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The Effect of Regional Development on The Sustainability of Local Irrigation System (A Case of *Subak* System in Badung Regency, Bali Province)

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Abstract

This study was aimed at investigating the sustainability of *subaks* in the dynamics of regional development in the metropolitan area of Badung Regency, Bali Province. The data on *subak* sustainability were collected by using survey method in 69 *subaks* as the units of analysis, and the secondary data on the factors of regional development were collected by using document recording method. The data were analyzed by using quantitative decriptive technique, Analytical Hierarchy Process (AHP), and multiple linear regression. The results showed that the spatial distribution of subak sustainability levels forms cluster pattern with different dominations in short-, trantitional- and long- distance zones from the tourism center. The components/elements of *Tri Hita Karana* (*THK*) that constitute the first priority in subak sustainability protection are wet land conversion control and guarantee for irrigation water adequacy. It was found that five factors ot regional development have a strong influence on subak sustainability with 87.8% contribution, and the rest (12.2%) is acounted by other factors outside the scope of this study.

Keywords : subak sustainability, *Tri Hita Karana* (THK), regional development.

Abstrak

Tujuan penelitian adalah mengkaji keberlanjutan subak di tengah dinamika perkembangan wilayah di kawasan metropolitan Kabupaten Badung, Bali. Data keberlanjutan subak dikumpulkan dengan metode survai di 69 subak sebagai unit analisis, dan data sekunder faktor-faktor perkembangan wilayah dikumpulkan dengan metode pencatatan dokumen. Analisis data dilakukan dengan teknik deskriptif kuantitatif, *Analytical Hierarchy Process* (*AHP*), dan regresi linear berganda. Hasil penelitian menunjukkan bahwa sebaran spasial tingkat keberlanjutan membentuk pola mengelompok dengan dominasi yang berbeda di zona dekat, zona transisi, dan zona jauh dari pusat pariwisata. Komponen dan elemen *THK* yang menjadi prioritas utama perlindungan subak adalah pengendalian alih fungsi lahan sawah dan menjamin kecukupan air irigasi. Ditemukakan 5 faktor perkembangan wilayah yang berpengaruh kuat terhadap keberlanjutan subak, dengan kontribusi pengaruh sebesar 87,8% dan sisanya sebesar 12,2% dijelaskan oleh faktor lain di luar lingkup penelitian ini.

Kata kunci : keberlanjutan subak, *Tri Hita Karana* (*THK*), perkembangan wilayah.

Introduction

Subak is basically a Farmer-Managed Irrigation System Institution born of Balinese culture. Although it is derived from typical Balinese culture, various studies prove that *subak* can be used as a model of harmonious community life and a management of sustainable resources at scale of wider areas and communities. As stated by Ahimsa-Putra (1999), Susanto (1999), Windia (2002), and Sutawan (2008), *subak* is carried out based on the philosophy of *Tri Hita Karana (THK)* which has universal life values and can be transferred to other regions.

Application of local wisdom values of THK of *subak* has proved that *subak* is considered as the unique and the world's most effective local irrigation management (Geertz, 1979, 1980; Ostrom,1992; Ambler,1992; Lansing, 1987; Lorenzen, 2010), as stabilizer of social and cultural life and democracy model (Susanto, 1999, 2000; Ostrom,1992; Sutawan, 2005, 2008; MacRae and I.W.A. Arthawiguna, 2011), as regulator of ecosystem (Lansing and Therese A. De vet, 2012), as enabler of food security, as development of agricultural sustainability, and as application of good governance principle (Kasryno, dkk., 2003 ; Baharsyah, 2005; Sutawan, 2008).

On June 29, 2012, United Nations through the United Nations Educational, Scientific and Cultural Organization (Unesco) has set *subak* as world cultural heritage that must be protected. UN considers that *subak* has outstanding universal values; one of them is the values of strong social bond (ANTARA, 2012).

