

# Water conservation model in Ayung river estuary based on ecotourism

*by* I Gusti Agung Putu Eryani

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## Water conservation model in Ayung river estuary based on ecotourism

I G A P Eryani<sup>1,\*</sup> and M W Jayantari<sup>2</sup>

<sup>1</sup> Civil Engineering Department, Warmadewa University, Denpasar-Bali, 80239, Indonesia

<sup>2</sup> Civil Engineering Department, Tenth of November Institute of Technology, Surabaya, 80111, Indonesia

\*eryaniagung@gmail.com

**Abstract.** The Ayung river basin is the largest watershed in the Bali Penida River Region. The increase in population and the demands of a more viable livelihood have encouraged people to continue to strive to meet all their needs and the development of tourism in Bali that is growing rapidly, but behind that there will be a negative impact caused mainly on the river water environment and river estuary. For this reason, it is necessary to evaluate the environmental conditions of river estuaries and environmental arrangements to be able to support water needs and tourism activities. The purpose of this study was to create a model of water resources conservation at the Ayung river estuary based on ecotourism. The research method uses qualitative methods, which will integrate conservation of water resources that may be carried out in research areas based on ecotourism. The data used are in the form of primary data and secondary data where the primary data is in the form of observations directly to the location of the study and survey by interviewing the surrounding community about tourism activities in the research location. Meanwhile, secondary data in the form of water potential data, land use, topography obtained from survey and related agencies. The results of the study using the SWOT model obtained several alternative conservations that can be done based on ecotourism.

### 1. Introduction

Water is a very important resource for [12]. The utilization of water resources for various needs, it continues to increase from year to year, as a result of population growth and the development of its activities. Whereas on the other hand, the availability of water resources is increasingly limited, but it tends to be increasingly scarce, mainly due to a decrease in environmental quality and a decrease in water quality due to pollution. If this is not anticipated, it is feared that it can cause tension and even conflict due to conflicts of interest when demand [5] no longer balanced with the availability of water resources for supply. Therefore, there is [5] need for conservation of water resources.

According to Law No. 7 of 2004, conservation of water resources is an effort to maintain the existence and sustainability of the condition, nature and function of water resources so that they are always available in sufficient quantity and quality to meet the needs of living things, both now and in the future [1].

Bali is one of the provinces in Indonesia which has become an international tourism destination. Tourism activities in Bali utilize 65% of water in Bali [2]. Water availability and needs in each region in Bali are based on Bali water map data [3], so there are five districts/ cities that experience water



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deficits: Denpasar City, Badung Regency, Klungkung, Gianyar (South Bali) and Buleleng Regency (North Bali).

Watershed (DAS) is a unit of the water system that is formed naturally where water seeps and or flows through the river and the tributaries concerned [4]. The watershed consists of upstream, middle and downstream parts. Downstream of the river or river estuary is an area that has the potential for conservation, because every year a lot of watershed is wasted wastefully into the sea. If management is carried out with conservation, the water will not be wasted wastefully into the sea and can be utilized in the dry season.

The Ayung river basin is the largest watershed in the Bali Penida River Region with an area of 306,149 km<sup>2</sup> with a river length of 71,791 km. This watershed is through 6 regencies/cities. Ayung River is widely used as a source of clean water for drinking water (PDAM), irrigation water, domestic water, agriculture and livestock. The increase in population and the demands of a more viable livelihood have encouraged people to continue to strive to meet all their needs and the development of tourism in Bali that is growing rapidly, but behind that there will be a negative impact caused mainly on the river water environment and river estuary. The Ayung River estuary is connected with Padang Galak Beach. Padang Galak Beach is one of the beaches that has become a tourism destination in the Denpasar area.

The importance of this research is to tackle the water crisis in Bali especially in the dry season and reduce the amount of wasted discharge to the sea in the rainy season and tidal flooding to the mainland, as well as the sustainability of raw water supply, increase agricultural, fishery products and support the development of tourism in Denpasar, Bali province. The purpose of this study was to create a model of water resources conservation at the Ayung River estuary based on ecotourism. Ecotourism is a tourism activity that is environmentally and naturally responsible, contributing positively to environmental conservation and paying attention to the welfare of local communities. Ecotourism is one aspect that is highly related to the environment, development is expected to be able to preserve natural resources and the environment [5]. Through this research, communities in the downstream/ estuary of the Ayung river and coastal areas can continue to carry out tourism activities while at the same time carrying out water conservation so that sustainable management of water resources can occur.

