Study of slum settlement infrastructure in Pulonas Village, Babussalam Sub-district, South East Aceh Regency

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Abstract. In 2015 the population of Babussalam District was 2,758 people per km$^2$ with an area of 9.42 km$^2$ or a density of up to 293 inhabitants per km$^2$. With this population density, Babussalam District can be classified into areas with high density. Babussalam Subdistrict which consists of 27 villages. Pulonas Village which is indicated as slums and are predicted to continue to deteriorate. The condition of settlement infrastructure in Pulonas Village are very poor, such as narrow and damaged roads with infeasible clean water and infeasible waste collection. High building density with limited area and the number of occupants in a dense building is a big problem that occurs in Pulonas Village today. The research method used in this study is a Qualitative Descriptive Methodology, in which researchers interpret the data obtained through direct observation in the field. The data are interpreted and the method of data collection is based on theoretical basis. The results of the study were recommendations and directions for the management of slums in Pulonas Village Babussalam Sub-district, Southeast Aceh Regency, beneficial for local government and stakeholders in determining the direction of local government policy.

1. Introduction
Healthy Housing or settlement depend on the condition and availability of residential facilities and infrastructure, such as clean water service, waste service, road network and transportation services, as well as the availability of social services [1].

Based on Southeast Aceh’s Regent Adjudgment about Classification and Allocation of Slum and Slum Housing area in Southeast Aceh Regency on October 31, 2014 Babussalam Sub-District consisting of 27 villages indicated as slums, and Pulonas is one of those slum that assume to get deteriorate. The development of the city led to the increasing number of the population in the city center with a narrow area causing the increasing need for housing. However, the increasing need for inhabitable housing doesn’t grow in a line with availability of good facilities and infrastructure. This is one of the problems that occurs in Pulonas Village Babussalam District southeast Aceh Regency.

Pulonas village is located at latitude coordinates 4,74512452 longitude 97.14805556 with a village area of 35.55 Ha and a settlement area of 12.30 Ha. The boundaries of Pulonas village are as figure 1.
This research is aimed to have a beneficial research results that provide better direction for the future city development planning and design, and the main purpose of this research is to analyzes the slums level in Pulonas Village from it infrastructure conditions aspect.

2. Research methods
This study uses Qualitative Descriptive Analysis. Data analysis techniques in achieving study objectives are carried out by scoring on each variable. Doing an objective scoring, it is necessary to explain each issue of the problem found at the study field. The results of the assessment are an information about the variables that most affect the current condition of the Region and impact on the quality of settlements in the slum area. The value is given to each particular factor by giving weight to each parameter to determine the level of ability based on the criteria specified, so that by scoring we can determine the level of ability based on the levels of those parameters [2]. The first step is to analyze the data in this study, select the data needed in the study and then grouping it into each variable and be classified based on each indicator criteria. Variable scoring is the result of the accumulated summation of each indicator.

Clarification of weight to determine the level of slums is divided based on the level of condition or circumstance, level of importance, level of service provided [3]. The share of values is set at 5, 3 and 1, where the highest value is representative of the high slum conditions of the settlement area, which can be seen in Table 1.

| No. | Variable            | Indicator                  | Criteria | Weights | Weight Classification |
|-----|---------------------|----------------------------|----------|---------|-----------------------|
| 1.  | Infrastructure      | Environmental road conditions | >76%     | 1       | Bad                   |
|     | aspects             |                            | 51 – 75% | 3       | Are                   |
|     |                     |                            | 25 – 50% | 5       | Good                  |
|     |                     | Environmental drainage     | >76%     | 1       | Bad                   |
|     |                     |                            | 51 – 75% | 3       | Are                   |
|     |                     |                            | 25 – 50% | 5       | Good                  |
|     |                     | Clean water condition      | >76%     | 1       | Bad                   |
|     |                     |                            | 51 – 75% | 3       | Are                   |
| Indicator          | Percentage | Score |
|-------------------|------------|-------|
| Wastewater        | >76%       | 1     |
|                   | 51 – 75%   | 3     |
|                   | 25 – 50%   | 5     |
| Conditions of waste | >76%       | 1     |
|                   | 51 – 75%   | 3     |
|                   | 25 – 50%   | 5     |
| Fire protection   | >76%       | 1     |
|                   | 51 – 75%   | 3     |
|                   | 25 – 50%   | 5     |

