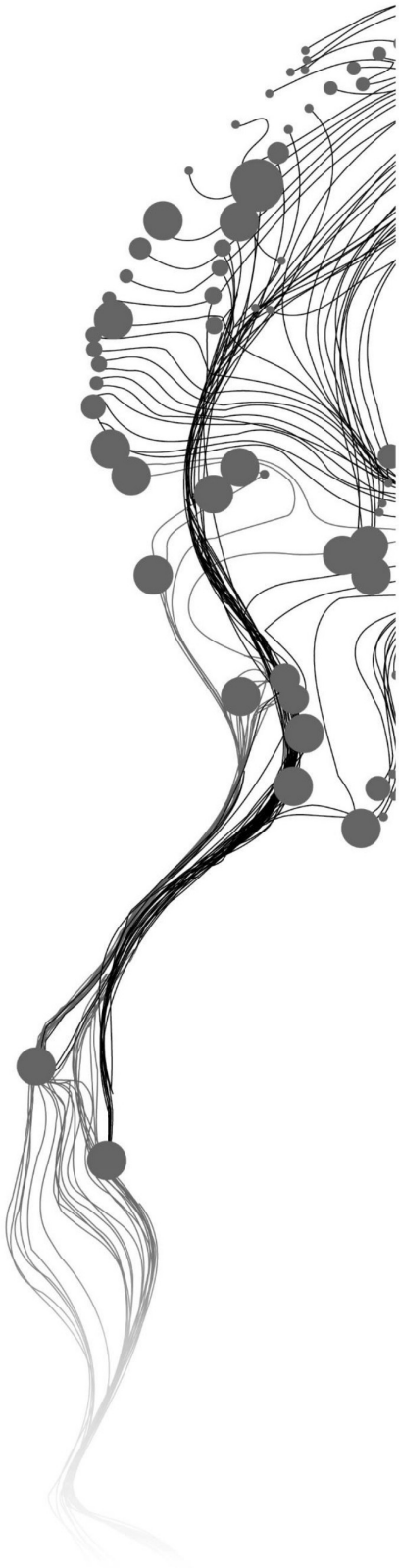
Tourism-Driven Land Use Land Cover Change in Bali: Impacts on Traditional *Subak* Practices and Spatial Planning

Cening Ayu Merta
June 2026

SUPERVISORS:
Dr. Divyani Kohli-Pol Jonker
Andre da Silva Mano, Msc



Tourism-Driven Land Use Land Cover Change in Bali: Impacts on Traditional *Subak* Practices and Spatial Planning

Cening Ayu Merta
Enschede, The Netherlands, June 2026

Thesis submitted to the Faculty of Geo-Information Science and Earth Observation of the University of Twente in partial fulfilment of the requirements for the degree of Master of Science.

SUPERVISORS:
Dr. Divyani Kohli-Poll Jonker
Andre da Silva Mano, Msc

THESIS ASSSESMENT BOARD:
prof.mr.dr.ir. J.A. Zevenbergen (Chair)
prof. R.M. Bennett (External Examiner)

DISCLAIMER

This document describes work undertaken as part of a program of study at the Faculty of Geo-Information Science and Earth Observation of the University of Twente. All views and opinions expressed therein remain the sole responsibility of the author, and do not necessarily represent those of the faculty.

ABSTRACT

Bali's *Subak* system, a centuries-old communal irrigation and land governance institution recognized as a UNESCO World Heritage cultural landscape, faces an existential threat from land use land cover changes (LULCCs). Kuta Utara subdistrict in Badung Regency exemplifies the rapid transformation of rice paddy landscapes that are closely linked to *Subak* practices through shared water management and agricultural organizations, have undergone rapid transformation into built-up and tourism-related land uses. This raises urgent questions about spatial planning effectiveness and the resilience of traditional land governance institutions. This study examines how tourism-driven LULCC (Land Use/Land Cover Change) reshaped the physical and institutional landscape of Kuta Utara between 2002 and 2025, focusing on rice paddy loss, spatial planning alignment, and the consequences for the *Subak* system of communal irrigation practices.

A mixed-methods approach was adopted, integrating spatial analysis of rice paddy loss across 2002, 2020, and 2025 using manually digitized field boundaries from Google Earth imagery; a grid-based tourism infrastructure field survey; structured interviews with 31 representatives from 10 *Subak* organizations and government officials; and policy content analysis of seven spatial planning documents. Findings were cross validated to assess correspondence between spatial patterns, regulatory frameworks, and community perceptions.

The spatial analysis documents a cumulative loss of approximately 74% of the subdistrict's 2002 rice paddy coverage, declining from 1,684 hectares to 438 hectares by 2025. Tourism infrastructure density was confirmed as a statistically significant spatial driver ($R^2 = 0.54$, $p < 0.001$), though the remaining 46% of unexplained variance points to structural economic conditions and intergenerational livelihood aspiration shifts. The policy analysis identified three structural inconsistencies within the spatial planning regulation on agricultural protection that undermines protective capacity independently of enforcement. Despite progressive regulatory strengthening, the 2020–2025 period recorded the highest proportional rate of paddy loss in the entire study period. The thematic analysis revealed that *Subak* members overwhelmingly frame LULCC as a threat to cultural continuity rather than agricultural productivity, with acceptance and adaptation as the dominant organizational response. Cross-validation confirmed strong spatial correspondence between areas of high measured paddy loss and Subak organizations reporting the greatest institutional pressure and planning ineffectiveness.

This study concludes that protecting *Subak* land requires not only stronger enforcement but structural regulatory reform, economic incentives, institutional support for Subak practices, and a reframing of land protection around cultural heritage rather than agricultural productivity alone.

Keywords: *Subak*; LULCC; spatial planning; LP2B; rice paddy; cultural landscape; Bali; Kuta Utara; mixed methods; institutional governance

ACKNOWLEDGEMENTS

For once I dreamt of this, now I live it.

First and foremost, I would like to express my gratitude to God (*Ida Sang Hyang Widhi Wasa*) and my ancestors for their blessings, guidance, and protection throughout this journey. In moments of doubt, challenge, and uncertainty, I always found strength in my faith and in the values passed down to me.

I would also like to acknowledge the financial support provided by the Indonesia Endowment Fund for Education (LPDP). This opportunity has allowed me to pursue my master's degree and grow both academically and personally. I am sincerely grateful for the trust and support that made this journey possible.

This thesis would not have been possible without the support, understanding, and encouragement of the many people to whom I am deeply grateful.

First, I would like to express my sincere gratitude to my supervisors, Dr. Divyani Kohli-Poll Jonker and Andre Da Silva Mano. *"Thank you"* feels far too small to express how grateful I am for your guidance throughout this journey. You believed in me even during the times when I doubted myself. Your feedback, patience, and encouragement during our meetings and email exchanges kept me moving forward and helped me reach the finish line.

I would also like to thank the local representatives in Badung Regency and Kuta Utara Subdistrict who assisted me during my fieldwork. Thank you for helping me navigate the data collection process and for sharing your time, knowledge, and experiences. Without your support, this research would not have been possible.

To my dearest family in Bali: thank you for every prayer, every form of support, and every word of encouragement. You never stopped believing in me, even when things felt difficult, and for that I will always be grateful.

Jurjen, thank you for your support throughout my studies. Whether it was cooking while I was on my way home, cleaning the house when deadlines were approaching, or simply being there when I needed someone to lean on, your care never went unnoticed. Meeting you was an unexpected gift that came from this journey.

To Medha and Klaudia, thank you for being my *demurest* friends of all (hahahaha). Joke aside, I will miss our mental well-being walks. The foods, the laughter's, the tears from laughing too hard, the gossip, Vanderpoel ice cream, and our heart-to-heart conversations kept me grounded and sane throughout this master's journey. Thank you for being there through the highs and lows, and for making this experience so much more memorable.

To my Indonesian friends—Ceudah, Riesa, Rise, Dimas, Engel, and the entire GIMLA squad, including Bernadette—thank you for all the memories we created together. To all the friends I met from around the world at the University of Twente and ITC, supporting one another through this experience is something I will cherish for the rest of my life.

Finally, to my late mother: *I promised to bring you here for my graduation, but sadly that is no longer possible. I firmly believe, your strong prayers got me here today. And through every challenge, setback, moment of doubt, your spirit continued to guide me and gave me the strength to keep going. I dedicate this thesis to you with all my love and gratitude. May you rest in peace.* ♥

Table of Contents

List of Figures

List of Tables

GLOSSARY

Term	Definition
***Adat* (Customary Law)**	A system of locally established norms, values, and practices that govern social, cultural, and environmental life within Indonesian communities, operating alongside formal state law and often shaping land use, resource management, and local governance structures.
Badung	It is a regency in the southern part of Bali Island, Indonesia.
KP2B ***Kawasan Pertanian Pangan Berkelanjutan***	Short term for Sustainable Food Agricultural Area that refers to an agricultural cultivation area, predominantly in rural regions, consisting of contiguous areas of Sustainable Food Agricultural Land and/or Reserved Sustainable Food Agricultural Land, including their supporting components, with the primary function of supporting national food self-sufficiency, food security, and food sovereignty under the Law No. 41 of 2009 on the Protection of Sustainable Food Agricultural Land.
Kuta Utara	It is a subdistrict (*kecamatan*) located in Badung Regency, Bali, Indonesia, known for its rapid tourism development and transformation of agricultural land, particularly rice paddies.
KKPR ***Kesesuaian Kegiatan Pemanfaatan Ruang***	An official approval confirms whether a proposed activity or development is consistent with the spatial plan (RTRW/RDTR).
LP2B ***Lahan Pertanian Pangan Berkelanjutan***	A short term for Sustainable Food Crop Agricultural Land that refers to designated agricultural land that is protected and managed according to Law No. 41 of 2009 on the Protection of Sustainable Food Agricultural Land.
Mixed-Methods Approach	A research approach that combines both quantitative (e.g., spatial analysis, in-situ survey data) and qualitative (e.g., interview analysis, policy content analysis) data to provide a more comprehensive understanding of a research problem.
Pekaseh	The elected head of a *Subak* institution, who, along with other board members, is responsible for coordinating water distribution, managing agricultural practices, organizing religious activities, and upholding customary regulations (*adat*) within the *Subak* system.
RDTR ***Rencana Detail Tata Ruang***	Short term for Detailed Spatial Plan, which is defined as a detailed plan of the spatial arrangement of a regency area (detailed into subdistricts), which is supplemented by zoning regulations.
RTRW ***Rencana Tata Ruang Wilayah***	Short-term spatial plan refers to the outcome of spatial planning within a defined region, representing a geographical unit along with all its associated elements, whose boundaries and system are determined based on administrative considerations. Most likely, this term is found in the National, Provincial, and Regional Spatial Plan.
SARBAGITA	An acronym referring to the metropolitan region comprising the regencies of Badung, Gianyar, and Tabanan, together with Denpasar City in Bali Province.
SIMTARU ***Sistem Informasi Tata Ruang***	Spatial Planning Information System is the spatial planning and regional geospatial information platform of Badung Regency.
Subak	*Subak* is a traditional socio-ecological irrigation system in Bali, where farmers collectively manage water distribution for rice cultivation through a community-based organization, guided by customary rules (*adat*) and religious practices rooted in the philosophy of *Tri Hita Karana*.
Subak Yeh	Also referred to as *Subak Sawah* or *Subak Basah*, it governs lowland irrigated rice cultivation through shared hydrological boundaries defined by river or spring-fed water sources.
UNESCO **United Nations Educational, Scientific, and Cultural Organization**	a specialized agency of the United Nations that promotes international cooperation in education, science, culture, and communication to foster peace and sustainable development.

1. INTRODUCTION

This chapter presents the background of the study, focusing on the relationship between tourism development and land-use change in Bali, particularly the conversion of rice paddy fields into tourism-related uses. It highlights the key issues arising from this transformation, identifies the research gap regarding its implications for sustainability and traditional systems such as the *Subak* system, and outlines the research objectives and questions that guide the study.

1.1. Bali's Tourism Growth and Decreased Farmland

Over the past decade, tourism has emerged as one of the fastest-growing sectors of the global economy, outpacing many traditional industries. The World Travel & Tourism Council (WTTC) projects that tourism will contribute nearly 10% to global GDP (USD 11.1 trillion) by 2024, supporting an estimated 348 million jobs worldwide (Reuters, 2024; World Travel & Tourism Council, 2024). This surge in tourism has been accompanied by widespread investment in travel-related infrastructure, including hotels, airports, and recreational facilities. While this growth stimulates economic development and employment, it often exerts significant pressure on land resources, particularly in developing countries (Morrison, 2022).

Mass tourism-related development often comes at a cost, particularly in terms of how land is used and governed in tourism-dependent regions. The rapid expansion of tourism infrastructure frequently leads to land use and land cover changes (LULCCs), including the conversion of forests, wetlands, and agricultural land into urban or recreational areas (Wang & Liu, 2013). Such transformations are commonly associated with biodiversity loss, soil degradation, and habitat fragmentation. For instance, on Phu Quoc Island in Vietnam, tourism-driven urbanization reduced habitat quality by 5.6% through the replacement of natural ecosystems with resorts and roads (Nguyen et al., 2025, p.1). In many parts of the Global South, these LULC changes are further linked to environmental challenges such as deforestation, groundwater depletion, and pollution of coastal and marine ecosystems (Lambin et al., 2003; Liyanage, 2024; Saha & Paul, 2021).

Bali, as Indonesia's primary tourism destination both nationally and globally, is increasingly experiencing the impacts of LULCC driven by rapid tourism development. This growth has intensified demands on limited land resources, contributing to both physical and social challenges. As a result, LULCCs have generated a range of environmental and socio-economic pressures, including water scarcity, declining agricultural land, and ecosystem degradation (Rimba et al., 2020; Zen et al., 2024). Beyond environmental degradation, LULC changes also pose significant governance challenges, particularly in regions with customary tenure systems like Bali's *Subak*. *Subak* is a centuries-old irrigation and land management institution that has regulated water distribution and rice cultivation through communal governance. Recognized by UNESCO in 2012 as part of the "Cultural Landscape of Bali Province: the *Subak* System as a manifestation of the Tri Hita Karana Philosophy," *Subak* integrates ecological, social, and spiritual dimensions, ensuring equitable water sharing and reinforcing the Balinese cosmological principle of harmony between humans, nature, and the divine (Lansing, 2006; UNESCO, 2012). Despite its resilience, *Subak* has become increasingly vulnerable to LULCC pressures, as tourism development and urban expansion disrupt irrigation networks and weaken the communal structures that sustain them (Lanya et al., 2017; Vel et al., 2022).

While LULCC in Bali encompasses multiple agricultural types, including dry fields, plantations, and mixed gardens (Indrawan et al., 2022) this study focuses specifically on rice paddy areas (*sawah*) as the primary unit of analysis. This focus is deliberate and justified for two interconnected reasons. First, rice paddy fields are the physical and functional foundation of the *Subak* system (*Subak Yeh*), the wet irrigated form of *Subak*, which is defined by and operates through the hydrological boundaries of shared rice paddy land (Lansing, 1987, 2012; Suanda et al., n.d.). The conversion of rice paddy areas, therefore directly and immediately threatens the operational integrity of *Subak* governance in ways that the conversion of other agricultural land types does not (Budiasa et al., 2015; Lanya et al., 2017). Second, rice paddies are the dominant agricultural land use in Kuta Utara Subdistrict and represent the most spatially significant and culturally embedded form of agricultural land in Bali's southern tourism corridor (Lanya et al., 2017). Their conversion is not only an agricultural loss but a cultural and landscape transformation, eroding the terraced rice field scenery that has defined Bali's identity as a UNESCO World Heritage cultural landscape and as a global tourism destination. For these reasons, rice paddy areas serve as both the empirical focus and the analytical lens through which this study examines the broader dynamics of tourism-driven LULCC and its governance implications.

A 2018 study by the Transnational Institute on Tourism and Land Grabbing in Bali reveals that, with a resident population of around 4 million, the island attracted nearly 10 million international visitors annually by the late 2010s, positioning tourism as the dominant driver of economic activity. To accommodate this influx, vast areas of farmland and forest have been converted into hotels, villas, restaurants, and transportation infrastructure. The same study shows that between 1990 and 2015, Bali lost nearly 25% of its agricultural land, as the proportion of land under traditional *Subak* irrigation fell from 18% to 13.6% (Colorni, 2018, p.7). During this period, the resident population increased by 66%, while the tourism population grew by 330% (Colorni, 2018, p.7). These changes contributed to the abandonment of cultivation by over 13,000 rice-farming households and 55,000 other agricultural producers (Colorni, 2018, p.8). This study reported "a very strong direct correlation" between the expansion of tourism facilities and the decline in cultivated land (Colorni, 2018, p.8).

Several studies on Land Use and Land Cover Changes (LULCCs) have been conducted to quantify the significant transformations driven by tourism. In Bali's densely touristed "*Sarbagita*" region (Denpasar–Badung–Gianyar–Tabanan), Rimba *et al.* (2020) found that between 2000 and 2015, much agricultural land and vegetation were reclassified as urban built-up, with built area projected to grow by 43% from 2015 to 2025 (Rimba et al., 2020, p.1621). Another study report analogous trends in Badung Regency: built-up land persistently increased (especially 2010–2020), while paddy rice fields and mixed plantations decreased in later years (Indrawan et al., 2022). Qualitatively, Budiasa *et al.* (2015) showed how Bali's traditional rice-irrigation communities (*Subak*) are undermined by tourism: in the Saba watershed (northern Bali), rapid tourism and population growth drastically changed LULC, converting a large share of paddy fields to tourism-related uses. Coastal ecosystems are also affected. Sunarta and Saifulloh (2022) specifically analyzed coastal tourism zones (Pandawa-Kuta); using Sentinel-2 in Google Earth Engine (GEE), they found that new hotels and amenities drove NDBI (built-up) increases and NDVI decreases between 2016 and 2021. Mangrove forests have been affected too; it is confirmed in a study by As-Syakur *et al.* (2025) that applied Landsat-8 NDVI time-series analysis (via Google Earth Engine) to Benoa's Bay urban mangroves that located on the southeastern of Bali within the Badung regency (2013–2023). They detected a net mangrove loss of ~4 hectares, primarily due to infrastructure and tourism facilities, though these estimates lack field validation of tourism infrastructure and tourism facilities.

1.2. Research Gap

Despite increasing evidence of LULCC in tourism areas, limited attention has been given to how these transformations affect traditional land governance systems, interact with zoning regulations, and enable LULCC through tourism-related development.

Previous studies provide useful insights but remain limited in scope. For example, Sunarta, Nugroho, and Adikampana (2021) examined tourism expansion in Kuta Utara using spatial and qualitative methods, including interviews and group discussions on spatial transformation of *Subak* in Northern Kuta tourism area. Their study shows how agrarian landscapes have shifted toward service-oriented cultural spaces, and how the role of the *Subak* has changed. However, the analysis is largely descriptive and gives limited attention to land-use regulations or to how *Subak* institutions and farmers perceive and respond to these changes.

Similarly, Mahaendrayasa et al. (2024) identified spatial planning and economic policies as key drivers of agricultural land conversion for tourism in Bali. However, their study does not include a spatial analysis of the extent and pattern of agricultural land loss. As a result, there is still a lack of integrated research that connects spatial patterns of LULCC, planning regulations, and local perspectives, particularly in rapidly developing tourism areas such as Kuta Utara in the northern part of Bali.

To address this gap, this study examines how tourism development has reshaped LULC specifically on *Subak* rice paddy of Kuta Utara, an area that has transformed from a semi-rural region with strong *Subak* traditions into a major tourism hub (Lanya et al., 2017). The study adopts a mixed-methods approach, combining a 23-year spatio-temporal analysis of LULCC, with a focus on rice paddy areas combining tourism infrastructure point survey and qualitative data from interviews to capture local and institutional perspectives. This is supported by a review of spatial planning policies, land-use regulations, and zoning frameworks.

By integrating geospatial analysis, policy review, and community perspectives, this study aims to examine how tourism pressures influence LULCC, how these changes align with spatial planning, and how they affect the resilience of the *Subak* system. In doing so, it seeks to contribute to a better understanding of land governance in tourism areas and provides insights into more sustainable and balanced development.

1.3. Research Objective and Questions

The main objective of this study is to investigate how tourism-driven development has impacted the *subak* rice paddy in Kuta Utara Subdistrict, Badung Regency, Bali, from 2002 to 2025. To that end, four research objectives and associated research questions are defined:

1. To quantify the extent and patterns of tourism-driven rice paddy loss in Kuta Utara Subdistrict from 2002 to 2025.
    a. What are the spatial patterns of rice paddy loss in Kuta Utara Subdistrict?
    b. To what extent is tourism development associated with these changes?
2. To evaluate how rice paddy loss aligns with spatial planning regulations in Bali.
    a. What key spatial planning laws and regulations have been placed between 2002 and 2025?
    b. How have the observed rice paddy losses aligned with spatial planning regulations?
3. To investigate the consequences of rice paddy land conversion on local land governance systems, especially on the *Subak* System.
    a. How do *Subak* leaders and members describe the impacts of rice paddy land conversion on the functioning of *Subak* system practices?
    b. How have the *Subak* organizations and their members responded or adapted to rice paddy land conversion pressures?
4. To examine how spatial patterns of rice paddy land conversion intersect with community perceptions and governance practices under tourism pressures.
    a. In what ways do local perceptions of rice paddy land conversion correspond to observed spatial trends in land use and land cover changes?

1.4. Conceptual Framework

The conceptual framework, as shown in **Figure 1-1**, illustrates the interdependent relationship between rice paddy areas and the *Subak* system, where each sustains the other. Tourism, development pressure, spatial planning, LULCC, and community perceptions are interconnected variables that influence one another in a causal sequence leading to the reduction of paddy areas, which, in turn, weakens the *Subak* system. Community perceptions provide feedback to both spatial planning and the *Subak* system, potentially reinforcing or further undermining *Subak* resilience. Overall, the framework outlines the dynamics of tourism-driven LULCC explored in this study.

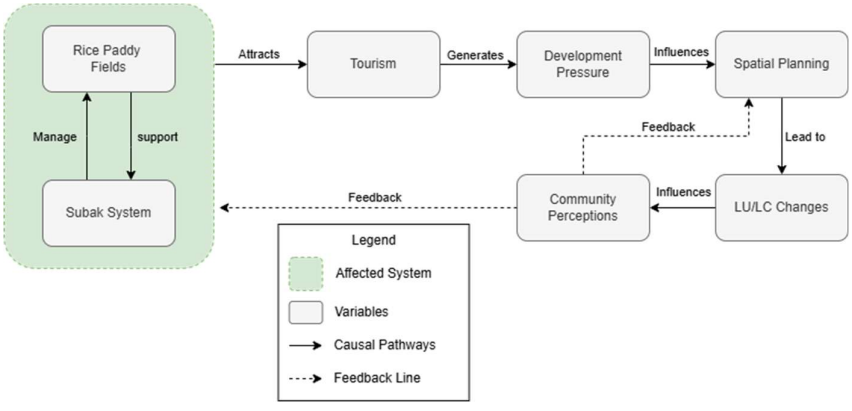


Figure 1-1
Conceptual Framework of the study

2. LITERATURE REVIEW

This chapter reviews the key theoretical and empirical literature relevant to the study. It begins by examining tourism-led spatial transformation and how tourism development reshapes land use patterns. It then discusses theories and methods of land use and land cover change (LULC) to understand the processes and tools used to analyze landscape dynamics. The chapter also explores the *Subak* system as a socio-ecological institution, emphasizing its role in managing agricultural land and water resources in Bali. Furthermore, it reviews Indonesia's spatial planning framework to provide a policy context for land use regulation. Finally, the chapter discusses the relationship between tourism development and the *Subak* system in Bali, focusing on how tourism influences its functioning and continuity.

2.1. Tourism-Led Spatial Transformation

Tourism is increasingly understood not merely as an economic sector but as a major driver of spatial transformation in both rural and urban contexts. From a landscape perspective, tourism and spatial change are deeply interconnected because tourism hinges on the consumption of space and landscape resources, and at the same time, reshapes those very spaces through infrastructure development, LULCC, and economic reorientation (Meneghello, 2021). The "tourism–landscape" nexus literature highlights that tourism activities both depend on place qualities and actively modify spatial patterns, leading to new configurations of land use and social landscapes (Meneghello, 2021; Terkenli, 2004). In this sense, tourism operates not as a passive activity but as a structural driver influencing how land is valued, allocated, and governed (Hall, 2008; Torres & Momsen, 2005).

A key mechanism through which tourism shapes land systems is land commodification, whereby land is increasingly treated as an economic asset for exchange rather than as a resource embedded in social, cultural, or productive systems (Liu et al., 2025). Under tourism development, landscapes such as coastlines, agricultural terraces, and culturally significant areas are increasingly valued in terms of their capacity to attract visitors and generate revenue (Iannucci et al., 2022; Petrişor et al., 2020). This shift promotes tourism-driven urban expansion, marked by the rapid growth of hotels, resorts, restaurants, and related infrastructure. Unlike conventional urban growth, which is typically driven by population increase, this type of expansion is shaped by demand from tourists and external investors. As a result, land development tends to focus on profit and accessibility rather than on maintaining well-organized and consistent spatial patterns (Hall, 2008). Consequently, development tends to concentrate in high-value tourism zones, leading to uneven spatial growth and more fragmented urban forms (Torres & Momsen, 2005).

Tourism also accelerates the conversion of agricultural land into built-up and commercial uses, leading to a fundamental restructuring of land systems. Because tourism-related activities often generate higher economic returns than agriculture, landowners are encouraged to sell or repurpose their land for development (Liu et al., 2025). This process gradually reduces the role of agriculture and shifts land use from production-based activities to consumption-oriented uses. As a result, productive land is lost, traditional livelihoods are disrupted, and ecological systems are altered (Gössling, 2002; Hall & Page, 2014). In regions where agriculture is closely tied to cultural identity and local institutions, such transformations can also erode intangible heritage and weaken community-based land management systems (Liu & Wall, 2006; Lorenzen & Lorenzen, 2011).

In addition, tourism acts as a catalyst for peri-urban growth and land speculation, extending spatial transformation beyond established tourism cores. As central tourism areas become saturated or expensive, development pressures spill over into surrounding rural and peri-urban zones, where land is relatively cheaper and more accessible (Gao & Cheng, 2020). These areas become attractive for new tourism-related developments, including villas, second homes, and boutique accommodations. This expansion is closely linked to speculative dynamics, where land is acquired based on anticipated increases in value rather than immediate use (Lorenzen, 2021; Mullins, 1991). Such land speculation drives rapid increases in land prices, often exceeding local affordability and limiting access to land for resident populations (Su et al., 2024). It can also result in fragmented and unregulated development patterns, particularly in contexts with weak planning and governance frameworks (Gemeda et al., 2021; Su et al., 2024).

Taken together, these processes show that tourism acts as a major driver of spatial transformation, reshaping land systems through land commodification, land use conversion, and speculative development. It changes how land is valued, shifting it toward market-based considerations and aligning spatial development with global tourism demand. This often occurs at the expense of local socio-economic conditions and environmental sustainability (Gössling, 2002; Hall & Page, 2014). Understanding tourism in this way is therefore important for analyzing land-use changes in rapidly developing regions, especially where tourism strongly influences spatial development.

2.2. Land Use and Land Cover Change Theory and Methods

Land-use and land-cover change (LULCC) is widely recognized as a fundamental component of global environmental change, representing the interface between human activity and the biophysical environment. Through processes such as land conversion, intensification, and management, human activities directly influence ecological systems, hydrological processes, and landscape structure (Mir et al., 2025). As a result, LULCC operates not only at local scales but also contributes to broader environmental dynamics.

A key distinction in land use and land cover change (LULCC) research lies between land cover and land use. Land cover refers to the physical characteristics of the Earth's surface, such as vegetation, water bodies, or built-up areas, whereas land use reflects the socio-economic functions assigned to land, including agriculture, settlement, or tourism (Lambin et al., 2003; Turner et al., 1994). While analytically distinct, these dimensions are closely linked, as changes in land use often manifest as observable transformations in land cover (Lambin et al., 2003; Turner et al., 2007). This relationship is particularly relevant in areas experiencing rapid development, where land conversion processes are often spatially heterogeneous, fragmented, and occur at fine scales (Lambin, 2006; Verburg et al., 2004). Therefore, this study uses **LULC** and **LULCC** terms where appropriate. LULC refers to the land use and land cover characteristics observed at a particular point in time, while LULCC refers to the changes in those characteristics over time.

Methodologically, LULCC studies rely extensively on remote sensing and GIS-based techniques to detect and quantify spatial changes. Conventional approaches such as supervised and unsupervised classification have been widely applied and are capable of producing acceptable levels of classification accuracy for large-scale analyses (e.g., Supervised Maximum Likelihood Classification) (Dipson et al., 2015). However, these automated methods often face limitations in heterogeneous and fragmented landscapes, where spectral similarity between classes (e.g., cropland, grassland, and mixed vegetation) reduces classification reliability.

In response to these limitations, several studies have employed manual digitization techniques to improve the accuracy and spatial detail of land-cover mapping. Manual digitization, using high-resolution imagery such as Google Earth or photogrammetric data, enables researchers to delineate land-use features with greater precision, particularly in small or complex study areas. For example, urban studies have utilized manual digitization to capture fine-scale land-use changes that are not adequately represented in medium-resolution satellite classifications (Cunningham, 2006; Egigu et al., 2024; Mahamba et al., 2023). Similarly, in coastal research, manually digitized shore-normal transects have been used to precisely identify shoreline changes, demonstrating the method's capacity for detailed spatial analysis (Naik et al., 2026).

Manual digitization is also widely used as a reference or validation approach in classification studies. Research on crop identification has shown that manually digitized datasets provide more reliable ground truth data for accuracy assessment, highlighting their importance in evaluating automated classification outputs (Chanu et al., 2023; Guo et al., 2023). These findings indicate that, while automated classification methods are efficient for large-scale mapping, manual digitization remains a critical technique for achieving higher positional accuracy and thematic reliability at finer spatial scales.

Given the characteristics of the present study area where land-use change is likely to occur in small, fragmented patches driven by tourism development, manual digitization provides a suitable methodological approach. It allows for the accurate delineation of rice paddy boundaries and their conversion over time, which may not be fully captured by moderate-resolution or automated classification datasets. Therefore, the use of manual digitization is justified to enhance the precision and reliability of LULCC analysis in this context.

2.3. *Subak* as a Socio-Ecological Institution

The Balinese *Subak* system is widely recognized as a traditional socio-ecological institution that integrates communal water management, rice cultivation, and cultural practices into a coherent system of land and resource governance. Rooted in Balinese cosmology, particularly the philosophy of *Tri Hita Karana* (harmony between humans, nature, and the spiritual realm), *Subak* represents more than a technical irrigation network; it is an embedded institutional

arrangement that coordinates collective action, regulates resource use, and shapes landscape patterns across spatial and temporal scales (Lansing, 1987, 2012; Zen et al., 2024). Through this integration of ecological processes and social organization, *Subak* exemplifies a socio-ecological system (SES) in which human and environmental components co-evolve and are mutually dependent (Berkes & Folke, 2002; Ostrom, 2009).

From an institutional perspective, *Subak* operates as a self-organizing governance system structured around farmer associations that manage irrigation at the level of a shared water source, typically derived from rivers, lakes, or springs. Each *Subak* is composed of member farmers who collectively own or cultivate rice fields within a defined hydrological boundary, rather than administrative boundaries (Lansing, 1987). The system is coordinated by elected leaders (*pekaseh*), who oversee the implementation of rules related to water allocation, cropping schedules, and ritual obligations. Decision-making processes are typically participatory, relying on consensus-based deliberation among members, which reinforces accountability and social cohesion (Lansing, 2012; Ostrom, 2009).

Subak in Bali comprises two distinct types that differ in their ecological setting and agricultural function. The first, *Subak* Yeh (also referred to as *Subak Sawah* or *Subak Basah*), governs lowland irrigated rice cultivation through shared hydrological boundaries defined by river or spring-fed water sources. The second, *Subak* Abian (or *Subak Tegal*), manages dry or upland agricultural land without formal irrigation infrastructure, primarily cultivating horticulture and perennial crops such as coffee, clove, vanilla, and other *palawija* varieties (Suanda et al., n.d.; Wijaya, 2019) . While both types share the same philosophical and institutional foundations, their landscape expressions differ considerably: *Subak* Yeh is embedded within the water temple network and characterized by terraced paddy fields, whereas *Subak* Abian is oriented around dryland territories and perennial crop management (Bali Provincial Government, 2011, as cited in Budiasa et al (2015). Across Bali, there are approximately 1,546 *Subak* Yeh units and 799 *Subak* Abian units (Suanda et al., n.d.). This study focuses specifically on *Subak* Yeh, as Kuta Utara Subdistrict is characterized by lowland irrigated rice paddy fields, and it is within this irrigated landscape that the pressures of tourism-driven LULCC are most acutely observed.

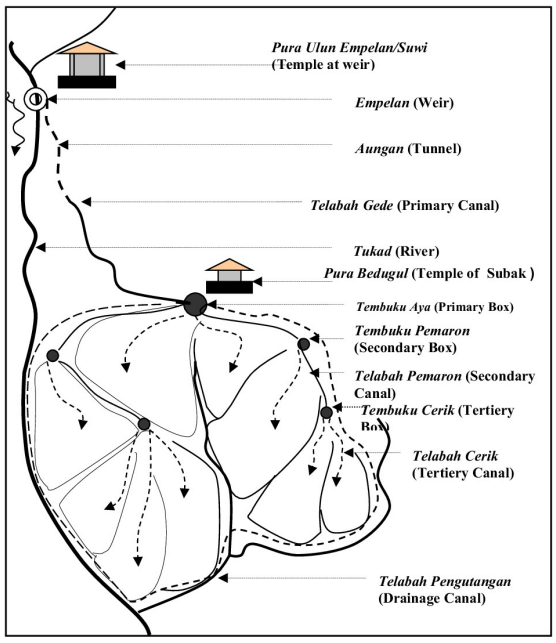


Figure 2-1
Example of Subak Irrigation System in Bali.
Source: Figure was directly captured from Norken (2019). MATEC Web of Conferences.

The central function of *Subak* lies in its role in water management and agricultural regulation. The system establishes detailed rules governing irrigation schedules, water distribution, and planting cycles, ensuring equitable access to water resources among upstream and downstream users (Lansing, 1987). These arrangements are closely aligned with ecological dynamics, such as seasonal water availability and pest control cycles. For example, synchronized planting

across *Subak* networks helps manage pest populations and optimize water use, demonstrating how institutional rules are adapted to ecological feedback (Lansing & Kremer, 1993). In this way, *Subak* integrates environmental knowledge into governance practices, contributing to both agricultural productivity and ecological sustainability (Berkes & Folke, 2002).

Beyond its technical functions, *Subak* also serves as a system of community governance, embedding social norms, cultural values, and religious practices into resource management. Ritual activities conducted at water temples play a crucial role in reinforcing collective responsibility and coordinating agricultural activities across multiple *Subak* (Lansing, 2012). These rituals are not merely symbolic; they function as institutional mechanisms that facilitate communication, synchronize decision-making, and strengthen compliance with agreed rules. Informal norms such as mutual monitoring, reciprocity, and shared sanctions further support the system's effectiveness, reducing the need for external enforcement (Ostrom, 2009).

The *Subak* system is also closely linked to customary (*adat*) governance structures, which historically regulate land tenure, inheritance, and community obligations in Bali. *Subak* operates alongside these *adat* institutions, often overlapping in membership and authority, and together they form a hybrid governance framework that connects land, water, and social organization (Lorenzen & Lorenzen, 2011; Roth & Sedana, 2015). However, this relationship has become increasingly complex in the context of modern state governance and formal land administration systems. The introduction of statutory land rights, spatial planning regulations, and tourism development pressures has created tensions between customary practices and formal legal frameworks, sometimes weakening the authority and coherence of *Subak* institutions (Lansing, 1987; Roth & Sedana, 2015).

Finally, the cultural and ecological significance of *Subak* extends beyond its functional role in agriculture. The system has been internationally recognized for its unique integration of cultural traditions, ecological knowledge, and landscape management, exemplified by its designation as a UNESCO World Heritage cultural landscape (UNESCO, 2012). *Subak* landscapes, characterized by terraced rice fields and interconnected irrigation networks, reflect centuries of adaptive management and collective action. They embody not only sustainable agricultural practices but also a living cultural heritage that sustains community identity and spiritual values (Lansing, 2012; UNESCO, 2012).

In summary, *Subak* represents a robust socio-ecological institution that integrates water management, agricultural production, and community governance within a culturally embedded framework. Its effectiveness lies in its ability to align social norms, institutional rules, and ecological processes, making it a resilient system of resource management. However, ongoing pressures from land-use change, tourism development, and institutional fragmentation pose significant challenges to its continuity, underscoring the need to understand *Subak* within broader processes of spatial and socio-economic transformation.

