International Refereed Journal of Engineering and Science (IRJES)
ISSN (Online) 2319-183X, (Print) 2319-1821
Volume 4, Issue 12 (December 2015), PP: 01-10

Analysis and Design of Green Open Space Depok City Based On Geographic Information Systems

Agung Wahyudi[1], Joesron Alie Sjahbana[2] , Imam Buchori[3]
[1](Student Doctoral, Architecture and Urbanism, Diponegoro University, Semarang)
[23](Architecture and Urbanism, Diponegoro University, Semarang)

Abstract:- Land use planning aim at improved sustainable use and management of resources. This would imply that those who use and manage the resources are the key players in the planning process. Thus planning for sustainable land management can only be relevant and successful when all stakeholders are involved. In this study considers on biophysical characteristics to make land evaluation, with special attention to open space. The objectives of this study were: (1) to analysis the existing land use based on land suitability for open space with attention to paddy field, dry land cultivation, and protected area; and (2) to calculate the area of open space that are paddy field, dry land cultivation, and protected area based land suitability and compare to the existing condition. The result of this study is expected to be used as an input for decision maker in the term land use management decision making at study area. The capabilities of Geographic Information Systems (GIS) were used to determine suitable area for specific land use in study area. The research has been applied in Depok Municipality, West Java Province. The result indicates that in study the total area of existing open space is 42.94% or about 8,600.45 Ha from the total area of study. The existing paddy field cultivation based on land suitability evaluation, i.e. 69.53% on area with suitability class S1 (Highly Suitable); 25.11% on S2 (Moderately Suitable); 5.33% on S3 (Marginally Suitable); and 0.02% on N class (Not Suitable). For dry land cultivation the existing condition 63.36% on area with suitability class S1 (Highly Suitable); 28.82% on S2 (Moderately Suitable); 7.60% on S3 (Marginally Suitable); and 0.22% on N class (Not Suitable). While the protected area that is used for any development activity in existing (infringe area) is 2.39% from the total area of study or about 479.17 Ha

Keywords: - Land Use Planning, Land Evaluation, Open Space, GIS

I. INTRODUCTION

Indonesia is a country with abundant of natural resources. Land and water are essential natural resources for development process; especially for the people in Indonesia whose most of them depend on the sector of agriculture. The success on preservation of land resources will support to the sustainable development effort that meeting the needs of current generations and preserving the opportunities for future generations. Therefore, the quality of land resources should be preserved from any degradation that can decrease its capacity and productivity.

The rapid human population growth and increasing human prosperity cause an increasing need of land resources, such as for settlement, agriculture, industry, and recreation. The general problem related to the land resources allocation is the development activities that not match with the land capacity. This is may generates degradation of environment caused by unwise land use planning that only emphasize on the economic than environmental aspect. The basis of land resource utilization by man is to achieve the prosperity. This is depending on the potency of land resources and human activities in managing of natural resources. Accordingly, there is a need for generating the optimal land allocation for sustainability development by considers the indicators of the economic, social, and the environment. Sustainable development must balance the needs of these aspects By applying the act No.22/1999 on Local Government Administration (Regional Autonomy) and the act No.25/1999 on Central.-.Local Fiscal Balance, the local government around in Indonesia has an authority to arrange and manage natural resources in each area. Related to that issue, wise land use is an essential basis for a healthy and prosperous of current and future generation. Therefore, land use planning at local government level become very important for sustainability of natural resources in the area. It depends on the systematic evaluation of the land and water resources.

Land use planning is the systematic assessment of land and water potential, alternatives for land use and social economic conditions in order to select the best land use options. It can help decision-makers to use

land in such a way that current land use problems are reduced and specific social, economic and environmental goals are satisfied. The driving force in planning is the need for change, the need for improved management or the need for a quite different pattern of land use dictated by changing circumstances [1].

The function of land use planning is to guide decisions on land use in such a way that the resources of the environment are put to the most beneficial use for people, whiles at the same time conserving those resources for the future. This planning must be based on an understanding both of the natural environment and of the kinds of land use envisaged. There have been many examples of damage to natural resources and of unsuccessful land use enterprises through failure to take account of the mutual relationships between land and the uses to which it is put. It is a function of land evaluation to bring about such understanding and to present planners with comparisons of the most promising kinds of land use [2].

Land evaluation is an important part in the process of land use planning. It assesses the suitability of land for specified land uses based on the matching of qualities of different land units in a specific area, with the requirements of actual or potential land use. The result is a land classification that indicates the suitability of land for specific land uses. This is very useful for rational land use planning. These suitability assessments are then examined in economic, social and environmental considerations in order to develop an actual plan for the use of land in the area. When this has been done, development can begin [3].

Depok is a city growing rapidly which functioned as buffer to DKI Jakarta, the capital and the biggest city of Indonesia. As a city that adjacent with the center of socio-economic and governance activity, give an implication to land use change that happened excessively without considers to the capability and suitability of the land and the effect of ecosystem damage. Land conversion from agriculture area to non-agricultural areas such as industrial zones, and settlement has happened quickly[4]. This conversion cause decreasing the area of open space. As a result, the environmental effects have become a new problem not only to the area itself but also to the surrounding area. It is needed the comprehensive thinking as part of land resources management effort toward sustainable development at district level.

