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LANDSCAPE ECOLOGY AS A BASIS FOR DEVELOPING A REGIONAL SYSTEM IN BADUNG DISTRICT OF BALI

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ABSTRACT
Since 1995 until now, the zoning system that uses an administrative approach has never been evaluated for its impact on changes in the ecological structure of the Badung Regency landscape and pressure on the environment. This study focuses on the analysis of changes in the ecological structure of the landscape which includes patches, matrix and corridor as a result of the application of an administration-based zoning system in Badung Regency. The objectives to be achieved in this study are to analyze the impacts and factors that influence changes in the ecological structure of the landscape and the quality of the environment as a result of the implementation of an administrative-based zoning system in Badung Regency. The results of the study concluded that the ecological analysis of the landscape is an important aspect in the development of the zoning system in Badung Regency which pays attention to the principles of sustainable development and protection of ecological space. The zoning system of Badung Regency based on landscape ecology is formulated based on 4 (four) groups, namely: very high ecological zone, high ecological zone, medium ecological zone and low ecological zone.

KEY WORDS
Landscape ecology, zoning system, patch, matrix, corridors.

Landscape ecology is an interdisciplinary field that aims to understand and improve the relationship between spatial patterns and ecological processes at multiple scales (Wu and Hobbs, 2007). A branch of ecology, landscape ecology offers a conceptual blend of theories and methods that reveal the importance of spatial patterns on the dynamics of interactions that occur in ecosystems. Land use change often takes place on a small scale, and is not significant to the overall landscape structure.

Land use change also occurs in the Badung Regency area, along with the rapid development due to the development of the tourism sector. This has an impact on changes in land use and changes in landscape structure caused by the increasing population and the need for land for development. Land use change and space utilization deviation are the most important driving factors for changes in landscape structure and function. Land use and land cover change is mainly driven by socioeconomic forces, and is one of the most important and challenging research areas in landscape ecology (Wu et al., 2015). Another factor that is expected to influence the changes in landscape structure in Badung Regency is the regional system policy in the Regional Spatial Plan of Badung Regency. In the Regional Regulation of Badung Regency No. 29/1995 on the Regional Spatial Plan of Badung Regency, three Development Areas (WP) were established based on sub-district administrative boundaries, namely North Badung WP covering Petang and Abiansemal Sub-districts, Central Badung WP covering Mengwi Sub-district and South Badung WP covering North Kuta, Kuta and South Kuta Sub-districts.

Furthermore, in the Regional Regulation of Badung Regency No. 26 of 2013 concerning the Regional Spatial Plan of Badung Regency 2013-2033, which is a replacement for the Regional Regulation of Badung Regency No. 29 of 1995, the North Badung Region is directed with the main function of conservation and integrated agriculture, the Central Badung Region with the main function of sustainable agriculture, the Regency Capital and regional scale public service centers and the South Badung Region with the

main function of tourism. Since 1995 until now, the regional system that uses this administrative approach has never been evaluated by the Badung Regency Government. The development of the South Badung Region with the main function of tourism has made its economy continue to grow when compared to the North Badung and Central Badung Regions which are still dominated by agriculture, where most of the people in the region earn a living as farmers (BPS Badung Regency, 2021).

Previous research from Pebriani et al., (2017) stated that inequality is caused because the potential in the North Badung region has mostly not been explored and developed further. In line with this opinion, Wihadanto and Firmansyah (2013) stated that the occurrence of inequality in the distribution of the results of tourism activities is caused by differences in regional capabilities in developing existing tourist destinations, differences in natural conditions and the quality of human resources, as well as government policies in distributing the results of tourism activities.

Inequality is basically caused by differences in the content of natural resources and differences in demographic conditions contained in each region. The ability of a region to drive the development process is also different. The high level of disparity not only creates social strain but can also hamper economic growth and development (Muhtarom, 2017). Inequality between regions, when viewed from the concept of mechanistic thinking - Descartes' reductionist version is more influenced by ideas that view space solely as a physical reality and marginalize the realm of cognition. Therefore, the idea of prioritizing ecological space emerged as an alternative solution to contemporary development problems. The acceptance of the idea of ecological space will have implications for changes in development paradigms, planning approaches, and analytical methods in regional development (Setiadi, 2007).

