LAND AVAILABILITY AND CAPACITY ANALYSIS FOR BUILDING IN TERRITORY OF URBAN

Case Study of Palu City

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Introduction

Urban land is divided into lands for buildings and lands not for buildings. Lands for buildings consist of resident, industry, office, trade and services. Lands not for buildings are divided into land used for the urban activities (cemetery, recreation, transportation, open space), and land used for non urban activities (agriculture, plantation, water area, production and mining of natural resource). Land use is defined as a form of human intervention on land in order to meet their needs. Hakim and Nasoetion (1994) add that land use is a dynamic process, as a result of changes in the pattern and enormity of human activities all the time. So that problems related to land is a complex problem. Therefore, effort to optimal utilization of land resources requires an efficient allocation of land use.

Building is one of urban land-cover which has very important in land use classification. The land use for building distribution and development is very important information for planning and environmental study in urban territory. Nevertheless, data and information collection to land use for building is not a simple matter (Zhang, 1999). The land use for building that continues to increase especially in urban areas will cause problems later on. This is because of its limited land area, while the land requirement for building is constantly growing as the population growth and urban activities which at certain times, the land in urban areas will be full of buildings.

The inaccuracy of land use is generally caused by the pressure of increase population which needs land for the development of settlement sector, industry, trades and services as a consequence of the growth process of economy to non-agriculture (Mansur, 2004). Factor of population growth is one of the greatest contributions to the formation of urban activity. To accommodate the activity, the population needs overflowing land, until eventually there is competition of urban land which has limited extent.

Therefore, land use planning needs to be done to accommodate and anticipate the various needs of urban land. Comprehensive consideration to planning of a city is needed to know data and information related to land capacity and potency which capable to development resource on sustainable, especially related with land avaibility and capacity for building and its requirement of infrastructure (Hudson, 1997).

The purpose of this study is to determine: a) the extent of effective land use for building that is available based on the physical characteristics of land in Palu city, b) the capacity number or maximum capacity of land in Palu city on population and land use for building based on the extent of available effective land, and c) the time limit of the availability of effective land that is capable of supporting the growth of land use for building in Palu city based on the land capacity. The study is conducted in all sub-districts in Palu city on population, households (families), population density, building, the extent of building and yard as well as the total area.

Types of data collected consisted of space data (spatial) and non-space data (aspatial) which described the physical characteristics of land in Palu as city of bay. Spatial data were data of the topographic map, the

geological map, the hydrology map, and the map of land user for protected areas and cultivated areas (residential areas, offices, RTH, tourism, trade and services) obtained from the Revision Map of Spatial Plan of Palu in year 2010 , while aspatial data covered the data of physical condition of land, data of the number and the population growth, as well as data of the number and the building growth such as the time series data obtained through document recording technique and GIS mapping.

Data analysis techniques used were projection analysis, land capacity analysis, and overlay spatial which was a process of combining two maps to form a new map as the basis for determining the broad availability of land for building. To residential areas and the existing cultivated areas, they were not changed regarded as a region that retained. Indonesia as a developing country still faces major problems in the development of cities. The development of economic activities and population growth will be followed by increasing demand for space/land primarily for the building as a place that holds a variety of urban activities such as housing and office affairs.

Palu as one of the cities in Indonesia is also experiencing problems related to the population growth together with the increase of urban land use, especially land use for building. Palu City has an area of 38,018.15 hectares (ha) or 380.18 km^2 (GIS Analysis and Territory Boundary Synchronization, 2010) with the population growth rate from year to year has increased significantly. From 2000 to 2010, the population growth rate has an average of 1.68% per annum, which the amount at the end of 2000 was 269,083 people and at the end of 2010 was 335,297 people (Results of SP2010, Palu).

Along with the increase of population in Palu, the demand/need for land has increased, particularly the land use for building. Based on data obtained, it shows that the number of buildings and the level of land use for building in Palu city from year to year also increase significantly. In 2000-2010, the number of buildings has increased in an average of 3.45% per annum or 34.47%, in interval of 10 years i.e. from 65,668 units of buildings with an extensive land use for building and yard about 2,502.99 hectares (6.74 %) in 2000 to around 75,536 units of building at the end of 2010 with an extensive land use for building and yard about 3,345.47 hectares (8.80%).

