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Institutional assessment through climate and disaster resilience initiative in Surabaya

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Abstract. Climate change is inevitable and adaptation is a must. Surabaya as an urban area that contributes to the phenomenon of global warming. The challenges of the City of Surabaya in managing the impacts of climate change need to be further considered. On 21-22 February 2018, the City Government of Surabaya joined the Climate Change Adaptation Workshop. In managing the impacts of climate change, it is necessary to synchronize national, regional and local government policies and create SOPs for climate change adaptation actions. In addition, another priority is spatial planning that takes into account climate change in the context of development. Responding to the suggestions expected from the workshop, this research focuses on assessing risks due to climate change involving institutional aspects. This institutional aspect was taken with the intention of providing recommendations to managers and decision makers in making processes and designing policy analyzes to reduce and adapt to climate change. The results showed that there were six Surabaya City Organizations that were considered to have significant influence and interest in the field of climate change. In addition, historical disaster data on climate change has been derived, which states that disasters in Surabaya include floods, whirlwinds (extreme weather), drought, and forest and land fires. Based on the Likert scale scoring calculation results, it is known that the Surabaya City Organizations resilience a with the CDRI concept is 4.47. This figure indicates that the resilience level of the City of Surabaya is seen from the institutional aspect is relatively high and needs to be maintained.

1. Introduction
Climate change is inevitable and adaptation is a must. In the past few decades, the need for urgent actions to adapt to this changing climate and its impacts has become a subject of many climate related discussions globally, with emphasis on strengthening resilience and adaptive capacity to climate risks and natural disasters [1]. Meteorological data records show increased climate variability or extreme weather events that have never been felt before in modern human history [2]. The increase in extreme weather is related to global warming [3]. The very rapid rate of global warming [2] gives concern to the increasing magnitude of the hydrometeorology disaster and the degradation of natural resources that are on the surface of the earth. In the end this will slow down the development process or even destroy the achievement of development outcomes [4][5]. On the other hand, global warming cannot be stopped for at least the next few decades. Global warming will continue because of the inertia of the climate system, although greenhouse gas emissions are stopped now [6][7].
Humans have naturally adapted when disruption or climate change affects human life, which is part of a strategy for survival. The National Council on Climate Change (DNPI) report in 2012 recorded 269 adaptation activities in Indonesia over a 5-year period from 2007-2012 [8]. The adaptation activities are carried out in various ways and approaches both reactive and planned. Based on the criterion dimensions of adaptation activities [9], the DNPI report states that the majority (72%) of adaptation activities in Indonesia are still in the dimensions of adaptive capacity enhancement. While those in the dimension of adaptation measures are as much as 20%, and in the dimensions of sustainable development 8%. On the other hand, the implementation of adaptation faces political doubts when weighing the value of the benefits of adaptation and belief in climate change [10].

Surabaya City as a city that has a relatively high population and tends to increase every year. This has an impact on economic changes and quality of life. Improved quality of life gives a tendency to use more and more resources [11]. Significantly increased energy consumption, increased environmental pollution, and indirectly ecological functions of the environment that support human life occur damage, for example depletion of the ozone layer in the stratosphere by chlorofluorocarbons (CFCs) increases skin cancer and increases in carbon dioxide (CO2) levels in the atmosphere. With rising levels of CO2 in the atmosphere causing global warming.

The challenges of the City of Surabaya in managing the impacts of climate change need to be further considered. On 21-22 February 2018, the City Government of Surabaya joined the Climate Change Adaptation Workshop [12]. In this workshop one of the suggestions is that synchronization of national, regional and local government policies and SOP of climate change adaptation actions are needed. The use of science such as climate patterns through scientific studies can help people deal with climate change. In addition, another priority is spatial planning that takes into account climate change in the context of development. Responding to the suggestions expected from the workshop, this research focuses on assessing risks due to climate change involving institutional aspects. This institutional aspect was taken with the intention of providing recommendations to managers and decision makers in making processes and designing policy analyzes to reduce and adapt to climate change.

2. Identification of Stakeholders Related to Duties and Functions of Climate Change Disaster Management in Surabaya

The selection of the Surabaya Regional Organization (OPD) was carried out on the basis of stakeholder mapping. The main consideration in stakeholder mapping is based on the influence and interests of each OPD in efforts to assess the risk of disasters due to climate change. The identification of stakeholders according to their level of importance and influence is as follows:

| Stakeholder Interest Level | Influence of Stakeholder’s Activity |
|----------------------------|-----------------------------------|
| 0                          |                                   |
| 1                          |                                   |
| 2                          |                                   |
| 3                          |                                   |
| 4                          | Development Planning Agency (Bappeko) |
|                            | Department of Food Security and Agriculture (DKPP) |
| 5                          | Fire Department (PMK) |
|                            | Surabaya Maritime Meteorology Climatology |
|                            | Environmental Department (DLH) |
|                            | Disaster Management and Community |
3. Identification of the Characteristics of the Climate Change Disaster in Surabaya

