CHAPTER III
STUDY METHOD

General

Methodology study used in EIA study of Ayung Dam development at Badung Regency, Bali Province is interdisciplinary approach. The study begins with scooping to understand the main issues which should be comprehended during the study implementation. Then, secondary data is collected as the basic information of study implementation which then followed by primary data collecting for some main parameters. After secondary and primary data are collected, then data analysis is conducted using appropriate method to predict the big and important impact and evaluate it according to the big and important impact as the basic in arranging the environment management plan and environment monitoring plan.

3.1 Methodology of Collecting and Data Analysis

Data collecting for this Andal study requirements done toward teh environment components such as physic-chemical environment component, biology, socio-economy and community's health. The collected data includes primary and secondary data. Primary data obtained through field monitoring and laboratory test, while the secondary data obtained through literature study to the sources and documented or published reports. Monitoring and sampling implemented at the locations which have been decided based on the scooping result. The data which are obtained from field monitoring and laboratory test are expected to be combined with the available secondary data in order to sharpen the analysis.

In detail, data collecting, analysis method, and sample numbers, sampling locations and impact prediction method, and impact evaluation are described below:

3.1.1 Climate, Air Quality, Noise and Friction

1. Data Collecting

The climate data which will be collected includes macro climate and micro climate. Macro climate data as secondary data which will be investigated consists of:

a. Data as: climate type; rainfall, rain day, average annually rainfall; maximum, minimum, average temperature; humidity; wind direction, wind velocity and sun radiation intensity. This data is obtained from teh Meteorology and Geopfysics Station Region III Tuban and also resemble research report, and data from other related services.
b. Periodic data (annually cycle, five years, and so on) as typhoon and flood.
c. Data of air quality and noise will be directly measured on the field at the decided spots including dust parameter, NOx, SOx, CO, H_2S, NH_3 and noise. For noise

measurement, will be directly measured with an instrument called *Sound Level Meter* . While for vibration data will be measured with vibrator meter.

2. Analysis

Analysis of air quality which measured on the field will be analyzed with the equipments and methods as shown in Table 3.1 below

Table 3.1 Analysis method and air quality analysis equipment

Parameter	Analysis Metodh	Equipment
Dust	Gravimetri	Hi. Vol. Sampler
NOx	Grietz Saltzmann	Spectrophotometer
SOx	Pararo samiline	Spectrophotometer
CO	Kalium Yodida	Spectrophotometer
H_2S	Mercuri Thiocyanate	Spectrophotometer
NH_3	Nessler	Spectrophotometer
Noise	-	Sound Level Meter

3. Location

Monitoring will be implemented on the spots found in the project site and its surroundings which still in the scope of study area. Decision of monitoring location spot based on the pollutant spread pattern according to the dominant wind direction. Location of sampling shown on Picture 3.1. The result of air quality then is compared with the ambien air quality standard of Decree of Minister of Demography and Environment No. 02/MENKLH/I/1988 and Decree of Governor of Bali Province No. 515 Tahun 2000 considering Environment Quality Standard.

Method of measurment, calculation and evaluation of environment noise level which is used, refers to Appendix 1 Decree of Minister of Environment No.Kep-48/MenLH/11/1996. The method which is implemented is using simple one, with a sound level meter which measures soundlevel dB (A) for 10 (ten) minutes for each measurement. The reading is every 5 (five) seconds.

3.1.2 Physiography

The analyzed physiography data includes land form topography, type of soil and soil structure, land stability delas with Data fisiografi yang dianalisis meliputi topografi bentuk lahan, jenis tanah dan struktur tanah, stabilitas tanah terutama berkaitan dengan phorocity, earthquake and uniqeness and dangers of land form. Physiography for this study obtained from the secondary data from Bappeda, Public Works Service, Forestry Service, and other institutions that have investigation result at the study location.

