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PRESERVING HERITAGE, PROMOTING GROWTH: THE TOURISM CARRYING CAPACITY OF SUBAK PULAGAN

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Abstract: This study aims to analyze the Tourism Carrying Capacity (TCC) of Subak Pulagan in Gianyar, Bali, and propose adaptive policy directions that integrate tourism with sustainable agricultural practices, ensuring the preservation of its ecological and socio-cultural dimensions. The research utilized a mixed-method approach, combining field observations, spatial measurements, and TCC analysis, including physical, real, and effective capacities. Prospective policy analysis using MULTIPOL was employed to explore various future scenarios and formulate responsive strategies. The research utilized a mixed-method approach, combining field observations, spatial measurements, and TCC analysis (physical, real, and effective). Prospective policy analysis using MULTIPOL was employed to develop policy alternatives based on multiple scenarios. The findings indicate that Subak Pulagan has considerable potential for eco-agro-tourism development, supported by its cultural significance and landscape beauty. Existing tourism activities remain within acceptable limits, presenting an opportunity for growth. However, several limitations must be addressed, such as weak infrastructure, institutional fragmentation, and low community engagement in tourism planning and management. The policy analysis identified several strategic directions, including rural tourism development, infrastructure upgrades, and the empowerment of local communities through education and participatory governance. Strengthening Subak institutions is also key to maintaining agricultural traditions alongside tourism growth. Integrated programs involving marketing, heritage conservation, and inter-sectoral collaboration are essential. With careful planning and inclusive policies, Subak Pulagan can become a leading model of sustainable tourism in rural heritage landscapes. Such development must be grounded in conservation values and respect for local wisdom to ensure long-term resilience and benefits for future generations.

Keywords: tourism carrying capacity, sustainable tourism, eco-tourism, sustainable agriculture, world cultural heritage

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INTRODUCTION

Sustainable agriculture-based tourism (agro-tourism) has become an important model in developing tourist destinations that not only aim to increase local economic income but also to preserve natural resources and culture (Maamar & Abbadie, 2025; Wirahayu et al., 2022). Agro-tourism integrates traditional agricultural activities with educational and interactive tourist experiences, thereby strengthening the economic resilience of local communities while maintaining environmental sustainability (Tew et al., 2017). In this context, Subak Pulagan, as part of the Cultural Landscape of Bali Province recognized by UNESCO, serves as a prime example of a traditional agricultural system combining social, cultural, and ecological values.

The Subak Pulagan system is a traditional institution for managing irrigation water that has been practiced for generations in Bali. The uniqueness of Subak lies not only in its irrigation technology but also in the social and religious values that bind the community in harmonious cooperation (Suasih et al., 2024; Putra et al., 2023). The sustainability of this system heavily depends on how the community and stakeholders maintain the balance between land use, water resource conservation, and cultural preservation (Budiasa et al., 2015). Therefore, tourism development in this area must be carefully planned so as not to disrupt the ecological and social functions of Subak Pulagan. The tourism potential of Subak Pulagan is significant due to its status as a UNESCO World Cultural Heritage site, attracting both domestic and international tourists. This recognition not only elevates the cultural value and uniqueness of the Subak agricultural system but also opens great opportunities for developing agro and cultural tourism sectors. Destinations offering authentic experiences, beautiful landscapes, and community interactions are increasingly favored by modern tourists seeking sustainable and educational tourism (Richards, 2018).

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However, the World Cultural Heritage designation carries a dual consequence. On one hand, it acts as a major attraction that can boost visitor numbers and provide substantial economic benefits for the local community (Hosseini et al., 2021). On the other hand, it demands strict preservation to ensure that the cultural values and ecosystems underpinning this heritage are not damaged by over-tourism or uncontrolled development (Mustra et al., 2023; UNESCO, 2018). Therefore, tourism development in Subak Pulagan must prioritize conservation principles and implement strict limits on visitor management.

As tourist visits increase, Subak Pulagan faces significant pressures on its environmental and social capacity. Without proper management, a surge in tourists can lead to degradation of agricultural land, pollution, cultural shifts, and social conflicts (Miller et al., 2019). This situation necessitates a comprehensive understanding of Tourism Carrying Capacity (TCC), defined as the maximum number of tourists a destination can accommodate without causing significant negative impacts on its environment, economy, and socio-cultural conditions (Coccossis & Mexa, 2004).

TCC analysis is a critical tool in formulating sustainable tourism management policies. Knowing the capacity limits enables managers to design strategies to regulate visitor numbers and behavior within safe bounds (Suasih et al., 2024). International studies demonstrate that effective application of TCC can mitigate risks of over-tourism and reinforce preservation efforts in vulnerable destinations (Gössling et al., 2021).

