Drought Adaptation of Water Usage in Regular and Irregular Settlements (Case Study: Jatinegara District, East Jakarta)

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Abstract. Today big cities become the first aim for people who wants to get a better condition for their economy and half of the population in the world lives in big cities (United Nation Population Fund, 2007). Climate change is a condition where the atmosphere in unstable. It can happen in places that has high population. There are some data to support this research which are primary and secondary data. But data processing, including the processing, statistical and tabular data, and also spatial data processing. The process to find dry area is delineation form based on PDAM pipe and based on types of settlement. So, there are two types of adaptation based on area which are very dry and not dry. The adaptation pattern in regular and irregular settlement at very dry area are minimize the amount of water usage, and hold water. On the other hand, the pattern of adaptation in regular settlement at not dry area are minimize the amount of water usage and also adding bottled water for dish and drink.

1. Introduction
Jakarta has unique characteristics based on geographical, geological and demographic characteristics. Based on geographical characteristics Jakarta has 13 rivers and 2 canals. Based on geological characteristics, the northern part of Jakarta has alluvial soil and it has depth about 10 to 25 meters. But the alluvial soil on southern Jakarta has depth about 8 to 15 meters. Jakarta has complex condition such as demographics, social, economy and culture. The population in 2014, East Jakarta has already reached about 2,817,994. On Kecamatan Jatinegara the population in 2014 already reaches 271,216. Today big cities become the first aim for people who wants to get a better condition for their economy and half of the population in the world lives in big which can encourage higher population in Jakarta.

Climate change is a condition where the atmosphere in unstable. It can happen in places that has high population. In 2014, Jakarta is experiencing drought that caused by El-Nino. The greatest impact in 2014 occurs in North Jakarta, Central Jakarta and East Jakarta. But, in 2015 the greatest impact occurs in East Jakarta and West Jakarta [1]The characteristics of drought in East Jakarta are meteorology and hydrology. The condition during drought are the supply from PDAM and groundwater are getting a reduction. Residents in Kecamatan Jatinegara will deepen the well to get. Because of the reduction of groundwater, residents who lived in Kecamatan Jatinegara experience difficult to get water.

There is some reason for site selection in the study, which are based on social economy and densely populated settlements. The settlements are choosing to help for spatial analyzing which are using spatial approach. This approach are used for comparing each territory that has equality and differences each place. Based on the paragraph above, there are two problems that will help explain two conditions such as the water usage in households with difference economy and the number of family members. So, there are two research questions first how the water usage based on the household characteristics and water sources in regular settlements and irregular settlements on dry area. Second, how to change the water usage in drought condition based on the regular settlements and irregular settlement. The purposes of this research are to identify adaptation on two settlements based on each characteristic of a number of family members and water usage when the drought occurs.

2. Methodology
2.1 Flow of Thinking
This research is explaining about the adaptation of water usage. There are some influential things that form adaptation, such as education, experiences, and individual background [2,3,4,5]. Another factor is the social-economic factor which explained about the location of residence to find the level of risk to be faced from climate change [6]. In this research, we measured the spatial behaviour to get the adaptation capacity. People with low economic condition are very risk to their new environment and they are very sensitive and they are also vulnerable to adapt [7].

Figure 1. Flow of Thinking

2.2 Data Collecting
There are some data to support this research which are primary and secondary data. There are six data to complete this research which is regular and irregular settlement maps (scale 1:250,000 in 2014 from spatial administration city East Jakarta), land use maps East Jakarta Kecamatan units in 2006 from Badan Informasi Geospasial, water sources data from PT. Aetra Air Jakarta, water distribution data in Kecamatan Jatinegara from PT. Aetra Air Jakarta, zonation maps Kecamatan Jatinegara in 2014 from DI Kecamatan Jatinegara. Primary data are collected from agencies, studies, characteristics family member (number of family members, income, jobs and level of education), water usage (shower, wash, toilet, dish and drink) and also water resources (groundwater, bottle water, and PDAM water) were collected through field survey on January 2017 by doing the observation, questionnaire and interview.