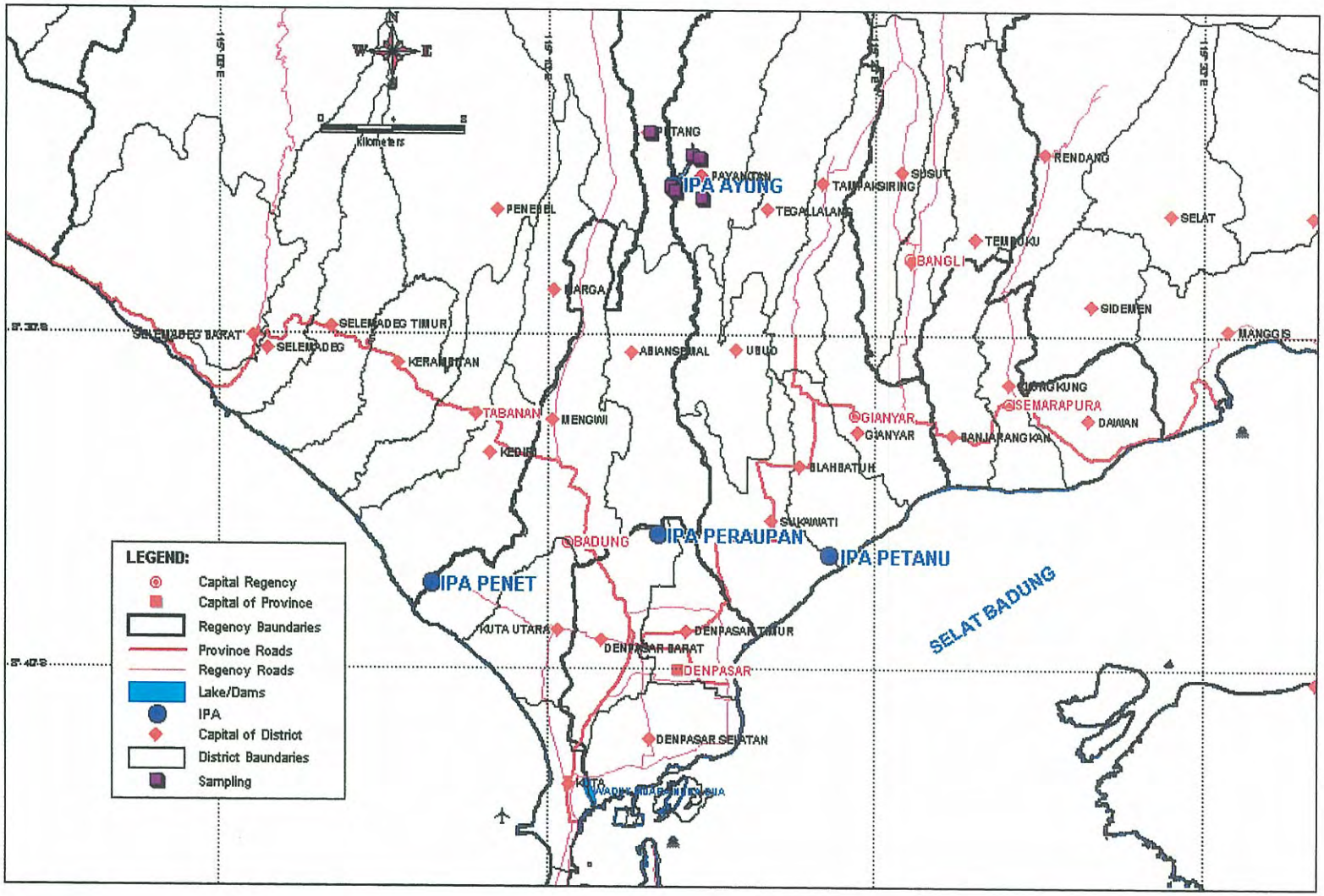

Figure 3.1 Air Quality Sampling Location

3.1.3 Hydrology

Hydrology data which includes physical characteristic of water absorption area, level of supply and requirement of potable water, bathing and washing in the study area are obtained from the secondary data of related institutions. Primary data is measured for surface water quality parameter deals with the water quality at the study area. The water quality data from the closest are a to the project is obtained from the secondary data from result of resemble research, and also data obtained from technical institutions.

1. Water Quality

Data collecting for water quality (river, lake, spring, and shallow ground water) will be done from various water resources. The water quality parameters which are easily changed such as: DO, pH, DHL and temperature will be measured with in-situ method, and the other quality parameters will be done in the Laboratory of Analitic Chemistry, Udayana University.

2. Analysis

The water quality parameters analyzed in the laboratory include physical, chemical characteristic and bacterial content is analyzed with the analysis method and equipments shown on Table 3.2.

3. Location

Water sampling location will be done at the spots shown at Figure 3.2

Tabel 3.2 water Quality Parameter, Equipment and Analysis Method

No	Parameter	Unit	Equipment/Metodh	Explanation
	Physics			
1	Temperature	^{0}C	Expansion, thermometer	In-situ
2	Turbidity	-	Turbidimetri	Reference laboratory
3	Total Suspended Solid	mg/l	Gravimetri	Reference laboratory
4	Total Disolved Solid	mg/l	Gravimetri	Reference laboratory
5	Electricity conducting power	µS/cm	Conductivity Eletrode Pt	Reference laboratory
	Chemistry			
1	Acid Degree (pH)	-	pH-meter	In-situ
2	DO	mg/l	DO Meter, Winkler modification	In-situ
3	BOD5	mg/l	Winkler modification	Reference laboratory
4	COD	mg/l	Titrimetri	Reference laboratory
5	Permanganat Value	mg/l	Titimetri	Reference laboratory
6	Chloride (Cl)	mg/l	AAS	Reference laboratory
7	Sulphida	mg/l	Metode Iodometri	Reference laboratory