Beyond capacity measurement, developing adaptive and scenario-based policies is key to addressing the uncertainties and dynamics of socio-economic and environmental changes. MULTIPOL (Multi Policy) analysis techniques, combining quantitative and qualitative methods, enable researchers to identify various policy alternatives and evaluate their comprehensive impacts (Papadopoulou et al., 2025). This approach also supports the design of potential path policies that are realistic and flexible in anticipating changing conditions on the ground. Research by Suasih et al. (2024) applied Bayesian Networks to predict agricultural sustainability in Subak Pulagan, indicating that integrating statistical methods with policy management can provide deep insights into influencing factors and possible future scenarios. A broader multipol approach can complement this by including more dynamic social and policy aspects. Furthermore, sustainable agro-tourism development in Subak Pulagan is not only about environmental preservation but also about empowering local communities to gain equitable economic benefits. Hence, policy formulation should focus on inclusive development, considering the interests of farmers and indigenous communities as the primary owners and custodians of this cultural heritage.

Other challenges to anticipate include globalization pressures and climate change, which can disrupt the stability of agricultural and tourism systems. Management policies must be responsive to these threats with strong adaptation strategies such as diversifying tourism products and developing environmentally friendly agricultural technologies (Gössling et al., 2021).

Overall, this study aims to provide a comprehensive overview of Subak Pulagan's tourism capacity and sustainable development policies. This is crucial to ensure that tourism grows as a source of prosperity without compromising the ecological and cultural functions of the area. The objectives of this study are: (1) to comprehensively analyze the Tourism Carrying Capacity in Subak Pulagan to understand the destination's support limits for tourism activities, and (2) to formulate potential path policies based on policy development scenarios that consider social, economic, and environmental factors to support sustainable agro-tourism development in the area. The analysis will be conducted using prospective analysis with multi-policy approach to generate adaptive and practical policy recommendations.

LITERATURE REVIEW

Concept and Approaches of Tourism Carrying Capacity (TCC)

Tourism Carrying Capacity (TCC) is a concept used to determine the maximum number of tourists that a destination can accommodate without causing significant damage to its physical environment, social, economic, and cultural aspects. According to the World Tourism Organization (WTO), TCC is defined as "the maximum number of people that may visit a tourist destination at the same time without causing destruction of the physical, economic, and socio-cultural environment and an unacceptable decrease in the quality of visitors' satisfaction" (WTO, 2004).

TCC consists of several main dimensions, including: (1) Physical Carrying Capacity (The maximum number of tourists that can be present at a location at one time without disrupting visitor comfort and safety); (2) Economic Carrying Capacity: The extent to which a destination can support tourism economic activities without sacrificing other local economic activities or causing detrimental price inflation for the community; (3) Social-Cultural Carrying Capacity: The threshold of tourists that the local community can accept without altering social structures, culture, and community values; (4) Biophysical Carrying Capacity: The ability of the natural environment to support tourism activities without significant ecological degradation. However, the most basic and widely used basis for TCC analysis is physical carrying capacity.

This study initially focuses on physical carrying capacity (PCC) as it provides a quantifiable and objective foundation for assessing tourism limits based on land area and space per visitor. PCC is commonly used as a baseline in TCC analysis because it allows for the calculation of visitor thresholds without requiring subjective social or managerial inputs. Subsequent layers such as real and effective carrying capacities can then be built upon this baseline to reflect environmental and institutional constraints (Saveriades, 2000; Elmahdy et al., 2020). In the context of Subak Pulagan, a traditional agricultural system recognized as a UNESCO World Cultural Heritage, applying TCC is critical. The unique Subak system requires protection of its ecological and social capacities to function sustainably. Thus, conducting a TCC analysis can assist in designing tourism policies that support economic development while preserving cultural and environmental integrity.

Sustainable Tourism and Eco-Tourism

Sustainable tourism is an approach to tourism development that balances economic, social, cultural, and environmental needs over the long term. According to the World Tourism Organization (UNWTO, 2018), sustainable tourism is defined

as “tourism that takes full account of its current and future economic, social, and environmental impacts, addressing the needs of visitors, the industry, the environment, and host communities.” Its main principles include the efficient use of resources, the preservation of local culture, and the fair distribution of economic benefits to the community.

The implementation of sustainable tourism requires careful management of the area's carrying capacity and the participation of local communities as key stakeholders. In the context of cultural landscapes such as Subak Pulagan, this principle is especially important due to the close interrelationship between agricultural systems, cultural values, and ecosystems. A study by Gössling et al. (2021) emphasizes the importance of data-driven regulation in maintaining the sustainability of highly vulnerable destinations, particularly through the carrying capacity approach.

Furthermore, sustainable destination management not only prioritizes conservation but also adaptation to global changes such as climate crises, global market pressures, and shifts in tourist preferences. Therefore, policy strategies must be dynamic, collaborative, and based on evidence-based planning.