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## 2. Research methods

### 2.1. Method of data collection

Data used in the form of primary data and secondary data where the primary data is in the form of observations directly to the location of the study and survey by interviewing the surrounding community about tourism activities in the study area. Meanwhile, secondary data in the form of water potential data, land use, topography obtained from the literature survey and related agencies.

The research process begins by looking at the symptoms that occur related to the use of water to support the development of tourism development and then study the symptoms through written material, both in textbooks and more specifically such as articles on print media, the internet and certain personal experiences that understand the topic this. The literature survey was conducted to obtain primary data sources, namely from textbooks and secondary data, including journal articles, print media and the internet. The experience survey is carried out by seeking information from people who are experts or experienced in the field of water resources management to support tourism activities.

### 2.2. Time and place of research

This research takes the location of the downstream/ Ayung River estuary located in Kesiman Kertalangu Village which is connected with Padang Galak Beach, Bali Province, Indonesia.



**Figure 1.** Research location.

### 2.3. Technique of data analysis

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This research is qualitative research, which will integrate conservation of water resources that may be carried out in research areas with ecotourism. From the existing water potential and tourism potential, there is a SWOT model to find out which ecotourism-based conservation model is best done in the Ayung River Estuary. SWOT analysis according to Philip Kotler is interpreted as evaluation to overall strengths, weaknesses, opportunities, and threats [6]. SWOT analysis is one of the most widely known internal and external environmental analysis instruments. This analysis is based on the assumption that an effective strategy will minimize weaknesses and threats. When applied accurately, these simple assumptions have a major impact on the design of a successful strategy. According to Ferrel and Harline the function of SWOT analysis is to obtain information from situation analysis and separate it from internal issues (strengths and weaknesses) and external issues (opportunities and threats) [7].

## 3. Results and discussion

### 3.1. Land use of Ayung river estuary

There are many restaurants and hotels downstream of the Ayung river and agricultural lands that can be developed as tourist areas. While at the river estuary there are several temples, including Pura Campuhan Windhu Segara. Pura Campuhan Windhu Segara is one of the many temples that are visited for melukat activities.



**Figure 2.** Ayung river downstream land use.





**Figure 3.** Measurement of Ayung river estuary topography.

### 3.2. Water potential

The success of the Ayung watershed water balance for irrigation is 83,13%, while for raw water is 100%. The potential of water resources found in the Ayung Watershed is 15,37 m<sup>3</sup>/s (438,70 million m<sup>3</sup>) consisting of ground water 1,47 m<sup>3</sup>/s (46,43 million m<sup>3</sup>), return flow of 4,02 m<sup>3</sup>/s (126,92 million m<sup>3</sup>) and water distric at 9,88 m<sup>3</sup>/s (311,48 million m<sup>3</sup>). The total utilization utilized for irrigation is 6,25 lt/s/ha (average allocation of 1,6 lt / s / ha), RK of 0,30 m<sup>3</sup>/s (208,492 people), the hotel industry is 0,04 m<sup>3</sup>/s (10,486 rooms) and wasted 12,63 m<sup>3</sup>/s (398,30 million m<sup>3</sup>). So there is still 12,63 m<sup>3</sup>/s (398,30 million m<sup>3</sup>) that can be managed for conservation in the downstream/ Ayung River estuary.

### 3.3. Water conservation

Conservation of water resources is an effort to maintain the existence, sustainability of the condition, nature and function of water resources so that they are always available in adequate quality and quantity to let the needs of living things both at present and future generations. Every person or business entity is prohibited from carrying out activities that cause damage to water sources and infrastructure, disrupt water preservation efforts, and/or cause water pollution. Conservation of water resources is carried out on rivers, lakes, reservoirs, swamps, groundwater basins, irrigation systems.

One type of conservation in quantitative terms that can be done is by building a long storage/ reservoir for storing water in the rainy season and can be used during the dry season. This long storage/ reservoir can also be used for recreation areas of the surrounding community with proper arrangement.

Based on the total population in 2015, then the population growth was calculated to calculate the required water requirements.