3.1 Surabaya Climate Disaster Trend

Based on the Surabaya City Disaster Risk Assessment Document for 2019-2023, the total number of disasters in the city of Surabaya in the 2008 - 2017 period were 23 events consisting of tornadoes, drought, forest and land fires, and floods. Disasters in that period were whirlwinds (7 events), drought (2 events), forest and land fires (1 event) and flooding were the most common types of natural disasters in the city of Surabaya (a total of 13 events). Other types of natural disasters such as earthquakes, tidal waves / abrasions, landslides, flash floods and tsunamis have never occurred during this period.

![Figure 1. Trends of Disasters in Surabaya in the Last 10 Years](source)

From the graph and table above, it can be seen that there is a tendency for disasters in the city of Surabaya in the span of 2008-2017, namely:

a. Flood

Flood disaster is the most common disaster in the city of Surabaya in the span of 2008-2017 with 13 incidents resulting in victims suffering and displaced as many as 2800 people. In addition to causing many victims to evacuate, the flood disaster in Surabaya City also recorded minor damage to 114 housing / residential buildings and 968 other units submerged during the flood.

The areas most prone to flooding in the city of Surabaya are Pakal Subdistrict, Tambak Dono and Sumberejo Subdistricts. Pakal Subdistrict, especially Tambak Dono and Sumberejo Sub-Districts are very flood-prone areas, because the West Surabaya region was directly affected by the overflow of Kali Lamong. Lamong River is a river that crosses Gresik Regency, Lamongan, and Surabaya City.

Medium level flooding occurred in Pakal Subdistrict, Benowo and Babat Jerawat Sub-Districts. Furthermore, the areas with the lowest level of flood events occurred in Benowo Subdistrict, Romokalisari, Sememi, and Kandangan Sub-Districts and in Sukolilo Subdistrict, Keputih and Medokan Semampir Sub-Districts.
As a result of the floods in 2011, the City of Surabaya suffered losses of Rp. 31 Million. Most of the areas that suffered losses were in the western part of the city, precisely in Pakal District (Babat Jerawat, Benowo, Sumberejo and Tambakdono), Benowo District (Sememi, Kandangan and Romokalisari), and Sukolilo District (Medokan Semampir and Keputih Kelurahan). The worst affected villages with losses reaching Rp. 8 million in 2011 were Tambakdono and Sumberejo.

b. Whirlwind (Extreme Weather)
A whirlwind disaster is the second most frequent disaster in the city of Surabaya with 7 events in the last 10 years period which resulted in the death of 2 people dead / missing and 2 people injured. The incident also caused minor damage to 110 residential buildings and 1 Education facility.

The threat of whirlwind disasters with still low levels occurred in three districts in the city of Surabaya, namely Benowo District, Asem Rowo District, Sawahan District. As a result of this disaster, the city of Surabaya suffered a loss of Rp 3 million in 2011 (Podes 2011). Areas that suffered losses include Petemon, Asemrowo and Kandangan. The losses suffered by each village reached Rp. 1 million.
c. Drought
Drought in the period 2008 - 2017 only happened 2 times which did not cause fatalities or damage to housing units or public facilities.

d. Forest and Land Fire
Forest and land fires only occurred once during the period 2008 - 2017 with a limited area so as not to cause casualties and damage to housing units and public facilities.

3.2 Surabaya City Development Plan Related to Disaster
Based on the Medium-Term Regional Development Plan (RPJMD) of Surabaya 2016-2021, the discourse on climate change is included in the issue of strategic environmental studies. Unfortunately, in this five-year document, climate change is not seen as an accumulation of long-distance phenomena that affect urban development, but rather leads to the consequences of other activities.

Nevertheless, Surabaya City Government still accommodates the possibility of disasters in the city development plan. In Surabaya RPJMD 2016-2021, the following is an accommodation of the existence of disaster issues:

| Table 2. Surabaya RPJMD Review 2016-2021 |
|------------------------------------------|
| **Vision** | **Mision** | **Purpose** | **Target** |
| Surabaya Prosperous City with Ecology-Based Character and Global Competitiveness | Mission 4: Achieve integrated spatial planning and maintain the carrying capacity of the city | Purpose 3: Creating a city resilience system that is reliable against disasters | Development of an anticipatory and responsive disaster management system |
| Based on Ecology: Surabaya City as a city whose spatial planning is capable of integrating the functions of trade / service areas and residential areas with road and transportation network systems, is able to anticipate disaster risks and is able to preserve coastal areas while paying attention to the carrying capacity of the city through stabilizing environmental facilities and infrastructure and environmentally friendly settlements |

*Source: RPJMD, 2019*

In addition to development plans, disasters due to climate change have also been included in Surabaya City sectoral plans, such as floods. The problem of flooding due to the overflow of Kali Lamong has become a routine disaster that occurs in parts of Gresik Regency and Surabaya City. The impact that is felt is the emergence of traffic congestion and a decline in public health due to settlements plague the disease. Mitigation of floods and inundation can be done with intensive conservation / conservation of coastal areas and control of river border areas and drainage canals in the city of Surabaya.