Ecotourism is a form of sustainable tourism that specifically focuses on nature-based travel experiences and conservation, with an emphasis on education and the empowerment of local communities. The International Ecotourism Society (TIES, 2015) defines ecotourism as “responsible travel to natural areas that conserves the environment, sustains the well-being of local people, and involves interpretation and education.” Subak Pulagan, as part of the UNESCO World Cultural Heritage, has high potential to be developed as an ecotourism destination. The distinctive features of its sustainable water-based agricultural system (Subak irrigation), religious ceremonies related to the agricultural cycle, and a social structure grounded in local wisdom make this area ideal for educational and environmentally conscious tourism experiences. Visitors can interact directly with farmers, participate in seasonal farming activities, and learn about philosophical values such as Tri Hita Karana, which is the foundation of harmony between humans, nature, and the divine. Suasih et al. (2024) show that ecotourism development based on Subak Pulagan can strengthen the sustainability of the agricultural system while also promoting economic diversification for the local community. However, the success of this initiative depends on a management system that can balance tourism activities with agricultural functions and strengthen local institutional capacity to preserve cultural values. Previous studies on tourist village development have highlighted the importance of community empowerment, local institution strengthening, and alignment with local cultural values. For instance, Sakrianti & Saskara (2024) emphasize participatory approaches, product diversification, and infrastructure improvement as key strategies. These findings offer useful comparisons for sustainable agro-tourism planning in Subak Pulagan.

The Subak System as Cultural Heritage and Tourism Potential

The Subak system represents a unique traditional irrigation management practice developed over centuries in Bali, Indonesia. Rooted deeply in Balinese Hindu philosophy, Subak is more than just a water management system; it embodies a community-based institution that integrates social, religious, and ecological dimensions (Huang, 2020).

Subak reflects a collective approach to resource sharing, decision-making, and mutual cooperation, governed by customary laws known as awig-awig and religious rituals centered around water temples (Pura Tirta) (Vickers, 2012). In 2012, UNESCO recognized the Subak system of Bali as a World Cultural Heritage under the title “Cultural Landscape of Bali Province: the Subak System as a Manifestation of the Tri Hita Karana Philosophy.” This inscription acknowledges the Subak’s outstanding universal value in demonstrating a harmonious relationship between humans, nature, and the spiritual world (UNESCO, 2012). The recognition has raised global awareness of the importance of preserving such indigenous knowledge systems and cultural landscapes. The Subak system plays a crucial role in maintaining the ecological balance of the Bali agricultural landscape. It effectively manages water distribution, conserves soil fertility, and supports biodiversity through integrated rice terraces and agroecosystems (Ardana et al., 2024). Socially, Subak serves as a platform for cooperation among farmers, fostering social cohesion and conflict resolution, which are vital for the system’s sustainability (Zen et al., 2024).

The governance of Subak through traditional institutions contributes to its resilience against external pressures such as modernization and tourism development. This social-ecological resilience underpins the sustainability of both agricultural production and cultural heritage (Suasih et al., 2024). The Subak system’s cultural and ecological uniqueness presents significant tourism potential, particularly for cultural and agro-tourism markets. Visitors are attracted to the scenic beauty of rice terraces, the cultural rituals associated with Subak, and the opportunity to experience traditional Balinese agricultural life (Cole, 2012). Such tourism activities can generate additional income for local communities, thus contributing to rural development and heritage conservation. However, the dual role of Subak as both a productive agricultural system and a tourism attraction necessitates careful management to prevent conflicts between farming and tourism uses (Picard, 2006). Unregulated tourism can threaten the integrity of the Subak landscape and disrupt traditional practices.

METHOD

Research Design

This study applies a mixed-methods approach combining Tourism Carrying Capacity (TCC) assessment with Multipol policy analysis to develop sustainable tourism strategies for agro-tourism development in Subak Pulagan. The TCC framework assesses the limits of visitor numbers to maintain environmental, social, and cultural sustainability, while the Multipol method facilitates the design and evaluation of adaptive policy pathways that address multiple stakeholder perspectives and future uncertainties.

Tourism Carrying Capacity (TCC) Assessment

Tourism Carrying Capacity (TCC) is defined as the maximum level of tourist activities that a destination can accommodate

without causing unacceptable ecological degradation, social disruption, or economic imbalance (Coccossis & Mexa, 2004; Elmahdy et al., 2020; Yusoh et al., 2020). This study focuses on the Physical Carrying Capacity (PCC), which refers to the maximum number of tourists that a site can physically sustain. The formula for calculating PCC is (Elmahdy et al., 2020):

$$PCC = A\ x\ \frac{V}{a}\ x\ Rf$$

Where A represents the total accessible area for tourists, V/a denotes the visitor density per square meter, Rf is the rotation factor, indicating the number of times a site can be visited by tourists within a day. The rotation factor accounts for the environment's ability to recover from tourist activities, with typical values being 1 for activities such as swimming or picnicking (Fandeli & Muhammad, 2009). Increasing the rotation factor corresponds to a higher number of visits per day. Fandeli & Muhammad (2009) also proposed a modification by replacing visitor area per m2 with the minimum area required per tourist to ensure visitor satisfaction during activities. For example, thus the adjusted formula is (Elmahdy et al., 2020):

$$PCC = Ax\ \frac{V}{b}\ x\ Rf$$

Where b is the minimum area required per tourist to ensure visitor satisfaction during activities.