**Table 1.** Total population in Kesiman Petilan village.

Year	Population (People)	Population growth	
		People	Percent (%)
2011	11.763		
2012	12.100	337	2.86%
2013	12.184	84	0.69%
2014	12.522	338	2.77%
2015	12.716	194	1.55%
Total		953	7.88%

Source: BPS, 2018

From the calculation of the smallest standard deviation, the arithmetic method is used to calculate the projected population of 15 years with a correlation value of 0,988.

**Table 2.** Projected total population of Kesiman Petilan Village in the Next 15 Years.

Year	Total Population (People)
2018	14.021
2023	15.459
2028	17.043
2033	18.790

Source: Analysis result, 2018

**Table 3.** Calculation of water demand in Kesiman Petilan village.

No	Description	Unit	2018	2023	2028	2033
1	Total population	People	14,021	15,459	17,043	18,790
2	Service Level	%	70	70	75	80
3	Number of Served Residents	People	9815	10821	12782	15032
4	Consumption level					
	SR	lt/people/day	90	90	90	90
	HU	lt/people/day	30	30	30	30
			765573,3			
5	17 Needs for Domestic	lt/day	2	844038,73	997013,84	1172480,1
6	Percentage of Non-Domestic Needs	%	20	20	20	20
7	Total Non-Domestic Water Needs	lt/day	153115	168808	199403	234496
8	Total Kebutuhan Air Domestik + Non Domestik	lt/day	918688	1012846	1196417	1406976
	in lt/s		10,63	11,72	13,85	16,28
9	Level of leakage	16	20	20	20	20
10	Total leakage	lt/s	2,127	2,345	2,769	3,257
11	Average Water Needs	lt/s	12,76	14,07	16,62	19,54
12	Maximum Day Factor		1,2	1,2	1,2	1,2
13	Maximum Day Capacity	lt/s	15,31	16,88	19,94	23,45
14	Peak Hour Factor		2	2	2	2
15	Peak Hour Capacity	lt/s	30,62	33,76	39,88	46,90

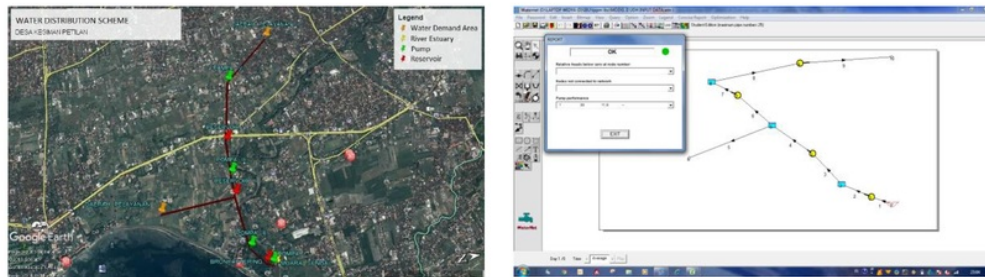
Source: Analysis result, 2018

After calculating water demand, then proceed with calculating reservoir capacity, that's calculated based on the maximum number of days needed in the service area multiplied by 15% -20%. In this plan there is a reservoir serving the Kesiman Petilan Village. For the value of maximum day needs, the value of the maximum day requirement is used at the end of the service plan year.

**Table 4.** Reservoir dimension.

Name	Maximum Day Capacity (l/s)	Reservoir Volume (l/det)	Volume in 24 hours (l)	Volume in 24 hours (m <sup>3</sup> )	Reservoir Dimension			Reservoir Dimension Used (m <sup>3</sup> )
					L(m)	B(m)	H(m)	
Broncaptering	23,45	4,69	405209,13	405,21	11	10	3.5	385
Reservoir 1	23,45	4,69	405209,13	405,21	11	10	3.5	385
Reservoir 2	16,41	3,28	283646,39	283,65	10	8	3.5	280

