

A Calculation and Compiling Models of Land Cover Quality Index 2019 uses the Geographic Information System in Pariaman City, West Sumatra Province, Indonesia



Olivia Oktorie, Dedi Hermon, Erianjoni, Azhari Syarief, Aprizon Putra

Abstract: *The purpose of calculation and compiling the Land Cover Quality Index (LCQI) is to evaluate the value of natural and environmental resources based on land cover conditions in an administrative region such as city, regency and province in Indonesia referring to the Regulation Director General of Pollution Control and Environmental Damage Number P.1/PPKL/PKLA.4/2018. The analytical method used in the calculation of the Normalized Difference Vegetation Index (NDVI), the Maximum likelihood classification approach, and the preparation of LCQI calculation methods based on 1) sufficiency area (forest region) and forest cover at minimal 30% on rivers and islands; 2) Ability and suitability of land minimal 25%; and 3) a link with the direction of land use in urban areas of at minimal 30%. The results showed the vegetation density index value in Pariaman city was classified as a good category with a value of 0.474903 μm , the results of a land cover classification in Pariaman City with the largest region are found in mixed gardens land of 2,736.57 ha or 37%. Whereas the smallest region is found in cypress vegetation land as a greenbelt at the coastal border 12.06 ha or 0,16%, and the results of the LCQI calculation indicate the LCQI value in 2019 (24,06) which is in the alert classification (<50). The increase in land cover outside the forest region is mainly directed at increasing green open space because Pariaman City does not have natural forest which are vulnerable to changes in land cover because of its high population density.*

Index Terms: Land Cover, LCQI, Pariaman City

1. INTRODUCTION

The increasing number of damaging vegetation in a coastal city with sloping topography as mangrove, green open space, shrubs, and mixed gardens from land cover changes that are affecting the high number of carbon emission in the atmosphere [1] [2] [3] [4].

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This problem can be resolved with increasing the number of existing forest and vegetation area in the coastal city that doesn't have any protected forest or buffer zone [5] [6] [7] [8]. Forest cover in coastal city area is having a big impact to decreasing CO² and reducing carbon emission level [9] [10] [11] [12] [13].

Pariaman City is having a mangrove region, greenbelt in various type such as cypress, shrubs, mixed gardens, green open space but the Pariaman City itself doesn't have any natural forest which is resistant to land cover change because of a high density of population. Land cover changes will have an impact on ecology condition to this region. One of them is carbon dioxide in the air will contribute to greenhouse gas [14] [15]. Pariaman city having a vegetation in medium category for coastal city with flat to gently undulating topography that can be predicted is lack of carbon stock because of the lack of existing vegetations. Based on that, vegetation region in Pariaman City should be maintained, such as the mangrove region, mixed gardens, and shrubs.

Pariaman City has 3 Watershed those are Manggung watershed that passes through North Pariaman Subdistrict, Pariaman watershed and Mangor Watershed passes through East Pariaman Subdistrict, Central Pariaman Subdistrict, and South Pariaman Subdistrict. The length of Pariaman Watershed is 12,00 km, Manggung Watershed is 11,50 km, and Mangor Watershed is 11,80 km. The upper course that passes through Pariaman City is functioning as a conservation area and buffer zone for the forest. [16] [17] [18] [19]. explains if Watershed component changes it would change the entire parts of the Watershed. Besides the ecologies function, Pariaman City is located in the middle course and lowest course of the Watershed also have another function as production region, cultivation region, and coastal protected (mangrove). The vegetation in the coastal region in Pariaman City that located in the middle and lowest course of 3 Watershed are plains and slopes which is located on the west coast of West Sumatera Province and its elevation is 2-35 m above sea level [20] [21].

The purpose of mapping, calculation and compiling the Land Cover Quality Index (LCQI) is to evaluate the value of natural and environmental resources based on land cover conditions in an administrative region such as city, regency and province in Indonesia referring to the Regulation Director General of Pollution Control and Environmental Damage Number P.1/PPKL/PKLA.4/2018



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concerning Guidelines for Calculation of Land Cover Quality Index and Management of Land Cover. The data used in this research of calculation and compiling the LCQI of Pariaman City in 2019 are *Satellite Pour l'Observation de la Terre* (SPOT)-6 date October 2018 with 1,5 m spatial resolution and direct field observation on March 2019.