2.4. Indonesia's Spatial Planning

Indonesia's spatial planning system provides the formal institutional framework that regulates land use, allocates space for different functions, and guides development across national, regional, and local levels. At its core, spatial planning is governed by Law No. 26/2007 on Spatial Planning, which establishes a hierarchical and integrated system intended to ensure sustainable, balanced, and coordinated land use (Firman, 2009; Hudalah & Woltjer, 2007). In principle, this framework is designed to manage competing land demands such as agriculture, conservation, and urban development by aligning spatial policies with broader economic and environmental objectives.

A central component of this system is the Rencana Tata Ruang Wilayah (RTRW), or general spatial plan, which defines the structure and pattern of space within a given administrative territory. The RTRW is complemented by more detailed zoning regulations (*rencana detail tata ruang*, RDTR), which specify allowable land uses, building intensities, and development controls at finer spatial scales (Hudalah & Woltjer, 2007). Through these instruments, the planning system seeks to designate protected areas, agricultural zones, and urban development areas, thereby providing a legal basis for controlling LULCC and guiding investment decisions.

The implementation of spatial planning is strongly shaped by Indonesia's decentralized governance structure, in which local and regional governments play a key role in planning and land management. Since the decentralization reforms

of the early 2000s, regencies (*kabupaten*) and municipal (*kota*) governments have been granted significant authority to prepare and enforce spatial plans within their jurisdictions (Firman, 2009; Hudalah & Woltjer, 2007). Provincial governments act as intermediaries, coordinating spatial planning across subdistricts and ensuring alignment with national policies. In practice, however, this multi-level governance structure can create challenges related to coordination, capacity, and consistency, particularly when local development priorities conflict with national or environmental objectives.

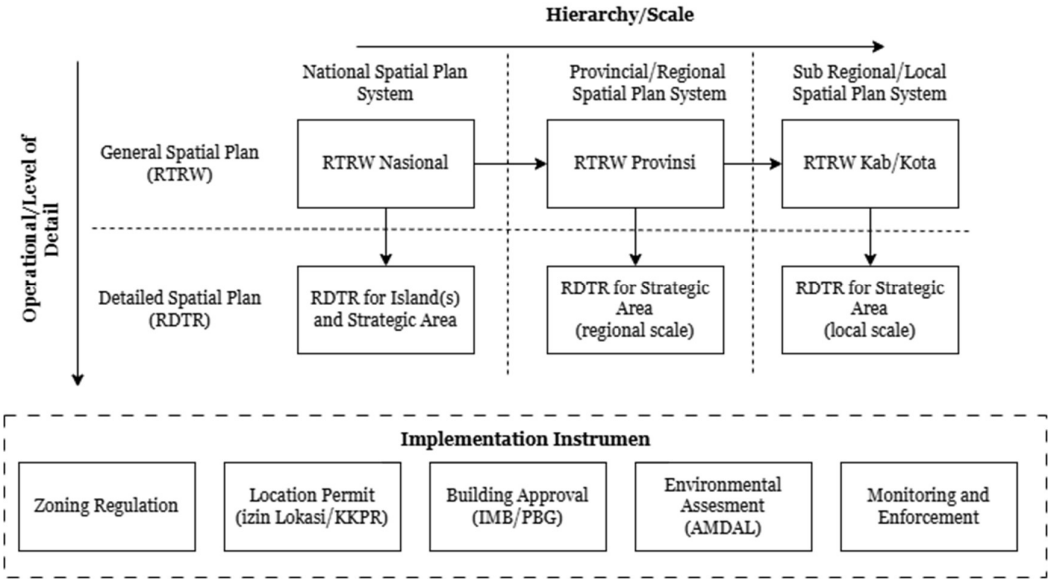


Figure 2-2
Spatial planning system in Indonesia
Source: Figure created by Cening Ayu Merta (author) inspired by (Hudalah & Woltjer, 2007) based on Law No 26/2007 on Spatial Planning

To regulate land use, the spatial planning system relies on a range of policy instruments, including zoning regulations, development permits, and environmental assessments. Zoning ordinances define what types of activities are permitted in specific areas, while permits such as location permits (*izin lokasi*) and building permits (*IMB*, now replaced by *PBG*) serve as mechanisms to control and monitor development (Widiatedja, 2022). Environmental impact assessments (*AMDAL*) are also required for certain projects, providing an additional layer of regulation aimed at mitigating negative environmental effects. Together, these instruments are intended to ensure that LULC is consistent with approved spatial plans and sustainability principles.

Despite the existence of this formal framework, a significant gap often persists between planning and implementation. Numerous studies have documented inconsistencies between spatial plans and actual land use outcomes, particularly in rapidly developing regions (Firman, 2009; Hudalah & Woltjer, 2007; Widiatedja, 2022). Weak enforcement, overlapping regulations, and limited institutional capacity at the local level contribute to these discrepancies. In addition, economic pressures such as demand for tourism development, real estate investment, and infrastructure expansion frequently lead to the conversion of land in ways that deviate from official plans. Informal practices, political interests, and fragmented governance further complicate the effectiveness of spatial planning as a regulatory tool (Widiatedja, 2022).

These challenges are especially pronounced in areas experiencing rapid tourism growth, where high land values and investor demand can undermine zoning controls and accelerate land-use change. In such contexts, spatial planning may function more as a negotiated framework rather than a strictly enforced regulatory system, with outcomes shaped by interactions between state actors, private investors, and local communities (Hudalah & Woltjer, 2007). As a result, the capacity of spatial planning to manage land transformation and protect agricultural or culturally significant landscapes remains uneven.

In sum, Indonesia's spatial planning system provides a comprehensive formal framework for regulating land use through instruments such as RTRW, zoning regulations, and development permits. However, its effectiveness is contingent upon the capacity of local governments, the coherence of multi-level governance, and the ability to enforce regulations in the face of strong market pressures. Understanding both the structure of this system and its implementation gaps is essential for analyzing land-use change, particularly in regions where tourism-driven development challenges existing planning controls.

2.5. Bali's Tourism and *Subak*

Bali is one of the most prominent global tourism destinations and serves as Indonesia's primary international gateway for leisure travel. Its strong global recognition has positioned tourism as the dominant sector in the regional economy, contributing significantly to foreign exchange earnings and regional development (Morrison, 2022). Data from Statistics Indonesia (BPS) show that between 2010 and 2024, tourism-related activities consistently accounted for the largest share of Bali's Gross Regional Domestic Product (GRDP), surpassing traditional sectors such as agriculture. This reflects a structural shift from an agrarian economy toward a service-oriented economy centered on tourism.

Despite a sharp decline in visitor arrivals during the COVID-19 pandemic, tourism remained the largest contributor to GRDP in relative terms. This persistence highlights the depth of Bali's economic dependence on tourism, as well as its limited sectoral diversification. While this dominance has supported economic growth, it has also intensified pressures on land systems.

In Bali, tourism development has driven increasing demand for land for accommodation, infrastructure, and related services, often at the expense of agricultural areas (Corboş et al., 2025; Morrison, 2022). As a result, irrigated rice fields managed under the *Subak* system are increasingly converted into built-up and commercial uses. This process not only alters land cover but also disrupts the institutional foundations of *Subak*, which depend on coordinated water management and collective land use (Lansing, 2012).

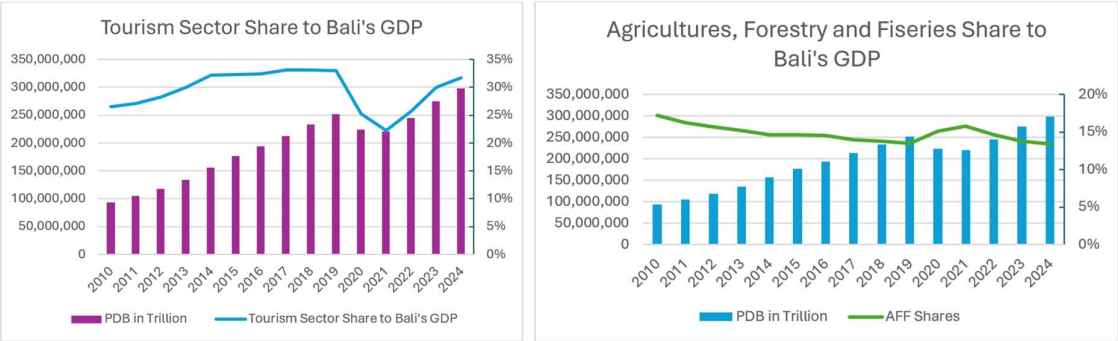


Figure 2-3

Chart of Tourism vs Other Sectors Shares to Bali's GDP from 2010 – 2024.

Source: Charts were created by Cening Ayu Merta (Author interpretation). Data source: Indonesia's Central Statistic Agency (Badan Pusat Statistik Indonesia, 2025)

The expansion of tourism into peri-urban and rural areas further fragments agricultural landscapes and weakens the ecological and social cohesion of *Subak* systems (Budiasa et al., 2015). At the same time, higher economic returns from tourism create strong incentives for landowners to shift away from agriculture, reinforcing LULCC dynamics. Although *Subak* has gained recognition as a cultural landscape and tourism asset, this integration is ambivalent. While it may support preservation, it can also lead to the commodification of *Subak* landscapes, where their value is increasingly tied to tourism rather than agricultural and institutional functions (Roth & Sedana, 2015).

Overall, the relationship between tourism and *Subak* is characterized by a structural tension: tourism drives economic growth and spatial transformation, but in doing so, it undermines the land systems and institutional arrangements that sustain *Subak*. This dynamic is central to understanding the change of land-use in Bali.

3. METHODS

This chapter describes the research design and methodological approach used to analyze the relationship between tourism development and LULCC in Bali. It outlines the data sources, including spatial and qualitative data, and explains the methods applied to assess LULCC as well as the influence of tourism on farmland conversion. The chapter also details the analytical techniques employed, including spatial and qualitative analysis methods, and justifies their selection. In addition, it explains how the *Subak* system is incorporated into the analysis as a socio-ecological component through qualitative approaches. Finally, the chapter addresses the limitations of the methodology and presents the overall research workflow.

3.1. Research Approach and Design

This study adopts a mixed-methods case study approach to investigate the complex relationship between tourism-driven LULCC, spatial planning governance, and the *Subak* system as a traditional land governance institution in Kuta Utara Subdistrict, Badung Regency, Bali. This approach was chosen for its ability to provide a holistic understanding by combining quantitative spatial data with qualitative insights from local stakeholders and policy frameworks (Sawungrana, 2025). The research is structured into four analytical steps: spatial analysis (**Step 1**), policy content analysis (**Step 2**), thematic analysis (**Step 3**), and cross-validation (**Step 4**). By combining spatial, policy, and qualitative approaches, this study aims to provide a more complete understanding of LULCC than any single method could offer alone, linking observed spatial patterns with planning frameworks and local governance experiences.

3.2. Research Area Context

Kuta Utara Subdistrict is located in Badung Regency, in the southern part of Bali Province, Indonesia. Situated on the western coast of the island, the subdistrict borders the Indian Ocean to the west, Denpasar City to the south, and the regencies of Badung's central zone to the north and east. Within the broader geographic context of Indonesia, Bali itself is a small island province in the western part of the Lesser Sunda Islands chain, approximately 1,000 kilometers east of Jakarta and directly east of Java. As one of Indonesia's most internationally recognized tourist destinations, Bali and particularly its southern coastal corridor, has experienced some of the most rapid and intensive tourism-driven LULCC transformation in the country over the past three decades.

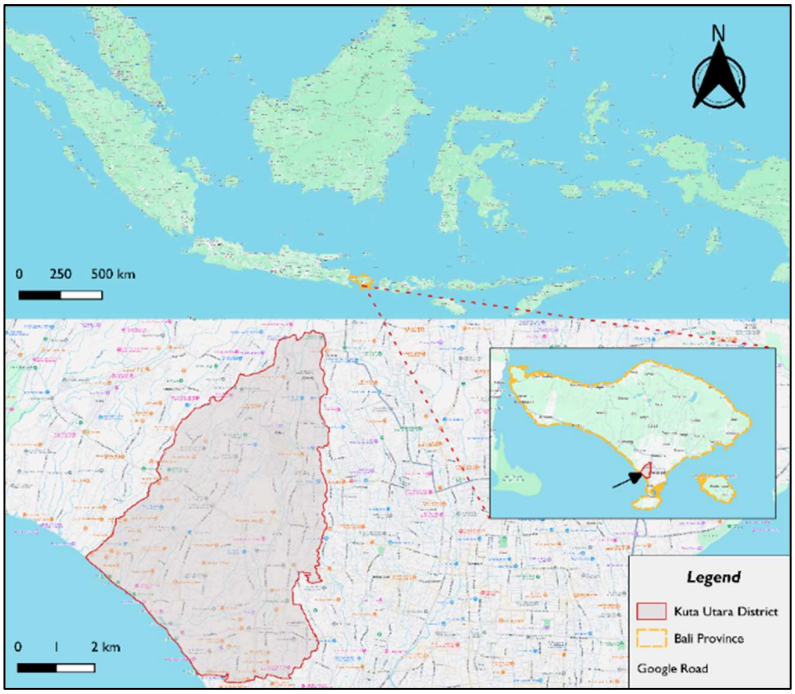


Figure 3-1

Kuta Utara map, as the study area in accordance with province of Indonesia

Source: Map created by Cening Ayu Merta (author). Basemap from Google Roads (Google, 2025), © Google Maps. Administrative boundaries provided by Badan Informasi Geospasial (BIG, 2025).

Previously, Kuta Utara Subdistrict was part of Kuta Subdistrict. In 2004, it was divided into three different subdistricts, which are the Kuta Subdistrict, Kuta Utara Subdistrict, and Kuta Selatan Subdistrict. Kuta Utara Subdistrict itself is composed of three urban villages (*kelurahan*) and 3 villages (*desa*) which are *Kelurahan* Kerobokan Kelod, *Kelurahan* Kerobokan, *Kelurahan* Kerobokan Kaja, *Desa* Tibubeneng, *Desa* Canggu and *Desa* Dalung totalimg into six (6) villages/urban villages. Kuta Utara Subdistrict covers a total area of 33.86 km² with a population of approximately 89.99 thousand people in 2024 (Badan Pusat Statistik Kabupaten Badung, 2025), resulting in a population density of about 2,660 people per square kilometres. This high population density reflects the subdistrict's rapid transformation from a semi-rural area with strong *Subak* traditions into a major tourism hub (Lanya et al., 2017), a shift driven by the concentration of internationally prominent tourism destinations such as Canggu and Petitenget within its boundaries.

Figure 3-2
Example of rice paddy area in Canggu Village over a 20-year period.
Source: Google Earth Pro (Google LLC, 2026); author's interpretation.
Note: This image represents a partial view of the rice field area in Canggu village, Kuta Utara and is not indicative of its full extent.

Kuta Utara is chosen as the study area because it exemplifies the rapid transformation of LULCC driven by tourism development, making it an ideal location to investigate the impacts of tourism on spatial planning, traditional land governance, and LULCC. Its combination of high population density, concentrated tourist activity, and ongoing shifts from traditional agricultural practices to commercial and residential development provides a representative case for understanding broader traditional land governance challenges in Bali.

3.3. Data Acquisition and Preparation

This research draws on a combination of primary and secondary datasets, collected and compiled to support a comprehensive analysis of tourism-driven LULCC specifically on rice paddy and its implications for the *Subak* system in Kuta Utara Subdistrict. **Table 3-3** provides an overview of all datasets used in this study, including their sources, formats.

3.3.1. Primary Data

The primary dataset was obtained through two approaches: desk-based digitization and direct fieldwork conducted between February and March 2026.

a. Desk-Based Data: Rice Paddy Digitization

Rice paddy areas were digitized from Google Earth imagery for the years 2002, 2020, and 2025. This desk-based process was conducted using Google Earth Pro (Google LLC, 2026), where rice paddy boundaries were manually delineated based on visual interpretation of historical satellite imagery. Results of the manual digitization were later exported as *.KML/KMZ* file and further processed using QGIS software.

The selected years for rice paddy digitization (2002, 2020 and 2025) were chosen to capture major events and policy changes that significantly influenced tourism development and LULC dynamics in Bali. On 12 October 2002 a massive bombing in Kuta, Bali has caused a major tourism shocked that followed by deep fall of tourism visitor numbers which leads to economic downturn in Bali (Putra & Hitchcock, 2006). Therefore 2002 was chosen as the starting point

of LULC happened in Bali specifically for rice paddy area. After almost 7 years later, in 2009 a law with the main purpose of protecting agricultural land especially rice paddy area (*sawah*) was enacted (Law No.41/2009). The COVID-19 outbreak in 2020 significantly reduced tourist arrivals in Bali, contributing to an economic downturn on the island (Dewi, 2021). This makes 2020 a suitable reference year for analysis, particularly to assess the post Bali bomb tourism recovery as well as the impacts of the 2009 agricultural land protection law. Finally, 2025 was selected to provide an up-to-date assessment of land-use conditions following the recovery of Bali's tourism sector after the pandemic. Comparing 2025 with the earlier years allows for an evaluation of recent rice paddy conversion trends and the effectiveness of land protection policies under renewed tourism development pressures.

For the purpose of this study, rice paddy classification was based on a consistent visual interpretation framework to ensure comparability across all time periods. Rice paddy fields were identified as actively cultivated areas characterized by discernible field boundary patterns, visible flooding conditions where present, and bund structures associated with irrigated rice cultivation. Other agricultural land was distinguished by more heterogeneous spatial configurations, mixed vegetation cover, and field patterns that were clearly distinct from rice paddy characteristics. Built-up areas were identified based on the presence of impervious surfaces, road networks, and high-density structural development. Areas that had undergone complete conversion to built-up land or other LULC types were excluded from the rice paddy category. Transitional agricultural areas were also excluded to maintain consistency with the study's focus on functional rice cultivation within the *Subak* system. Figures in **Table 3-1** provides a visual reference of the classification criteria used during the digitization process, illustrating the key visual differences between rice paddy fields, other agricultural land, and built-up areas.

Table 3-1 presents Google Earth imagery organized by feature type and year (2002, 2020, and 2025) for comparative visual interpretation. The quality and interpretability of the imagery vary across the analyzed years. In the earliest year of analysis (2002) Google Earth imagery was of comparatively lower resolution, and rice paddy fields were at times difficult to distinguish due to varying seasonal conditions and the limited visual detail available at this resolution. Under these conditions, rice paddy areas were identified primarily through their characteristic geometric field boundary patterns, the presence of continuous bund lines between adjacent parcels, and the faint reflectance of residual water or saturated soil where present. In contrast, the 2020 and 2025 imagery benefited from higher spatial resolution and clearer visual detail, allowing rice paddy areas to be identified more confidently through the combination of crop color, regular field boundaries, and visible water reflectance.

The reliability and accuracy of the rice paddy delineation across all time periods was further reinforced by the researcher's own contextual knowledge as a Balinese native with lifelong familiarity with the physical characteristics, seasonal patterns, and spatial organization of rice paddy landscapes in Bali (Dwyer & Buckle, 2009). This insider knowledge informed interpretive decisions during the digitization process. The delineation of the earliest time period (2002) was additionally validated through accounts provided by *Subak* members during the interviews. When asked to describe the extent of rice paddy coverage in Kuta Utara during the early 2000s, respondents consistently confirmed that approximately 90% of the subdistrict's farmland area was under active rice paddy cultivation at that time, with minimum *Subak Abian* or dryland agricultural systems present. Several respondents further recalled that during this period it was possible to see an uninterrupted horizon of rice paddy fields stretching continuously from the northeast areas to the southwest coastal parts of the subdistrict, a description that corroborates the large rice paddy extent captured in the 2002 digitized dataset and provides a community-based of validation that complements the visual interpretation framework described above.

Multiple Google Earth images available within each reference year were examined to support visual interpretation. The most reliable observations were used for digitization, prioritizing cloud-free and clearly interpretable imagery. No image processing was applied; instead, each scene was assessed individually to ensure consistent classification within each time period. These temporal datasets form the basis for analyzing LULCC, with a specific focus on rice paddy dynamics. They enable the identification of spatial and temporal patterns of agricultural land conversion in Kuta Utara over time.

Table 3-1
Temporal evolution of LULC classes in Kuta Utara (2002–2025)

Feature Type	Year		
	2002	2020	2025
Growing Rice Paddy			
Harvested Rice Paddy			
Feature of rice paddy fields on the bordering built-up			
Feature of rice paddy continue to other type of agriculture / abandoned land			

b. Fieldwork-Based Data: Tourism Infrastructure Survey

A grid-based field survey was conducted across 25 pre-selected grid units using a spatial resolution of 500 × 500 meters (**Figure 3-3**). The grid system was applied systematically across the study area to capture the distribution of tourism-related developments, covering approximately 18.46% of the total area resulting in 2109 observation points. The grid-based approach has been widely adopted in urban and tourism studies for its ability to balance spatial detail with analytical efficiency and accessibility (Kelly & Gartland, 2016; Raymond & Brown, 2007). The gridded dataset

was designed to ensure spatial representation across all villages within Kuta Utara Subdistrict while aligning with the most detailed spatial zoning for the area (Badung Regent Regulation No. 9/2021 on the Detailed Spatial Plan (RDTR) of Kuta Utara 2021-2041). The selection of grids makes sure that every spatial zoning (e.g. tourism area, agricultural area, urban area, etc.) in each village were represented somewhat equally to enable consistent comparison between observed tourism development patterns and zoning classifications.

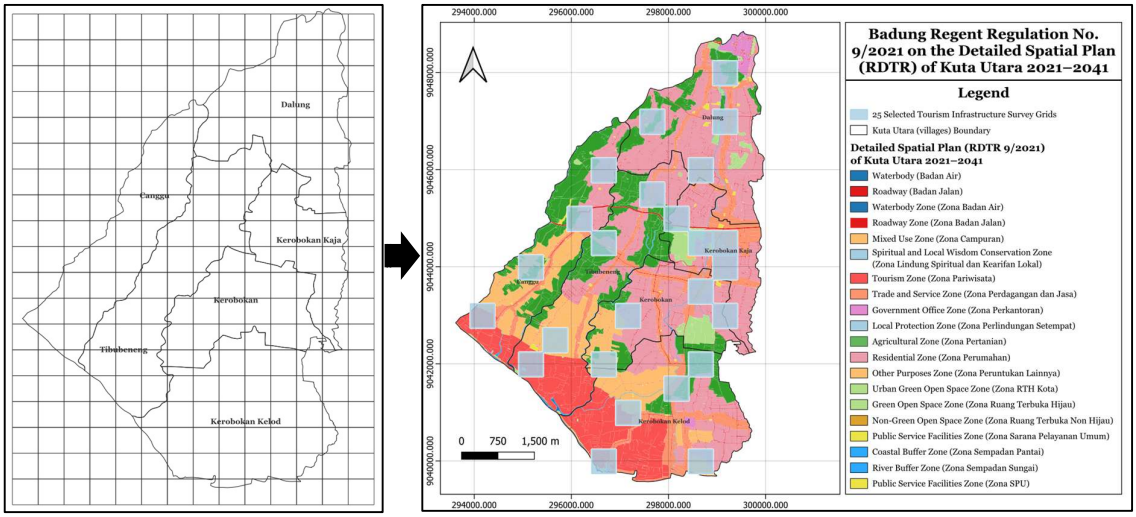


Figure 3-3
Spatial grids of 500 × 500m cells covering Kuta Utara on the left and selected grids for tourism infrastructure survey overlaid on the detailed spatial plan on the right

The selection of tourism infrastructure indicators was guided by established frameworks in the tourism literature that define infrastructure as the material and physical basis through which tourist activities are facilitated, encompassing both access and visitor experience (Corboş et al., 2025). Three primary categories were recorded across the survey grids:

1. **Accommodation services** comprising hotels, hostels, guesthouses, resorts, motels, bed and breakfasts, vacation rentals, camping sites, and villas reflecting the range of lodging facilities that directly signal tourism land demand and drive conversion of agricultural land into built-up uses;
2. **Food and beverage services** include restaurants, cafés, bars, and nightclubs which together with accommodation constitute the core of tourism's spatial footprint; and
3. **Transport and mobility services** encompassing bus stations, taxi and online transportation stands, car and motorcycle rentals, tour and travel agencies, and bike rentals which support tourist circulation within and between attractions.

These three categories align with the key components of tourism infrastructure identified in the literature, collectively shaping the attractiveness and sustainability of tourist destinations (Corboş et al., 2025). Beyond their functional roles, these infrastructure types are understood not merely as static physical objects but as active forces that structure and reorganize the landscapes through which tourism operates (Adey & Lisle, 2025). In the context of Kuta Utara Subdistrict, the presence and density of these infrastructure elements serve as spatial indicators of tourism pressure, enabling the identification of areas where land-use competition with *Subak Yeh* is most acute.

c. Fieldwork-Based Data: Semi-Structured Interviews (Subak Actors)

To assess the implications of tourism pressure on the *Subak* system, structured interviews were conducted face-to-face with 31 respondents in Bahasa Indonesia, each lasting approximately 15 to 20 minutes. The respondents comprised representatives from 10 out of 18 *Subak* organizations in Kuta Utara Subdistrict, representing approximately 55.6% of the total *Subak* population in the study area. The selection of these 10 *Subak* was not random but purposively grounded in two criteria: first, ensuring that at least one *Subak* from each of the six villages (*kelurahan* and *desa*) within Kuta Utara Subdistrict was represented, capturing the spatial diversity of LULC conditions across the

subdistrict; and second, ensuring that the selected *Subak* covered the range of spatial planning zones designated under the Badung RDTR 2021, including areas designated as LP2B protected agricultural land, tourism zones, and mixed-use areas to enable a spatially representative assessment of how different regulatory contexts are experiencing tourism pressure. Each selected *Subak* was represented by one *Pekaseh (Subak* head organization) and two farmer members, ensuring both leadership-level and grassroots perspectives were captured across all ten units. A total of 17 questions were administered, consisting of a shared set of questions addressed to all respondents and an additional set directed exclusively at *Subak* heads, capturing both general member perspectives and leadership-level insights into land governance and institutional responses to LULCC (see *Annexes 8.4*).

To assess the perceived level of tourism pressure on the Subak system, respondents' answers related to impacts were categorized into three levels: minor, moderate, and major. These categories refer to the intensity of impact experienced by Subak members, where "minor" indicates limited or minimal effects on agricultural activities or Subak functioning, "moderate" reflects noticeable but manageable disruptions, and "major" represents strong impacts that significantly affect rice paddy land use conditions, farming practices, or Subak governance.

In addition, a separate set of categories was used to assess perceptions of spatial planning effectiveness as perceived by *Pekaseh*. These were classified as limited or ineffective, moderately important, and important or strong influence. The indications for these categories are as follows: "limited or ineffective" refers to spatial planning that is perceived as weakly implemented, poorly enforced, or having little observable influence on controlling land conversion and protecting Subak areas; "moderately important" indicates that spatial planning is present and exerts some influence, although its implementation or enforcement is inconsistent and its effectiveness in controlling land conversion is limited; and "important or strong influence" reflects spatial planning that is perceived as actively implemented, relatively well enforced, effective in guiding development patterns and protecting Subak areas from land conversion pressures.

The questions were developed directly from the research objectives, with each question designed to draw out information relevant to a specific aspect such as the impact of LULCC, tourism pressure, or *Subak* governance. The answer options were formulated drawing on two complementary sources: the author's lived experience as a Balinese native with lifelong familiarity with local LULC conditions and *Subak* practices, and a review of existing research conducted in Bali and the Kuta Utara area, which informed the range and framing of plausible responses (Budiasa et al., 2015; Lanya et al., 2017)(for detailed questionnaire see *Annexes 8.4*). This combination of insider knowledge and prior literature ensured that the answer options were rooted in local knowledge and aligned with existing literature. The majority of questions were closed or semi-closed in format. During the interviews, respondents were first encouraged to answer in their own words, with the prepared options used as a reference to identify the closest match. Where respondents had difficulty answering independently, the options were explained to facilitate their selection. A small number of open-ended questions were also included to capture biographical information, such as the respondent's length of tenure in their role. This approach allowed for systematic comparison across respondents while retaining flexibility to capture individual perspectives where relevant.

The author's positionality as a regional insider, born and raised in Bali, though not a direct community member of Kuta Utara Subdistrict is acknowledged as both an asset and a potential source of bias (Dwyer & Buckle, 2009). While cultural proximity facilitated rapport with participants and contextual sensitivity in data interpretation, reflexivity was maintained throughout the analytical process to ensure that interpretations remained grounded in participants' perspectives rather than the author's own assumptions, and that familiarity with the local context did not lead to overlooking divergent experiences.

d. Fieldwork-Based Data: Semi-Structured Interviews (Government Officials)

To complement the perspectives obtained from *Subak* actors, key informant interviews were conducted with three government officials involved in spatial planning and agricultural department in Badung Regency. These interviews aimed to capture institutional perspectives on LULCC, tourism development, and the governance and protection of *Subak* areas.

The interviews were conducted face-to-face in Bahasa Indonesia using a semi-structured format, guided by nine open-ended questions covering four thematic areas: (1) spatial planning and *Subak* integration, (2) policy implementation and enforcement, (3) LULCC and tourism pressure, and (4) coordination and community involvement. Each interview lasted approximately 15 to 20 minutes (see *Annexes 8.4.3*).

The selection of respondents followed a purposive sampling approach, targeting individuals with roles relevant to spatial planning and agricultural department. Due to differences in institutional responsibilities, not all questions were applicable to every respondent. Interviews were therefore conducted flexibly, allowing respondents to focus on topics aligned with their expertise.

Unlike the structured interviews conducted with *Subak* members, these interviews emphasized depth and contextual understanding. The data obtained were used to provide institutional insights and to complement findings from spatial analysis and *Subak*-level interviews, rather than to produce statistically generalizable results. These interviews are treated as supporting informant data and are analyzed separately from *Subak* interviews due to differences in institutional role and question applicability.

3.3.2. Secondary Data

a. Spatial Zoning Regulation Data

Spatial zoning regulation data in shapefile format were obtained from the Badung Regency Government through the Web-GIS Spatial Planning Portal (*SIMTARU*). Three spatial datasets are available from *SIMTARU* and were used in this study, covering three different periods of enactment:

1. Badung Regent Regional Regulation No. 26/2013 on the Regional Spatial Plan of Badung Regency for 2013–2033 (**Figure 3-4**)
2. Badung Regent Regulation No. 9/2021 on the Detailed Spatial Plan (RDTR) of Kuta Utara 2021–2041 (**Figure 3-5**)
3. Badung Regent Regional Regulation No. 04/2025 on the Regional Spatial Plan (RTRW) of Badung Regency for 2025–2045 (**Figure 3-6**)

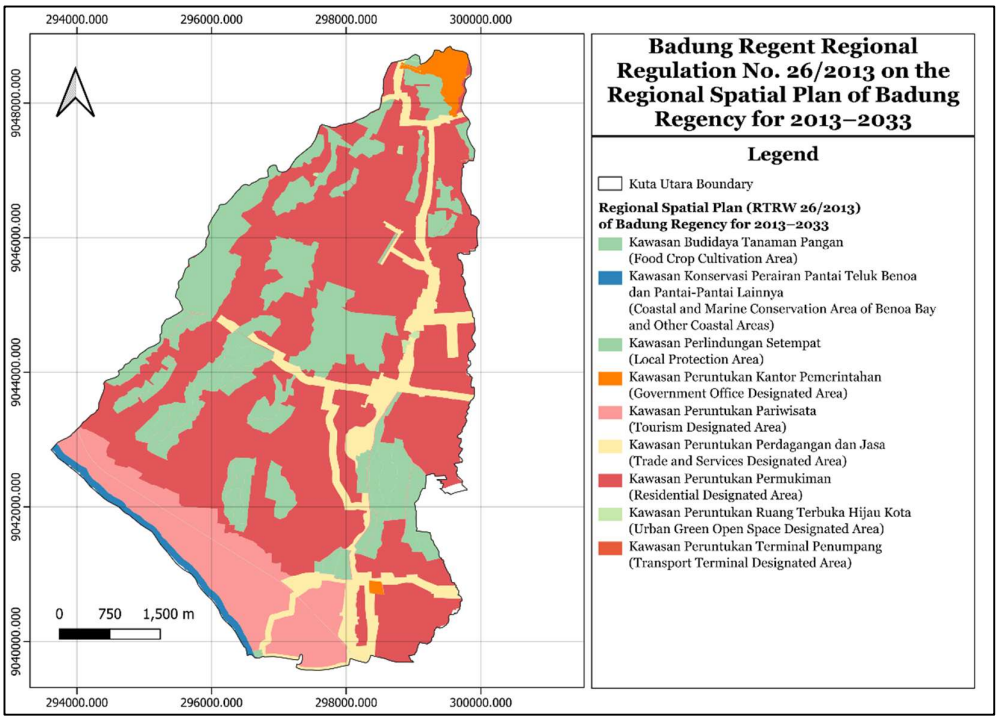


Figure 3-4

Map of spatial plan from Badung Regent Regional Regulation (RTRW) No. 26/2013 on the Regional Spatial Plan of Badung Regency for 2013–2033

Source: Adapted by author from Badung Regency Government (2025), RTRW 2025–2045 Regional Regulation Map.

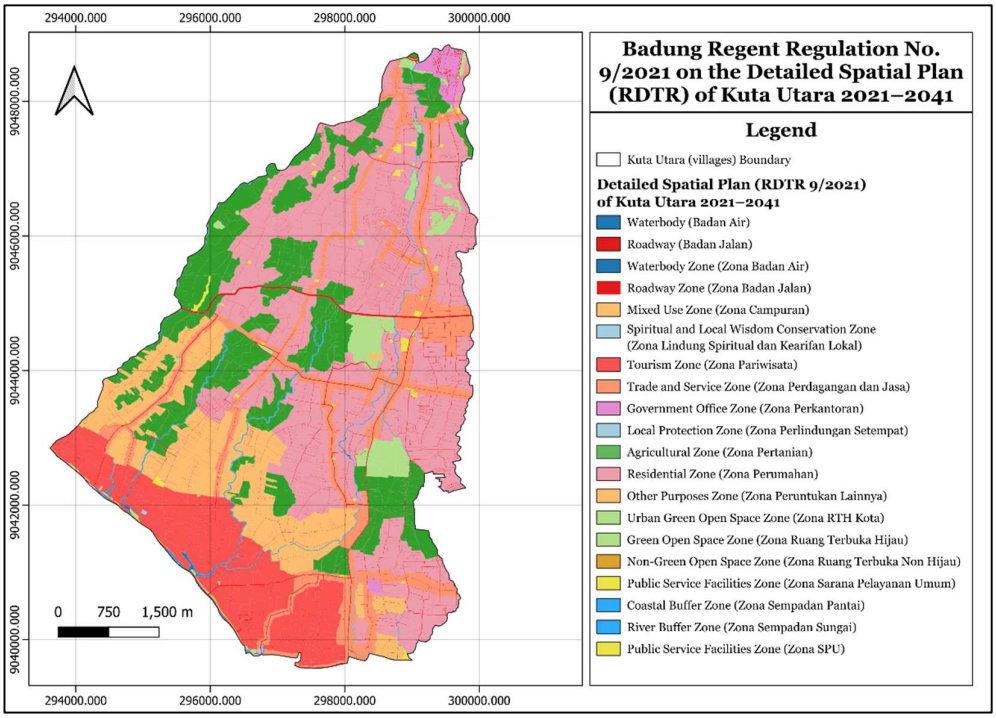


Figure 3-5

Map of spatial plan from Badung Regent Regulation No. 9/2021 on the Detailed Spatial Plan (RDTR) of Kuta Utara 2021–2041
Source: Adapted from Badung Regency Government (2021), RDTR of Kuta Utara 2021–2041 Map.