Beyond PCC, the Real Carrying Capacity (RCC) considers environmental correction factors (Correction Factors, CF) that reflect the biophysical characteristics of the tourist site. The RCC is calculated as (Elmahdy et al., 2020):

$$RCC = PCC\ x\ Cf1\ x\ Cf2\ x\ \ldots x\ Cfn$$

Each correction factor (Cf) is derived from (Elmahdy et al., 2020):

$$Cfn = 1 - \left(\frac{Mn}{Mt}\right)$$

Where Mn is the current condition of a given biophysical variable, and Mt is the maximum permissible threshold for that variable. These correction factors adjust the physical capacity to reflect environmental constraints, including biotic factors such as the diversity of flora and fauna which serve as tourist attractions, and abiotic factors like landscape features, slope, soil erosion sensitivity, and rainfall. Lastly, the Effective Carrying Capacity (ECC) accounts for the site's management capabilities (Management Capacity, MC), including legal frameworks, policies, staffing, funding, infrastructure, and facilities (Insani et al., 2019). The ECC is expressed as:

$$ECC = PCC\ x\ MC$$

The management capacity modifies the carrying capacity to ensure that the destination can handle visitors sustainably through effective governance and resource provision.

The calculated values of PCC, RCC, and ECC provide estimates of the maximum number of tourists per day that the destination can support without compromising environmental integrity and visitor experience. Comparing these capacities with actual visitor numbers (JKr) indicates whether the site is under or over capacity. If actual visitation exceeds carrying capacity, management interventions are necessary to mitigate potential negative impacts. Conversely, if visitation remains below capacity, sustainable development opportunities may still be pursued. The method for calculating tourism environmental carrying capacity is derived from a modified approach presented in (Cifuentes, 1992), and is outlined as follows in Table 1, which provides a classification and suggested limits for tourism carrying capacity.

Table 1. Classification and Recommended Tourism Carrying Capacity

Type of Tourism Carrying Capacity		Carrying Capacity Classification	Recommendation
PCC>JKrRCC>JKr	ECC>JKr	Big Opportunity	Can be developed
PCC<JKrRCC<JKr	ECC<JKr	Overuse	Controlled and styled
PCC=JKrRCC=JKr	ECC=JKr	Optimal	Effective and efficient

Prospective Analysis with MULTIPOL

After confirming the potential for tourist visits, clear policy formulation is needed to optimize outcomes. The formulation of potential path policies is carried out using prospective MULTIPOL analysis.

Figure 1. Potential Path Policy (Source: Fauzi (2019)

MULTIPOL stands for "MULTI-criteria" and "POLicy" with an integrated participatory approach. The three main elements in MULTIPOL analysis, as further explained by Fauzi (2019), are scenario, policy (policy direction), and actions (Sakrianti & Saskara, 2024):

a) Scenario refers to structured developments that can be pursued in the future where goals can be achieved.

b) Policy is the strategy required to support the scenario.

c) Actions, also known as policy measures, are the means to achieve the goals and represent potential interventions aimed at policy implementation.

The potential policy paths that can be formulated based on these three main elements through MULTIPOL analysis are illustrated in Figure 1. Next, the steps in the MULTIPOL analysis can be explained, which consist of five stages, as shown in Figure 2. The first and second stages/blocks involve determining scenarios, actions, policies, criteria, and weights, where this stage uses a participatory approach. MULTIPOL assigns different weights to the three main elements. This is what distinguishes MULTIPOL from other multi-criteria approaches. The following stages (blocks three to five) are the MULTIPOL software blocks, where the software determines the hierarchy of actions.

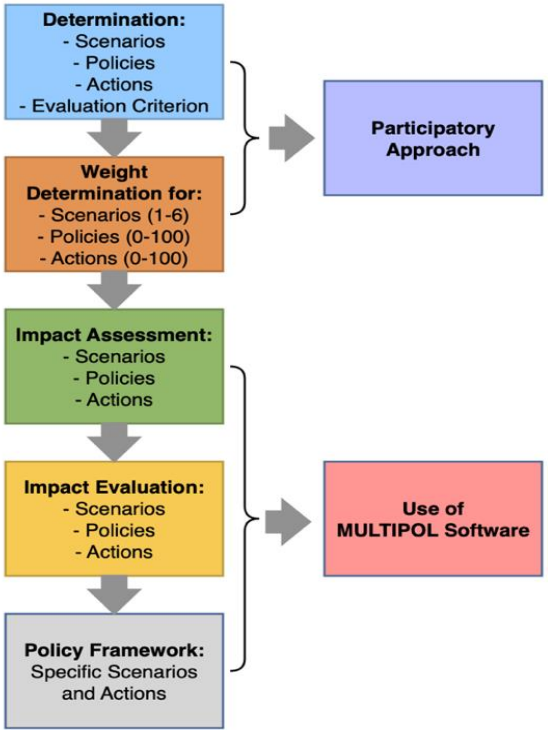

Figure 2. Stages of MULTIPOL Analysis (Source: Fauzi, 2019)