Although *subak* has various advantages and has been considered as world cultural heritage, the problems encountered are getting heavier and more complex. Lorenzen (2010), MacRae and Arthawiguna, (2011), Bali Post (2014), noted some serious problems: the uncontrollable conversion of the rice terraces, the increase on irrigation scarcity, the high cost of facilities and production processes, the uncertain selling price of the harvests, the increased amount of the living cost, and the low appreciation of the young generation towards the agricultural sector. Rai and Menaka (2011) reported that the conversion of paddy field in Bali reached 560.1 – 1,000 ha/year. While Purnama (2009) found that water balance ratio in Bali reached 47%, that it means almost a critical point.Those are supposed to be serious problems for the sustainability of *subak*.

The sustainability concept of *subak* refers to its basic philosophy, *THK* (Susanto, 1999; Mawardi, 1999; Sutawan, 2005, Windia, 2006, 2008). Literally, *THK* means three components that cause happiness/prosperity (*Tri* = three, *Hita* = happiness, and *Karana* = cause of). The three components are *parhyangan* (the relationship between mankind and God), *pawongan* (the relationship between mankind), and *palemahan* (the relationship between mankind and nature). Balinese society believes that creating harmonious relationship among those three components would instigate blissful/prosperous life. Practically, *parhyangan*, *pawongan*, and *palemahan* are reflected in cultural life, social and economic life, and technology and physical environment (rice terrace and water ecologies) respectively. The core philosophy of *THK* is in line with the concept of sustainable development, mainly in the development of sustainable agriculture proposed by SEARCA (1995).

Local government policies which extremely enhance tourism sector lead to rapid development of areas presented by a number of factors, such as the increasing number of transportation infrastructures that open the locational access, the increasing number and heterogeneity of demography, the density of the socio-economic facilities, the transformation of economic structure and agrarian culture to economic structure and manufacturing, trade, and tourism cultures. Bastakoti et al (2010) found that the local irrigation system managed by farmers has convincing ability in facing external growth pressure by creating beneficial strategies and adaptation and therefore it keeps maintaining its high performance. Different findings were stated by Susanto (1999), Alit et al (2006), and Lorenzen (2010), that the rapid growth of some areas, in terms of economic and tourism developments, on one hand, is economically profitable but on the other hand has threaten the sustainability of *subak*.

The focus of this research is to analyze the sustainability of *subak* irrigation system in the middle of the dynamic development of areas. Specifically, the aims of this research are: (1) to describe the spatial pattern of the level of *subak* sustainability, (2) to define the components and elements of *THK* determining the sustainability of *subak*, and to analyze the influence of factors of area development towards the sustainability of *subak*.

Research Method

This research applied survey method with three areas (Kuta, Kuta Utara, and Mengwi) situated in Badung regency as its research locations (sites). Other than as irrigated agricultural lands (rice terraces), those areas are enacted as metropolitan areas. The unit of analysis included 69 units of *subak*. The data of *subak* sustainability, components of *THK* and elements of *THK* as determining factors for the sustainability of *subak* were collected from the *subak* management board with group interview technique based on questionnaires and lists of statements prepared.

The data of area, number and width of *subak*, as well as factors contributing to the area development, covering 6 variables, were collected with document-recording technique from data-storing institutions such as Central Bureau of Statistics (*Biro Pusat Statistik/BPS*), Regional Development Planning Board (*BAPPEDA*), and Department of Highways and Irrigation (*Dinas Bina Marga dan Pengairan*) of Badung regency. Data unit of the 6 variables consisted of proximity of *subak* area to tourism center (km), existence of road (weighted score = score of the existence of road multiplied by the weight of road level), existence of socio-economical facilities (weighted score = total of types of facilities multiplied by weight), population density (inhabitant(s)/ha), population growth (%), and percentage of non-agricultural families (%). The data of the last four variables are at village level, while the unit of analysis is at *subak* area level. Therefore, the data obtained were transformed into *subak* area level by measuring the percentage of *subak* area contribution in village area.

