Regional function-based land use balance

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Article Info	ABSTRACT
	The balance between the availability of land and the need for control, use and utilization of land based on regional functions is important as a reference for sustainable development directions and maintaining environmental sustainability. Imbalance in land use affects the direction of development and environmental sustainability. For this reason, it is necessary to conduct an analysis to determine the balance between land availability and land needs within a certain period of time through the preparation of a land use balance based on regional function directions. This research aims to analyze the balance between land availability and land use as well as the suitability of land use for the direction of regional functions. The method in this research uses a multi-temporal approach by utilizing remote sensing technology and geographic information systems. The overlay process was carried out to see the land change of Baubau city and see the level of conformity of existing land use with the direction of regional functions. The results show that the 2016 land use balance has the highest assets in forest land use of 21097.66 Ha and the 2020 land use balance has the highest liabilities in forest land use of 20959.56 Ha. The trend of land change in 2016-2020 is the change of forest, open land, mixed gardens, settlements and shrubs/shrubs. The level of conformity of existing land use with the direction of the function of the area is very high with a percentage level of suitability of 90.83% and a level of incompatibility of 9.17%.

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Introduction

The land use balance is defined as a picture of the balance between land availability and the need for control, use and utilization of land based on the regional function of the Regional Spatial Plan (RTRW) (Zhang et al., 2019). The land use balance includes changes in land use over a period of time, the suitability of current land use to the RTRW, and the availability of land based on use, control and RTRW (Puspita & Saputra, 2019; Savitri et al., 2023; Yulianto, n.d.).

Land use is a tangible manifestation of the influence of human activities on the physical part of the earth's surface (Borrelli et al., 2020; Ikhsan et al., 2019). Urban areas have dynamic land use conditions, so it is necessary to continue to monitor their development, because often land use is not in accordance with its designation and does not pay attention to environmental sustainability (Reba & Seto, 2020; Surya et al., 2020). Land use change within a certain period can be used to obtain an overview of

land use change. With GIS technology, land use change can be analyzed to obtain an overview of land use change (Bielecka, 2020; Hussain et al., 2020; MohanRajan et al., 2020).

Natural resource balance is a balance between the original condition of natural resources (initial condition) and the next condition (final condition), or between the previous year's condition and the next year's condition, if the natural resources are exploited (Tang et al., 2022). The preparation of a natural resource balance sheet is like the preparation of a financial balance sheet in a discount table, with the previous year's condition as the asset value and the final condition value as the liabilities. The balance sheet of natural resources and the environment prioritizes balance and environmental sustainability. This means that in preparing the balance sheet of natural resources, in addition to presenting the balance value of the condition of natural resources after exploitation, it also takes into account the balance of environmental conditions due to exploitation (Achkari & El Fadar, 2020).

Natural resource balance includes land, forest, water and mineral resources. Land resources referred to in this case are land use and its distribution of ownership status (tenure) and spatial planning, the value of land use functions and the value of depletion due to changes in land functions in an area (Grebner et al., 2021; Saleh et al., 2020; Surya et al., 2021).

Land use will certainly affect the availability of land both in quality and quantity. Therefore, land use must be in accordance with the direction of the function of the area contained in the Regional Spatial Plan (RTRW). Land utilization that is not in accordance with the direction of regional functions will certainly have an impact on the direction of development and also environmental sustainability. For this reason, it is necessary to prepare a land use balance based on the direction of regional functions.

The preparation of a land use balance sheet can describe and show the spatial aspects of land use, so that the potential and changes in function can be known in position and distribution over a period of time. At the same time, it can also analyze the suitability of land use to the direction of regional functions.

Baubau City does not yet have a detailed land use balance, so it is necessary to conduct research to provide projections of land use change and land availability in Baubau City. Land use change in Baubau City is very dynamic. This is due to the relatively high population growth that affects the availability of land for future settlements. In addition, the activities of the population itself will affect land use change. Activities in fulfilling needs will encourage land use efficiency which has an impact on changes in the main function of the land.