II. RESEARCH METHODS

The observation to calculate and compile LCQI of Pariaman City in 2019 are all sorts of vegetation covers in Pariaman City administrative region at position 0°33'00" – 0°40'43" S and 100°10'33" – 100°10'55" E (Table 1 and Figure 1).

Table 1. Survey location vegetation types of land cover

No	Coordinate		Village	Subdistrict
	Long	Lat		
1	100° 6'32.21"E	0°35'54.14"S	Apar	North Pariaman
2	100° 7'1.49"E	0°37'10.97"S	Kampung Pondok	Central Pariaman
3	100° 5'29.09"E	0°34'4.41"S	Padang Birik-birik	North Pariaman
4	100° 7'38.58"E	0°38'42.21"S	Karan Aur	Central Pariaman
5	100° 8'22.25"E	0°39'20.38"S	Pasir Sunur	South Paria
6	100° 6'23.03"E	0°33'55.10"S	Sintuk	North Pariaman
7	100° 7'15.50"E	0°35'0.76"S	Cubadak Air	North Pariaman
8	100° 8'8.98"E	0°36'13.08"S	Talago Sarik	East Pariaman
9	100° 8'54.92"E	0°37'11.55"S	Bungo Tanjung	Pariaman Tengah
10	100°10'10.07"E	0°38'59.94"S	Kampung Abar	East Pariaman
11	100° 7'16.21"E	0°33'41.35"S	Sei Rambai	North Pariaman
12	100° 8'2.81"E	0°34'28.64"S	Sikapak Timur	North Pariaman
13	100° 8'15.80"E	0°35'38.18"S	Kampung Gadang Padusunan	East Pariaman
14	100° 9'26.32"E	0°36'35.10"S	Kajai	East Pariaman
15	100°10'13.55"E	0°36'20.31"S	Punggung Lading	East Pariaman

