death Victims                     | 20    | 8     | 11    |
| Victims of injuries               | 6     | 2     | 10    |
| Missing Victims                   | 3     | 0     | 2     |
| Heavy Damaged Houses              | 117   | 66    | 1     |
| Houses moderately damaged         | 65    | 18    | 35    |
| Indirect Affected                 | 58797 | 244398| 92016 |
| Evacuates                         | 13598 | 7151  | 7470  |

Source: Badan Nasional Penangulangan Bencana 2017[9]

Based on Table 1, the frequency of floods in Central Java Province is 192 times in 2017, decreasing 85 times in 2018 and 111 times in 2019. Every year Data of Information of Disaster in Indonesia (DIBI) report victims of death and injury. In 2017 the number of deaths was highest (deaths: 20, injuries: 6) compare with 2018 (deaths: 8, injuries: 2) and 2019 (deaths: 11, injuries: 10).

Surakarta City is an area that often experiences regular floods every year. Surakarta city, which is traversed by Bengawan Solo river from the past until now has recorded frequent floods. Both Jebres Pasar Kliwon sub-regency are the two areas where Bengawan Solo river passes by. Jebres sub-regency consists of 11 villages and Pasar Kliwon sub-regency consists of 9 villages. Bengawan Solo river passes the villages, including Pucang Sawit, Sewu, Sangkrah, and Semanggi.

Sewu village has 48.5 hectares. It is part of Jebres sub-regency, Surakarta, with the northern border of Jagalan village, Sukoharjo regency in the East, Sangkrah village to the south, and Gandekan ilage to the West. Administratively speaking, Sewu is divided into nine Citizens Association or Rukun Warga (RW), and thirty-six Neighborhood Associations or Rukun Tetangga (RT). Citizens Association is the division of regions in Indonesia under the Village or Kelurahan (or Disusun). Rukun Warga is not included in the division of administration, and the formation of local communities is through consultation in the framework of community service set by the village or villager. Rukun Warga is further divided into Rukun Tetangga (RT). While RT is the lowest administrative division of Indonesia. Rukun Tetangga is through consultation in the framework of community service.

The total population in Sewu sub-regency is 7,238 people, with 2,568 heads of families or Kepala Keluarga (KK). Due to the frequent overflow of floods of the Bengawan Solo River, there are many negative impacts experienced by the residents in Sewu village. Floods often hit Sewu village. In 2017, a total of 246 residents were displaced by the overflow of the Bengawan Solo river. They were evacuated from the settlement from Wednesday (1/3/2017) at 11.30 pm Western Indonesia Time (WIB) until Thursday (2/3/2017) at 07.20 am WIB. The water level in residential areas was almost as high as 75 centimeters. We took a total of 86 families (KK) and 246 residents were displaced. Heavy
rain accompanied by wind occurred on Wednesday. Besides, there was a tornado that caused damages to the rooftops of five houses [10].

Natural disasters are difficult to predict even though the symptoms are scientifically predictable. Community resilience is necessary to deal with disasters because strengthening community resilience can reduce the impact of losses resulting from disasters so that the community is more resilient. Disasters will befall people who have weak resilience. The wealthy community is the one who often shows a strong resilience against disaster like floods whereas poor people are the most vulnerable to disasters because they have weak resilience.

The level of community resilience is measured in various ways. One method that can be used to measure community resilience is by using the Climate and Disaster Resilience Index (CDRI). The CDRI method is a tool for measuring city conditions at a certain point in time and building a sustainable city to increase its resilience capacity [11]. The research's purpose was described as follows: 1) to determine the level of community resilience to flood disasters in Sewu village; 2) to determine the variables that cause the low level of community resilience in Sewu village. The benefits of this research could be addressed into two aspects. First, the aspect is a practical aspect and the second one is the empirical aspect. For practical aspects, this study can be used as a reference for governmental policies related to risk and disaster management in urban zoning development and as a reference for the local residents in Sewu village or communities affected by floods to increase their resilience capacity facing disasters. For empirical aspects, this research will support further research, mainly for coping with climate disaster based on community resilience issues. Reducing the disaster risk has to address not only into the hazard, but also vulnerability and resilience.