The consequence of this paradigm shift, according to Setiadi (2007), is the need to change the pattern of regional development planning from a discrete approach to a continuum approach. So far, the discrete planning pattern manifested in the boundaries of administrative areas or island units has actually created a counter-productive atmosphere because each region is only oriented towards self-assertion. Administrative boundaries seem to be concrete fences that allow residents within them to behave without feeling the need to communicate with their neighbors or worry about disturbing the surrounding environment. In contrast, through the continuum approach each region or island unit will be seen as an integral part of the ecological totality. Therefore, the concept of landscape ecology has an important role in the study of environmental change in an ecosystem (Soeprobowati, 2011). Changes in land surface or land use due to exploration are important indicators in measuring the potential for landscape change (Gizawi et al., 2017).

METHODS OF RESEARCH

This research was conducted in the Badung Regency area covering 6 (six) sub-districts, 16 (sixteen) urban villages and 46 (fourteen) villages. The data required in this research includes quantitative data and qualitative data sourced from primary and secondary data. Primary data was obtained from field surveys, documentation, and Focus Discussion Groups (FGDs). Based on the identification of the main data needed in this study, it includes 7 types of quantitative data and 9 types of qualitative data. This research uses 7 (seven) variables, namely: (1) land use, (2) space utilization, (3) environmental quality, (4) landscape, (5) environmental carrying capacity, (6) land capability, and (7) land suitability.

RESULTS AND DISCUSSION

The landscape ecology analysis of Badung Regency was conducted on the landscape structure/parameters forming the landscape including: matrix, patches and corridors, then studied based on changes in the landscape ecology structure that occurred and the landscape ecology index. Landscape ecology analysis of Badung Regency was conducted through overlay techniques with Geographic Information System (GIS) technology using

ArcGIS 10.8 application. Based on the results of spatial data analysis, 4 (four) types of land cover patches were identified in Badung Regency with a total area of 156.63 ha in 2013, then increased to 231.43 ha in 2021 or an increase in area reaching 74.80 ha (47.76%). The largest patch is the golf course which reached 90.35 ha in 2013 and increased to 160.15 ha in 2021 or an increase in area of 69.80 ha (77.26%) and the smallest is the freshwater pond patch of 5.31 ha in 2013 and increased to 10.31 ha in 2021 or an increase in area of 5.00 ha (94.08%). Meanwhile, the parking area and field patches as well as runways and taxiways have not changed in area.

Table 1 – Land Cover Patches of Badung Regency in 2013 and 2021

No	Patch	Wide (ha)		Changes	
		2013	2021	Wide (ha)	Percentage (%)
1	Parking Area and Field	21,42	21,42	0,00	0
2	Freshwater Pond	5,31	10,31	5,00	94,08
3	Runway and Taxiway	39,55	39,55	0,00	0,00
4	Golf Course	90,35	160,15	69,80	77,26
Total		156,63	231,43	74,80	47,76

Source: Analysis Results, 2022.