Method

The method in this research uses a temporal approach (multidate/multiyear approach) by utilizing digital remote sensing technology and GIS (Ahmadi & Pekkan, 2021; Yasir et al., 2020). The data used in this research is in the form of multi-temporal Landsat images in 2016 and 2020 with detailing using World View images and field surveys. Broadly speaking, the research stages are divided into three main stages, namely the image correction and cropping stages, the data processing stage and finally the results analysis stage.

Results and Discussions

a. Land Use of Baubau City

Land use in Baubau City consists of land use of ponds, forests, open land, shrubs/shrubs, mixed gardens, offices, swamps/mangroves, rice fields, settlements, city parks, sea docks, airports, mines and others. In 2016 land use, the form of forest land use has an area of 21097, 66 Ha which is spread across Sorawolio District, Bungi District, Wolio District and Lea-Lea District and Kokalukuna District. The land use that has the second highest area is the bush/shrub land use with an area of 2643.64 Ha which is spread in almost all sub-districts in Baubau City. The form of bush/shrub land use is most widely spread in Kecamatan and Kecamatan Lea-Lea.

Forms of land use in the form of gardens / fields also dominate land use in Baubau City. The area of land use in the form of plantation/forest/field is 1933.67 hectares, which is spread in Lea-lea sub-district, Sorawolio sub-district and Bungi sub-district. Rice field land use in Bau-bau city is 1195.77 hectares, spread across Bungi and Lea-Lea sub-districts. Land use in the form of open land with an area of 839.61 Ha is spread across almost all areas of

Baubau City. The area of residential land use in Bau-bau City amounted to 1439.38 Ha which is spread across all sub-districts. Settlement land use is dominant in Batupoaro, Murhun, Betoambari and Wolio sub-districts. While in other sub-districts settlements are located along the main road following the existing road pattern.

Next is land use in the form of swamp/mangrove covering an area of 211.09 hectares spread across two sub-districts, namely Kecamatan Lea-Lea and Kecamatan Kokalukuna. The land use of ponds is embedded in Bungi Sub-district with an area of 29.78 Ha. The type and use of land in the form of cultural heritage has an area of 28.13 Ha located in Murhum Sub-district. For other land use, mining land has an area of 75.74 hectares located in Bungi and Sorawolio sub-districts. Land use in the form of educational facilities has an area of 35.84 hectares spread across several sub-districts. In addition, other uses that have been identified are terminal land use, health facilities, green spaces, city parks, offices, cemeteries, landfills and fuel oil depots as well as installations and electricity networks (PLTD). And also the form of land use in the form of an airport can already be identified or recognized, because in that year the airport has started operating again with an area of observation with an area of 49.99 Ha. For details of the form of land use in Baubau City in 2016 can be seen in the following table and graph.

Table 1. Land Use 2016

No	Form of Land Use	Hectares
1	Ponds	29,78
2	Airport	49,99
3	Cultural Heritage	28,13
4	Fuel Depot	17,94
5	Sea Dock	32,43
6	Health Facilities	3,91
7	Education Facilities	35,84
8	Forest	21097,66
9	Electricity Installation and Network	1,41
10	Trade and Services	23,00
11	Open Land	839,61
12	Correctional Institutions	0,53
13	Office	21,17
14	Garden/Field/Forest	1933,67
15	Settlement	1439,38
16	Swamp/Mangrove	211,09
17	GREEN SPACES	7,36
18	Cemetery	3,13
19	Rice Fields	1195,77
20	Shrubs/Shrubs	2643,64
21	City Park	12,79
22	Mine	75,74
23	Terminal	3,42
24	Coral Reef	116,9
25	LANDFILL	2,39
26	Water Body	30,97
	Total	29857,65