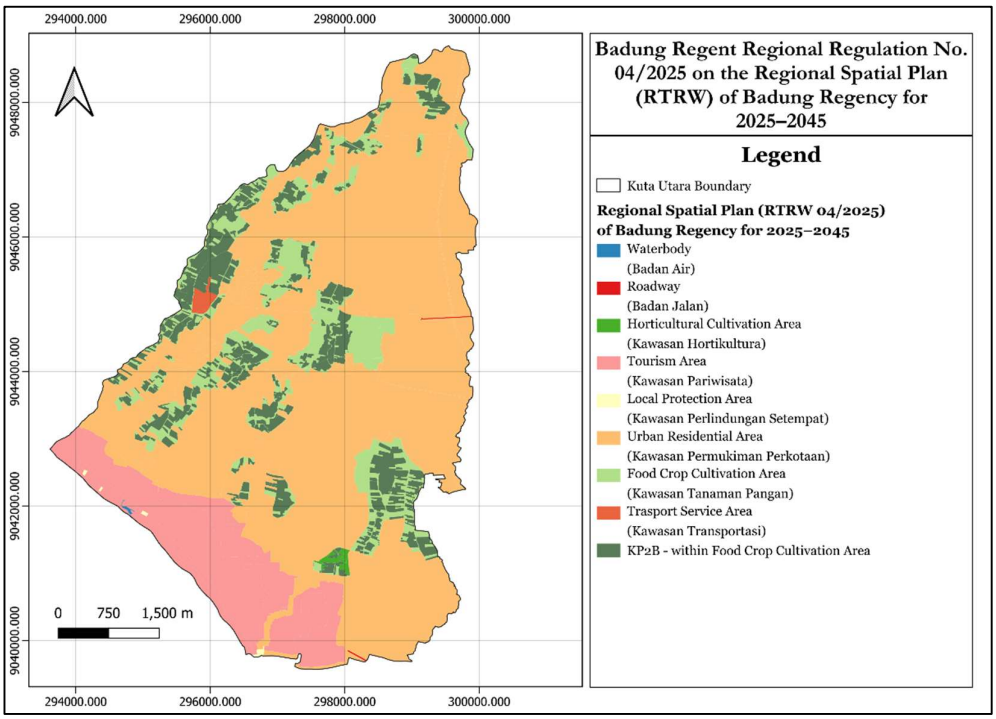


Figure 3-6

Map of spatial plan from Badung Regent Regional Regulation No. 04/2025 on the Regional Spatial Plan (RTRW) of Badung Regency for 2025–2045
Source: Adapted from Badung Regency Government (2025), RTRW 2025–2045 Regional Regulation Map.

These three datasets collectively span the period from 2013 to 2025 and reflect two governance levels, regency wide spatial plan (RTRW) and regency for detailed subdistrict spatial plan (RDTR), enabling a multi-period assessment of how zoning designations have evolved in relation to observed LULCC. The availability of zoning data from three distinct regulatory periods allows for an examination of how spatial planning provisions for agricultural land protection and tourism development have changed over time, and the degree to which observed rice paddy loss has occurred within or outside formally designated protection zones. This data forms a key input for the spatial overlay analysis conducted in **step 1** of the analytical framework (**Section 3.6**), where the digitized rice paddy datasets are overlaid against the corresponding zoning maps to assess the alignment between planned LULC and observed land transformation.

b. Policy Documents

A set of seven spatial planning policy documents was compiled across provincial and regency governance levels, covering the period from 2002 to 2025. These documents form the basis for the policy analysis conducted in **Step 2** and are listed in full in **Table 3-2**. Their selection was guided by the hierarchical structure of spatial planning governance in Indonesia, in which lower-level plans are required to conform to higher-level directives.

Table 3-2

Policy Documents included in the Content Analysis

Year	Regulation	Level
2005	Bali Provincial Regulation on Regional Spatial Plan (RTRW) No. 3/2005	Provincial
2009	Bali Provincial Regulation on Regional Spatial Plan (RTRW) No. 16/2009 for 2009-2029	Provincial
2013	Badung Regent Regional Regulation No. 26/2013 on the Regional Spatial Plan (RTRW) of Badung Regency for 2013–2033	Regency
2020	Bali Provincial Regulation No. 3/2020 (Amendment of Bali Provincial Regulation on Regional Spatial Plan (RTRW) No. 16/2009 for 2009–2029	Provincial
2021	Badung Regent Regulation No. 9/2021 on the Detailed Spatial Plan (RDTR) of Kuta Utara 2021–2041	Regency
2023	Bali Provincial Regulation No. 2 of 2023 on the Regional Spatial Plan (RTRW) of Bali Province for 2023–2043	Provincial
2025	Badung Regent Regional Regulation No. 04/2025 on the Regional Spatial Plan (RTRW) of Badung Regency for 2025–2045	Regency

3.3.3. Data pre-processing

All datasets were pre-processed to ensure spatial consistency and comparability. This included reprojection, clipping to match the defined study area, checking geometric consistency, removing overlaps, and correcting topological errors. A uniform coordinate reference system (EPSG:32750), was applied across all datasets to maintain consistency in spatial analysis and integration. All spatial processing was performed predominantly using QGIS software (QGIS.org, 2025).

Table 3-3

Datasets prepared or procured to be used for this research

Dataset	Source
Digitized Rice Paddy Kuta Utara 2002	Google Earth Pro Imagery Date 2002 (Author)
Digitized Rice Paddy Kuta Utara 2020	Google Earth Pro Imagery Date 2020 (Author)
Digitized Rice Paddy Kuta Utara 2025	Google Earth Pro Imagery Date 2025 (Author)
Subak Leader and Member Interview	Field Observation (Author)
Government Official Interviews (Spatial Planning and Agricultural Agency)	Field Observation (Author)
Gridded Tourism Point Survey	Field Observation (Author)
Designated Rice Paddy Land	Agricultural Department of Badung Province
Restricted Rice Paddy Land	Agricultural Department of Badung Province
Regional Spatial Plan (RTRW Bali) for 2009-2029	Government of Badung Regency (WebGIS Spatial Planning Portal – SIMTARU)
Regional Spatial Plan of Badung Regency for 2013–2033	Government of Badung Regency (WebGIS Spatial Planning Portal – SIMTARU)
Detailed Spatial Plan (RDTR) of Kuta Utara (North Kuta) 2021–2041	Government of Badung Regency (WebGIS Spatial Planning Portal – SIMTARU)

3.4. Analytical Framework

The analysis is structured into four sequential yet interconnected steps, each addressing a distinct dimension of the research problem while collectively building towards an integrated understanding of tourism-driven LULCC and its implications for the *Subak* system. **Figure 3-7** provides a visual overview of the analytical workflow. **Step 1** translates the spatial datasets into measurable evidence of land conversion through LULCC analysis, spatial overlay, and examination of the relationship between LULCC and tourism infrastructure distribution. **Step 2** then situates these spatial findings within their regulatory context, using policy content analysis of spatial planning documents to evaluate how observed patterns of land conversion align or conflict with the frameworks governing land use and agricultural land protection across governance levels. **Step 3** situates the spatial and policy findings within qualitative evidence derived from interviews with *Subak* members and government officials through thematic analysis. This step captures local perceptions of LULCC and organizational responses from *Subak* actors, as well as institutional perspectives on spatial planning, policy implementation, and governance challenges from government stakeholders. **Step 4** integrates the findings from **Steps 1** and **3** through cross-validation, comparing spatially observed patterns with qualitative insights to assess their consistency and to identify convergences and divergences that enrich the overall interpretation. Together, these steps reflect the mixed-methods logic of the study, in which spatial evidence, policy frameworks, and local knowledge are treated as complementary rather than competing sources of understanding.

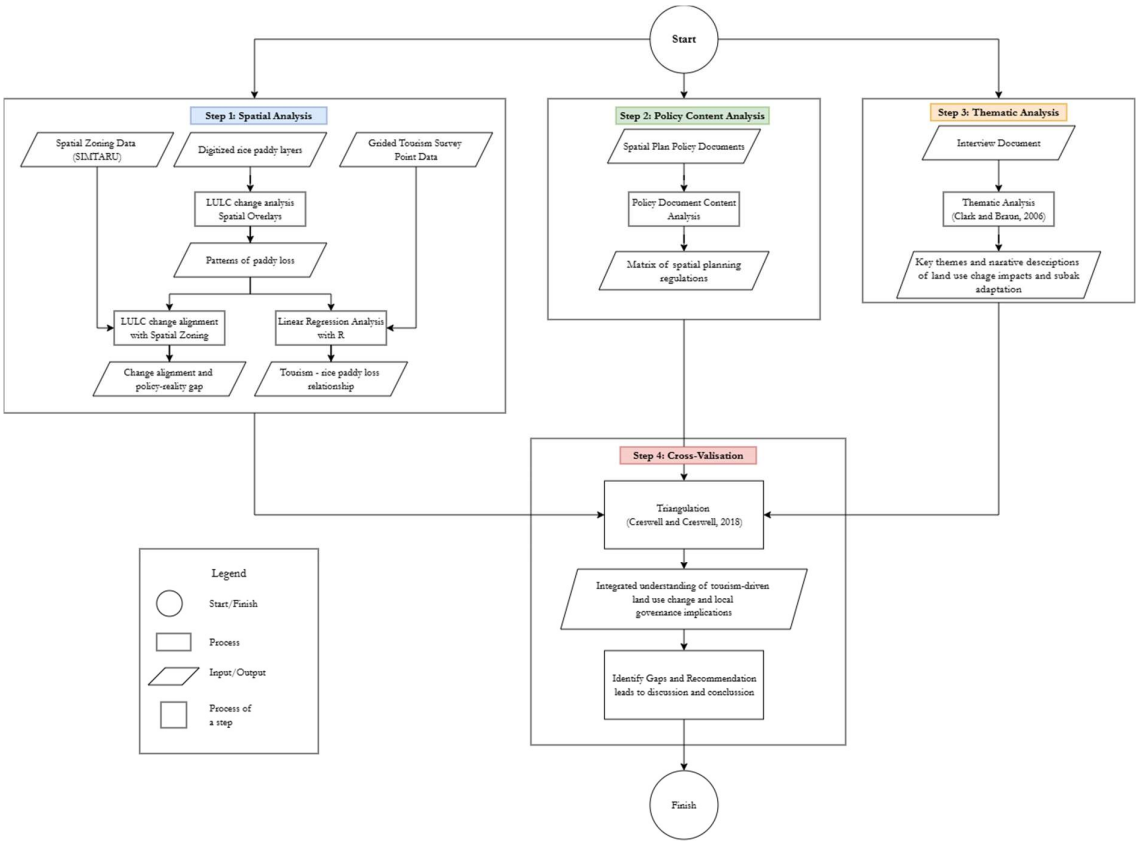


Figure 3-7
Methodology Workflow

3.5. Step 1: Spatial Analysis

The spatial analysis examines the extent, pattern, and trajectory of rice paddy loss in Kuta Utara Subdistrict over the period 2002–2025. This step forms the spatial core of the research and addresses the first research objective, and part of the second objective, by quantifying the extent and spatial patterns of tourism-driven LULCC. By translating digitized rice paddy datasets and field survey data into measurable indicators, the analysis provides empirical evidence of agricultural land conversion and its spatial relationship with tourism development and spatial planning zones.

The analysis is structured into three interconnected components, each corresponding to a specific analytical objective. First, a temporal assessment is conducted to quantify the magnitude and rate of rice paddy loss across three reference years (2002, 2020, and 2025), addressing the question of how rice paddy area has changed over time. Second, the spatial relationship between observed rice paddy loss and tourism development is examined, contributing to the objective of assessing whether tourism expansion is associated with rice paddy loss. Third, a spatial overlay analysis compares observed rice paddy loss with designated spatial planning zones, supporting the second research objective by evaluating the extent to which rice paddy losses aligns with spatial planning regulations.

Temporal changes in rice paddy extent were assessed using a spatial overlay approach. Rice paddy layers from different years were compared to identify areas of persistence and loss. The total extent of rice paddies was calculated for each year, and changes were quantified in hectares as well as percentage loss over time (**Table 4-1**). To ensure precise calculation of changes between periods, the Union operation from geoprocessing tools in QGIS was applied. This step addresses the objective of quantifying the scale and trajectory of agricultural land loss in Kuta Utara.

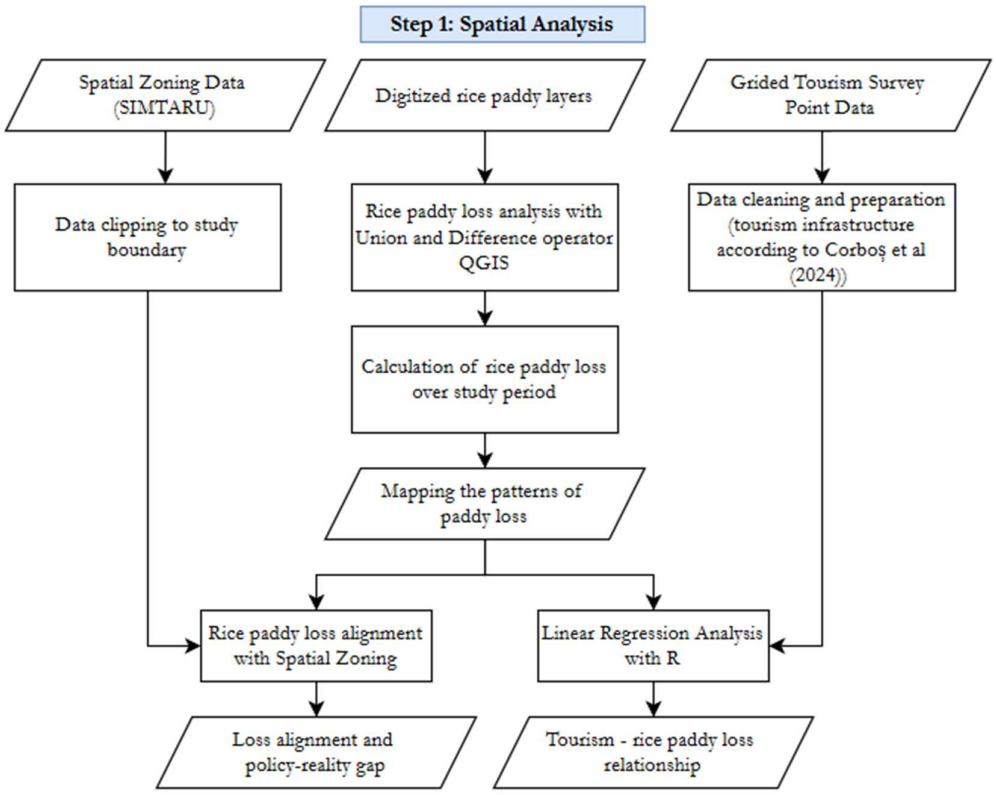


Figure 3-8
Workflow of operation of Step 1

Spatial patterns of rice paddy loss were analyzed through overlay and visual interpretation to identify the distribution and concentration of converted areas. This enabled the identification of spatial clusters and hotspots of land loss, particularly in areas experiencing rapid development. The trajectory of change was assessed by comparing spatial patterns across the three reference years.

To examine the relationship between rice paddy loss and tourism development, the spatial distribution of gridded tourism infrastructure derived from field surveys was overlaid with areas of rice paddy loss. It was hypothesized that areas with higher concentrations of tourism infrastructure would correspond to greater levels of rice paddy loss. To assess this relationship, a regression analysis was conducted using R (R Core Team, 2025), with rice paddy loss between 2002 and 2025 as the dependent variable and tourism infrastructure density within grid cells as the independent variable.

Furthermore, a spatial conformity analysis was conducted by overlaying observed rice paddy loss with spatial planning zones derived from relevant planning documents. This analysis focuses on the detailed spatial plan (RDTR), as it provides the most precise and operational zoning framework at the local level. The overlay identifies whether LULCC occurred within areas designated for agricultural use, protected agricultural land (e.g., LP2B), or tourism development zones. This step supports the evaluation of spatial planning effectiveness by assessing whether rice paddy land cover changes aligns with or deviates from formal zoning regulations.

All spatial analyses were conducted using QGIS software, including tools for spatial overlay, area calculation, and visualization. The outputs include maps of rice paddy distribution over time, maps of rice paddy loss, and spatial overlays illustrating the relationship between LULCC, tourism development, and spatial planning zones.

It is important to note that this analysis is limited to the detection of changes in rice paddy areas and does not capture the full range of LULC transitions. While the results provide robust evidence of agricultural land loss, the specific post-conversion LULC (e.g., tourism or residential use) is inferred primarily through spatial association rather than direct classification. Together, these analyses provide spatially explicit evidence that forms the basis for evaluating the role of tourism and the effectiveness of spatial planning policies in shaping LULCC in Kuta Utara.

3.6. Step 2: Policy Content Analysis

Building on the spatial patterns identified in **Step 1**, the policy analysis situates observed LULCC within their regulatory context by examining key spatial planning documents and regulations enacted between 2002 and 2025. The analysis aimed to evaluate how the extent and distribution of rice paddy loss align with or deviates from the frameworks governing land use, agricultural land protection, and tourism development in Kuta Utara. This step provides the institutional and governance context necessary to assess whether observed LULCC has occurred in compliance with, or in violation of, existing spatial planning instruments.

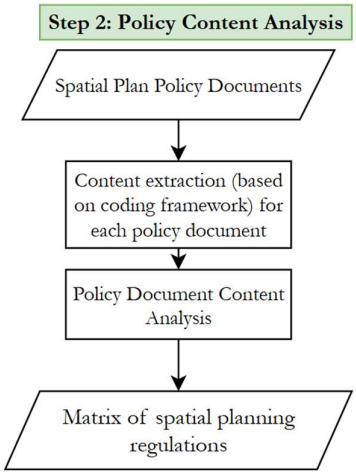


Figure 3-9
Workflow of operation of Step 2

The first step involved identifying a comprehensive set of policy documents across multiple governance levels, including provincial spatial plans, and regional (*Kabupaten*) spatial plans for Badung Regency. This multi-level selection was designed to capture the hierarchical structure of spatial planning governance in Indonesia, in which lower-level plans are required to conform to higher-level directives (as listed in **Table 3-2**) (Widiatedja, 2022). Content analysis was chosen as an appropriate method for this purpose, as it enables the inductive examination of official texts to form a typology grounded in the data, sort material into categories, and identify patterns, regulatory priorities, and changes in governance frameworks over time (Tunison, 2023).

Once assembled and prepared, each document was subjected to content analysis using a coding framework (**Table 3-4**) developed around the research objectives, focusing on five key aspects commonly addressed in Indonesian spatial planning documents.

Table 3-4
Coding framework for thematic analysis on Subak

Coding	Description
Zoning type	Designated land use for each area, such as residential, agricultural, tourism, or conservation
Agricultural land protection	Provisions aimed at preserving farmland, including rice paddies and *Subak* areas
Tourism promotion	Provisions of land purposely for tourism activity
Control measures	Looking for any restrictions linking to land conversion
Sanctions or enforcement mechanisms	Penalties or regulatory consequences for non-compliance

Relevant sections of each document were systematically read, and the relevant content was extracted and recorded in full for each of the five aspects. This extraction process produced detailed textual summaries for each regulation, capturing the specific language, provisions, and emphases found within each document. These detailed extractions were subsequently condensed into a comparative summary matrix (**Table 4-2**). This two-stage process, detailed extraction followed by structured condensation was conducted using Microsoft Excel, in which each policy document forms a row and the coding categories formed the column. This matrix structure ensured that the summary matrix remained grounded in the original textual evidence while enabling systematic comparison across documents and governance levels (Tunison, 2023).

3.7. Step 3: Thematic Analysis

Thematic analysis is a widely used approach for analyzing qualitative data, offering a systematic yet flexible way to identify, examine, and report recurring patterns or themes within a dataset (Braun & Clarke, 2006). Unlike more prescriptive qualitative methods, thematic analysis does not require alignment with a particular theoretical framework, making it well-suited to mixed-methods research where qualitative findings need to be interpreted alongside spatial and policy evidence (Braun & Clarke, 2006). This method was applied to data collected through semi-structured interviews from two distinct respondent groups: *Subak* members and government officials. The analysis was designed to capture both community-level experiences of LULCC and institutional perspectives on spatial planning and governance responses as explained below.

3.7.1. *Subak* Interview Analysis

Given the structured nature of the interview instrument, which consisted predominantly of closed and semi-closed questions with pre-prepared answer options, a thematic analysis that following a directed approach was adopted. This approach was chosen because the analysis was guided by the research questions and the coding categories embedded in the instrument rather than emerging freely from unstructured narratives (Hsieh & Shannon, 2005). The primary analytical material consisted of response patterns across a total of 17 questions drawn from both respondent groups *Subak* organizational board members and farmer members covering observations of land conversion impacts, organizational responses, and perceptions of land use conversion. These structured responses were complemented by audio recordings captured through koboToolbox web application (Kobo Inc., n.d.) and field notes during the interviews, which preserved elaborations, contextual remarks, and observations that extended beyond the pre-prepared answer options. This combination allowed for both systematic comparison across respondents and the retrieval of richer contextual insights where relevant.

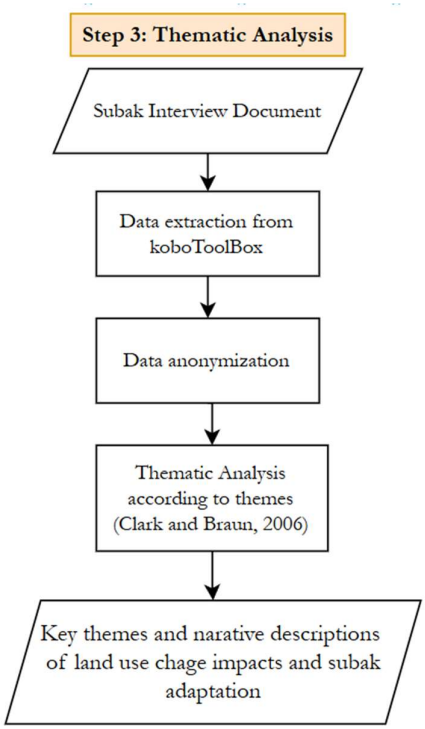


Figure 3-10
Workflow of operation of Step 3

The analysis adapted the phases proposed by Braun and Clarke (2006). In the familiarization phase, response data and interview recordings were reviewed to identify initial patterns across the 31 respondents within the 10 *Subak* organizations. In the coding phase, responses were grouped according to the coding categories established in the instrument. Codes were then reviewed and organized into five themes that directly address the research questions: (1) Impacts on *Subak* Functioning, (2) Drivers of Land Conversion, (3) Organizational Responses and Adaptation, (4) Perceptions of Future Impacts, and (5) the Role of Spatial Planning. Each theme was reviewed to ensure internal coherence and meaningful distinction from the others and was defined to capture both the frequency of responses and the qualitative patterns observed across respondent types and *Subak* locations (**Table 4-3**). Throughout the process, reflexivity was maintained to ensure that interpretations remained grounded in respondents' perspectives rather than the researcher's assumptions, and that the author's insider familiarity with Balinese *Subak* practices did not lead to overlooking divergent or unexpected responses.

3.7.2. Government Official Interview Analysis

For government officials, interviews were conducted using a semi-structured format with open-ended questions. In contrast to the *Subak* interviews, no predefined coding categories were applied during data collection This approach was chosen because the small number of respondents (3 officials) and their differing institutional roles made a flexible, narrative-based approach more appropriate than a structured coding framework, allowing the conversation to follow the specific institutional knowledge and experience of each respondent rather than constraining responses to predetermined categories (Patton, 2015). These interviews focused on institutional perspectives related to spatial planning, policy implementation, land use regulation, and governance challenges in managing agricultural land conversion. Each interview was reviewed and coded based on recurring concepts and meanings rather than structured response options.

Given the small number of respondents and their differing institutional roles, not all interview questions were answered uniformly. The analysis therefore focused on synthesizing key institutional themes rather than comparing responses across individuals. Although *Subak* and government interviews were analyzed separately due to differences in structure and purpose, the results were later integrated. Government interview findings were incorporated where relevant to support and contextualize the analysis. This integration ensured that community-level experiences and institutional perspectives could be interpreted in relation to one another.

3.8. Step 4: Cross Validation

The fourth and final analytical step integrates the findings from the preceding spatial and qualitative analyses to produce a more comprehensive and internally consistent understanding of tourism-driven LULCC in Kuta Utara Subdistrict. Cross-validation in this context does not refer to a statistical procedure but rather to a methodological strategy of triangulation, in which evidence derived from different data sources and analytical approaches is compared to assess the consistency, convergence, or divergence of findings (Creswell & Creswell, 2018). Specifically, this step brings together the spatially measured patterns of rice paddy loss and tourism infrastructure distribution identified in **Step 1** with the local perceptions, institutional experiences, and governance responses documented through the thematic analysis in **Step 3**. The policy findings from **Step 2** provide the regulatory context within which this spatial-qualitative correspondence is interpreted, enabling an assessment of whether observed gaps between spatial reality and local perception reflect broader failures of planning governance.

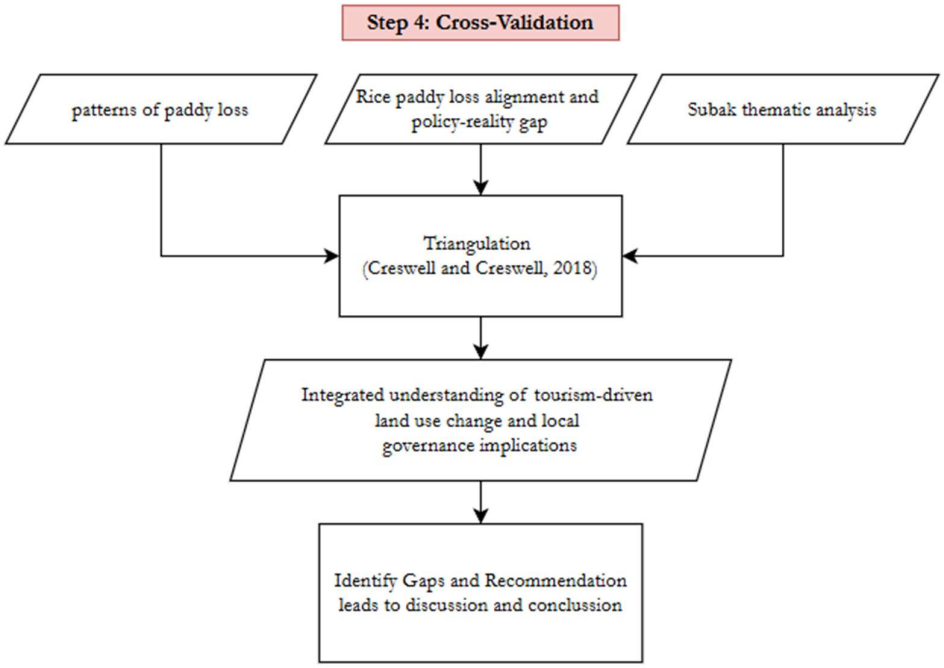


Figure 3-11
Workflow of operation of Step 4

The comparison between these three strands of evidence allows for an assessment of how observed rice paddy land conversions relate to formal spatial planning regulations and how both correspond to local and institutional interpretations of LULCC processes. Cross-validation proceeds by spatially mapping the correspondence between measured conversion intensity as documented in the spatial change analysis and the severity of impacts and planning perceptions reported by *Subak* organizations across the ten surveyed units. As an example, where spatial evidence and local perceptions converge for instance, where areas of high measured paddy loss correspond to *Subak* reporting the greatest institutional pressure and the strongest perceptions of planning ineffectiveness, this convergence strengthens the reliability and interpretive validity of both sources of evidence.

In instances of divergent findings, where the spatial framing of paddy loss as an agricultural metric does not capture the cultural and spiritual dimensions of loss described by *Subak* members, these divergences are treated as analytically productive, revealing dimensions of the research problem that no single method could capture alone. This integrative step ultimately enables the research to move beyond descriptive documentation of LULCC towards a more comprehensive and spatially grounded understanding of how tourism-driven conversion is experienced, perceived, and governed at the community level.

3.9. Ethical Considerations

Conducting research involving local communities, particularly *Subak* members and stakeholders affected by LULCC, requires careful attention to ethical principles throughout the research process. Central to this study was the principle of informed consent. Prior to any data collection, participants were provided with clear information about the study's

aims, methods, expected outcomes, voluntary nature of participation, confidentiality measures, and their right to withdraw at any time without consequence. This information was delivered in Bahasa Indonesia to ensure full understanding. Informed consent was obtained from all participants, ensuring that they understood the purpose of the study and agreed to participate voluntarily.

Anonymity and confidentiality were treated as a priority. All collected data, including interview recordings and notes, were anonymized at the earliest stage of processing. Pseudonyms were used in transcripts and reports, and any potentially identifying information was removed. Spatial data used in the study, particularly those related to LULC and tourism infrastructure, were analyzed and presented in aggregated form to avoid identifying specific individuals, landowners, or sensitive locations. All digital data were stored securely on password-protected devices and university servers, in line with institutional data management policies and relevant data protection regulations.

Potential risks to participants were carefully considered and minimized. These included possible discomfort when discussing LULCC, tourism pressures, or institutional challenges related to the *Subak* system. To reduce these risks, interviews were conducted in a respectful and flexible manner, allowing participants to skip questions or stop the interview at any time. Interviews were arranged at convenient times and locations, ensuring a comfortable and safe environment for participants.

Attention was also given to the relationship between the researcher and participants. Care was taken to ensure that participants felt comfortable expressing their views openly, without pressure or influence. The research design followed ethical guidelines established by the University of Twente, ensuring appropriate oversight and accountability. Finally, efforts toward reciprocity included sharing summarized and anonymized findings with relevant stakeholders, with the aim of contributing to better understanding and management of LULCC in Kuta Utara.

3.10. Methodological Limitations

This study explored how tourism-driven LULCC has reshaped agricultural areas in Kuta Utara Subdistrict, and how these changes are experienced by local traditional land governance systems, particularly the *Subak*, using a mixed-methods approach. However, its design, execution, and data sources have several limitations, meaning the findings cannot be widely generalized and should be interpreted with caution, but they do point to areas for future research.

The primary data collection included 10 out of 18 *Subak* organizations in Kuta Utara Subdistrict, representing approximately 55.6% of the total *Subak* population in the study area, with a total of 31 participants. This level of coverage is considered adequate for a mixed-methods case study and provides a reasonably representative basis for examining LULCC experiences and institutional responses across the subdistrict. However, the selection of *Subak* was purposive, based on village representation and spatial planning contexts, which may introduce selection bias. The remaining eight *Subak* not included in the sample were excluded primarily due to time and access constraints during the fieldwork period rather than systematic exclusion. As a result, while the findings provide substantial coverage of the subdistrict, some variation in experiences across all 18 *Subak* systems may not be fully captured.

The spatial representation of tourism infrastructure also presents limitations. The selected data covers approximately 18.46% of the total study area, based on village representation and available zoning data. While this approach ensures some spatial coverage, it may not fully reflect the overall distribution and intensity of tourism development across Kuta Utara. In addition, the identification and classification of LULCC, namely rice paddy areas, rely partly on manual digitization and interpretation, which may introduce subjectivity and potential classification errors.

The study also relies on secondary data sources, including digital spatial zoning and spatial planning documents. These datasets may contain inconsistencies in classification, resolution, or temporal coverage, which can affect the accuracy of the spatial analysis. Similarly, policy documents may vary in detail and clarity, and interpreting them requires careful judgment, which may introduce some level of subjectivity.

Qualitative data is based on self-reported information from interviews, which may be influenced by personal perceptions, recall bias, or social desirability. While thematic analysis provides a structured way to interpret these responses, it does not fully eliminate these limitations. In addition, differences in background, roles, and experiences among *Subak* members may not be fully captured due to the limited sample size.

Furthermore, the cross-validation between spatial analysis and interview findings is interpretative in nature. While this approach helps to link observed LULCCs with local experiences, it does not establish direct causal relationships between tourism development, policy implementation, and impacts on the *Subak* system.

Finally, this study focuses specifically on Kuta Utara Subdistrict. While this allows for an in-depth case study, the findings may not be directly transferable to other regions in Bali or other tourism contexts with different social, environmental, and governance conditions.

These limitations were considered during data interpretation and in the development of conclusions and recommendations. They highlight the need for further research with broader spatial coverage, larger samples, and longitudinal approaches to better understand the long-term impacts of tourism-driven LULCC.

3.11. Research Matrix

Table 3-5 presents the research matrix, which summarizes the analytical structure of this study by mapping each research objective and its corresponding research questions against the data sources, collection methods, and analytical approaches employed, providing a concise overview of how the methodology presented in this chapter is structured to address the research objectives.

Table 3-5
Research Matrix used for this research

Goal/Objective	Research Questions	Data Needed	Collection Method	Analysis Method
Objective 1: Quantify the extent and patterns of tourism-driven rice paddy loss in Kuta Utara Subdistrict from 2002 to 2025.	What are the spatial patterns of rice paddy loss in Kuta Utara Subdistrict?	Digitized rice paddy area of 2002, 2020 and 2025	- Primary Data Collection - Manual rice paddy area digitization	- Spatial data preprocessing (projection, classification consistency) - Change detections - Rice paddy loss calculation
	To what extent is tourism development associated with these changes?	- Digitized rice paddy area of 2002, 2020 and 2025 - Gridded tourism infrastructure point data	- Primary Data Collection - Manual rice paddy area digitization - Field data collection	- Linear regression analysis using R of 2025 digitized rice paddy area with tourism point data - Overlay analysis - Observation notes
Objective 2: Evaluate how rice paddy loss aligns with spatial planning regulations in Bali.	What key spatial planning laws and regulations have been placed between 2002 and 2025?	Law and or regulations of spatial planning from 2002 – 2025 related to study area	- Secondary data collection	- Policy content analysis - Descriptive policy review - Extraction of zoning categories and land use rules
	How have the observed rice paddy loss aligned with spatial planning regulations?	- Digitized rice paddy area of 2002, 2020 and 2025 - Gridded tourism infrastructure point data - Digital spatial zoning map	- Primary and Secondary data collection - Spatial data preprocessing - Integration of datasets	- GIS overlay of rice paddy loss with zoning categories of available spatial plan - Quantification of conversion within protected vs non-protected zones - Policy compliance analysis (policy–reality gap)
Objective 3: Investigate the consequences of land use change on local land governance systems, especially on the *Subak* System.	How do *Subak* leaders and members describe the impacts of land conversion on the functioning of *Subak* system practices?	Interview data of *Subak* Head Organisations and its member(farmer)	- Field data collection - Semi-structured interview collected with KoboToolbox app	- Thematic analysis (closed-ended impact of tourism pressure response) - Identification of key impact themes
	How have the *Subak* organizations and their members responded or adapted to land use change pressures?	Interview data of *Subak* Head Organisations and its member(farmer)	- Field data collection - Semi-structured interview collected with KoboToolbox app	- Transcription - Thematic analysis (closed-ended organizational adaptations response) - Identification of key adaptation themes
Objective 4: Examine how spatial patterns of land conversion intersect with community perceptions and governance practices under tourism pressures.	In what ways do local perceptions of land conversion correspond to observed spatial trends in land use and land cover changes?	- Outputs from Objective 1 (spatial patterns) - Outputs from Objective 3 (interview themes) - Outputs from government official interview analysis	Data integration	- Discrepancy analysis (GIS + qualitative comparison) - Identification of governance gaps - Triangulation of spatial, policy, and interview data

4. RESULT

This chapter presents the findings of the study on the relationship between tourism development and LULCC in Bali. It reports the results of spatial and qualitative analyses, highlighting patterns of rice paddy land conversion and their association with tourism growth. The chapter also presents findings on how these changes affect the functioning of the *Subak* system.

4.1. Rice paddy loss in Kuta Utara (2002–2025)

Rice paddy loss in Kuta Utara was analyzed based on digitized rice paddy data derived from multi-temporal spatial datasets, as described in the methodology section. By comparing the spatial extent of rice paddy fields between 2002, 2020 and 2025, the analysis identifies the magnitude and spatial distribution of rice paddy loss over time.

4.1.1. Temporal patterns of rice paddy decline

The spatial analysis reveals a dramatic and sustained decline in rice paddy coverage across Kuta Utara Subdistrict over the study period, coinciding with the rapid expansion of tourism infrastructure throughout the area. **Table 4-1** summarizes the temporal changes in rice paddy extent in Kuta Utara Subdistrict between 2002, 2020 and 2025. The total area declined approximately from 1,684 hectares in 2002 to 671 hectares in 2020, and further to 438 hectares in 2025, representing a cumulative loss of approximately 1,246 hectares or 74% of the original rice paddy area.

To better understand the spatial dynamics underlying these changes, a union operation analysis was conducted in QGIS to compare rice paddy distributions across time periods. This approach enabled the classification of land into stable, loss, and gain categories by identifying areas that remained unchanged, were converted out of rice paddy, or were newly classified as rice paddy.

The results show that between 2002 and 2020, approximately 1,034.73 hectares were lost, while only approximately 21.88 hectares were gained. A similar pattern is observed between 2020 and 2025, where losses (249 hectares) far exceed gains (16 hectares), resulting in continued net decline. Despite the overwhelming trend of conversion, the presence of minor gains suggests localized or temporary LULCCs, which will be further explored in the discussion section.

Table 4-1

Rice Paddy Area and Loss in Kuta Utara Subdistrict (2002–2025) (approximation in hectares)

Year	Total Area (ha)	Stable (ha)	Loss (ha)	Gain (ha)	Net Change (ha)	% Change
2002	1,684.27	-	-	-	-	-
2020	671.42	649.54	1,034.73	21.88	-1,013	-60.15%
2025	438.71	422.78	249.37	16.92	-233	-34.73%

Note: rice paddy loss reflects a multi-directional land use transition, including conversion to other agricultural types, land abandonment, and speculative land holding practices, with only partial direct conversion to built-up areas.

