

# Model Analysis of River Watershed Development Based on Local Wisdom (Case Study Banjar Sala Area, Bangli)

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**Keywords:** River Management, Local Wisdom, Embedding.

**Abstract:** From ancient times until now rivers have been used for human activities such as agriculture, plantations, fisheries and animal husbandry, clean water, water traffic, and so on. The Sangsang River originates in Bangli Regency, flows south in the Gianyar Regency area. On the river section located in Banjar Sala, Abuan Village, Bangli Regency, has been utilized for self-purification activities that combine activities on the river section with activities on the springs next to the river. Some areas are located in river bodies, but structurally they do not disturb the river morphology. This area is managed by the Banjar Sala Traditional Village by involving all elements such as youth, religious leaders, and traditional leaders. From the field analysis it is known that the Sala river has a width of 5 m, a channel height of 3 m, and a channel bottom slope of 0.03. From the analysis of the capacity of the river, the capacity of the river at the point in front of the embedding area is 91.38 m<sup>3</sup>/s. This capacity is still greater than the flood discharge that occurs with a return period of 25 years of 78.39 m<sup>3</sup>/second. Economic studies show that this area can improve people's welfare.

## 1 INTRODUCTION

The river and the surrounding community have a very close relationship and provide very positive things for life. Communities around the river have local wisdom which is a way to protect the sustainability of the river area (Sumarmi 2015), (Ferry 2019), (As'Ari et al. 2019).

The purification place of Banjar Sala, which is located in Banjar Sala, Abuan Village, Susut District, Bangli Regency is one of the favorite places for residents around Bangli and other areas in Bali to carry out self-cleaning/purification activities. Banjar Sala is located on the east side of the Sangsang river which flows from the northern area around Kintamani. In this section the river has the characteristics of a volcanic river with the walls mostly in the form of volcanic rocks. The width of the river varies widely between 2-15 meters with a very steep slope and a terraced riverbed. This geographical condition provides its own charm and challenge for visitors. The embracing place itself is divided into three areas, namely the Pancoran Dedari area, the North Pancoran area and the Sala Park area whose water comes from springs. This unique place is one

of the attractions for visitors to come to this place which on holidays even reaches hundreds of people per day.

To support the comfort for visitors, this area has been arranged by constructing several buildings as supporting facilities such as changing rooms, toilets, structuring the Pancoran Dedari area, building a connecting bridge in North Pancoran, structuring river channels and structuring the main landing site in the form of construction. statues and ponds for embracing are equipped with areas for prayer. All these activities are coordinated with the community (banjar) management and are fully supported by residents living around the area. The more familiar this place is, the more people visit it, especially on holidays such as Saturdays and Sundays. The arrival of visitors has an impact on improving the welfare of the surrounding community through donations given and the opportunity to sell for the surrounding community on a small scale.

The very rapid development in this area has not been followed by in-depth studies related to technical and socio-cultural aspects such as aspects of safety against flooding in the area, as well as in-depth planning related to local wisdom-based river management which is associated with the concept of

one river one management which carries the system. sustainable river management in various aspects, both elements of the government, the community around the river and the community of visitors who come to this area. For this reason, it is necessary to carry out technical studies in the form of hydrology and hydraulics related to flooding as well as socio-cultural and environmental analysis related to community participation in river management. The current problems are how is the current condition of the Banjar Sala area, how is the technical study related to flood conditions that can occur in this area, how is the socio-cultural and environmental study of river management based on local wisdom to support sustainable river management?

## 2 METHOD

### 2.1 Research Approach

In this study, the research is based on quantitative analysis based on the results of direct observations and measurements in the field, secondary data collection from relevant agencies in this case the Bali Penida River Council and the Bangli Regency Public Works Office, conducted interviews with the Banjar Sala management group and village officials and community, conduct analysis and provide recommendations.