Regional Spatial Planning (RTRW) of Depok city comprise: a) policy, approach, and spatial development strategy to achieve the goals of qualified spatial land utilization; b) goals of spatial land utilization of Depok city to improve the prosperity of society; c) structure and pattern of spatial land utilization of Depok city; and d) guidance for controlling the spatial land utilization of Depok city.

According to Regional Spatial Planning (RTRW) of Depok city 2010-2015, Depok has been decided as 'buffer cities' and 'counter magnet' for DKI Jakarta and the surrounding area. Furthermore biophysically, Depok included in the area of Botabek (Bogor.-.Tangerang.-.Bekasi) that has been decided as the catchments area and should be preserves the area of open space. As detailed it covers paddy field cultivation, dry land cultivation (dry land, plantation, grass/bare land), lake, recreation area, field sport, Grand Forest Park, special area (TVRI and RRI), and stream line (river, high voltage, and gas pipeline). Until 2015 the area of open space is targeted 49.21% from total area of Depok city. But because of development enforce, especially after Depok has developed to be municipality, has been happened degradation of open space significantly for agriculture land. This condition is contradictive with the policy that Depok area as water catchments that should be preserves the area of open space.

The current land use developments in the area of Depok City are lacking a firm sustainable basis. It is needed the thinking and consideration in land use decision so give optimum use of land resources for society and environment at present and future. Beside that, no systematic land suitability assessment and land use planning has been carried out in the area so far. A systematic inventory and analysis of present land resource and land use patterns is required to be followed by a land suitability evaluation to support land use planning. In this study, land evaluation will be examined to support land use planning of Depok city with attention to open space that comprises the cultivation area and the protected area. The cultivation area specifically covers paddy field and dry land cultivation, while protected area in this study is defined as the area of open space beyond the area for cultivation area. The result of this research is expected can give information and consideration in policy making in land use planning especially related to preservation of open space.

II. METHODOLOGY

The case study area is Depok Municipality, West Java Province, Indonesia. Depok is a city at Southern Jakarta which geographically located between 6o19'00" S - 6o28'00" South Latitude, and 106o43'00" E - 106o55'30" East Longitude with the total area covers 20,029 Ha (200.29 Km2). The area covers 6 sub districts i.e. Beji, Cimanggis, Limo, Pancoran Mas, Sawangan, and Sukmajaya (Figure 1.).

