

## Slum area mapping in Kiom, Tual, Maluku

L F Widyawati<sup>1</sup>, Aditianata<sup>1</sup>, and R Y Suryandari<sup>1</sup>

<sup>1</sup>Department of Urban and Regional Planning, Faculty of Engineering, Esa Unggul University, Jakarta, 11510, Indonesia

Corresponding author's email: lailifujiwidyawati@esaunggul.ac.id

**Abstract.** Tual City, Maluku is one of the cities in Indonesia with slum problems. Based on Mayor Decree No. 182/2014, Tual City contains 15 slum areas with a total area of 133.89 Ha. One of which is Kiom, Ketsoblak Village, North Dullah Sub-district with an area of 2.2 Ha. Kiom is located at the waterfront of a fishermen's settlement and has no legal permits. This paper aims to contribute to the development of tools for slum mapping, by using spatial information to characterize land use patterns, develop an area typology, as well as slum area mapping taxonomies. The typology of slum areas is based on seven physical criteria such as buildings, neighborhood roads, drinking water supply, drainage, wastewater treatment, waste management, fire protection and legality that identify Kiom as a slum area. Most building construction in Kiom is irregular and not in accordance with building standards. The slums in Kiom are categorized as illegitimate heavy slums. Thus, the best possible scheme is to legalize the land for urban renewal.

### 1. Introduction

According to UN-Habitat, slums are settlements that lack durable housing, sufficient space, safe water, adequate sanitation, and security of tenure. Its land use is not in accordance with its initial design as green open space has been turned into a settlement function. Slum areas have specific physical characteristics, social characteristics, and are context-dependent, thus, local knowledge is essential in studying these areas.

Slums are inappropriate settlements because of construction irregularities, high density, low building quality, and inadequate facilities. Slum dwellings are usually inhabited by low-income households, located on illegal locations, and are not served by urban facilities. Squatter settlement as a residential area that has developed without legal claims to the land and/or permission from the relevant authorities to construct it, as a result of their illegal or semi-legal status, infrastructure and services are usually inadequate [1]. As a result of their illegal or semi-legal status, infrastructure and services are usually inadequate. The study of informal settlements, also known as slums, squatter settlements, congested communities, shantytowns, self-help housing [2] and spontaneous settlements requires a formal definition followed by a discussion of the process of their formation and pattern [3]. The Regulation of the Ministry of Public Works and Public Housing No. 2/2016 concerning Quality Improvement of Slum Housing and Slum Settlements has determined the criteria for determining slum conditions in slum housing and slum settlements. This study will assess the slum settlements based on physical and non-physical criteria (legality). There are seven physical criteria, i.e., buildings,



neighborhood roads, drinking water supply, drainage, wastewater treatment, waste management, fire protection, and non-physical criteria. Another consideration is legality.

The problem of slums is not merely an issue of metropolitan areas such as Jakarta but also occurs in other cities in Indonesia. One of the cities with a slum problem is Tual City, Maluku. Tual City is an archipelago consisting of 66 islands, 13 of which are inhabited. Dullah Island is the largest island in the archipelago. Based on Mayor Decree No.182/2014, Tual City comprises 15 slum areas with a total area of 133.89 ha. One of which is Kiom, Ketsoblak Village, North DullahSubdistrict with an area of 2.2 Ha. Kiom is located near the entrance gate of Tual City. Considering this location, ideally, Kiom should have a beautiful and clean environment. However, its strategic location near the city center is not utilized due to the existence of a slum area. Kiom is located at the waterfront of a fishermen's settlement and lacks legal permits. Most buildings in Kiom are unregulated and not in accordance with technical building standards. The people of Kiom lack access to sanitation and have poor waste management which leads to pollution of the sea. In addition, they have limited access to clean drinking water.

The morphology of planned and unplanned built-up areas in cities in developing countries shows distinct differences. An unplanned area is usually developed without planning provision and is often associated with informality, overcrowding, insufficient infrastructure provision, poor housing quality, and haphazard layout [4].