Reported by APIFA, efforts that have been made by the Surabaya City Government are the development of drainage systems. Administratively, the city of Surabaya has an area of 33,048 hectares, but for the planned development of a drainage system it is necessary to add around 3,000 hectares in the
west (Gresik Regency) and south of the city (Sidoarjo Regency), as well as 500 hectares of reclamation land on the East coast. The Surabaya City drainage system is divided into 5 (five) rayon areas, namely Genteng, Gubeng, Jambangan, Wiyung, and Tandes rayon areas with a total area of less than 36,396.46 hectares.

Table 3. Area of Development Based on Rayon

| Rayon   | Total Area (Ha) |
|---------|-----------------|
| Genteng | 3841            |
| Gubeng  | 7123            |
| Jambangan | 7421        |
| Wiyung  | 7290.27         |
| Tandes  | 10721.19        |
| **Total** | **36396.46**   |

Source: Surabaya Drainage Master Plan, 2018

4. Assessing Surabaya's Resilience Risk Against Climate Change Disasters

The analytical method used in assessing the risk of institutional resilience against climate change is a Likert scale. The way it works is by identifying values of 1 (very low) to 5 (very high) and an assessment of the weight of the variable's influence on increasing institutional resilience. Likert scale is used to measure the attitudes, opinions and perceptions of a person or group of people about social phenomena.

The partial description of the Likert scale risk analysis process in Surabaya's resilience to climate change disasters can be seen in the table below:

Table 4. Analysis of Likert Scale Based on CDRI Concept

| Indicator & Variable | BMKG Score | BMKG Weight | PMK Score | PMK Weight | Bappeko Score | Bappeko Weight | DKPP Score | DKPP Weight | BPBL Score | BPBL Weight | DLH Score | DLH Weight | Final Score |
|---------------------|------------|-------------|-----------|------------|---------------|---------------|-------------|-------------|------------|--------------|------------|-------------|--------------|
| **Indicator 1**     |            |             |           |            |               |               |             |             |            |              |            |             |              |
| Variable 1          | 3          | 1           | 3         | 2          | 5             | 5             | 5           | 5           | 5          | 5            | 3          | 1           | 4.58         |
| Variable 2          | 3          | 2           | 3         | 1          | 5             | 3             | 5           | 2           | 5          | 3            | 3          | 2           | 4.23         |
| Variable 3          | 5          | 3           | 5         | 4          | 4             | 2             | 5           | 3           | 5          | 1            | 4          | 3           | 4.69         |
| Variable 4          | 5          | 5           | 2         | 3          | 4             | 1             | 5           | 1           | 5          | 2            | 4          | 4           | 4.13         |
| Variable 5          | 4          | 4           | 5         | 5          | 5             | 4             | 5           | 4           | 5          | 4            | 4          | 5           | 4.65         |
| **Average Score**   | **4.46**   |            |           |            |               |               |             |             |            |              |            |             |              |
| **Indicator 2**     |            |             |           |            |               |               |             |             |            |              |            |             |              |
| Variable 1          | 5          | 5           | 5         | 5          | 5             | 5             | 5           | 5           | 5          | 5            | 3          | 1           | 4.92         |
| Variable 2          | 5          | 4           | 1         | 2          | 4             | 4             | 5           | 3           | 5          | 1            | 3          | 2           | 4.00         |
| Variable 3          | 4          | 3           | 5         | 3          | 5             | 2             | 5           | 4           | 5          | 4            | 4          | 5           | 4.62         |
| Variable 4          | 4          | 2           | 1         | 1          | 5             | 1             | 5           | 1           | 5          | 3            | 4          | 4           | 4.17         |
| Variable 5          | 5          | 1           | 5         | 4          | 4             | 3             | 5           | 2           | 5          | 2            | 4          | 3           | 4.60         |
| **Average Score**   | **4.46**   |            |           |            |               |               |             |             |            |              |            |             |              |
| **Indicator 3**     |            |             |           |            |               |               |             |             |            |              |            |             |              |
| Variable 1          | 5          | 5           | 5         | 5          | 5             | 5             | 5           | 5           | 5          | 5            | 4          | 5           | 4.83         |
| Variable 2          | 4          | 3           | 1         | 1          | 5             | 2             | 4           | 2           | 4          | 1            | 3          | 1           | 3.80         |
| Variable 3          | 1          | 2           | 5         | 2          | 5             | 4             | 5           | 3           | 5          | 4            | 4          | 4           | 4.37         |
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Based on the Likert scale scoring calculation results, it is known that “very high” rating (score range 4-5) dominates the assessment of the Surabaya institutional resilience variable on climate change. There are only three variables that are not included in the “very high” rating, and all of them are three variables with the lowest score. It appears that the highest value is contributed by variables related to the effectiveness of the disaster management plan and the effectiveness and independence of the government system. While "collaboration" is something that is completely different for the City of Surabaya in this assessment.