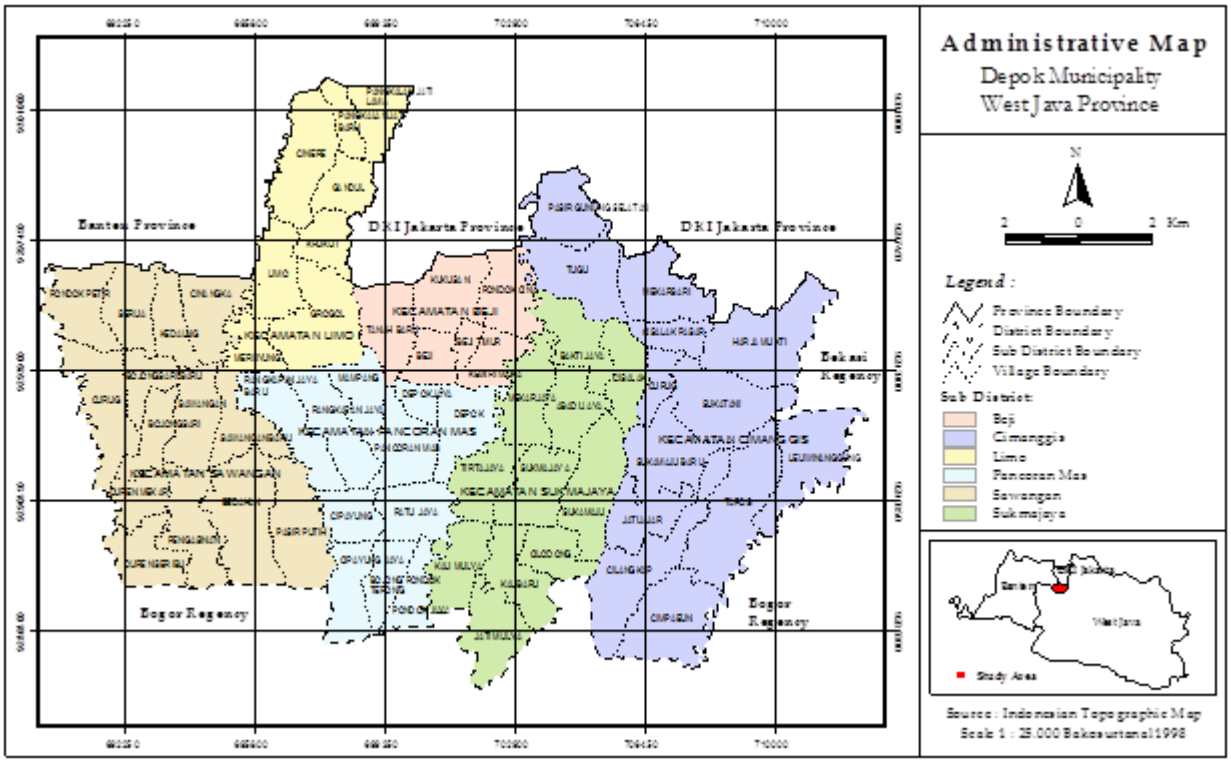


Figure 1 The Study Area and Administrative Boundary

2.1. Methods

This study will be carried out in two stages i.e. (1) Data Preparation and (2) Land Suitability Analysis. Figure 2. shows the conceptual framework of the analysis.

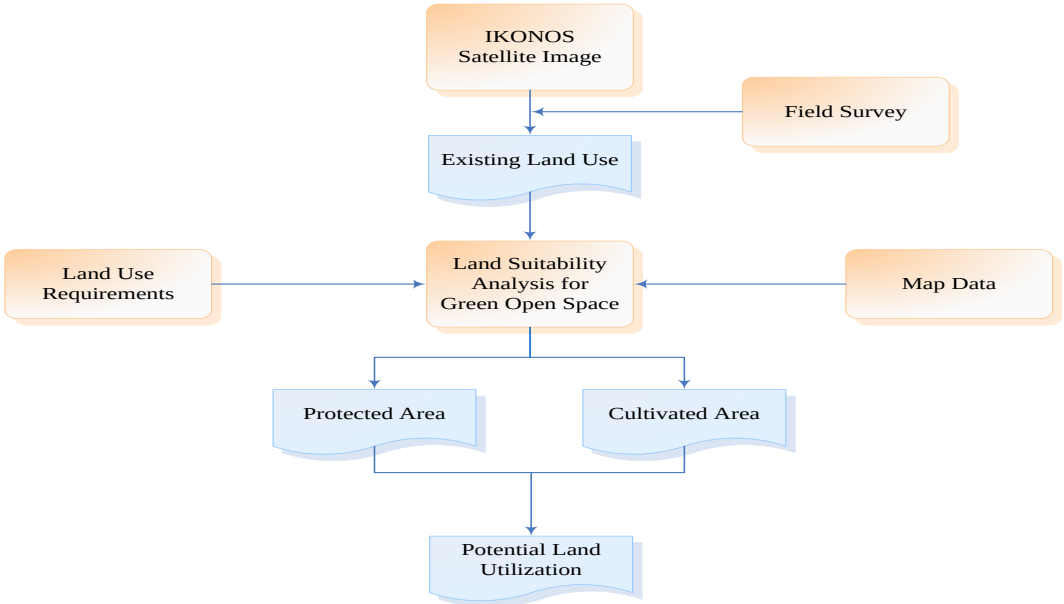


Figure 2. The Conceptual Framework

2.2 Analysis

The aim of the analysis is to get the area of land suitable for land use which categorized as green open space i.e. paddy field, dry land cultivation, and protected area. Each types of land use will be analyzed based on the biophysical criteria or requirement of land utilization types. From the analysis, the land suitability for each of land utilization type (LUT) will be classified into four classes, i.e. Highly Suitable (S1), Moderate Suitable (S2), Marginally Suitable (S3), and Not Suitable (N) that are defined as the following:

1. Class S1, Highly Suitable: Land has no significant limitations to sustained application of a given use. It may include minor limitations that will not significantly reduce productivity or benefits and will not raise inputs above an acceptable level.
2. Class S2, Moderately Suitable: Land has limitations that in aggregate are moderately severe for sustained application of a given use. The limitations may reduce physical productivity, benefits compared with S1 land to a lower limit set for the class.
3. Class S3, Marginally Suitable: Land has limitations which in aggregate are severe for sustained application of a given use and will so reduce physical productivity, benefits that the expenditure will only be marginally justified.
4. Class N, Not Suitable: Land is not suitable for the given use usually because of physical limitations. Actually, there are two classes for this order: Class N1 (Currently Not Suitable) and Class N2 (Permanently Not Suitable). In this study, these classes are joined into Class N [5].