8	Sulphate (SO_4)	mg/l	Spectrofotometri	Reference laboratory
9	Flouride (F)	mg/l	AAS	Reference laboratory
10	Nitrat (NO_3-N)	mg/l	Brusin Method	Reference laboratory
11	Nitrit (NO_2-N)	mg/l	Sulfanili Method	Reference laboratory
12	Amonium (NH_4-N)	mg/l	indofenol blue Method	Reference laboratory
13	Free amoniac (NH_3-N)	mg/l	Nessler Method	Reference laboratory
14	Oil and fat	mg/l	Extrasi	Reference laboratory
15	Pesticide	mg/l	Cromatograph	Reference laboratory
16	Fenol	mg/l	Spectrophotometri	Reference laboratory
17	Natrium (Na)	mg/l	AAS	Reference laboratory
18	Kalium (K)	mg/l	AAS	Reference laboratory
19	Calsium (Ca)	mg/l	AAS	Reference laboratory
20	Magnesium (Mg)	mg/l	AAS	Reference laboratory
21	Boron (B)		AAS	Reference laboratory
22	Arsen (Ar)		AAS	Reference laboratory
23	Nikel (Ni)		AAS	Reference laboratory
24	Cobalt (Co)		AAS	Reference laboratory
25	Barium (Ba)		AAS	Reference laboratory
26	Iron (Fe)	mg/l	AAS	Reference laboratory
27	Mangan (Mn)	mg/l	AAS	Reference laboratory
28	Copper (Cu)	mg/l	AAS	Reference laboratory
29	Timbal (Pb)	mg/l	AAS	Reference laboratory
30	Zinc (Zn)	mg/l	AAS	Reference laboratory
31	Crom (Cr)	mg/l	AAS	Reference laboratory
32	Cadmium (Cd)	mg/l	AAS	Reference laboratory
33	Quicksilver (total)	mg/l	AAS	Reference laboratory
34	Silica (SiO_2)	mg/l	Gravimetri	Reference laboratory
	Bacteriology			
1	Total Coliform	JPT/100 ml	Sterilized bottle double tube, incubator	Reference laboratory
2	Coliform Feces	JPT/100 ml	Sterilized bottle double tube, incubator	Reference laboratory

Source : Decree of Governor of Bali province No. 515 Tahun 2002, considering Water Quality Standard at the Water Body