The data analysis techniques for this research included quantitative descriptive analysis, analytic hierarchy process (AHP) analysis, and inferential statistical analysis. Quantitative descriptive analysis was used to explain the spatial pattern of *subak* sustainability level. The findings of the interviews comprised responses on questionnaires with the scores ranging from 1 to 4 (1 = very low, 2 = low, 3 = high, 4 = very high).

The criteria for assessing *subak* sustainability level were set based on the maximum and minimum ideal average scores ranging from 1 to 4. The scores were measured by dividing the total score with the numbers of questions. The total questions on *subak* sustainability were 61, consisting of cultural sustainability (10 items), social sustainability (22 items), economical sustainability (12 items), technical sustainability (10 items), and natural-physical sustainability (7 items). On the basis of the ideal average scores, the measurement criteria for *subak* sustainability level were set, i.e. high sustainability (average score > 3), medium sustainability (average score is 2-3), and low sustainability (average score < 2). Afterwards, empirical average score for the sustainability of each *subak* was linked to ideal criteria to indicate the position of *subak* sustainability level.

To describe the spatial pattern of *subak* sustainability level, the research areas were categorized into three zones on the basis of average distance of subak to Kuta tourism center. From the result of the calculation of distance using geographic information system (GIS) analysis, criteria for zoning were divided as follow: near zone (average distance < 9 km), transition zone (average distance is 9-16 km), and far zone (average zone > 16 km). The data of *subak* sustainability were then visualized into a map, analyzed (their distribution special characteristics), interpreted and reviewed narrative-analytically.

The data of measurement or perception on the importance level of components and elements of *THK* were indicated by the values of 1, 3, 5, 7, and 9, based on working principals of AHP expressed as matrix of pair comparisons (Saaty, 1994). The values have relative significance (1 = both compared elements are equally important, 3 = one element is a little more important than another, 5 = one element is more important than another, 7 = one element is much more important than another, and 9 = one element is extremely more important than another). The collected data were analyzed using AHP Expert Choice software.

The inferential statistical analysis applied in this research was called multiple linear regression analysis used to help explain the significance of the factors contributing to area development on *subak* sustainability. Equation model for multiple linear regressions is expressed by formula (1).

$$Y = bo + b_1X_1 + b_2X_2 + ... + b_6X_6 .... (1)$$

Y = *Subak* sustainability
X_1= Proximity of *subak* location to tourism center
X_2 = Existence of road in *subak* area
X_3 = Existence of socio-economical facilities
X_4 = Population density
X_5 = Population growth
X_6 = Percentage of non-agricultural families
bo = Constanta
$b_1, b_2, b_3..b_6$ =
Regression coefficient value of $X_1, X_2, X_3.........X_6$

Calculation of Constanta and regression coefficient values was carried out by utilizing SPSS version 15 program software. The influential power of each variable (X) was indicated by conducting *t* test with significance level of 10% and degree of freedom/db = n-1-k (n = number of subject and k = number of predictor/X). Meanwhile, to simultaneously measure the influential power of all predictors (X), either *F* test or Anava test was conducted with significance level of 5%.

Result and Discussion

Spatial Pattern of *Subak* Sustainability Level

Subak sustainability level is highly determined by the sustainability and manifestation of THK values harmoniously in the life of *subak*. *Subak* sustainability was analyzed by considering five aspects/dimensions derived from THK values, including cultural sustainability, social sustainability, economical sustainability, technical sustainability, and natural-physical sustainability. The result of the research on *subak* sustainability level is presented in Table 1 and Table 2.

Data in Table 1 show that out of 69 *subaks* observed, 32 *subaks* (46.38%) have high sustainability, 25 *subaks* (36.23%) have medium sustainability, and 12 ones (17.39%) have low sustainability). In spite of the fact that 32 *subaks* appear with high sustainability, the empirical field observation indicates that nearly all *subaks* are under a threat of danger resulted from area transformation as well as dynamic and accelerative human life. Unesco (Bali Post, 2014) even gives 'yellow light' for Balinese *subak* for the absence of stakeholder's real actions, especially the government, to protect *subak* which has been granted as world cultural heritage.