2.3 Land Suitability for Paddy Field Cultivation

Paddy field cultivation is divided into two categories: wetland and upland cultivation. The area of wetland paddy field is cultivated area with irrigation system continually during the year, seasonal or periodically, while the area of upland paddy field is cultivated area without irrigation system. According to land suitability classification proposed by Hardjowigeno et al. [6] and supported with any literatures related to land suitability, determining of land suitability for paddy field cultivation is using several criteria. The detail of those suitable criteria is described on Table 1

Table 1. Biophysical Criteria of Land Suitability for Paddy Field

No.	Biophysical Criteria	Weight (Default)	Score	Intervals
1.	Temperature (^{o}C)	16	1 2 3 4	>35 or <18 >32 - 35 or 18 - <22 >29 - 32 or 22 - <24 24 - 29
2.	Rainfall (mm/year)	33	1 2 3 4	<800 800 - <1200 1200 - 1500 >1500
3.	Elevation (m)	25	0 2 3	>1000 500 - 1000 <500
4.	Soil Type	26	1 2 3	Regosol Latosol Alluvial
5.	Slope (%)	16	0 1 2 3	>15 8 - 15 2 - 8 <2

III. RESULT AND DISCUSSION

3.1. Land Suitability Analysis

Land suitability analysis focused on green open space area that involve paddy field cultivation, dry land cultivation, and preservation area. Land suitability analysis is done according the criteria for specific land

use as recommended by expert as mention in Methodology. The analysis result then grouped into four categories (classes) of land suitability, i.e. Highly Suitable (S1), Moderate Suitable (S2), Marginally Suitable (S3), and Not Suitable (N). The assessing of land suitability is done by matching between land-use requirements for each land use type using index overlay model. In this method, each factor maps will be assigned scores (scored maps), as well as the maps themselves receive different weights. All scored maps will be assigned to a scale (e.g. ranging between 1 to 4). Weights are generally assigned to these maps to express the relative importance. Eventually, scored maps are combined with constraint maps to eliminate areas of absolute unacceptability. A final map will be generated that identifies the degrees of land suitability that are highly suitable, moderate suitable, marginally suitable or not suitable area[7].

$$TS = \sum_{i=1}^{n} (W_i \, . X_i)$$

Simple Additive Weighting Formula

Where:

TS = Total Score

Wi = weight value of factor i

Xi = score value of factor i

3.2. Paddy Field Cultivation

The suitability map resulting from the spatial overlay from several data available. Soil map, slope map are used to evaluate paddy field suitability of land. The others criteria i.e. temperature, elevation, and rainfall didn't used because the variability of data is small for the whole area. These two layers are then spatially overlaid to produce a resultant polygon layer. Application of the model to the resultant layer yields a suitability map with 4 classes according to the resultant values proposed in Table 2. While the area of the suitability evaluation is shown in Table 3. The analysis of land suitability classification for paddy field is shown in Figure 3

Table 2. Suitability Evaluation for Paddy Field

Total Score	Evaluation
> 95	Highly Suitable (S1)
64 - 95	Moderately Suitable (S2)
32 - 63	Marginally Suitable (S3)
< 32	Not Suitable (N)

Table 3. The Suitability Area for Paddy Field

Suitability Class	Area (Ha)	Percent
Highly Suitable (S1)	10,853.30	54.19
Moderately Suitable (S2)	7,210.66	36.00
Marginally Suitable (S3)	1,918.99	9.58
Not Suitable (N)	46.04	0.23
Total	**20,029.00**	**100.00**

By using physical criteria that are slope and soil type, could be concluded that the area of study physically suitable for paddy field that covers 54.09% and 36.00% for S1 and S2 suitability class respectively. This analysis might be better if consider the hydrological aspect, like ground water, but in this study this data is not available.