### 2.2 Analysis Method

The analysis used in this study includes hydrological analysis for determination of rain using the Gumbel and Log Perason type III methods, Nakayasu method for design flood analysis and Manning analysis for hydraulic analysis and river capacity. Socio-cultural analysis was carried out by quantitative statistical analysis of the respondents' answers (Sholihah et al. 2020), (Kwarteng, Dorvlo, and Kumar 2009), (Tessema 2011)

### 2.3 Data Collection Method

The data collection method is carried out by collecting secondary and primary data in the following ways:

Secondary data

- a. From the Bali River Council and the Public work Office of Bangli Regency in the form of:

1. Sangsang river morphological data (River length, watershed area, vegetation etc.)
2. River development policy data
- b. Meteorology, Climatology and Geophysics Agency (BMKG) Region III Bali in the form of annual maximum daily rainfall data
- c. Banjar Management data is in the form of existing data for banjar Sala management in the form of: administrators, membership, maintenance systems, development systems, cooperation systems etc.

### 2.4 Surveys, Field Observations, Preliminary Research

#### 1. Survey

Observations were made on the embedding building which is located on the edge of Sangsang river which is directly connected to the river. Observations made include:

- a. Location of the Banjar Sala building
- b. The physical condition of the Banjar Sala building
- c. Organizational and governance systems
- d. Cross-sectional survey of rivers and stream systems

#### 2 Field Observations

Most of the field observations focused on the work pattern of Banjar Sala from the initiation of development, governance and institutions. In this activity the most widely used method is the interview method with several elements such as managers, community leaders, surrounding communities, elements of the local Village Government and the Bangli Regency Government.

#### 3. Preliminary Observation

Preliminary observation was carried out one month ago for 1 day to obtain an overview of the location and current conditions. From the observations made, it shows that from a technical point of view, the Banjar Sala building is in direct contact with the riverbank so that it is vulnerable to flood hazards. From the socio-cultural and environmental point of view, visits on holidays are quite hectic with visits ranging from 50-100 people per day. There is no quotation for the visitors, but a donation box is opened if the visitors are willing to donate some of their money to repair the needed facilities. It is necessary to test the quality of the water at the trap because the water is drunk by the visitors. The current

conditions in the Banjar Sala are as shown in the Figure 1:



Figure 1: Condition of the Sala Banjar Sala.

### 3 RESULTS AND DISCUSSION

#### 3.1 The Balinese Hindu Community's View on Water

For the Hindu community in Bali, water is the first and foremost gift for humans because water is the source of human life. In the traditional rituals of the Hindu community in Bali, it can be stated that there is no ritual that does not use water as a means of ceremony. Starting from the beginning of life to the death ceremony, water becomes one of the means to the afterlife. The water facility that takes people who have died to another world is called Tirta Penatas. Tirta Penatas is taken in a spring, river or even the mouth of a river accompanied by sacred prayers from the family of the person who has died. Then Tirta Penatas is sprinkled on people who have died before being buried or burned (Wirawan and Pendit 2017). For the Hindu community in Bali, the three powers of the manifestation of God Almighty are called Dewa Vishnu (God = holy light from God) who have a role in regulating world life, one of which is by regulating water resources. In the Balinese Hindu concept, water is one of the elements that make up humans (buana alit) and the universe (buana Agung), namely pertiwi (land), apah (water), teja (heat), bayu (energy) and akasa (ether / marrow). With such a large role of water in human life, maintaining and conserving water is an effort to preserve life and life (Suarya, Paramadhyaksa, and Suryada 2018), (Fuady and Azizah 2008).

#### 3.2 Ritual of Self-Cleansing with Water (Self-Purification with Water)

Self-purification with water is an activity of self-purification either with fresh water (in rivers/springs) or with sea water. In general, the meaning of self-

purification with water is to clean oneself and clean the mind so that the inner and outer atmosphere becomes fresher and healthier. With a healthier body and soul, it has a very positive effect on productivity in living daily life. The current development in Bali is that the self-purification with water ritual is one of the activities carried out by many community groups or families which is usually carried out on certain days such as during the full moon, dead moon (tilem), and other holy days or on holidays, namely Saturday or Sunday (Sudiarta 2021), (Mahardika 2018). At the time of self-purification with water, the facilities brought by each participant were offerings (banten) in the form of banten pejati and canang sari which were presented to several place. Banten were presented with prayers asking for God's grace, the self-purification with water process could run smoothly and the people who self-purification with water would be given health.

