

Preservation Model for Subak in Bali From Environmental Economics Perspective

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PRESERVATION MODEL FOR SUBAK IN BALI FROM ENVIRONMENTAL ECONOMICS PERSPECTIVE

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ABSTRACT: This study aims to determine the social benefits, the total economic value of Subak and preservation models of Subak in terms of the environment economics aspect. The research was conducted in three Subaks: Subak Sangeh in Badung, Subak Bungan Kapal in Tabanan and Subak Padang Tegal in Gianyar. The social benefits value of Subak was determined by calculating the values of direct use, indirect use value and the value of alternative uses (option value), while the Total Economic Value was determined by the sum of use value and non-use value. The determination of Subak preservation model utilized investment eligibility criteria, namely Net Present Value (NPV) and Net Benefit Ratio (B/C). The findings suggest that, regarding to the environmental economics aspect, the Subak system is feasible and worthwhile to be preserved, as shown by social benefits NPV greater than zero and social benefits Net B/C greater than one. Based on these findings, Subaks in Bali should be managed properly to sustain their environmental functions and proper environmental economic assessment should be conducted as a reference for the efforts to avoid the conversion of Subak farmlands into other functions.

Keywords: subak, preservation, social benefits, environment

1. INTRODUCTION

"Subak" is a traditional form of organization that exists in Bali, particularly engaged in the permanent institutionalization of irrigation systems. Subak is widely known as an ecosystem management system, which synthesizes scientific knowledge on various ecological relationships in complex socio-political conditions and the framework of values on long-term conservation of the natural ecosystems [1]. In a Subak system, social, economic, and ecological factors are integrated in one inseparable unit [2]. In addition, almost each activity in the Subak system always reflect the balance of the relationships between God, man, and nature. As such, the Subak is often regarded as a socio-agro-spiritual organization [3]. Therefore, in addition to being the practice of sustainable farming, Subak is also one of the most quintessential part of Balinese culture.

However, nowadays there is a tendency for declining sustainability of the Subak system. This tendency has been caused by various factors, such as decreased interest of the young generation to work in the agricultural sector, the decrease in the quantity and quality of water for irrigation, and the narrowing of available farmlands due to the conversion of land usage and function. In 2005, the agricultural area in Bali is 87,850 hectares while in 2006 this area decreased to 87,777 hectares [4]. This illustrates that the average annual decrease of agricultural land in Bali

amounted to nearly 1,000 hectares. Additionally, modernization and the high rate of change in technological adaptation have infiltrated all layers of community life in Bali. If these problems are not promptly mitigated, there is a high possibility that Bali will lose one of its cultural uniqueness, which will have a wide-ranging effects on the environment of the island [2][5].

Today's Subak system faces a myriad of problems closely related to the degrading quality of natural resources and environment, which is happening on a worldwide scale. In relations to the various issues of environmental degradation, economic assessment is expected to properly analyze the conditions related to the usage of natural resources and the environment (positive) and then to give necessary information on the implications that suffice from the various alternative policies and decisions regarding the use of natural resources, which is then connected to the proper use of natural resources (normative).

The existence of Subak as a unique asset of Balinese culture that has been widely known internationally should be kept to attain the abovementioned goals. Therefore, a study from the perspective of environmental economics is necessary, which can provide recommendations to various stakeholders and authorities as a reference in enacting policies and in decision making processes for the proper management of culture and heritage.

The study from the perspective of environmental economics provides a frame of assessment or an effort to quantify the goods and services that exist within the Subak environments into monetary terms, regardless of the existence of the economic values of said goods and services. The economic value is measured in terms of willingness to pay in order to attain said goods and services.

This research is expected to answer the following questions: (1) What is the value of social benefits and total economic value contained in the Balinese Subak system? (2) Is it feasible or worthwhile to preserve the Subak system when seen from the environmental economics perspective?

2. MATERIALS AND METHODS

This research was conducted as a descriptive analytical study, which involves description of facts in terms of monetary valuation, social benefits and total economic value on the existence of Subak in Bali. To determine the economic value, two main variables were identified: (1) social benefit variable and (2) social cost variable. Within the social benefit variable, there are six components classified into three categories: direct use value, indirect use value, and option use value. Additionally, one more value should be taken into consideration: existence value.

