

The Analysis of Operation and Maintenance Costs of Retention Basin in Besakih Based on the Characteristics of River and Local Social Cultural Religious Condition

Ida Bagus Putu Bintana, I Made Suardana Kader

Politeknik Negeri Bali

gusbint@yahoo.com, imadesuardanakader@gmail.com

Abstract :- Karangasem is one of the regencies in Bali with the highest percentage of critical land condition. With this condition, during the dry season people in the area have difficulty to get clean water for both every day or livestock purposes. In 2009, the government has built Retention Basin in Banjar Temukus, Besakih Village, Rendang, Karangasem to fulfill the needs of water in the dry season for the people around the area. The problem is that the Government has not yet calculated the operating and maintenance costs required to operate the retention basin. Worth to be noted that its function depends on the operating system and maintenance supported by one of them by operating and maintenance cost.

This research tried to conduct a detailed technical study to determine the cost of operation and maintenance (O&M) both for routine O&M and for periodic O&M.

This study found that the routine operational costs is Rp 27.939.000, -, routine maintenance costs is Rp. 92,374,000, while the requirement of periodic operational cost which emphasized on investment to improve the complementary building condition and maintenance which aim to maintain the function of the building is Rp. 563,892,000,-.

1. Introduction

Retention Basin in Besakih aimed to hold water, and is an alternative solution to overcome the water shortage during the dry season. To support the sustainable function of retention basin, the analysis of the amount of operation and maintenance costs is urgently needed so that its function can be maintained well.

For that reason, knowing what kind of buildings that are located in Retention basin of Besakih and how much is the cost of O&M needed to maintain the function of Besakih retention basin are important. This needs to be done considering that retention basin in Besakih, which has the most semi-dry area in Bali, depends a lot on water reservoirs to help people overcoming water supply problems during the dry season.

Assessment of the retention basin performance is done to determine the functional percentage of the building. This is done because it is closely related to the operation and maintenance activities later. The building condition terminology can be classified according to the degree of damage [5].

The estimation of the cost and funding needs for the retention basin operation is done by calculating the real need costs of its operation and maintenance. Their unit cost is determined based on the type and frequency of O&M activities [6] where it can be divided into 3: annual, periodical, and special activities.

Annual / routine O&M activities are scheduled routinely in duration of less than one year or with a certain frequency such as daily, weekly or monthly. Annual O&M activities include the following activities: drafting the annual operation plan of retention basin, equipment operation, office operations; conducting maintenance activities including maintenance of water reservoir dam, cutting

grass, dredging sediment controlling dam, pipe maintenance, etc., painting, monitoring, inspecting and evaluating activities including visual inspection, equipment operation test. This activity is done periodically in more than 1 year. These activities may be done periodically or depend on the needs in the field. The special activities include the costs for the emergency repair and rehabilitation as a result of urgent condition or just for back up fund.

The arrangement of unit price for O&M of retention basin is based on PU Regulation No 11 of 2013 about the Analysis of Unit Costs in Public Works Sector especially section 2, AHSP on Water Resources [9].

The purpose of this study is to map the existing buildings and determine the cost of retention basin O&M in Besakih. Meanwhile this study hopefully could be beneficial in providing an overview or a reference in order to determine the cost requirements of Operation and Maintenance of Besakih retention basin, making it easier for the Government in planning the budget.

2. Method of Research

The research is conducted in the form of information gathering (primary and secondary data collection), field survey, problem analysis, and the formulation of O&M costs.

A preliminary study was conducted to see the early data on Besakih retention basins. Direct observation and field observation showed that retention basins in Temukus, Besakih village, Rendang, Karangasem was built in 2009 and used by 66 families, having dimensions of 100 meters x 40 meters x 5 meters, with total water reserved 16,750 m³. Type of Construction: landfill, geo-membrane, geogrid, geotextile with the type of collecting-water dam consisting of fixed dam with masonry construction completed with guard house type 36 and 2 field officers in which 1 person is paid by the Karangasem Government and 1 person is paid by *Balai Wilayah Sungai Bali Penida* (Department of River Area in Bali and Penida).

The scope of this study is the O&M Cost Calculation routinely, periodically or in special time. This was analyzed based on the basic unit price analysis issued by the Government of Karangasem and Bali Province

Instruments required in this research included earth map for Rendang district, documentation of O & M field activity, basic map of Glogor River flow system and the result of the soil characteristic test.

Analysis of data was conducted to determine the type of building and current condition of the building. Unit price analysis was used to determine the unit price for each item, as well as socio-cultural and economic analysis that was taken into account to consider the additional costs to the O&M related with socio-cultural conditions of society.