The results of the scoring are intended to answer the purpose of the study which is to know the dominant factors or variables that affect the condition of slums. From the analysis of the theory study concluded that the higher the score of each indicator then the lower slum inhabitable level, vice versa the lower the score gained then the higher inhabitable settlement value.

3. Results and discussions

3.1 Analysis of environmental road network conditions

In Regulation of the Minister of Public Works No. 13/PRT/M/2011 on Road Maintenance Procedures in the assessment table RCI (Road Condition Index) mentioned that damaged roads is one that found many holes on it surface and has not been maintained between 4 - 5 years. From the above statement, it can be seen that the condition of the road network in Babussalam sub-district is still quite feasible. Almost the entire length of the road is hardened by the width ≥ 1.50 m but there are still many roads that do not have roadside trench. The assessment of the percentage of roads network condition is apply to roads with good hardened surfaces and damaged surface and also with roadside trench [3].

The environmental road conditions in Pulonas Village are inappropriate, although there are some road network developments but not all of them are asphalted. Some road networks have been equipped with drainage networks. Environmental accessibility for some areas is still lacking especially in residential areas there are still footpaths with a width of less than 1.5 meters and roads with poor condition (muddy and rough when it is raining). The percentage of roads in Pulonas Village can be seen in Table 2.
Table 2. Condition of environmental road network in Pulonas Village

| No. | Village Name | Total length of environmental road network | Total length of environmental road network with width ≥ 1.5 m | Environmental road length with width ≥ 1.50 m hardened surface | feasible environmental road network coverage (%) | Environmental road length with width ≥ 1.50 m which is hardened and not damaged | The length of the environmental road width ≥1.5 m equipped with roadside trench | Road that meet technical requirements (%) |
|-----|--------------|-------------------------------------------|----------------------------------------------------------|------------------------------------------------------------|-----------------------------------------------|--------------------------------------------------------------------------------|---------------------------------------------------------------------------------|------------------------------------------|
| 1.  | Ban Ban      | 400,00                                    | 250,00                                                   | 250,00                                                     | 62.50                                          | 250,00                                                                           |                                                                                   | -                                         |
| 2.  | Manunggal    | 500,00                                    | 250,00                                                   | 250,00                                                     | 50.00                                          | 250,00                                                                           |                                                                                   | -                                         |
| 3.  | Pulonas Kute | 500,00                                    | 360,00                                                   | 300,00                                                     | 60.00                                          | 300,00                                                                           | 290,00                                                                           | 58.00                                    |
| Total|              | 1,400,00                                  | 860,00                                                   | 800,00                                                     | 57.14                                          | 800,00                                                                           | 290,00                                                                           | 20.71                                    |

So the total length of the environmental road in Pulonas Village is 1,400 meters, the length of the environmental road with width ≥ 1.5 meters is 860 and 800 meters with hardened surface, the length of the environmental road with width ≥ 1.5 meters with hardened surface and equipped with roadside trenches is 290 m. So the length of the road that does not meet the technical requirements is:

\[
\text{Damaged road length} = \text{Total road network length} - \text{Roads that meet technical requirements} \\
= 1,400 \text{ m} - 290 \text{ m} \\
= 1,110 \text{ m}
\]

After obtaining the length of the damaged road number then the percentage value of road conditions with a damaged surface is 79.29 % of the total roads and included in the bad category, it is calculated using the following formula:

\[
\text{Percentage value of Damage road} = \frac{\text{Damaged road length}}{\text{Total road length}} \times 100 \quad (1)
\]