#### 3.3 Abuan Village Overview

Abuan Village is one of the villages in the Susut District, Bangli Regency with an area of 4.18 km<sup>2</sup> with a population in 2021 of 7,490 people with a total area covering 5 Banjar Dinas namely: Banjar Dinas Abuan Kangin, Banjar Dinas Abuan Kauh, Banjar Dinas Preparation Serokadan Kaja, Banjar Dinas Sala and Banjar Dinas Serokadan. Meanwhile, the village boundaries include: North: Susut Village, East: Demulih Village, South: Abuan Village and West : Petak Village, Gianyar Regency.

The population of Abuan Village is spread over 5 hamlets with a male population of 3,716 and a female population of 3,774. Judging from the age distribution of the population, Abuan village is in the dominant composition in the productive age, namely at the age of 50-54 years with a percentage of 33.9%. Judging from the education status of its citizens, most of the dominant population graduated from elementary school/equivalent, followed by junior high school graduates/equivalent. Judging from the main livelihood of the residents of Abuan Village, most of them work as farmers/planters, followed by students, private employees. associated with the Village Development Index (IDM) there are several criteria that must be met from several indicators, namely the health sector, the education sector, the implementation of mutual cooperation, public facilities, sports, religion, security, information and telecommunications facilities, solid waste, clean water, the economy and handling disaster. Based on the 2021 assessment of the facilities and infrastructure index (IKS) with a score of 0.82, the

economic index of 0.58 and the environmental index of 0.93. Based on the index value, the IDM of Abuan village is 0.78 which is classified as a developed village.

### 3.4 Banjar Sala Temple

Banjar Sala Temple is one of the self-purification with water places located on the banks of the Sangsang tributary located in Banjar Sala, Abuan Village, Susut District, Bangli Regency. This self-purification with water place is located about 4.5 km west of Bangli City or about 40 km northeast of Denpasar city. Geographical location at 8°45'13.95" latitude, 115°32'46"45 east longitude. The history of the establishment of the Pecampuhan Sala self-purification with water place began with the desire of several community leaders in this area to create a representative purgation place whose location allows it to be built on the west side of Temple which is directly adjacent to the Sangsang river tributary. The wishes of several community leaders are fully supported by the community and village leaders as well as by the youth. As a first step, the construction of an embracing place was started, which contained two pools, several statues and a courtyard for praying. For the purposes of this development, the community independently raised an initial fund of Rp. 380 million rupiah. In 2017 initial construction began with the construction of a pond and several sculpture ornaments including the Shiva Statue, Nandini Ox Statue and other decorative statues made in the northeast. Each shower has also been equipped with a statue of an angel lined up in the main pool. To separate the embracing pool from the prayer area, a gate has been made in the form of the Kurung Temple gate made of red brick facing the south. Banjar Sala is also synergized with the preservation of the surrounding river area with a procession of embracing that takes place on the river body, namely at the Pancoran Dedari waterfall and at the Gua Tan Hana waterfall. The name Pecampuhan is taken from the name of the confluence of two tributaries (campuhan) in that location. While Sala is taken from the name of the banjar where the spring is located. At this time, there has been a parking park located to the south that can accommodate 25 minibus cars and several motorcycles. From the parking lot to the landing place, walk along the village road which is paved for about 75 m with a width of 5 m, followed by descending stairs made of concrete with a length of about 200 m. All the way to the hug has been planted with trees that blend with the surrounding environment. Likewise, the road along the stairs to