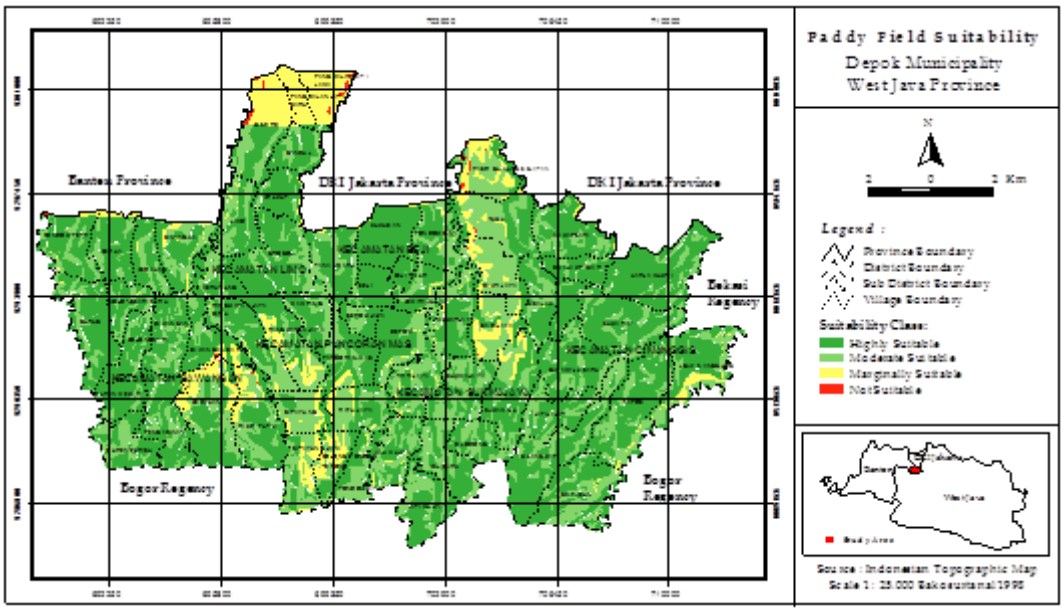


Figure 3. Land Suitability Classification Map for Paddy Field

3.3. Dry Land Cultivation

The area of dry land cultivation is area of dry land with conditions physically suitable for agronomy, horticulture, plantation, and animal husbandry. Similar with the suitability analysis for paddy field, soil type map, slope map are used to evaluate paddy field suitability of land. The others criteria i.e. temperature, elevation, and rainfall didn't used because the variability of data is small for the whole area. These two layers are then spatially overlaid to produce a resultant polygon layer [8]. Application of the model to the resultant layer yields a suitability map with 4 classes according to the resultant values proposed in Table 4. While the area of the suitability evaluation is shown in Table 5. The analysis of land suitability classification for paddy field is shown in Figure 4.

Table 4. Suitability Evaluation for Dry Land Cultivation

Total Score	Evaluation
> 108	Highly Suitable (S1)
73 - 108	Moderately Suitable (S2)
36 - 72	Marginally Suitable (S3)
< 36	Not Suitable (N)

Table 5. The Suitability Area for Dry Land Cultivation

Suitability Class	Area (Ha)	Percent
Highly Suitable (S1)	10,853.30	54.19
Moderately Suitable (S2)	7,210.66	36.00
Marginally Suitable (S3)	1,918.99	9.58
Not Suitable (N)	46.04	0.23
Total	**20,029.00**	**100.00**

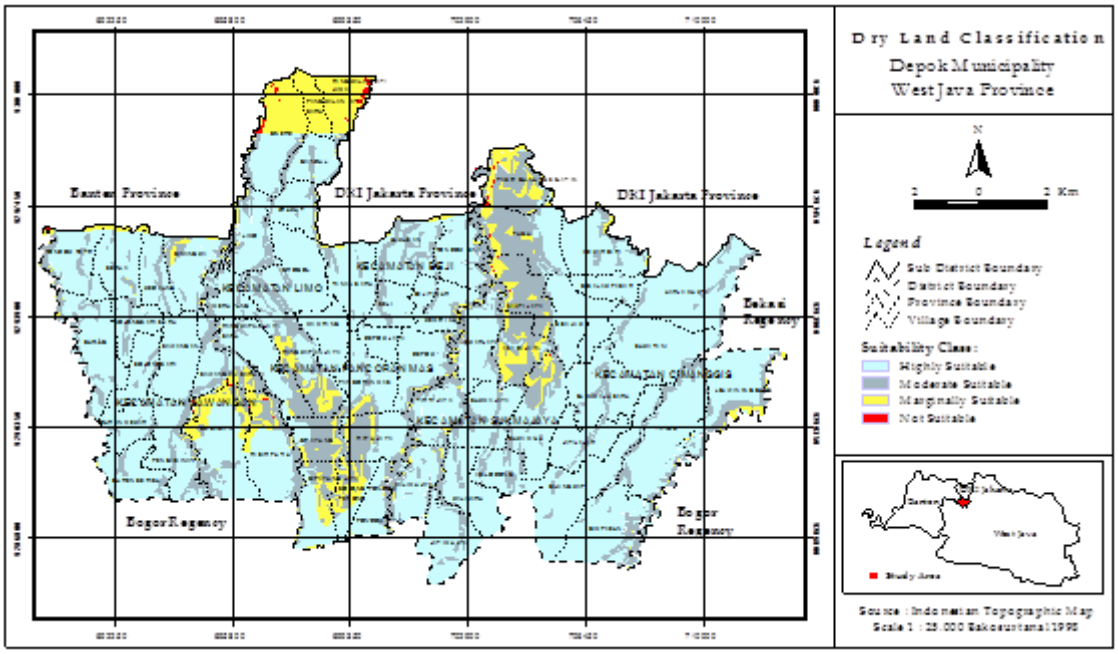
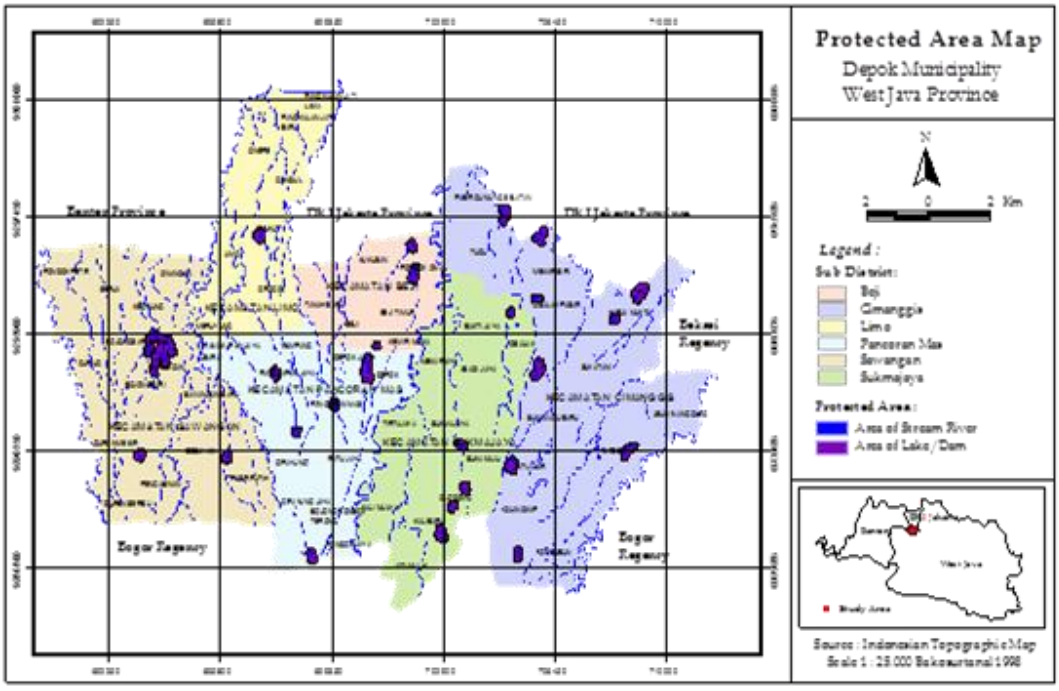