### Table 5. Highest and Lowest Variables on The Likert Scale Assessment

| Category of The Variable | Ranking | Final Score | Variable |
|--------------------------|---------|-------------|----------|
| Highest Variable         | 1       | 4.92        | The existence and effectiveness of Disaster Management Plans |
|                          | 2       | 4.83        | The effectiveness of local governments during and after disasters |
|                          | 3       | 4.82        | Level of dependency on external institutions / support during and after disasters |
| Average                  | 4 - 22  | 4.00 – 4.81 | 19 Variables |
| Lowest Variable          | 23      | 3.92        | Local governments collaborate with national governments during and after disasters |
The final score of Surabaya's resilience is calculated by calculating the average value of the variable in each indicator and the weight of the indicator set by the respondent. And the result, the Surabaya resilience level assessment based on institutional aspects is classified as very high, with a final score of 4.47. Of the 5 indicators, the indicators "Disaster Risk Reduction and Climate Change Adaptation" is considered the most influential, while the indicator "Inter-institutional Cooperation" is considered to have the weakest level of importance.

**Table 6.** Highest and Lowest Indicators on The Likert Scale and The Final Score of Assessment

| Indicator                                      | Weight of Indicator | Average Weight (W) | Variable's Score (X) | W x X | Order of Ranking |
|------------------------------------------------|---------------------|--------------------|----------------------|-------|------------------|
| Disaster Risk Reduction and Climate Change Adaptation | 2 2 5 5 5 | 4.00              | 4.46                 | 17.84 | 1                |
| Effectiveness of Critical Zone Management      | 3 3 2 4 2           | 2.67              | 4.46                 | 11.89 | 4                |
| Dissemination of Knowledge and Management      | 1 5 3 4 3           | 3.17              | 4.47                 | 14.16 | 3                |
| Inter-institutional Cooperation                 | 5 1 1 1 1           | 1.67              | 4.16                 | 6.93  | 5                |
| Governance                                     | 4 4 4 2 3           | 3.50              | 4.62                 | 16.17 | 2                |

**Surabaya Resilience Level Assessment**

4.47
*(Very High)*

*Source: Analysis, 2020*

Recommendations that are in line with the condition of Surabaya resilience institutionally are to optimize the formulation of climate change strategy forward. This can be developed from the main duty of each agency. The fact that Surabaya is considered to have a good disaster management plan and governance system is valuable capital in formulating a solid climate change strategy. The point is that the city system needs to be planned well and thoroughly, well maintained, and understood thoroughly by all citizens of the city. In addition, Surabaya also needs to learn to improve interagency integration. Climate change is a complex problem that can be faced through a collaborative approach involving various stakeholders.
5. Conclusion
The conclusion of this research is as follows:

1. The election of six Regional Government Organizations (OPD) of Surabaya City which is considered to have strong influence and interest in handling the phenomenon of climate change in the City of Surabaya. The six OPDs include the Development Planning Agency, Department of Food Security and Agriculture, Fire Department, Surabaya Maritime Meteorology Climatology and Geophysics Agency, Disaster Management and Community Protection Agency, and Environmental Department.

2. Based on the trend of the occurrence of disasters in the last 10 years in the city of Surabaya, disasters that have a tendency to recur trends are flood and tornado disasters. Whereas the other two types of natural disasters (drought and forest and land fires) only occurred incidentally, namely each drought (2 events) in 2011 and forest and land fires (1 event) in the same year, 2017.

3. Surabaya’s institutional resilience assessment of climate change disasters based on the CDRI concept is very good. With a Likert scale, it is known that the final score of institutional resilience in Surabaya is 4.47 and is in a very high category. This is in line with the results of the assessment of the variables, which are in the very high (22 variables) and high (3 variables) categories.

4. As recommendations, Surabaya needs to optimize the formulation of climate change strategy forward. The strategy can be developed from the main duty of each agency. The fact that Surabaya is considered to have a good disaster management plan and governance system is valuable capital in formulating a solid climate change strategy. In addition, Surabaya also needs to improve interagency integration. Climate change is a complex problem that can be faced through a collaborative approach involving various stakeholders.

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