## 2. Research method

The slum typology and slum handling scheme are determined through a survey using both observations (See Figure 1) and institutional data. The first stage was a study of literature and supporting regulations. Then, an institutional survey was carried out to assess the framework of the application of slum baseline data and slum locations. Later, the criteria and indicators of slum areas were determined. The study comprised observations and community mapping in a field survey. Community-based mapping aims to attain an overall picture of the characteristics, potential and slum problems within a region, whereas, GIS is used for data processing. There are many examples of advanced techniques to estimate population in informal settlements using GIS and remote sensing, but the need for field surveys, land records, or census data to supplement the analysis can be costly, may require local government permission, and may need compliance to strict institutional review board rules when humans are subjects of research [5]. The most important function of GIS is to enable the analysis of the spatial data and their attributes for decision support. Spatial analysis is done to answer questions about the real world including the present situation of specific areas and features, the change in situation, the trends, the evaluation of capability or possibility using overlay technique and/or modeling and prediction [6]. The detail of research analysis framework can be seen in Table 1.



**Figure 1.** Observation and community mapping

There are several issues in mapping slum areas, i.e., identifying potential and problems mapping, land use patterns, urban morphological analysis, identifying area typologies, and planning design. Using Geographic Information Systems (GIS) to map these areas is important as a baseline for urban spatial research. First, GIS can identify the different typologies based on Regulation of the Ministry of Public Works and Public Housing No. 2/2016. There are seven physical criteria such as buildings, neighborhood roads, drinking water supply, drainage, wastewater treatment, wastemanagement, fire protection and legality that can be used to identify Kiom as a slum area. Second, GIS can be used to map slum settlements based on the slum types [7] i.e., settled slum, appears overnight slum, potential slum, settled non-slum.

**Table 1.** Research analysis framework

	Slum area Characteristic	Urban Morphological
Purpose	Identify the slum area mapping, slum level and typology by Geographic Information System	Identify land use pattern and planning design
Sub-Variable	Buildings, roads, drainage, wastewater, waste, drinking water, fire protection and the legality of the land	1. Size 2. Density 3. Pattern
Technique Analysis	Spatial Mapping with GIS	Morphological Analysis and design
Data Collection	1.Observations 2.Survey 3.Mapping	1.Observations 2.Survey 3.Design

**Table 2.** Morphological features of unplanned areas

Morphological features	Unplanned areas	Planned areas
Size	<ul style="list-style-type: none"> <li>• Small (substandard) building sizes</li> </ul>	<ul style="list-style-type: none"> <li>• Generally larger building sizes</li> </ul>
Density	<ul style="list-style-type: none"> <li>• High densities (roof coverage densities at least 80% and more)</li> <li>• Lack of public (green) spaces within or in the vicinity of residential areas</li> </ul>	<ul style="list-style-type: none"> <li>• Low-moderate-density areas</li> <li>• Provision of public (green spaces) within or in vicinity of residential areas</li> </ul>
Pattern	<ul style="list-style-type: none"> <li>• Organic layout structure (no orderly road arrangement and noncompliance with set back standards)</li> </ul>	<ul style="list-style-type: none"> <li>• Regular layout pattern (showing planned regular roads and compliance with set back rules)</li> </ul>

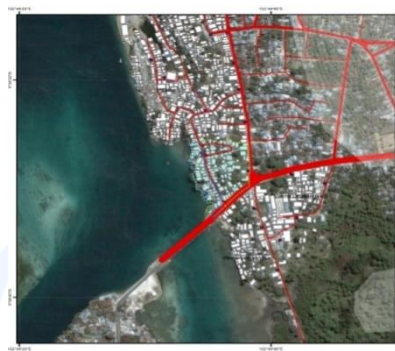
The analysis is based on the framework that has been determined and adjusted to the goals and objectives of the paper. Data analysis is the stage after processing or compiling data. To lay out the basis for this research the problem will first be described by a definition of informal settlements and a characterization of the settlement (buildings, roads, drainage, wastewater, waste, drinking water, fire protection and the legality of the land) in Kiom. This research requires prior ancillary GIS datasets, administrative boundaries, and field surveys. Despite the fact that many settlements can be detected through visual imagery interpretation, the human eye cannot quantitatively measure informal settlement properties. No prior research effort has performed slum area mapping and settlement typology using spatial analysis. Spontaneous settlements can be classified according to locational and morphological characteristics in inner city and peripheral settlements [8]. These morphological

features [9] were used as criteria for the identification of unplanned areas in remotely sensed imagery, as demonstrated in Table 2.