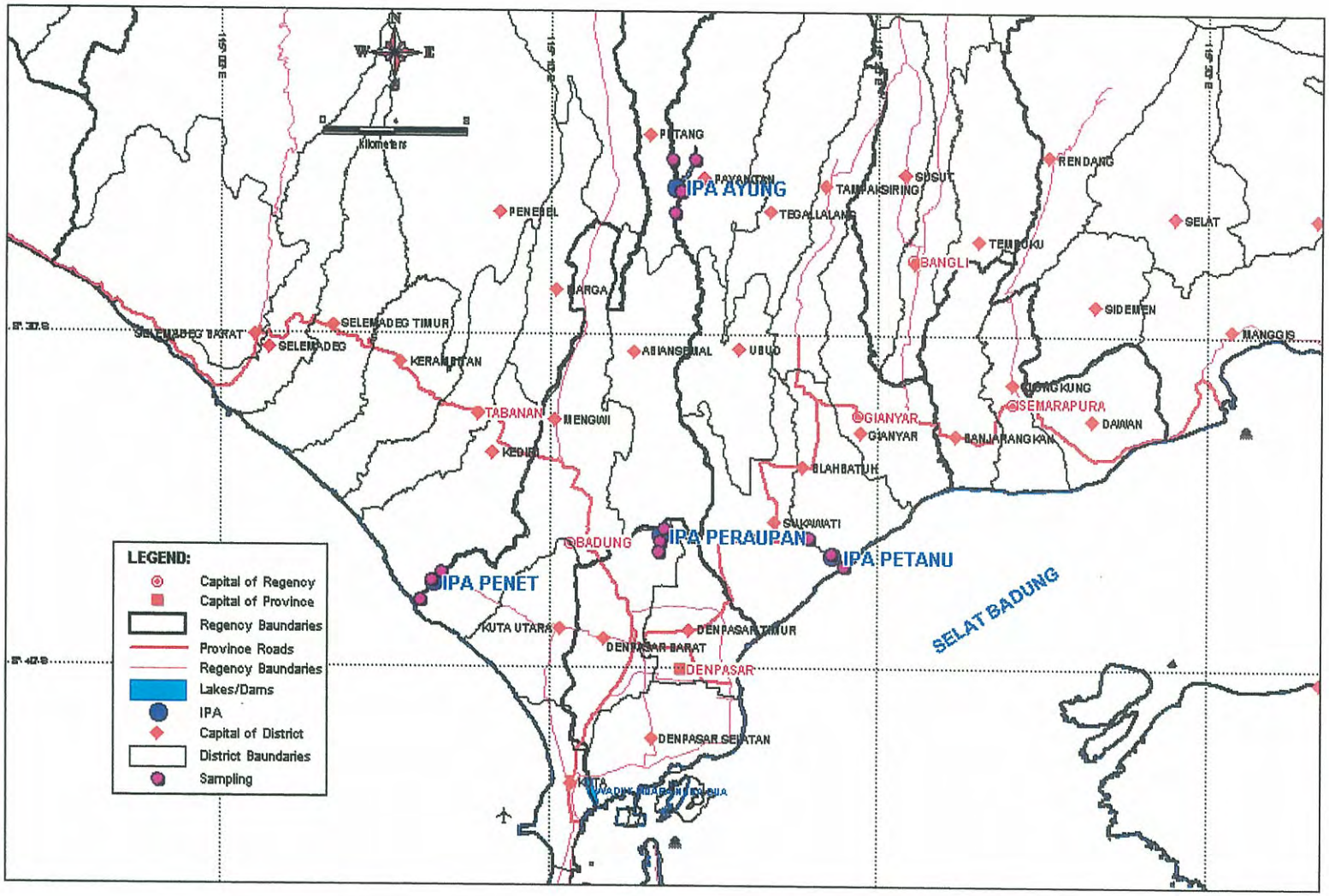

Figure 3.2 Water Quality Sampling Location

3.1.4 Space, Land and Soil

The collected data includes:

- Land use and other resources inventory include forest and its development potential in the future
- Plan of area development, spatial plan (cultivated and non cultivated area), other resources which are officialy or non officially set by the government
- Possibility of conflict or bordering which is valid by the ownership/decision of activity plan location
- Inventory of aesthethic and uniqueness of landscape and recreation area available at the study area.

The collected primary data are the beginning condition of landscape, traffic volum before the activities persisted and location of material source which will be used

The secondary data is obtained from Bappeda, BPDAS Unda Anyar, BPN such as RTRW data, administration borderd, landscape and transportation volum of project location

1. Analysis

Space and land analysis are implemented using RTRW of Bali Province map with the scale 1 : 50.000. Analyzed parameter includes excavation material sources usage and connecting roads. Analysis to the traffic volum about the project site implemented by combining the result of direct monitoring and secondary data.

2. Location

The survet location include all of the project site and its environs which predicted to be directly or indirectly impacted.

3.1.5 Biologic Component

1. Biology data collecting (flora and fauna)

a. Terrestrial Flora Data Collecting

Terrestrial flora data collecting in this study is conducted through two approaches, those are qualitative approach (general inventory) and quantitative approach (measurement).

Data of flora which will be investigated includes:

- Type of vegetation, characteristics and its dangers which exist in the study area of effort/activity plan
- Sort of vegetation and ecosystem which are protected by the law at the study area of effort/activity plan.
- Uniqueness of vegetation and ecosystem at the study area of effort/activity plan

- Qualitative approach is fast inventory in order to do sort introduction morphologically, without doing any measurement. This method is done through observing the study area as decided in Chapter II. The recognized types are directly noted and for those which have not been recognized are collected then identify based on atlas/flora or available herbarium identification book
- Quantitative approach is data taking by "Quarter Sampling Method" or "Square Transect". The used method is systematic sampling with plot measurement for the vegetation type are as followed:
- Tree : plant with wide stem diameter more than 35 cm, plot measurement of 20 m x 20 m
- Pole : plant with stem diameter of between 10 – 35 cm and plot of 10 m x 10 m
- *Pancang/sampling/sapihan* : plant with height more than 1,5 m with diameter less than 10 cm and plot of 5 m x 5 m
- Seeding : all sprouts up to plant with height until 1,5 m and plot of 1 m x 1 m
- Beside the approaches above, in this research, interview with local community around the project is also conducted, in order to recognize the local values of existing vegetation/flora.

1) Analysis

The result of inventory and each plot population calculation then are analyzed to get the Relative Dominant (SDR) and Diversity Index as well as type comparation which has economic, endemic and protected value also local and regional value. Parameter which is calculated and the formula as followed. The formula of calculation: (Cox Metodh, 1969) :

$$\text{a. Frequency} = \frac{\text{Total of spots found from certain species}}{\text{Total of all monitoring spots}}$$

$$\text{b. Density} = \frac{\text{Total of certain species found}}{\text{Total of all species found}}$$

$$\text{c. Domination} = \frac{\text{Total of certain species canopy}}{\text{Wide of quotation area}}$$

$$\text{d. FR} = \frac{\text{Frequency of certain species}}{\text{Frequency of all species}} \times 100\%$$

$$\text{e. KR} = \frac{\text{Density of certain species}}{\text{Density of all species}} \times 100\%$$

$$\text{f. DR} = \frac{\text{Domination of one species}}{\text{Domination of all species}} \times 100\%$$

Tabel 3.3 Calculation Table for Flora Analysis

Type of analysis	Calculation	Explanation
INP (Important Value Index) Based on Curtis method according to Cox	$INP = Fr + Kr + Dr$	INP = Important Value Index Fr = Relative frequency Kr = Relative density Dr = Relative domination
Diversity Index Based on Shannon method	$H = -\sum_{i=1}^{n}\left(\frac{ni}{N}\log\frac{ni}{N}\right)$	H = Shannon diversity index ni = important value of certain species N = important value of all species

2) Location

Sampling location is done at 7 locations include project site and its surroundings which are predicted to be directly or indirectly impacted. The sampling locations are shown at Figure 3.3.

b. Terrestrial Fauna

Scope of study of terrestrial fauna is focusing on aves (bird), reptile, amphibie and mammals, which are predicted in or outside the project site. This is based on the fauna's attitude which is much more mobile so that the scope of study area becomes wider. The parameter/variable which is monitored deals with: diversity, abundance, habitat condition, distribution pattern and migration as well as fauna status (endemic, rare or protected).