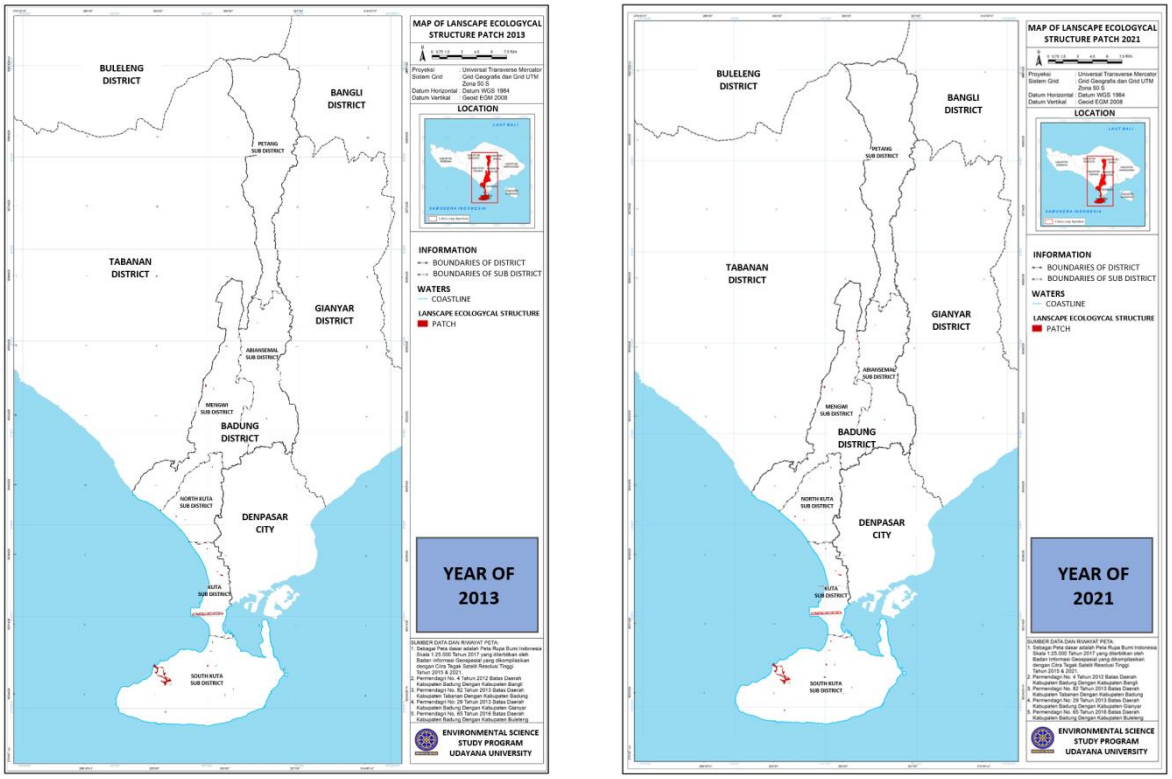

Figure 1 – Land Cover Patch Map of Badung Regency, 2013 and 2021

Based on the identification results from the interpretation of quickbird imagery and the Rupa Bumi Indonesia (RBI) map, there are 2 (two) main types of corridors in Badung Regency, namely rivers and non-volcanic beach sand.

Table 2 – Land Cover Corridor of Badung Regency in 2013 and 2021

No	*Corridor*	Wide (Ha)		Change	
		2013	2021	Wide (Ha)	Percentage (%)
1	Non-Volcanic Sand Beach	235,70	208,35	-27,35	-11,60
2	River	17,37	17,37	0,00	0,00
Total		253,07	225,71	-27,35	-11,60

Source: Analysis Results, 2022.

Corridors are homogeneous surface areas that are elongated and continuous (connectivity). Land cover corridors in Badung Regency consist of non-volcanic coastal sand corridors and river corridors with a total area of 253.07 ha in 2013, then decreasing to 225.71 ha in 2021. The river corridor tends not to change in area compared to other landscape ecological structures, while the non-volcanic coastal sand corridor with a function as a coastal border experiences dynamic changes as a result of the development of tourism activities. The dynamics of change are indicated by the reduction in the area of the coastal sand corridor from an area of 235.70 ha in 2013 to an area of 208.35 ha in 2021 or a reduction of 27.35 ha (-11.60%).