Source: Analysis result, 2018

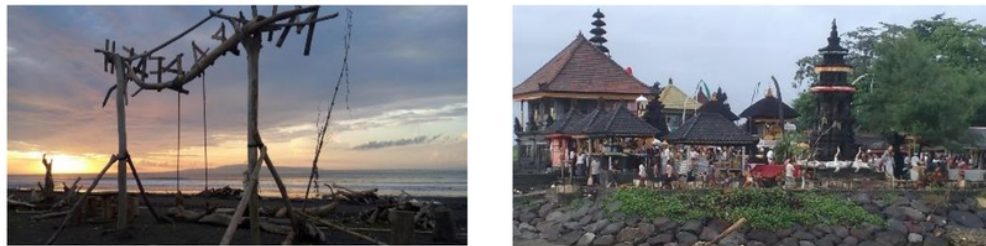


**Figure 4.** Waternet model for river estuary reservoir.

### 3.4. Potential tourism of the estuary of the Ayung watershed

The potential for tourism can be interpreted as a capital or asset owned by a tourist destination and can be exploited for economic interests that are ideally summarized therein concern for cultural aspects. Suarka explains that tourism potential is everything that exists in an area that can be developed into a tourist attraction, the potential can be divided into two, namely cultural potential and natural potential [8].

Cultural potential includes potential that grows and develops in the community such as customs, livelihoods and arts, while natural potential is the potential in the form of physical, geographical potential of nature, including the type of flora and fauna in an area. Ecotourism potential is a capital or asset (both in the form of cultural and natural potential) that is owned by an area, which can be developed for tourism activities that are environmentally responsible, contribute positively to environmental conservation, and improve the economy of the surrounding community.



**Figure 5.** Potential tourism place in the estuary of the Ayung watershed.

Based on Figures 5 it can be seen that in the Ayung River area has tourism potential that can attract tourists who want to know about culture Hindu Balinese, especially for activities of *melukat* (cleaning themselves) and religious ceremonies carried out in the temple of Campuhan Windhu immediately. In addition, on the other side of the river estuary there are swings made from twigs which are carried to the downstream area of the Ayung River. This swing can be used as a photo spot that is very interesting for visiting tourists.

### 3.5. Ecotourism

Ecotourism (usually translated as natural tourism, which is actually inappropriate) is a tourism activity that utilizes environmental services, whether natural (beauty, uniqueness) or society (culture, way of life, social structure) by presenting elements of conservation, education and empowering local communities [9].



Wood describes the components of ecotourism as follows [10].

- Contributing to biodiversity conservation.
- Supporting <sup>13</sup> welfare of the local community.
- Add to the learning experience.
- <sup>14</sup> Involve responsible actions from the tourists and the tourism industry.
- Provided to small business groups.
- <sup>15</sup> The use of non-renewable resources is as low as possible.
- Emphasizing local community participation in both ownership and business opportunities, especially for rural communities.

The principles of ecotourism according to Wood are as follows [10].

- Minimizing <sup>20</sup> negative impacts on nature and local culture.
- Educate tourists on the importance of conservation.
- Emphasize the importance of responsible businesses, work with local governments and communities to meet local needs and provide conservation benefits.
- <sup>6</sup> Direct source of income for conservation and management of natural areas.
- Emphasize the need for regional tourism zoning and visitor management plans for one area or natural area that is scheduled to become an ecotourism destination.
- Emphasize the use of basic environmental and social studies, as well as long-term monitoring programs, to <sup>15</sup> assess and reduce negative impacts.
- Maximizing the benefits of the economy, business and local people living in the surrounding <sup>6</sup> area.
- <sup>8</sup> Ensure that tourism development does not exceed acceptable social and environmental limits determined by researchers with local residents.
- Relying on infrastructure developed in harmony with the environment, minimizing the use of fossil fuels, preserving local plants and wildlife, and mixing with natural and cultural environments.
- Ecotourism is part of the component of sustainable tourism.

### 3.6. Arrangement of the river estuary area

Although it has great potential for water conservation and interesting potential in the tourism sector, there are still some problems in arrangement the downstream area of the Ayung River. There is still damage to the river bank buildings. To increase the conservation and tourism potential found in the downstream area of the Ayung River, it is necessary to arrange the downstream area of the Ayung River with the construction of an integrated river embankment so that during the rainy season, water will not reach the potential tourism area in the river estuary.

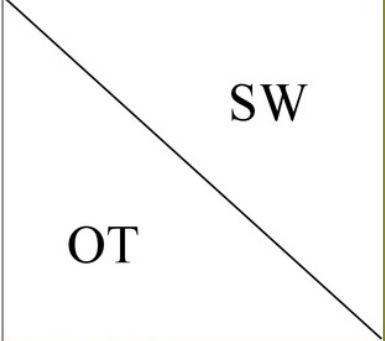


**Figure 6.** Bank damage in the Ayung river estuary area.

### 3.7. Ecotourism-based water resources conservation model with SWOT analysis

Based on the potential and existing conditions in the area of the Ayung River, a SWOT model can be made based on Strength, Weakness, Opportunity, and Threaten as follows.