2. Materials and methods

2.1. Concept of Climate and Disaster Resilience Initiative (CDRI)

There are many methods to measure the level of community resilience. One way that can be used to measure community resilience is by using the Climate and Disaster Resilience Initiative (CDRI). CDRI is a tool used to measure a city’s condition at a certain point in time and develop a sustainable city to increase its resiliency. CDRI emerged from a study conducted by Rajib Shaw, who examined resilience in various cities in Asia [11].

The scope of CDRI research is limited to climates that cause disasters (hydrometeorological disasters), such as cyclones, floods, heatwaves, drought, and heavy rain that cause landslides. CDRI was developed based on five dimensions, namely physical, social, economic, institutional, and natural. The matrix for assessing the level of community resilience is shown in the following Table 2 [12].

This research was quantitative descriptive research. The research subjects were groups of people who live in Sewu village who were considered indispensable in examining the level of community resilience facing the overflow of the flood of the Bengawan Solo river affecting Sewu village, Jebres sub-regency, Surakarta. Those subjects were precisely local communities in Sewu village who were divided into sub-areas knows as RT, especially those affected by the overflow of the flood of the Bengawan Solo river and those who were not affected by the Bengawan Solo flood as a comparison. The following is Table 3 shows the research subjects in Sewu village.

The classification of impacted or not affected area in Sewu village was based on an interview with the head of Sewu village. The sampling technique used in this research was purposive sampling technique. Samples were taken based on the area per RT of the community affected by the flood overflow of the Bengawan Solo river and the community that was not affected by the Bengawan Solo flood overflow in Sewu village. The total sample was 40 respondents consisting of 5 respondents in each RT of the research location. The respondent criteria include residents affected by the flood, head of RT, involved members and village apparatus residing in the research RT. The data collection technique used was the collection of field observations, questionnaires and interviews.
Table 2. Matrix of dimensions and variables of community resilience levels

| Dimensions     | Variables                                      |
|----------------|------------------------------------------------|
| Physics        | Electricity                                    |
|                | Water                                          |
|                | Sanitation and waste disposal                   |
|                | Road accessibility                             |
|                | Housing and land use                           |
| Social         | Population                                     |
|                | Health                                         |
|                | Education and awareness                        |
|                | Social capital                                  |
|                | Community preparedness for disasters           |
| Economy        | Income                                         |
|                | Profession                                     |
|                | Household assets                               |
|                | Finances and savings                           |
|                | Budget and subsidies                           |
| Institutions   | Disaster risk reduction                        |
|                | Disaster risk management                       |
|                | Knowledge and management dimensions            |
|                | Institutional collaboration with other organizations and stakeholders |
| Nature         | The intensity of natural disasters              |
|                | The frequency of natural disasters             |
|                | Ecosystem                                      |
|                | Land use                                       |
|                | Environment                                    |

Source: Razafindrabe et. al. 2009 [12]

Table 3. Research subjects

| No  | Location  | Information   |
|-----|-----------|---------------|
| 1   | RT 02/RW I| Impacted      |
| 2   | RT 03/RW I| Not Affected  |
| 3   | RT 01/RW II| Impacted     |
| 4   | RT 02/RW II| Impacted    |
| 5   | RT 03/RW II| Impacted    |
| 6   | RT 01/RW IV| Not Affected |
| 7   | RT 01/RW VIII| Not Affected|
| 8   | RT 01/RW IX| Not Affected  |

Source: Primary data

The CDRI dimensions are derived into several variables. Among the variables postulated by Rajib Shaw, a variable was selected according to the field conditions and data availability. This study measured the community resilience index with the scales numbered 1, 2, 3, 4 and 5 according to very low, low, medium, high and very high. The level of community resilience in Sewu illage, Jebres sub-regency, Surakarta city (Table 4).
Table 4. Research analysis unit matrix