3. Result and Discussion of the Study

Retention Basin of Besakih is located in Temukus, Besakih Village, Rendang, Karangasem Regency. This retention basin has a very strategic role as a provider of water, especially in the dry season for the surrounding community. It also helps the activities of religious ceremonies in Besakih Temple. Technical data of Besakih Retention Basin can be seen in Table 3.1 below:

Table 3.1 Technical data of Besakih Retention Basin

NO.	NAMA EMBUNG	LOKASI	TAHUN DIBANGUN	SUMBER DANA	JUMLAH BIAYA (RP)	LAYANAN (KK)	TUBUH EMBUNG					RUMAH JAGA	KRAN UMUM (UNIT)	PIPA DISTRIBUSI (M)	PENJAGA EMBUNG	KETERANGAN
							DIMENSI (M)			VOLUME (M ³)	KONSTRUKSI					
							P	L	T							
1	BESAKIH	DSN. TEMUKUS	2009	APBN	11.999.546.000,00	66	100,00	40,00	5,00	16.750,00	TMB. TANAH	ADA	10	5,584	NGH. DAN	PETUGAS DARI BWS BALI PENIDA
		DS. BESAKIH			(TOTAL)						GEOTEXTILE					
		KEC. RENDANG			8.000.000.000,00						GEOGRID				WENGAH MUDANA	PETUGAS DARI DINAS PU. KAB.

Source : *Balai Wilayah Sungai Bali Penida* (Department of River Area in Bali and Penida)

The main river where the water is caught in Besakih retention basin is Glogor River. It is located in the north of Besakih retention basin. The river in general is an intermittent volcanic river with the riverbed consists of the rock material from Mount Agung with a very steep incline. The average width of the river is between 3-6 m. Dense vegetation is observed on the upstream of water reservoir dam that potentially brings the sediment after the rainy season ends. Upstream area is a state forest area located on the southern slopes of Mount Agung.



Figure 3.1 The Condition of Watershed in Glogor River

The water reservoir dam at Besakih retention basin is constructed with pairs of stone and has been completed with a water-draining building with an intake and its filter. At the time of the visit, it can be observed that this dam is very well-maintained. To get to this dam, there are an 800 m - footpath whose width is 0.5-1 m. Thus, some parts of the way can be taken by motorcycle.



Figure 3.2 The Condition of Upstream of Dam on Besakih Retention basin.

Besakih Retention basin has been completed with water supply pipes and reservoirs as a mud container before the water goes into the retention basin. Data of water reservoir dam on Besakih retention basin can be seen in Table 3.2 below:

Table 3.2 Building Inventory of Water reservoir dam on Besakih Retention basin

NO.	NAMA BANGUNAN	JENIS	DIMENSI				DIAMETER Cm	BAIK	KONDISI			FOTO
			PANJANG (M)	LEBAR (M)	TINGGI (M)	RUSAK						
						RUSAK RINGAN			RUSAK SEDANG	RUSAK BERAT		
1	Pelimpah	Pasangan Batu		6	1,5		Baik					
2	Sayap Hulu (Kanan Kiri)	Pasangan Batu	16	0,5	3,5		Baik					
3	Sayap Hilir (Kanan Kiri)	Pasangan Batu	20	0,5	3		Baik					
4	Pintu Penguras	Pintu Baja Stang Tunggal		0,8	2		Baik					
5	Pintu Intake Kiri	Pintu Baja Stang Tunggal		0,6	1,5		Baik					
6	Pipa Intake	Pipa PVC dengan lubang	4			20	Baik					
6	Kantong Lumpur (1 Buah)	Beton	6	3	2,5			Penutup Hole Berkarat				
7	Pipa Pembawa (2 buah pipa)	HDPE	1700			25	Baik					

Source : Result of Survey, 2017

Besakih retention basin has been equipped with body pool, geomembrane, retaining wall in the north, wire fence around the pool, parking lot, guard house and barbed wire fence and gate in the south. The complete building of water reservoir dam can be seen on the Table 3.3 below:

Table 3.3 Building Inventory of Besakih Retention basin

NO.	NAMA BANGUNAN	JENIS	DIMENSI			BAIK	KONDISI			FOTO
			PANJANG (M)	LEBAR (M)	Tinggi (M)		RUSAK			
							RUSAK RINGAN	RUSAK SEDANG	RUSAK BERAT	
1	Tubuh Bendungan	Timbunan Tanah Geogrid Geotextile Geomembran	100	40	5	Baik				
2	Tangga OP	Tidak ada								
3	Peilschal	Baja			5	Baik				
4	Pipa Inlet 3 buah Diameter 10 inch	Baja				Baik				
5	Geomembran		100	40	5	Baik				
6	Reservoir (3 buah)	Beton	4	4	2	Baik				
7	Jalan Akses	Beton	1600	3		Baik				
8	Rumah Jaga (Tanpa listrik)	Type 36	6	6		Baik				
9	Pagar	Baja	280		4	baik				
10	Taman Parkir	Paving	40	10		baik				
11	Pagar Kawat Pondasi pasangan batu	Kawat Berduri	250		4	baik				

Source : (Survey 2017)

The assessment of the retention basin performance is done to know the functional percentage of the building. This is done because it is closely related to the operation and maintenance activities later.

The results of the assessment of the building condition of Besakih retention basin can be seen in Table 3.4 and Table 3.5 as follows:

Table 3.4 The Assessment of Water Reservoir Dam in Besakih Retention Basin

NO.	NAMA BANGUNAN	JENIS	DIMENSI				DIAMETER	BAIK	KONDISI			Kinerja (%)	FOTO
			PANJANG (M)	LEBAR (M)	Tinggi (M)				RUSAK RINGAN	RUSAK SEDANG	RUSAK BERAT		
1	Pelimpah	Pasangan Batu		6	1,5		Baik				95		
2	Sayap Hulu (Kanan Kiri)	Pasangan Batu	16	0,5	3,5		Baik				95		
3	Sayap Hilir (Kanan Kiri)	Pasangan Batu	20	0,5	3		Baik				95		
4	Pintu Penguras	Pintu Baja Stang Tunggal		0,8	2		Baik				95		
5	Pintu Intake Kiri	Pintu Baja Stang Tunggal		0,6	1,5		Baik				95		
6	Pipa Intake	Pipa PVC dengan lubang	4			20	Baik				95		
6	Kantong Lumpur (1 Buah)	Beton	6	3	2,5			Penutup Hole Berkarat			95		
7	Pipa Pembawa (2 buah pipa)	HDPE	1700			25	Baik				95		

Source : Analysis Result

Table 3.5 The Assessment of Besakih Retention Basin Building Performance

NO.	NAMA BANGUNAN	JENIS	DIMENSI			BAIK	KONDISI			Kinerja %	FOTO
			PANJANG (M)	LEBAR (M)	Tinggi (M)		RUSAK RINGAN	RUSAK SEDANG	RUSAK BERAT		
6	Reservoir (3 buah)	Beton	4	4	2	Baik				95	
7	Jalan Akses	Beton	1600	3		Baik				95	
8	Rumah Jaga (Tanpa listrik)	Type 36	6	6		Baik				95	
9	Pagar	Baja	280		4	baik				95	
10	Taman Parkir	Paving	40	10		baik				95	
11	Pagar Kawat Pondasi pasangan batu	Kawat Berduri	250		4	baik				95	

Source : Analysis Result

After several field visits and deep observations, some problems found in Besakih retention basin can be stated as follows:

1. The water reservoir dam requires a door house, 2 x 2 m in size, with the intention of reducing the rusting potential of the door

2. Electricity is required on the guard house, for night lighting and supports the activities of the officer.
3. The dam needs a gazebo on which can be used as a resting place for officer in the dam
4. The road with width of 1 m as far as 1800 m to access the dam needs to be repaired. Currently, the road is a very slippery especially after raining or in the morning.
5. A concrete road which costs 150 m with width 4 m needs to be built for an easy access for the people around the retention basin.

The society around retention basin is mostly farmers and cowbreeder as well as sellers in Besakih temple. The farmers usually plant flower especially *Kenikir* flower and *Kasna* flower for offerings in Bali. Besides, there are also tomatoes, oranges, chili and clove. The marketing of the agriculture is done through the collectors who come to the location or sell directly to the market in Klungkung regency.

Local people believe that retention basin has function as water source for all needs include for religious purposes. Therefore, people have responsibility to keep retention basin. It can be shown by the result of survey and direct observation in the field in which retention basin is used as a place for begging holy water.

Historically, *Tri Hita Karana* concept is an ancient Balinese concept of which emphasize on living harmony with the natural environment, society, and to God. It is also as a balance concept between fulfilling material or individual needed and social spiritual needed.