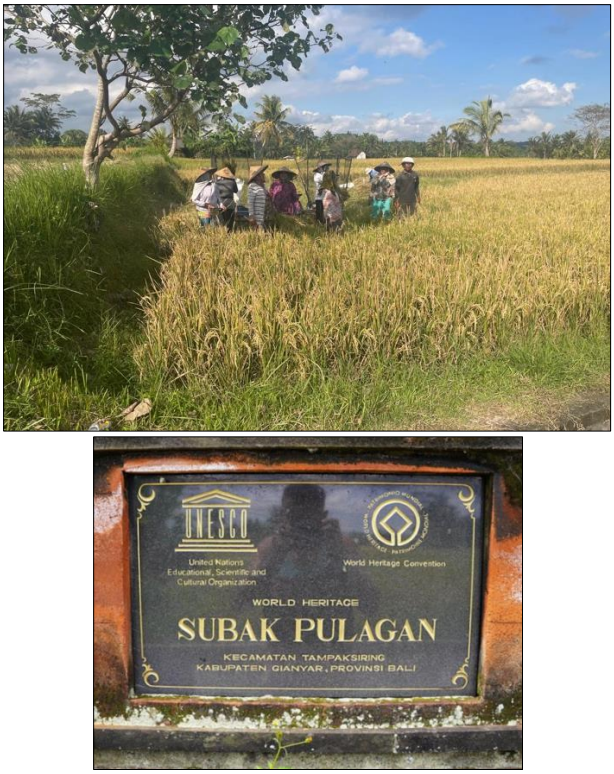

Figure 3. Photos of Subak Pulagan
(Source: Authors documentation, 2025)

RESULTS AND DISCUSSION

Overview of Subak Pulagan

Subak is a traditional irrigation system unique to Bali that not only functions as an irrigation technology but also reflects the philosophy of Tri Hita Karana, which emphasizes harmony among humans, nature, and spirituality (Moriarty, 2023). This system regulates the fair distribution of water through a network of canals and water temples, and involves farming communities in collective decision-making (Lansing, 1991). Subak Pulagan, located in Tampaksiring Village, Gianyar Regency, is a prominent example of the Subak system. Covering an area of approximately 104 hectares with 223 farmers, this Subak plays an important role in maintaining the sustainability of agriculture and local culture. The irrigation water of Subak Pulagan originates from the sacred springs at Pura Tirta Empul, flowing through a canal network to the farmers' rice fields.

The uniqueness of Subak Pulagan lies in its spiritual and cultural values. The rice grown in this area is considered sacred and is used in various religious ceremonies around Tampaksiring. Additionally, the area features beautiful landscapes with green terraced rice fields and a mountainous backdrop, making it a potential agro-tourism attraction. The natural and cultural potentials serve as the main supporting factors for Subak Pulagan to become one of the Subak landscapes in Bali designated by UNESCO as a World Cultural Heritage site (Figure 3).

The ecotourism potential in Subak Pulagan is very high because the area offers educational and authentic tourism experiences. Visitors can participate in farming activities, learn about the Subak irrigation system, and take part in traditional ceremonies. Moreover, trekking along the rice field ridges, visiting water temples such as Tirta Empul, and observing biodiversity around the agricultural area can be major attractions. This type of community-based tourism aligns with sustainable development principles by supporting nature conservation, local community empowerment, and cultural preservation.

Research by Suasih et al. (2024) shows that ecotourism development in Subak Pulagan can improve farmers' welfare through income diversification without compromising the ecological and cultural functions of the area. The study

emphasizes the importance of the role of Subak institutions and government in managing tourism potential sustainably, as well as the need for incentives and training for farmers to support adaptation to economic and social changes.

Overall, Subak Pulagan is an ideal example of integrating traditional agriculture, cultural values, and sustainable tourism potential. With proper management, this area can not only maintain its function as an agricultural system but also transform into a model of inclusive and globally competitive cultural ecotourism destination.

Results of Tourism Carrying Capacity Analysis in the Subak Pulagan

The environmental carrying capacity of a natural tourism site refers to its ability to accommodate a certain number of visitors within a specific area and time frame (Soemarwoto, 2016). Tourism carrying capacity encompasses biogeophysical, socio-economic, and socio-cultural dimensions of a destination, ensuring that tourism activities can take place without degrading environmental quality or diminishing visitor satisfaction (18). The results of the calculation include: (1) Physical Carrying Capacity (PCC); (2) Real Carrying Capacity (RCC); and (3) Effective Carrying Capacity (ECC), as outlined below.

Physical Carrying Capacity (PCC)

Based on observations and supporting data from documents and information, several components were identified for calculating the physical carrying capacity. The total area of Subak Pulagan is 110 hectares (1,100,000 m²). For the comfort of tourists visiting the area, the space required per tourist is 20 m². Regarding the rotation factor (number of repeat visits per day), the best times for tourism activities in Subak Pulagan are generally morning (sunrise) and late afternoon (sunset). These times offer cool air and stunning natural views. Based on this, the PCC in the Subak Pulagan area is calculated to be 110,000 people per day. The PCC value does not yet take into account the biophysical conditions present at the site. As noted by Soemarwoto (2016), one key factor influencing tourism carrying capacity is the biophysical environment of the site, which determines the resilience or vulnerability of the ecosystem. Nevertheless, physical carrying capacity remains a crucial component in informing tourism development planning.

Real Carrying Capacity (RCC)

The biophysical parameters used to calculate the real carrying capacity (RCC) are adjusted to the conditions of the area, specifically Subak Pulagan. Observations in the Subak Pulagan area show that the biophysical aspects that serve as limiting factors for environmental carrying capacity include the rice field area (Cf1), which accounts for 86% of the area, irrigation channels (Cf2) at 5%, and public facilities/other Subak areas (Cf3) at 5%. Therefore, if the PCC is 88,000 people per day and adjusted by these biophysical parameters, the RCC is calculated to be 212 people per day.