the hug is very clean and comfortable. For activities at night, it has been equipped with lighting facilities in the form of electricity. The scenery around the embrace of natural mountain conditions with tropical plants. The meandering river and steep walls make the natural conditions even more pronounced. For the self-purification with water place, this place is located just below Taman Temple, there are 9 showers, divided into two separate places. The first part at the very top has 7 showers, with the height of the shower reaching 3 meters in this place a 1-meter-high water reservoir is made. Then 2 pancorans are located at the bottom on the riverbank. Apart from the holy water that flows from the 9 showers, the other place of embracing is in the river which is the meeting place for the flow of two rivers (campuhan). The two sources of river flow are called Grojogan Pesiraman Tan Hana for the right side of the river and Grojogan Pesiraman Dedari for the left side of the flow. For the flow of the river to the right there is another shower for self-purification with water. The water that flows in each of these rivers is very clear, thus adding to the coolness of the heart and mind for those who want to self-purification with water. Information about Taman Pecampuhan Sala Temple is believed to have good fortune and benefits such as Tirta Pule for treatment, Tirta Pandan for repellent Bala, Tirta Bungbung for economic smoothness and Tirta Tulak Wali for family harmony, strengthening husband and wife relationships so that they last.

### 3.5 Concept of Community-Based River Management (Local Wisdom)

The river management model in Banjar Sala Taman Sala applies the concept of balanced river management referring to the Balinese cultural philosophy, namely Tri Hita Karana (harmonious relationship with God, between human beings and with the surrounding environment). Some important concepts from the Banjar Sala Taman Sala management system with the concept of a sustainable river are as follows:

1. The building that is made is not in the middle of the river so that morphologically the flow of the river is not disturbed
2. The minimum building height has taken into account the height of the flood water so that the influence of scouring and puddles during floods can be reduced
3. Arrangement of the river into a place of embedding does not change the original shape of

the river such as the walls and width and material around the river

4. There are guides who are very helpful in explaining the local wisdom of the local community towards the existence of rivers and their environment
5. Any additional decorative ornaments that are complementary to the place of attachment are discussed at the management coordination meeting which is fully supported by the villagers
6. There was a very high independent effort from the local community at the time of the initial construction of the self-purification with water place
7. There is full involvement of citizens both as managers, stakeholders and as guides
8. The added value of this self-purification with water place does not charge entrance fees, but the concept is in the form of donations from visitors.
9. Maintenance of the embracing area is carried out jointly by all levels of society

### 3.6 Hydrological Analysis

Hydrological analysis was carried out to determine the design rain and design floods which were used as the basis for analysing river capacity (Burgan and Ieaga 2019), (Yihdego, Reta, and Becht 2016), (Tessemma 2011). This analysis is especially necessary to find out whether the cross section of the river in front of the Pura Banjar Sala Taman Sala is still able to accommodate the existing water at the time of the flood. flood design and river capacity analysis.

#### 3.6.1 Rain Station Analysis

This analysis is carried out to determine which rain stations are around the location and the range of recording rain data for how many years. In this analysis, a search was carried out on rain data owned by the Meteorology, Climatology and Geophysics Agency (BMKG) and rain stations owned by the Bali Penida River Council. From the analysis carried out, the rain stations used are the Ubud rain station in the west, the Gianyar rain station in the south and the shrinkage rain station in the north. Figure 2 shows the position of the rain station. Double mass test method shown Figure 3-5

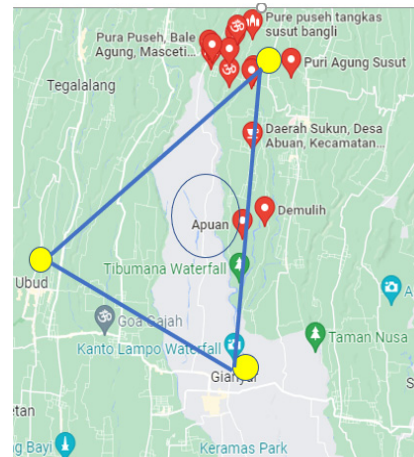


Figure 2: Rain station in Sala.

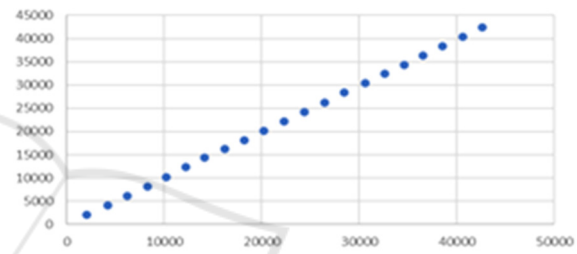


Figure 3: Ubud station double mass test.