In Table 2 shows that cultural sustainability as a representation *parhyangan* component were the highest compared *pawongan* components and *palemahan*. The results are consistent with the findings of Astra Wesnawa (2010) that *parhyangan* components in micro settlement in coastal areas and plain areas in Buleleng Regency is still strong survive in accordance with normative concept. While the components *pawongan* and *palemahan* began to change the direction economically.

Rapid transformation of area and life posing a threat to *subak* sustainability are triggered by some interrelated factors. To begin with, there are globalization and Green Revolution policies which carry market economic or capitalist economic system. Secondly, the local government's policies biased on tourism and are not able to accommodate agricultural sectors' interest (*subak*). Thirdly, spatial planning policies enacting research area as a part of metropolitan area of Sarbagita (Denpasar, Badung, Gianyar, Tabanan) are set based on President Regulation No. 45 Year 2011, and they, hence, potentially force productive agricultural fields. Finally, social and economical condition of farmers, specifically their farming income, can no longer meet a demand of the ever-increasing life expenses, while working opportunity and salary rate in non-agricultural sectors are widely opened.

Tabel 1. Distribution of the Number of Subaks According to THK Sustainability Level for Each Zone

Subak Sustainability	Short Zone	Trantitional Zone	Long Zone	Total
1. High	2 (9.09)	13 (48.15)	17 (85.0)	32 (46.38)
2. Medium	8 (36.36)	14 (51.85)	3 (15.0)	25 (36.23)
3. Low	12 (54.55)	-	-	12 (17.39)
Total	22 (100.0)	27 (100.0)	20 (100,0)	69 (100.0)

Source : Result of data analysis. Note : ( ) = Percentage.

Tabel 2. Distribution of the Mean Scores of Subak Sustainability Level of Each Zone

Component of Subak Sustainability	Mean Score of Each Zone			Mean Scores
	Short	Trantitional	Long	
1. Cultural Sustainability	2.4	3.2	3.6	3.1
2. Social Sustainability	2.2	3.1	3.5	2.9
3. Economic Sustainability	1.7	2.2	2.5	2.1
4. Technical Sustainability	2.1	2.9	3.3	2.8
5. Natural Physical Sustainability	2	2.8	3.3	2.7
Mean Scores	2.1	2.9	3.3	2.8

Source : Result of data analysis.

Spatial distribution of *subak* sustainability level indicates zoning-based grouping pattern. In near zone, the *subak* sustainability grouping is low, however, in transition zone; it is dominated by medium *subak* sustainability. Meanwhile, in far zone, the *subak* sustainability is high. The same pattern is also presented on the average score, in which the score for *subak* sustainability is 2.1 in near zone, 2.9 in transition zone, and 3.3 in far zone. The lowest average score is in near zone, while the highest one is in far zone. Spatial pattern of those three zones is visualized in Figure 1.

The spatial pattern of *subak* sustainability level as presented in Figure 1 is related to the fact that the area of Kuta belongs to major urban area and tourism center which functions as the key factor of international-scaled economic activities. The area of Kuta is the area of growth center in Badung regency, which possesses great backwash effect and spread effect on resource development in the surrounding areas. The closer an area to the center point is, the higher the transformation level of will be.