Figures 1. Land Use 2016

In 2020 land use in the form of forest land use has an area of 20959.56 Ha which is spread in Sorawalio District, Bungi District, Wolio District, Lea-Lea District, and Kokalukuna District. The land use that has the second highest area is the bush/shrub land use with an area of 2675.33 Ha which is spread in almost all sub-districts in Baubau City. The form of bush/shrub land u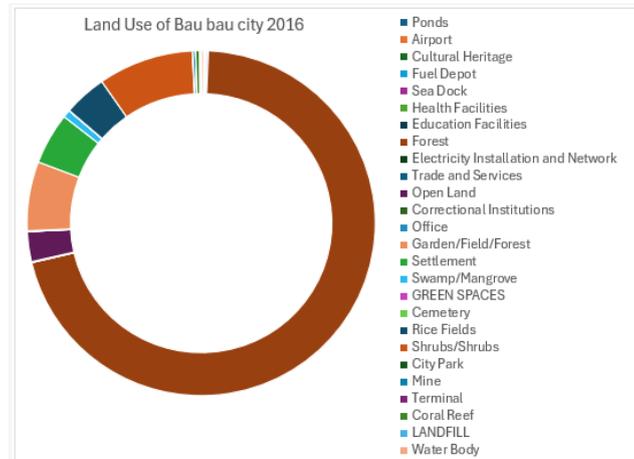se is most widely spread in Kecamatan and Kecamatan Lea-Lea. Forms of land use in the form of gardens / fields also dominate land use in Baubau City. The area of land use in the form of plantation/forest/field is 1901.82 hectares which is spread in Lea-lea sub-district, Sorawolio sub-district and Bungi sub-district. Rice field land use in Bau-bau city is 1159.07 hectares, spread across Bungi and Lea-Lea sub-districts. Land use in the form of open land with an area of 798.16 Ha is spread across almost all areas of Baubau City. The area of residential land use in Bau-bau City amounted to 1489.20 Ha which is spread across all sub-districts. Settlement land use is dominant in Batupoaro, Murhun, Betoambari and Wolio sub-districts. While in other sub-districts settlements are located along the main roads following the existing road pattern.

Table 2. Land Use 2020

No	Form of Land Use	Hectares
1	Ponds	31,94
2	Airport	195,37
3	Cultural Heritage	28,13
4	Fuel Depot	17,95
5	Sea Dock	33,65
6	Health Facilities	4,08
7	Education Facilities	49,10
8	Forest	20959,56
9	Electricity Installation and Network	2,65
10	Trade and Services	27,26
11	Open Land	798,16
12	Correctional Institutions	0,53
13	Office	27,30
14	Garden/Field/Forest	1901,82
15	Settlement	1489,20
16	Swamp/Mangrove	204,11
17	GREEN SPACES	10,73
18	Cemetery	4,00
19	Rice Fields	1159,07
20	Shrubs/Shrubs	2675,33
21	City Park	16,47
22	Mine	75,74
23	Terminal	3,42
24	Coral Reef	108,83
25	LANDFILL	2,28

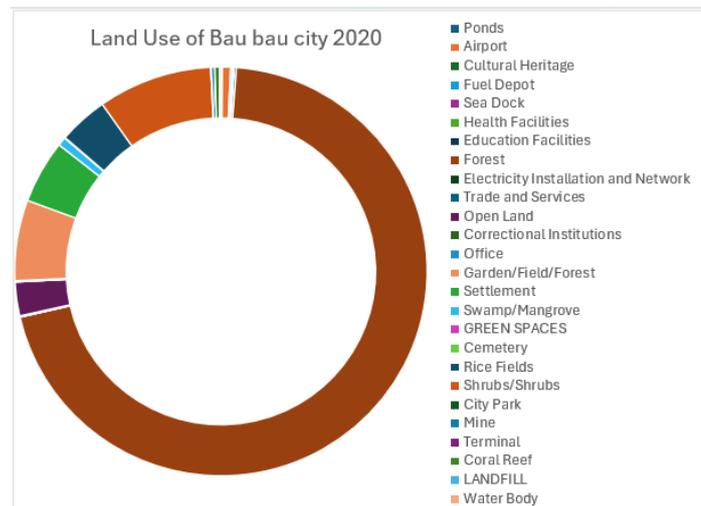|			
26	Water Body		30,97
		Total	29857,65