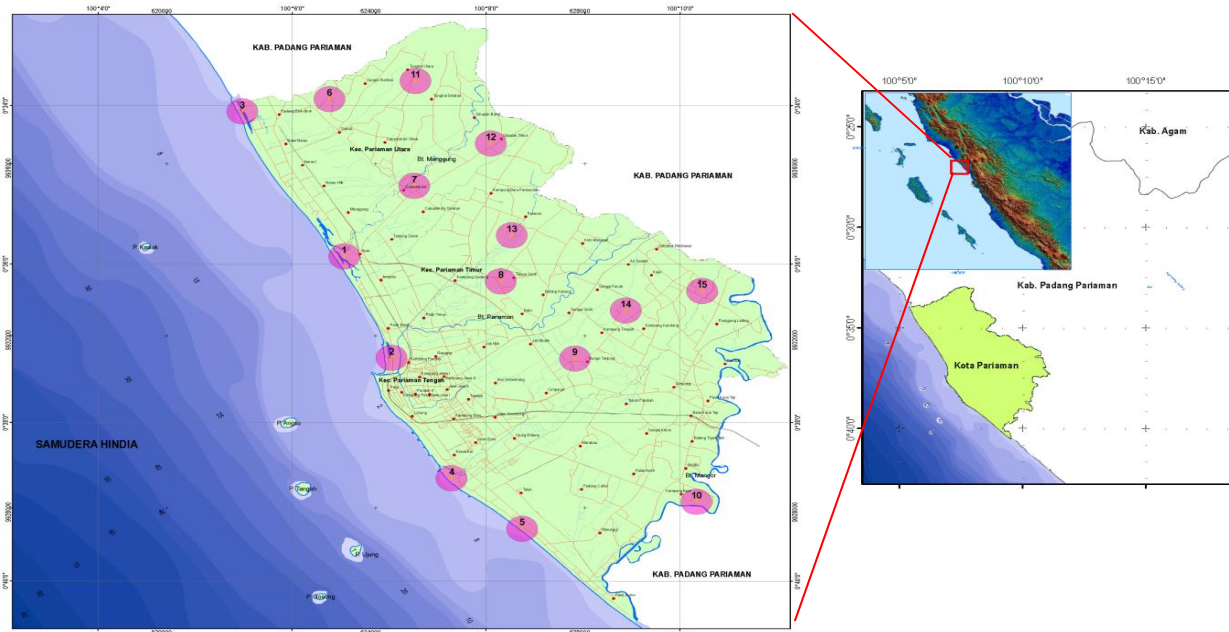


Figure 1. Map of Observation Location in Pariaman City

Normalized Difference Vegetation Index (NDVI)

According to [22] [23] NDVI transformation of vegetation density found out the aggregate of different types that cover the ground level. This research uses the vegetation index NDVI, with the following equation:

$$NDVI = \frac{R - Nir}{R + Nir}$$

In which :

- NDVI = Normalized Difference Vegetation Index
- NIR = Near infrared ray
- R = Red light (Franklin, 2011).

Table 2. NDVI values with vegetation density

Vegetation Density	NDVI value (μm)
Very good	0,72-0,92
Good	0,42-0,72
Normal	0,22-0,42
Bad	0,12-0,22
Very bad	-0,1-0,22

Processing of Satellite imagery data for Land Cover

The classification process of spot-6 is using Supervised Classification. The Classification is digital based and only based on every absolute pixel than compiling it into classification. While the classification method is using the maximum likelihood method to obtain every pixel in the righteous classification. The supervised classification system is using m mainly for the land with a complexion that difficult to find the differences if the supervised classification was used [24] [25] [26] [27] [28] [29] [30] [31]. Unsupervised classification will obtain the classification of vegetation not the difference of vegetation.

The calculation and compiling the Land Cover Quality Index (LCQI)

LCQI 2018 is updating based on the Regulation Director General of Pollution Control and Environmental Damage Number P.1/PPKL/PKLA.4/2018. For LCQI calculation that can represent the city characteristic, upper and lower course of watershed and lands, this can be identified with a few approaches for LCQI method, which is:

1. Sufficiency area (forest region) and forest cover at minimal 30% on rivers and islands.
2. Ability and suitability of land for certain land character that needs land cover such as trees in river borders, coastal region, lake, and slope >25%. Land characteristic also represents the upper and lower course of the watershed. The river borders, coastal area, lake, and slope >25% are generally in the middle to the upper course while the border of the beach in the lower course of the watershed.
3. Relating to the direction land use in the city region, minimal 30% of land use should use as green open space. Green open space can be formed as urban forest (minimal 10% from the total space of the city), mixed gardens, natural conservation or garden that dominating with the tree.

$$LCQI = 100 - ((84,3 - (LC \times 100)) \times \frac{50}{54,3})$$

In which :

LCQI = Land Cover Quality Index

LC = Land Cover

LC calculated by formula:

$$LC = \frac{LCA}{RCRA}$$

In which :

LCA = Land Cover area

RCRA = Regency/City region area.

After analyzing the LCQI, the next step is categorizing the LCQI values according to the table below:

Table 3. Classification and range of LCQI values

Classification	Value Range
Superior	X > 90
Very good	82 < X ≤ 90
Good	74 < X ≤ 82
Enough	66 < X ≤ 74
Less	58 < X ≤ 66
Very less	50 < X ≤ 58
Alert	X > 50

Source: Environmental Quality Index (EQI) Indonesia, 2014.

III. RESULTS AND DISCUSSION

3.1 Vegetation density

The highest NDVI value of land cover vegetation in the satellite imagery SPOT-6 is represented by red and lower blue which represents the lowest pixel value [32]. From the type of land cover vegetation, it was found that green shrubs and paddy fields had the highest average vegetation index value of 0,474903 μm , and the lowest value was found in several mangrove locations that were flooded with water and vegetation at river banks with an average vegetation index value -0,188034 μm (Tabel 4 and Figure 2). The results of the NDVI analysis show the level of the proportion of the type of land cover vegetation that is more optimal in the satellite imagery appearance. This application shows the type of land cover vegetation such as shrubs, mixed gardens and mangroves shows a fairly good appearance.