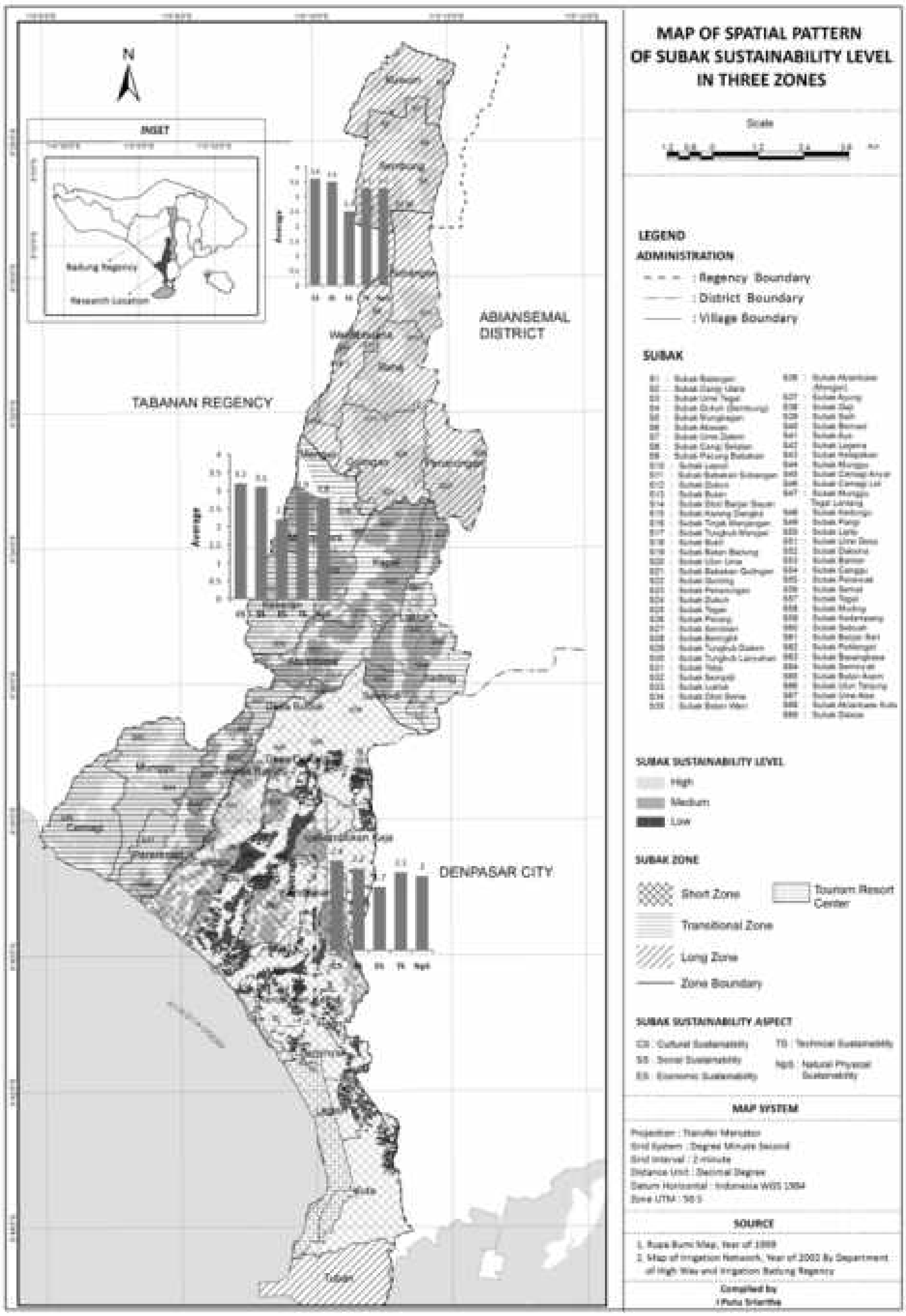

Figure 1. Spatial Pattern of Subak Sustainability Level

Components and Elements of *THK* Performing as Determinants for *Subak* Sustainability

Subak, based on the philosophy of *THK*, consists of complex components and elements. Hence, it is required to identify the components and elements which function as main determinants for *subak* sustainability, which will be used as a guide for spatial priority to maintain it. The components and elements of *THK* analyzed with AHP technique are presented in Table 3, and the results are presented in Figure 2.

Having examined Figure 2, we conclude that two main elements to determine *subak* sustainability are controlling conversion of rice terraces with significance level of 24% and striving for irrigation water sufficiency with significance level of 21%.