Fauna data collecting at the study area is using direct and indirect semi-census method. The census methods are cruising method and statitionnaire method (by installing trap and or net) at the sampling area. The analysis of terrestrial fauna is qualitatively implemented.

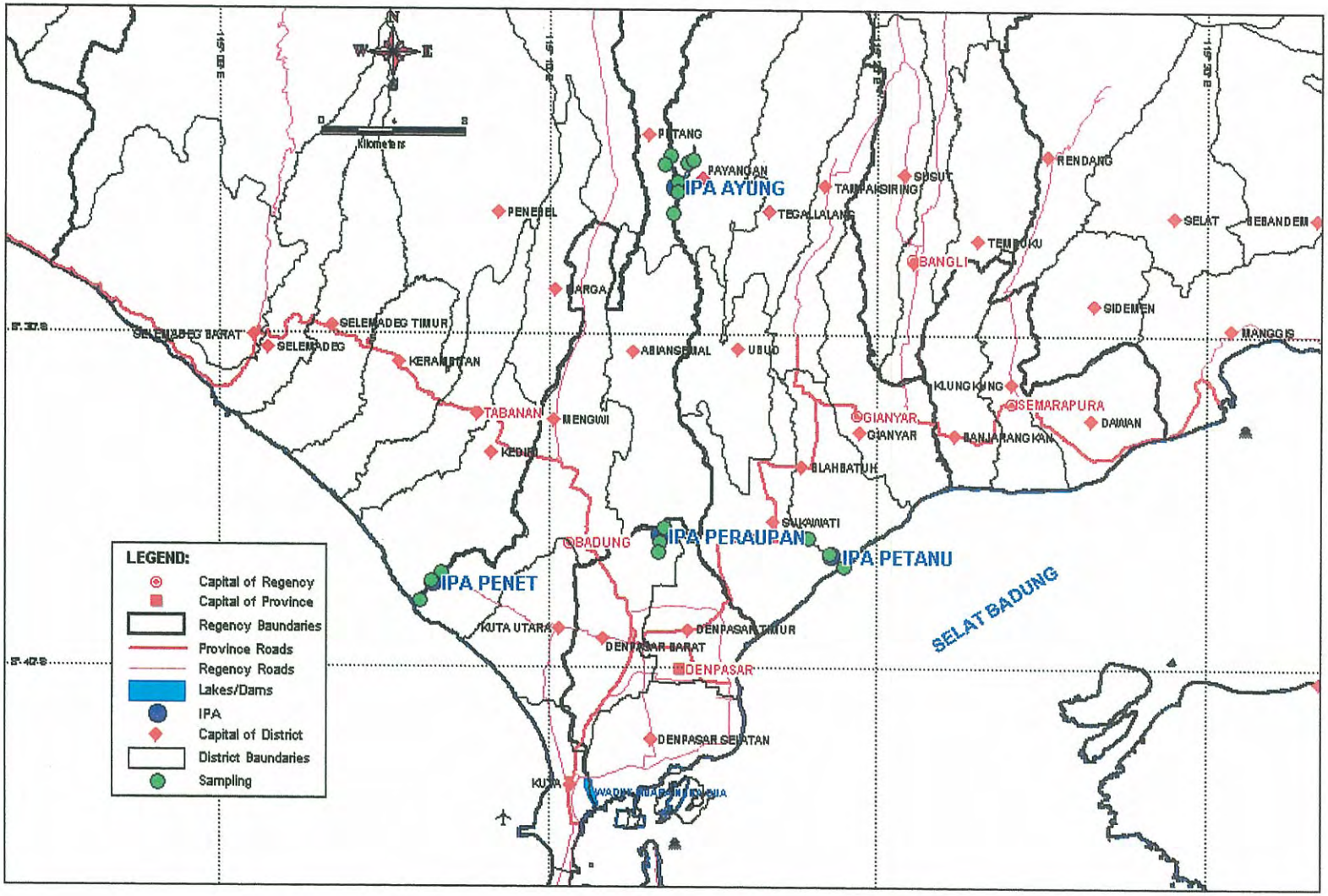

Figure 3.3 Flora and Fauna Sampling Location

c. Aquatic Biologic Component

Aquatic biologic components which are studied are perifiton, macrozoobenthos and necton (fish) community. The sampling location of aquatic biology decided at 4 (four) sampling stations.

1) Perifiton Community

Perifiton (Aufwuch) is Suspended aquatic organism (similar with Plankton on lentic ecosystem), generally it is microscopic sized. Perifiton sampling is using quotation method, by filtering water sample of 500 litre. The filtered water is collected in one bottle with volum of 50 ml. The sample water is preserved with compound and 4 % formalin and 75 % lugol, afterwards it is identified and its abundance is calculated microscopically at the Biology Laboratory, Udayana University, Denpasar.