An examination of the spatial distribution of rice paddy loss across the study period reveals a clear directional pattern of conversion, progressing from the southern coastal areas of Kuta Utara Subdistrict towards the northern inland zones over time. Between 2002 and 2020, the most significant losses were concentrated in the southern parts of the subdistrict, particularly in villages in close proximity to the coastline such as Canggu, Tibubeneng and Kerobokan Kelod where the earliest and most intensive tourism development took place. By 2025, this pattern of conversion had extended progressively northward into areas that had previously retained active rice paddy coverage, suggesting a spatial diffusion of tourism-driven LULCC pressure from the coast inland over time (see **Figure 4-1**).

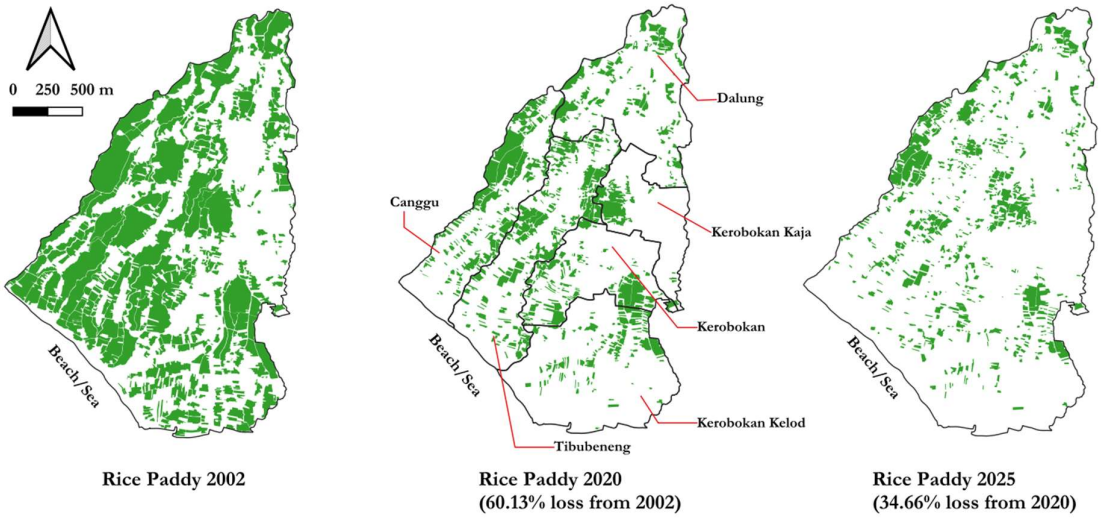


Figure 4-1
Pattern of digitized rice paddy over 23 years in Kuta Utara.

This spatial pattern carries important implications for the remaining rice paddy areas in Kuta Utara. The northern villages, which currently retain a greater proportion of active *Subak Yeh*, could face intensifying conversion pressure in the coming years as the southward wave of tourism development continues its inland trajectory. Without proactive spatial planning interventions specifically targeted at these transitional zones, the subdistrict may undergo rapid agricultural land conversion, similar to what has already occurred in the southern areas. It is important to note, however, that this loss does not represent a straightforward or uniform conversion of rice paddies to built-up land uses, further discussed in discussion section.

4.1.2. Spatial distribution of tourism infrastructure

A gridded tourism infrastructure survey (see **Figure 3-3**) was used to analyze the intensity and spatial distribution of tourism development in Kuta Utara Subdistrict. The survey recorded a total of 2109 tourism facilities across the 25 grid units, distributed across three primary categories: accommodation (1785 facilities), food and beverage services (282 facilities), and transport and mobility services (42 facilities). These figures represent the tourism infrastructure captured within approximately 18.46% of the total study area.

The results show a strong concentration of tourism infrastructure in the three key villages of Canggu, Tibubeneng, and Kerobokan Kelod, where 1,586 out of 2109 recorded tourism points are located (**Figure 4-3**). This clustering shows that tourism development is not evenly distributed across Kuta Utara but is instead spatially concentrated in areas that are already well-established tourism hubs. When compared with the spatial pattern of rice paddy loss from 2002 to 2025 (**Figure 4-2**), a clear overlap emerges. The same villages that exhibit the highest density of tourism infrastructure also correspond to areas with the most significant agricultural land conversion.

Chart below (**Figure 4-3**) illustrates the relationship between rice paddy land loss between 2002 and 2025 and the tourism infrastructure in Kuta Utara for 2026. Villages such as Tibubeneng, Canggu, and Kerobokan Kelod show high levels of both paddy field conversion and tourism development, indicating strong tourism pressure on agricultural land. In contrast, Kerobokan Kaja and Dalung experienced relatively lower changes compared to Kerobokan Kelod, Tibubeneng and Canggu.

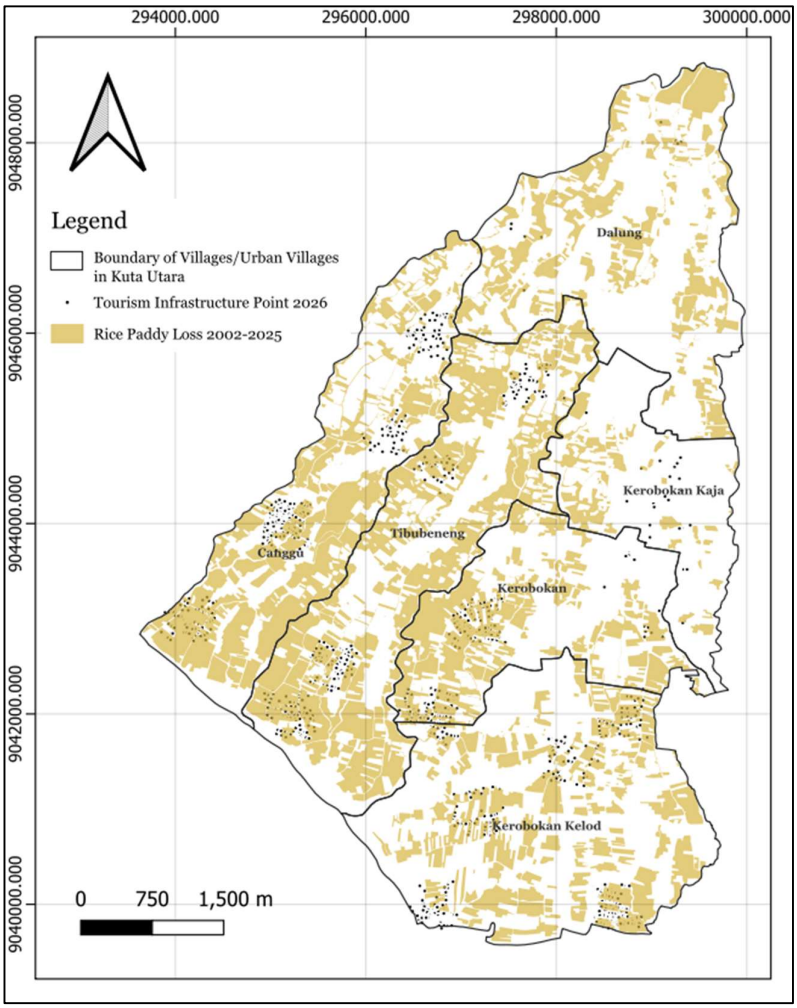


Figure 4-2
Spatial patterns of tourism infrastructure points in 2026 overlaid on rice paddy area loss from 2002-2025

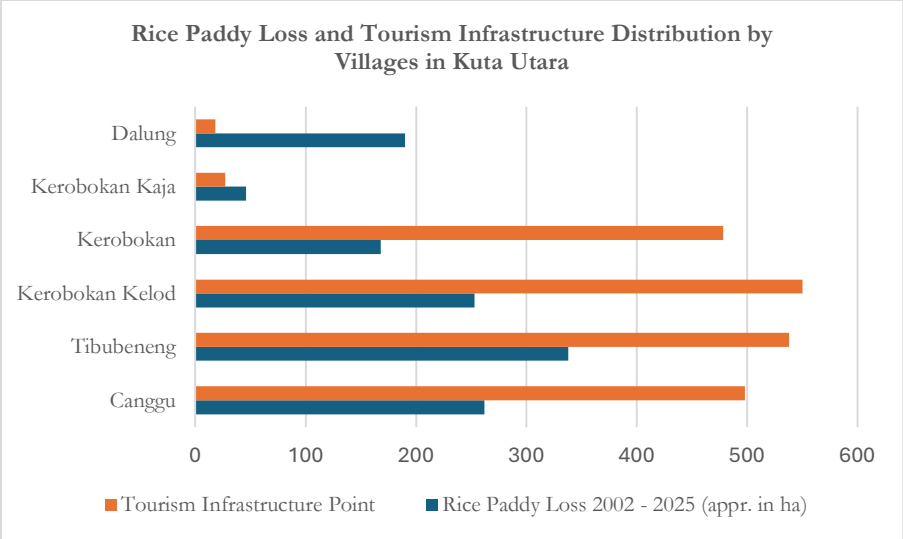


Figure 4-3
Chart of rice paddy loss and tourism infrastructure distribution by villages in Kuta Utara

4.1.3. Statistical relationship between tourism density and paddy loss

The spatial relationship between tourism infrastructure density and rice paddy loss was examined using a linear regression analysis in R, based on 2025 digitized rice paddy loss data (derived from 2002–2025 land-use change) and tourism point density aggregated at the grid level. The results indicate a statistically significant positive association between tourism infrastructure density and rice paddy loss ($R^2 = 0.544$, $F(1, 23) = 27.44$, $p < 0.001$), with tourism infrastructure density explaining approximately 54% of the spatial variation in rice paddy loss across the surveyed grid units. The regression coefficient ($\beta = 0.053$) suggests that each additional tourism facility within a grid unit is associated with an average increase of approximately 0.053 hectares of rice paddy loss, representing a small per-unit effect that becomes substantial in areas of high tourism concentration.

The intercept value (4.80) indicates that a baseline level of rice paddy loss is present even in grid cells without recorded tourism facilities, suggesting that LULCC processes are not solely driven by tourism development but also reflect other underlying dynamics such as land speculation, agricultural abandonment, and broader urban expansion pressures. While the model demonstrates moderate explanatory power, the remaining 46% of unexplained variance suggests that tourism infrastructure density does not fully account for observed patterns of rice paddy loss. These findings provide statistically grounded support for the hypothesis that tourism development is a significant spatial driver of agricultural land conversion in Kuta Utara.

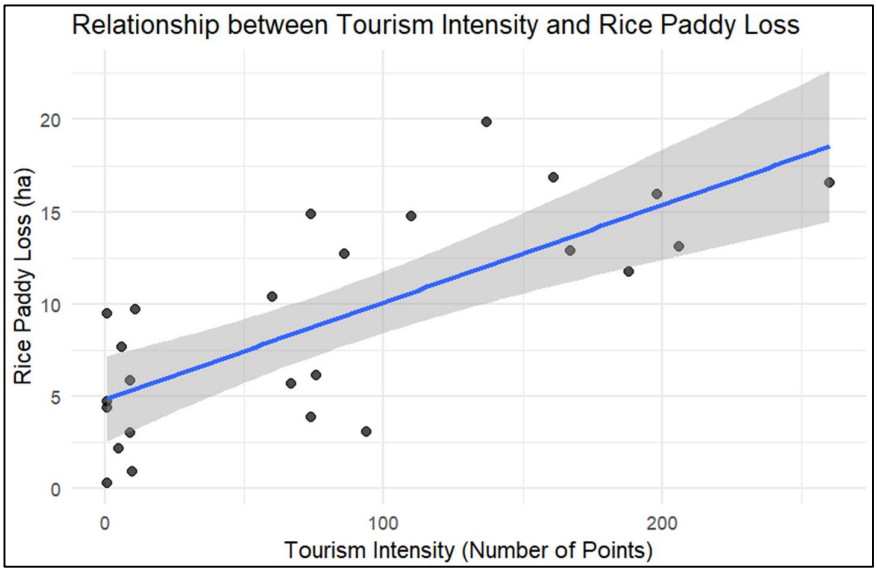


Figure 4-4
Scatterplot and linear regression of tourism intensity versus rice paddy loss at grid level

Field observations in Kuta Utara (Canggu, Tibubeneng, Kerobokan, and Kerobokan Kelod) show that tourism facilities are frequently located adjacent to Subak rice field areas (see **Figure 5-3**). Villas, cafés, and short-term accommodations were commonly observed along agricultural boundaries. Several plots also showed signs of partial conversion, including ongoing construction, land clearing, or abandoned paddy fields.

Together, the statistical analysis, spatial pattern, and field observations present a consistent and mutually reinforcing picture of accelerating tourism-driven land use change in Kuta Utara Subdistrict. Between 2002 and 2025, the subdistrict lost approximately 74% of its 2002 rice paddy coverage, a transformation that has unfolded alongside the rapid proliferation of tourism infrastructure and is now extending its frontier northward into previously less affected *Subak* areas. The following section examines how this observed pattern of LULCC aligns with or diverges from the spatial planning regulations enacted to govern land use of Kuta Utara over this period.

4.2. Spatial planning regulations and observed land use change

Building on the spatial patterns of rice paddy loss identified in Section 4.1, this section examines how successive spatial planning instruments have governed land use in Kuta Utara Subdistrict and the extent to which these instruments have translated into effective agricultural land protection on the ground. The analysis draws on seven spatial planning

documents issued between 2002 and 2025, along with three regency-level zoning maps (Badung RTRW 2013–2033, Badung RDTR 2021–2041, and Badung RTRW 2025–2045), which are assessed against observed rice paddy changes over corresponding periods. Full coding and document-level extraction are provided in the Annexes, while **Table 4-2** presents a summary of the full analysis.

The table summarizes the results of the content analysis of spatial planning policies in Kuta Utara from 2005 to 2025. It compares seven spatial planning instruments using five analytical categories: zoning type, agricultural land protection, tourism promotion, control strength, and sanctions. The table shows how each policy allocates land for agriculture and tourism, how strongly agricultural land is protected, and how strictly land use is regulated. It also highlights changes in regulatory approaches over time, particularly in relation to the strengthening or weakening of enforcement mechanisms and land protection measures.

Table 4-2
Content Analysis Summary of Spatial Planning Regulations Across Governance Levels (2002–2025)

Policy	Year	Level	Zoning Type	Agricultural Land Protection	Tourism Promotion	Control Strength	Sanctions
Bali Provincial Regulation on Regional Spatial Plan (RTRW) No. 3/2005	2005	Provincial	Functional zoning (protected–development structure) with multiple sector-based land-use allocations including agriculture and tourism.	Agriculture area covers 228,153 hectares (40.3%) with wetland rice areas accounting for 82,095 hectares (14.56%) protected through general strategy.	Tourism area covers 99,226 hectares, with 12,497 hectares (2.2%) allocated for intensive tourism development. The detailed spatial distribution is not specified.	Control through supervision and enforcement, including reporting, monitoring, and evaluation.	The regulation enforces compliance through administrative and criminal sanctions.
Bali Provincial Regulation on Regional Spatial Plan (RTRW) No. 16/2009 for 2009-2029	2009	Provincial	Functional zoning (protected–development structure) with multiple sector-based land-use allocations including agriculture and tourism.	Agricultural designated areas cover 298,214 hectares (52.9%) with LP2B designated for 76,337 hectares; 13.5%.	Tourism area designated through different categories with effective tourism utilization areas covering 12,512 hectares (2.3%)	Control is implemented through zoning regulations, licensing systems, incentives and disincentives, and institutional coordination.	The regulation enforces compliance through administrative, criminal, and civil mechanisms.
Badung Regent Regulation No. 26/2013 on the Regional Spatial Plan of Badung Regency for 2013–2033	2013	Regency	Functional zoning (protected–development structure) with multiple sector-based land-use allocations including agriculture and tourism.	Agricultural areas occupy 21,060.89 ha (50.32%) with food crop zone designated area of 9,737.42 ha; 23.27%. Protection includes *Subak* based food crop area as LP2B area.	Tourism areas cover 3,515.41 ha (8.40%) with development concentrated in Kuta and South Badung, particularly in Canggu, Tibubeneng, and Kerobokan.	Control is structured through zoning regulations, licensing, incentives and disincentives, and sanctions by Regent through Regional Spatial Planning Coordination Board (BKPRD)	Enforcement system combines administrative, criminal, and disciplinary sanctions.
Bali Provincial Regulation Number 3 of 2020 on Amendments to Provincial Regulation Number 16 of 2009 on the Bali Provincial Spatial Plan (RTRW) for the Period 2009–2029	2020	Provincial	Functional zoning (protected–development structure) with multiple sector-based land-use allocations including agriculture and tourism.	Agricultural areas occupy 293,723 ha (52.50%), with designated Sustainable Food Agricultural Land Area (KP2B) covering 67,668 ha (12.10%) to support food security.	Tourism areas cover 39,369 ha with particular emphasis on coastal zones such as Badung regency.	Control is implemented through zoning, permitting, incentives/disincentives, and sanctions directives. Explicit restriction on agricultural land conversion.	The regulation does not clearly specify sanction mechanisms.
Badung Regent Regulation No. 9/2021 on the Detailed Spatial Plan (RDTR) of Kuta Utara 2021–2041	2021	Regency	Specify detailed zoning at the sub-subdistrict level, including agricultural zones with subzones such	LP2B explicitly mapped (≈526.95 ha)	Clearly defined tourism zones (≈416.16 ha)	Detailed zoning control instruments, including land use regulations, development intensity (e.g.,	Enforcement by local government following the applicable laws

			as food crop areas, and tourism zones.			building density and scale), building regulations, infrastructure requirements, and specific zoning rules.	and regulations without detailed sanction.
Provincial Regulation of Bali No. 2 of 2023 on the Regional Spatial Plan (RTRW) of Bali Province for 2023–2043	2023	Provincial	Functional zoning (protected–development structure) with multiple sector-based land-use allocations including agriculture and tourism.	Agricultural areas cover 300,411 ha with KP2B designated at 53,663 ha	Tourism areas cover 38,358 ha defined by tourism attraction potential and capacity for facility development.	Control is implemented through zoning directives, monitoring and evaluation, incentives/disincentives, and sanctions.	Apply administrative sanctions for spatial violations, supported by criminal penalties
Badung Regent Regulation No. 4/2025 on (RTRW) Regional Spatial Plan of Badung Regency for 2025–2045	2025	Regency	Functional zoning (protected–development structure) with multiple sector-based land-use allocations including agriculture and tourism.	Agricultural areas with food crop zones covering 8,445 ha and KP2B designated at 6,675 ha.	Tourism areas cover 5,170 ha with North Kuta is designated as a strategic tourism urban area.	Control is implemented through zoning regulations, evaluation mechanisms, incentives/disincentives, and sanctions. Land use regulation through spatial permits (KKPR).	Apply administrative sanctions ranging from warnings to fines, permit revocation, demolition, and spatial restoration, supported by criminal penalties for violations

4.2.1. Evolution of spatial planning governance in Kuta Utara (2002–2025)

Early spatial planning (pre-2007) is defined by broad functional zoning and limited operational control. The Bali Provincial Regulation on Regional Spatial Plan (RTRW) No. 3/2005 establishes a protected–development structure with sector-based land-use allocations, including agriculture and tourism. Agricultural areas cover 228,153 hectares (40.3%), while tourism areas are broadly designated at 99,226 hectares (18%) without detailed spatial specification. Although both sectors are formally recognized, agricultural protection is framed through general strategies rather than enforceable instruments, and spatial control relies primarily on monitoring and supervision mechanisms. In the absence of regency-level plans, rapidly transforming areas such as Kuta Utara were governed largely through non-operational principles.

A clear shift occurs after 2007 with the formalization of the national spatial planning framework. Law No. 26/2007 and Law No. 41/2009 introduce legally binding spatial hierarchies and the food and crop cultivation area mechanism for agricultural land protection (LP2B). This is reflected in the Bali Provincial Regulation on Regional Spatial Plan (RTRW) No. 16/2009 for 2009-2029, which designates 298,214 hectares (52.9%) as agricultural land, including 76,337 hectares (13.5%) under LP2B. At the same time, tourism is more explicitly structured through designated categories and defined utilization areas (12,512 hectares; 2.3%).

Shortly after, the regency level enacted Badung Regent Regulation No. 26/2013 on the Regional Spatial Plan of Badung Regency for 2013–2033 translates this framework into more spatially explicit zoning. Agricultural land (21,060.89 hectares; 50.32%) which a portion of 9,737.42 ha; 23.27% is protected through LP2B designation and *Subak*-based systems, while tourism development (3,515.41 hectares; 8.40%) is concentrated in coastal and rapidly urbanizing zones. More importantly, this regulation is also aimed at maintaining at least 90% of the available agricultural land and is restricted to conversion. Across these instruments, spatial control becomes more institutionalized through zoning, licensing, incentives, and sanctions. However, the results show that agricultural protection and tourism expansion are strengthened simultaneously within the same regulatory framework, establishing structural duality in land-use priorities.

From 2015 onwards, spatial planning becomes significantly more detailed and operational, particularly at the regency and subdistrict levels. The Bali Provincial Regulation Number 3 of 2020 on Amendments to Provincial Regulation Number 16 of 2009 on the Bali Provincial Spatial Plan (RTRW) for the Period 2009–2029 and Bali Provincial Regulation No. 2 of 2023 on the Regional Spatial Plan (RTRW) of Bali Province for 2023–2043 further formalize agricultural protection through KP2B designation (67,668 hectares and 53,663 hectares respectively), while tourism areas expand and remain strongly oriented toward coastal regions such as Badung regency area. Although control instruments are comprehensive, inconsistencies in sanction clarity particularly in the 2020 regulation suggest uneven enforcement design at the provincial level.

The most detailed instrument, Badung Regent Regulation No. 9/2021 on the Detailed Spatial Plan (RDTR) of Kuta Utara 2021–2041, operates spatial planning at the subdistrict scale. It explicitly maps LP2B agricultural land (≈526.95 ha) alongside clearly defined tourism zones (≈416.16 ha), supported by detailed regulations on building intensity, land use, and infrastructure as well as specific zoning rules. This represents a shift from strategic planning to implementation-oriented zoning control. However, enforcement provisions remain largely referential, relying on broader legal frameworks rather than clearly specified mechanisms.

The latest Badung Regent Regulation No. 4/2025 on (RTRW) Regional Spatial Plan of Badung Regency for 2025–2045 continues this pattern, consolidating zoning, permitting (KKPR), and sanction systems, including administrative and criminal measures. Together, these instruments demonstrate a high level of regulatory completeness, combining spatial designation, control mechanisms, and enforcement tools within a single framework.

Across all phases, spatial planning governance in Kuta Utara evolves from general and weak operational frameworks into highly detailed and technically sophisticated systems. Zoning becomes more precise, agricultural protection is formalized through LP2B/KP2B mechanisms, and control instruments expand to include licensing, incentives, and sanctions.

However, this increasing regulatory sophistication does not correspond to improved land-use outcomes. The continued and accelerating loss of rice paddy areas, as shown in Section 4.1, indicates a persistent gap between formal spatial planning provisions and their implementation. This suggests that the central issue is no longer the absence of regulatory instruments, but the effectiveness of their enforcement in the context of strong tourism-driven

development pressure. To provide a clear picture of how spatial planning enforcement operates in Kuta Utara, three spatial planning instruments available through SIMTARU were analyzed together with digitized rice paddy data from 2002–2025 in the following subsection. Among these, the two plans explicitly designate food crop cultivation areas as LP2B and clearly recognize them as Subak-based rice field areas (Badung Regent Regional Regulation No. 26/2013 on the Regional Spatial Plan of Badung Regency for 2013–2033 and Badung Regent Regulation No. 9/2021 on the Detailed Spatial Plan (RDTR) of Kuta Utara for 2021–2041).

4.2.2. Rice Paddy Loss Under the Badung RTRW 2013–2033

The first policy-reality assessment examines rice paddy loss between 2002 and 2020 against the zoning designations established under Badung Regent Regional Regulation No. 26/2013 on the Regional Spatial Plan of Badung Regency for 2013–2033. This regulation introduced explicit spatial designations for Kuta Utara, including food and crop cultivation areas which are designated for wet land rice cultivation and aligned with the LP2B framework under Law No. 41/2009 alongside clearly delineated Tourism Development Areas in villages such as Canggu and Tibubeneng. It should be noted that the 2013 RTRW was enacted approximately halfway through the 2002–2020 period of analysis, meaning that a portion of the recorded paddy loss occurred prior to its enactment and cannot be assessed as a regulatory violation. Nevertheless, the overlay analysis provides a spatial assessment of where conversion occurred relative to the zoning categories subsequently established.

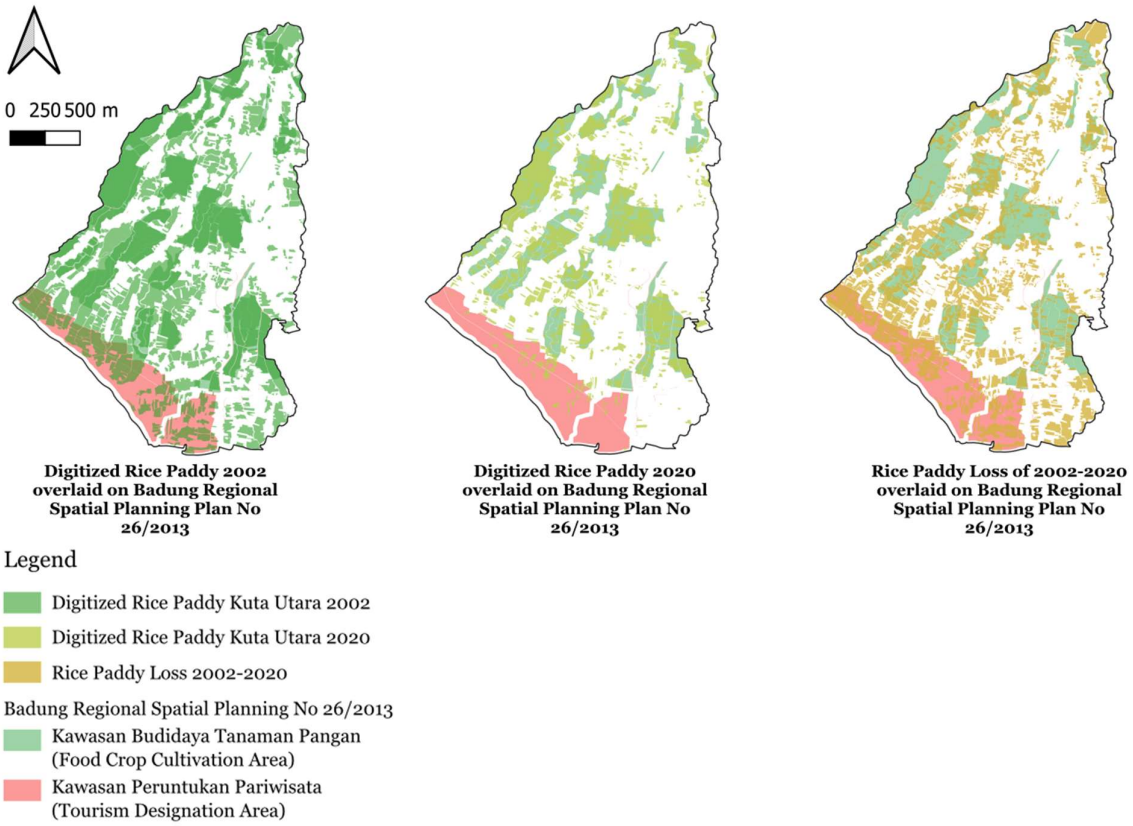


Figure 4-5

Digitized rice paddy coverage and loss (2002–2020) in relation to food crop cultivation and tourism designation areas under Badung Regional Spatial Plan No. 26/2013

The analysis shows that approximately 378 (45.3%) hectares of the 834 hectares designated as Food and Crop Cultivation Areas are no longer occupied by rice paddy in 2020. This result is derived from a spatial difference analysis in QGIS between the 2013 RTRW Food and Crop Cultivation Area and the 2020 digitized rice paddy dataset. It indicates that a significant portion of land formally allocated for wetland cultivation (as defined in the Explanation of Article 40(1) of Regional Regulation No. 26 of 2013) had been converted to other land uses or was no longer functioning as rice paddy by 2020. **Figure 4-5** shows the spatial distribution of rice paddy coverage in 2002 and 2020, alongside areas of loss within zones designated for Food and Crop Cultivation under the Badung Regional Spatial Plan No. 26/2013.

As shown in **Table 4-1Table 4-1**, the net loss of rice paddy area between 2002 and 2020 is approximately 1,013 hectares. To examine how this loss relates to spatial planning, a GIS overlay analysis was conducted using the 2013 RTRW zoning map with rice paddy loss of 2002 - 2020. The results show that approximately 182 hectares of rice paddy loss occurred within areas designated as Tourism Development Zones. In contrast, a spatial clipping of the rice paddy loss dataset with the Food and Crop Cultivation Zones shows that approximately 300 hectares of rice paddy loss occurred within areas formally designated for agricultural use. This means that around 18% of total loss is associated with tourism-designated areas, while nearly 30% occurred within zones allocated for wetland agricultural cultivation.

4.2.3. Rice Paddy Loss Under the Badung RDTR 2021–2041

The second policy-reality assessment focuses on the most recent and operationally specific regulatory instrument, Badung Regent Regulation No. 9/2021 on the Detailed Spatial Plan (RDTR) of Kuta Utara for 2021–2041. The RDTR represents a significant advancement in regulatory specificity, explicitly mapping LP2B protected food and crop cultivation land at 526.95 hectares and designating tourism zones covering 416.16 hectares, with detailed zoning rules governing building intensity, floor area ratios, and permitted land uses.

The analysis shows that approximately 247 hectares or roughly 46% of land within zones designated as ***Zona Tanaman Pangan*** **(Food Crop Zone)** are no longer occupied by rice paddy in 2020. This result is based on a difference analysis in QGIS between the RDTR 09/2021 on designated Agricultural Zone layer (*Food Crop Cultivation Zone)* and the 2020 digitized rice paddy dataset. The same analysis was also conducted using the 2025 rice paddy dataset, revealing that approximately 366 or roughly 69% hectares of the designated Food Crop Zone in 2021 are no longer occupied by rice paddy in 2025. These results indicate that a substantial portion of land designated for food crop production is not currently rice paddy cultivation, a continued reduction in active agricultural use within areas planned for food crop cultivation.

The overlay of 2020-2025 rice paddy loss against the RDTR 09/2021 zoning map revealed that approximately 128 hectares of the 233 hectares lost between 2020 and 2025 occurred within Food Crop designated zones that was designated as LP2B area which carry the strongest legal protection against conversion under Indonesian spatial planning law. A further 15 hectares of loss was recorded within tourism zone boundaries, while 90 hectares occurred in other zoning categories.

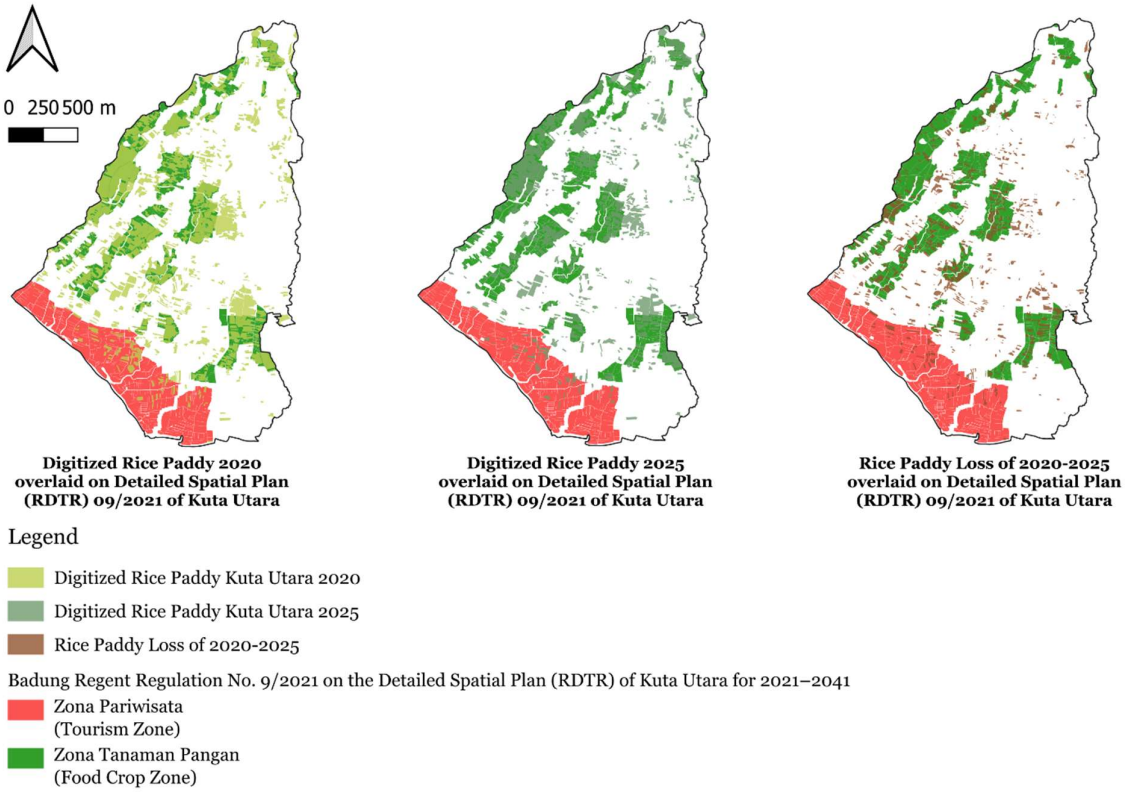


Figure 4-6
Digitized rice paddy coverage and loss (2020–2025) in relation to food crop cultivation and tourism designation zones under Badung Regent Regulation No. 9/2021 on the Detailed Spatial Plan (RDTR) of Kuta Utara for 2021–2041

Beyond recent conversion within LP2B zones, a comparison between the RDTR's LP2B designated area (approximately 526.95 hectares) and the remaining rice paddy coverage in 2025 (approximately 438 hectares) reveals that the total remaining active rice paddy area falls below the area formally designated for protection. This reveals that a portion of land designated as LP2B protected agricultural area under the RDTR no longer exists as active rice paddy in 2025.

While the previous analysis demonstrates the extent of agricultural land loss within protected zones, it does not reveal the types of land uses replacing rice paddy. To address this, the 2026 tourism infrastructure data was overlaid with the RDTR 2021 food crop protection zone (see **Figure 4-7**). These points include accommodation facilities, food and beverage services, and transport infrastructure, indicating that tourism-related development has occurred within areas where it is formally prohibited. This finding provides direct spatial evidence of non-compliance with the RDTR 2021 zoning provisions within the study period. **Figure 4-8** further supports this finding by illustrating the distribution of tourism infrastructure points across the RDTR 2021.