The determination of Subak preservation model uses the investment feasibility criteria, which include Net Present Value (NPV) and Net Benefit Ratio (B/C) from the social benefits of the Subak, complemented with Sensitivity Analysis to account for the possibilities of valuation errors, such as the presence of social cost overrun and the possibility of decrease in the social price.

2.1. Research Location

The research location was focused on active Subaks that experience some degree of degradation (narrowing of available farmland, decreasing quantity and quality of water for irrigation, movement of labor to other sectors, wave of modernization, and other forms of stress to the system). Based on those criteria, the research location was determined by purposive sampling, which consists of: (1) The Sangheh Subak in Badung Regency, (2) The Bungan Kapal Subak in Tabanan Regency, and (3) The Padang Tegal Subak in Gianyar Regency. The research was conducted throughout 2014 and 2015.

The population in this study is the Subak communities (farmers) in respective research locations. Additionally, the population needed in this study is the merchants of natural products,

such as the wildlife that exists in the Subak areas, but are non-marketable in terms of monetary valuation. Theoretically, the basis of identification for each variable component, either in the social benefit variable or social cost variable, as well as the assumptions applied in the valuation of each variable component can be elaborated as follows: 1) Identification, basis of valuation/assessment and assumption in monetary valuation on social benefits, and 2) Social benefits identified are based on the previous work by Odum and Johannes [6], which can be categorized as follows: a) Physical benefits, which refers to the benefits of physical or actual use of Subak as a place for agricultural activities for the farmers based on the presence of vegetation, wildlife inhabitants the Subak lands (e.g., eels, fish, frogs, reptiles, and other animals), and other wildlife associated with the open areas of Subak farmlands (e.g., birds, bats, dragonflies, and other animals); b) Option value benefits, which refers to something that should be bequeathed to the next generations, as a place for wildlife preservation, as a place for recreation/tourism attraction, and to preserve the air quality; and c) Existence value benefits, which refers to the existence of Subak as an ecosystem in which natural resources in the form of various vegetation and wildlife exist.

Further, the assessment principle can be categorized into two distinct categories. Firstly, the assessment of marketable goods utilized market value and productivity level approaches. Therefore, the value of benefits from the various variable components can be attained by multiplying the productivity level with market price. This type of assessment/valuation was conducted on the vegetation and the wildlife associated with vegetation. Meanwhile, the assessment of non-marketable goods utilized direct survey methods termed Contingent Value Method through structured and systematic interviews equipped with questionnaire as the study instrument, which consisted of questions with optional answers related to the monetary value of willingness to pay for non-marketable goods with the assumption of involvement of actions to maintain the quality of the natural goods. This was done for the reasons of effectiveness and efficiency. Sample from potential population that took advantage of the natural goods and services was utilized. This technique was applied in the assessment of benefit components classified in the option value and existence value categories.

2.2. Techniques of Analysis

2.2.1. Net Present Value/NPV

Refers to the difference of the flow of benefits with the flow of costs, each of which discounted is with a certain interest rate [6]-[7].

$$NPV = \sum_{t=1}^n \frac{B_t - C_t}{(1+r)^t} \dots\dots\dots(1)$$

Description: *NPV* is Net Present value, *r* is the discount rate and interest, *n* is the amount of time (year), *t* is the year related to the activity, *B_t* is the benefit in the year, *C_t* is the cost in the year

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 2.2.2. Net Benefit Cost Ratio/BCR

Benefit-cost ratio compares the benefits with costs, each of which discounted with a certain interest rate [6]-[7].

$$BCR = \frac{\sum_{t=1}^n \frac{B_t}{(1+r)^t}}{\sum_{t=1}^n \frac{C_t}{(1+r)^t}} \dots\dots\dots(2)$$

Description: *BCR* is Benefit Cost Ratio, *r* is the discount rate and interest, *n* is the amount of time (year) is the year related to the activity, *B_t* is the benefit in the year, *C_t* is the cost in the year

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 2.2.3. Determining the Total Economic Value

Total economic value refers to the sum of usage values with non-usage values or the sum of direct usage, indirect usage, optional, existence, and legacy values [8]-[9].

$$TEV = UV + NUV \text{ or } TEV = (DUV + IUV + OV) + (EV + BV) \quad (3)$$

Description: *TEV* is Total Economic Value, *UV* is Use Value, *NUV* is Non Use Value, *DUV* is Direct Use Value, *IUV* is Indirect Use Value, *OV* is Option Value, *EV* is Existence Value and *BV* is Bequest Value