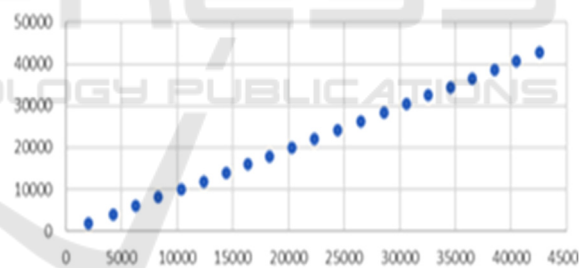


Figure 4: Susut station double mass test.

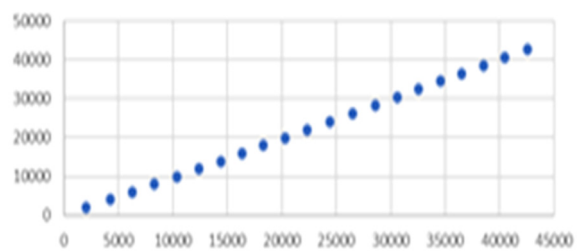


Figure 5: Gianyar station double mass test.

#### 3.6.2 Design Rain

Recapitulation of Design Rainfall Analysis with various return periods. The details can be seen in Table 1.

Table 1: Recapitulation of Design Rain with Various Repeat Periods.

No	Period	G	Extravolation
1	2	0.63	97.21
2	5	0.97	99.13
3	10	1.12	100.2
4	20	1.11	105.23
5	25	1.11	107.34
6	50	0.96	110.72
7	100	0.82	112.54

### 3.6.3 Design Flood

Design flood analysis was carried out to determine the magnitude of the flooding that occurred in an area by entering several parameters such as the design rainfall value, the length of the main river, the area of the watershed and others (Harahap, Jeumpa, and Hadibroto 2018), (Marhendi and Fathurohman 2020). The design flood was calculated by the Nakayasu method. The results of the design flood calculations can be presented in Figure 6 below:

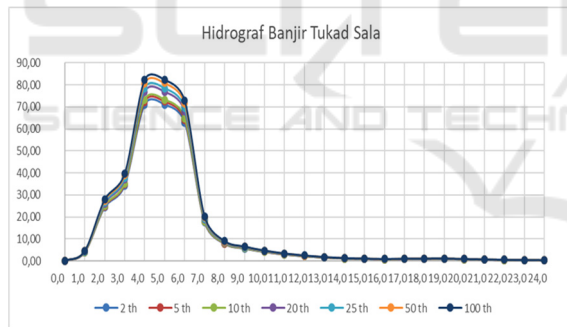


Figure 6: Flood Hydrograph of the Sala River.

### 3.6.4 Capacity Analysis

From the field analysis, it was found that Sala River has a data width of 5 m, a channel height of 3 m and a channel bottom slope of 0.03. From the analysis of river capacity, the river capacity at the point in front of the embedding area is 91.38 m<sup>3</sup>/sec. This capacity is still greater than the flood discharge that occurred with a 25-year return period of 78.39 m<sup>3</sup>/sec. With a river width of 5 m and a dam in front of the catchment area, if there is a flood discharge with a return period of more than 25 years, it has the potential to cause flooding and puddles.

## 3.7 Community Based River Management

The development of the self-purification with water place at Banjar Sala has various effects on the surrounding community, on the river and on Taman Temple itself. Based on interviews with community leaders, managers, the community around the temple and followed by interviews with visitors, an analysis of the community-based river management system was carried out. The results of the analysis are shown in the following sections:

### Technical Overview

Technically Banjar Sala Taman Sala is located on the edge of a tributary of the Sangsang river with a river wall in the form of rock. The river flows in the dry season with a height of about 0.5-0.6 m. During the rainy season the water level can reach a height of 2 m. Strength

1. The results of the hydrological analysis show that the capacity of the river in front of Banjar Sala is still able to accommodate flood discharges with a return period of 265 years, so that morphologically the river does not erode existing buildings.
2. The high slope of the river has an impact on high water velocity thereby reducing the potential for inundation in front of the embedding area
3. Sturdy River walls have a positive impact on overall river stability.

