

# Examining the Level of Vulnerability and Adaptation of Middle Class Urban Communities to Climate Change

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**Keywords:** Adaptation, Climate Change, Vulnerability, Middle Class Urban Communities.

**Abstract:** This study aims to examine the level of vulnerability and adaptation of middle class urban communities to climate change that happened in Malang City. Quantitative approach method is done by examining the air temperature changes in 1991—2016 and the results of questionnaires respondents middle class urban communities. The results show the trend of increasing in the air temperature from year after year increases. The level of community adaptation is categorized as low, both the variables of green open space availability and the diversity of potted plants. Settlement conditions in urban areas vulnerable to climate change should be directly proportional to the level of community adaptation. However, the fact that occurs to middle-class urban communities shows a low adaptation capacity. Whereas adaptation capacity can reduce the level of vulnerability that occurs to urban areas. The higher the level of community adaptation, the lower the vulnerability due to climate change. Efforts to conserve the environment need to be done so that the sustainability of urban area can be maintained.

## 1 INTRODUCTION

Climate change leads to every sector of urban community life. The community is a part to the most affected by climate change (Doherty, et al., 2016). Essentially the condition of the Earth's climate will continue to change, but the process of changing elements of weather and climate to become faster. The latest report issued Intergovernmental Panel on Climate Change (IPCC) in its Assessment Report V mentions the end of 21<sup>st</sup> century increases global surface temperature projected to exceed 1.5-2°C (IPCC, 2014).

Urban areas with all its heterogeneity of activities that occur therein exposed to the impacts on climate change (Alistair & Watkiss, 2011). Change the function of the urban land due to the increased population will increase urban air temperature (Sharifi & Lehmann, 2015). Communities are the ones most affected by climate change. Increased temperatures will increase people's discomfort.

Improving the capacity of communities in climate change adaptation is an important part of reducing the risks and vulnerability levels of the disaster that will be experienced by the community. The vulnerability is a state prone to danger from exposure to pressure

related to environmental and social changes as well as the capacity of adaptation of the people. The vulnerability of the community is the ability of adaptation to society in adjusting to the level of exposure (Adger, 2006).

Study of the level of vulnerability to climate change has been done, but haven't much done on the middle-class urban communities. The results of the study of Lemonsu et al. (2015) mentions an increase in the air temperature in a dense urban area will produce higher urban heat thermal which increases the overall vulnerability of the population. Results of the study of Wang & Zhou (2016) large-scale urban development is producing urban heat island in urban area. Results of the study of Giollio (2018) proposing the adaptation of climate of the city of Sao Paulo, Brazil needs to increase the capacity of adaptation of the political policy in Sao Paulo to address the challenges of climate change on communities of the city, such as the settlement policy, infrastructure, sanitation, water management, and migration.

Large cities, creating other urban environmental problems such as haze weather. Limitations of research about the levels of vulnerability in the urban middle-class communities need to watch out for. Because nearly two-thirds of the population of a

region in the developing world live and activities in urban areas. A middle-class community is a community with revenues that have ranges of \$2-40 per day (Nizar, 2015). Middle-class communities with limited economic conditions expected to adapt to the existence of climate change. Therefore this study aims to examine the level of vulnerability and adaptation of middle class urban communities to climate change that happened in Malang City.

## 2 METHODOLOGY

### 2.1 Research Method

The method that is used in this research is quantitative method with region survey approach. This quantitative method is used to know about the level of vulnerability and adaptation of middle class urban communities to climate change by observation, interview, filling in the form, and collecting the secondary data.

### 2.2 Variety and Source of Data

The data collected is the primary data and secondary data. Primary data is the result of a detailed questionnaire and interviews to the respondents of the research that has been determined. Sampling is done to 96 respondents. The selection of the sample of respondents is selected by purposive random sampling. Selected research respondents in this study is 1) community that has been living in Malang City during the 10-25 years. 2) Community with earnings range of \$2-20 (IDR 27,000-270,000) per day or \$60-600 (IDR 810,000-8,100,000) per month.

Secondary data are data air temperature of Malang 1991-2016 year from Indonesian Agency for Meteorology, Climatology and Geophysics (BMKG) and NOAA's National Climatic Data Center (NNCDC) and map of Malang City.

### 2.3 Analysis Data

Variation on / in air temperature changes was analysis using secondary data have been obtained from Indonesian Agency for Meteorology, Climatology and Geophysics (BMKG) and NOAA's National Climatic Data Center (NNCDC). The analysis was conducted to know the variations changes in the year 1991-2016 so that it can be known increases have occurred in every month and year. The Level of Vulnerability and Adaptation of Middle Class Urban

Communities are analysis in a descriptive by presenting an explanation in detail about the level of adaptation in a middle-class community in Malang City.