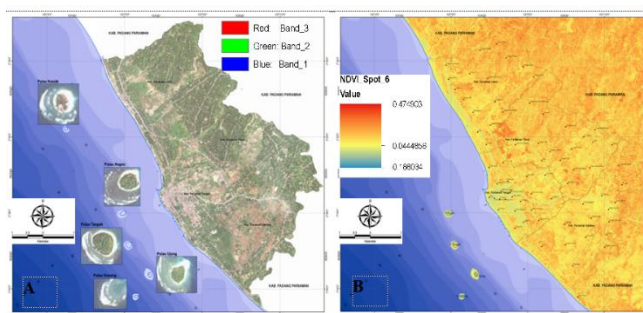


Figure 2. A) Satellite imagery SPOT-6 2018 of Pariaman City; and B) Map of vegetation density value

3.2 Land Cover

Based on the imagery interpretation of SPOT-6 using a combination of band 321 for the classification of land cover vegetation types, and observation of land cover in the field, obtained of 10 land cover classes in Pariaman City. The appearance of land cover in SPOT-6 in Pariaman City displayed in different colours. Such as water body in blue colour. Dark blur also used for new planting rice fields. The new planting rice fields is usually having a lot of water. The vegetation represented by light to dark green [33]. The degree of green colour brightness usually represents the vegetation density, such as mangrove cover and shrubs high-density will appear dark green when compared to low density mixed gardens or mixed forest. Whereas built-up land (settlements, buildings, and roads) is represented in red colour, and open land (fields, and sand coastal) is represented with orange colour.



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The results of the classification of land cover vegetation types in Pariaman City with the largest area are found in the mixed gardens of 2,736.57 Ha or 37% and rice fields 2,178.97 Ha. Whereas the smallest area is found in cypress vegetation as a greenbelt in the coastal border 12,06 Ha or 0.16%. For the results of the classification of non-vegetation types of land cover with the largest area found on built-up land (settlements, buildings, and roads) 914.36 ha or 12%. Whereas the smallest area is found in the water body (river bodies, ponds and lagoon) in the coastal border which has an area of 122,30 Ha or 2,67% (Table 4 and Figure 3).

Table 4. Analysis result of land cover in Pariaman City 2019

No	Type	Land Cover	Area (Ha)	(%)
1		Mixed gardens	2,736.57	37%
2		Rice fields	2,178.97	30%
3		Field/moor	715,25	10%
4	Vegetation	Shrub+Small island	392,50	5,35%
5		Mangrove forest	40,30	0,55%
6		Greenbelt (cypress)	12,06	0,16%
7		Green open space	54,14	0,74%
		Open land+Small islands	170,04	2%
8	No	islands	170,04	2%
9	Vegetation	Built-up land	914,36	12%
10		Water body	122,30	1,67%
Total area of land cover			7,336	100%

Source: Data analysis, 2019.

3.3 Land Cover Quality Index (LCQI)

Pariaman City as one of the western coastal region of Sumatra island has a sloping topography [34] [35] [36] [37]. The topography is also associated with the slope of a region which describes how the suitability of land cover in a region. Hermon (2016) explains that these conditions affect land cover patterns and activities managed by the community. Based on the results of the analysis of the above land cover, refers to the Regulation of the Director General of Pollution Control and Environmental Damage Number P.1/PPKL/PKLA.4/2018 land cover in Pariaman City is dominated by mixed gardens (2,792.17 Ha), shrubs (392,50 Ha), green open space (54,14 Ha), mangrove forest (40,30 Ha) and greenbelt (12,06 Ha). Where the land cover needed is only forest cover with the criteria described in the calculation and compiling method of LCQI 2019. The land cover area for the forest category in LCQI 2019 in Pariaman City can be seen in Table 6.