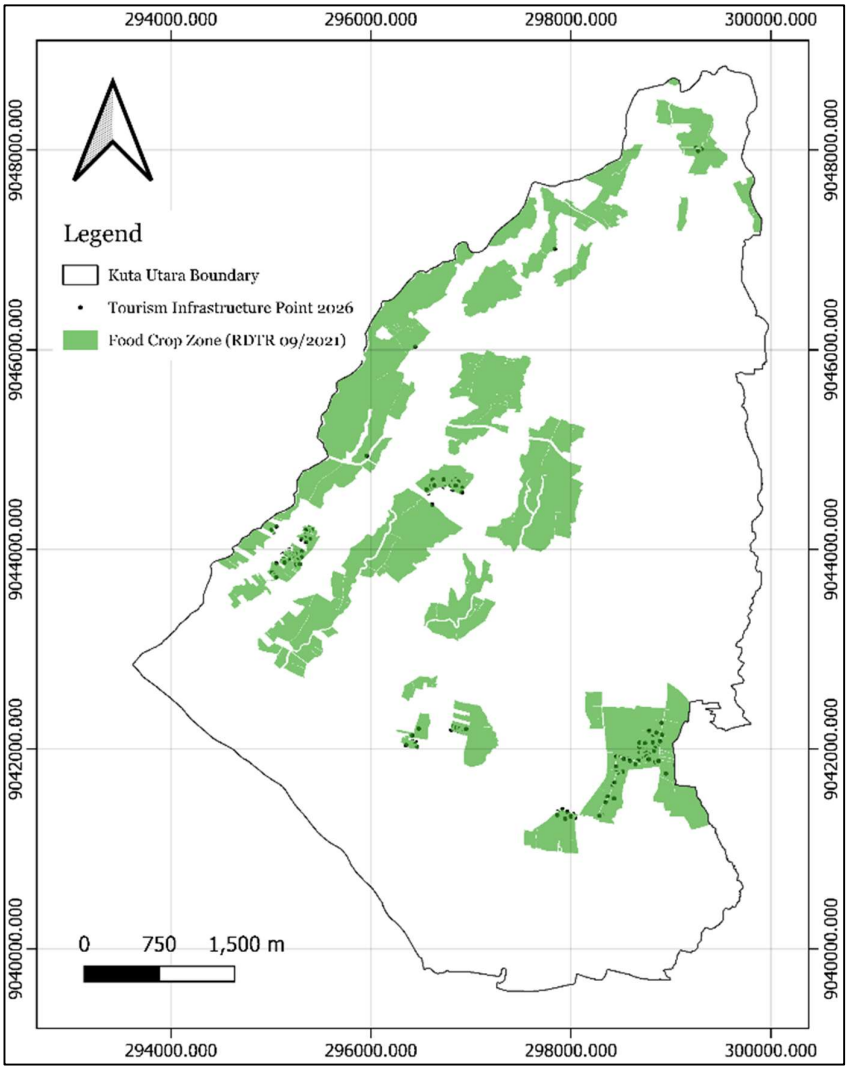


Figure 4-7
Tourism infrastructure points (2026) that fell within the Food Crop Protection Zone under RDTR No. 09/2021

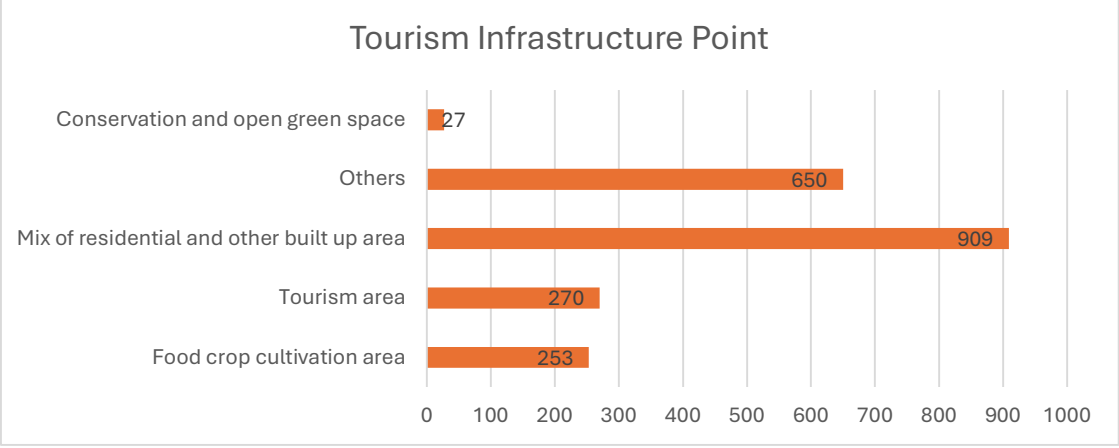


Figure 4-8
Chart of tourism infrastructure point distribution on RDTR 2021

4.2.4. The Badung Regency RTRW 2025-2045: Future Protection Context

The most recent spatial plan, established through Badung Regent Regulation No. 4/2025 on the Regional Spatial Plan (RTRW) 2025–2045, was enacted too recently to assess its direct impact on LULCC observed within the study period. Nevertheless, it provides an important forward-looking framework for the protection of remaining rice paddy areas in Kuta Utara. Nevertheless, it provides an important forward-looking framework for the protection of the remaining rice paddy areas in Kuta Utara.

The regulation designates several spatial zones, including tourism areas and food crop cultivation areas. Within the latter, *Kawasan Pertanian Pangan Berkelanjutan* (KP2B) are specifically identified as protected agricultural zones where land-use conversion is strictly prohibited. The total extent of KP2B designated in the plan is approximately 341.696 hectares.

At the same time, the available digitized dataset of rice paddy fields also from 2025 limits the ability to assess discrepancies between planned and actual land use over time. However, a comparison can still be made between the extent of existing rice paddy areas and the KP2B designation. Based on the digitized data, the current rice paddy area is approximately 438 hectares.

Because the most recent available digitized rice paddy dataset is also from 2025, it is not yet possible to evaluate the implementation outcomes of the RTRW 2025 over time. However, a comparison can be made between the extent of existing rice paddy land and the newly designated KP2B protection area. Based on the digitized dataset, the total rice paddy area remaining in 2025 is approximately 438 hectares.

This comparison shows that not all existing rice paddy land is covered under the KP2B protection scheme. Moreover, part of the remaining rice paddy area falls within zones designated for tourism development (see **Figure 4-9**). Together, these findings suggest potential gaps in the spatial allocation of protected agricultural land and raise concerns regarding the long-term preservation of *Subak* landscapes.

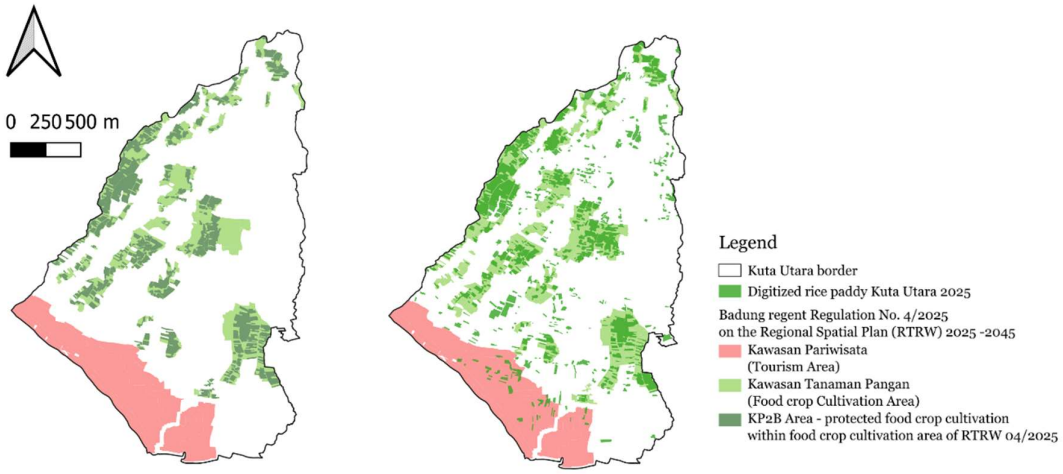


Figure 4-9
Badung Regency Spatial Plan (Regional Regulation No. 4/2025) with highlight on KP2B protection area clipped to Kuta Utara Subdistrict on the left and overlaid with digitized rice paddy 2025 on the right

Figure 4-9 above presents a side-by-side spatial comparison of the RDTR 2021 and RTRW 2025 zoning designations against the 2025 digitized rice paddy dataset, illustrating the gap between regulatory mapping and observed land use. On the left, the RDTR 2021 designates approximately 526.95 hectares as LP2B-protected food crop land, an area that exceeds the total remaining rice paddy coverage of 438 hectares recorded in 2025. On the right, RTRW 2025 introduces a revised KP2B designation of approximately 341.696 hectares, which is lower than the current rice paddy extent.

Below **Figure 4-10** synthesizes the spatial comparisons presented in **Sections 4.2.3** and **4.2.4.** The RDTR 2021 designates approximately 526.95 hectares of LP2B-protected food crop land, while the total remaining rice paddy extent in 2025 is approximately 438 hectares. In contrast, the RTRW 2025 designates approximately 341.696 hectares as KP2B, which is smaller than the remaining rice paddy extent. The figure further illustrates the extent of protected

areas that were not identified as rice paddy in 2020 and 2025. Together, these results shows inconsistencies between planning designations and observed land use.

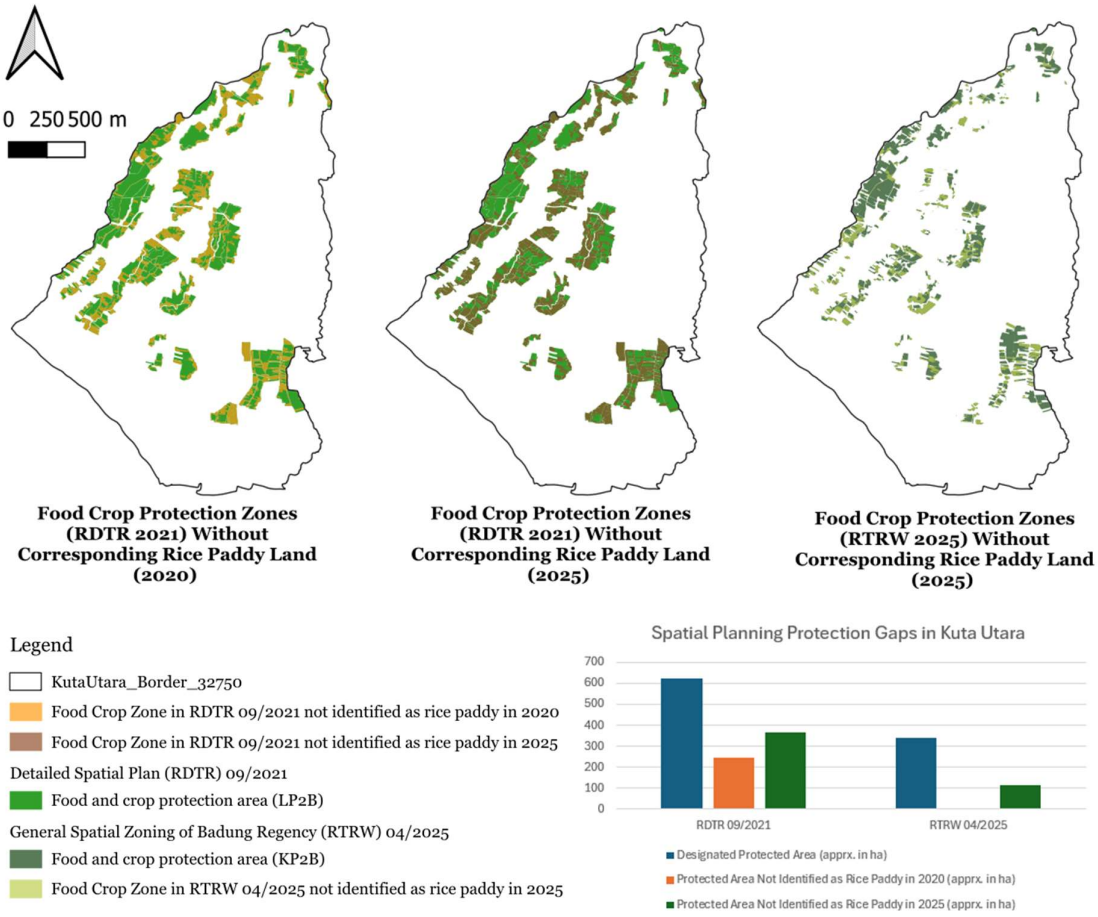


Figure 4-10
Evidence of the Planning–Land Use Paradox in RDTR 2021 and RTRW 2025

4.3. *Subak* perceptions of land use change and institutional responses

Building on the observed patterns of rice paddy land conversion and the policy analysis of spatial planning in Kuta Utara, this section examines how these processes are perceived and experienced at the local level within *Subak* institutions. It provides an evidence-based perspective on how land-use changes, particularly the conversion of rice fields into tourism-related uses, is understood by *Subak* members, and how customary institutions respond to these changes in practice.

As outlined in the methodology section, a directed thematic analysis was applied to the interview data, guided by predefined questions and coding categories derived from the research objectives. The results, summarized in **Table 4-3**, highlight both the systemic nature of land-use change and the differentiated capacity of *Subak* institutions and its member to respond to these pressures. The table should be read by first identifying the main theme (e.g., impacts, drivers, responses), then examining the corresponding codes and their observed patterns across Subak and respondent groups, as well as the source questions used for each code. For example, irrigation disruption under Theme 1 appears consistently across Subak and is linked to Q3 in the interview instrument for both *pekaseh* and farmers are linked to the exact number of questions (see Annex 8.3 for the full questionnaire). Overall, the table provides a structured overview of recurring patterns across interviews, while detailed question wording and instrument design are provided in the annex. Each theme is explained in the following section accordingly.

Table 4-3

Summary of Thematic Analysis: Codes, Patterns, and Respondent Sources

Theme	Code/Sub-Theme	Key Pattern Observed	Source Questions	Respondents
Theme 1 — Impacts on *Subak* functioning				
	Irrigation disruption	Dominant across all 10 *Subak*; rated major impact by majority of respondents; most pronounced in high-conversion *Subak*	Q3 *(pekaseh)*; Q3, Q5 (farmers)	Both
	Environmental impacts	Soil quality decline and increased pest pressure reported in *Subak* located in the tourism area; reflect ecological consequences of built-up encroachment	Q3 *(pekaseh)*; Q3 (farmers)	Both
	Membership decline	Secondary impact; appears in *Subak* located in agriculture and built-up zone; linked to reduced farming participation	Q3 *(pekaseh)*; Q5 (farmers)	Both
	Cultural and ritual decline	Reported in tourism area *Subak*; associated with weakening of ceremonial obligations tied to rice cultivation	Q3 *(pekaseh)*; Q5 (farmers)	Both
Theme 2 — Drivers of land conversion				
	Financial pressure	Most frequently cited driver; encompasses family expenses (education, healthcare, ceremonies), debt, and low farming profitability; consistent across most *Subak*	Q5 *(pekaseh)*; Q2 (farmers)	Both
	Livelihood shift	Selling land to open businesses or work in tourism; prominent in *Subak* located in tourism area; reflects pull of tourism economy	Q5 *(pekaseh)*; Q2 (farmers)	Both
	Rising land values and developer pressure	Secondary driver; more prominent in tourism-proximate *Subak* which also lies on LP2B area; reflects external market pressures	Q5 *(pekaseh);* Q2 (farmers)	Both
Theme 3 — Organizational responses and adaptation				
	Acceptance and adaptation	Overwhelmingly dominant response across 8 of 10 *Subak* heads; suggests organizations have largely accommodated conversion rather than resisted it	Q6, Q7 *(pekaseh)*	*Pekaseh* Only
	Negotiation and persuasion	Reported exclusively in one *Subak*; represents a more active governance compared to the dominant pattern	Q6 *(pekaseh)*	*Pekaseh* Only
	Enforcement of customary rules	Documented only in one *Subak*; suggests limited but existing capacity for formal institutional resistance	Q6 *(pekaseh)*	*Pekaseh* Only
	Education and awareness campaigns	Mentioned by several *Subak* heads in follow-up measures; suggests limited effectiveness in practice	Q7 *(pekaseh)*	*Pekaseh* Only
	Concern-raising by farmers	Majority of farmers raised concerns with their *Subak* organization; in most cases the organization acted; one case of no response	Q6 (farmers)	Farmer Only
Theme 4 — Perceptions of future impacts				
	Loss of cultural and ritual functions	Near-universal anticipated outcome; cited across all 10 *Subak* and both respondent groups; reflects deep concern for the socio-spiritual dimensions of *Subak*	Q9 *(pekaseh)*; Q7 (farmers)	Both
	Loss of irrigation control and organizational weakening	Closely associated secondary concerns; perceived as inevitable consequences of continued land conversion across most *Subak*	Q9 *(pekaseh)*; Q7 (farmers)	Both
	Tourism transformation and economic opportunity	Minority perspective; expressed mainly in 2 *Subak* located on tourism proximity; suggests pragmatic acceptance of tourism as a possible future role for *Subak* communities	Q9 *(pekaseh)*; Q7 (farmers)	Both

Theme 5 — Role of spatial planning				
	Limited or ineffective	Most common assessment in tourism-intensive *Subak*; reflects perceived gap between regulatory intent and on-ground reality	Q10 *(pekaseh)*	*Pekaseh* Only
	Important or strongly influential	Expressed in less intensively developed *Subak*; suggests planning retains perceived authority where tourism pressure is lower	Q10 *(pekaseh)*	*Pekaseh* Only
	Moderately important	Recorded again in tourism-intensive *Subak*; intermediate position reflecting partial confidence in planning amid ongoing conversion pressures	Q10 *(pekaseh)*	*Pekaseh* Only

Note: Q numbers refer to the interview instrument. "Pekaseh" refers to the Head of Subak organizational board members; "Farmers" refers to Subak member farmers. Source questions are numbered separately for each respondent group as per the instrument design (see Annexes).

4.3.1. Impacts on *Subak* functioning

The most consistently reported impact of land-use change is the disruption of irrigation systems, which emerges as the dominant concern across all *Subak*. Respondents describe declining water availability, increasing accumulation of waste such as plastic and construction debris and weakened coordination within irrigation networks due to blockages in canals, particularly in areas experiencing high levels of rice paddy land conversion or in the proximity of tourism area designation. This indicates that LULCC does not only reduce agricultural areas but also disrupts the hydrological and organizational logic of the *Subak* system, which depends on collective water management.

A second key impact is the decline in membership, particularly in *Subak* located within or adjacent to designated urban built-up zones. This decline is directly linked to reduced agricultural participation as land is sold or converted, weakening the institutional base of *Subak* organizations. Closely related to this is the reported decline in cultural and ritual practices, especially in *Subak* closely located in tourism area proximity, where rice cultivation is increasingly replaced by non-agricultural land uses. These findings suggest that LULCC contributes not only to functional disruption but also to the gradual erosion of the socio-cultural foundations of *Subak* institutions.

Environmental impacts, including soil degradation and increased pest pressure, are also reported in several *Subak*, particularly in high tourism point intensity were recorded. These effects are interpreted as indirect consequences of fragmented agricultural landscapes and encroaching built-up development, reinforcing the ecological dimension of land-use change.

4.3.2. Drivers of land conversion

Across all respondents, financial pressure emerges as the most dominant driver of land conversion. *Subak* members frequently report (6 out of 10 *subak*) that land is sold or rented due to household economic needs, including education costs, healthcare expenses, ceremonial obligations, and accumulated debt. This indicates that LULCC is not only externally driven by investors, but also internally mediated through livelihood constraints faced by farming households.

The second key driver is livelihood transition, where land is sold to finance entry into tourism-related activities or non-agricultural employment. This pattern is particularly visible in *Subak* located near tourism centers. In these cases, LULCC is closely associated with structural shifts in the local economy, where agriculture is increasingly perceived as less economically viable compared to tourism-linked livelihoods.

A third factor is rising land values and developer pressure, which is reported mainly by *pekaseh* in tourism-proximate *Subak*. This reflects external market dynamics, where increasing land prices incentivize land sales and accelerate conversion. Together, these findings demonstrate that land-use change is driven by a combination of household-level economic vulnerability and broader market-led tourism expansion.

4.3.3. Organizational responses and adaptation

The analysis reveals that *Subak* organizational responses are predominantly characterized by acceptance and adaptation. In most cases (8 out of 10 *Subak*), *Subak* leaders report limited ability or willingness to resist land conversion, instead focusing on accommodating changes as they occur. This suggests a gradual normalization of land conversion within *Subak* governance structures.

More active forms of response, such as negotiation and persuasion, are rare and only clearly observed in *Subak* 4. Similarly, enforcement of customary rules is documented in only one case (Subak 6), indicating that regulatory authority at the *Subak* level is highly uneven and context dependent. Even when awareness campaigns are mentioned, they are often described as ineffective or not followed by concrete action, highlighting limited institutional leverage.

From the farmers' perspective, most respondents report (24 out of 31 respondents) that concerns about land conversion are communicated to *Subak* leaders, and in several cases, some form of response is initiated. However, there is also evidence of institutional inaction in at least one *Subak*.

Overall, these findings reveal that *Subak* institutions are not absent, but their role has shifted from regulatory actors to adaptive organizations operating within externally driven land-use pressures.

4.3.4. Perceptions of future impacts

Perceptions of future impacts are highly consistent across respondents, with 29 out of 31 respondents concerned over the loss of cultural and ritual functions of *Subak*. This is identified as the most significant anticipated consequence of continued land conversion, reflecting the central role of rice cultivation in maintaining *Subak*'s socio-religious system.

Closely related is the expectation of weakened irrigation control and organizational decline, as further land conversion is seen as reducing both physical infrastructure and institutional cohesion. These concerns are particularly strong in areas already experiencing intensive conversion, suggesting a cumulative perception of irreversible transformation.

A minority perspective emerges in *Subak*, where tourism transformation is also seen as a potential economic opportunity. However, this view remains limited and does not outweigh dominant concerns about cultural and institutional loss.

4.3.5. Role of spatial planning

Perceptions of spatial planning vary significantly across *Subak*. In tourism-intensive areas, spatial planning is predominantly viewed as limited or ineffective, particularly in controlling ongoing land conversion. This reflects a perceived disconnect between formal planning instruments and actual land-use outcomes.

In contrast, *Subak* located in less intensively developed areas perceive spatial planning as more influential, suggesting that regulatory effectiveness is spatially uneven and conditioned by development pressure.

Intermediate perceptions are found in *Subak*, where spatial planning is seen as partially effective but constrained by ongoing market dynamics. Overall, these findings reinforce the policy analysis results by demonstrating that spatial planning authority is not uniform in practice but varies according to tourism intensity and land market pressure.

Meanwhile, government officials from both spatial planning and agricultural institutions emphasize that many of the challenges in protecting rice paddy areas and *Subak* systems stem from limited compliance with existing regulations. Reports from agricultural agencies indicate cases of land conversion occurring without valid permits, as well as instances where construction proceeds while permit applications are still under review.

Another issue highlighted is the nature of land tenure in Indonesia. The registration system allows individuals to hold full ownership rights (*hak milik*), which in practice officials often perceive themselves as having limited room to impose constraints, as land use is ultimately expected to align with formally established spatial plans. This creates a situation where, despite the existence of regulations, enforcement becomes difficult in practice, particularly when development pressures are high.

4.4. Cross-Validation: Do Local Perceptions of Land Conversion Correspond to Observed Spatial Trends?

This section addresses the fourth research objective to examine how spatial patterns of land conversion intersect with community perceptions and governance practices under tourism pressures by systematically comparing the spatially measured patterns of rice paddy loss documented in **Section 4.1** with the perceptions and experiences reported by *Subak* members and leaders in **Section 4.3**. The comparison is structured around the specific research question: in what ways do local perceptions of land conversion correspond to observed spatial trends in land use and land cover change? As outlined in the methodology (**Section 3.8**), this step does not seek to resolve contradictions but to treat both convergences and divergences as analytically meaningful the former reinforcing the robustness of findings, and the latter revealing the complexity of land governance that no single method could capture alone. **Table 4-4** summaries the cross-validation findings across all three analytical strands.

Table 4-4
Spatial analysis and qualitative analysis correspondence

Subak	**Location/ Zone**	**Estimated conversion (interview – ha)**	**Total estimated loss 2002 – 2025 (digitized – ha)**	**Dominant impact (interview)**	**Impact Severity**	**Organizational Response**	**Planning perception**	**Spatial – qualitative correspondence**
Southern and western zones – high tourism pressure								
***Subak* 7**	Kerobokan Kelod/ Southern coastal	~15 – 79	~253	Irrigation disruption	Major	Acceptance/Adaptation	Limited/Ineffective	✓Strong
***Subak* 8**	Kerobokan/ Central	~35 – 180	~168	Irrigation disruption	Moderate	Acceptance/Adaptation	Important/strong influence	~Partial
***Subak* 6**	Canggu/ Western	~ 15 – 40	~262	Irrigation disruption	Major	Enforcement of customary rules	Moderately Important	~Partial
***Subak* 5**	Canggu/ Western coastal	~20 – 100		Irrigation disruption	Major	Acceptance/Adaptation	Moderately Important	✓Strong
***Subak* 1**	Tibubeneng/ Southern coastal	~68	~338	Irrigation disruption	Moderate	Acceptance/Adaptation	Limited/Ineffective	✓Strong
***Subak* 2**	Tibubeneng/ Southern coastal	~25 - 30		Environmental	Major	Acceptance/Adaptation	Limited/Ineffective	✓Strong
***Subak* 3**	Tibubeneng/ Central	~49		Irrigation disruption	Major	Acceptance/Adaptation	Moderately Important	~Partial
Northern zones – lower tourism pressure								
***Subak* 10**	Kerobokan Kaja/ Northern	~117 – 217	~46	Irrigation disruption	Major	Acceptance/Adaptation	Limited/Ineffective	✓Strong
***Subak* 9**	Kerobokan Kaja/ Northern	~18		Irrigation disruption	Major	Acceptance/Adaptation	Important/strong influence	✓Strong
***Subak* 4**	Dalung/ Northern	~12 – 30	~190	Irrigation disruption	Major	Negotiation/Persuasion	Important/strong influence	✓Strong

Note: *Cross-validation of spatially measured rice paddy loss and Subak organizational perceptions across 10 Subak organizations in Kuta Utara Subdistrict. Estimated conversion figures are based on Subak head and farmers approximations recorded during interviews and are indicative rather than precise measurements. Total estimated loss is calculated at the village level rather than the Subak level. Spatial location zones reflect the south-to-north gradient of tourism development pressure identified in the spatial analysis (Section 4.1). Color coding supports interpretation of key variables: green indicates lower estimated rice paddy loss and stronger planning influence, while red indicates higher loss and weaker planning influence; yellow represents moderate levels. Planning perception ratings are drawn from Question 10 of the Subak head interview instrument. Correspondence assessment reflects the degree to which spatial loss is measured and reported perceptions align directionally. ✓Strong = clear directional alignment between spatial and qualitative evidence. ~ Partial = partial alignment with some inconsistency between strands.*

4.4.1. Convergence: Spatial Correspondence Between Measured Loss and Perceived Pressure

Cross-validation reveals mostly a strong and consistent spatial correspondence between the locations of high measured rice paddy loss and the *Subak* organizations reporting the most major impacts, the highest conversion pressure, and the strongest perceptions of planning ineffectiveness. As shown in **Table 4-4**, *Subak* organizations located in the southern and western parts of Kuta Utara Subdistrict areas identified in the spatial analysis as having experienced the earliest and most extensive conversion consistently reported more major organizational impacts and greater dissatisfaction with spatial planning protection than those located in the northern and less tourism-intensive parts of the subdistrict.

There are 3 out of 7 *Subak* (*Subak* 7, *Subak* 1 and *Subak* 2) reported limited/ineffective spatial planning perception, which also experienced the highest rice paddy loss (the digitized dataset) approximately 591 hectares in sum for the past 23 years, are located in the southern part of the subdistrict and is among the areas most directly exposed to the tourism development. Their heads rated irrigation disruption has a major impact and perceived spatial planning as limited or ineffective, a perception that aligns directly with the spatial evidence of large-scale paddy loss in this area. *Subak's* in Canggu, as one of the subdistrict's most intensively developed tourism villages, reported an estimated 262 hectares of conversion and described irrigation disruption as major concern, a finding that corresponds directly with the spatial analysis documenting Canggu as one of the areas of most rapid and recent paddy loss, particularly between 2020 and 2025.

In contrast, *Subak* organizations located in the northern and less tourism-intensive parts of the subdistrict reported comparatively lower estimated conversion areas with only one *Subak* present highly conversion outside of tourism proximity. *Subak* 9, with an estimated conversion of approximately 18 hectares, and *Subak* 4, with an estimated 12 to 30 hectares, both rated impacts at major levels but their heads perceived spatial planning as important or strongly influential, a markedly different assessment from their counterparts in the more heavily converted southern *Subak* with the same impact perceived. This north-south gradient in both measured loss and perceived pressure provide strong evidence of spatial correspondence between the spatial analysis data and the qualitative interview findings and confirms that local perceptions of land conversion pressure are not randomly distributed but reflect the actual spatial distribution of tourism-driven conversion documented in the spatial analysis.

4.4.2. Convergence: Correspondence Between Perceived Planning Effectiveness and Spatial Conversion Intensity

A notable correspondence can be observed between the spatial intensity of tourism-driven conversion and Subak heads' perceptions of spatial planning effectiveness. As noted in **Section 4.3**, *Subak* heads in the most tourism-affected areas consistently perceived spatial planning as limited or ineffective and moderately important, while those in less intensively developed areas expressed greater confidence in planning as a protective mechanism. When mapped against the spatial distribution of paddy loss, this pattern of perceptions closely mirrors the actual distribution of conversion intensity across the subdistrict (see **Table 4-4**).

This correspondence goes beyond simply confirming the spatial results. It shows that Subak heads' views on planning effectiveness are closely linked to what is happening in their own areas, rather than being just personal opinions. In places where there has been clear loss of paddy fields within Subak boundaries, they tend to see spatial planning as ineffective. In contrast, in northern Subak areas where land conversion is less evident, planning is still seen as having some protective effect. Overall, the match between what people observe and what the spatial data shows suggests that local knowledge reflects real changes on the ground. This also supports the credibility of both the perception data and the spatial analysis.

4.4.3. Divergence: Where Perceptions and Spatial Data Differ

While the overall correspondence between spatial trends and local perceptions is strong, the cross-validation also identifies important areas of divergence that enrich the interpretation of the findings. The most significant divergence concerns the framing of the conversion problem itself. The spatial analysis frames paddy loss in terms of measurable area reduction hectares converted, percentages lost, rates of change over time. The interview data, however, reveals that *Subak* members frame the problem primarily in terms of cultural and ritual loss rather than spatial or agricultural loss with near-universal anticipation of the erosion of cultural and ceremonial functions as the primary long-term consequence of continued conversion (**Table 4-3**).

This divergence between spatial and cultural framings of the same phenomenon is analytically significant. It suggests that the spatial metric (hectares of paddy lost) while an accurate and necessary measure of the problem, does not fully capture what is at stake for *Subak* communities. A 74% reduction in paddy coverage is not experienced by *Subak*

members primarily as a loss of agricultural land but as a gradual fragmentation of the landscape conditions that make their cultural and spiritual practices possible which are the rice terraces, irrigation networks, and water temples that together constitute the material substrate of Bali's living cultural heritage. This divergence between what the spatial data measures and what the community experiences points to the need for a more integrated and culturally sensitive framework for assessing the impacts of land conversion in UNESCO World Heritage cultural landscapes, one that goes beyond spatial metrics to capture the irreplaceable cultural and spiritual dimensions of the loss.

A second area of divergence concerns the role of non-tourism drivers. As shown in **Table 4-4**, the northern part of the subdistrict, where the tourism pressure remains limited, still experienced substantial conversion with Dalung recorded 190 hectares of rice paddy conversion between 2002 and 2025. Looking closely at the spatial zoning for each year, most of the Dalung area were designated as residential or built-up area purposes for the study period (see **Figure 4-11**). As tourism infrastructure became concentrated in the southern part of Kuta Utara, residential expansion increasingly occurred in northern areas such as Dalung where land prices are relatively cheaper compared to the south area.

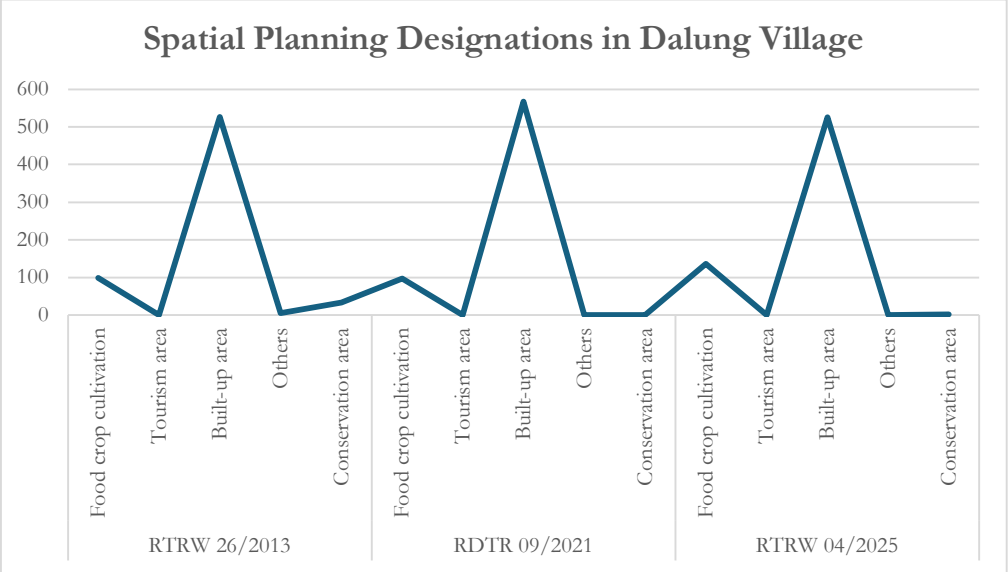


Figure 4-11
Area distribution of spatial planning designations in Dalung Village, Kuta Utara
Source: Calculated by the author using available spatial planning maps (2013, 2021 and 2025) for Dalung Village, Kuta Utara Subdistrict, Badung Regency, Bali.

While the spatial regression model attributes 54% of paddy loss to tourism infrastructure density, interview participants also identified financial hardship, declining farm profitability, aging farmers, and inheritance fragmentation as important factors influencing land conversion decisions. These factors were particularly evident in Dalung Vilage as part of Kuta Utara District, where substantial paddy conversion occurred despite relatively lower tourism infrastructure density.

5. DISCUSSION

Tourism-driven LULCC in rapidly urbanized destinations has been extensively documented across Southeast Asia (Lanya et al., 2017; T. Liu et al., 2025; Petrişor et al., 2020; Rimba et al., 2020; Saha & Paul, 2021; Sunarta et al., 2022), yet the combined relationship between spatial analysis of these changes, spatial planning, customary land institutions, and local perceptions of LULCC remains underexplored. This study contributes to this gap by examining the case of Kuta Utara in Badung regency of Bali, Indonesia through a mix methods lens that combine spatial evidence, policy analysis and community perspectives. The following discussion interprets the key findings of this study in relation to existing literature, and considers their implications for spatial planning, institutional governance, and cultural heritage protection in tourism-driven landscapes. It is organized around the four research objectives, which together provide a full picture of tourism-driven land use change in Kuta Utara.

5.1. Objective 1: The Scale, Pattern, and Drivers of Rice Paddy Loss

5.1.1. What Does a 74% Loss of Rice Paddy Means for Kuta Utara?

The spatial analysis documents a cumulative loss of approximately 74% of Kuta Utara's 2002 rice paddy coverage over 23 years, declining from approximately 1.684 hectares in 2002 to 438 hectares in 2025. To contextualize this figure, Budiasa et al. (2015) documented a 35.8% reduction in rice paddy area in the Saba watershed in northern Bali over a comparable period, while Rimba et al. (2020) projected a 43% increase in built-up area across the broader *Sarbagita* (shorten name for Denpasar, Badung, Gianyar and Tabanan) region between 2015 and 2025. The scale of loss recorded in Kuta Utara substantially exceeds both figures, strongly suggest that the southern coastal corridor of Badung Regency and Kuta Utara in particular represents one of the most intensively converted agricultural landscapes in Bali. This finding is consistent with Lanya et al. (2017), who identified Kuta Utara as a subdistrict undergoing rapid transformation from a semi-rural agricultural area into an urbanized tourism destination, and with the accounts of *Subak* members interviewed for this study, who described a landscape that was almost entirely rice paddy in the early 2000s and is now increasingly fragmented by tourism and residential development.

This scale of loss has direct and measurable consequences for the *Subak* system in Kuta Utara that depends on shared hydrological networks that connect paddy fields within a defined watershed boundary. As individual parcels within these boundaries are converted to built-up uses, the physical continuity of irrigation networks is disrupted, water allocation becomes increasingly difficult to manage, and the collective maintenance burden falls on a shrinking number of remaining members of the *subaks*. This dynamic is directly reflected in the interview findings (see **Table 4-3**) and fieldtrip findings (see **Figure 5-1**), where irrigation disruption was identified as a major impact across all ten surveyed *Subak*, as one of the most consistent findings of the thematic analysis. The spatial loss of rice paddy is therefore not experienced by *Subak* members as an abstract statistical decline but as a day-to-day problem that interferes with the basic governance roles their organizations were set up to carry out.

The acceleration of rice paddy loss between 2020 and 2025 is particularly significant. During this period, 233 hectares were converted, equal to 34.7% of the remaining paddy area in 2020. This shows that LULCC is intensifying relative to what is left, rather than slowing down or stabilizing. If the trend continues, the remaining 438 hectares could shrink by another third within the next five years, which raises questions about whether the Subak system in Kuta Utara can still function as a viable governance institution in the coming decade.

Figure 5-1
Irrigation disruptions caused by household and development waste in the Subak system
Source: Author's field survey, 2026
Note: figures A and B show household waste that has been partially cleaned, with residual plastic visible along both sides of the irrigation channels. Figures C and D illustrate irrigation disruptions caused by construction and development waste in the rice paddy area.

Importantly, this loss does not reflect a uniform shift from rice paddies to built-up land. Instead, conversion follows a multi-directional process, including shifts to other agricultural uses, land abandonment, and speculative holding, alongside direct development. Abandoned or speculatively held land is effectively removed from production without contributing to coordinated land use. For the Subak system, this can be more disruptive than direct conversion, as it fragments irrigation networks and reduces active participation, allowing institutional weakening to begin before visible

urbanization occurs. This pattern aligns with broader dynamics in rapidly urbanizing tourism regions, where speculative holding and incremental conversion often precede formal development (Budiasa et al., 2015).