Figure 4. Land Suitability Classification Map for Dry Land Cultivation

3.4. Protected Area

Defining the protected area is according to Presidential Decree No.32/1990. Protected areas is defined as the areas which decided to preserve the sustainability of natural environment including natural resources, man-mad resources and story value and culture for sustainable development of the country. Management of protected area stated that the areas along riverside, ravine side, water courses, and around dam/lake should be avoided from tree cutting.

Figure 5. Map of Protected Area



According to the rules stated in Presidential Decree No.32/1990 the physical characteristics to determine protected area, i.e.:

1. Forest area with slope is 40% or more

2. Area within at least 100 meters of existing river and 50 meters of stream beyond settlement area, while within settlement area, riverside is around 15 meters from streams.
3. Area around lake/dam is area within 100 meters of existing lake/dam.
4. Area around wellspring within 200 meter from point of wellspring.

Based on those physical characteristics, GIS analysis is done to determine where and how much the area that should be protected from tree cutting and any development activities. In this study area the physical characteristics as mention in point 1 is not considered because the area of study relatively flat in slope. The result from GIS analysis show the protected area covers is about 1,617.28 Ha (8.07% from the total area of Depok). The map of protected area in this study is shown in Figure 5

3.5. Land Use Analysis

This Analysis is done to compare the existing land use with land suitability classification, so can be shown the area that is not match with the criteria of land suitability i.e. Paddy Field, Dry Land Cultivation, and Protected Area that categorized as Open Space[9].

3.5.1. Cultivated Area

Comparisons between existing land use, that are cultivated area (paddy field and dry land cultivation) and land suitability map is done using overlay method, then calculate each area based on suitability class.

Table 4.8. Existing Paddy Field Cultivation Based on Land Suitability

Suitability Class	Area (Ha)	Percent
Highly Suitable (S1)	772.95	69.53
Moderately Suitable (S2)	279.19	25.11
Marginally Suitable (S3)	59.27	5.33
Not Suitable (N)	0.26	0.02
Total	**1,111.68**	**100.00**

Table 4.9. Existing Dry Land Cultivation Based on Land Suitability

Suitability Class	Area (Ha)	Percent
Highly Suitable (S1)	1,716.75	63.36
Moderately Suitable (S2)	781.00	28.82
Marginally Suitable (S3)	205.79	7.60
Not Suitable (N)	5.94	0.22
Total	**2,709.48**	**100.00**

3.5.2. Protected Area

Comparisons between protected area according to Presidential Decree No.32/1990 with existing land use is needed to show where and how much the area that was used for development activity, especially for settlement or housing and other infrastructure development. Figure 6 show the map of recommended for protected area compared with existing land use. Using GIS analysis[10] then have been calculated that land use 'settlement' which infringe protected area about 479.17 Ha (Infringe Area) as shown in Figure 8.