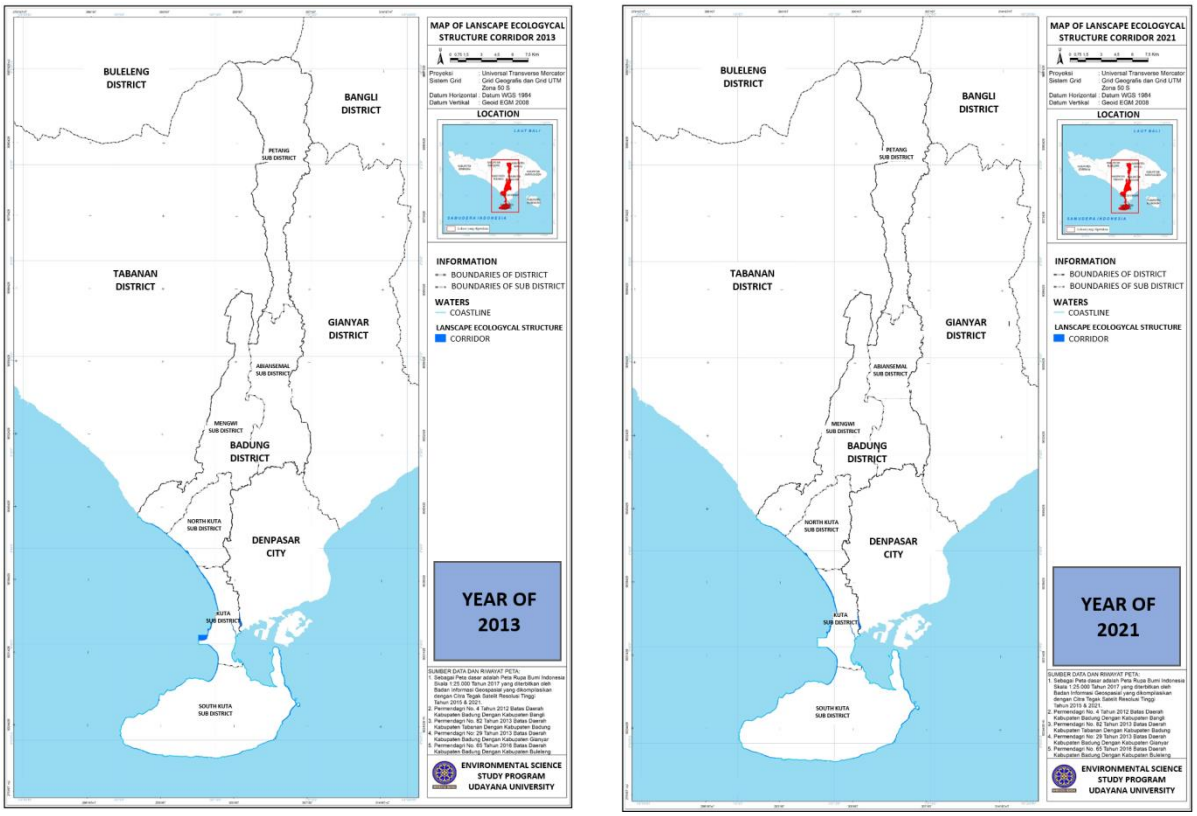

Figure 2 – Corridor Map of Land Cover of Badung Regency, 2013 and 2021

The matrix is the most dominant surface area of the landscape mosaic that eventually becomes the type of landscape element and plays a dominant functional role in the landscape (Forman & Godron, 1986 and Arifin et al., 2009). The matrix in Badung Regency is reflected in the composition of land cover which includes: north Badung and central Badung areas have a dominant land cover composition of agricultural land, forests, and settlements. South Badung area, the dominant land cover is agricultural land, plantations, horticulture, settlements, and tourism. Given the basic physical conditions that are difficult to develop food crop agriculture, in the South Badung Area, land use development is more dominant in built-up lands including settlements, tourism, and trade and services.

Based on the results of the analysis, the total area of the land cover matrix in Badung Regency in 2013 was 39,503.49 ha, reduced to an area of 39,456.05 ha in 2021 or a reduction in area of 47.45 ha (-0.12%). Changes in the form of additional area occurred in the settlement land cover matrix reaching an area of 4,810.76 ha (57.50%). While changes in the form of area reduction occurred in the mixed garden land cover matrix reaching an area of 4,109.55 ha (21.98%), rice fields covering an area of 736.47 ha (-6.81%), and mangroves covering an area of 12.19 ha (-1.93%), meanwhile, the forest land cover matrix did not change in area.

Table 3 – Land Cover Matrix of Badung Regency in 2013 and 2021

No	Matrix	Wide (Ha)		Change	
		2013	2021	Wide (Ha)	Percentage (%)
1	Settlement	8.366,59	13.177,34	4.810,76	57,50
2	Mixed Garden	18.699,38	14.589,84	-4.109,55	-21,98
3	Rice Fields	10.816,61	10.080,13	-736,47	-6,81
4	Forest	990,78	990,78	0	0,00
5	Mangrove	630,14	617,96	-12,19	-1,93
Total		39.503,49	39.456,05	-47,45	-0,12

Source: Analysis Results, 2022.

