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Monitoring of Existing Settlement Land Development and Adjustment in Kupang City

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***Abstract*—** *As the capital city of East Nusa Tenggara province, Kupang City is experiencing rapid development in terms of both physical and non physical development. The increase in the number of people both naturally and as migration effects from other regions outside the city contributes to the increased demand for the provision of residential areas. It is affected the turning/conversion of land from non-built to built land. Physically, Kupang City is a Kars area which legally is protected area with development that must be limited. However, on the other hand the provision of land for settlements should be continued in order to equilibrate the growing number of people. The provision of land for settlements should consider the aspects of land physical capability and land adjustment criteria so that the construction of settlements undertaken does not disturb the existing ecosystem of the environment.*

The current study is aimed to measure the extent of the development of the settlement land area within last 10 years and evaluate the adjustment of the existing settlement land based on physical land adjustment criteria. The change of the settlement area is known by utilizing the interpretation of landsite satellite imagery and the adjustment of existing settlement land which is analyzed using overlay method.

***Keywords*—** *Settlement Development, Settlement Land Adjustment*

I. INTRODUCTION

Population growth is natural consequence of human development. The world population today has reached 6.5 billion. The number will continue to grow considering every second the 4.4 babies born. According to the estimation, the world population in 2050 is predicted on 9 billion (Kent & Haub, 2005)

Urban area (City) is the region with the highest population growth compared to the rural area. From 1990 to 2000, Indonesia's urban population has grown by around 60 million people (Majale & Tipple, 2011). The population increase will be directly correlated with the need of facilities provision whether housing facilities or other supporting facilities in urban areas that ultimately lead to the increase of land conversion. Population growth, incompatibility and intensive land use activities have caused various types of land degradation in different parts of the world (Cerda et al., 2010)

Rapid physical development can lead to several urban problems, such as the need for new settlements, the provision of social facilities and services, the addition of environmental infrastructure networks such as clean water, drainage channels, power grids and other infrastructures. Furthermore, there is a problem of less controlled development of new settlement environments which spread out sporadically so that will impact on the difficulty of procurement planning of infrastructure and facilities (Bhatta, B, 2010).

Kupang city is one of the middle-sized cities in Indonesia, having a population of 390,877 in 2015 growing by 32.2% when compared to the population in 2005. (BPS Kupang City, 2016). The status as the capital city of NTT province makes the number of population increase significantly in the last 10 years. Beside that the physically Kupang city is a Kars area categorized as a protected area with the main function of ecology and hydrology (Darmawan and Listiadi, 2010). According to that matter, then the development and growth of city particularly residential sector must consider the adjustment of land use due to avoid the damaged of Kars area which will impact on the environmental degradation and hamper the development sustainability.

Basically, city is defined as a surface area where there is centralization (concentration) of population and various types of economic, social culture, and government administration activities (Adisasmita, 2010: 49). In detail the city is depicted as its main function as a geographical land for settlements.

According to (Yunus, 2004) City becomes its own attraction for the people. It is due to the attractive and stimulant factors. The attractive factor of a city such as the availability of employment, and the income generated. While the stimulant factor of a city is the availability of public services provided and available to the population. In addition, the city is assessed by people as a place to live, to work, and to hold their life.

City has strong appeal to the inhabitants of both local residents and from outside the city. As the population grows, the city develops. The occurrence of the development of a city is due to the increasing population and the density of buildings supported by geographical conditions. The development of the city occurred is in accordance with the physical density that is population and buildings in such geographical area.

The planning of settlement area refers to the normative rule of Law No. 1 year 2011 regarding the residential areas and settlements. The planning criteria and norms of residential areas are as follows:

a. Space utilization must be in accordance with carrying capacity of local land and can provide a healthy and safe environment from natural disasters and appropriate environment for the society development while maintaining the sustainability of environmental functions.

b. The designated area of the settlement should be have road infrastructure and affordable by means of public transport.

c. Utilization and management of the area should be supported by the availability of physical facilities or public utilities (markets, trade and services centers, offices, clean water

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facilities, garbage, waste handling, and drainage) and social facilities (health, education, religion).
d. Not interfere the existing protected functions.

Beside that the terms of settlement area based on location characteristic and land adjustment included the land used for residential areas adjusted to the characteristics and environmental carrying capacity. Then the use of land for the development of new housing is 40% - 60% of the existing land area. Furthermore, in settlement areas should be completed with adequate public utilities and residential buildings density are not structured maximum 50 houses / ha. In order to produce an appropriate living environment for the development of society, and remain considering the preservation of environmental functions in residential areas, so that in residential areas should be completed with infrastructure such as the provision of facilities for education, health, green space, and trade and services. Not less important the rain water, garbage and waste disposal channel. It is intended to the development of new settlements not lead to inappropriate spaces and expected to utilize the existing space efficiently.