Calculation of perifiton abundance:

$$N = Q1/Q2 \times V1/V2 \times 1/P \times 1/A \times n$$

Explanation :

N	:	Abundance of plankton organism per liter
Q1	:	Wide of glass cover (400 mm2)
Q2	:	Wide of view (1,7663 mm2)
V1	:	Volume of water sample (50 ml)
V2	:	Volume of water monitored underneath the microscope (0,25)
P	:	Total of view (25 times)
A	:	Volume of filtered water (250 liter)
n	:	Total of monitored plankton individual

2) Benthos Community

This study is focusing in macrozoobenthos, it is benthos organism/basic organism filtered by 1 mm^2 mezh size filter. The study focus is only on macrozoobenthos, based that for microbenthos, there is difficulty of filtering and speciment identification due to unavailability of equipment, comparing speciment and representative reference; beside that in micro size most of the benthos are larva so that the appeared morphology is not showing the true species.

Benthos taking at the river is done with *surber bothoom sampler (40 x 40 cm^2)*, dig the river bottom substrate of 25 x 25 cm^2, on the soft part at the river side, the digging is done with spade. Then the substrate is filtered with sieve (1 mm^2 mezh size). The trapped benthos is preserved in 70 % alcohol compound or 5 % formalin, then it is identified and its abundance is calculated at Biology Laboratory,Udayana University.

3) Necton Community (Ikan)

Fish samplins is done with active equipment as handnet and electrofishing and gillnet as the border. Fish sampling is taken through river corse swept method along 300 – 500 meter. The fish sample is preserved in 70 % alcohol compound or 10 % formalin. The result of preserved fish sample then is identified at Biology Laboratory, Udayana University. To complete the fish data, interview with local community (fishers) about type of fish which is usually trapped at the river near the project is conducted.

4) Other Macro Community

Other macro community such as amphibie, reptile and aquatic mammals are qualitatively (visually) monitored through cruising method.

The result of preserved fish sample is then identified and its abundance is calculated. Identification of fish type at Ecology Laboratory, Biology Department, Faculty of Mathematics and Science, Udayana University, is using identification books as: Weber and de BEAUFORT (1931, 1936, 1940); FAO-UN (Vol. I-V) (1974); FAO-UN (Vol. 8) (1988); Kuiter (1992); Saanin and Saanin (1993); Mohsin *et al.* (1993); Whitten *et al.* (1993) and Helfman *et al.* (1994).

3.2 Method of Aquatic Biota Analysis

3.2.1 Analysis of Diversity, Equitability, and Domination Index

Analysis of plankton, macrozoobenthos and fish structure by index analysis approach such as diversity index of Shannon-Wiener, equitability and domination index. The calculation of Shannon-Wiener's diversity index is using two basics logaritm. To simplify the calculation, a transformation from $\log_2$ to 10 basics logaritm is conducted (Legendre and Legendre 1983 in Bengen 2000).

Formulation of Shannon-Wiener's Diversity Index is below:

$$H = -\sum pi \log_2 pi$$

$$H = 3{,}322 \{\text{Log } N - (\text{nilog ni})/N\}$$

Where :

H : Diversity index (Shannon-Wiener)
N : Total of individual in the community ($\sum$ni)
Ni : Total of species individual/I type
pi : Proportion of individual i species (ni/N)

The equitability index as an approach which describes different species distribution in the community, which is calculated with formula:

$$E = H / H\,max$$

where :

H_{max} : $\log_2 S$, --- S : total of species (taxa).

The calculation of species domination index with the formula below:

$$Id = \sum(pi)^2$$

Id : Species domination index
pi : Proportion of individual i species (ni/N)

In order to implement the index analysis and make a conclusion so that it requires to use the trheshold below as shown in the table:

Table 3.4. Thres hold Standard of Diversity, Equitability and Domination of Aquatic Biota

Thresh hold	Explanation
Diversity Index (H)	
H < 1,0	The diversity belongs to low category, poor, very low productivity as the indication of heavy pressure and unstable ecosystem.
1.0 < H < 3,322	The diversity belongs to medium category, adequate productivity, quite balance ecosystem condition, medium ecologic pressure.
H > 3,322	Very high diversity, steady ecosystem stability, endure of ecologic pressure.
Equitability Index (E)	
E < 0,5	The equability is low categorized, it means that individual distribution of each species in the community is not balance and unstable ecosystem.
0,5 < E < 0,75	The equability belongs medium category, it means that individual distribution of each species is quite balance and somewhat stable ecosystem.
E > 0,75	The equability belongs to high category, it means that individual distribution of each species in the community is very balance and very stable ecosystem.
Domination Index (Id)	
Id < 0,4	There is no domination, balance species development
0,4 < Id < 0,8	There is light domination, light-medium ecologic pressure
Id > 0,8	There is real domination, seriously polluted condition

3.3 Socio-economy-cultural and Community's health Component

The social component which will be analyzed in this study includes: demography, economy, culture and defense & security.