5.1.2. Tourism as a Confirmed Spatial Driver of Rice Paddy Loss

The regression analysis identifies tourism infrastructure density as a significant spatial predictor of rice paddy loss in Kuta Utara ($R^2 = 0.54$, $p < 0.001$). This finding supports earlier studies that have linked tourism development to agricultural land conversion in Bali (Budiasa et al., 2015; Indrawan et al., 2022; Lanya et al., 2017; Rimba et al., 2020). Similar patterns have also been reported elsewhere in Southeast Asia, where the expansion of accommodation, food and beverage services, and transport infrastructure has been associated with the decline of cultivated land in coastal and peri-urban areas (Adey & Lisle, 2025; Gaughan et al., 2009; Lanya et al., 2017; Liu et al., 2025; Wang & Liu, 2013).

The regression coefficient ($\beta = 0.053$) suggests that the influence of tourism infrastructure is cumulative rather than the result of individual developments. A single tourism facility occupies only a limited area, but the combined effect of many tourism-related developments over time can substantially alter the landscape. This indicates that tourism-driven LULCC is not only associated with large-scale resort projects, but also with the gradual spread of smaller commercial, residential, and tourism-related developments across the subdistrict.

However, while the confirmation of tourism as a primary spatial driver is an important finding, it is equally important to be precise about what the regression model does and does not demonstrate. The model establishes a statistically significant spatial association between tourism infrastructure density and paddy loss at the grid unit level, but it does not establish a direct causal mechanism at the parcel level, nor does it account for the full range of processes through which tourism development drives conversion. Tourism may drive conversion directly, through the physical demand for land to build facilities, but it also drives conversion indirectly, by reshaping land values, labor markets, and livelihood opportunities in ways that make agricultural retention less attractive even for landowners whose parcels are not directly adjacent to tourism infrastructure (Gao & Cheng, 2020; Liu et al., 2025; Lorenzen, 2021; Terkenli, 2004).

The model therefore captures an important part of the conversion process, but not the whole picture. With 46% of the variation in paddy loss remaining unexplained, other factors are also shaping rice paddy loss patterns in Kuta Utara. Examining these factors is necessary to better understand the broader conditions that continue to drive agricultural land loss beyond the spatial concentration of tourism infrastructure.

5.1.3. Beyond Tourism — Structural Economic Conditions and Intergenerational Change

The regression intercept of 4.80 hectares (**Figure 4-4**), indicating a baseline level of paddy loss predicted even in grid units with no recorded tourism facilities, is one of the most analytically significant findings of the spatial analysis, precisely because it points to conversion processes that the tourism-focused model cannot capture. This baseline effect is not statistical noise: it represents a consistent and spatially distributed pattern of paddy loss that occurs independent of whether tourism infrastructure is physically present in a given area. Understanding what drives this baseline is essential for developing a complete picture of LULCC dynamics in Kuta Utara and it is here that the thematic analysis makes its most important contribution to the study.

The interview data reveals that the structural conditions driving this baseline conversion are not primarily about tourism infrastructure proximity but about the changing economic and social calculus of farming as a livelihood in contemporary Bali. Financial hardship, low agricultural profitability, and developer pressure were all identified as significant drivers of LULCC across the surveyed *Subak* organizations (see **Table 4-3**), findings that are consistent with the broader literature on Bali's agricultural transition (Budiasa et al., 2015; Lorenzen & Lorenzen, 2011). Moreover, several respondents across multiple *Subak* organizations expressed not just economic dissatisfaction with farming but a deeper cultural revaluation of agricultural work as a livelihood. As one respondent noted, *"we do not want our children to continue farming; we want them to study and obtain higher-status employment outside agriculture."* Others similarly emphasized that younger generations are increasingly reluctant to engage in rice cultivation and, in some cases, actively encourage the conversion or leasing of family land for tourism-related uses, not because they face immediate financial crisis but because farming is no longer seen as a desirable or respectable occupation relative to the non-agricultural opportunities that Bali's tourism economy makes visible and accessible.

This pattern resonates with Lorenzen and Lorenzen (2011), who documented the same generational shift in south-central Bali over a decade earlier, noting that teenagers were rarely seen working in the rice fields and that parents and children alike viewed education as the key to permanent off-farm employment. The evidence from this study suggests that what Lorenzen and Lorenzen (2011) identified as a labor reallocation dynamic has since deepened into a more fundamental land use transition: it is no longer only that younger generations prefer non-agricultural work, but that

they actively encourage the conversion of family land, a shift from labor withdrawal to land withdrawal that carries far more significant consequences for the long-term viability of Subak governance.

Budiasa et al. (2015) similarly show that LULCC within Subak systems is driven not only by tourism development but also by broader economic pressures, particularly the declining profitability of rice farming compared to alternative land uses. However, their analysis pays less attention to the intergenerational dimension that emerges in this study. When the decision to convert land is shaped not only by the current economic position of the farmer but by the aspirations of their children, the governance challenge becomes fundamentally different in character, a *Subak* organization can in principle negotiate with a member facing temporary financial hardship, but it cannot negotiate with the aspiration of an entire generation to pursue non-agricultural livelihoods.

The spatial evidence collected during the digitization process provides a compelling visual illustration of this dynamic. **Figure 5-2** presents three satellite images capturing the same location in Tibubeneng across the three study periods and documents the incremental progression from active cultivation to abandonment to development preparation at a single site. In 2002, the area shows intact and continuous rice paddy fields characterized by clear curved bund lines and regular terrace patterns, consistent with *Subak* members' accounts of an almost entirely cultivated landscape during this period. By 2020, the central portion had already transitioned to abandoned or fallow land, despite being located along the irrigation canal line, a particularly significant observation since abandonment of paddy parcels adjacent to irrigation infrastructure directly disrupts water distribution to downstream fields. By 2025, the area had been actively cleared and prepared for development, evidenced by large areas of exposed bare soil and a newly opened access road cutting through what were previously active paddy fields, signaling that the speculative holding phase had given way to active development preparation. This three-stage progression: from active cultivation to abandonment and speculative holding, to physical clearance, visually represents the conversion dynamic that the regression analysis quantifies and the interview data contextualizes.

Figure 5-2
Satellite evidence of paddy field conversion in Tibubeneng (2002–2025)
Source: Google Earth Pro (2025) with author's own interpretation.

Moreover, during the field trip, the author observed that numerous tourism infrastructures, particularly accommodation such as small villas, were located adjacent to rice paddy areas in Kuta Utara. Field photographs further confirm this spatial proximity between tourism infrastructures and active agricultural land (see **Figure 5-3**). This pattern indicates a strong integration between tourism development and the rice field landscape.

In addition, many tourism businesses appear to incorporate rice field scenery into their marketing and branding strategies. Several accommodation listings in Canggu, Tibubeneng, and Kerobokan terms such as *"rice field view"*, *"paddy view"*, and *"surrounded by rice fields"* are frequently used to promote villas and guesthouses. Cafés and restaurants often highlight rice paddy landscapes and rural ambiance as key elements of the visitor experience. These marketing practices suggest that rice fields are not only valued as agricultural landscapes but are also commodified as tourism assets that enhance the attractiveness of tourism-related developments.

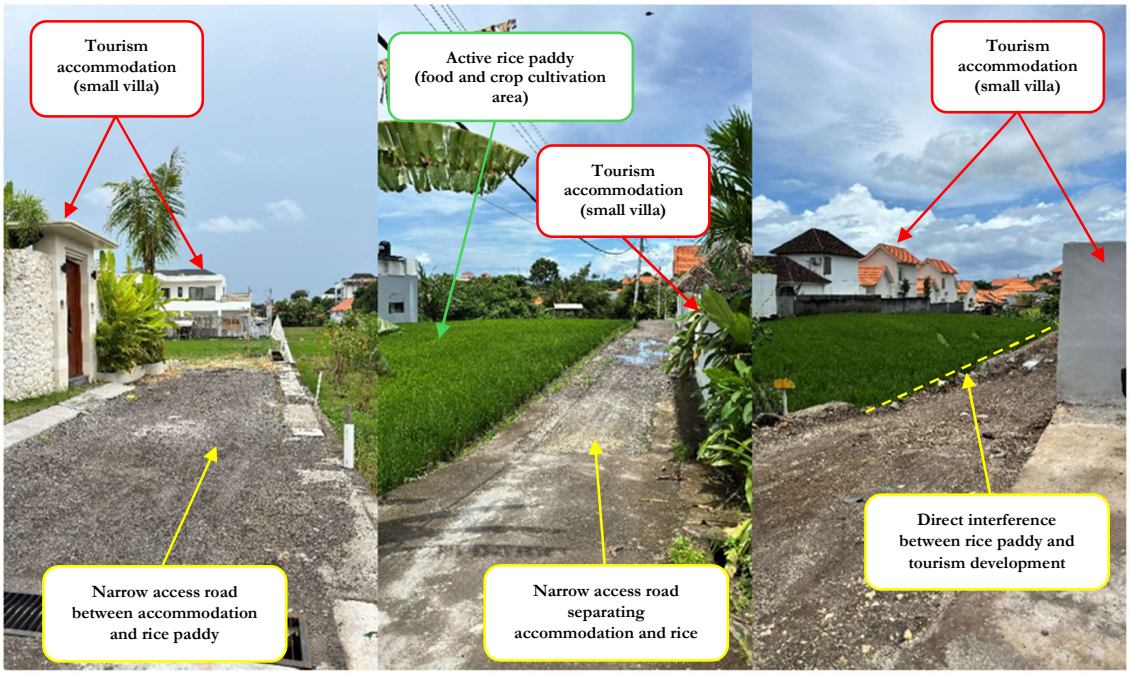


Figure 5-3
Field observation of tourism infrastructure (villas) adjacent to subak / rice paddy field
The photographs show that all villa developments are located immediately adjacent to active rice paddies, separated only by narrow access road or boundary.
Source: Author's field survey, 2026

This finding has direct implications for policy. If approximately 46% of paddy loss is driven by structural economic conditions and intergenerational dynamics rather than tourism infrastructure density, then regulatory instruments focused solely on controlling tourism development (zoning controls, building permits, and tourism zone designations) are insufficient to halt the overall trajectory of agricultural land conversion. These implications are developed further in **Section 5.2.**

5.2. Objective 2: Spatial Planning Regulations and the Reality of Land Conversion

5.2.1. Stronger Regulations, Faster Conversion — The Paradox

One of the most notable and policy-relevant findings of this study is the paradox between the progressive strengthening of spatial planning regulations and the simultaneous acceleration of rice paddy loss. The policy content analysis documents a gradual strengthening of the regulatory framework over the study period, from the broadly framed and weakly enforceable Bali RTRW of 2005 to the more detailed Badung RDTR of 2021. The RDTR explicitly maps approximately 526.95 hectares of LP2B-protected agricultural land and introduces specific zoning regulations, building intensity controls, and land use restrictions. Under the assumption that stronger regulations produce better land use outcomes, rice paddy conversion would be expected to slow following the enactment of the RDTR 2021. Instead, the spatial analysis shows the opposite: the period 2020–2025 records the highest proportional rate of loss in the entire study period, with 34.7% of the 2020 remaining paddy area converted in just five years.

The tourism infrastructure overlay provides a clear visual illustration of this paradox (see **Error! Reference source not found.**). When the 2026 tourism infrastructure grid survey data, recording the location of tourism facilities across 25 grid units in Kuta Utara is overlaid against the food crop zone designated under the RDTR 2021, there are 253 out of 2019 total tourism infrastructure points fall precisely within areas that the regulation designates for food crop cultivation area that should be under agricultural protection (see **Figure 5-4**). The presence of tourism facilities including accommodation, food and beverage services, and transport infrastructure, within formally designated food crop protection zones indicates that development has occurred in areas where it is explicitly prohibited or restricted under the most detailed planning instrument in the subdistrict's history. This is not a matter of regulatory ambiguity or zoning overlap, the RDTR 2021 is specific about where development is and is not permitted. It is a matter of enforcement failure: the regulation exists, the boundaries are mapped, but the development has happened anyway. This pattern of regulatory failure in Bali is not unique to agricultural land protection. Widiatedja (2022) documented

the same dynamic in the context of hotel development, finding that conflicting regulations and the consistent prioritization of economic interests over compliance systematically undermine spatial planning in Bali. The findings of this study extend that argument into the agricultural domain, demonstrating that the same structural conditions that enable hotel development in violation of spatial plans also enable the conversion of LP2B designated rice paddy land.

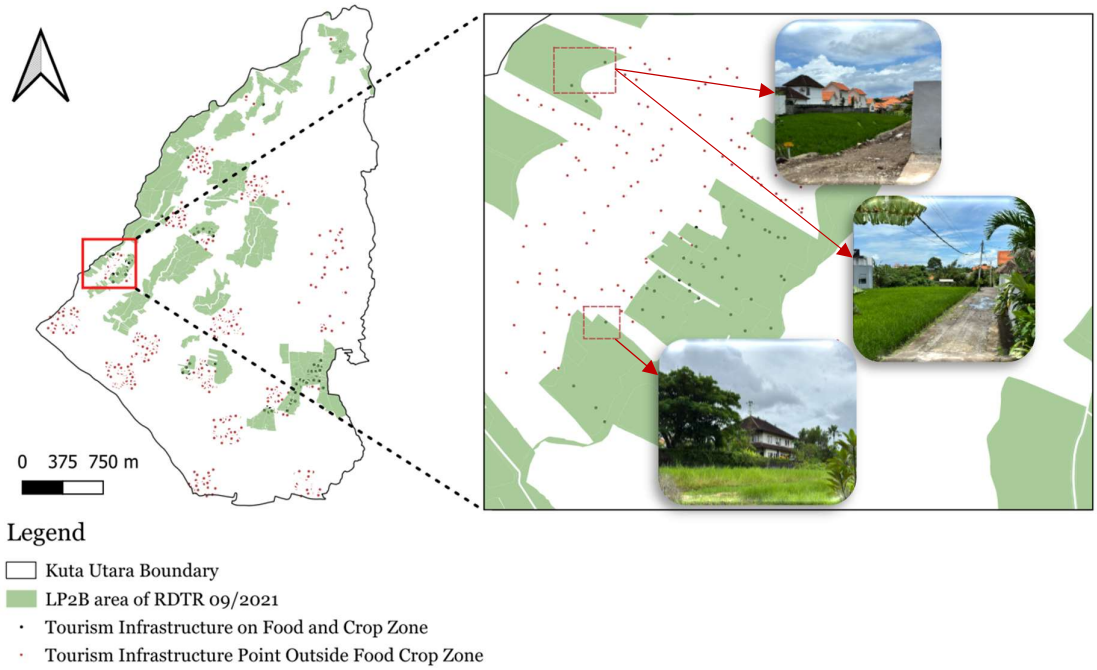


Figure 5-4

Field-trip photographs showing accommodation developments within designated agricultural protection zones.

This finding is also consistent with the perceptions expressed by *Subak* heads in the most tourism-affected areas of the subdistrict, who consistently described spatial planning as limited or ineffective in protecting *Subak* land. Their assessment is not merely subjective: it is corroborated by spatial evidence showing tourism infrastructure inside food crop zones, and by the statistical finding that paddy loss accelerated in the period following the enactment of the strongest regulatory instrument. Together, these three independent lines of evidence: spatial overlay, interview perceptions, and rice paddy loss statistics converge on the same conclusion: the effectiveness of spatial planning in Kuta Utara is constrained not only by the absence of meaningful enforcement but, as the following subsection demonstrates, by structural inconsistencies embedded within the regulatory framework itself.

5.2.2. When Regulations Undermine Themselves — Internal Inconsistencies

The paradox of stronger regulations alongside continued LULCC cannot be explained by enforcement alone. A review of the planning documents and their associated zoning maps reveals a series of omissions and inconsistencies that weaken the protective intent of the planning framework. These issues are embedded within the regulations themselves and affect how agricultural land protection is translated into practice.

The first issue can be observed in the Bali Provincial RTRW No. 16/2009. Article 117 explicitly requires the protection of Subak areas through LP2B designation, indicating a clear commitment to preserving agricultural land at the provincial level. However, comparison of this regulation with RTRW Badung No. 26/2013, RDTR No. 9/2021, and the actual distribution of rice paddy fields in Kuta Utara shows that several rice paddy fields (*Subak* areas) are located within tourism development zones rather than LP2B zones (see **Figure 5-5**). As a result, these areas do not receive the protection envisioned in the provincial regulation.

This does not represent a direct contradiction between the text and the map. Rather, it reflects an incomplete translation of provincial policy into local spatial planning. Subak areas located within tourism zones are effectively excluded from LP2B protection despite the broader policy objective of preserving agricultural land. Consequently, the protection framework is applied unevenly, leaving parts of the Subak landscape vulnerable to conversion.

A second issue emerges in the Bali RTRW No. 3/2020, which amended the 2009 regulation. While LP2B/KP2B remains part of the planning framework, its role has changed. In 2009 RTRW, LP2B was presented as a specific mechanism for protecting *Subak*-based wetland agriculture. In the 2020 amendment, KP2B is defined more broadly as part of the agricultural area (*Kawasan Pertanian*), which includes food crops, horticulture, plantations, livestock, and other agricultural activities. This shift broadens the scope of agricultural planning but reduces the focus on protecting specific areas of rice paddy land. The amendment also removes explicit references to *Subak* systems and no longer includes measurable protection targets such as the 90% preservation requirement. As a result, agricultural land remains recognised within the planning framework, but the protective function of LP2B/KP2B becomes less clearly defined, particularly in areas experiencing strong tourism development pressure.

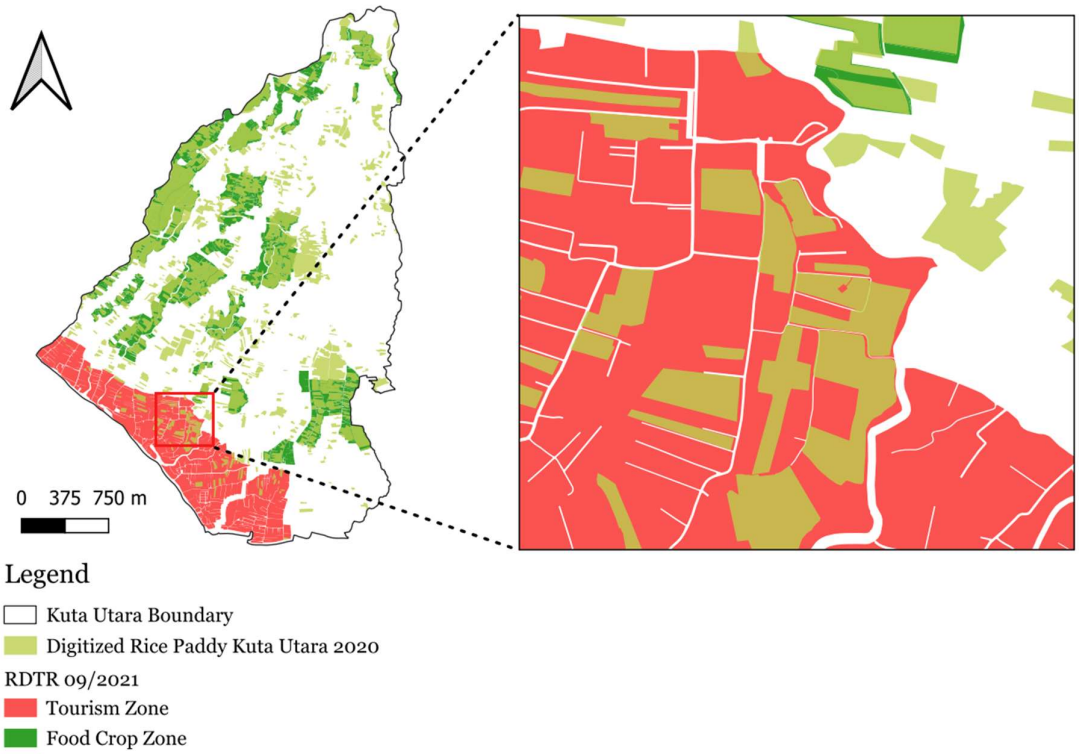


Figure 5-5
Zoomed-in view of digitized rice paddy areas located within tourism zones.

The third issue is found in the Badung RDTR No. 9/2021, which is the most detailed spatial planning instrument currently applied in Kuta Utara. The regulation states that the P-1 food crop subzone is equivalent to LP2B land. Based on this provision, all areas designated as P1 should also receive LP2B protection. However, comparison between the regulatory text and the zoning map reveals several inconsistencies. First, not all areas classified as P1 on the map are designated as LP2B (see **Figure 5-6**). Second, some areas designated as built-up areas (*badan jalan*: roadway) are simultaneously classified as LP2B. These classifications do not always correspond with the stated zoning framework and create uncertainty regarding the actual extent of protected agricultural land. Whether these discrepancies result from mapping errors, planning revisions, or other administrative processes, they reduce the clarity of the protection framework and may complicate planning and permitting decisions.

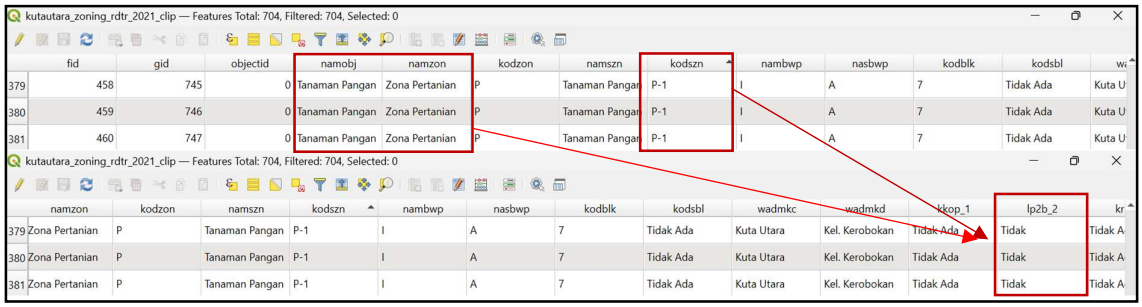


Figure 5-6

Evidence on spatial planning inconsistencies with textual on RDTR 09/2021

Note: The labels shown in the figure are taken directly from the QGIS dataset and are presented in Indonesian. ***Tanaman Pangan*** *under field "namobj" refers to* ***Food Crop Cultivation****, while* ***Tidak*** *under field "lp2b_2" means* ***No****. Together, Tanaman Pangan – Tidak indicates an area classified as a Food Crop Cultivation zone that is not designated as LP2B.*

Together, these findings suggest that the planning framework governing Kuta Utara contains structural weaknesses that go beyond implementation and enforcement. Protection objectives are not always consistently reflected in zoning designations, planning amendments have reduced the specificity of agricultural land protection, and zoning maps contain classifications that do not fully align with the regulatory text. These issues weaken the ability of spatial planning instruments to provide clear and consistent protection for agricultural land.

This finding supports the argument of Roth and Sedana (2015), who suggest that agricultural land protection in Bali is constrained by contradictions embedded within the planning framework itself. The results also align with Widiatedja (2022), who identifies inconsistencies in the review and amendment of spatial plans as an important source of planning failure. These studies suggest that the challenge is not only one of enforcement, but also of regulatory coherence. Strengthening protection therefore requires not only stricter implementation but also greater consistency between planning objectives, regulatory provisions, and spatial zoning maps. The implications of these weaknesses extend beyond the regulatory framework and influence the decisions of farming households and Subak organizations, as discussed in the following sections.

5.2.3. Why Economic Instruments Are Not Enough

Recognizing that spatial planning controls alone cannot prevent conversion, regional governments have introduced a set of economic instruments aimed at supporting the viability of rice farming. Interviews with government representatives confirm that several of these measures are currently implemented in Kuta Utara and Badung Regency. These include a 0% land tax policy for active Subak areas, financial and material support for Subak organizations such as fertilizer provision and infrastructure assistance, government procurement schemes for agricultural products, and compensation for crop failure or productivity loss. Together, these instruments reflect a clear policy effort to maintain agricultural livelihoods alongside spatial planning protections.

Despite these measures, LULCC continues to increase. The 2020–2025 period, which coincides with the implementation of RDTR 2021 and existing support schemes, recorded the highest rate of paddy loss in the study period. This suggests a gap between policy design and the main drivers of conversion at household level. The economic instruments currently in place are designed primarily to offset the direct financial costs of farming (taxes, input costs, price volatility) but they do not address the opportunity cost of holding agricultural land in a subdistrict where land values are rising rapidly due to tourism demand, nor do they address the intergenerational livelihood aspiration shifts documented in the interview data.

The opportunity cost is particularly evident in Kuta Utara. In areas such as Canggu and Tibubeneng, the value of land for tourism-related development can far exceed the cumulative returns from rice farming over time. While a 0% land tax reduces holding costs, it does not close this gap. Similarly, procurement schemes can stabilize farm income, but they remain less competitive than income from land sale or lease for tourism use. In this context, many households in Kuta Utara appear to retain land in the short term while values increase, with a view to selling or converting later when returns are higher. This pattern aligns with the baseline level of conversion identified in the regression results, including areas where tourism infrastructure is not yet present.

The intergenerational dimension further complicates this dynamism. Existing economic incentives do not address changing perceptions of farming among younger generations. For many, agriculture is no longer seen as an attractive livelihood compared to opportunities within the tourism economy or others. Addressing this issue would require

policy approaches that go beyond economic incentives and engage with the social and cultural position of farming. This could include strengthening the cultural recognition of *Subak* systems in line with Bali's UNESCO World Heritage status, educational initiatives linking younger generations to agricultural heritage, and agrotourism models that allow farming households to generate tourism income while maintaining cultivation.

Without addressing both the opportunity cost problem and the intergenerational aspiration dimension, existing economic instruments will continue to fall short, not because they are poorly designed but because they are addressing only part of a problem that is simultaneously economic, cultural, and intergenerational in character.

5.3. Objective 3: Consequences for the *Subak* System

5.3.1. What *Subak* Members Fear Most — Cultural Loss and the Limits of Resilience

A consistent finding from the interviews is that *Subak* members do not primarily describe land conversion as an economic or institutional issue, but as a cultural one. Across all ten *Subak* organizations, respondents expressed concern that continued loss of rice paddy land would lead to the erosion of the cultural practices, rituals, and collective identities associated with the *Subak* system. When respondents were asked what they thought would happen if most or all *Subak* land were converted to built-up or non-agricultural uses, concerns about the loss of cultural and ritual functions were raised more frequently than concerns about irrigation management or organizational capacity. This contrasts with the dominant policy framing of agricultural land loss in Indonesia, which tends to focus on food security and economic output. For respondents, however, the main concern is the possible loss of a way of life in which farming, ritual practice, and community organization are closely connected.

This finding is consistent with Lansing's (1987, 2012) description of *Subak* as a socio-ecological system in which irrigation management is closely linked to religious practice through the water temple network. In this framework, water temple rituals are not separate from agricultural governance but are part of how coordination takes place across *Subak* systems. Planting schedules, water allocation, and collective decisions are shaped through these rituals. If rice fields are no longer present, the basis for these practices is reduced, and the function of the ceremonies becomes less clear. The responses from *Subak* members reflect an awareness of this connection: the concern is not only about land loss, but about what happens to the institution when the land that supports it is no longer there.

Critically, this is not a hypothetical risk, it is a present and observable reality that *Subak* members in Kuta Utara can witness in the adjacent Kuta Subdistrict. Several respondents referenced the fate of *Subak* organizations in Kuta as an example of a possible future, describing how rice paddy conversion has left only the water temples standing, physically intact but functionally hollowed out. As one respondent described, the rituals still need to be performed even without rice paddies, because the temple and its spiritual obligations do not disappear when the land does. Yet the financial basis for performing those rituals, which historically derived from collective farming member contributions, supported in part by government funds is progressively eroded as the paddy area shrinks. The respondent posed the question directly: *"when the rice paddy is gone, the money from the government to cover ritual fees will also be gone, then who will pay for it, and with what?"*. This account reveals a dimension of the conversion problem that neither spatial planning regulations nor economic support instruments have addressed: the institutional and financial architecture of *Subak* governance is built around the assumption that rice paddy land exists and is actively cultivated. When that assumption no longer holds, as it already does not in Kuta Subdistrict, the entire governance structure, including its ritual, administrative, and financial dimensions, faces an existential question that no regulatory or economic instrument can retroactively answer. It is the integration of land, governance, and culture that constitutes the UNESCO World Heritage value of the *Subak* cultural landscape (UNESCO, 2012), and it is this integration that is being gradually disrupted by the conversion processes documented in this study.

5.3.2. Between Resistance and Resignation — Organizational Responses and Institutional Erosion

The thematic analysis shows that acceptance and adaptation are the dominant organizational responses among *Subak* heads in Kuta Utara, reported by eight of the ten surveyed Subak organizations. Only *Subak* 4 identified negotiation and persuasion as its main response, while only *Subak* 6 reported the enforcement of customary rules. In most cases, Subak organizations have adapted to land conversion rather than actively resisting it. This raises an important question: does this pattern indicate a loss of institutional capacity, or does it reflect a practical response to conditions beyond the control of Subak organizations?

The findings suggest that the latter explanation is more appropriate. According to Ostrom (2009), effective common-pool resource institutions depend on several conditions, including clearly defined boundaries, rules that fit local conditions, collective decision-making arrangements, effective monitoring, and recognition by external authorities. The evidence from Kuta Utara suggests that several of these conditions are becoming more difficult to maintain. As rice paddy land is converted, the physical boundaries that define *Subak* territories and irrigation networks become

increasingly fragmented. At the same time, the rules and practices developed to manage agricultural landscapes become less relevant as the area under cultivation declines. Although *Subak* is formally recognized in spatial planning documents, this recognition has not always been accompanied by the regulatory support needed to influence land use decisions within *Subak* territories.

Lansing (1987, 2012) described Subak as a resilient and self-organizing institution capable of coordinating irrigation management across complex agricultural landscapes. The findings of this study do not challenge this view. Rather, they suggest that the conditions facing Subak organizations today differ from those under which this resilience was historically demonstrated. Subak institutions were developed to manage water, coordinate cultivation, and organize collective agricultural activities within an active farming landscape. In Kuta Utara, however, the challenge now is not simply managing agriculture but responding to the gradual loss of the agricultural land on which the system depends.

5.4. Objective 4: Spatial Patterns and Community Perceptions — Convergences and Divergences

5.4.1. Spatial Variations in Perceived Planning Effectiveness

The interviews reveal notable differences in how *Subak* heads perceive the effectiveness of spatial planning across Kuta Utara. Respondents from the southern and coastal areas, where tourism development and land conversion are most extensive, generally described spatial planning as limited or ineffective in protecting *Subak* land. In contrast, respondents from the less intensively developed northern areas expressed greater confidence in planning as a mechanism for agricultural land protection. These differences in perception closely correspond with the spatial patterns identified in the analysis. Areas that have experienced higher levels of rice paddy loss and tourism development are also the areas where confidence in planning is lowest, while areas with lower levels of conversion tend to show more positive perceptions of planning effectiveness.

These findings suggest that the effectiveness of planning instruments is influenced not only by their regulatory design but also by the broader economic and institutional context in which they operate. As tourism development increases, the financial incentives associated with land conversion may become increasingly difficult to counter through zoning regulations alone. This may help explain why planning is perceived more positively in areas where development pressure remains relatively low than in areas where conversion pressures are already well established.

This interpretation is consistent with Healey's (2006) argument that planning outcomes depend not only on the content of planning regulations but also on the institutional capacity, political commitment, and resources available to implement them. In Kuta Utara, these challenges may be amplified by the role of tourism as a major source of economic activity and local government revenue. As noted by Roth and Sedana (2015), this can create tensions between agricultural land protection objectives and broader development priorities, particularly in areas experiencing rapid tourism growth.

5.4.2. What the Integration of Evidence Reveals

The integration of spatial, policy and qualitative evidence provide a broader understanding of tourism-driven land use change in Kuta Utara than any single method could achieve independently. Through cross-validation processes, several findings converged across methods, while others diverged in a way that revealed additional dimensions of the research problem that spatial or policy analysis alone cannot see. In this study, convergence strengthens confidence in the findings, whereas divergence provides further insight into aspects of land conversion that are not fully captured by a single analytical approach.

One of the clearest areas of convergence concerns the effectiveness of spatial planning in protecting rice paddy land. The spatial analysis documented a 74% decline in paddy area between 2002 and 2025, with conversion rates continuing to increase despite the introduction of stronger planning regulations. The policy analysis identified several weaknesses within the planning framework, including inconsistencies between regulations and zoning maps, a protection gap during the 2020 planning transition, and a mismatch between LP2B-designated land and the actual extent of remaining paddy fields. These findings are supported by the interview data, particularly from Subak heads in areas experiencing high tourism pressure, who generally described spatial planning as having limited effectiveness in preventing conversion. Although each method examined the issue from a different perspective, they point to a similar conclusion regarding the limited capacity of the current planning framework to protect agricultural land in Kuta Utara.

A second area of convergence relates to the spatial distribution of conversion pressure. The spatial analysis showed that paddy loss and tourism infrastructure are concentrated in the southern and coastal parts of the subdistrict. Interview responses followed a similar pattern, with Subak heads in these areas reporting greater institutional pressure and lower confidence in planning protections. In contrast, respondents from the less developed northern areas expressed more positive views regarding the role of spatial planning. This correspondence suggests that local

perceptions are closely linked to the conditions experienced within the landscape and provide qualitative support for the spatial patterns identified through the LULC analysis.

At the same time, several areas of divergence help explain dimensions of land conversion that are not visible through spatial analysis alone. One example concerns how the consequences of paddy loss are understood. The spatial analysis measures conversion as a reduction in agricultural land area, while planning policies generally frame the issue in terms of food security and agricultural productivity. In contrast, respondents most often described land conversion as a threat to cultural continuity, ritual practices, and collective identity. These perspectives are not contradictory. Rather, they reflect different ways of understanding the same process. While spatial and policy analyses highlight the physical and economic consequences of conversion, the interview findings draw attention to its cultural and social implications.

Another area of divergence concerns the drivers of land conversion beyond tourism infrastructure. The regression analysis confirmed a significant relationship between tourism infrastructure density and paddy loss, but it could not explain all observed variation. The interviews provide additional insight into this unexplained component by highlighting factors such as low agricultural profitability, changing livelihood aspirations among younger generations, and the practice of retaining or leasing land while waiting for future increases in land value. These findings suggest that land conversion is influenced not only by the physical expansion of tourism infrastructure but also by broader economic and social changes occurring within farming communities.

Together, the convergences and divergences identified through this integrated analysis confirm that the governance challenge facing Kuta Utara is simultaneously spatial, economic, institutional, and cultural in nature. The implications of these findings for policy and practice are addressed in the conclusion chapter.

6. CONCLUSION

This chapter presents the study's conclusions, organized into a summary of key findings, recommendations for the government, and directions for future research. Together, these draw together the spatial, policy, and qualitative evidence presented in the preceding chapters to reflect on what the findings mean for the governance of rice paddy land and the Subak system in Kuta Utara District and beyond.

6.1. Conclusion of the Research

This study explored the impact of tourism-driven land use change in Kuta Utara subdistrict, Bali, focusing on how the extensive loss of rice paddy land has affected the *Subak* system as a traditional land governance institution and its relationship with spatial planning. The study integrated three analytical approaches: spatial analysis of rice paddy area conversion, qualitative analysis of interview data from *Subak* members and government officials, and policy analysis of spatial planning documents, to build a comprehensive understanding of how tourism development has reshaped both the physical and institutional landscape of the district. The findings from these three approaches were then compared and cross-validated to examine the degree to which the perspectives of traditional land governance actors align with the patterns documented through spatial and policy analysis.

One of the most significant insights to emerge from this integration is the contrast between how land conversion is understood by technical and institutional actors on one hand, and by *Subak* members on the other. From a technical perspective, land cover change is measured in hectares, how much rice paddy area has been converted to other uses, at what rate, and in which locations. But for *Subak* members, the same loss is experienced not as a reduction in agricultural areas but as the erosion of cultural traditions, ritual obligations, and a way of life that has been sustained for centuries. This contrast reveals that land is not merely a spatial unit to be measured and protected through zoning instruments, it is a living cultural landscape whose preservation simultaneously sustains environmental functions, social cohesion, and a distinctive Balinese way of relating to nature, community, and the divine.

When the rice paddy datasets for 2002, 2020, and 2025 were overlaid with the available spatial planning maps, the analysis revealed that the current spatial planning framework does not fully protect the rice paddy areas present in the subdistrict. While there is policy that is explicitly committed to retaining at least 90% of existing agricultural land and protecting the *Subak*, the spatial overlay tells a different story. The 2002 rice paddy area of approximately 1,684 hectares had declined to only 438 hectares by 2025, representing just 26% of the original extent, far below the 90% retention target stated in provincial policy. Furthermore, not all remaining rice paddy areas fall within designated LP2B food crop protection zones, a few active *Subak* areas are located within tourism development zones and therefore carry no formal agricultural protection under the current spatial plans, leaving them effectively exposed to conversion despite the provincial commitment to their protection. This mismatch highlights a clear policy–implementation gap:

although formal policies exist to safeguard rice paddy and *Subak* areas, their spatial designation and enforcement are poor, allowing continued conversion of agricultural land despite stated protection targets.