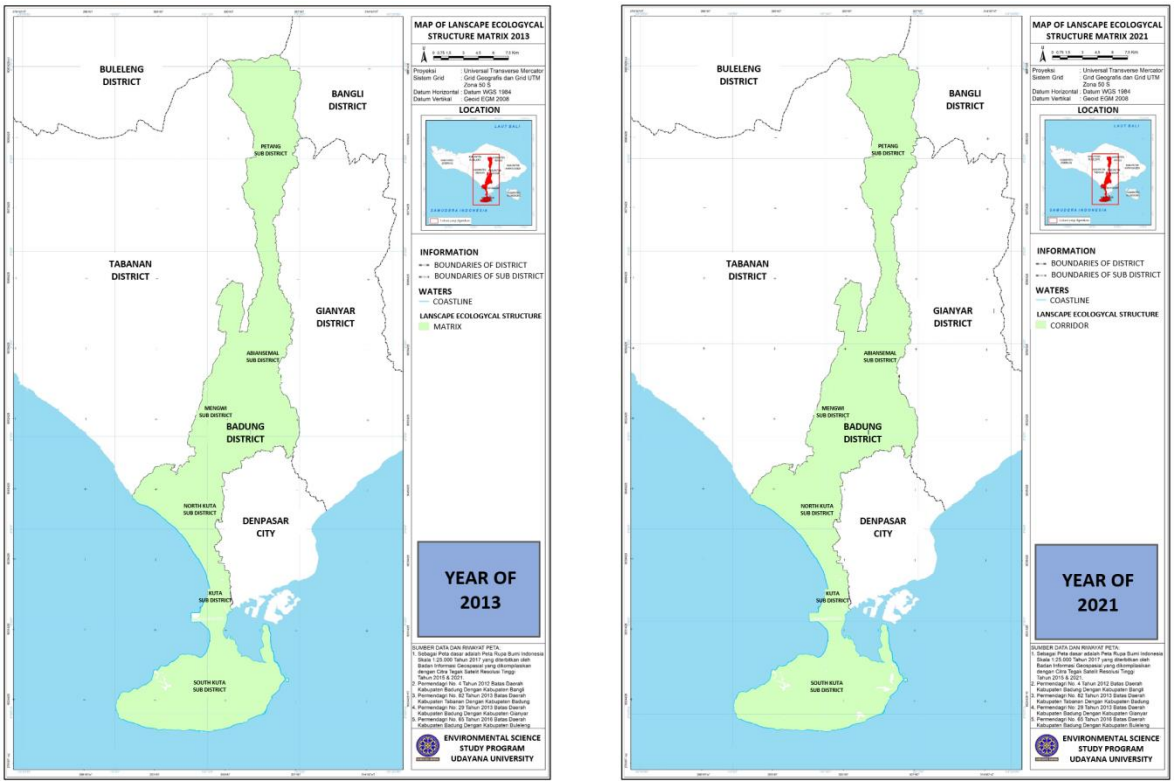

Figure 3 – Land Cover Matrix Map of Badung Regency, 2013 and 2021

The results of spatial data analysis show that the ecological structure of the Badung Regency landscape based on land cover has a different landscape configuration in each part of the Badung Regency. Based on the landscape ecological structure map, in the South Badung section, the landscape ecological structure is dominated by artificial structures (residential buildings, runways and taxiways, golf courses, as well as parking areas and fields, while the natural structures include non-volcanic beach sand, mixed gardens, and mangroves. While the condition of the ecological structure of the landscape in the Central Badung section is still dominated by natural structures in the form of rice fields and mixed gardens, but the artificial structures show development and fragmentation. In contrast, the ecological structure of the landscape in the North Badung area has natural characteristics that dominate compared to artificial structures. North Badung landscape conditions are dominantly formed from mixed garden land cover and protected forests. This condition according to Arifin et al. (2009) illustrates that the landscape ecology of Badung Regency has been occupied by artificial structures (built-up land), as a form of human intervention in the landscape to meet their needs.

The dynamics of a landscape indicate that the landscape in general is not permanent, but undergoes changes in terms of quality, configuration, size, shape, function, and others. Understanding landscape dynamics has major implications for landscape management and planning. Landscape change is change caused by alteration/disturbance to the structure

and/or function of the landscape, either in the form of natural events or human disturbance. Disturbance to function does not necessarily change structure, but disturbance to structure will definitely change landscape function. Landscapes change all the time due to the influence of various driving factors including physical, social and economic factors. Predicting the direction of landscape change and estimating its future consequences is important information. This information can be used as a basis for appropriate management and policy interventions.