| Dimensions          | Variable                        | Indicators hypothesis                                                                 |
|---------------------|---------------------------------|----------------------------------------------------------------------------------------|
| Physical            | Electricity                     | The more complete the electrical indicator, the higher the resistance level             |
|                     | Water                           | The more complete the water indicator, the higher the resistance level                   |
|                     | Sanitation and Waste Disposal   | The more complete the indicators for sanitation and waste disposal, the higher the level of resistance |
|                     | Road Accessibility              | The more complete the road accessibility indicators, the higher the level of resistance |
| Social              | Population                      | The higher the level of vulnerable age (under 14 years and over 60 years) and the higher the population density, the lower the level of resistance |
|                     | Education and awareness         | The higher the level of education and awareness, the higher the level of resistant       |
|                     | Social capital                  | The higher the indicator of community participation in socializing, the higher the level of resilience |
|                     | Community readiness during disasters | The higher the indicator of community readiness during a disaster, the higher the level of resistance |
| Economy             | Income                          | The higher the population level below the poverty line, the lower the level of resilience |
|                     | Finance and Savings             | The higher the financial and savings indicators, the higher the level of resilience      |
|                     | Budgets and Subsidies           | The higher the budget and subsidy indicators the higher the level of resilience          |
| Institutions        | Effectiveness of City Institutions in Responding to Disasters | The higher the indicators of city institutions in responding to disasters, the higher the level of resilience |
|                     | Collaboration between government agencies and non-governmental institutions | The more institutions that participate, the higher the level of resilience               |
| Nature              | Intensity Severity              | The greater the intensity of the severity, the lower the level of resistance             |
|                     | Disaster Frequency              | The greater the frequency of disasters, the lower the level of resistance                |
|                     | Land Use in natural terms       | The higher the land use indicator, the lower the level of resilience                    |
|                     | Environment                    | The higher the environmental indicator the higher the resistance level                   |

Source: Shaw et. al. 2014 [11]

3. Result and discussion

3.1. Level of community resilience
CDRI calculated from each dimension, namely the physical, social, economic, institutional and natural dimensions, a score was obtained from each location. The scores were then added up according to each location and average of the level of community resilience to disasters. Following is the level of community resilience:
Based on Table 5, it shows the level of community resilience facing disasters from each location. The location that had the highest level of resilience was RT 03/RW I with a score of 3.5, which was in the high category because the sub-locations were rarely flooded and often receive interference from Sibat Sewu in anticipating flood disasters; besides, these locations were very close to flooding prone areas as the main focus of Sibat Sewu. The location that had the second level of resilience was RT 01/RW VIII, with a score of 3.4, and had a high category. The location that had the third level of endurance was RT 01/RW II, with a score of 3.35, and was in the high category. The locations that had the fourth place were RT 02/RW I and RT 01/RW IV, with a score of 3.22, which were situated in high category. The locations that had the fifth level of endurance was RT 02/RW II, with a score of 3.05, which was in the high category. Meanwhile, the location with the lowest level of resistance was RT 01/RW IX, with a score of 2.98, set in the moderate category because the location had a high altitude compared to other locations where flood never exists. So, the lack of interference by Sibat Sewu in disaster management at RT 01/RW IX affected the low level of community resilience.

Based on all aspects, we transformed into simple terms the level of community resilience from various dimensions (Physical, Social, Economic, Institutional and Natural) as shown in Figure 6 as follows:

![Figure 1. Community resilience based on five dimensions](image-url)
Based on Figure 1, the economy aspect was the lowest resilience among physical, social, economic, institutional, and nature. This result has been proved by Nurul [13] that conclude variable of economy, especially saving and finance, then budget and subsidy. In terms of financial support, the lack of credit facility and disaster risk financing for the two case study cities indicated that credit facilities need to be improved to allow local communities within disaster-prone areas to have options in the preparation to face any future disasters.

A study conducted by Razafindrabe [12] measured the level of resilience that occurred in several cities with high levels of vulnerability. From the test results, there is a tendency that regions that have a low level of resilience in the economic dimension will have an impact on their low level of resilience. This research also showed the same thing that economic dimension still needs to be improved so that resilience increases.

Conclusion of Nurul [13] also supported by study result from Shah et al [14] and Frankenberg et al [15], level of resilience has supported by the education of people and income rate. According to Shah et al [14] the women who become head of household have limited access to health and food, livelihood strategies, social networks and natural disaster/climate change variability. Meanwhile, Frankenberg et al [15] argued that institutional resilience needs considerable attention and support from economic front such as diversified sources to raise incomes, budget and subsidy to risk reduction activities, and widening savings and insurance base.