## 3 RESULT AND DISCUSSION

### 3.1 Air Temperature Changes Due to Climate Change in Malang City

Climate change is felt by the people of Malang. Rapid growing and concentration of population in urban area are increasing vulnerable to climate change (Tumini & Rubio-Bellido, 2016). Research results showed 94.8% of respondents feel the impact on climate change. Impacts on climate change are felt by the community is increasing the temperature of the air. The results showed a trend of rising temperatures from year after year. In 1991 the range of temperatures ranging from 21.39 °C on the lowest temperature and 24.57°C on the highest temperature. Whereas, in the year 2016 the lowest temperature range 24.32 °C and highest temperatures 25.67°C.

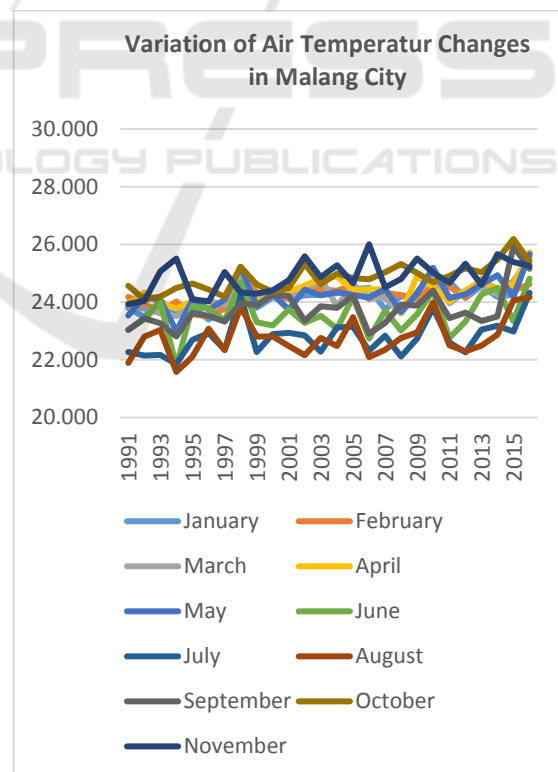


Figure 1: Variation of Air Temperatur Changes in Malang City 1991-2016.

The increase in the air temperature of Malang as one exposure to the disaster that happened to be felt by the community. 58% of respondents stated that the temperature is getting hotter. Increasing air temperature in urban area heat can impact citizens health and the quality of public life in cities (Sharifi & Lehmann, 2015).

Many people have modified the thermal landscape on many spatiotemporal level experiencing negative health effect from increasing air temperature (Sheridan & Dixon, 2016). Increasing air temperature in urban area has been found to be function of urban surface properties with influence by land cover (Wang & Zhou, 2017). High density urban residential development changes micro climate in urban area.

The increased air temperatures caused by devastating open green space in the urban area. The reduction of open green spaces increased micro air temperature in some big cities in Indonesia (Effendy & Aprihatmoko, 2014). When in the open green space have put a damper on solar radiation up to the surface of the Earth.

Open green space able to withstand the maximum temperature. Areas with high temperature have disaster risk is higher compared to areas with low temperatures. This is due to the high temperature areas have a high percentage of the land enclosed which will cause the absorption of solar radiation is high, so that the reflection of the sun's radiation back into the atmosphere is also high (Rushayati, et al, 2011).

Open green space has the ability to stabilize climatic conditions become cool and comfortable. Vegetation reduces the urban heat island effect and stabilization of urban climate (Sarkar & Bhattacharyya, 2015). Open green space can reduce temperature by transpiration (Ramdhoni, et al , 2016).

Benefit of open green space can be ecological, economic, and social benefit. Ecological benefit such as balance carbon and oxygen, absorb toxic gas, adjust urban heat island, water conservation, and biodiversity. Economic benefit such as property values, food and medicine, provide fuel and energy, and reduce damage risks. Social benefits such as shelter and cooling, landscape aesthetics, human health, and education (Byomkesh, at al., 2012).

### 3.2 The Level of Vulnerability and Adaptation of Middle Class Urban Communities

The level of adaptation to climate change was demonstrated through the availability of open green

space settlements and diversity the types of plants in a pot that is owned by the people of the middle class.

First variable of adaptation to climate change showed the none of middle-class community have open green space >7% of the house total area. The results showed 60.4% of respondents do not have open green space, 33.3% have 1-3% of open green space, and 6.3% of the respondents have open green space 4-6% of the house total area. The availability of open green space settlements on middle-class society is very minimal. This is because most of the ownership of land used for building. The limitations of economic conditions and limitations of the land for not doing conservation work.

Table 1: The availability of open green space.