Figure 2. Land Use 2020

Furthermore, land use in the form of swamp/mangrove covers an area of 204.11 hectares, spread across two sub-districts, namely Kecamatan Lea-Lea and Kecamatan Kokalukuna. The land use of ponds is embedded in Bungi Sub-district with an area of 31.94 hectares. The type and use of land in the form of cultural heritage has an area of 28.13 Ha located in Murhum Sub-district. For other land use, mining land has an area of 75.74 hectares located in Bungi and Sorawolio sub-districts. The form of land use in the form of educational facilities has an area of 49.1 Ha which is spread across several sub-districts. For details of the form of land use in Baubau City in 2020 can be seen in table 2.

B. Land Use Balance 2016 - 2020

Land use balance is a scale to see the reserve to land use change in Baubau City. Land use changes between the initial year of assets (T1), namely the 2016 hatun image and the 2020 image into the final year of liabilities (T2). The results of the land resource balance analysis between 2016 and 2020 forest land use experienced a considerable reduction in area. In 2016 the forest area reached 21097.66 Ha while in 2020 it was reduced to 20959.56 Ha. The area of forest land use reduction amounted to 138.10 Ha. This change is influenced by increasing human activities in meeting needs.

Changes in the form of land use that also decreased were the use of open land, which in 2016 (T1) had an area of 839.61 Ha to 798.16 Ha in 2020 (T2). The form of land use in the form of gardens / fields / fields also experienced a change in area which originally in 2016 (T1) had an area of 1933.67 Ha reduced to 1901.82 Ha in 2020 (T2). Land use of gardens / fields / fields experienced a reduction in area of 31.85 Ha. In addition, land use that experienced a reduction in area was the use of rice fields, which decreased by 36.70 Ha where in 2016 (T1) had an area of 1195.77 Ha and 1159.07 Ha in 2020 (T2). Swamp/magrove land use also experienced a reduction in area of 6.98 Ha. In 2016 (T1) the area of swamp/mangrove land use amounted to 211.09 Ha to 204.11 Ha in 2020 (T2).

Land use that experienced an increase in area was airport land use, which originally in 2016 (T1) had an area of 49.99 Ha, which increased to 195.37 Ha in 2020 (T2). In addition to airport land use, residential land use also experienced an increase in area of 49.82 Ha which originally in 2016 (T1) had an area of 1439.38 Ha increasing in area to 1489, 20 Ha in 2020 (T2). Table 3 shows that the form of land use in 2016 is called the form of land use in the initial state (assets) and the form of land use in 2020 is called the form of land use in the final state (liabilities).

Furthermore, land use that experienced an increase in area was offices. Office land use experienced an increase in area of 6.13 Ha. In 2016 (T1), office land use was 21.17 hectares while in 2020 (T2) it increased to 27.3 hectares. In addition to the land use above, bush/shrub land use also experienced an increase in area, which increased by 31.69 Ha. In 2016 (T1), shrubs had an area of 2643.64 hectares, which increased to 2675.33 hectares in 2020 (T2).

Forms of land use that experienced an increase in area were the use of ponds, airports, fuel oil depots, sea docks, health facilities, educational facilities, power plants, trade and services, offices. Settlement land use experienced an additional area of 49.82 Ha. This form of land use became the form of land use that experienced the most increase in area. Bushes/shrubs experienced an additional area of 31.68 Ha.