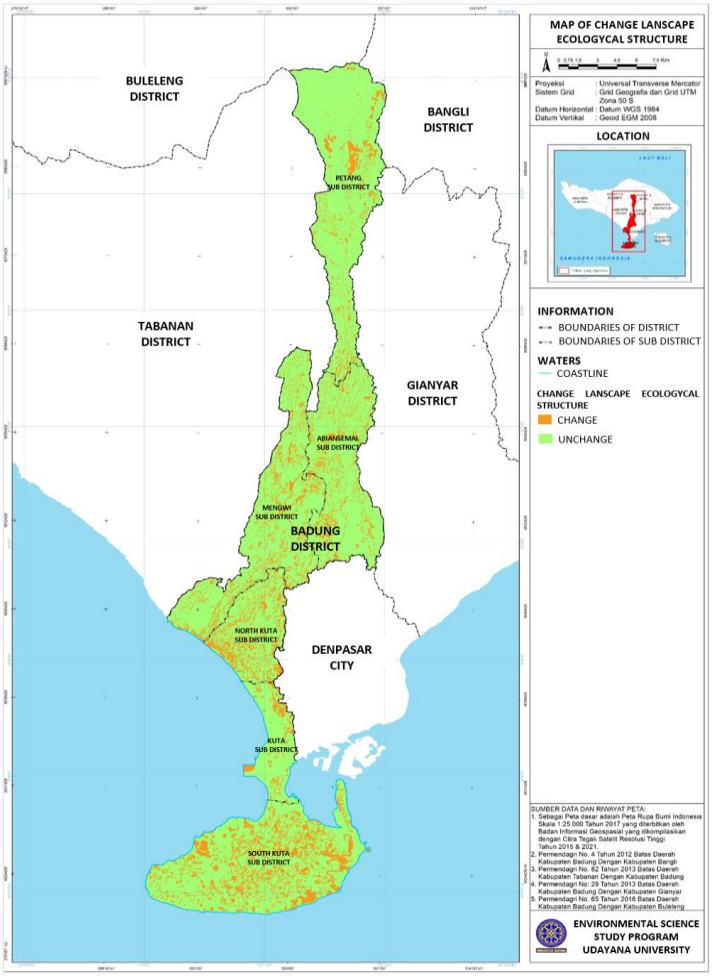

Figure 4 – Map of Changes in Landscape Ecological Structure of Badung Regency 2013-2021

The availability of multi-time spatial data allows long-term landscape changes to be compiled and when combined with spatial data on driving factors, allows spatially explicit models of landscape change to be created. Changes in the ecological structure of the landscape that occur in Badung Regency tend to be exploratory and do not pay attention to the ecological conditions of the landscape, especially in areas that are related to tourism. Ecological conditions that naturally have a buffer character and / or limitation to development, have actually changed into areas with massive development. In fact, this condition results in the balance of spatial balance being in favor of economic aspects alone and at the expense of ecological aspects, so that the goal of sustainable development is increasingly difficult to implement.

CONCLUSION

Based on the results of research conducted in the Regency, the following conclusions can be drawn: The impact and influential factors on the ecological structure of the landscape and the quality of the environment as a result of the application of the administrative-based zoning system in Badung Regency, showed that changes in the ecological structure of the

landscape in Badung Regency occurred in the three parameters, namely pacth, matrix and corridor, as shown by changes in the area of the three landscape structure parameters in the 2013-2021 period. The addition of matrix area in the residential land use class and golf course patches causes changes in the area of the matrix of mixed gardens, rice fields and mangroves and corridors of non-volcanic coastal sand that dominantly have ecological functions. Total Pacth in Badung Regency in 2013 was 156.63 ha, then in 2021 it was 231.43 ha, or an increase in area of 74.80 ha (47.76%). Total Corridor in Badung Regency in 2013 was 253.07 ha, then in 2021 it will be 225.71 ha, or a reduction in area of 27.35 ha (-11.60%). Total Matrix in Badung Regency in 2013 was 39,503.49 ha, then in 2021 it will be 39,456.05 ha, or a reduction in area of 47.45 ha (-0.12%).

The formulation of the development of the Badung Regency regional system based on landscape ecology is grouped into 4 (four) zones including first, a very high ecological zone with the direction of land use as a very high conservation / limitation zone. Second, high ecological zone with the direction of land use as agricultural areas, plantations, livestock, rural settlements, ecotourism, agro-tourism, regional scale trade and services and agricultural infrastructure. Third, medium ecological zones with land use directions as urban residential areas, small industries, regional-scale trade and services, tourism, and urban infrastructure. Fourth, the low ecological zone with the direction of land use as urban residential areas, tourism areas, regional-scale trade and service areas and regional infrastructure.

Based on the results of research conducted in the Badung Regency, suggestions can be made for further research to be developed until the economic and social analysis of human influence on the occurrence of changes in the ecological structure of the landscape so that it becomes more comprehensive, and the results of the analysis of landscape ecological parameters become an important consideration in the preparation of the regional system and the concept of direction of the Badung Regency spatial pattern.

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