No	Indicator	Percentage	Category	
1	The availability of open green space	None	60,4%	Very low
		1-3% of the house total area	33,3%	Low
		4-6% of the house total area	6,3%	Middle
		7-10% of the house total area	0%	High
		> 10% of the house total area	0%	Very high

Source: Research analysis

The limitation of land, cost of living, and the cost of management of open green space into a middle-class community cause factor does not provide open green space. According to the law of spatial planning No. 26/2007, open green space is a minimum of 30% of the urban area. Which comprises 20% of public open green space and 10% private open green space. The proportion of 30% is the minimum standard for balancing the urban's climate conditions.

Open green space has function to climate amelioration (Ramdhoni, et al, 2016). Open green space help in local habitat and biodiversity conservation, enhance micro climate by reducing albedo and solar radiation load, and keep air quality by trapping particulate pollutants. The role of green space in urban system is very crucial and very important for urban community (Sarkar & Bhattacharyya, 2015). Open green space assumed to

influence health and well-being of urban community (Khotdee, et al, 2012).

Second variable of adaptation to climate change showed that the diversity of the types of plants in a pot. Ownership and diversity of plants in a pot that is owned by the people of the middle class in Malang City belongs to the category of low (53%). Plant in a pot that is owned by the community only a fraction is ecologically beneficial. Most of the plants in a pot that are owned by the community more towards aesthetic function. Because of the condition of the economy of the community tend to meet the most urgent necessities of life. Concern for environmental conservation efforts is the need that can only be enjoyed after the basic needs are met.

Table 2: The diversity the types of plants in a pot.

No	Indicator	Percentage	Category	
1	The diversity the types of plants in a pot	None	19,8%	Very low
		1-3 type	53%	Low
		4-6 type	25%	Middle
		7-9 type	1,1%	High
		>9 type	1,1%	Very high

Source: Research analysis.

Green area consists of different elements, e.g. single trees in gardens, lawns and grass, flowers and ornamental plants as the main provider of ecosystem services (Breuste, et al., 2013). Green area is particularly needed for stabilized ecosystem in urban environment (Byomkesh, at al., 2013). According from ecosystem services of urban green area by Breuste, et al. (2013) each part of vegetation group have different function on ecosystem service.

Table 3: The ecosystem services of urban green space.

No	Vegetation group	Vegetation structure type	Main existing ecosystem services	Main potential ecosystem services
1	Ornamental, horticultural and designed urban vegetation space	Allotment gardens urban trees	Micro climate regulation, air filtering, air temperature reducing	Biodiversity, learning about nature
		Gardens/ parks	Micro climate regulation, rainwater drainage, air filtering.	Recreation, biodiversity, rainwater drainage
		Decorative green (flower beds, small lawn patches, bushes, hedges, etc)	Decoration, cultural values	Biodiversity

Source: Adaptation from Breuste, et al., 2013.

Adaptability is the response from individuals and communities to the impacts of changes in the environmental conditions that have and will happen (Adger, 2006). Low adaptability in middle-class communities causing them is vulnerable to the risk that is going to happen to the future. However, the expectation is through good financial management on individuals and community groups the middle class will be able to set aside a portion of revenues for environmental conservation efforts. Because of the increase in temperature due to climate change impacts will continue to occur (IPCC, 2014).

The level of vulnerability is a condition of an individual or society that lead to or cause incapacity in the face of the threat of danger (Kumalasari, 2014). Analysis results to indicate that increasing the level of exposure to increased air temperature then must be

balanced by an increased rate of adaptation. If exposure to increased temperatures are offset by an increase in adaptation to climate change risk then it will continue to be felt. High adaptation capacity will be able to reduce the level of vulnerability that occurs to urban areas (Kumalasari, 2014).

Urban area must be central to global climate change mitigation. Urban areas are responsible for around three quarter of global energy use, because more than half of world's population live in urban area (Gouldsaon, et al., 2016). High speed and high density of urban area must be contributed not only urban environmental problems but also solution of the problem in urban area. The environmental conservation activity of middle class of urban communities must be increasing cope with climate change for the future.



## 4 CONCLUSIONS

Based on the results of the study it was concluded that the variations in temperature increase due to climate change has occurred and its impact has been felt by the people in Malang City. The level of adaptation and vulnerability based on results of research shows an alarming results. This is because the level of adaptation seen from the variable availability of open green space settlements is on average lower categories and diversity of plants in a pot in the middle-class communities fall into the category of low. Whereas the impact on vulnerabilities to climate change has been felt by 94.8% of respondents, however, the conservation of the environment is only a fraction of the community. Advice can be given on the basis of the findings of the research was the need for socialization to society the middle class will be the importance of environmental conservation efforts as an attempt on adaptation to climate change and further research to analysis another variable the level of vulnerability and adaptation so that it can give a contribution to the society to be more prosperous and comfortable.

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