Table 5. Calculation of LCQI in Pariaman City 2019

Land Cover	Area
Secondary Mangrove	40,30
Green open space	54,14
beach 250 m (buffer)	
- greenbelt	12,06
- scrubs	10,48
total	22,54
river 50 m (buffer)	
- greenbelt	1,71
- scrubs	41,85

Land Cover	Area
total	43,57
An area	7336
Forest Cover Area	160,54
Forest Cover Index	0,02
Land Cover Quality Index	24,06

Source: Data analysis, 2019.

The result of the LQCI in Pariaman City to show that in 2018 is 22,5 and LCQI in 2019 is 24,06 where in alert category (<50). For the increases in the land cover area outside the forest area is mainly directed at increasing green open space, thus affecting the LQC increase in 2019 by 1,56 compared to 2018. Green open spaces spread over 15 points in Pariaman City are Simpang Apa, Simpang Jati, Padusunan Intersection, Merdeka Square, Gandoriah Beach, Asean Youth Park, Anas Malik Park, Tabuik Subarang and Pasa, Simpang Tabuik, Cermin Beach, Kata Beach, city limits in Padang Biriak-Biriak, and the office park of the Mayor of Pariaman and the Regent of Padang Pariaman.

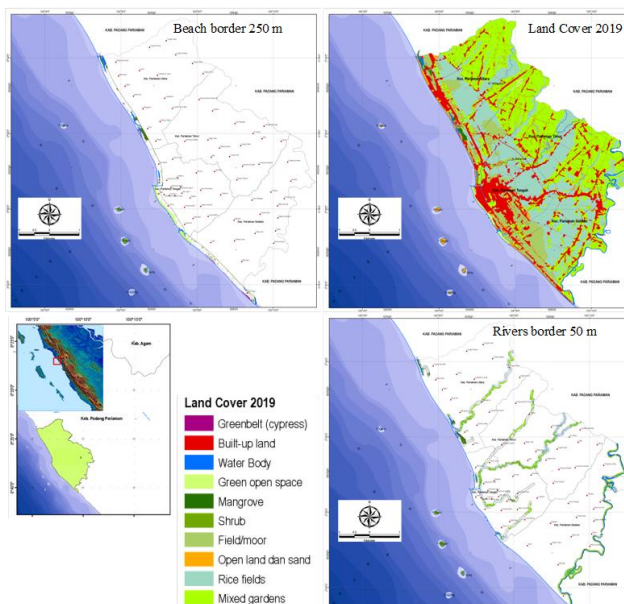


Figure 3. Land cover model, and forest vegetation in the coastal border and river border in Pariaman City.

IV. CONCLUSIONS

Generally, LQCI value obtains the trend to increasing to 1,56 which is LCQI in 2018 (22,5) and LCQI (24,06). LCQI value is the total number of forest cover. Pariaman doesn't have any natural forest, the forest is dominated by mangrove. The others vegetation that also the part of forest cover are bush (392,50 Ha), GOS (54,14 Ha) and Greenbelt (12,06 Ha) will always be following the trends from the 4 types of forest cover. Based on that LCQI value also have a fluctuating trend. And linearly obtaining to increase every year. If we only see the trends between 2018 and 2019 is the increasing trend. The portion of LCQI of Pariaman City from every component of forest cover especially mangrove, green open space and greenbelt contributing biggest to every increasing value of LCQI in Pariaman.



There are 4 sub-district which one of the subdistrict Central Pariaman is decreasing its LCQI value. Subdistrict Central Pariaman doesn't have mangrove, greenbelt and a small area of GOS (5,53 Ha). And the others 3 sub-district is increasing its LCQI value similarly because the location is in the coastal area.

The significant contribution to the LCQI value is Subdistrict Central Pariaman (27%) with bush category about 87,69 Ha, Greenbelt 1,24 Ha and GOS 36,50 Ha. The recommendation is to have a land cover plan with lowest emission base and increasing LCQI in 2 aspects, they are 1) Policy; and 2) Technical.

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