Effective Carrying Capacity (ECC)

Effective carrying capacity refers to the maximum number of visitors that a site can sustain while remaining viable under existing management conditions. One common challenge in managing village tourism in Indonesia and Bali is management by local institutions, local community participation, capital availability, as well as infrastructure and facilities. These variables are further classified into three condition criteria: good (score 3), moderate (score 2), and poor (score 1). The management aspect assessment results are presented in Table 2. As shown in Table 2, the management capacity value is 50%, and the effective carrying capacity is 106 people per day. Current observations show that daily tourist visits at Subak Pulagan are about 30 people per day, which can increase during events and has also risen since the addition of supporting facilities such as coffee shops. Considering that ECC is higher than the actual number of visitors (ECC > Actual Visitors), the carrying capacity falls into the category of a big opportunity. Therefore, strategic policies are needed to balance tourism and sustainable agriculture.

Table 2. Management Capacity Variable Calculation

Variable	Score	Percentage (%)
Capacity of local tourism practitioner	2	66.67
Local people participation	2	66.67
Capital	1	33.33
Infrastructure and facilities	1	33.33
	Average	50.00

Tourism and Sustainable Agriculture Development Policy in Subak Pulagan Through MULTIPOL Analysis

The formulation of policies or strategies for agricultural and tourism development is carried out using the MULTIPOL analysis technique, or Multi Policy, as previously explained. The results of the MULTIPOL analysis begin with identifying input factors (scenario, policy, program/action, criteria) and produce an output called the potential path policy.

Identification of Scenario, Policy, Program/Action, Criteria as MULTIPOL Input Factors

The identification of MULTIPOL input factors focuses on three main scenarios: agricultural development, tourism development, or business as usual. The details of the MULTIPOL input factors are presented in Table 3. The results of this identification serve as input for the MULTIPOL analysis to formulate potential path policies for sustainable agricultural and tourism development in Subak Pulagan.

Table 3. Identification of Scenario, Policy, Program/Action, Criteria (Source: Author's work, 2025)

No	Criteria	Code of Criteria
1.	Sustainable agriculture in Subak Pulagan	sus.agri
2.	Sustainable tourism in Subak Pulagan	sus.tour

3.	Increasing local community income	income
4.	Development in the Subak Pulagan area	development
No	**Policy**	**Code of Policy**
1.	Subsidies and development in agriculture	agri.subsi
2.	Development of village tourism and/or rural tourism	tour.vilge
3.	Development and improvement of area infrastructure	infrastruc
4.	Empowerment of local communities	empower
5.	Strengthening local institutional capacity	insti.cap
No	**Action**	**Code of Program**
1.	Subsidy and distribution of fertilizer	fertilizer
2.	Land and building tax subsidy	subsidy.pb
3.	Marketing of post-harvest agricultural products	market.agr
4.	Strengthening tourism awareness groups	tour.aware
5.	Improvement of farm roads	farm.road
6.	Capacity building of Subak institutions	subak
7.	Education for local communities	local.edu
8.	Expansion of tourism cooperation networks	network.tou
9.	Support programs for the World Cultural Heritage (WCH) designation	suport.WCH
No	**Scenario**	**Code of Scenario**
1.	Agricultural development in Subak Pulagan	agri.dev
2.	Tourism development in Subak Pulagan	tour.dev
3.	Development in Subak Pulagan as usual without intervention	bus.as.usu

Table 4. Evaluation Based on Actions and Policies of Sustainable Agriculture and Tourism in Subak Pulagan
(Source: Author's work – MULTIPOL output, 2025)

Code of Action	Code of Policy					Mean	Std. dev	Rank
	agri.subsi	tour.vilge	infrastruc	Empower	insti.cap			
fertilizer	12.3	8.2	8.9	10.4	9.8	10.1	1.5	1
subsidy.pb	11.5	10.7	10.6	11.1	10.8	11	0.3	3
market.agr	13.4	11.8	11.9	12.7	12.2	12.5	0.6	6
tour.aware	11.6	13.5	12.9	12.4	12.6	12.5	0.7	7
farm.road	12.2	12.5	13.4	12.5	13.1	12.6	0.4	8
subak	13.2	11.4	12.4	12.5	12.7	12.5	0.6	5
local.edu	12.7	11.9	12.6	12.4	12.7	12.5	0.3	4
network.tou	11.7	14.5	13.4	12.9	12.9	13	1	9
support.WCH	10.7	9.7	11.3	10.5	11.2	10.6	0.5	2

Potential Path Policy (MULTIPOL Output)

In formulating the potential path policy, it is necessary to understand the relationships between actions and policies, as well as between policies and scenarios. Table 4 below presents the results of the MULTIPOL analysis based on scores for each policy, along with the average scores and standard deviations obtained.