### 3. Result and discussion

#### 3.1 Slum area mapping

Kiom is located near the entrance gate of Tual City. Ideally, as the gateway to the city, Kiom should reflect a beautiful and clean environment. However, its strategic location near the city center is unutilized due to the existence of a slum settlement. Kiom borders the sea (see Figure 2), lacks a clean water service system, and has broken pipelines. Unfiltered wastewater and garbage are disposed of in the sea without treatment. As such, the slum area causes the environmental issue of a dirty seashore scattered with rubbish.



**Figure 2.** Kiom slum area

The Kiom area in Tual is a waterfront. As such, the scheme to handle the slum problems in the area should consider the area's specific characteristics and typology. The settlements in Kiom are characterized by an irregular coastal area with a densely built fishermen's settlement. The upstream areas generally have a clustered pattern, which is irregular and organic. The buildings are constructed according to traditional and modern rules in accordance with their respective cultural and tribal backgrounds. The following section presents the existing profile of the Kiom area.

Kiom, Ketsoblak Village, North Dullah Sub-district, Tual City, Maluku with an area of 2.2 Ha. The population of Kiom is less than 150 million peoples. Administrative Status of Buildings are without legal permission, there are 35 inadequate houses. Kiom has area characteristics as fisherman settlement with waterfront slum area typology. Kiom has 199.3 meters length of public road and 199.3 meters length of drainage. The detail of Kiom's profile can be seen in Table 3, Table 4, Table 5, Table 6, and Table 7.

**Table 3.** Kiom's state of building construction

State of building construction	Unit
The Number of buildings/houses that do not meet the standards in the detailed spatial plan	63
Area with density $\geq 200$ units / ha (for medium and small towns)	<200
Number of buildings with inadequate technical requirements (adequacy, security, comfort, health, and convenience)	63

**Table 4.** Kiom's drinking water supply condition

Drinking water supply condition	Unit
The number of people without access to clean drinking water (clean, and unpolluted)	252 people
Number of people who cannot meet the minimum standard of drinking water supply (60 liters/day)	252 people

**Table 5.** Kiom's wastewater processing condition

Wastewater processing condition	Unit
Size of the area	0.7 Ha
The area with a wastewater system that does not meet the technical requirements	0.7 Ha

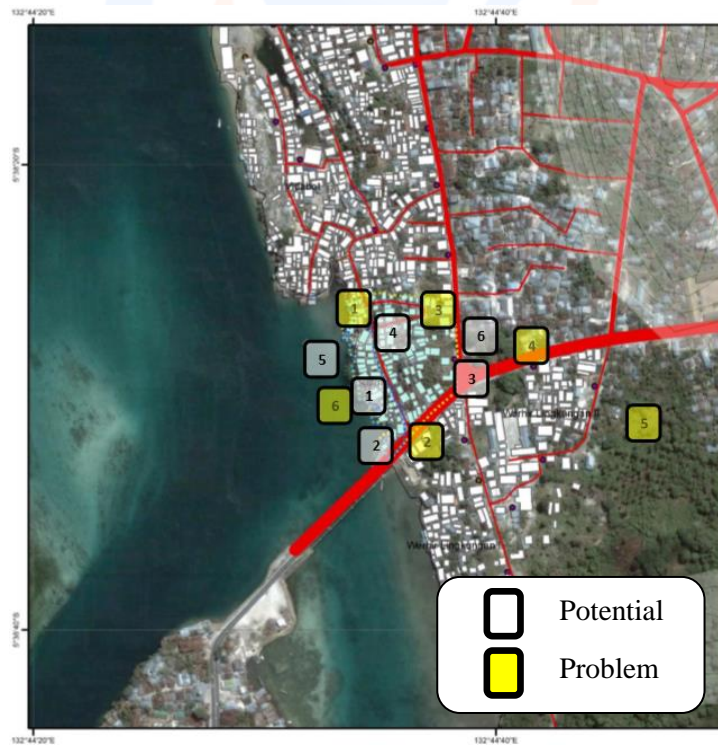
**Table 6.** Kiom's condition of waste processing