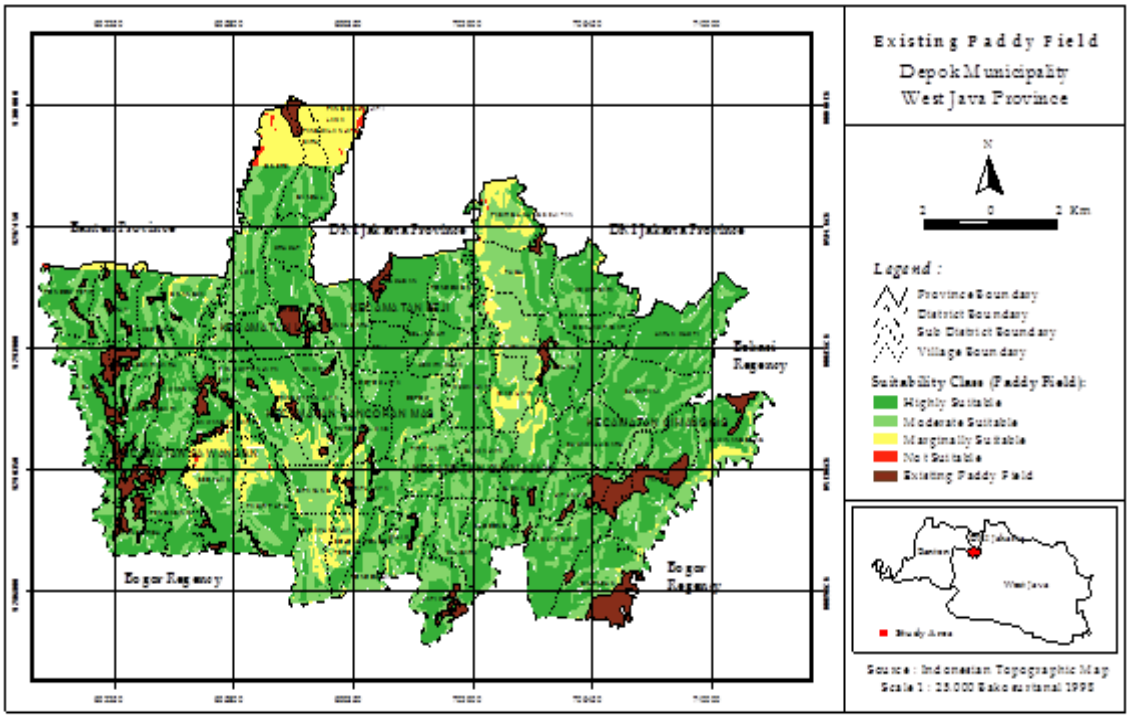


Figure 6. Existing Paddy Field Map

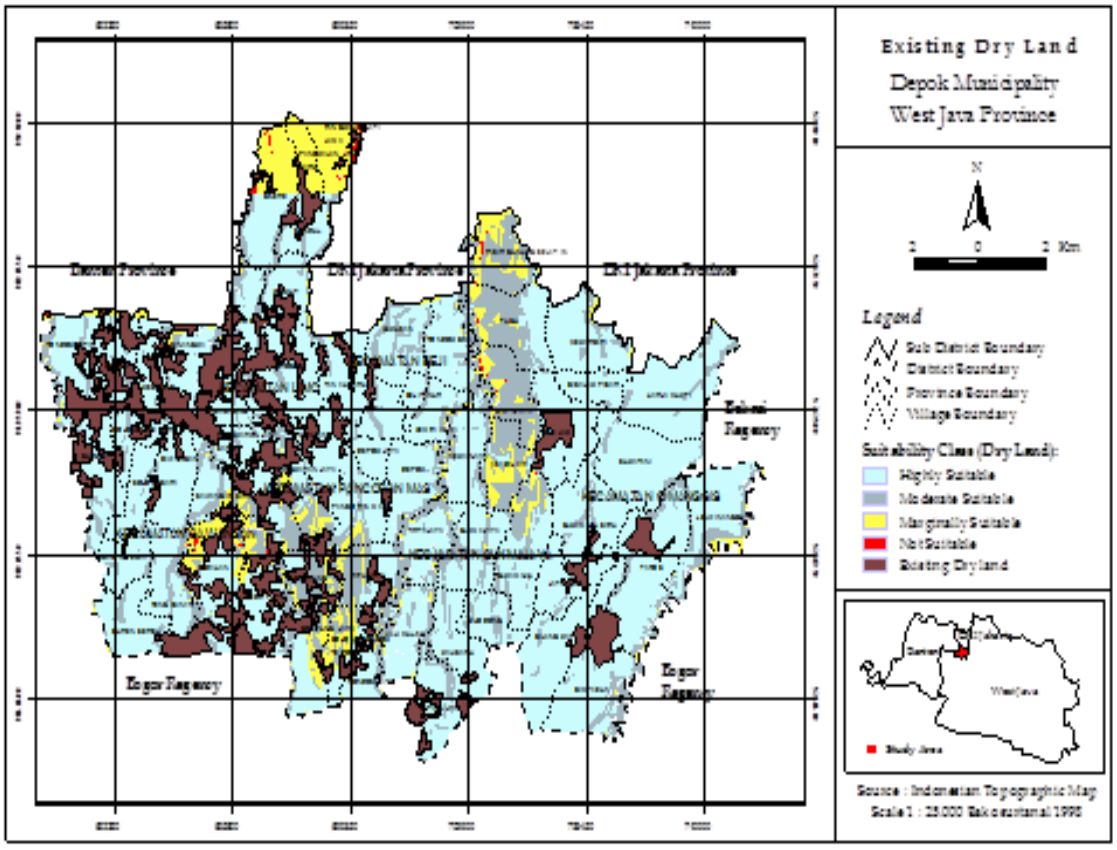


Figure 7. Existing Dry Land Map

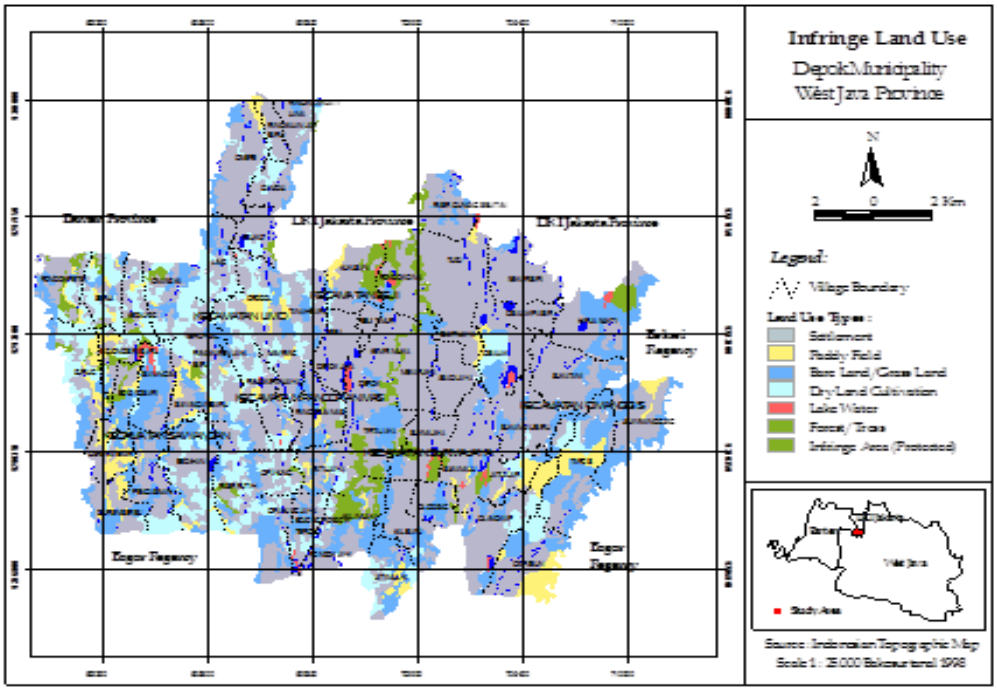


Figure 8. Land Suitability Classification Map for Dry Land Cultivation

IV. CONCLUSION

Open space evaluation in study area is done by considered a set of physical characteristics with special attention to the cultivated area (i.e. paddy field and dry land cultivation) and the protected area. Total area of existing open space is 42.94% or about 8,600.45 Ha from the total area of study. Existing paddy field cultivation based on land suitability evaluation, i.e. 69.53% on area with suitability class S1 (Highly Suitable); 25.11% on S2 (Moderately Suitable); 5.33% on S3 (Marginally Suitable); and 0.02% on N class (Not Suitable). Existing dry land cultivation based on land suitability evaluation, i.e. 63.36% on area with suitability class S1 (Highly Suitable); 28.82% on S2 (Moderately Suitable); 7.60% on S3 (Marginally Suitable); and 0.22% on N class (Not Suitable). Protected area that is used for any development activity (infringe area) is 2.39% or about 479.17 Ha from the total area of study.

REFERENCES

[1] FAO. *Guidelines for Land-Use Planning*. FAO Development Series 1. Rome, 1993