3.3.1 Socio- Demography includes

- Community structure based on age, gender, earning, education and religion.
- Community's density level.
- Community's growth (birth rate, baby's immortal rate, migration pattern).
- Labour (workers participation level, jobless level).

3.3.2 Socio - Economy includes

- Household's economy (income level, double income pattern).
- Natural resources (ownership and natural resources usage pattern, land use pattern, land and other natural resources value, public natural resources).
- Local and regional economy (job and business opportunity, total of non formal economy activities, income distribution, economy double effect, PDRB, PAD, centres of economy growth, public and social facilities, and regional accessibility).

3.3.3 Socio – Cultural includes:

- Culture (tradition, cultural value and norm)
- Social process (association/coordination, disassociation/social conflict, aculturation, assimilation, integration, and social cohession)
- Social Institutional/Community Institutional in economy, education, religion, social and family sectors.
- Culture's heritage and existence.
- Social layering (archeological sites, culture preserve)
- Social layering based on education, economy, culture and power)
- Community's attitude and perception toward effort and or activity plan
- Ecology adaptation

3.3.4 Community's Health

- The environment parameter which is predicted to be impacted that will affect the community's health
- Process and potential of sharpen
- Potential of impact magnitude of disease (illness and immortal rate)
- The risky community's specific characters
- Health resource
- Condition of sanitation
- Community's nutrition status

- Environment condition which is able to make the disease distribution becomes worse

3.3.5 Data Collecting

The research methods that will be used on the social study data (demography, economy, culture, defense and security) and community's health are descriptive or systematic method, factual and accurate fact, characters between the phenomenon relation which is related to the research's object.

To collect data and information related to study object, we implement following method :

- Litterature study by studying the documents and written reports which are related to research's object.
- Observation by conducting monitoring and recording about the facts, indications which are related to the research's object.
- Structured interview/guided by direct communication with respondent using questionnaire.
- Deep interview/unstructured interview (with interview guideline) which is done to several informants, those consist of community's figure or thise who are competent at social and Balinese culture (Hindu).

Type of the collected data consists of primary data and secondary data. The collecting of primary datas is directly done from the abject of study by using interview and observation method. Secondary datas are collected from Regional Government of Bali Province, Statistic Office, BPN, Education Service, Labour Service, Sub district, Village, and so on.

1. Location, Population and Sampling

Determination of research location is conducted by using stratified random sampling, ownership, local residents, farmers and poor community. Location is determined based on by particular consideration as the area which is predicted to be most impacted by the project.

Population of analysis unit from this research is the entire households (KK) of the villages chosen, carangsari, Getasan and Pangsan on Petang Sub district, Melinggih and Buahan Village on Payangan Sub district. The numbers of sample have been determiined of 130 respondents. The numbers of respondents have been determined through quota, in this case, owner 30 persons, local residents 44 persons, farmers 32 persons and poor community 24 persons.

2. Stages of data collecting

Data collecting is done in 4 stages, those are

a. First stage is approach stage and secondary data collecting. In this stage, the location approach and determination of respondent sample are implemented, as well as secondary data collecting from Provincial institutes until village level.

b. Second stage is visiting the respondent to do the interview to the determined respondent.
c. Third stage is rechecking the questionnaire.
d. Fourth stage is re-visiting the respondent in order to correct if there are incomplete, unlogic, or mistaken answers which are found on the checking step. Therefore, the census taker is ordered to re-visit the respondent to ask the truth of their answers

3. Analysis Method

Quantitative data will be analyzed descriptively and shown in form of: frequency table, figure, graphic, while qualitative data is analyzed through interpretative descriptive method, it is all of information interpretation about Ayung River Multifunction Dam development plan will be shown in accordance to their world of view. Then the appeared inclination is explained.

3.4 Method of Big and Important Impact Prediction

Impact identification matrix and vertical flow draft will be used to predict the impact. By this impact identification matrix, whether there will be impact towards the environment due to the effort and/or activity plan can be recognized. The it is followed by the prediction of big and important impact.

The analysis toward the important impacts which will occur contains:

1. Prediction of activity impact in Pre-construction, Construction, Operational and Post-Operational Phase, by analysing the difference between the predicted environment condition with the existence of activity and predicted environment quality condition without existence of activity.
2. Guideline of important value of environment quality changing by refering to Guideline About Measure of Important Impact based on Decree of Bapedal Head No. Decree 056/1999.
3. Concerning the primary and secondary impact in anlysing the prediction of activity impact and detrmination of important value of environment quality changing. Therefore, it needs to concern about the existence of impact final mechanism on various environment components as followed:
   a. Activity causes direct important impact on social component.
   b. Activity causes direct important impact on physic, chemical component and then causes sustain impact chain to the biology and social component.
   c. Activity causes direct important impact to the chemical aspect, and afterwards causes impact to the social component.
   d. The important impacts occur in sequence among the social components it self. Important impact which has been explained above then cause contrary impact to the activity plan.