3. RESULTS AND DISCUSSION

3.1. Social Benefits of Subak Farmlands in Bali

Subak is a place for various agricultural activities for Balinese farmers. The main agricultural activity is rice farming. Since the invention of superior rice paddy variety, farmers have been able to cultivate rice twice annually and other crops once annually. Farmers typically conduct alternating cultivation (planting patterns) to manage water distribution due to the irrigation system consisting of several Subaks that derive their source of water from the same water irrigation channel. The planting pattern carried out by the farmers is typically rice-rice-other crops or rice-other crops-rice. The research found that the benefits from the agricultural activities of rice and crop cultivations in Bali's Subak farmlands yielded Rp. 35,712,300/hectare/annum. This is relatively small and not optimal, because well-managed agricultural management, with

vegetation-livestock integration, should have yielded Rp. 48,342, 010/hectare/annum [10].

Other types of bordering vegetation can be found in Bali's Subak farmlands, particularly in the borders between one Subak with another (typically in the form of a river, *munduk* or valley), in the form of coconut and other trees. The benefits of these vegetation can be valued based on the productivity of coconuts per hectare per annum multiplied by average market price for each coconut fruit. Meanwhile, the value of other trees on the farmlands can be calculated by multiplying firewood produced with the average price of firewood in several traditional markets throughout Bali. The total benefits of bordering vegetation in Bali's Subak farmlands reached Rp. 9,720,075/hectare/annum, which is relatively small compared to the value of vegetation from the economic valuation of mangrove forest of Bali's Benoa Bay in a research conducted by Wiradarma [11], which reached Rp. 62,283,466/ hectare/ annum, as well as compared to the research conducted by Nurdin [12] on mangrove forests in East Java. This phenomenon can be explained by the fact that the tree vegetation in the mangroves are the main commodities for the mangrove forests, while the tree vegetation in the Bali Subak farmlands are only secondary and found in the border areas between one Subak with another, since the main vegetation of the Subak is rice paddies or other food crops.

The assessment of benefits gained from fresh water animals or fisheries surrounding the Subak farmlands are based on the various productions of fresh water animals found in the farmlands, including snails, eels, frogs, which are then multiplied by the market price of each animal. The catching of eels are typically done directly, from the beginning of farmland cultivation cycle until the rice paddies are two weeks old, using a traditional device called the *bubu*. This activity is rarely done by the farmers, particularly catching of dragonflies, snails, and frogs are done in a very small number because of the direct impact of the overuse of chemical fertilizers and pesticides. The total benefits derived from fresh water animals in Bali's Subak farmlands amounted to Rp. 3,647,500/hectare/annum, which is relatively small compared to the valuation of wildlife in the mangrove forests, due to the short lifespan of rice paddies and the fact that the wildlife in Subak farmlands have been largely diminished by the use of chemical fertilizers and pesticides.

The assessment on the benefits of wildlife was based on the number of species identified. The wildlife on the upper canopy of farmlands are represented by birds (*aves*), meanwhile the wildlife on the lower canopy of farmlands are represented by reptiles. It is estimated that 56 bird species, 13

of which are protected, and 29 reptile species, two of which are protected, can be found. In assigning monetary value on said wildlife, it is based on the opinion of Ruitenbeek (1991), which valued the benefits per species of birds at US\$ 0.12 and US\$ 0.73 per species of reptiles. Therefore, the value of economic benefits derived from birds is US\$ 6.72 or Rp. 60,480 and from reptiles is US\$ 21.17 or Rp. 190,530. The total economic benefits from birds and reptiles are valued at Rp 251,000/ hectare/ annum.

3.2. Benefits from Alternative Use (Option Value)

Deriving the benefits from alternative use (option value) of Subak farmlands in Bali began with uncovering various views on the quality of Subak farmlands as something that possess alternative usage (option value). The quality of natural goods consists of: Subak farmlands in sustainable conditions as something to be inherited by the next generations, as a place for wildlife conservation, as a place of recreation, and as the means to sustain good air quality.