The average score measures the overall performance of each action against the policy (or program against the policy), while the standard deviation indicates the sensitivity of each action to the policy (Stratigea et al., 2013). In general, the best performance is shown by a high average score combined with a low standard deviation. In MULTIPOL, the higher the position number, the better the performance of that action. However, an action with a relatively high standard deviation can still have a relatively good position as long as it is supported by a high score for a specific policy. As presented in Table 4.5, the highest scores were obtained for programs such as the expansion of tourism cooperation networks, development of farm road infrastructure, and development of village tourism. Every policy naturally requires programs/actions as forms of implementation. Figure 4 presents a profile map that links the scores of each program (actions) with the policies.

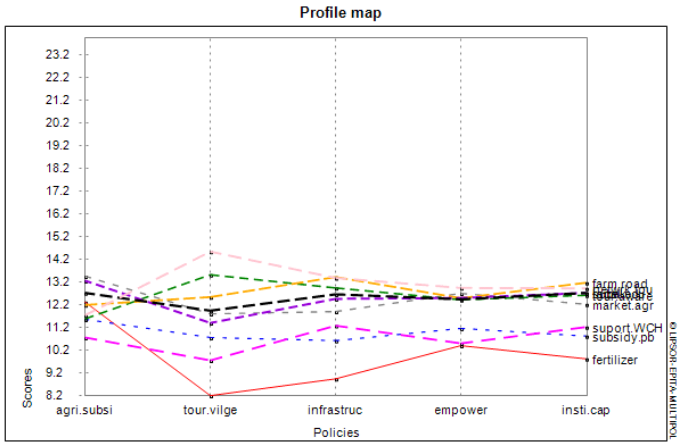

Figure 4. Linkages Between Policies and Actions for Sustainable Agriculture and Tourism in Subak Pulagan
(Source: Author's work-MULTIPOL output, 2025)

Figure 4 shows that the programs of post-harvest agricultural product marketing, strengthening the capacity of the Subak institution, and local community education excel under the policy of subsidies and agricultural development. Meanwhile, the programs of expanding tourism cooperation networks, strengthening tourism awareness groups, and improving farm road quality excel under the policy of developing village tourism and/or rural tourism.

Furthermore, under the policy of development and infrastructure enhancement in the area, the standout programs are improving farm road quality, expanding tourism cooperation networks, and local community education. The policy of empowering local communities is supported by programs expanding tourism cooperation networks, strengthening the capacity of the Subak institution, and educating the local community. Meanwhile, the policy of strengthening local institutional capacity is supported by programs improving farm road quality, expanding tourism cooperation networks, and enhancing the capacity of the Subak institution and local community education. As previously mentioned, MULTIPOL is a strategic formulation technique with a multi-scenario and multi-criteria approach.

Table 5. Policy scores against scenarios for sustainable agriculture and tourism in Subak Pulagan (Source: Author's work-MULTIPOL output, 2025)

Code of Policy	Code of Scenario			Mean	Std. dev	Rank
	agri.dev	tour.dev	bus.as.usu			
agri.subsi	27.2	23.7	27.1	26	1.6	5
tour.vilge	22.7	27.4	21.6	24	2.5	1
infrastruc	24.4	25	24.9	24.7	0.3	2
empower	25.2	25.1	24.9	25.1	0.1	3
insti.cap	25.2	24.6	25.6	25.1	0.4	4

A clearer mapping of each policy against the scenarios is presented in Figure 5. According to Table 4 and Figure 5, the analysis results show that under the agricultural development scenario in Subak Pulagan, policies are directed towards subsidies and agricultural development, as well as local community empowerment and strengthening local institutional capacity. Meanwhile, for the tourism development scenario in Subak Pulagan, the prioritized policies are the development of village tourism and/or rural tourism, local community empowerment, and development and enhancement of area infrastructure. The overall results of the MULTIPOL analysis can be presented in the form of potential policy paths.