This study found that tourism infrastructure density statistically explains approximately 54% of the spatial variation in rice paddy loss, confirming tourism as a primary, but not exclusive, driver of conversion. The remaining 46% points to a range of structural conditions that the spatial analysis alone cannot capture. By integrating policy analysis and interview data, the study identified additional drivers, including financial hardship, low agricultural profitability, speculative landholding, and intergenerational shifts in livelihood aspirations, in which younger generations increasingly pursue non-agricultural careers and, in some cases, actively encourage land conversion. This demonstrates the value of the mixed-methods approach adopted in this study: spatial analysis establishes the scale and pattern of loss and confirms the role of tourism, but it is only through the qualitative and policy dimensions that the full complexity of why conversion happens (and why existing protections fail to prevent it) becomes visible.

The study also found that existing government support programs for farmers and Subak organizations have not been sufficient to halt land conversion. While financial assistance, agricultural subsidies, and other support mechanisms are available, interview respondents consistently highlighted the declining interest of younger generations in farming. Most respondents were aged 45 years and above, and many reported that younger family members increasingly prefer non-agricultural employment. While this study did not directly examine generational attitudes toward farming, these concerns were raised consistently across different Subak organizations. This suggests that the long-term challenge facing the Subak system extends beyond agricultural profitability and land protection, involving broader changes in livelihood aspirations and generational succession within farming communities.

Bali is widely known for its cultural heritage and agricultural landscapes, including its iconic rice paddy terraces. However, both face increasing pressure if current patterns of tourism-driven land conversion continue. The findings of this study suggest that protecting what remains will require not only stronger and more coherent spatial planning regulations, but also recognition that the rice paddy landscape of Kuta Utara is more than agricultural land. It forms the physical basis of the Subak system, and the cultural practices associated with it. At the same time, the findings indicate that regulatory protection alone is unlikely to be sufficient.

6.2. Recommendations

Based on these findings, several recommendations emerge. For the government, the policies protecting rice paddy areas linked to *Subak* require serious and consistent enforcement, as issuing permits alone is insufficient. A regular monitoring system for designated LP2B protection zones should be established, with clear sanctions for violations, including penalties for illegal development, accountability for officials issuing non-compliant permits, and restoration orders for illegally constructed buildings within protected zones. Beyond enforcement, the structural inconsistencies identified in the regulatory framework must be addressed, including incomplete LP2B spatial translations across governance levels and internal mapping discrepancies in the RDTR 2021. Proactive enforcement should be prioritized in the northern villages of Kuta Utara, where tourism pressure remains lower, and planning retains its protective authority, before conversion pressure advances northward beyond the point where intervention remains effective.

At the same time, the economic drivers of land conversion require greater policy attention. Existing incentive schemes for agricultural land protection should be reviewed and redesigned to better reflect the economic realities faced by landowners and farmers. As tourism has become the dominant economic sector in Kuta Utara, the financial returns from maintaining rice paddy land are often not competitive with those generated through leasing, selling, or converting land for tourism-related development. Consequently, incentive mechanisms should provide benefits that are more commensurate with the opportunity costs of retaining agricultural land. For example, compensation schemes or payment for ecosystem services programs could be developed to reward farmers who maintain a specified proportion of their land under rice cultivation, with payments calibrated to partially offset potential income from tourism-related land uses. Such measures would help align conservation objectives with local economic interests and reduce the pressure of LULCC.

Looking ahead, further research could build upon these findings. Future research could strengthen the evidence base on rice paddy conversion in Kuta Utara by incorporating additional temporal observations, including a digitized 2015 rice paddy dataset, to provide a more detailed assessment of land-use change trends over time. Comparative studies across other districts in Bali that are facing growing but lower tourism pressure, such as Tabanan, Gianyar, and Karangasem, would help determine whether the governance patterns documented in Kuta Utara represent a broader regional trajectory. Additionally, a dedicated investigation of the political economy of spatial planning enforcement in

Bali would also help explain why increasingly sophisticated regulatory instruments consistently fail to prevent conversion in practice.

6.3. Use of AI

In preparing this thesis, the author used generative artificial intelligence (AI) tools to assist with grammatical correction and the structural organization of written content. The use of AI was limited to improving the clarity and readability of the author's own ideas, arguments, and findings. All intellectual content, analysis, interpretation, and conclusions presented in this thesis are entirely the author's own. The AI tools were not used to generate research findings, produce data analysis, or develop original arguments. The author takes full responsibility for the accuracy, integrity, and originality of the work presented.

7. REFERENCES

Adey, P., & Lisle, D. (2025). Tourism infrastructures. *Tourism Geographies*, *27*(3–4), 756–766. https://doi.org/10.1080/14616688.2024.2412543

As-syakur, Abd. R., Setiawati, M. D., Novanda, I. G. A., Rachman, H. A., Wirayuda, I. K. A. K., Aryunisha, P. E. P., Saifulloh, Moh., & Pratama, R. T. (2025). Spatio-Temporal Variation Trends of Mangrove Canopy Cover in Urban Areas Using Landsat 8 Imagery and Implications of Management Policies: A Case Study of the Benoa Bay Mangrove Area, Bali, Indonesia. *Wild*, *2*(1), 8. https://doi.org/10.3390/wild2010008

Badan Informasi Geospasial. (2025). Administrative boundary data of Indonesia [Geospatial dataset]. https://www.big.go.id

Badan Pusat Statistik Kabupaten Badung. (2025). Badung Regency in figures 2025 [Statistical report]. Badan Pusat Statistik Kabupaten Badung. https://badungkab.bps.go.id

Berkes, F., & Folke, C. (Eds.). (2002). *Linking social and ecological systems: Management practices and social mechanisms for building resilience* (Transferred to digital printing). Cambridge Univ. Press.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Budiasa, I. W., Setiawan, B., Kato, H., Sekino, N., & Kubota, J. (2015). *The role of the Subak system and tourism on land use changes within the Saba watershed, Northern Bali, Indonesia*. *21*, 31–47.

Chanu, L. K., De, A., Chakraborty, K., & Paul, S. (2023). Characterization of shifting cultivation, trends, and diversification of livelihood patterns: A case study from forest villages in Barak valley, Assam, Northeast India. *Trees, Forests and People*, *14*, 100420. https://doi.org/10.1016/j.tfp.2023.100420

Colorni, R. R. (2018). Tourism and land grabbing in Bali. Transnational Institute. https://www.tni.org/files/publicationdownloads/tourism_and_land_grabbing_in_bali.pdf

Corboș, R.-A., Bunea, O.-I., Bucharest University of Economic Studies, Romania, Moncea, M. I., & Bucharest University of Economic Studies, Romania. (2025, March 27). *A LITERATURE REVIEW ON TOURISM INFRASTRUCTURE INVESTMENTS AND THEIR IMPACT ON TOURISM DEVELOPMENT*. International Management Conference. https://doi.org/10.24818/IMC/2024/03.01

Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (Fifth edition). SAGE.

Cunningham, M. A. (2006). Accuracy assessment of digitized and classified land cover data for wildlife habitat. *Landscape and Urban Planning*, *78*(3), 217–228. https://doi.org/10.1016/j.landurbplan.2005.08.002

Dipson, P. T., Chithra, S. V., Amarnath, A., Smitha, S. V., Harindranathan Nair, M. V., & Shahin, A. (2015). Spatial changes of estuary in Ernakulam district, Southern India for last seven decades, using multi-temporal satellite data. *Journal of Environmental Management*, *148*, 134–142. https://doi.org/10.1016/j.jenvman.2014.02.021

Dwyer, S. C., & Buckle, J. L. (2009). The Space Between: On Being an Insider-Outsider in Qualitative Research. *International Journal of Qualitative Methods*, *8*(1), 54–63. https://doi.org/10.1177/160940690900800105

Egigu, M. L., Moges, A., & Addis, H. K. (2024). Hydro-sediment responses to management options under current and future climate change scenarios in Maybar watershed, South Wollo Zone, Ethiopia. *Environmental Challenges*, *15*, 100896. https://doi.org/10.1016/j.envc.2024.100896

Firman, T. (2009). DECENTRALIZATION REFORM AND LOCAL-GOVERNMENT PROLIFERATION IN INDONESIA: TOWARDS A FRAGMENTATION OF REGIONAL DEVELOPMENT. *Review of Urban & Regional Development Studies*, *21*(2–3), 143–157. https://doi.org/10.1111/j.1467-940X.2010.00165.x

Gao, C., & Cheng, L. (2020). Tourism-driven rural spatial restructuring in the metropolitan fringe: An empirical observation. *Land Use Policy*, *95*, 104609. https://doi.org/10.1016/j.landusepol.2020.104609

Gaughan, A. E., Binford, M. W., & Southworth, J. (2009). Tourism, forest conversion, and land transformations in the Angkor basin, Cambodia. *Applied Geography*, *29*(2), 212–223. https://doi.org/10.1016/j.apgeog.2008.09.007

Gemeda, B. S., Girma Abebe, B., & Eckardt, F. (2021). Urban land speculation; failure of land market. *Survey Review*, *53*(376), 1–7. https://doi.org/10.1080/00396265.2019.1661165

Gössling, S. (2002). Global environmental consequences of tourism. *Global Environmental Change*, *12*(4), 283–302. https://doi.org/10.1016/S0959-3780(02)00044-4

Google. (2025). Google Earth [Satellite imagery]. https://earth.google.com

Google LLC. (2026). Google Earth Pro [Computer software]. https://earth.google.com

Google. (2025). Google Maps [Map]. https://maps.google.com

Guo, R., Zhu, X., & Liu, T. (2023). Automatic detection of crop lodging from multitemporal satellite data based on the isolation forest algorithm. *Computers and Electronics in Agriculture*, *215*, 108415. https://doi.org/10.1016/j.compag.2023.108415

Hall, C. M. (2008). *Tourism planning: Policies, processes and relationships* (2. ed). Prentice Hall.

Hall, C. M., & Page, S. J. (2014). *The Geography of Tourism and Recreation* (0 ed.). Routledge. https://doi.org/10.4324/9780203796092

Healey, P. (1997). *Collaborative Planning* (1st Edition). Red Globe Press. https://doi.org/10.1007/978-1-349-25538-2

Hsieh, H.-F., & Shannon, S. E. (2005). Three Approaches to Qualitative Content Analysis. *Qualitative Health Research*, *15*(9), 1277–1288. https://doi.org/10.1177/1049732305276687

Hudalah, D., & Woltjer, J. (2007). Spatial Planning System in Transitional Indonesia. *International Planning Studies*, *12*(3), 291–303. https://doi.org/10.1080/13563470701640176

Iannucci, G., Martellozzo, F., & Randelli, F. (2022). Sustainable development of rural areas: A dynamic model in between tourism exploitation and landscape decline. *Journal of Evolutionary Economics*, *32*(3), 991–1016. https://doi.org/10.1007/s00191-022-00785-4

Indrawan, I. N. P., Widiatmaka, & Trisasongko, B. H. (2022). Land use land cover change in Badung Regency, Bali. *IOP Conference Series: Earth and Environmental Science*, *950*(1), 012096. https://doi.org/10.1088/1755-1315/950/1/012096

Kelly, A., & Gartland, D. (2016). *Dún Laoghaire-Rathdown Spatial Energy Demand Analysis*. Sustainable Energy Authority of Ireland (SEAI). https://www.seai.ie/sites/default/files/publications/2016_RDD_82._Spatial_Energy_Demand_Analysis_Dun_Laoghaire-Rathdown_-_CODEMA.pdf

Kobo Inc. (n.d.). KoboToolbox [Data collection software]. https://www.kobotoolbox.org

Lambin, E. F. (with Geist, H.). (2006). *Land-Use and Land-Cover Change: Local Processes and Global Impacts*. Springer Berlin / Heidelberg.

Lambin, E. F., Geist, H. J., & Lepers, E. (2003). Dynamics of Land-Use and Land-Cover Change in Tropical Regions. *Annual Review of Environment and Resources*, *28*(1), 205–241. https://doi.org/10.1146/annurev.energy.28.050302.105459

Lansing, J. S. (1987). Balinese "Water Temples" and the Management of Irrigation. *American Anthropologist*, *89*(2), 326–341. https://doi.org/10.1525/aa.1987.89.2.02a00030

Lansing, J. S. (2012). *Perfect Order*. Princeton University Press.

Lansing, J. S., & Kremer, J. N. (1993). Emergent Properties of Balinese Water Temple Networks: Coadaptation on a Rugged Fitness Landscape. *American Anthropologist*, *95*(1), 97–114. https://doi.org/10.1525/aa.1993.95.1.02a00050

Lanya, I., Dibia, I. N., Diara, I. W., & Suarjaya, D. G. (2017). Analysis of Subak Landuse Change Due to Tourism Accomodation Development in North Kuta Sub-district, Badung Regency, Indonesia. *IOP Conference Series: Earth and Environmental Science*, *98*, 012024. https://doi.org/10.1088/1755-1315/98/1/012024

Liu, A., & Wall, G. (2006). Planning tourism employment: A developing country perspective. *Tourism Management*, *27*(1), 159–170. https://doi.org/10.1016/j.tourman.2004.08.004

Liu, L., Liu, X., & Zhang, Y. (2025). Tourism-Driven Land Use Transitions and Rural Livelihood Resilience: A Spatial Production Approach to Sustainable Development in China's Heritage Areas. *Sustainability*, *17*(23), 10839. https://doi.org/10.3390/su172310839

Liu, T., Zhao, S., & Peng, F. (2025). Tourism-driven Commodification of Island Landscapes: An Actor-Network Analysis of Dynamic Mechanisms in Guanglu Island, China. *Chinese Geographical Science*, *35*(4), 867–881. https://doi.org/10.1007/s11769-025-1536-z

Liyanage, N. (2024). *ASSESSING THE RISKS OF LAND USE CHANGES DUE TO TOURISM GROWTH: A CASE STUDY IN ELLA, SRI LANKA: SRI LANKA JOURNAL OF GEOGRAPHY AND ENVIRONMENTAL MANAGEMENT*. *01*, 128–153.

Lorenzen, M. (2021). Rural gentrification, touristification, and displacement: Analysing evidence from Mexico. *Journal of Rural Studies*, *86*, 62–75. https://doi.org/10.1016/j.jrurstud.2021.05.015

Lorenzen, R. P., & Lorenzen, S. (2011). Changing Realities—Perspectives on Balinese Rice Cultivation. *Human Ecology*, *39*(1), 29–42. https://doi.org/10.1007/s10745-010-9345-z

Mahaendrayasa, I. N., Suasih, N. N. R., & Mahaendrayasa, M. S. A. (2024). Polemic on the Agricultural Land Conversion for Tourism Sector in the Province of Bali: Factors and Actors. *Research on World Agricultural Economy*, 270–282. https://doi.org/10.36956/rwae.v5i4.1164

Mahamba, J. A., Kayitoghera, G. M., Musubao, M. K., Chuma, G. B., & Sahani, W. M. (2023). Evolution of gully erosion and susceptibility factors in the urban watershed of the Kimemi (Butembo/DR Congo). *Geography and Sustainability*, *4*(3), 268–279. https://doi.org/10.1016/j.geosus.2023.07.001

Meneghello, S. (2021). The Tourism–Landscape Nexus: Assessment and Insights from a Bibliographic Analysis. *Land*, *10*(4), 417. https://doi.org/10.3390/land10040417

Mir, Y. H., Mir, S., Ganie, M. A., Bhat, J. A., Shah, A. M., Mushtaq, M., & Irshad, I. (2025). Overview of Land Use and Land Cover Change and Its Impacts on Natural Resources. In H. S. Jatav, V. D. Raiput, & T. Minkina (Eds.), *Ecologically Mediated Development: Promoting Biodiversity Conservation and Food Security* (pp. 101–130). Springer Nature Singapore. https://doi.org/10.1007/978-981-96-2413-3_5

Morrison, A. M. (2022). Editorial: Land Issues and Their Impact on Tourism Development. *Land*, *11*(5), 658. https://doi.org/10.3390/land11050658

Mullins, P. (1991). Tourism Urbanization. *International Journal of Urban and Regional Research*, *15*(3), 326–342. https://doi.org/10.1111/j.1468-2427.1991.tb00642.x

Naik, S., Mandal, S., & Mazumdar, J. (2026). The effect of shoreline changes on the development of coastal tourism. *Regional Studies in Marine Science*, *95*, 104847. https://doi.org/10.1016/j.rsma.2026.104847

Nguyen, C. T., Downes, N. K., Sitthi, A., & Losiri, C. (2025). Tourism-Induced Land Use Transformations, Urbanisation, and Habitat Degradation in the Phu Quoc Special Economic Zone. *Urban Science*, *9*(1), 11. https://doi.org/10.3390/urbansci9010011

Norken, I. N. (2019). Efforts to preserve the sustainability of subak irrigation system in Denpasar city, Bali Province, Indonesia. *MATEC Web of Conferences*, *276*, 04002. https://doi.org/10.1051/matecconf/201927604002

Ostrom, E. (2009). A General Framework for Analyzing Sustainability of Social-Ecological Systems. *Science*, *325*(5939), 419–422. https://doi.org/10.1126/science.1172133

Patton, M. Q. (2015). *Qualitative research & evaluation methods: Integrating theory and practice* (Fourth edition). SAGE.

Petrişor, A.-I., Hamma, W., Nguyen, H. D., Randazzo, G., Muzirafuti, A., Stan, M.-I., Tran, V. T., Aştefănoaiei, R., Bui, Q.-T., Vintilă, D.-F., Truong, Q. H., Lixăndroiu, C., Ţenea, D.-D., Sîrodoev, I., & Ianoş, I. (2020). Degradation of Coastlines under the Pressure of Urbanization and Tourism: Evidence on the Change of Land Systems from Europe, Asia and Africa. *Land*, *9*(8), 275. https://doi.org/10.3390/land9080275

Putra, I. N. D., & Hitchcock, M. (2006). The Bali bombs and the tourism development cycle. *Progress in Development Studies*, *6*(2), 157–166. https://doi.org/10.1191/1464993406ps134oa

Raymond, C., & Brown, G. (2007). A Spatial Method for Assessing Resident and Visitor Attitudes Towards Tourism Growth and Development. *Journal of Sustainable Tourism*, *15*(5), 520–540. https://doi.org/10.2167/jost681.0

Rimba, A. B., Atmaja, T., Mohan, G., Chapagain, S. K., Arumansawang, A., Payus, C., & Fukushi, K. (2020). IDENTIFYING LAND USE AND LAND COVER (LULC) CHANGE FROM 2000 TO 2025 DRIVEN BY TOURISM GROWTH: A STUDY CASE IN BALI. *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, *XLIII-B3-2020*, 1621–1627. https://doi.org/10.5194/isprs-archives-XLIII-B3-2020-1621-2020

Roth, D., & Sedana, G. (2015). Reframing *Tri Hita Karana*: From 'Balinese Culture' to Politics. *The Asia Pacific Journal of Anthropology*, *16*(2), 157–175. https://doi.org/10.1080/14442213.2014.994674

Saha, J., & Paul, S. (2021). An insight on land use and land cover change due to tourism growth in coastal area and its environmental consequences from West Bengal, India. *Spatial Information Research*, *29*(4), 577–592. https://doi.org/10.1007/s41324-020-00368-0

Sawungrana, A. R. (2025). *Migrant Children's Wellbeing and Urban Green and Blue Spaces in Enschede* [MSc Thesis]. University of Twente, Faculty of Geo-Information Science and Earth Observation.

Su, Y., Shi, S., Hu, M., & Wu, Y. (2024). Land financialization and gentrification: Evidence from China. *Cities*, *154*, 105330. https://doi.org/10.1016/j.cities.2024.105330

Suanda, D. K., Suryadi, F. X., & Kasniari, D. N. (n.d.). *Bali's Subak water management systems in the past, present and future*. Retrieved https://www.rid.go.th/Thaicid/_6_activity/Technical-Session/SubTheme2/2.17-DK_Suanda-FX_Suryadi-DN_Kasniari.pdf

Sunarta, I. N., Saifulloh, M., & Gadjah Mada University, Faculty of Geography, Master Program on Planning and Management of Coastal Area and Watershed, Yogyakarta, Indonesia. (2022). COASTAL TOURISM: IMPACT FOR BUILT-UP AREA GROWTH AND CORRELATION TO VEGETATION AND WATER INDICES DERIVED FROM SENTINEL-2 REMOTE SENSING IMAGERY. *GeoJournal of Tourism and Geosites*, *41*(2), 509–516. https://doi.org/10.30892/gtg.41223-857

Terkenli, T. S. (2004). Tourism and Landscape. In A. A. Lew, C. M. Hall, & A. M. Williams (Eds.), *A Companion to Tourism* (1st ed., pp. 337–348). Wiley. https://doi.org/10.1002/9780470752272.ch27

Torres, R. M., & Momsen, J. D. (2005). Gringolandia: The Construction of a New Tourist Space in Mexico. *Annals of the Association of American Geographers*, *95*(2), 314–335. JSTOR.

Tunison, S. (2023). Content Analysis. In J. M. Okoko, S. Tunison, & K. D. Walker (Eds.), *Varieties of Qualitative Research Methods* (pp. 85–90). Springer International Publishing. https://doi.org/10.1007/978-3-031-04394-9_14

Turner, B. L., Lambin, E. F., & Reenberg, A. (2007). The emergence of land change science for global environmental change and sustainability. *Proceedings of the National Academy of Sciences*, *104*(52), 20666–20671. https://doi.org/10.1073/pnas.0704119104

Turner, B. L., Meyer, W. B., & Skole, D. L. (1994). Global land-use/land-cover change: Towards an integrated study. *Ambio*, *23*(1), 91–95. Scopus.

Vel, J., Bedner, A., Utama, T. S. J., & Ichlas, H. (2022). Law and Heritage for Protecting Water Resources and Access to Water in Indonesia. *Blue Papers*, *1*(2), 12–23. https://doi.org/10.58981/bluepapers.2022.2.01

Verburg, P. H., Schot, P. P., Dijst, M. J., & Veldkamp, A. (2004). Land use change modelling: Current practice and research priorities. *GeoJournal*, *61*(4), 309–324. https://doi.org/10.1007/s10708-004-4946-y

Wang, J., & Liu, Y. (2013). Tourism-Led Land-Use Changes and their Environmental Effects in the Southern Coastal Region of Hainan Island, China. *Journal of Coastal Research*, *290*, 1118–1125. https://doi.org/10.2112/JCOASTRES-D-12-00039.1

Widiatedja, I. G. N. P. (2022a). The regulatory failure of spatial planning and its environmental impact: A case study of hotel projects in Bali, Indonesia. *Journal of Property, Planning and Environmental Law*, *14*(1), 25–44. https://doi.org/10.1108/JPPEL-10-2021-0048

Widiatedja, I. G. N. P. (2022b). The regulatory failure of spatial planning and its environmental impact: A case study of hotel projects in Bali, Indonesia. *Journal of Property, Planning and Environmental Law*, *14*(1), 25–44. https://doi.org/10.1108/JPPEL-10-2021-0048

Wijaya, A. (2019). Tri Hita Karana: Subak Abian's Wisdom to Improve the Coffee Quality. *Proceedings of the First International Conference on Advances in Education, Humanities, and Language, ICEL 2019, Malang, Indonesia, 23-24 March 2019*. First International Conference on Advances in Education, Humanities, and Language, ICEL 2019, Malang, Indonesia, 23-24 March 2019. https://doi.org/10.4108/eai.23-3-2019.2284919

Zen, I. S., Surata, S. P. K., Titisari, P. W., Ab Rahman, S. A., & Zen, S. (2024). Sustaining subak, the balinese traditional ecological knowledge in the contemporary context of Bali. *IOP*

Conference Series: Earth and Environmental Science, *1306*(1), 012034.

https://doi.org/10.1088/1755-1315/1306/1/012034

8. ANNEXES

8.1. Result extensive table

Table 8-1

Policy content analysis matrix

Policy	Year	Level	Zoning Type	Agricultural Land Protection	Tourism Promotion	Control Strength	Sanctions
Bali Provincial Regulation on Regional Spatial Plan (RTRW) No. 3/2005	2005	Provincial	The spatial plan divides land into protected and development areas. The development (cultivation) areas cover 365,884 ha (64.7% of the provincial area) and include production forests, agriculture, tourism (including special tourism attraction areas/ODTWK), industry, settlements, mining, and defense.	Agriculture area covers 228,153 hectares (40.3%), including wetland and dryland farming as well as plantations, with wetland rice areas accounting for 82,095 hectares (14.56%). Protection is mainly framed through general strategies to optimize use and reduce conversion.	Tourism areas are designated as 15 open zones covering 99,226 hectares (18.0%), with 12,497 hectares (2.2%) allocated for intensive tourism development, though their detailed spatial distribution is not specified. Designation is based on natural, cultural, and infrastructural criteria, and development is directed to balance tourism growth with the protection of conservation areas and productive agricultural land.	Spatial utilization control at the provincial level is implemented through supervision and enforcement, including reporting, monitoring, and evaluation. A Spatial Planning Coordination Team is established to coordinate planning, utilization, and control processes. The system also uses incentive and disincentive instruments to encourage compliance with the spatial plan and discourage non-aligned activities.	The regulation enforces compliance through administrative and criminal sanctions. Administrative measures include activity suspension, business closure, permit revocation, and demolition for non-compliant land use, alongside disciplinary action for officials who breach procedures. It also imposes general obligations to maintain spatial quality and comply with the spatial plan. Violations may lead to criminal penalties of up to six months' imprisonment or fines of up to IDR 50 million, with additional sanctions possible under other laws.
Bali Provincial Regulation on Regional Spatial Plan (RTRW) No. 16/2009 for 2009-2029	2009	Provincial	The spatial plan divides land into protected and development (cultivation) areas. The development (cultivation) areas covering 388,089 hectares (68.9% of Bali	Agricultural designated areas cover 298,214 hectares (52.9%), comprising food crops, horticulture, plantations, and livestock. Food crop cultivation areas (76,337 hectares; 13.5%) are	Tourism areas are designated through three categories: Tourism Areas, Special Tourist Attraction Area (KDTWK), and Tourist Attraction (DTW), with effective tourism	Spatial control is implemented through zoning regulations, licensing systems, incentives and disincentives, and institutional coordination. The	The regulation enforces compliance through administrative, criminal, and civil mechanisms. Administrative sanctions include warnings, suspension of activities, closure, permit

			Province), including production forests, community forests, agriculture, fisheries, tourism, industry, settlements, mining, and other designated uses.	distributed across all regencies/cities and are subject to sustainable agricultural land protection, requiring at least 90% retention of existing agricultural land to reduce conversion pressures while maintaining food security functions.	utilization areas covering 12,512 hectares (2.3%). The policy emphasizes integration of tourism development with accessibility, infrastructure, and socio-cultural assets, while also recognizing that tourism areas may overlap with protected and other development zones, requiring integrated spatial regulation.	framework emphasizes alignment of land use with spatial plans, particularly restricting agricultural land conversion and ensuring that all development activities are subject to formal planning approval and regulatory oversight.	revocation, demolition, and fines. Criminal penalties include up to six months' imprisonment or fines up to IDR 50 million. Additional liability applies to officials issuing non-compliant permits and to parties causing spatial damage, including civil compensation claims.
Badung Regent Regulation No. 26/2013 on the Regional Spatial Plan of Badung Regency for 2013–2033	2013	Regency	The spatial plan divides land into protected and development (cultivation) areas. The development (cultivation) areas cover 38,969.43 ha (93.11% of the regency) and include multiple functional land uses such as forestry, agriculture, fisheries, tourism, industry, settlements, services, education, infrastructure, defense, and green open space.	Agricultural areas occupy 21,060.89 ha (50.32%) and include food crops, horticulture, plantations, and livestock. Food crop zones (9,737.42 ha; 23.27%) are spatially distributed across key sub-subdistricts and are explicitly designated to support food security and maintain cultural identity. Agricultural zoning includes protection of *Subak*-based food crop areas as sustainable agricultural land, maintaining at least 90% of agricultural land, restricting land conversion.	Tourism areas cover 3,515.41 ha (8.40%) and are structured into Tourism Areas, Promoted Special Tourism Attraction Area (KDTWKp), and Tourist Attraction (DTW). Development is concentrated in Kuta and South Badung, particularly Canggu, Tibubeneng, and Kerobokan.	Spatial utilization control is structured through zoning regulations, licensing, incentives and disincentives, and sanctions, and implemented by the Regent through Regional Spatial Planning Coordination Board (BKPRD) with supervision and enforcement support to ensure conformity with spatial plans. Licensing is a key control instrument applied before development, covering principle, location, building, and other permits for all spatial and investment activities. It ensures compliance with the spatial plan (RTRW), supported by BKPRD technical review, and prohibits officials from issuing non-compliant permits.	The enforcement system combines administrative, criminal, and disciplinary sanctions. Administrative measures range from warnings to demolition and fines, while criminal penalties include imprisonment and monetary fines. Additional accountability applies to government officials who violate permitting procedures, reinforcing institutional compliance within spatial governance.

Bali Provincial Regulation Number 3 of 2020 on Amendments to Provincial Regulation Number 16 of 2009 on the Bali Provincial Spatial Plan (RTRW) for the Period 2009–2029	2020	Provincial	The spatial plan divides land into protected and development (cultivation) areas with development (cultivation) areas cover 430,285 ha (76.91% of the province) and include forestry, agriculture, fisheries, tourism, industry, settlements, mining and energy, and other uses, reflecting a dominant allocation of land for productive and economic functions.	Agricultural areas occupy 293,723 ha (52.50%), including food crops, horticulture, plantations, and livestock, with designated Sustainable Food Agricultural Land Area (KP2B) covering 67,668 ha (12.10%) to support food security.	Tourism areas cover 39,369 ha and include Tourism Areas and Tourist Attraction (DTW), distributed across all regencies, with particular emphasis on coastal zones such as Badung regency.	Spatial control is implemented through zoning, permitting, incentives/disincentives, and sanctions directives, with explicit restrictions on agricultural land conversion and detailed regulation of tourism activities, including permitted and conditional uses within designated tourism zones.	The regulation does not clearly specify sanction mechanisms, creating ambiguity compared to earlier regulations that explicitly defined administrative and criminal penalties, and leaving uncertainty regarding enforcement continuity.
Badung Regent Regulation No. 9/2021 on the Detailed Spatial Plan (RDTR) of Kuta Utara 2021–2041	2021	Regency	The regulation defines detailed zoning at the sub-subdistrict level, including agricultural zones (Zona Pertanian – P) with subzones such as food crop areas (P-1), and tourism zones (Zona Pariwisata – W) with subzones including nature tourism (W-1) and artificial tourism (W-2).	Agricultural land is explicitly designated as Sustainable Food Agricultural Land (LP2B), with a total area of approximately 526.95 hectares within Subzone P-1.	Tourism zones cover approximately 416.16 hectares and include both natural tourism and artificial tourism subzones. This demonstrates a clearly defined spatial allocation for tourism development within Kuta Utara.	The regulation provides detailed zoning control instruments, including land use regulations, development intensity (e.g., building density and scale), building regulations, infrastructure requirements, and specific zoning rules. Zoning regulations function as an operational tool for controlling land use, guiding permits, applying incentives and disincentives, and minimizing land use conflicts.	Enforcement is carried out by the local government in accordance with applicable laws and regulations. While specific sanctions are not detailed extensively in this regulation, it refers to the broader legal framework for imposing penalties on violations of spatial planning provisions.
Provincial Regulation of Bali No. 2 of 2023 on the Regional Spatial Plan (RTRW) of Bali Province for 2023–2043	2023	Provincial	The spatial plan divides land into protected and development areas, with development areas including forestry, agriculture, fisheries, salt	Agricultural areas cover 300,411 ha and include food crops, horticulture, plantations, and livestock, with KP2B designated at 53,663 ha.	Tourism areas cover 38,358 ha across terrestrial, coastal, and marine zones, including key coastal regions such as Badung, and are	Spatial control is implemented through zoning directives, monitoring and evaluation, incentives/disincentives,	The regulation applies administrative sanctions for spatial violations, supported by criminal penalties for activities causing changes in

			production, mining and energy, industry, tourism, settlements, transport, and defense.	Land control focuses on maintaining rice field extent to support food security and preserve landscape identity, while detailed regulation is delegated to lower-level spatial plans.	defined by tourism attraction potential and capacity for facility development.	and sanctions. The framework differentiates permitted, conditional, and prohibited activities, with strict controls on agricultural land conversion and regulation of tourism activities to balance development and environmental quality.	spatial functions, with enforcement based on the scale of impact, public loss, and legal provisions.
Badung Regent Regulation No. 4/2025 on (RTRW) Regional Spatial Plan of Badung Regency for 2025–2045	2025	Regency	The spatial plan divides land into protected and development areas, with development zones including road infrastructure, forestry, agriculture, fisheries, mining and energy, industry, tourism, settlements, transport, and defense, reflecting a comprehensive functional land-use structure at the regency level.	Agricultural areas include food crops, horticulture, and plantations, with food crop zones covering 8,445 ha and KP2B designated at 6,675 ha. These areas are concentrated in key subdistricts and further reinforced as strategic agricultural zones, supported by incentives and *Subak*-based institutional strengthening.	Tourism areas cover 5,170 ha and are concentrated in major tourism subdistricts such as Kuta and North Kuta, supported by DTW. North Kuta is designated as a strategic tourism urban area, with development focused on expanding accommodation, attractions, accessibility, and amenities.	Spatial control is implemented through zoning regulations, evaluation mechanisms, incentives/disincentives, and sanctions. Land use is strictly regulated through mandatory spatial permits (KKPR), ensuring that all development activities comply with zoning provisions and spatial plans.	The regulation applies administrative sanctions ranging from warnings to fines, permit revocation, demolition, and spatial restoration, supported by criminal penalties for violations causing changes in spatial functions, with enforcement based on impact and public loss.

8.2. Research Data Management

8.2.1. Research Data Collection

NAME OF DATA FILE	SOURCE	IF SECONDARY, WHO IS THE OWNER?	RESTRICTIONS AND LICENSE	DATA FORM	DATA FORMAT	CONTAINS PERSONAL DATA
kutautara_grid_25selectedsample	Primary	-	-	Geopackage	.gpkg	No
kutautara_grid_500mx500m_coverage	Primary	-	-	Geopackage	.gpkg	No
kutautara_ricepaddy_digitized_2002	Primary	-	-	Geopackage	.gpkg	No
kutautara_ricepaddy_digitized_2020	Primary	-	-	Geopackage	.gpkg	No
kutautara_ricepaddy_digitized_2025	Primary	-	-	Geopackage	.gpkg	No
kutautara_foodcropzone_rtrw_2025	Secondary	Provincial Government of Bali	-	Geopackage	.gpkg	No
kutautara_foodcropzone_rtrw_2013	Secondary	Provincial Government of Bali	-	Geopackage	.gpkg	No
kutautara_boundary	Secondary	Geospatial Information Agency (BIG -- *Badan Informasi Geospasial*)	-	Geopackage	.gpkg	No
kutautara_boundary_village	Secondary	Geospatial Information Agency (BIG -- *Badan Informasi Geospasial*)	-	Geopackage	.gpkg	No
kutautara_lp2b_foodcropzone_rdtr_2021	Secondary	-	-	Geopackage	.gpkg	No
kutautara_ricepaddy_change_2002_2020	Primary	-	-	Geopackage	.gpkg	No
kutautara_ricepaddy_change_2002_2025	Primary	-	-	Geopackage	.gpkg	No
kutautara_ricepaddy_change_2002_2025	Primary	-	-	Geopackage	.gpkg	No
kutautara_zoning_rdtr_2021_clip	Secondary	Provincial Government of Bali	-	Geopackage	.gpkg	No
kutautara_zoning_rtrw_2025_clip	Secondary	Provincial Government of Bali	-	Geopackage	.gpkg	No
kutautara_zoning_rtrw_2013_clip	Secondary	Provincial Government of Bali	-	Geopackage	.gpkg	No
kutautara_*subak*_interview_result	Primary	-	-	Microsoft Excel Worksheet	.xlsx	Yes, Anonymized
kutautara_government_interview_result	-	-	Microsoft Excel Worksheet	.xlsx	Yes, Anonymized	
kutautara_tourisminfra_point	Primary	-	-	Geopackage	.gpkg	Yes, Anonymized
kutautara_tourismarea_rtrw_2025	Secondary	Provincial Government of Bali	-	Geopackage	.gpkg	No
kutautara_tourismarea_rtrw_2013	Secondary	Provincial Government of Bali	-	Geopackage	.gpkg	No
kutautara_tourismzone_rdtr_2021	Secondary	Provincial Government of Bali	-	Geopackage	.gpkg	No

8.2.2. Organizing and Documenting Research Data

Name of main folder(s):	▪ **spatial_data** ▪ **qualitative_data**
Name of secondary or tertiary folders (if applicable):	
Version control strategy:	**Version control was not used in this study.**
Metadata standards used:	**Metadata standard was not used in this study.**
Readme file contents:	**Readme file was not created in this study**

8.2.3. Storage and Sharing of Research Data

Data	**Storage locations** (justify your choices)	**Back-up location and frequency**	**Strategy to prevent unauthorized access to data during research**	**Strategy for pseudonymization or anonymization of data** (if applicable)
Master files	University of Twente (UT) provided OneDrive for Business. Justification: secure, reliable, university-managed storage, compliant with UT data policies and GDPR. Allows for version control and collaborative access with supervisor if needed	Local Drive	Password-protected access to university accounts and storage. Use of strong, unique passwords. Data stored on encrypted university servers. Physical security of university IT infrastructure.	Not applicable for most secondary spatial/administrative data or research codes which do not inherently contain personal identifiers.
Raw interview data and tourism infrastructure points	Password-protected, encrypted local drive. Justification: High security needed before full anonymization for the most sensitive version of the data.	Local Drive	As above. Additionally, limit access to this specific raw data folder strictly to the primary researcher until anonymization is complete.	N/A for this raw stage if it still contains identifiers (anonymization happens next).
Anonymized interview result (.xlsx) and anonymized tourism infrastructure points (.gpkg)	University of Twente (UT) provided OneDrive for Business. Justification: Secure, university-managed storage, compliant with UT data policies and GDPR. Allows for version control and collaborative access with supervisors if needed.	Local Drive	Password-protected access to university accounts and storage. Use of strong, unique passwords. Data stored on encrypted university servers. Physical security of university IT infrastructure.	All direct personal identifiers are not collected. Tourism infrastructure points data aggregated or generalized to prevent re-identification of individual participants (e.g., using common or general terms for each infrastructure, ensuring no single point can be identified to a specific precise location if that was marked). Unique *Subak*'s IDs used are not linked to any identifying information.