Such condition would need to get an attention and it is anticipated early in order to get the balance between the need and the availability of land for building, particularly in the territory of Palu as a coastal city, for now and future. Then, it can be an input to the Spatial Plan of Palu city for giving more direct patterns of land use for building based on availability and capacity of their own land.

Availability Analysis of Land for Building

Associated with aspects of consumption and demand of land for the establishment of buildings, the continuity of urban activities with the urban population as the main doers/actors, requires the availability of appropriate land both technical aspects and legal aspects in the extent that is adequate and sustainable. Besides being a key factor in accommodating urban activity, land also has unique properties because of its function that cannot be replaced by any other factors. Therefore the availability of land for adequate and sustainable building is very fundamental in order to create urban spaces that are safe, comfortable, sustainable, and productive.

Provision of land for building in accommodating urban activity in several big cities in Indonesia, nowadays, faces problems and challenges that are quite heavy due to "explosion" of uncontrolled population. The implication, a competition will occur in land use that the number is very limited and will increase the degradation rate of environmental quality of urban land as a result of human pressure on land resources that exceed the capacity. It is time to pay attention for Palu city as one of the developing cities in Indonesia to see the problem of land availability, particularly in relation to the provision and growth in land use for building to accommodate urban activities in the future, as the impact of urban population growth which is relatively high, so it might be expected to arrange the land use of town which is harmonious, balanced and sustainable, and can anticipate the degradation of environmental quality for very limited urban land that might be occurred.

Analysis for the availability of land is one step that needs to be done, especially related to the availability of the extent of effective land that can be

utilized for the establishment of buildings, both the technical aspects of land and the legal aspects. As has been described previously in operational definitions of variables that in order to obtain the availability of extent of effective land, there are several supporting variables to consider, namely: the area extent, the extent of protected areas, the extent of constructed cultivation area, the extent of urban infrastructure and the extent of strategic area of city. Mathematically, the variables of effective land availability can be modeled as follows :

$$L_{EF} = L_W - (K_L + K_{BT} + K_{PK} + K_{SK}) \dots\dots\dots\dots\dots 1)$$

In which : L_{EF} = The Extent of Effective Land Availability for Buildings (ha)
L_W = The Extent of Study Area (ha)
K_L = The Extent of Protected Area (Ha)
K_{BT} = The Extent of Existing Constructed Cultivation Area (ha)
K_{PK} = The Extent of Urban Infrastructure Area (ha)
K_{SK} = The Extent of Urban Strategic Area (ha)

The Extent of Study Area

Extent of an area can generally be divided into two parts, namely land area and ocean area, especially areas that have sea as their boundaries. The extent of study area is more focused on the mainland extension of Palu city. Land area of Palu city used as a study area in this research is ± 38,018.15 ha (380.18 km^2). This is technically total land area according to the result of digitization through the help of Ikonos satellite images in 2005 and 2009 toward the administrative boundaries which adjusted and synchronized with the administrative boundaries of its surroundings.

The Extent of Protected Area

The extent of protected area is the extent of area defined by the primary function of protecting the environmental sustainability covering natural resources and man-made resources. These types of land use for the protected area according to the direction of Palu RTRW include: protected forest, local protected areas, green open space areas (RTH) including buffer zone in it, nature reserves and cultural reserves, prone to natural disasters areas, and protected areas of geology.

The extent of protected area is one factor which reducing the availability of effective land for building. Calculation of the extent of protected area of Palu city is the accumulation of various types of the extent of land use for protected area as dictated by the space pattern of RTRW Palu 2010 - 2030 and the result of spatial analysis from researcher to the plan of land use of protected area that has not been contained or measured quantitatively in the product RTRW Palu city. The extent of protected area of Palu city is ± 16,591.837 ha.