Table 3. Land Use Balance

	Assets			Passives	
No	Form of Land Use	Hectares	No	Form of Land Use	Hectares
1	Ponds	29,78	1	Ponds	31,94
2	Airport	49,99	2	Airport	195,37
3	Cultural Heritage	28,13	3	Cultural Heritage	28,13
4	Fuel Depot	17,94	4	Fuel Depot	17,95
5	Sea Dock	32,43	5	Sea Dock	33,65
6	Health Facilities	3,91	6	Health Facilities	4,08
7	Education Facilities	35,84	7	Education Facilities	49,10
8	Forest	21097,66	8	Forest	20959,56
9	Electricity Installation and Network	1,41	9	Electricity Installation and Network	2,65
10	Trade and Services	23,00	10	Trade and Services	27,26
11	Open Land	839,61	11	Open Land	798,16
12	Correctional Institutions	0,53	12	Correctional Institutions	0,53
13	Office	21,17	13	Office	27,30
14	Garden/Field/Forest	1933,67	14	Garden/Field/Forest	1901,82
15	Settlement	1439,38	15	Settlement	1489,20
16	Swamp/Mangrove	211,09	16	Swamp/Mangrove	204,11
17	GREEN SPACES	7,36	17	GREEN SPACES	10,73
18	Cemetery	3,13	18	Cemetery	4,00
19	Rice Fields	1195,77	19	Rice Fields	1159,07
20	Shrubs/Shrubs	2643,64	20	Shrubs/Shrubs	2675,33
21	City Park	12,79	21	City Park	16,47
22	Mine	75,74	22	Mine	75,74
23	Terminal	3,42	23	Terminal	3,42
24	Coral Reef	116,9	24	Coral Reef	108,83
25	LANDFILL	2,39	25	LANDFILL	2,28
26	Water Body	30,97	26	Water Body	30,97
	Total	29857,65		Total	29857,65

The forms of land use that experienced a reduction in area are forest land use, open land, gardens / fields / fields, swamps / mangroves, and rice fields and landfills. The dominant form of land use that experienced a lot of area reduction was forest land use, which amounted to 138.10 Ha. While the forms of land use that experienced an increase in area were airport land use, educational facilities, electricity installations and networks (PLTD), trade and service areas, offices, settlements, and bushes/shrubs. The dominant form of land use that experienced an increase in area was airport land use of 145.38 Ha and also residential land use increased in area by 49.82 Ha. In addition to land use that has experienced an increase or reduction in area, there is also land use that has not changed. For land use that has not changed is the use of cultural heritage land, correctional institutions, mines, water bodies and terminals.

C. Land Use Change 2016 – 2020

Forest land use change is mostly changed into mixed gardens spread in several sub-districts namely Bungi, Lea-Lea, Sorawolio and Wolio sub-districts. Forest land use change is also changing into bushes/shrubs spread across several sub-districts in Baubau City. In addition, forest land use also changes into open land and settlements which are also scattered in several sub-districts. Furthermore, the land use of mixed gardens has changed into open land, settlements, forests, shrubs/shrubs and air badar and ponds. These land changes occurred in several sub-districts such as Kecamatan Lea-Lea. Other land uses that changed were open land turned into mixed gardens, settlements, offices, educational facilities and shrubs. The use of paddy fields has also changed into mixed gardens, settlements and

bushes/shrubs, which are concentrated in Kecamatan Lea-Lea. Land change also occurs in swamp/mangrove land use which changes to bush/shrub land use and open land.

Table 4. Changes in Land Use of Baubau City in 2016-2020

No	Form of Land Use	Land Use Change	
		Addition (Ha)	Reduction (Ha)
1	Ponds	2,16	0
2	Airport	145,38	0
3	Fuel Depot	0,01	0
4	Sea Dock	1,22	0
5	Health Facilities	0,17	0
6	Education Facilities	13,26	0
7	Forest	0	138,10
8	Electricity Installation and Network	1,24	0
9	Trade and Services	4,26	0
10	Open Land	0	41,45
11	Office	6,13	0
12	Plantation/Field/Forestry	0	31,85
13	Settlement	49,82	0
14	Swamp/Mangrove	0	6,98
15	OPEN SPACE	3,37	0
16	Cemetery	0,87	0
17	Rice Fields	0	36,70
18	Shrubs/Shrubs	31,68	0
19	City Park	3,68	0
20	Coral Reef	0	8,07
21	LANDFILL	0	0,11
	Total	263,26	263,26