8.3. Forms
8.3.1. Consent Form

Information Document for Informed Consent

Project Name: Tourism Driven Land Use Land Cover Changes: Impacts on Traditional Land Governance and Spatial Planning

Student Name: Cening Ayu Merta

S-Number : 3313352

Supervisors :

Dr. Divyani Kohli-Poll Jonker

Andre Da Silva Mano, M.Sc

Contact Information: c.a.merta@student.utwente.nl, phone number : +6285738721576

Purpose of the Project: Tourism Driven Land Use Land Cover Changes: Impacts on Traditional Land Governance and Spatial Planning is a Thesis Project that focused on studying the LULC changes drive by tourism sector in Bali, particularly in Kuta Utara Subdistrict. The main objective of this study is to investigate how tourism-driven development has reshaped land use in Bali from 2004 to 2024, assess the extent to which land conversions align with spatial zoning controls, and examine their implications for traditional land governance, particularly in the *Subak* organization, through the integration of remote sensing analysis, spatial planning regulations, and qualitative interviews with subobjectives including i)To investigate the consequences of land use change on local land governance systems, especially on the *Subak* System; ii)To examine how spatial patterns of land conversion intersect with community perceptions and governance practices under tourism pressures. The main object of this study is *Subak* System that are available in Kuta Utara regency including government. To be able to provide answers to those subobjective interviews (approximately 3 per *Subak* organization) will be conducted with experts (pekaseh/head of the *Subak* organization, penyarikan alit/head of the subdistrict level *Subak* organization, farmers, etc) to help us shed light on aspects such as how rapid tourism-related land conversion affects traditional governance mechanisms, community decision-making, and the resilience of Bali's customary land systems, etc.

Transparency During In-Situ Observations: In addition to interviews, this study includes in-situ field observations, such as GPS-based documentation of land use patterns within the *Subak* landscape. These observations do not involve collecting personal data or direct interaction with individuals. To ensure transparency and avoid any perception of covert research, my presence as a researcher will be clearly communicated. A permission letter will be sent to each village office or urban village office in Kuta Utara Subdistrict to request permission and provide information about the study. A short research notice will be placed in relevant public community areas a few days before data collection, explaining the purpose of the field observations and providing contact details for anyone who wishes to ask questions or raise concerns. During fieldwork, I will carry printed information sheets to explain the study to anyone who approaches me while data is being collected.

Participants for the Interviews: The potential expert profiles to be interviewed are as follows:

- **Head of *Subak* Organisations (Pekaseh):** responsible for managing water distribution, land use coordination, and decision-making within the *Subak* community.
- **Subdistrict-level *Subak* Coordinators (Penyarikan Alit):** coordinate activities among several *Subak* organisations and represent their interests in broader land governance discussions.

- **Farmers and *Subak* Members:** individuals directly engaged in agricultural practices who have experienced land use change and their impact on farming activities.
- **Government Officials:** representatives from local planning or land agencies who oversee zoning, land conversion permits, or tourism development regulations.

Approximately 3 participants will be interviewed from selected *Subak* organisation to ensure that a range of perspectives from leaders to individual farmers are represented.

Interview Outline: We invite you to take part in a short interview that will last approximately **30 minutes**. During this interview, we will discuss your experiences and perspectives related to land use and land cover changes in your area, and how these changes have affected agricultural work and traditional land governance, particularly the *Subak* system. In this context, we will collect and process some limited personal data to help interpret your responses accurately. This includes:

- **Basic demographic information** (gender, role/expertise);
- **Your opinions and experiences** related to land use changes, tourism pressures, and governance practices.

Voluntary Participation: Your participation is entirely voluntary. You may withdraw from the study at any time without any consequences.

Thank you for participating in this Interview for Tourism Driven Land Use Land Cover Changes: Impacts on Traditional Land Governance and Spatial Planning.

What will we do with your data?

The project's deliverables that the interview will derive will not include your personal data or any other information that could identify you.

How can you withdraw your consent?

You can withdraw your consent at any time by communicating by email or call or WhatsApp with the contact person listed above.

Contact Information for Questions or Concerns: If you have any questions or concerns about the research, please contact:

Cening Ayu Merta
c.a.merta@student.utwente.nl
+62 85738721576

Consent Form for the Thesis Project Interviews

YOU WILL BE GIVEN A COPY OF THIS INFORMED CONSENT FORM

Please tick the appropriate boxes	**Yes**	**No**
Taking part in the study		
– I have read and understood the study information dated 10/10/2025. I have been able to ask questions about the study and my questions have been answered to my satisfaction.	□	□
– I consent voluntarily to be a participant in this study and understand that I can refuse to answer questions, and I can withdraw from the study at any time, without having to give a reason.	□	□
– I understand that taking part in the study involves written notes being taken and audio transcripts recorded by the enumerator. The audio transcripts will be deleted later.	□	□

Participants' names will be collected solely for the purpose of obtaining informed consent. All analyses will be conducted using anonymized data (after assigning a unique anonymous identifier to each participant), and no personal identifiable information will be included in any shared dataset or report.

Use of the information in the study		
I understand that information I provide will be used for reports and publications produced as part of the thesis project.	□	□
I agree that my information can be quoted (unnamed) in research outputs	□	□
Future use and reuse of the information by others		
I give permission for the anonymised information that I provide to be archived and published in the DANS repository so it can be used for future research and learning.	□	□

Your expert profile is (*Please select any that apply*):

- ***Subak* Organizational member:** an individual involved in the administration or management of a *Subak* organization, with knowledge of its structure, decision-making, and water management practices.
- **Farmer under a *Subak* Organization:** a farmer who owns or cultivates land managed under a *Subak* irrigation system and participates in its collective agricultural practices.
- **Government Official (Urban Policy and Spatial Planning):** a government representative responsible for the formulation, implementation, or oversight of spatial planning policies, land use regulations, and zoning laws that guide urban development and land management.
- other (please specify) ☐

Gender: How do you identify?

- Man
- Non-binary

- Woman
- I prefer to self describe, below: ☐

What is your age range?

- <26
- 26-45
- 46-65
- >65

What is your education level?

- High School or Less
- Bachelor's Degree
- Master's Degree or higher

I hereby give my consent to the processing of my personal data needed for:

#	Consent Subject	Tick box
1	My participation in an interview that will be carried out by Cening Ayu Merta to understand better how rapid tourism-related land conversion affects traditional governance mechanisms, community decision-making, and the resilience of Bali's customary land systems, etc	

Signatures

_____ _____ _____

Name of participant Signature Date

Study contact details for further information: Cening Ayu Merta, c.a.merta@student.utwente.nl

Contact Information for Questions about Your Rights as a Research Participant

If you have questions about your rights as a research participant, or wish to obtain information, ask questions, or discuss any concerns about this study with someone other than the researcher(s), please contact the Secretary of the Ethics Committee/domain Geo-Information Sciences of the Faculty of Geo-Information Sciences and Earth Observation at the University of Twente by ethicscommittee-geo@utwente.nl

Bahasa Indonesia version

Information Document for Informed Consent

Dokumen Informasi untuk Persetujuan Responden

Judul Penelitian: Perubahan Penggunaan dan Tutupan Lahan yang Didorong oleh Pariwisata: Dampaknya terhadap Tata Kelola Pertanahan Tradisional dan Perencanaan Tata Ruang

Nama Mahasiswa: Cening Ayu Merta

Nomor Mahasiswa : 3313352

Supervisors :

Dr. Divyani Kohli-Poll Jonker

Andre Da Silva Mano, M.Sc

Kontak : c.a.merta@student.utwente.nl, nomor telepon (WA) : +6285738721576

Tujuan Penelitian: Perubahan Penggunaan dan Tutupan Lahan yang Didorong oleh Pariwisata: Dampaknya terhadap Tata Kelola Pertanahan Tradisional dan Perencanaan Tata Ruang merupakan proyek tesis yang mengkaji perubahan penggunaan dan tutupan lahan (Land Use and Land Cover/LULC) yang dipicu oleh sektor pariwisata di Bali, dengan fokus khusus pada Kecamatan Kuta Utara. Tujuan utama penelitian ini adalah untuk menganalisis bagaimana pembangunan yang didorong oleh pariwisata telah membentuk kembali pola penggunaan lahan di Bali selama periode 2004–2024, menilai sejauh mana konversi lahan tersebut sesuai dengan ketentuan zonasi tata ruang, serta mengkaji implikasinya terhadap sistem tata kelola pertanahan tradisional, khususnya organisasi *Subak*.

Penelitian ini mengintegrasikan analisis penginderaan jauh, kajian regulasi tata ruang, dan wawancara kualitatif. Adapun tujuan khusus penelitian ini meliputi: (i) mengkaji dampak perubahan penggunaan lahan terhadap sistem tata kelola pertanahan lokal, terutama sistem *Subak*; dan (ii) menganalisis keterkaitan antara pola spasial konversi lahan dengan persepsi masyarakat serta praktik tata kelola di bawah tekanan pariwisata.

Objek utama penelitian ini adalah sistem *Subak* yang terdapat di Kecamatan Kuta Utara, yang melibatkan institusi adat serta pemangku kepentingan pemerintah terkait. Untuk menjawab tujuan penelitian tersebut, wawancara semi-terstruktur akan dilakukan dengan informan kunci, dengan jumlah sekitar tiga wawancara untuk setiap organisasi *Subak*. Informan yang diwawancarai meliputi pimpinan *Subak* (*pekaseh*), perwakilan *Subak* tingkat kecamatan (*penyarikan alit*), petani, serta pihak-pihak terkait lainnya. Wawancara ini bertujuan untuk menggali pemahaman mengenai bagaimana konversi lahan yang cepat akibat perkembangan pariwisata memengaruhi mekanisme tata kelola tradisional, proses pengambilan keputusan komunitas, serta ketahanan sistem pertanahan adat di Bali.

Transparansi dalam Observasi Lapangan (In-Situ):

Selain wawancara, penelitian ini juga mencakup observasi lapangan secara langsung (*in-situ*), seperti pendokumentasian pola penggunaan lahan di dalam lanskap *Subak* berbasis GPS. Kegiatan observasi ini tidak melibatkan pengumpulan data pribadi maupun interaksi langsung dengan individu. Untuk menjamin transparansi

dan menghindari persepsi adanya penelitian tersembunyi, keberadaan peneliti akan dikomunikasikan secara terbuka.

Surat permohonan izin penelitian akan disampaikan kepada setiap kantor *desa* atau *kelurahan* di Kecamatan Kuta Utara sebagai bentuk permohonan izin sekaligus penyampaian informasi mengenai pelaksanaan penelitian. Selain itu, pemberitahuan singkat mengenai kegiatan penelitian akan ditempatkan di ruang-ruang publik komunitas yang relevan beberapa hari sebelum pengumpulan data. Pemberitahuan tersebut akan menjelaskan tujuan observasi lapangan serta mencantumkan informasi kontak yang dapat dihubungi apabila terdapat pertanyaan atau keberatan. Selama pelaksanaan kerja lapangan, peneliti akan membawa lembar informasi tercetak untuk menjelaskan tujuan dan ruang lingkup penelitian kepada siapa pun yang mendekati peneliti pada saat pengumpulan data berlangsung.

Partisipan Wawancara:

Profil calon partisipan ahli yang akan diwawancarai dalam penelitian ini meliputi:

- **Ketua Organisasi *Subak* (*Pekaseh*):** bertanggung jawab atas pengelolaan distribusi air, koordinasi penggunaan lahan, serta pengambilan keputusan di dalam komunitas *Subak*.
- **Koordinator *Subak* Tingkat Kecamatan (*Penyarikan Alit*):** mengoordinasikan kegiatan antar beberapa organisasi *Subak* serta mewakili kepentingan *Subak* dalam pembahasan tata kelola pertanahan yang lebih luas.
- **Petani dan Anggota *Subak*:** individu yang terlibat langsung dalam praktik pertanian dan memiliki pengalaman terhadap perubahan penggunaan lahan serta dampaknya terhadap kegiatan pertanian.
- **Pejabat Pemerintah:** perwakilan dari instansi perencanaan atau pertanahan di tingkat lokal yang memiliki kewenangan dalam pengawasan zonasi, perizinan konversi lahan, atau regulasi pembangunan pariwisata.

Sekitar tiga partisipan akan diwawancarai dari setiap organisasi *Subak* yang dipilih, guna memastikan keterwakilan beragam perspektif, mulai dari pengurus hingga petani sebagai pelaku langsung di lapangan.

Garis Besar Wawancara: Kami mengundang Anda untuk berpartisipasi dalam wawancara singkat yang akan berlangsung sekitar 30 menit. Dalam wawancara ini, kami akan membahas pengalaman dan pandangan Anda terkait perubahan penggunaan dan tutupan lahan di wilayah Anda, serta bagaimana perubahan tersebut memengaruhi kegiatan pertanian dan tata kelola lahan tradisional, khususnya sistem *Subak*. Dalam konteks ini, kami akan mengumpulkan dan mengolah sejumlah data pribadi terbatas untuk membantu interpretasi jawaban Anda secara akurat. Data tersebut meliputi:

- Informasi demografis dasar (jenis kelamin, peran/keahlian);
- Pendapat dan pengalaman Anda terkait perubahan penggunaan lahan, tekanan pariwisata, dan praktik tata kelola.

Partisipasi Sukarela: Partisipasi Anda sepenuhnya bersifat sukarela. Anda dapat mengundurkan diri dari penelitian ini kapan saja tanpa konsekuensi apapun.

Terima kasih atas partisipasi Anda dalam wawancara untuk penelitian *Tourism Driven Land Use Land Cover Changes: Impacts on Traditional Land Governance and Spatial Planning*.

Apa yang akan kami lakukan dengan data Anda?

Hasil dari penelitian ini yang diperoleh melalui wawancara tidak akan memuat data pribadi Anda ataupun informasi lain yang dapat mengidentifikasi Anda.

Bagaimana cara menarik kembali persetujuan Anda?

Anda dapat menarik kembali persetujuan kapan saja dengan menghubungi kontak person yang tertera di atas melalui email, telepon, atau WhatsApp.

Informasi Kontak untuk Pertanyaan atau Keluhan:

Jika Anda memiliki pertanyaan atau kekhawatiran terkait penelitian ini, silakan menghubungi:

Cening Ayu Merta
c.a.merta@student.utwente.nl
+62 85738721576

Formulir Persetujuan untuk Wawancara Tesis

ANDA AKAN MENDAPATKAN SALINAN FORMULIR PERSETUJUAN INI

Silahkan centang pada kotak yang sesuai	**Ya**	**Tidak**
Pernyataan Persetujuan Berpartisipasi dalam Penelitian		
– Saya telah membaca dan memahami informasi penelitian tertanggal 10/10/2025. Saya dapat mengajukan pertanyaan mengenai penelitian ini dan semua pertanyaan saya telah dijawab dengan memuaskan.	□	□
– Saya secara sukarela menyetujui untuk menjadi peserta penelitian ini dan memahami bahwa saya dapat menolak menjawab pertanyaan serta dapat menarik diri dari penelitian kapan saja tanpa perlu memberikan alasan.	□	□
– Saya memahami bahwa dalam penelitian ini akan dilakukan pencatatan tertulis dan perekaman audio oleh enumerator. Rekaman audio tersebut akan dihapus setelahnya.	□	□

Nama peserta hanya akan dikumpulkan untuk tujuan memperoleh persetujuan yang diinformasikan. Semua analisis akan dilakukan menggunakan data anonim (setelah pemberian identifikasi anonim unik kepada setiap peserta), dan tidak ada informasi pribadi yang dapat mengidentifikasi individu yang akan dimasukkan dalam dataset atau laporan yang dibagikan.

Penggunaan Informasi dalam Penelitian		
Saya memahami bahwa informasi yang saya berikan akan digunakan untuk laporan dan publikasi yang dihasilkan sebagai bagian dari proyek tesis ini.	□	□
Saya setuju bahwa informasi saya dapat dikutip dalam hasil penelitian tanpa mencantumkan nama.	□	□
Penggunaan dan Pemanfaatan Data di Masa Depan oleh Pihak Lain		
Saya memberikan izin agar informasi anonim yang saya berikan dapat diarsipkan dan dipublikasikan dalam repositori DANS untuk digunakan dalam penelitian dan pembelajaran di masa depan.	□	□

Profesi anda dalam penelitian ini (silahkan centang yang sesuai)

- **Anggota Organisasi *Subak*:** individu yang terlibat dalam administrasi atau manajemen organisasi *Subak*, dengan pengetahuan tentang struktur, pengambilan keputusan, dan pengelolaan air**.**
- **Petani dalam Organisasi *Subak*:** petani yang memiliki atau mengelola lahan di bawah sistem irigasi *Subak* dan berpartisipasi dalam praktik pertanian kolektif.
- **Pejabat Pemerintah (Kebijakan Perkotaan dan Perencanaan Tata Ruang)**: perwakilan pemerintah yang bertanggung jawab atas perumusan, pelaksanaan, atau pengawasan kebijakan tata ruang, regulasi penggunaan lahan, dan peraturan zonasi yang mengatur pembangunan perkotaan dan pengelolaan lahan.
- Lainnya (harap sebutkan):

Jenis Kelamin: Bagaimana Anda mengidentifikasi diri?

- Pria
- Non-binary
- Wanita
- Saya memilih untuk meneskripsikan diri: ☐

Rentang Usia Anda?

- <26
- 26-45
- 46-65
- >65

Tingkat Pendidikan Anda?

- SMA atau kurang
- Sarjana
- Magister atau lebih tinggi

Saya dengan ini memberikan persetujuan untuk pemrosesan data pribadi saya yang diperlukan untuk:

#	Subjek Persetujuan	Centang
1	Partisipasi saya dalam wawancara yang akan dilakukan oleh Cening Ayu Merta untuk memahami lebih baik bagaimana konversi lahan yang cepat akibat pariwisata memengaruhi mekanisme tata kelola tradisional, pengambilan keputusan komunitas, dan ketahanan sistem adat Bali, dll.	

Tanda Tangan

_____ _____ _____

Nama Peserta Tanda Tangan Tanggal

Kontak Peneliti untuk Informasi Lebih Lanjut:
Cening Ayu Merta
c.a.merta@student.utwente.nl

Informasi Kontak untuk Pertanyaan tentang Hak Anda sebagai Peserta Penelitian:

Jika Anda memiliki pertanyaan tentang hak Anda sebagai peserta penelitian, atau ingin memperoleh informasi, mengajukan pertanyaan, atau membahas kekhawatiran mengenai penelitian ini dengan pihak selain peneliti, silakan menghubungi Sekretaris Komite Etik/domain Geo-Information Sciences Fakultas Geo-Information Sciences and Earth Observation Universitas Twente melalui email: ethicscommittee-geo@utwente.nl

8.4. Questionnaire

8.4.1. For Pekaseh

Background and role

1. **Question:** Which if the following best describes your role in the *Subak*?

   Coding categories: (single choice)

   A. Head of the *Subak*
   B. *Subak* Board member at subdistrict level
   C. Another organisational role
   D. Farmer

2. **Question:** How long have you held this position?

   Coding categories: (single choice)

   A. <5 years
   B. 5–10 years
   C. >10 years

Observations of land conversion

3. **Question:** Considering the categories below Indicate the level of impact in the *Subak* areas where rice paddy areas were converted to built-up.

   Coding categories: (multiple choices)

   A. Irrigation/water management disruption
   Minor Impact Moderate Impact Major Impact

   B. Decline in membership or participation
   Minor Impact Moderate Impact Major Impact

   D. Cultural/ritual decline
   Minor Impact Moderate Impact Major Impact

   E. Environmental changes (soil quality reduction, increased pest, etc)
   Minor Impact Moderate Impact Major Impact

   F. Other (please specify)
   Minor Impact Moderate Impact Major Impact

4. **Question:** In your observation, what area (ha) has been converted to built-up since you have the role? **(approximate number in ha)**

5. **Question:** What types of pressures and challenges influence farmers' decisions to sell their rice fields?

   Coding categories: (multiple choices)

   A. Financial hardship or debt
   B. Needing fund for family expense (education, healthcare, ceremonies or daily living)
   C. Lack of profitability in farming
   D. Rising land values
   E. Developer demands
   F. Selling lands to pursue alternatives livelihoods; working in tourism
   G. Selling lands to pursue alternatives livelihoods; open a business

H. Personal choice even without financial crisis
I. Decline in agricultural productivity

Organizational responses

6. **Question:** Consider a condition where a *Subak* member sold or converted their rice paddy area to built up. Which of the following best describes the organization response?

   Coding categories: (multiple choices)

   A. Negotiation/persuasion
   B. Enforcement of the customary rules
   C. Acceptance/adaptation
   D. Organizational adjustment (reallocation, mapping)
   E. Consult with external authorities

7. **Question:** What measures has the *Subak* organization taken to prevent or manage land conversion?

   Coding categories: (multiple choices)

   A. Education/awareness campaigns
   B. Monitoring/inspection
   C. Formal regulations or sanctions
   D. Adaptation of irrigation or resource allocation
   E. Collaboration with local government/NGOs

Perceptions and reflections

8. **Question:** How do you perceive the decision of a *Subak* member to sell their rice paddy area, particularly if it will be converted into non-farming land?

   Coding categories: (single choice)

   A. Understanding/acceptance
   B. Concern or disapproval
   C. Neutral/factual observation

9. **Question:** What do you think would happen if most or all *Subak* land were converted to built-up or non-farming areas?

   Coding categories: (multiple choices)

   A. Loss of cultural and ritual functions
   B. Loss of irrigation/control
   C. Organizational weakening
   D. Shift to heritage/tourism role
   E. Economic opportunities
   F. Infrastructure and modernization benefit
   G. Cultural adaptation/resilience
   H. Diversification of livelihoods

10. **Question:** In your view, what role does spatial planning play in protecting or managing *Subak* land?

    Coding categories: (single choice)

    A. Important/strong influence

B. Moderately important
C. Limited or ineffective
D. Other (describe)

Bahasa Indonesia versions

Latar belakang dan peran

1. **Pertanyaan:** Menurut Anda, peran Anda di dalam *Subak* saat ini paling sesuai dengan yang mana?
   Kategori pengkodean: (pilihan tunggal)
   A. Pekaseh (Ketua *Subak*)
   B. Pengurus *Subak* di tingkat kecamatan/kabupaten
   C. Peran organisasi lainnya
   D. Petani/anggota *Subak*

2. **Pertanyaan:** Sudah berapa lama Anda menjalankan peran ini?
   Kategori pengkodean: (pilihan tunggal)
   A. Kurang dari 5 tahun
   B. 5–10 tahun
   C. Lebih dari 10 tahun

Pengamatan terhadap konversi lahan

3. **Pertanyaan:** Berdasarkan pengalaman Anda, bagaimana tingkat dampak di wilayah *Subak* ketika sawah dikonversi menjadi bangunan (seperti villa, perumahan, dll.)?
   Kategori pengkodean: (pilihan ganda)

   A. Gangguan pada sistem irigasi/pengelolaan air
   Dampak kecil Dampak sedang Dampak besar

   B. Penurunan jumlah anggota atau partisipasi dalam *Subak*
   Dampak kecil Dampak sedang Dampak besar

   D. Berkurangnya kegiatan adat/ritual *Subak*
   Dampak kecil Dampak sedang Dampak besar

   E. Perubahan lingkungan (misalnya kualitas tanah menurun, hama meningkat, dll.)
   Dampak kecil Dampak sedang Dampak besar

   F. Lainnya (sebutkan)
   Dampak kecil Dampak sedang Dampak besar

4. **Pertanyaan:** Sepengetahuan Anda, kira-kira berapa luas sawah (dalam hektar) yang sudah dikonversi menjadi bangunan sejak Anda menjabat? (perkiraan saja)

5. **Pertanyaan:** Menurut Anda, apa saja tekanan atau alasan yang biasanya membuat petani memutuskan untuk menjual sawahnya?
   Kategori pengkodean: (pilihan ganda)

   A. Kesulitan ekonomi atau memiliki utang
   B. Kebutuhan biaya keluarga (sekolah, kesehatan, upacara adat, kebutuhan sehari-hari)
   C. Hasil bertani kurang menguntungkan
   D. Harga tanah yang semakin tinggi
   E. Adanya permintaan dari pengembang/investor
   F. Ingin beralih pekerjaan, misalnya bekerja di sektor pariwisata
   G. Ingin beralih usaha, misalnya membuka bisnis sendiri

H. Keputusan pribadi meskipun tidak dalam kondisi ter*desa*k
I. Penurunan produktivitas pertanian

Respons organisasi

6. **Pertanyaan:** Jika ada anggota *Subak* yang menjual atau mengonversi sawahnya, biasanya bagaimana respons dari *Subak*?
   Kategori pengkodean: (pilihan ganda)

   A. Negosiasi atau pendekatan secara persuasif
   B. Penegakan aturan adat (*awig-awig*)
   C. Menerima kondisi dan beradaptasi
   D. Penyesuaian dalam organisasi (misalnya pembagian air, pemetaan ulang)
   E. Berkoordinasi dengan pihak luar (pemerintah, dll.)

7. **Pertanyaan:** Upaya apa saja yang sudah dilakukan *Subak* untuk mencegah atau mengelola konversi lahan?
   Kategori pengkodean: (pilihan ganda)

   A. Sosialisasi atau peningkatan kesadaran
   B. Pemantauan atau pengawasan
   C. Penerapan aturan atau sanksi
   D. Penyesuaian sistem irigasi atau pembagian sumber daya
   E. Kerja sama dengan pemerintah daerah atau LSM

Persepsi dan refleksi

8. **Pertanyaan:** Bagaimana pandangan Anda terhadap keputusan anggota *Subak* yang menjual sawahnya, terutama jika akan dijadikan lahan non-pertanian?
   Kategori pengkodean: (pilihan tunggal)

   A. Bisa memahami/menerima
   B. Merasa khawatir atau tidak setuju
   C. Netral, melihat sebagai kenyataan di lapangan

9. **Pertanyaan:** Menurut Anda, apa yang akan terjadi jika sebagian besar atau seluruh lahan *Subak* berubah menjadi bangunan atau non-pertanian?
   Kategori pengkodean: (pilihan ganda)

   A. Hilangnya fungsi adat dan ritual *Subak*
   B. Hilangnya sistem irigasi dan pengelolaan air
   C. Melemahnya kelembagaan *Subak*
   D. Beralih menjadi fungsi pariwisata atau warisan budaya
   E. Munculnya peluang ekonomi baru
   F. Perkembangan infrastruktur dan modernisasi
   G. Adaptasi atau ketahanan budaya
   H. Diversifikasi mata pencaharian

10. **Pertanyaan:** Menurut Anda, seberapa besar peran tata ruang dalam melindungi atau mengatur lahan *Subak*?
    Kategori pengkodean: (pilihan tunggal)

A. Sangat penting dan berpengaruh besar
B. Cukup penting
C. Kurang berpengaruh atau belum efektif
D. Lainnya (jelaskan)

8.4.2. For Farmers

Background

1. **Question:** How long have you been engaged in farming within the *Subak*?

   Coding categories: (single choice)

   - A. <5 years
   - B. 5–10 years
   - C. >10 years

2. Land conversion experience

2. **Question:** Have you sold or converted any of your rice paddy land? If yes, could you explain the reasons?

   Coding categories: (multiple choices)

   A. Financial hardship or debt
   B. Needing fund for family expense (education, healthcare, ceremonies or daily living)
   C. Lack of profitability in farming
   D. Rising land values
   E. Developer demands
   F. Selling lands to pursue alternatives livelihoods; working in tourism
   G. Selling lands to pursue alternatives livelihoods; open a business
   H. Personal choice even without financial crisis
   I. Decline in agricultural productivity
   J. Did not sell/convert

3. **Question:** How have land conversions affected your farming practices or daily work?

   Coding categories: (multiple choices)

   A. Irrigation/water management disruption
   Minor Impact Moderate Impact Major Impact

   B. Decline in membership or participation
   Minor Impact Moderate Impact Major Impact

   D. Cultural/ritual decline
   Minor Impact Moderate Impact Major Impact

   E. Environmental changes (soil quality reduction, increased pest, etc)
   Minor Impact Moderate Impact Major Impact

   F. Other (please specify)
   Minor Impact Moderate Impact Major Impact

4. **Question:** In your observation, what area (ha) has been converted to built-up since you for the last 5 year? **(approximate number in ha)**

Effects on *Subak* organization

5. **Question:** In your view, how do land conversions affect the functioning of the *Subak* organization?

   Coding categories: (multiple choices)

   A. Decline in membership or participation
   B. Irrigation disruption
   C. Reduced financial contributions
   D. Weakening of rituals/tradition

6. **Question:** Have you raised concerns about land conversion with the *Subak* organization? How did the organization respond?

   Coding categories: (single choice)

   A. Raised concern; organization acted
   B. Raised concern; organization did not act
   C. Did not raise concern; organization acted
   D. Did not raise concern; organization did not act
   E. Other (describe)

7. **Question:** What would be the impact on the *Subak* and community if most rice paddies were converted into non-farming areas?

   Coding categories: (multiple choices)

   A. Loss of farming productivity
   B. Decline of rituals/cultural practices
   C. Social/organizational weakening
   D. Shift toward tourism/heritage functions
   E. Economic opportunities
   F. Infrastructure and modernization benefit
   G. Cultural adaptation/resilience
   H. Diversification of livelihoods

Bahasa Indonesia version

Latar belakang

1. **Pertanyaan:** Sudah berapa lama Anda terlibat dalam kegiatan bertani di *Subak*?
   Kategori pengkodean: (pilihan tunggal)
   A. Kurang dari 5 tahun
   B. 5–10 tahun
   C. Lebih dari 10 tahun

Pengalaman konversi lahan

2. **Pertanyaan:** Apakah Anda pernah menjual atau mengonversi sawah yang Anda miliki? Jika ya, apa alasannya?
   Kategori pengkodean: (pilihan ganda)

A. Kesulitan ekonomi atau memiliki utang
B. Kebutuhan biaya keluarga (pendidikan, kesehatan, upacara adat, atau kebutuhan sehari-hari)
C. Hasil bertani kurang menguntungkan
D. Harga tanah yang semakin tinggi
E. Adanya permintaan dari pengembang/investor
F. Menjual lahan untuk beralih pekerjaan, misalnya bekerja di sektor pariwisata
G. Menjual lahan untuk beralih usaha, misalnya membuka bisnis sendiri
H. Keputusan pribadi meskipun tidak dalam kondisi ter*desa*k
I. Penurunan produktivitas pertanian
J. Tidak pernah menjual/mengonversi lahan

3. **Pertanyaan:** Menurut pengalaman Anda, bagaimana dampak konversi lahan terhadap kegiatan bertani atau pekerjaan sehari-hari Anda?
   Kategori pengkodean: (pilihan ganda)

   A. Gangguan pada sistem irigasi/pengelolaan air
   Dampak kecil Dampak sedang Dampak besar

   B. Penurunan jumlah anggota atau partisipasi dalam *Subak*
   Dampak kecil Dampak sedang Dampak besar

   D. Berkurangnya kegiatan adat/ritual *Subak*
   Dampak kecil Dampak sedang Dampak besar

   E. Perubahan lingkungan (misalnya kualitas tanah menurun, hama meningkat, dll.)
   Dampak kecil Dampak sedang Dampak besar

   F. Lainnya (sebutkan)
   Dampak kecil Dampak sedang Dampak besar

4. **Pertanyaan:** Menurut pengamatan Anda, dalam 5 tahun terakhir kira-kira berapa luas sawah (dalam hektar) yang sudah dikonversi menjadi bangunan? (perkiraan saja)

Dampak terhadap organisasi *Subak*

5. **Pertanyaan:** Menurut Anda, bagaimana konversi lahan memengaruhi jalannya organisasi *Subak*?
   Kategori pengkodean: (pilihan ganda)

   A. Penurunan jumlah anggota atau partisipasi
   B. Gangguan pada sistem irigasi
   C. Berkurangnya iuran atau kontribusi anggota
   D. Melemahnya pelaksanaan ritual atau tradisi

6. **Pertanyaan:** Apakah Anda pernah menyampaikan kekhawatiran terkait konversi lahan kepada *Subak*? Bagaimana respons dari organisasi?
   Kategori pengkodean: (pilihan tunggal)

   A. Pernah menyampaikan, dan organisasi mengambil tindakan
   B. Pernah menyampaikan, tetapi organisasi tidak mengambil tindakan
   C. Tidak menyampaikan, tetapi organisasi tetap mengambil tindakan
   D. Tidak menyampaikan, dan organisasi juga tidak mengambil tindakan
   E. Lainnya (jelaskan)

7. **Pertanyaan:** Menurut Anda, apa dampaknya bagi *Subak* dan masyarakat jika sebagian besar sawah dikonversi menjadi lahan non-pertanian?
   Kategori pengkodean: (pilihan ganda)

A. Penurunan produksi pertanian
B. Berkurangnya kegiatan ritual/adat
C. Melemahnya hubungan sosial dan organisasi
D. Peralihan fungsi ke pariwisata atau warisan budaya

8.4.3. For Government Representatives

Spatial Planning and *Subak*

1. **Question:** What are the factors that influence spatial planning revision/changes?
2. **Question:** How is the *Subak* area recognized or incorporated into spatial planning?
3. **Question:** How is the *Subak* area protected under the spatial planning regulations?
4. **Question:** What are the main challenges in protecting *Subak* areas under current spatial planning regulations?

Policy Implementation

5. **Question:** How are land-use and zoning regulations enforced in your jurisdiction?
6. **Question:** What monitoring mechanisms are used to ensure compliance with spatial planning regulations?

LULCC and Tourism Pressure

7. **Question:** What measures has the government taken to control or manage land conversion for tourism-related activities?
8. **Question:** How are conflicts between agricultural preservation and tourism development typically resolved?

Coordination and Community Engagement

9. **Question:** What roles do local communities and *Subak* leaders play in spatial planning or land-use decision-making?

Bahasa Indonesia version

Perencanaan Tata Ruang dan Subak

1. **Pertanyaan:** Faktor-faktor apa saja yang memengaruhi revisi atau perubahan rencana tata ruang?
2. **Pertanyaan:** Bagaimana kawasan Subak diakui atau diintegrasikan dalam perencanaan tata ruang?
3. **Pertanyaan:** Bagaimana kawasan Subak dilindungi dalam peraturan tata ruang?
4. **Pertanyaan:** Apa saja tantangan utama dalam melindungi kawasan Subak berdasarkan peraturan tata ruang yang berlaku saat ini?

Implementasi Kebijakan

5. **Pertanyaan:** Bagaimana peraturan tata guna lahan dan zonasi ditegakkan di wilayah Anda?
6. **Pertanyaan:** Mekanisme pemantauan apa yang digunakan untuk memastikan kepatuhan terhadap peraturan tata ruang?

Perubahan Penggunaan Lahan dan Tekanan Pariwisata

7. **Pertanyaan:** Langkah-langkah apa yang telah diambil pemerintah untuk mengendalikan atau mengelola alih fungsi lahan untuk kegiatan terkait pariwisata?
8. **Pertanyaan:** Bagaimana konflik antara mempertahankan lahan pertanian dan pengembangan pariwisata biasanya diselesaikan?

Koordinasi dan Keterlibatan Masyarakat

9. **Pertanyaan:** Apa peran masyarakat lokal dan pemimpin Subak dalam perencanaan tata ruang atau pengambilan keputusan terkait penggunaan lahan?