This means that setting priority to handle threat on *subak* sustainability should begin with making an effort to maintain rice terraces and irrigation water. In *subak* with high sustainability, rice terraces and water should be preserved exclusively for agricultural purpose and used as agricultural area/ eternal *subak*. In *subak* with medium sustainability, rice terraces and water can be used restrictively and conditionally for non-agricultural purposes. In *subak* with low sustainability, rice terraces and water can be utilized for non-agricultural activities without strict conditions, as required in high and medium *subak* sustainability.

Tabel 3. Components and Elements of THK that Determine Subak Sustainability

Components	Elements
1. Culture	1.1. Strengthening belief in THK 1.2. Improving subak ritual 1.3. Improving physical quality and function of subak temple
2. Social	2.1. Consolidating organization 2.2. Improving solidarity and cooperation 2.3. Preventing violation and conflict
3. Economic	3.1. Developing subak economic enterprise 3.2. Maximizing dues, facility lease, and from other parties 3.3. Providing more access to the market and subak road
4. Technical	4.1. Improving irrigation network quality 4.2. Improving equality in water allocation and distribution 4.3. Modernizing farm enterprise technology
5. Natural physical	5.1. Controlling rice field conversion 5.2. Striving for irrigation water adequacy 5.3. Preventing land and water pollution disturbance

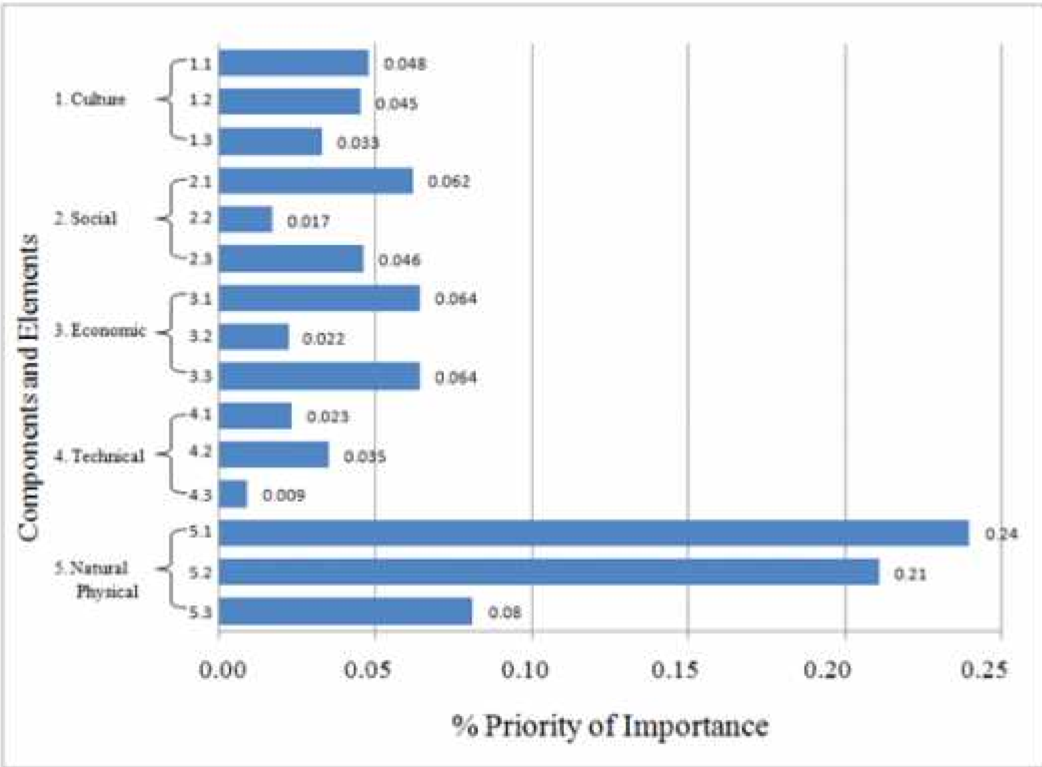

Figure 2. Relative Importance of Components and Elements of Subak Sustainability Determinants