Condition of waste processing	Unit
The area without solid waste treatment approach to technical requirement with 3R (Reuse, Reduce, Recycle)	0.7 Ha
The area with non-standardized waste processing systems (warehousing, collection, transportation and processing)	0.7 Ha
The area with facilities and irregular infrastructure maintenance of waste processing	0.7 Ha

**Table 7.** Kiom's condition of waste processing

Fire protection condition	Unit
Area without an active and passive protection system	0.7 Ha
The area without water supply	0.7 Ha
Length of roads	0.7 Ha

The indicator of access to improved water relates to the access to sufficient water for household use, at an affordable price, available to household members without extreme effort. The source of clean water for the people who live on Dullah Island including the Kiom area is the Local Water Utility (PDAM), however, locals have problems paying their utility bills. The clean water source is from Evu Springs with a debit capacity of 1,400 liters per second, whereas, currently only 50 liters per second is used. To anticipate the need for greater water supply and the reduced flow of the Evu Spring, the Tual City Government established Tual City PDAM in the year 2014. This institution is expected to overcome the problem of clean water supply in Tual City. Another water source is from Lake Fanil in Ohoitel Village, approximately eight kilometers from the center of Tual City. The indicator of access to improved sanitation relates to access to a human waste disposal system, either in the form of a private toilet or a communal public toilet. The people of Kiom have the problems of household and traditional waste disposal which pollutes the sea.



**Figure 3.** Potentials and problems Mapping

**Table 8.** Kiom’s Potentials Mapping Result

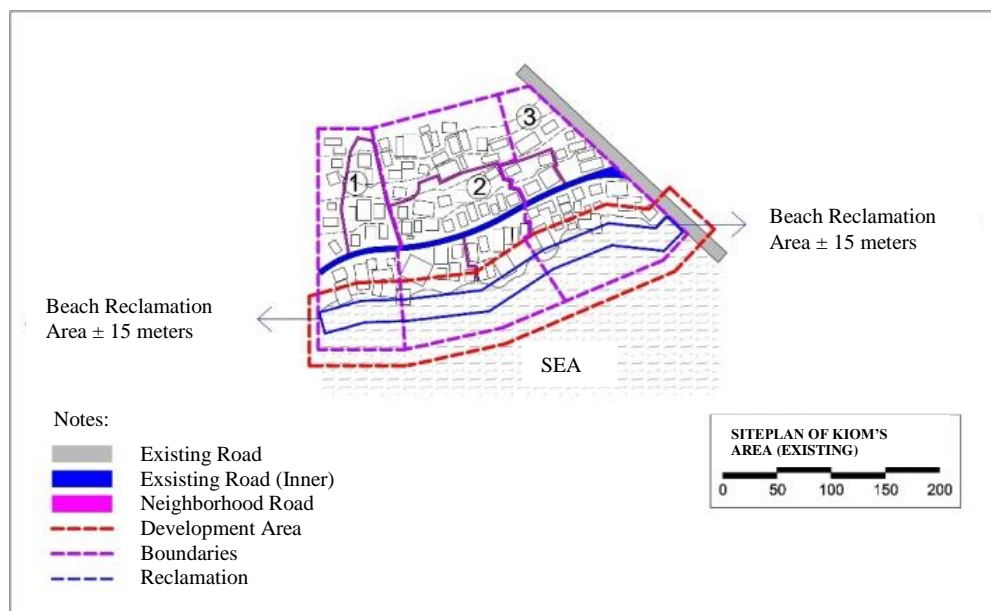
Number of Potential Location	Potential Description
1	A strategic location as a city façade.
2	Easy access to urban facilities.
3	The accessibility of the urban road network.
4	An integrated urban road network that can support Kiom’s development.
5	The coastal areas where most workers are fishermen.
6	Easy access to government services.