The Extent of Existing Constructed Cultivation Area

The extent of constructed cultivation area is the extent of cultivated area that has been built physically artificially, either in the form of buildings, regions, or networks, as well as the cultivated area is formed physically naturally in the form of surface water bodies as Blue Open Space (RTB) which is in Palu based on the existing conditions in 2010 as the base year of research implementation. The constructed cultivation area of Palu include: residential area; trade and service area; office area; industrial area; tourism area; mining area, public services area (education, health, and worship), public infrastructure area (transport, electricity, and waste), defense and security area, warehousing area, as well as non-green open space area including blue open space area in it.

Calculation of the extent of constructed cultivation area is needed to know how large the extent of cultivated area is used for building the current building as one factor reducing the availability of effective land. The total extent of land use of constructed cultivated area in Palu city according to the existing conditions in 2010 is ± 4,199.162 ha.

The Extent of Urban Infrastructure Area

The extent of urban infrastructure area is the extent of area that the space arrangement is allocated for the plan of urban infrastructure needs as part of the space structure of Palu include: land transport infrastructure area covering the plan of road network, rail network, and land transportation terminal; sea transport infrastructure area covering development plan of sea port area; air transport infrastructure area covering development plan of airport area; electrical infrastructure area covering development plan of power generation area, waste

management infrastructure in the form of regional allocation plan of the final processing site of waste, and disaster evacuation area such as paths of evacuation routes and gathering place when disaster strikes.

Similar to protected areas and constructed cultivation areas above, the extent of urban infrastructure area is also one reducing factor to the availability of effective land for building. Calculation for the extent of infrastructure area of Palu city is the accumulation of various types of the extent of land use for urban infrastructure area as dictated by the space structure of RTRW Palu in 2010 - 2030 and the results of spatial analysis from researcher on the extension plan of land use of the urban infrastructure area that has not been contained or measured quantitatively in the product of RTRW Palu. The total extent of the needs plan for land use of the infrastructure area of Palu is ± 3,445.430 ha.

The Extent of Urban Strategic Area

The extent of strategic area is the extent of area that the arrangement of space is prioritized because it has a very important influence in the scope of the city towards economic, social, cultural and/or environmental aspect, as well as the utilization of natural resources and technology. The strategic area of Palu includes: a strategic area of economic growth, a strategic area of social culture, and a strategic area of environment. In the allocation of land use, urban strategic area is part of the protected area and the cultivation which are more prioritized to the development and empowerment. Therefore, the existence and direction from the extent of land use for this strategic area become one reducing factor to be considered to the availability of effective land for building as well as the previous areas.

The calculation of the extent of strategic area of Palu city is more focused on new areas that have been ready to be developed and not yet charged on the land use for protected areas and constructed cultivation areas above. In addition, most of strategic areas directives in the product RTRW Palu the land use has become the part of the protected area and cultivated area. The extent of land use needs of strategic area in Palu city is ± 1,500.00 ha.

The counting results showed that there is ± 12,281.721 ha of land categorized as effective land for cultivation activities, including the establishment

of buildings, namely the land that is biophysically, especially from the aspect of topography and slope, appropriate or suitable to be utilized and developed as a development land from various cultivation activities. The meaning of appropriateness or suitability for land to accommodate the urban activities is the land that is legally and technically capable of supporting the growth of land use for building optimally and if the land is used properly, it will not disturb the sustainability of resource and environment.

Picture of land use patterns as described above indicates that Palu city still has ample land reserves to be used and developed the utilization to meet the need of land for development projects, mainly related to the land use for building as a place for people's activity. Therefore, it would be very important to plan, organize, and predict the use of land reserves that are still available and have been utilized, especially the land use for building, to the development of number and density of population, so that later there is a balance and harmony between the availability and capacity or power capacity of the land with the physical development of Palu city in the future.

Land Capacity Analysis for Building

Land capacity analysis is one step that needs to be done, mainly related to the maximum limit of carrying capacity of urban land to the population number and land use for building based on the available effective land area, so it can anticipate urban environment degradation and sustainable development. As has been described in previous variable operational definitions that in order to obtain the land capacity, there are several supporting variables to consider, namely: the extent of effective land availability for building, the extent of protected area, the extent of land requirements for building and yard per person and/or per households, the number of population and/or existing households as well as the extent number of land use for existing building. Mathematically, variables of land capacity or maximum capacity of this land can be modeled as follows:

$$\text{DT}_{Max} = \frac{L_{EF}}{L_{KB}} \qquad .... \; 2)$$

In which : DT_{Max} = Maximum capacity of land for building (person or household)