3.2. Factors affecting the low community resistance

The results indicated that variables were still low, affecting the level of community resilience facing disasters in Sewu village. Variables that caused the low resistance levels of the community were: 1) the variables of sanitation and waste disposal that is influenced by the existence of many houses without trash bins, where many residents are littering, and each RT still do not have a single waste bank, with no waste treatment or waste recycling places [16]; 2) the education and awareness variables due to the unavailability of the village library as a reading place, where there was no educational disaster awareness for elementary school children in Sewu village and the disaster simulation training was only carried out in a few places at certain RTs; 3) the variable of community readiness during a disaster that was influenced by the lack of readiness of the community in terms of logistics, materials and management during floods; 4) income variable was influenced by the high level of poverty in Sewuillage; 5) financial variables and savings were influenced by the low interest of the community to save or have household savings. In addition, there was no credit facility from the government for the community for investment purposes or micro, small and medium enterprises (MSMEs) to improve the community's economy; 6) land-use variables in natural terms were influenced by indicators of disaster-prone residential areas related to climate, flood-prone settlements and the unavailability of green open spaces.

4. Conclusion

The results showed that the resilience of the people living in flooded areas was relatively and frequently higher than in areas that were rarely flooded. The area with the highest level of community resilience was RT03/RW I whereas the area with the lowest level was RT01/RW IX. The existence of assistance from a Non-Profit Organization such as Sibat Sewu had increased the community resilience index (CDRI); on the other hand, areas that did not receive the threat had a low level of community resilience. The limitation of study was scope area of research, it was still limited on Sewu village. For further research, the scope of area can be expanded. Besides the scope of area, the number of respondents should be increased. Our findings suggested to the government to address disaster risk management on increasing of capacity building of people. When their capacity building has been improved, they have the knowledge and capacity to reduce disaster risk.

References

[1] Eyre S R, R G Barry, and R J Chorley 2012 Atmosphere, weather and climate Geogr. J.,
[2] Field C B et al Managing the risks of extreme events and disasters to advance climate change adaptation: Special report of the intergovernmental panel on climate change

[3] Surmaini E, E Runtunuwu, and I Las 2011 Efforts of agricultural sector in dealing with climate change J. Litbang Pertan.

[4] Runtunuwu E and H Syahbuddin 2007 Perubahan pola curah hujan dan dampaknya terhadap periode masa tanam J. Tanah dan Iklim 26 1–12.

[5] Olorunfemi T O, O D Olorunfemi, and O I Oladele 2020 Determinants of the involvement of extension agents in disseminating climate smart agricultural initiatives: Implication for scaling up J. Saudi Soc. Agric. Sci. 19 285–92.

[6] IPCC 2014 Climate Change 2014: Climate Change, Adaptation, and Vulnerability.

[7] Banwell N, A S Gesche, O R Vilches and S Hostettler 2020 Barriers to the implementation of international agreements on the ground: Climate change and resilience building in the Araucanía Region of Chile Int. J. Disaster Risk Reduct. 50 101703.

[8] Keating A and S Hanger-Kopp 2020 Practitioner perspectives of disaster resilience in international development,” Int. J. Disaster Risk Reduct. 42 101355.

[9] Badan Nasional Penangulangan Bencana 2017 Data dan Informasi Bencana Indonesia.

[10] Tribun Solo 2017 Kebanjiran, 246 Warga Kelurahan Sewu, Solo, hingga Kamis Pagi Ini Masih Mengungsi.

[11] Shaw D, J Scully, and T Hart 2014 The paradox of social resilience: How cognitive strategies and coping mechanisms attenuate and accentuate resilience Glob. Environ. Chang.

[12] Razafindrabe B H N, G A Parvin, A Surjan, Y Takeuchi, and R Shaw 2009 Climate disaster resilience: focus on coastal urban cities in Asia Asian J. Environ. Disaster Manag. - Focus. Pro-active Risk Reduct. Asia 1.

[13] Nurul W et al 2018 Measuring urban resilience using climate disaster resilience index (CDRI) in the International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XLII-4/W9, 2018 International Conference on Geomatics and Geospatial Technology (GGT 2018), 3–5 September 2018, Kuala Lumpur, Malaysia

[14] Shah K U, H B Dulal, C Johnson and A Baptiste 2013 Understanding livelihood vulnerability to climate change: Applying the livelihood vulnerability index in Trinidad and Tobago Geoforum 47 125–37.

[15] Frankenberg E, B Sikoki, C Sumantri, W Suriastini and D Thomas 2013b Education, vulnerability, and resilience after a natural disaster Ecol. Soc.

[16] Son H H and N Kakwani 2004 Economic growth and poverty reduction: Initial conditions Matter Int. Poverty Cent. United Nation Dev. Program.