3.2 Environmental drainage condition analysis

Drainage is an infrastructure engineering in an area to anticipate flooding [4]. Drainage network condition in Babussalam sub-district is quite feasible because there is side waterways on every building along the road although there are still few are not connected to the city waterways. The drainage problem that occurs in Babussalam sub-district is that there is no a proper drainage management so that drainage is clogged. Criteria slums reviewed from environmental drainage including [3]:

a. Drainage environment is not available, is a condition where the tertiary waterways of local waterways is unavailable, does not connect to the waterways above it level and preventing water to flow and causing inundation.

b. Drainage environment is unable to drain off the rain water and causing inundation, it is a condition where environmental drainage network is unable to drain water off and causing inundation with more than 30 cm height for more than 2 hours and occurs more than 2 times a year.

c. Environmental drainage construction quality is poor, is a condition where the quality of drainage construction is poor because it is build on soil without coating material or cover or there has been damaged.
Pulona village does not have feasible drainage, poor drainage maintenance conditions at some spot are seen covers with some wild plants and garbage that prevent drainage from drain properly. Most of Environmental road drainage conditions quality does not meet technical requirements nor working properly, so there are often puddles during the rainy season even though it is only for a few hours but it can disturb the comfort of residents across the area and also cause a bad smell. Any development of the city or region should be followed by improvements to the drainage system, not only at the developed site, but also should cover the surrounding area, and should get to landfill [5]. If a drainage cannot drain rainwater and wastewater into the final waterways then the drainage is failed fulfilling it function. The assessment of drainage percentage in Pulonae Village can be seen in Table 3.

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\text{Table 3. Quality of drainage construction in Pulonae Village}
\]

| No. | Village Name | The area of the settlement that is not inundation / flood (Ha) | Percentage of settlement areas do not inundation / flooding (%) | Total drainage length (meters) | The length of the drainage network condition at the settlement area in a good quality and work properly (meters) | The percentage of drainage network conditions at settlement area has feasible and minimum quality (%) |
|-----|--------------|-------------------------------------------------------------|---------------------------------------------------------------|-------------------------------|-------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|
| 1.  | Ban Ban      | 5.00                                                        | 0.00                                                          | -                             | -                                                                                               | -                                                                                               |
| 2.  | Manunggal    | 5.75                                                        | 0.00                                                          | -                             | -                                                                                               | -                                                                                               |
| 3.  | Pulonae Kute | 8.81                                                        | 98.00                                                         | 290.00                       | 285.00                                                                                          | 98.28                                                                                           |
| TOTAL | 19.56        | 32.67                                                       | 290.00                                                        | 285.00                       | 32.76                                                                                           |

So the length of drainage that does not meet the technical requirements is

\[
\text{Damaged drainage length} = \text{Total drainage length} - \text{drainage according to technical requirements}
\]

The percentage value of road conditions with damaged surfaces is 1.72%.

3.3 Analysis of clean water conditions

Clean water in the settlement should be available properly both in the sense of quality and standards, the amount is sufficient, continuous availability and easily affordable, which makes the residents of the settlement will be comfortable living with [3, 6]. The needs of clean water in Pulonae Village in the dry season can be fulfilled, the assessment of the percentage of clean water services in Pulonae Village can be seen in Table 4.

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\text{Table 4. Condition of clean water service in Pulonae Village}
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| No. | Village Name | Total Household (H) | Number of household served by proper drinking water, bathing and washing (piping or non-proper protected piping) (H) | Percentage of Household served with drinking water, bathing and washing (piping or non-proper protected piping) (%) | Number of household met the needs of drinking water, bathing and washing (minimum 60 liters / day) |
|-----|--------------|---------------------|---------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------|
| 1.  | Ban Ban      | 74                  | 74                                                                                                           | 100                                                                                                           | 74                                                                                           |
| 2.  | Manunggal    | 100                 | 34                                                                                                           | 34                                                                                                           | 100                                                                                           |
| 3.  | Pulonae Kute | 100                 | 53                                                                                                           | 53                                                                                                           | 73                                                                                           |
| TOTAL | 274          | 161                 | 62                                                                                                           | 247                                                                                                           | 73                                                                                           |
So the total number of household (H) in Pulonas Village are 274 households and the number of people who met their drinking water needs, bathing and washing (at least 60 liters / day) are 247 households, so the number of people who have not accessed the needs of clean water are:

Underserved communities = Total number - Underserved communities
= 274 H - 247 H
= 27 H

After obtaining the number of people who have not accessed the need for clean water, the percentage value of people who have not accessed clean water amounted to 9.85% of the total community in household units and belongs to the good category, calculated using the following formula:

\[
\text{Percentage value} = \frac{\text{Number of underserved communities (H)} \times 100}{\text{Total number of Household (H)}}
\] (2)

3.4 Wastewater condition analysis

Defines wastewater as residual water from activities that have been used by humans [7]. So if the wastewater flows continuously it must be flowed technically so it will not pollute the environment [3]. The criteria for slums reviewed from wastewater management including [3]. For more details on the condition of wastewater located in Pulonas village can be seen in Table 5.

**Table 5. Wastewater management conditions in Pulonas Village**

| Village Name | Total Household | Number of household have access to family latrines / collective latrines (5 H/latrines) (H) | Percentage of Household have access to family latrines / Collective latrines (5 H/latrines) (%) | Number of family latrines/collective latrines meet technical requirements (has a goose neck toilet connected to a septic-tank) | Percentage of family latrines/collective latrines meet technical requirements (has a goose neck toilet connected to a septic-tank) (%) | Separate household wastewater separated with environmental drainage (%) |
|---------------|-----------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|-------------------------------------------------|---------------------------------------------|
| Ban Ban       | 74              | 68                                              | 92                                              | 69                                              | 93                                              | 90                                         |
| Manunggal     | 100             | 56                                              | 56                                              | 5                                               | 5                                               | 0                                          |
| Pulonas Kute  | 100             | 94                                              | 94                                              | 90                                              | 90                                              | 0                                          |
| **Total**     | **274**         | **218**                                         | **81**                                          | **164**                                         | **63**                                          | **-**                                      |

So the total number of household (H) is 274, the people who have access to family latrines / collective latrines (5 H / latrines) in Pulonas Village are 218 households and the number of family latrines / collective latrines that meet technical requirements of having a closet connected to septic-tanks are 164 households, so the number of communities that have not access to wastewater management needs are:

Non Underserved communities = Total number of Household - underserved Household
= 110 H

The percentage value of people who have not accessed to wastewater management is 40.15%.
3.5 Analysis of the condition of the waste
The management of waste including several phases, starting from the initial phase to the final phase with several methods including: 1. The provision phase or the shelter phase; 2. Collection and transport phase; 3. Disposal phase [8, 9]. Domestic collecting and sorting.

Table 6. Condition of waste management in Pulonas Village

| No. | Village Name | Total number of Household | Waste Management Conditions |
|-----|--------------|---------------------------|----------------------------|
|     |              |                           | The amount of domestic waste of households in settlement areas transported to the landfills minimum twice a week | The percentage of domestic household waste in settlement areas transported to landfills min. twice a week (%) |
| 1.  | Ban Ban      | 74                        | 6                          | 8                          |
| 2.  | Manunggal    | 100                       | 0                          | 0                          |
| 3.  | Pulonas Kute | 100                       | 59                         | 0                          |
| Total|              | 274                       | 65                         | 22                         |

So the number of people who have not accessed the needs of waste management are:

Non Underserved communities = Total Household - Underserved Household = 209 H

The percentage value of people who have not accessed waste management is 76.28%.

3.6 Fire protection analysis
It is divided into passive protection, active protection, and fire safety management [10, 11]. The assessment of the percentage of fire protection in Pulonas Village can be seen in Table 7.