The criteria of this settlement area development are according to Minister of Agriculture Decree No. 837 / KPTS / UM / 11/1980 and no.583 / KPTS / UM8 / 1981 are as follows:
a. The slope of the land is declivous to rather skewed (0-8% and 8- 15%).
b. Excluding disaster prone areas
c. It has good accessibility (roads, public and social facilities) and located in strategic location.

II. Study Method

The present research uses descriptive evaluative and spatial analysis. The steps of analysis are described as follows:

1) Land Development Progress Analysis

Interpretation of landsite satellite imagery is used to identify the development of settlement land. The image used is landsite 7 TM imagery in 2007 and landsite image 8 in 2017. Classification method used is guided classification with maximum likelihood algorithm. (Balulescu et al, 2013) after that conducting change detection analysis to find out how big the land change occurred (Bhatt, A, 2012**)**

2) Analysis of Area Function Determination

According to Minister of Agriculture Decree, then the function of area is divided into protected areas, buffers and cultivation. This function classification is based on the slope class, soil type, and rainfall which is then overlaid to produce

3) Analysis of Land Allocation for Settlements

Furthermore, after knowing the land capability then proceeded with overlaying the map of land capability with the criteria of land allocation for settlements that have been predetermined. The Adjustment Criteria of settlement areas development is according to PERMEN PU no. 41 / PRT / M / 2007 which states that:
a) Flat to wavy topography (slope of 0-25%);
b) Available sources of water, both groundwater and water treated by the organizers with sufficient quantities. For PDAM the water supply is about 60 liters/person/day-100 liters/person/day;
c) Not in disaster prone areas (landslide, flood, erosion, abrasion);
d) Good to medium drainage;
e) Not in the boundary areas of rivers/beaches/reservoirs/lakes /springs/irrigation channels, railroad and flight safe areas;
f) Not in the protected area;
g) Not located in fishery cultivation and agriculture/buffer area;
h) Avoid technical irrigation rice fields.

4) Evaluation of Existing Settlements Land Adjustment

At this step, the merging series of analysis /the overlay of settlement land allotment with the use of existing settlement land in 2017 are conducted.

III. Result and Disscusion

1) The Development of Settlement Land

According to the land cover in 2007 the area of settlement is 3016.64 Ha. The sub-districts with the largest settlement area are Oebobo sub-district with an area of 788.55 Ha while the smallest area is Kota Lama Sub-district with an area of 256.68 Ha.

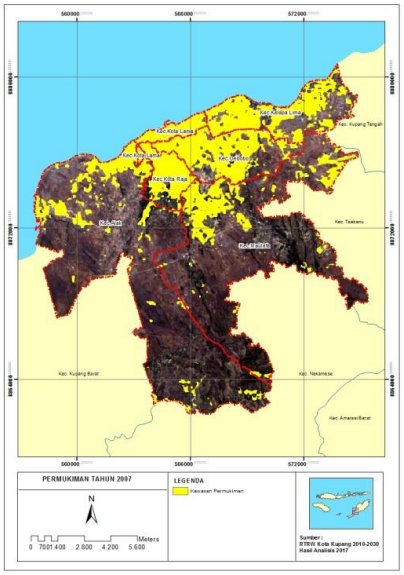

Fig. 1. Coverage of settlement area in 2007.

In 2017, the settlement area was increased to 4489.73 ha or increased significantly by 32.81%. The largest settlement area is oebobo sub-district with an area of 1102.23 Ha and the smallest settlement area is Kota Lama sub-district (257,06 Ha). If reviewed from the proportion of the settlement area addition compared to the year 2007, then the sub-district with the largest expansion of settlement area is Alak sub-district with the addition of 49.30%, followed by Maulafa sub-district with 46.24%.

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Alak and maulafa sub-districts area is larger than other four sub-districts. Moreover, in these two sub-districts, the land use for built land is not many yet so that the space for building is still available.

Meanwhile, Kota Lama and Kota Raja sub-districts are the urban centers which already densely settled with settlements so that the residential development opportunities are impossible.

2) Regional Functions

Kupang City consists of 6 sub-districts those are Kota Lama, Oeboo, Alak, Kelapa Lima, Kota Raja, and Maulafa. The area of each sub-district can be seen in the following table

TABLE I. Sub-district area.

No	Sub district	Area	
		Ha	%
1	Alak	7040	42,58
2	Maulafa	5567	33,67
3	Oebobo	1472	8,90
4	Kota Raja	619	3,74
5	Kelapa Lima	1531	9,26
6	Kota Lama	305	1,84
	Total	16534	100

Source: Central Bureau of statistic Kupang city, 2017

The weighing and scoring of regional function which is conducted using 3 criteria/physical aspects then obtained the result as follows:

TABLE II. Analysis result of regional function.