**Table 9.** Kiom’s Problem Mapping Result

Number of Problem Location	Problem Description
1	Slum area in a coastal settlement.
2	Poor sanitation and waste management.
3	Settlements located at high elevation sites/45 °.
4	Poor water service system (low access, low reliability of supply, poor water quality).
5	The water distribution pipe on the eastern side does not work.
6	Urban dwellers live without access to adequate sanitation and wastewater facilities. Untreated sewage may contain (sea) water; nutrients, solids, pathogens, helminths, oil, and greases, runoff from streets, and roofs, heavy metals, and many other toxins.

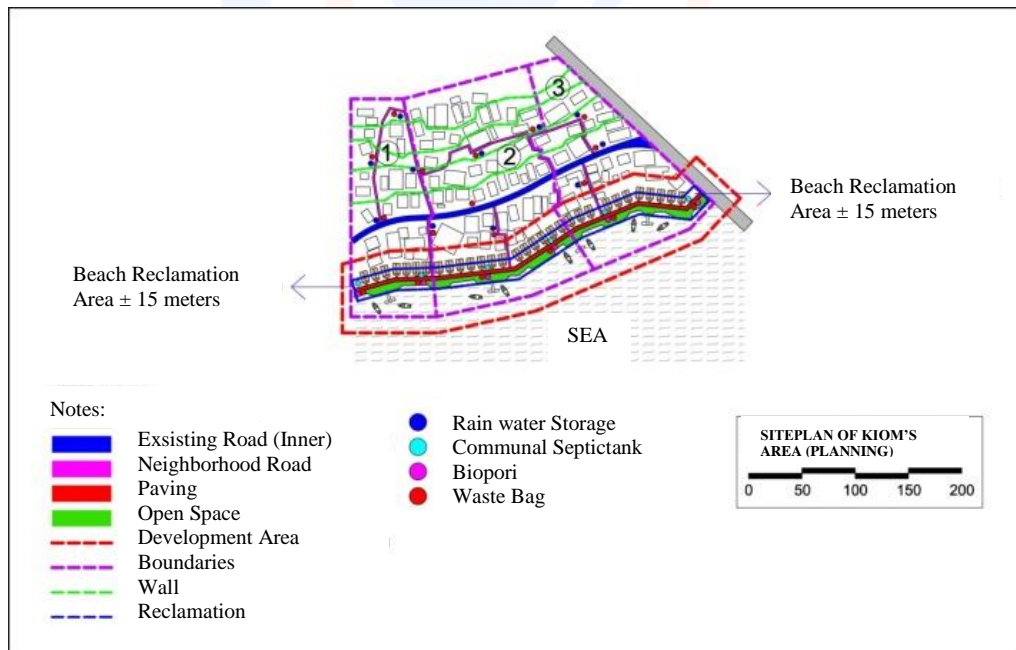
### 3.2 Morphological analysis

The housing of the urban poor is of very low-quality [10]. Most of them live in temporary homes especially in tin-shed housing and a very small portion of them live in buildings with semi-permanent walls. In coastal areas, housing is generally sporadic, shaped by the people and characterized by the freedom to build. There are two kinds of settlements in coastal areas, i.e., land and water segments (on water). A settlement in a water segment is established on a body of water, stage-shaped and constructed with wood and bamboo. Floating houses built on water are characterized by irregular patterns or extend along the river or beach line. Houses that are built on land in coastal areas have traditional forms or platforms with wood and bamboo materials. These types of houses are generally established on land that should be a coastal border area or they construct their houses illegally on privately owned land. Modern or non-stage houses are made from bricks. Housing forms such as this are generally built along the neighborhood road or village road in areas that not bordering the coast. The types of housing built on a water segment are mobile homes that float and move, whereas, homes with poles are embedded in sand or soil.