By determining an image of societal views on Subak farmlands in Bali, the option value can be predicted from the respondents' statements regarding the importance of Subak farmland preservation to be bequeathed to the next generations, as a place for wildlife conservation, as a place of recreation, and as a natural good that functions to sustain good air quality. Based on the respondents' willingness to pay on the

environmental goods present in Bali's Subak farmlands, which in their function possess a certain option value, it can be predicted that the value of this option value is Rp 3,214,286/hectare/annum.

The assessment of physical benefits of Subak farmlands utilized the surrogate market approach, which means that if the Subak farmlands vanish due to human activities then the wells of the surrounding communities will dry up to maintain the function of Subak farmlands in sustaining ground water. This can be determined by the value of clean water needed by surrounding communities. If the number of inhabitants in communities surrounding Subak farmlands are 210 households, on average, and the average need for clean water is one gallon/household/day and the average price of clean water is Rp 150/gallon, then the total community expenditure for clean water per household/annum is $210 \times 265 \times \text{Rp } 150 = \text{Rp. } 11,497,500$.

In the determination of existence value of Subak farmlands in Bali, the same technique as in determining the option value was utilized, which is the Contingent Value method. This method employed the survey method by uncovering the willingness to pay of certain natural goods (in this case, the Subak farmlands in Bali), as something that possess existence value. Based on the respondents' willingness to pay on natural goods present in Bali's Subak farmlands, which in its function has existence value, the figure was predicted to be Rp 3,154,762/hectare/annum.

Table 1 Types of Benefits and Monetary Value of Subak in Bali per Hectare, per Annum, Year 2011-2012

No	Type of Benefit	Benefit Valuation (Rp)
1.	Farming Activities	35,712,300
2.	Bordering Tree Vegetation	9,720,075
3.	Fresh Water Animals / Fisheries	3,647,500
4.	Wildlife	251,010
5.	Option Value	3,214,286
6.	Physical Value	11,497,500
7.	Existence Value	3,154,762
Total		67,197,433

Source : *Processed from Primary Data*

3.3. Social Costs of Subak in Bali

Social costs consist of investment costs, agricultural activity costs, vegetation maintenance costs, fresh water animal usage costs, and wildlife conservation costs. Investment costs consist of rice field creation costs, social opportunity costs as the sacrificial costs as a result of creating/cultivating new rice fields (which took place at the beginning of the project, or year 0). Based on the research

conducted, total investment cost was determined to be Rp 29,050,000/hectare/annum, agricultural activity cost was determined to be Rp. 9,437,778, while the vegetation maintenance cost amounted to Rp. 879,750, fresh water animal usage cost was Rp. 1,072,800, and lastly wildlife conservation cost was Rp. 29,200. As such, the recapitulated total social costs per hectare per annum on the Subak farmlands in Bali were determined to be Rp 40,469,528.

3.4. Assessment of Social Benefits of Subak in Bali

The net value of social benefits of Subak in Bali was determined by using the criteria for investment feasibility, which arrived at $NPV = Rp. 121,968,624 > 0$, which indicated that the social benefits gained from the preservation of Subak farmlands in Bali exceeded the social costs incurred. This also indicated that the preservation of Subak in Bali is a worthwhile endeavor. The Net B/C ratio of $5.1986 > 1$ indicated that the social benefits derived from conducting the project outweighed the social costs associated (5 to 1) on the life of the project. This signified that Subak preservation, through the scenario of banning the conversion of land function from Subak farmlands to other uses, is feasible and worthy to be implemented. Lastly, when compared to the Net B/C on the economic assessment of mangrove forests, which only reached 7.22, the Net B/C for Subak is far/ less great.

Net benefit refers to the difference between social benefit value and social cost value per hectare/annum after being discounted with a 12% discount rate. The findings showed that the usage of Subak farmlands for development through the conversion of Subak farmlands in Bali into other functions yielded externalities of Rp. 23,864,200 for each hectare of farmlands converted into residential or other functions, which is the net benefit of the first year. Therefore, if conversion of Subak farmlands occurred as a result of human activities, then the person could be charged with a minimum penalty of Rp. 23,864,200 per annum. However, in reality land function conversion continues to be a problem, without any compensation to the Subak itself, and ironically the most strategic Subak farmlands (vulnerable to be converted into other land usage/functions) are the ones levied the highest tax rates, which is one of the prevailing reasons for farmers to be powerless in preserving and protecting their Subak farmlands.