Score Slope	Score Rainfall	Score Land Type	Total Score	Regional Function
40	10	15	65	Cultivation
40	10	15	65	Cultivation
40	20	15	75	Cultivation
40	20	15	75	Cultivation
40	10	15	65	Cultivation
40	20	15	75	Cultivation
40	20	15	75	Cultivation
40	20	15	75	Cultivation
40	20	15	75	Cultivation
80	30	15	125	Buffer
80	30	15	125	Buffer
80	30	15	125	Buffer
80	30	15	125	Buffer
80	30	15	125	Buffer
80	30	60	170	Buffer
80	30	60	170	Buffer
80	30	60	170	Buffer
80	30	60	170	Buffer
80	30	60	170	Buffer
80	30	60	170	Buffer
80	30	60	170	Buffer
80	30	60	170	Buffer
80	40	60	180	Protected
80	40	60	180	Protected
100	20	60	180	Protected
100	20	60	180	Protected
100	20	60	180	Protected
100	20	60	180	Protected
100	20	60	180	Protected

Source: Analysis result

The regional function based on the sub-district can be seen on the table below:

TABLE III. Regional function width of Kupang City (Ha).

Sub District	Regional Function		
	Protected	Buffer	Cultivation
Alak	41,85	1.285,79	5.925,06
Kelapa Lima	-	1,29	1.516,62
Kota Lama	-	0,44	300,11
Kota Raja	-	3,80	619,41
Maulafa	12,74	328,49	5.206,10
Oebobo	-	4,12	1.471,11
Kota Kupang	54,59	1.623,93	15.038,40
	0,33	9,71	89,96

Source: Analysis result

According to the analysis result, almost the entire areas of Kupang City (89.9%) are used as cultivation area. The buffer area has total area 1623.93 (9.71%) and the protected area has smallest proportion that is 0.33 %. For details information look at the figure below:

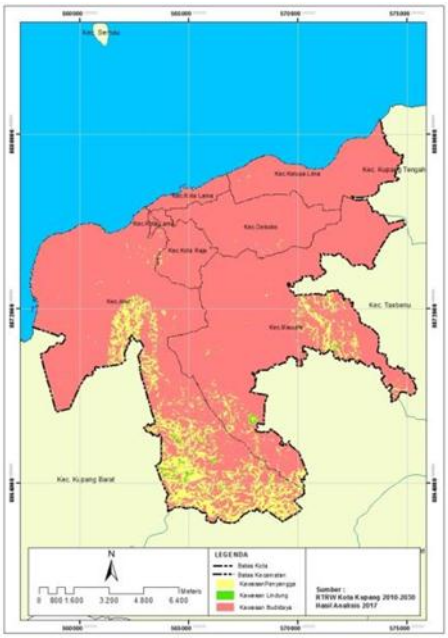

Fig. 2. Region function.

Adjustment Evaluation of Existing Settlement Land

After knowing the function of the study area, then land adjustment analysis for particular settlement in the cultivation area is conducted. The location criteria which appropriate with the settlements are as follows:

TABLE IV. Criteria of land allotment.

Settlement Allotment	Non Allotment
Slopes 0-25%	Slopes >25%
Not in disaster prone area	in disaster prone area
Good to medium drainage	Bad Drainage
Not in the boundary area of rivers	in the boundary area of rivers
Not in technical irrigation rice field area	in technical irrigation rice field area
In the kars area with the type of mintakat mesokars and non kars	In holokars area

Source: Analysis result

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TABLE V. Settlement land allotment.

Sub District	Allotment	
	Non settlement allotment	settlement allotment
Alak	2135,48	4904,52
Kelapa Lima	779,92	741,08
Kota Lama	13,62	291,38
Kota Raja	85,905	533,095
Maulafa	1412,12	4154,88
Oebobo	808,435	663,565
Total	5235,48	11502,37

Source: Analysis result

According to the result of classification overlay, obtained that 68.32% of land is allotment for settlement whereas 31.68% is not for settlement. Non-allotment land is located in the southern part which is protected and buffer zone, as well as the eastern part which has poor soil drainage conditions.

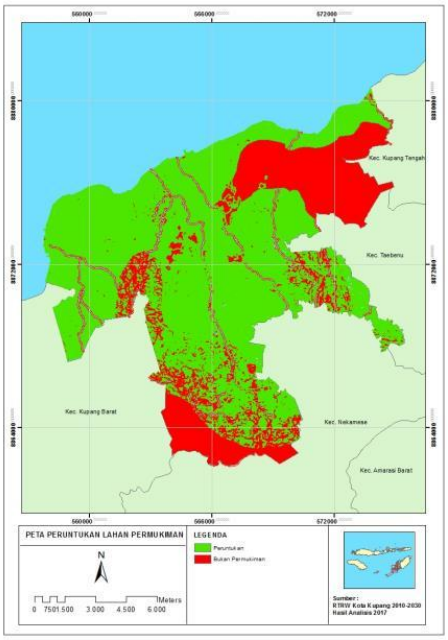

Fig. 3. Settlement allotment.