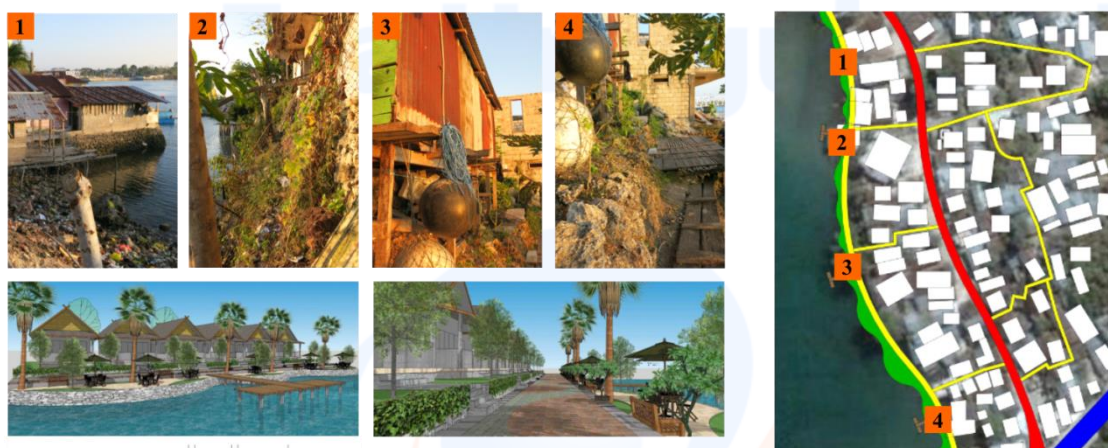
**Figure 4.** Land use pattern

The study generalized that informal settlement patterns (morphological features of unplanned) can be recognized by the following: a lack of obvious planned structure; substandard building sizes; a lack of vegetation in housing areas; and high building density. In Kiom, most buildings are technically inadequate (seen from aspects such as adequacy, security, comfort, health, and convenience). Furthermore, people in this area are unable to have proper building measures on sloping fields (45°). The remaining houses are made of wood on illegal locations; a few houses have roofs that are made of bricks and cement. Most residents have no toilet; they share toilet and shower facilities with their neighbors. Moreover, there is a lack of open space and vegetations and the street pattern is disorganized.



**Figure 5.** Land use pattern planning

Considering the local conditions, the best scheme for the handling the slums in Kiom is by resettlement or land legalization and urban renewal. The upgrading of slum and informal settlements allows them the right to have adequate housing and living standards by focusing on the role of housing as a central aspect of quality of life. Water efficiency can be increased through investing in the water drainage system, desalination, and wastewater treatment. The government should take the initiative to support community awareness and participation in waste management. They could do so by providing training and building awareness among the slum dwellers to improve the environmental and physical condition in their settlement. Figures 6 to 10 give an overview of the plans that could be implemented to improve the housing situation in Kiom.



**Figure 6.** Planning of coastal housing





Figure 7. Planning of hillside housing



Figure 8. Neighborhood road planning



Figure 9. Drainage planning



Figure 10. Sanitation planning

Table 10. Slum level and typology in Kiom

Sub-District	Urban Village	Name of the area	Area (Ha)	Level of slum condition	Status of the land	Slum typology	Pattern scheme
South Dulah	Ketsoblak	Kiom	2.2	Heavy	Illegal	Slum housing located at the edge of the water (rivers, beaches, lakes, reservoirs, etc.) , but cross the water border	Resettlement or land legalization for further renewal

4. Conclusion

The study identified Kiom as a 2.2 Ha slum located in a coastal area. Most of the people are living in a temporary habitat in vulnerable conditions due to low income and lack of support. In addition, the area is characterized by irregular road access, and poor water services (quality of access, low reliability of supply, poor water quality). Further, people are accustomed to throw their garbage and untreated

sewage water directly into the sea contributing to pollution. Moreover, the current buildings used by the community are based on a customary system with illegal status.

The identification of characteristics, the assessment, and the morphological analysis was based on seven physical indicators and one non-physical indicator. In summary, the slum in Kiom area is a high-level slum with illegal land status. Its housing typology is a settlement on a water segment. Thus, the best handling scheme is resettlement or land legalization and urban renewal.

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