3.5. Total Economic Value of Subak in Bali

Use value consists of proceeds from agricultural activities, proceeds from tree vegetation, proceeds from fisheries and other fresh water animals, proceeds from the utilization of wildlife. Meanwhile, non-use value consists of physical function value, option value, and existence value. In other words, direct use value consists of proceeds from agricultural activities, proceeds from tree vegetation, proceeds from fisheries and other fresh water animals, proceeds from the utilization of wildlife, while indirect use

value is the value of physical benefits. Based on the abovementioned formula, the sum of use value and non-use value, or direct use value and indirect use value, added to option value and existence value, then subtracted by social costs on per hectare scale of farmlands, this calculation would arrive at the net social benefit per hectare. Therefore, the Total Economic Value of Subak, derived from the multiplying Net Benefit ($\Sigma Bt - \Sigma Ct$) per hectare per annum (after being discounted with a discount rate of 12% per annum), was found to be Rp 12,196,862. The total economic value of Subak can be increased if the Subak is properly managed, meaning that the farmlands are well preserved, so that the direct usage value in terms of agricultural activities can be improved through the use of environmentally-friendly technology, which can bring positive externalities to the indirect use of the Subak farmlands, while maintaining the ecological balance as well as the environmental functions (supporting and carrying capacities) of Subak as a well-functioning ecosystem.

3.6. Sensitivity Analysis

In a condition of 10% cost overrun, while the social benefit components are kept unchanged, NPV yielded $Rp 96,197,438 > 0$ and $Net B/C Ratio = 4,0104 > 1$. This indicated that the preservation of Subak farmlands in Bali, with the scenario of banning land usage conversion from farmlands to other functions, even though an increase in social costs of 10% is experienced (compared to the previous/normal condition), the project is still deemed to be feasible and worthwhile. Further, with a 5% reduction of benefit component prices, which caused a decrease in monetary value of social benefit components, this yielded NPV of $Rp 102,984,600$ and $Net B/C Ratio = 4,5451$. This indicated that the preservation of Subak farmlands in Bali, with the scenario of banning land usage conversion from farmlands to other functions, even with the decrease in benefit component prices of 5% (compared to the previous/normal condition), the project is also still deemed to be feasible.

In relations to this sensitivity analysis, the Total Economic Value also experienced a change with the alterations in the monetary values of social benefits and social costs. The changes are as follows: (a) if cost overrun of 10% is experienced, in which an increase in monetary values of social cost components occurred, this yielded Total Economic Value of Subak farmlands in Bali of Rp 9,619,744/hectare/annum, and (b) if a price decrease of the social benefit components of 5% is experienced, this yielded Total Economic Value of Subak farmlands in Bali of Rp. 10,298,460/hectare/annum.

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4. CONCLUSION

Based on the research findings and discussions, the following can be concluded: 1) The social benefit value contained in the Subak system in Bali yielded NPV = Rp. 121,968,624 > 0 and Net B/C ratio of 5.1986 > 1, which suggested that Subak farmlands in Bali is feasible to be preserved from the environmental economics aspect. The condition of 10% cost overrun, while the social benefit components remain unchanged, yielded 96,197,438 > 0 and Net B/C Ratio = 4,0104 > 1. Further, if a decrease of benefit component prices of 5% is experienced, this yielded NPV = Rp 102,984,600 and Net B/C Ratio = 4, and 2) The Total Economic Value (TEV) simultaneously showed the value of assets in the form on Subak area ecosystem = Rp 12,196,862/hectare/annum. With sensitivity analysis, the value would change in a 10% cost overrun condition into TEV = 60,062,658.96/hectare/annum, and in a 5% price decrease of the social benefit components it would change into TEV = 10,298,460 /hectare/annum.

5. RECOMMENDATION

Based on the conclusion above, the following recommendations can be given: 1) The Subak farmlands should be preserved in order to sustain ecological balance of nature, so that the environmental functions (supporting and carrying capacities) of the Subak farmlands as a unique form of ecosystem can be well-maintained, 2) The economic assessment of Subak has been used as a benchmark to avoid the conversion of land use/function, so that the Subak system can be sustained and properly preserved, and 3) Subak will be sustainable if efforts to increase its contained Total Economic Value (TEV) are taken, so that conversion of Subak farmlands to other functions and development can be avoided. Therefore, further research is necessary to increase the understanding of the social functions contained within the Balinese Subak system.

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