2.3 Data Processing
Data processing including the processing, statistical and tabular data, and also spatial data processing. Tabular data processing by calculating the average number from water usage in normal condition and dry condition (litres/household/day). The calculated average number of water usage is using Ms. Excel. There are 4 classifications from water usage calculation which are low, medium, high and very high. The classification of water usage in normal condition which are low (<350 litres), medium (350 – 699 litres), high (700 – 1050 litres) and very high (>1051 litres). Besides that the classification of water usage in dry condition which are low (<361 litres), medium (362 – 721 litres), high (722 – 1081 litres) and very high (>1082 litres). Statistical data processing used to see the correlation between family characteristics and the number of water usage in normal condition and also dry condition. This data processing is using SPSS 2.1. Other than that, there are two spatial data processing which is delineation for regular and irregular settlement and also delineation for dry area. There are three classifications in dry area which are not dry (5499.68 m), dry (5500 – 11000 m) and (11001 – 16501 m), and very dry (>16502 m).
2.4 Data Analysis
In this research, there are two questions that support this study. First, “How is the pattern of water utilization under normal conditions based on the family member characteristics and water sources at for this question we used descriptive spatial analysis and statistics analysis. Descriptive spatial analysis is used for analyzing water usage in regular and irregular settlements on dry area. Statistical analysis is used for correlating the family member characteristics and water usage based on daily activities. Second, “How is the adaptation pattern of regular and irregular settlement on dry area?” for this question we used descriptive spatial analysis. Descriptive spatial analysis is used for analyzing the adaptation on dry area. It aims for analyzing the changes of water sources and water usage.

3. Study Area
3.1 Land Use of Kecamatan Jatinegara
Kecamatan Jatinegara is one of the sub-district in East Jakarta that has 8 kelurahan (Kelurahan Kampung Melayu, Bidaracina, Balimester, Cipinang Besar Utara, Rawabunga, Cipinang Besar Selatan and Cipinang Muara). The location of Kecamatan Jatinegara is at 106° 49’ 35” BT and 06°10’37” LS. Kecamatan Jatinegara borders with several sub-districts and other administrative areas, consisting of:
- North: Kecamatan Pulogadung and Matraman, East Jakarta
- East: Kecamatan Duren Sawit, East Jakarta
- South : Kecamatan Makasar and Kecamatan Kramat Jati, East Jakarta
- West: Kecamatan Tebet, South Jakarta
The area of land was built in Kecamatan Jatinegara is about 95%. Based on the percentage of area of land was built there are two types that dominate in Kecamatan Jatinegara which are regular and irregular settlement. The area for regular settlement is about 32%, but the area of irregular settlement is about 36%. So, we can conclude that the irregular settlement area is wider than regular settlement.

3.2 Water Sources in Regular and Irregular Settlement
There are two types of water sources in Kecamatan Jatinegara which are groundwater and PDAM. People in Kecamatan Jatinegara still dominate use groundwater than PDAM. Based on water sources, people who use groundwater are very minimize their water usage for a drink from bottled water than people who use PDAM (See table 1).

| Table 1. Percentage of Water Sources Based on Types of Settlement |
|---------------------------------------------------------------|
| **Type**          | **Regular Settlement** | **Irregular Settlement** |
| Groundwater (%)   | 65.71                  | 57.14                     |
| PDAM (%)          | 34.29                  | 42.86                     |
Sources: Field survey, 2017

3.3 Water Usage on Regular and Irregular Settlement
There are several types of activities for water usage in regular and irregular settlement which are shower, wash, toilet, dish and drink. Overall, people who lived in regular and irregular settlement has the higher water usage for the shower. But based on the types of settlement, there are several differences from water usage. On regular settlement, the highest amount of water usage is to wash, dish and drink, but in irregular settlement the highest amount of water usage is for toilet, shower and drink (See table 2).

| Table 2. Percentage of Water Usage Based on Types of Settlement |
|---------------------------------------------------------------|
| **Settlement Type**               | **Shower** | **Wash** | **Toilet** | **Dish** | **Drink** |
|-----------------------------------|------------|----------|------------|----------|-----------|
| Regular Settlement (%)            | 49.34      | 57.54    | 48.23      | 55.10    | 50.01     |
| Irregular Settlement (%)          | 50.66      | 42.46    | 51.77      | 44.90    | 49.99     |
Sources: Field survey, 2017
4. Results and Discussion

4.1 Drought Sensitivity

4.1.1 Population in Kecamatan Jatinegara

Highest population can cause stress to people in big cities. This influence can increase for water usage and the density of urban areas, so it can affect drainage in the settlement. The high density of the population causes the higher land to be built thus reducing the water catchment area. This condition can explain that there is inequality of water sources, so people cannot access the water sources in maximum quantity.

There are other impacts from the high density of the population. Especially for people who has income less than Rp.2,700,000 prefer to choose an area which has a lower cost. In big cities, the high density of population can cause the high growth of irregular settlement and also it cause the high stress for people when the dry condition happened. So, based on the paragraph we can conclude that the high population in irregular settlement can affected the highest level of sensitivity in society (See figure 2).