L$_{EF}$ = The extent of effective land availability for building (ha)

L$_{KB}$ = The extent of land requirements for building and yard per person or per household (Ha/person or Ha/household)

while :

$$L_{KB} = \frac{\Sigma LB_{Eks}}{\Sigma P_{Eks}} \quad ....3)$$

In which : L$_{KB}$ = The existing extent of land requirements for building and yard per person or per household (Ha/person or Ha/household)

ΣLB_{Eks} = Total area of land use for existing building (Ha)

ΣP_{Eks} = Total population /existing household (person or household)

Referring to the result of the existing extensive calculation of land requirements for building and yard in per 1 person = 92.35 m2/person (0.0092 ha/person) and in population per 1 family = 364.40 m2/family (0.0369 ha/family), it can be counted that the capacity or the remaining land capacity for building and yard in Palu city based on the availability of effective land for building has been previously analyzed. To calculate the capacity of land for building, it is assumed and concluded that the extensive use of building and yard per 1 person and per 1 family from year to year is considered permanent.

In more detail, the description of the remaining land capacity for building in Palu city can be stated as follows: (1) for land use of building and yard in an average per 1 person inhabitant in an area of 92.35 m^2, it is acquired that the remaining land capacity for building is 1,329,924 inhabitants. When added to the total population of Palu city in 2010 in amount of 335,297 people, then the effective cultivation land in Palu can accommodate 1,665,221 people; (2) for land use of building and yard in an average per 1 family in an area of 369.40 m^2, it is acquired that the remaining land capacity for building is 332,481 families. When added to the number of families in Palu in 2010 in amount of 83,824 families, then the effective cultivation land in Palu can accommodate 416,305 families.

Time Limit of Land Analysis in Palu to be Able to Support the Growth of Land use for Building

Time limit calculation of the availability of land on the ability to support the growth of land use for building in Palu city is done as projective and anticipatory step for urban management as early as possible to be able to organize and plan the development of construction more wisely and sustainably. As has been described previously that the time limit for land is capable of supporting the growth of land for building is when the extent of land use for building achieves the same extent as the effective land availability. There are several supporting variables to consider for calculating the time limit, namely: the extent of effective land availability for building, the extent number of land use for existing building and the average number of growth in land use for building in Palu city for the last 10 years (2000 - 2010).

The calculation of time limit is made by the assumption that the growth average number of land use for buildings in Palu city is fixed. Mathematically, time limit variables of land which are capable of supporting the growth of land for building in Palu city above can be modeled:

$$BWL = \frac{L_{EF}}{(\Sigma LB_{Eks} \, x \, R_{PL})} \quad \text{.........................4)}$$

In which : BWL   = Time limit of land to be able to support the growth of land use for building (year)
            L_{EF} = The extent of effective land availability for building (Ha)
            ΣLB_{Eks} = Total area of land use for existing building (Ha)
            R_{PL} = Average number for the growth of land use for building per year (%/year)

The extent of effective land availability for building that is cultivation area in Palu obtained from the results of GIS analysis in 2010 is ± 12,281.72 Ha. The time limit of cultivation area in Palu city as a coastal city which is capable of supporting the growth of land use for the building is the year 2169 or 159 years from the year of research base, namely when the extent of land use for the building is reaching the same extent as the effective land availability as cultivation area in Palu city. Calculation of time limit is done by assuming that the growth of land use for building in Palu city is fixed with growth average number 2.50% per year.

Conclusion

Effective potential land which is still remaining for building is ±12,281.72 ha (32.30%) out of the land use for the existing cultivation areas and protected areas today. Capacity of the remaining land for the building is 1,329,924 people or 332,481 families. When added to the population of Palu city in 2010 amounted to 335,297 people or 83,824 families, then the effective cultivation area in Palu can accommodate 1,665,221 people or 416,305 families. In the future, the extent of land use for building in Palu city will have enhancement by an average growth 2.50% per year. The extent of effective potential land is capable of supporting the growth of land use for building over 159 years or until the year of 2169.

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