The term of *Tri Hita Karana* concept means three causes of prosperity, wealth, and happiness in human life (Sudarma, 1971; Kaler, 1983). Those three causes of happiness can be done through creating a peaceful living between human and God, among human beings, and between human and environment. The implementation of *Tri Hita Karana* also relates with Balinese activities that live near the river.

a. Parahyangan

Parahyangan is one of the three concepts which relates to the God. For Balinese people who live near the river, this concept is implemented through *Taman Beji* temple which is located near the river.

b. Palemahan

Palemahan is the concept of life which represents a harmonic relationship between human and environment. The implementation of this concept is showed by cleaning the river to keep the environment balance.

c. Pawongan

Pawongan is the concept of living in harmony among the society. For Balinese people who live near the river, this concept is implemented by showing tolerance among the society.

The concept of *Sad Kertih* comes from the word *Sad* which means six. *Kertih* means a positive result. This concept reflects that in order to keep living in harmony and balance, there are six things to do such as *Atma Kertih*; *Samudra Kertih*; *Wana Kertih*; *Danu Kertih*; *Jagat Kertih* dan; *Jana Kertih*. The concept of *Sad Kertih* can be found in Lontar Purana Bali (I Ketut Wiana, 1999 – paghe 48; 2007 – page 14). On six pages which are talked about *Danu Kertih*, it is stated that some efforts are needed to maintain water source such as spring, lake, river, etc. So, this concept shows that the society who live besides the river have important role to keep the river well functioned for the future.

In *Manawa Dharmasastra* IV.56 stated that it is forbidden to spit, pee and defecate to the river. Moreover, the people are also banned to speak rude words or throw poisonous things to the river. This policy wants to persuade the society not to allow polluting the water source, river, lake and also retention basin in any forms to keep the environment holy, clean and sustainable.

Based on the research, it can be described the existence of retention basin for the surrounding society, so it is needed Operation and Maintenance cost to keep the sustainability of retention basin.

The estimation cost for conducting O&M activities can be done through the calculation of Real Need Operation number and Maintenance of retention basin or known as AKNOP which is analyzed based on the type and the frequency of its activities.

The number of real need O&M can be showed in table 3.6 and table 3.7 as follows:

Table 3.6 Real Need Operation number of Retention Basin in Besakih

NO.	URAIAN	SATUAN	JUMLAH	HARGA SATUAN	TOTAL PERTAHUN
1	Tenaga Operasi (12 bulan)	Orang/bulan	1	1,800,000	21,600,000
2	Service Sepeda motor + ganti oli dan spare part (12 kali)	kali	1	120,000	1,440,000
3	Biaya listrik	bulan	1	200,000	2,400,000
3	Biaya samsat sepeda motor	kali	1	220,000	220,000
4	Biaya pulsa (perbulan)	Ls	1	100,000	1,200,000
5	Buku laporan bulanan	Ls	1	30,000	360,000
6	Pulpen	buah/bulan	2	6,000	72,000
7	Penghapus white board	buah/bulan	2	12,000	288,000
8	Spidol	buah/bulan	2	6,000	144,000
9	Jas Hujan	buah/tahun	1	100,000	100,000
10	Sepatu boat	pasang/tahun	1	65,000	65,000
11	Senter	buah/tahun	1	50,000	50,000
				Jumlah	27,939,000

Source : result of analysis

Table 3.7 Real Maintenance number of Retention Basin in Besakih

ANGKA KEBUTUHAN PEMELIHARAAN RUTIN EMBUNG BESAKIH					
NO.	URAIAN	SATUAN	JUMLAH	HARGA SATUAN	TOTAL PERTAHUN
1	Pemeliharaan bangunan kantor dan fasilitasnya, di luar pengecatan (misal perbaikan genteng, pintu, kran air, dll)	Ls	1	7.500.000	7.500.000
2	Pemeliharaan peralatan eletrikal (misal penggantian lampu, AC, lampu jalan, kabel, baterai, dll)	Ls	1	3.500.000	3.500.000
3	Pembersihan rumput di jalur bendung penangkap (3 bulan sekali)	m2	750	2.553	7.659.000
4	Pembersihan rumput di areal kolam (3 bulan sekali)	m2	1500	2.553	15.318.000
5	Pengecatan pipa (setahun sekali)	m2	200	28.158	5.631.600
6	Pengerukan sedimen di bendung penangkap (6 bulan sekali)	m3	18	63.204	2.275.344
7	pengerukan sedimen di bak kantong lumpur (6 bulan sekali)	m3	2,88	63.204	364.055
8	pengerukan sedimen di kolam embung (6 bulan sekali)	m3	120	63.204	15.168.960
9	Pengecatan pintu intake dan penguras (setahun sekali)	m2	4	28.158	112.632
10	Pemeliharaan pintu	Ls		924.110	1.848.220
11	Pengecatan kawat BRC	m2	160	28.158	4.505.280
12	Penambalan kerusakan geomembran	Ls	1	3.500.000	3.500.000
13	Pwebaikan dan penggantian seal sambungan pipa	Ls	1	3.500.000	3.500.000
14	Biaya Upakara sehari-hari	Bln	12	500.000	6.000.000
15	Biaya Upakara Piodatan	keg	2	7.500.000	15.000.000
14	Pengadaan alat pemeliharaan				
	Sabit	buah	2	50.000	100.000
	Skop	buah	2	65.000	130.000
	Tali plastik	m	20	8.000	160.000
	Penyaring sampah panjang	buah	2	50.000	100.000
				Jumlah	92.373.091