Factors of Area Development Attributable to *Subak* Sustainability

Research on the effect of external factors, especially area development factors, on irrigation system sustainability, like subak, is still limited. This research determines 6 factors of area development which are estimated to put an effect on *subak* sustainability, including: proximity of *subak* location to tourism center (X_1), existence of road (X_2), existence of socio-economical facilities (X_3), population density (X_4), population growth (X_5), and percentage of non-agricultural family (X_6). The result of the data analysis with multiple linear regression analysis technique is presented in Table 4.

T test or *t* significance value (*t* Sig.) as displayed in Table 4 reveals that it is only variable X_5 which has insignificant or unconvincing effect (*t* Sig. > 10%), while the other 4 variables show significant correlation (*t* Sig. < 10%). Of the five variables having strong effects, variable X_1 shows positive direction, while the other 4 variables, i.e. X_2, X_3, X_4 and X_6 show negative direction.

The role of variables X_1, X_2, X_3, X_4, X_6 as predictors on the shift of *subak* sustainability level is indicated by the regression coefficient value or beta value (Table 4). Regression coefficient of X_1 = 0.270 means that if the distance of *subak* area is one unit farther, the *subak* sustainability level increases 27%, and conversely. Regression coefficient of X_2 = 0.255 means that if the existence of road increases one unit, the *subak* sustainability level decreases 25.5%, and conversely. In the same way, prediction and estimation of X_3, X_4, and X_6 variables on the shift of *subak* sustainability level can be interpreted identically to the meaning of the effect of X_2.

By conducting *F* test or examining *F* significance value = 0.000 (Table 4), it is found that simultaneously, the six X variables contribute significantly on the shift of *subak* sustainability. The contribution value is indicated by R^2 (*adjusted R square*) amounting to 0.878. This means that the shift of *subak* sustainability level of 87.8% is caused by the six variables simultaneously, while the rest, 12.2%, is caused by other variables beyond this research scope.

Tabel 4. The Result of Multiple Regression Analysis on the Effect of External Factors on Subak Sustainability

Multiple R =	0.943	Adjusted R Square =	0.878	F =	82.381
R Square (R^2) =	0.889	Standar Error =	12.81	Sig. F =	0

Variable	B	SEB	Beta	t	Sig.t
X_1	1.395	0.426	0.27	3.276	0.002
X_2	-1.35	0.432	-0.26	- 3. 130	0.003
X_3	-0.03	0.011	-0.28	-3.083	0.003
X_4	-0.27	0.148	-0.1	-1.838	0.071
X_5	-0.53	0.945	0.026	0.374	0.709
X_6	-0.23	0.106	-0.19	-2.173	0.034
Constant	184.4	11.084	-	16.639	0

Conclusion and Recommendation

Development of the region in the form of urban and tourism development which goes rapidly is threatening the sustainability of water control system in the study area. Subak sustainability spatial distribution level forms a clustered pattern with different value between close zones, transition zone, and the zone away from the tourism center. THK components and elements which become the top priority of the protection of Subak is to control over wetland function and ensure adequate irrigation water. There are five factors of region development that strongly influence Subak sustainability, namely: distance of Subak region into a tourism center, the road, economic facilities, population density, and the percentage of non-farm families. Simultaneously, these five factors contributing 87.8% to Subak sustainability, while the remaining 12.2% is explained by other factors outside the scope of this study.

Government has to be the institution with the most responsibility to determine the Subak sustainability because this insttitution has the political authority to plan and set the development policy. It is recommended that the government conduct a policy priority to develop the agricultural sector and synergize it with the tourism sector. Steps that need to be done are: (1) establishing wetland zoning and Subak sustainability through legislation, (2) Revising or creating new legislation about Subak economic empowerment and autonomous and legal institution, (3) Revising the regulation on protection of local agricultural products produced by farmers.

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