[2] FAO. *A Framework for Land Evaluation*. FAO Soils Bulletin 32. Food and Agriculture Organization of the United Nations. Rome, 1976.

[3] FAO and UNEP. *The Future of Our Land.* Guidelines for integrated planning for sustainable management of land resources. UNEP-FAO. Rome, 1999.

[4] Rodriguez, P.O.S.. *Land Use Conflicts and Planning Strategies in Urban Fringes. A Case Study of Western Caracas, Venezuela*. PhD thesis, ITC, Enschede, The Netherlands, 1995

[5] Khoram, M.R., Shariat, M., and Azar, A. GIS Application for Land Evaluation and Planning of Hamadan Province for Agricultural Activity. *Proceeding of the FOSS/GRASS*, Bangkok, Thailand, 12-14 September 2004

[6] Hardjowigeno, S., Widiaatmaka, A.S. dan Yogaswara. *Kesesuaian Lahan dan Perencanaan Tataguna Tanah*. Jurusan Tanah, Fakultas Pertanian IPB, Bogor, 2013.

[7] Carver, S.J, Integrating Multi Criteria Evaluation with Geographical Information System. *International Journal of Geographical Information Systems.* Volume 5, No.3, 1991.

[8] Dent, D, *Guidelines for Land Use Planning in Developing Countries*. Soil Survey and Land Evaluation, 1988.

[9] Vink, A.P.A, *Land Use in Advancing Agriculture.* Springer-Verlag. New York Heidelberg Berlin, 1975.

[10] Burrough, P.A. and McDonnell, R.A. *Principles of Geographical Information Systems*. Oxford University Press Inc., New York, 1998.