Source : Result of analysis

O&M is emphasized on maintenance which is done regularly. The aim is keeping the function of its building. For further explanation can be seen on table 3.8 as follows:

Table 3.8 Real Need number maintenance Retention basin in Besakih

NO.	URAIAN	SATUAN	JUMLAH	HARGA SATUAN	TOTAL
1	Sepeda motor	buah	1	16,000,000	16,000,000
2	Pengadaan listrik 1300 VA	Ls	1	3,500,000	3,500,000
3	Papan OP	buah	1	350,000	350,000
4	Papan plat penunjuk arah	buah	3	600,000	1,800,000
5	Papan nama	buah	1	600,000	600,000
6	Rumah pintu (2 x 2)	buah	1	12,000,000	12,000,000
7	Bale bengong untuk pelinggih di bendung	buah	1	12,000,000	12,000,000
8	Jalan beton dari jalan utama menuju embung lebar 6 m, panjang 30 m	m3	27	2,184,143	58,971,861
9	Jalan beton dari embung ke bendung penangkap lebar 1,5 m, panjang 700 m	m3	210	2,184,143	458,670,030
				Jumlah	563,891,891

Source : Result of analysis

4. Conclusions and Suggestions

From the result of the analysis and field observation through technical field investigation, the conclusion can be stated as follows:

1. There are 2 main building of retention basin in Besakih such as:
 - 1) Water collecting
 - 2) Main building of retention basin
2. Retention basin in Besakih is well functioned. It can be proven by having index technical performance above 90%
3. Besakih retention basin is really needed by the society for water needed such as ceremonial purposes, bath, and farms.
4. The needs of operational cost of retention basin in Besakih is Rp. 27.939.000,-
5. The needs of maintenance routine cost of retention basin in Besakih is Rp. 92.374.000,-
6. The needs of maintenance regularly cost of retention basin in Besakih is Rp. 563.892.000,-

Looking at the importance of retention basin in Besakih for the society, it can be suggested that it should be provided operational and maintenance cost so that retention basin in Besakih will be well function accordance with the plan for the society. Balinese people also can preserve the existence of retention basin in Besakih by inserting the status of retention basin to the regulation or *perarem subak* as a duty to keep and preserve it.

References

- [1] Agus Maryono, 2003. *Pembangunan Sungai Dampak Dan Restorasi Sungai*. Yogyakarta : Universitas Gajah Mada Press.
- [2] Balai Penelitian dan Pengembangan Pengairan.2000, *Standar Nasional Indonesia : Perhitungan Banjir Rancangan*. Jakarta : Departemen Pekerjaan Umum, Bidang Sumber Daya Air.
- [3] BPS Kabupaten Karangasem,2012. *Karangasem Dalam Angka 2012*. Amlapura, Pemerintah Daerah Kabupaten Karangasem.
- [4] CD. Sumarto, 1985. *Hidrologi Teknik*. Surabaya : Usaha Nasional
- [5] Kodoatie, Robert dan Sjarief, Rustam, 2005. *Pengelolaan Sumber Daya Air Terpadu* . Yogyakarta: Andi
- [6] Linsley, R.K dan Franzini, Josep B. 1995. *Teknik Sumber Daya Air*. An Jakarta: Erlangga
- [7] Santoso, Gempur. 2005. *Fundamental Metodologi Penelitian Kuantitatif dan Kualitatif*. Jakarta: Prestasi Pustaka
- [8] Sharin, 1990. *Statistical Of Hidrology*. Mc.Graw Hill
- [9] ri Harto.1993. *Analisa Hidrologi*. Jakarta : PT. Gramedia Pustaka Utama
- [10] Suyono Sosrodarsono dkk. 1993. *Hidrologi Untuk Pengairan*. Jakarta : Pradnya Paramita
- [11] Ven Te Chow, 1987. *Hidrolika Saluran Terbuka*. Jakarta : Erlangga