4.1.2 Water Supply in Kecamatan Jatinegara

There are two water sources in big cities which are groundwater and PDAM. People in Kecamatan Jatinegara are still using groundwater than PDAM. There is some reason for people in Kecamatan Jatinegara to use groundwater are cheaper and they can get the water easier than PDAM. But based on water sources, groundwater is very sensitive than PDAM. But, people in Kecamatan Jatinegara are still using groundwater than PDAM. Groundwater depends on surface water condition, if the intensity of rainfall getting low so the condition of water surface is getting low. PDAM water supply is more stabilized than groundwater. Most of the people in Kecamatan Jatinegara that use PDAM can do their activities, especially people who have high income they can use PDAM when the drought occurs. Based on the paragraph, level sensitivity of PDAM is lower than groundwater (See figure 3).
4.1.3 Income in Kecamatan Jatinegara

There are three classifications of income which are less Rp.2,700,000, Rp.2,800,000 to Rp.5,900,000 and more than Rp.6,000,000. The higher the amount of income per months can minimize stress from climate change. People who have an income less than Rp.2,700,000 cannot access the facility, especially to get water sources when drought occurs. And, they also prefer to choose irregular settlement. Not only that, people who have low income are very risk and the amount of water usage are very low which is about 300 litres per day. Based on income, people who have low income can affect selection of living environment, jobless and less education. And also they cannot tackle the climate change. In Kecamatan Jatinegara are dominated with people who has low income than high income (See figure 4)
4.2 Drought in Kecamatan Jatinegara

The drought occurrence in Kecamatan Jatinegara caused a change of water utilization. Overall, in Kecamatan Jatinegara experiencing drought, especially in irregular settlement. This drought is measured by doing measuring the pipe of PDAM. Based on sensitivity, people who has a low income and use groundwater has higher sensitivity than people who has high income and use PDAM (See figure 5).

![Figure 5. Drought in Kecamatan Jatinegara](image)

4.3 Adaptation

4.3.1 Adaptation Based on Water Sources

There are several ways for people to adapt when drought occurs. First, people in regular and irregular settlement at dry area are minimizing the water usage, because of the limitations of the water sources. Other than that, they try to reduce and adding a new water sources for their daily needs. For example, people in the irregular and irregular settlement reduce the water usage for shower, wash, toilet, dish and drink. They use groundwater or PDAM for shower, wash, and a toilet, but they use bottled water for dish and drink. On different area, people at not dry area usually only reduce their frequency of water usage and they not adding new water sources. They use groundwater or PDAM for shower, wash, toilet, dish and drink (See figure 6).

![Figure 6. Adaptation Based on Water Resources](image)
4.3.2 Adaptation Based on Income

There are several adaptation patterns based on income. Income is the best measure to know about sensitivity in the face of change. People who have low income is very risk than people who has a high income. This condition can affect the level of sensitivity to survive in climate change. Based on income, people who has low income are very risk when the drought occurs, because they cannot access the facilities of water sources. The amount of water usage for people with low income for shower, wash and toilet is decreased about 194 litres per day. On the other condition, people who have high income are not affected significantly. The amount of water usage for people with high income for shower, wash and toilet is decreased about 158 litres per day (See figure 7)

**Figure 7. Adaptation Based on Income**

4.3.3 Adaptation Based on Number of Family Member

The number of family members is the main factors from the amount of water usage. There are four classifications the number of family members which are less than 3 peoples, 3 to 5 peoples, 5 to 7 people and more than 7 people. The average of water usage from 3 to 5 peoples is about 269 litres per day for shower, wash and toilet and also the average of water usage for a drink and dish about 187 litres per day. But when the drought occurs, they decrease the amount of water usage for shower, wash and toilet is about 129 litres per day and also they decreased the amount of water usage for dish and drink is about 4.47 litres per day. Overall, the highest of family member are usually adding bottled water for drink and dish (See figure 8)
5. Conclusion
There are two types of adaptation based on area which are very dry and not dry. The adaptation pattern in regular and irregular settlement at very dry area are minimize the amount of water usage, hold water, minimize the frequency for shower, wash and toilet, and also adding bottled water for dish and drink. On the other hand, the pattern of adaptation in regular settlement at not dry area are minimize the amount of water usage for shower, wash and toilet, not to change the water sources for shower, wash and toilet, and also adding bottled water for dish and drink.

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