**Table 5.** SWOT model for water resources conservation in Ayung river estuary.

	<b>Strength (S)</b> <ul style="list-style-type: none"> <li>Has the potential for water that is large enough to be conserved</li> <li>Accessibility to easy locations</li> <li>Having the potential of interesting cultural tourism</li> <li>Have interesting photo spots</li> <li>Having tourism potential in the form of a fierce desert beach that is visited by many tourists</li> </ul>	<b>Weakness (W)</b> <ul style="list-style-type: none"> <li>There is still no arrangement of the river estuary cliff area</li> <li>Sedimentation that occurs is still quite large</li> <li>Lack of plans to make water conservation facilities in river estuary</li> <li>There is still a lot of garbage carried in the river basin area</li> <li>There are still vacant land that is not maintained on the edge of the river area</li> </ul>
<b>Opportunity (O)</b> <ul style="list-style-type: none"> <li>Located in Denpasar City which is within easy reach of the city</li> <li>Construction of conservation facilities can reduce water shortages in the dry season</li> <li>Can improve the economy of tourism developed</li> <li>Can be easily developed into a tourism area because it is close to Padang galak beach which has been visited a lot</li> <li>The visual conditions of the river estuary are interesting as a tourist area</li> </ul>	<b>SO Strategy</b> (Use the strength to take advantage of opportunities) <ul style="list-style-type: none"> <li>Make water conservation in the form of a reservoir/ long storage to hold water in the rain and be used during the dry season.</li> <li>Arrange areas that have good visual views in accordance with environmental conditions (ecotourism) to increase tourism potential without having to damage the environment</li> </ul>	<b>WO Strategy</b> (Minimize weaknesses to take advantage of opportunities) <ul style="list-style-type: none"> <li>Plan for water conservation facilities by adding aspects of tourism to increase the power of use</li> <li>Conduct an untreated area arrangement to become a more attractive visual area</li> </ul>
<b>Threaten (T)</b> <ul style="list-style-type: none"> <li>During the rainy season and flooding, the water will overflow to tourist areas</li> <li>There is still a lot of garbage carried in the flow area</li> <li>Sedimentation that occurs can cause siltation which can reduce water discharge</li> <li>Activities around the estuary are still not ecologically based so that it still disturbs the environment</li> <li>Still the low level of knowledge of the surrounding community on the importance of conservation of water resources based on ecotourism</li> </ul>	<b>ST strategy</b> (Use strength to overcome threats) <ul style="list-style-type: none"> <li>Build river bank/ river dikes according flood discharge should not overflow and damage tourism/conservation areas later.</li> <li>Start arrangement watersheds by taking into account the environmental aspects</li> </ul>	<b>WT Strategy</b> (Minimize weaknesses to avoid threats) <ul style="list-style-type: none"> <li>Invite community participation to protect the watershed environment by not throwing garbage into the river</li> <li>Socializing to the community about the importance of conservation of water resources and paying attention to environmental aspects in tourism activities (ecotourism)</li> </ul>

Source: Analysis result, 2019

## 4. Conclusion

Based on existing water potential in estuary area of the Ayung River can be concluded that:

- Based on the waternet model it can be seen that the reservoir with a capacity of 4,69 lt / sec and 3,28 lt/ sec and meets the water needs of the Kesiman Petilan Village community.

- Based on the SWOT model in determining the potential development based on ecotourism in Ayung River Estuary there are several strategies that can be carried out, such as:
  - Make water conservation in the form of a reservoir/ long storage to hold water in the rain and be used during the dry season.
  - Arrange areas that have good visual views in accordance with environmental conditions (ecotourism) to increase tourism potential without having to damage the environment
  - Plan for water conservation facilities by adding aspects of tourism to increase the power of use
  - Conduct an untreated area arrangement to become a more attractive visual area
  - Build river bank/ river dikes according flood discharge should not overflow and damage tourism / conservation areas later.
  - Start arrangement watersheds by taking into account the environmental aspects
  - Invite community participation to protect the watershed environment by not throwing garbage into the river
  - Socializing to the community about the importance of conservation of water resources and paying attention to environmental aspects in tourism activities (ecotourism)

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