Furthermore, the evaluation of the existing settlements is conducted by overlaying the settlements allotment with the existing settlements in 2017. Based on the analysis of landsat 8 OLI image in 2017, there are 6 land cover classes including settlements, forests, rice fields, open land, gardens, and other built lands with the following extents.

TABLE VI. Land cover width 2017.

Land Cover	Area (Hectares)
Forest	1437,91
Farm land	7398,35
Other build land	1713,25
Open land	811,66
Settlement	4489,73
Rice fields	683,10
Total	16534

Source: Analysis result

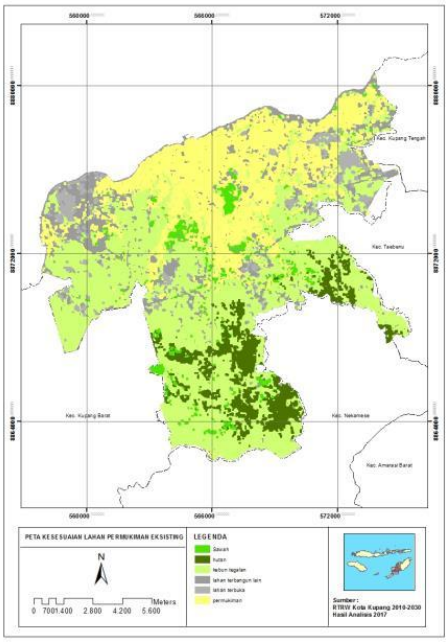

Fig. 4. Settlement allotment.

After overlaying the land allotment with the land cover map, then will be obtained any appropriate settlement area and inappropriate area to the land allocation for the settlement. The cover area of settlement land used in the current analysis is a combination of the existing settlement area with other developed land in the form of industry and mining which is included in the 'other build land' class.

TABLE VII. Evaluation of existing settlement land (In Hectares).

Sub District	Existing Settlement Adjusment	
	Appropriate	Inappropriate
Alak	1457,82	122,97
Kelapa Lima	673,81	539,75
Kota Lama	283,47	11,16
Kota Raja	444,71	35,83
Maulafa	1076,44	296,46
Oebobo	574,71	650,30
Total	4510,96	1656,46

Source: Analysis result

According to the table above the adjustment level of existing settlement on the settlement allotment is adequate (reaching 73%) and the inappropriate one has a proportion of about 27%. However, one of the main considerations is the tendency of the settlement land development that leads to the south which is indicated by an increase in the area of settlements in Maulafa and Alak sub-districts which reach about 40% within 10 years. Based on the regional function analysis results that the southern part of Kupang City is an area with protected and buffer function so that the planning of settlement development in these two districts should be more considered in the future.

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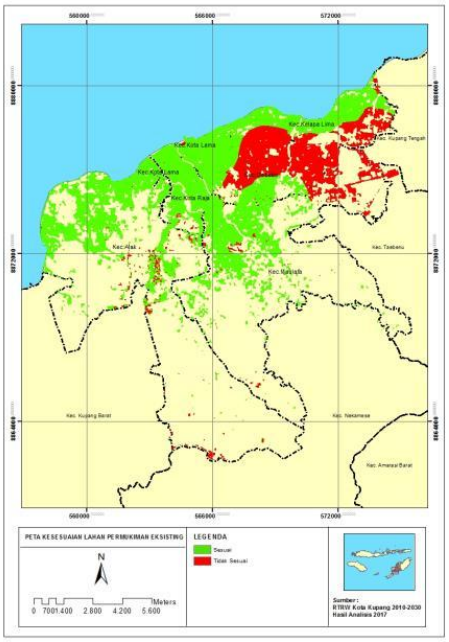

Fig. 5. Existing settlement adjustment with land allotment for settlement.

IV. CONCLUSION

According to the research result then obtained the conclusion as follows:

1. Based on the regional function, the majority of Kupang City's land can be developed into a cultivation area.
2. The adjustment level of existing settlement land in Kupang City has generally been in accordance with its allotment.
3. Direction of settlement land development Kupang City tends to lead to the south which is a protected area and water absorption.

V. SUGGESTION

The suggestions and inputs that can be given for this research are:

1. Due to the changes in land use is a continuous process it is necessary to study in order to predict the land use changes, particularly the settlements in the future concerning the land adjustment
2. Along with the trend of housing development, it is necessary to study the potential land for housing development, particularly in the Kupang city.

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