### Weakness

1. With a typical mountain river, when it rains it carries a lot of sediment which causes the watercolour to be cloudy and dangerous for visitors
2. There is still a lack of lighting/electricity facilities at night

### Follow-up

1. It is necessary to install dangerous signs/signs at several points as a guide for visitors
2. It is necessary to preserve the forest in the upstream area to prevent sedimentation that can occur during the rainy season
3. Need additional lighting/electricity facilities in several places at night

### Economic Review

Economically Banjar Sala at Pura Pecampuhan Taman Sala provides benefits for improving the community's economy even though it is still on a small scale.

### Strength

1. From the existing conditions in the field, the community can start to open a business selling several types of food such as fried bananas, traditional Balinese snacks such as lempog, laklak and jaja injin, snack chips such as taro chips, glass noodles, coffee and various drinks and one of them is traditional drinks. Loloh (herbal medicine) made from cem-cem leaves that are widely available around the area. This drink is a typical drink of the Bangli people. Besides that, there are people who sell prayer facilities such as incense, water containers, canang etc.
2. The income from parking fees for each 4-wheeled vehicle is Rp. 5000 and 2 wheels for Rp. 2000. This levy provides income for traditional villages
3. There are donations from the community who carry out the hug

#### Weakness

The sales system is still a very simple shop and looks untidy. The roof of the shop is still made of tarpaulin, reducing the interest of buyers. The sellers do not provide adequate places to sit and rest after self-purification with water so that buyers rarely shop for a long time.

#### Follow-up

Need to arrange the food sales area with a neater environment and buildings

#### Socio-Cultural Overview

##### Strength

1. This place is a favourite place in southern Bali as a self-purification with water place. Of course, this has an impact on the success of traditional villages in managing their potential wisely and sustainably
2. Activities at Banjar Sala received positive support from the entire community, starting from traditional leaders, youth and other communities
3. Starting to grow awareness of maintaining the cleanliness of the surrounding environment so that this place is always kept clean
4. The existence of traditional regulations that supports the existence of Banjar Sala Taman Sala so that it has a very positive impact on the preservation of the area

#### Weakness

1. The number of visitors who come if excessive and the time is late at night has the potential to pose a danger when carrying out the ritual of embracing
2. The small parking area has the potential to spill over into the residential streets and disturb the residents' comfort

#### Follow-up

Need arrangements for visitors, especially during holidays to avoid the accumulation of visitors until late at night

## 4 CONCLUSION

Based on the results of the analysis that has been done, it can be concluded several things as follows:

1. Conditions Banjar Sala is located on the edge of the Sangsang river tributary. The structure of the building is a place for self-purification with water with stone masonry construction. Conditions nself purification with water Pancoran Dedari and Tan Hana Caves are located on the river body with the condition of the building in the form of a natural river. The river flows meandering with the riverbed in the form of rock. The lighting conditions are still limited so that it is dangerous for visitors if the activities are carried out until the evening.
2. From the field analysis, it was found that Sala River has a data width of 5 m, a channel height of 3 m and a channel bottom slope of 0.03. From the analysis of river capacity, the river capacity at the point in front of the embedding area is 91.38 m<sup>3</sup>/sec. This capacity is still greater than the flood discharge that occurred with a 25-year return period of 78.39 m<sup>3</sup>/sec. With a river width of 5 m and a dam in front of the catchment area, if there is a flood discharge with a return period of more than 25 years, it has the potential to cause flooding and puddles.
3. Socio-cultural and environmental studies show that the existence of Banjar Sala has the following impacts:

Economic aspect: increasing community participation in the small-scale economy through the sale of traditional food-based foods. Increase village income through parking fees and donations from visitors.

Socio-cultural aspects: the socio-cultural analysis shows that the existence of this Banjar Sala has received support from various groups such as community leaders, community youth and government institutions. The existence of trust from the water community as a source of life and welfare has an impact on sustainable and wise river management through community values and regulations (customary village law).

Environmental aspects: the maintenance of trees and tree diversity and the situation of the waters around the banjar sala area.

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