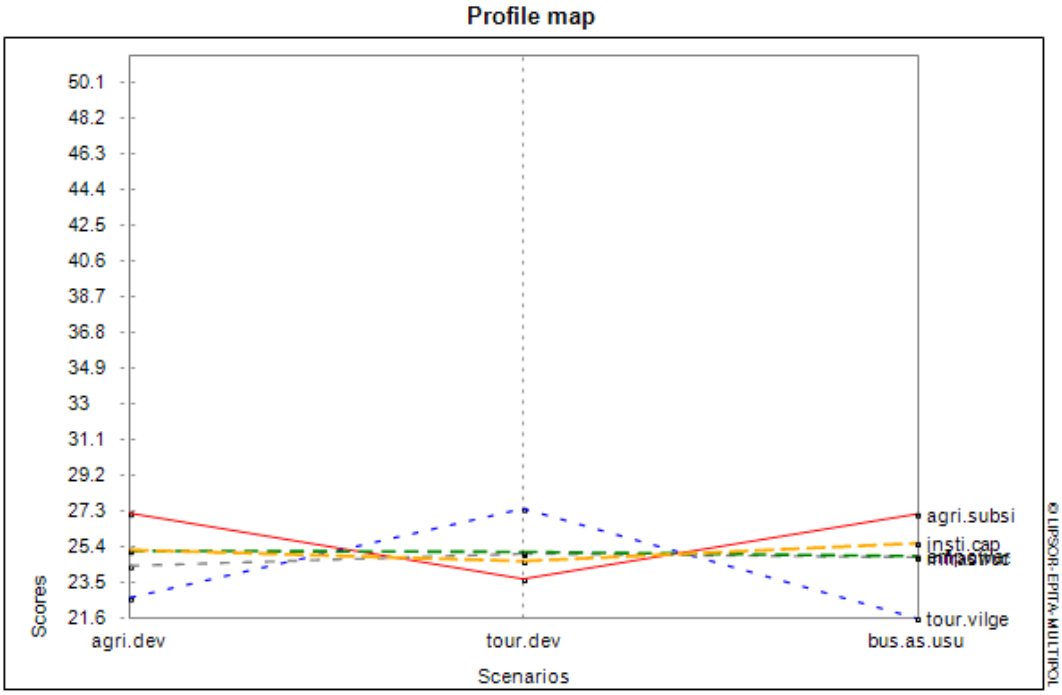

Figure 5. Linkages between scenarios and policies for sustainable agriculture and tourism (Source: Author's work-MULTIPOL output, 2025)

Based on the potential path policy (Figure 6), in the scenario of agricultural development in Subak Pulagan, the policies that can be prioritized are subsidies and agricultural development. Subsidies are crucial for agriculture in developing countries like Indonesia, as farmers generally have limited access to capital. Moreover, considering Subak Pulagan's status as a world cultural heritage site, which brings the consequence of land-use change restrictions, the government needs to provide subsidies in the form of tax exemptions related to this. Other subsidies to support sustainable agriculture include the provision of organic fertilizers, which have been relatively difficult to obtain.

Next, for the tourism development scenario, the prioritized policy is the acceleration of village tourism or rural tourism development. This is followed by the empowerment of local communities to strengthen the capacity of those who will become tourism practitioners. Meanwhile, if there are no interventions, and development continues as usual, subsidies remain an important policy, especially concerning land tax exemptions as a consequence of the world cultural heritage status.

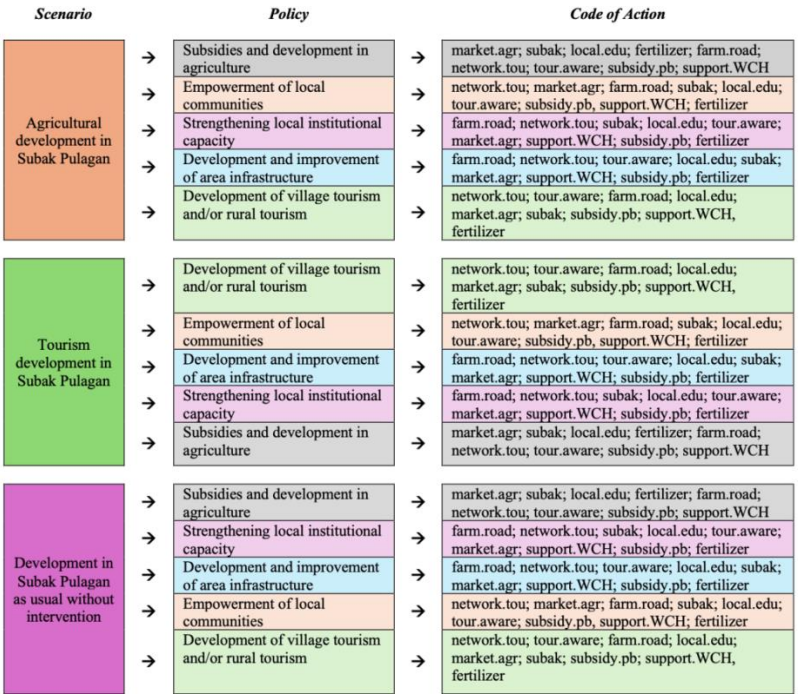

Figure 6. Potential Policy Path for Sustainable Agriculture and Tourism in Subak Pulagan (Source: Author's work, 2025)

CONCLUSION

The analysis of tourism carrying capacity is crucial to conduct before formulating tourism development policies in any area, especially natural tourism sites. Subak Pulagan is a UNESCO cultural heritage site, serving as a conservation area for agriculture and the Subak irrigation system, but at the same time, it also holds significant tourism potential for development. This is evidenced by the analysis results showing that the effective carrying capacity is still higher than the current actual number of visitors, indicating a substantial opportunity for development. This presents a strategic opportunity for managed tourism growth that aligns with environmental preservation and agricultural functions inherent to the Subak system.

To ensure sustainable agro-tourism development, it is recommended that future policies prioritize capacity-building for local tourism actors, improvements in infrastructure—particularly access and basic facilities—and stronger institutional support for Subak organizations. Additionally, integrating participatory approaches and expanding inter-sectoral collaboration, especially between agricultural and tourism stakeholders, will enhance the resilience and long-term viability of Subak Pulagan as a sustainable tourism destination. Targeted interventions such as community education, agro-tourism product development, and infrastructure upgrades should be aligned with the village's ecological character and cultural values to ensure tourism complements rather than compromises the integrity of the traditional Subak landscape.

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