D. Analysis of Existing Land Use Conformity with Area Function Direction

Broadly speaking, the existing land use in Baubau City is in accordance with the direction of the planned area functions in the Regional Spatial Plan. The amount of land use that has been in accordance with the direction of the area function shows that development in Baubau City has been well organized following the directions set in the Regional Spatial Plan. The suitability of existing land use in the form of housing with the direction of the function of residential areas is one example of the suitability of land use with its land use plan. Another example is the suitability of existing land use in the form of paddy fields with the direction of the function of the food crop area, the suitability of existing land use of plantations with the direction of the function of the plantation area, the suitability of existing land use of trade and services with the direction of the function of the trade and services area, the suitability of existing land use of cultural heritage with the direction of the function of the cultural heritage area, the suitability of land use of airbars with the direction of the function of the transportation area, sea docks with the direction of the function of the transportation area, etc.

However, it should be noted that certain land uses such as forests have experienced many changes that tend to be incompatible with the direction of the function of the area. Based on land use changes, forest land use tends to decrease every year. This indicates that there is a need to increase supervision to monitor forest land use. In addition to forest land use, the use of rice fields also continues to experience changes that tend to change not in accordance with the direction of the function of the area that has been determined in the Regional Spatial Plan. Given the direction of the function of the area that has been determined, it is also necessary to monitor changes in paddy fields. It is hoped that land use in accordance with the direction of the area can create a balance of development with environmental sustainability.

Figure 2. Existing Land Suitability Level Diagram

Figure 3. Land Use Suitability Map

The area of conformity of existing land use with the direction of regional functions if it is represented by 90.83% or an area of 27119.77 Ha. This shows that the level of conformity between existing land use and the direction of regional functions is very high, which illustrates that the direction of development is in accordance with the direction of regional planning. In addition to many existing land uses whose use is in accordance with the direction of the regional function, there are also existing land uses that are not in accordance with the direction of the regional function. Existing land use that is

not in accordance with the direction of the function of the area is 2738.88 Ha with a percentage of 9.17%. Land use that is not in accordance with the direction of regional functions is spread across several sub-districts.

Conclusions

The results of the study can be formulated several conclusions, namely: (a). Land Use Balance in 2016 - 2020 which has the highest Asset is the form of forest use of 21097.66 Ha and the highest Pasiva is the form of forest land use of 20959.56 Ha (b). The trend of land use change in 2016 - 2020 in Baubau City is the change of open land, mixed gardens, forests and shrubs / shrubs and settlements. (c). The level of conformity of existing land use with the direction of the function of the area is very high with a percentage of the level of suitability of 90.83% and the level of incompatibility of 9.17%. While the conclusions drawn from the study on land use change in Baubau City provide valuable insights into the dynamics of land utilization, certain limitations should be acknowledged. Firstly, the study's reliance on data from 2016 to 2020 may not capture recent or ongoing changes in land use patterns, especially considering the rapid pace of urban development and environmental changes. Additionally, the analysis primarily focuses on the spatial aspect of land use change without delving deeply into the underlying drivers and socio-economic factors influencing these changes. Future research could address these limitations by incorporating more recent data and employing qualitative methods such as interviews or surveys to understand the motivations behind land use decisions. Moreover, exploring the implications of land use change on ecosystem services, biodiversity conservation, and community livelihoods could provide a more comprehensive understanding of the sustainability implications. Collaborative efforts involving interdisciplinary approaches and engagement with local stakeholders could enhance the applicability and relevance of future research findings for informing land use planning and management strategies in Baubau City.

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