Table 7. Fire protection conditions in Pulonas Village

| No. | Village Name | Percentage of settlement areas have fire protection infrastructure/ facilities | Total number of house | Number of homes with fire protection infrastructure/ facilities |
|-----|--------------|--------------------------------------------------------------------------------|-----------------------|-------------------------------------------------------------|
| 1.  | Ban Ban      | 63%                                                                            | 42                    | 0                                                           |
| 2.  | Manunggal    | 80%                                                                            | 26                    | 0                                                           |
| 3.  | Pulonas Kute | 60%                                                                            | 41                    | 0                                                           |
| Total|              | 58%                                                                            | 109                   | -                                                           |

Up to now Pulonas village area is vulnerably potential of fire risk with only 42% of settlement areas have fire protection infrastructure and 0% of settlement areas do not have the availability of infrastructure.

3.7 Study of slum level in Pulonas Village
The results of scoring analysis that has been done on the infrastructure aspects that affect slums, from scoring analysis obtained the level of slums in Pulonas Village that can be seen in Table 8.

Table 8. Summary of Analysis of slum infrastructure conditions in Pulonas Village

| No. | Variable | Indicator | Criteria | Analyzes | Indicator Value | Classification | Handling Priorities |
|-----|----------|-----------|----------|----------|-----------------|----------------|---------------------|
| 1.  | Infrastructural environment road conditions | >76% | 79.24% | 1 | Bad | Handling priorities are: |
|     |          | 51 – 75% |          |          |                 |                | 1. Neighborhoo      |
There are still some bad scores > 76% such as indicator of environmental road conditions with a value of 79.24% and waste condition indicator at 76.28% which is means bad condition.

4. Conclusion
There is a recommendation and direction of structuring the infrastructure of slums as follows:
1. Slum management policy should be emphasized at Pulonas Village especially for road infrastructure, wastewater management and wastewater conditions;
2. For Local Managers/Governments
   a. Regulations are required to support the restructuring of slums.
   b. Continuous development and supervision are required.

References
[1] Kodoatie 2002 Krieger J and Higgins DL 2002 Housing and Health : Time Again For Public Action Am J Public Health 92 5 758–759.
[2] Farizki M and Anurogo W 2017 Majalah Geografi Indonesia 31(1) 39–45.
[3] Peraturan Menteri Pekerjaan Umum dan Perumahan Rakyat. Nomor 14/PRT/M/2018 Tentang Pencegahan Dan Peningkatan Kualitas Terhadap Perumahan Kumuh Dan Permukiman Kumuh, Jakarta.
[4] Trisakti B, Lubis J, Husaini T, Irvan 2017 IOP Conf. Series: Materials Sci. Eng. 180(1) 012150
[5] Fauzie F 2012 Banjir karena Salah Konstruksi Drainase. Haryono P 2010 Perencanaan Pembangunan Kota Dan Perubahan Paradigma. Yogyakarta: Pustaka Pelayar.
[6] Yanqoritha N, Turmuzi M, Irvan, Fatimah, and Derlini 2018 Oriental Journal of Chemistry 34 (3) 1653-1657
[7] Achmad, Supriyadi S and Maharani V 2011 Metodologi Penelitian Manajemen Sumber Daya Manusia, UIN-Maliki Press, Malang. Budihadjo E 1997 Sejumlah Masalah Masalah Permukiman Kota. Bandung: PT. Alumni.
[8] Wasito S 1992 Pengelolaan Sampah di Daerah Perkotaan, Jakarta.
[9] Mantra I B G W 2005 Kajian Penanggulangan Bahaya Kebakaran pada Perumahan Sarjadi, Bandung (Sebuah Kajian Pendahuluan di Perumahan Sarjadi, Bandung).
[10] Nizar M, Munir E, Munawar E and Irvan 2018 IOP Conf. Ser: Journal of Physics 1116(5) 052045
[11] Nizar M, Munir E, Irvan and Waller V 2018 IOP Conf. Ser: Earth and Environ. Sci. 216(1) 012043