The prediction of big and important impact on factors which are included in Decree of Bapedal Head No. 56/1994 and Governmental Regulation No. 27/1999 as followed:

1. **Total of impacted human**

Due to the definition of impacted human covers a wide aspect, hence the criteria of important impact is related to the hinges of life which have important position/value in the community if:

The amount of humans in the Andal study area which are impacted but cannot take the benefit from the effort and or activity are equal or more than the amount of those who can take benefit of the effort or activity in the study area.

2. **Wide of the Impact Spread Area**

The environment impact of a certain effort and or activity is important, if:

Effort and or activity plan causes the area which experiences basic change on the impact intensity aspect or unreturned impact or impact cummulative aspect.

3. **The Term of Impact Existence**

Environment impact can be occured in a particular stage or various stages. In other words, impact can be occured in such a long term. In accordance to it, impact is important, if:

Effort or activity plan causes basic change on the impact intensity or unreturned impact or impact cummulative aspect which occurs simply in one or more activity stage.

4. **Impact Intensity**

Impact intensity has a definition of great or drastic evironment change and persisted in a relatively wide area, in a relatively short term. The environment impact is important, if:

a. *Effort or activity plan causes physical change and or environment biological which exceed the environment quality standard based on effective laws.*
b. *Effort or activity plan will cause basic change on environment component which exceeds the admitted criteria according to scientific consideration.*
c. *Effort or activity plan will lead to threat with extinction for rare species and or endemic and protected based on the effective laws, or damage its natural habitat.*
d. *Effort and or activity plan causes damage or disturbance to the protected region which has been detrmined based on laws.*
e. *Activity plan which damages or destroys things and valuable historical haritage building.*
f. *Effort or activity plan which will cause conflict or controversion among the community, regional government or central government.*
g. *Effort or activity plan changes or modifies the area which has valuable natural beauty.*

5. **The numbers of impacted environment component**

Because the impact on environment component is not on its own or related and impacted and a certain impact on a evironment component will continuously impact the other impact. By this definition therefore an impact is important, if: *Effort or activity plan causes secondary impact and other continuous impact which the component is more or the same as the environment component that impacted by primary impact.*

6. **Characteristic of impact cummulative**

   Impact is important if:

   a. *Environment impact is repeated occurs and contiouously, so that in a particular term it cannot be asimilated by nature or the receiver.*
   b. *Various environment impacts pile in a certain space so that it cannot be asimilated by the nature or social environment.*
   c. *Environment impact from various activity sources lead to effects which strengthen each other.*

7. **Reversibility or irreversibility of an impact**

   The impact is reversible if the persisted impact can be recovered and no human's intervension. The impact is important if: *Change on a certain component cannot be recovered even with human's interviension.*

Magnitude of impact will be predicted by these methods below:

1. **Formal Method**

With this method, the causal effect that describes influence of project's activities toward change of particular environment component is formulated in form of mathematical equations, experimental model, fast perdiction model. Choosing or impact prediction method is adjusted to the problem. This method is done to the physic-chemical components such as climate, air quality, physiography and geology, hydrology, water quality, land, flora and fauna and aquatic biota.

2. **Non Formal Method**

Non formal method is used if the parameter cannot be quantificated. "Profesional judgement" is used to predict impact. The two types of non formal method that will be used are analogic impact prediction and expert's evaluation. Analogic impact prediction is implemented by predict the impact with similar activity at other place and or persisted in the past which is going to be consideration of to predict the occured impact.

Expert's evaluation is done by deciding impact prediction which based on expert's knowledge and experience. This technique is used if the available data and information are limited, lack of comprehension of the predicted phenomenon.

3.4.1 Impact Evaluation Method

Impact evaluation is a result from the analysis of important impact.

1. Analysis to important impact

   Analysis to important impact is done by holistic analysis based on various environments which are predicted to be basically changed, by using criteria in Guideline about Measure of Important Impact, according to Decree of Bapedal Head No. Decree 056/1994 and Governmental Regulation No. 27/1999.

2. Analysis as the basic of management

This analysis is an analysis which explains the causative relation between effort or activity plan and existing environment with the positive and negative impact that possibly occurs.

Analysis above are done as the basic of control to resolve the negative impact and develop the positive impact. The holistic impact evaluation is purposed to make syhthetic of two hypotetic important impact as followed:

1. The ecologic sustainability of project site and its environs which characterized by the impact to the land, water, micro climate and air quality.
2. The sustainability of socio-economic around the project is characterized by the impact towards demography, local economy and social process.

Evaluation of important impact is done by giving important and umimportant verbal value, which is determined based on the result of the impact prediction. Evaluation of important impact is the result of important impact analysis which hass been done through impact prediction. In this method, the evaluation considering the magnitude and importance of impact to the impacted environment by the activity is implemented. The evaluation is based on several approaches:

1. Litterature approach
   Evaluation is based on comparative study with litterature data.
2. Comparison approach
   Evaluation is done by comparing the activity with the similar activity that has been going on.
3. Environment Quality Standard Approach

Evaluation by comparing impacted environment quality that caused by existing activity of environment quality standard. Hence the carrying weight of the impact qualitatively or quantitatively.

CHAPTER IV

ACTIVITY PLAN

4.1. The identity of the Initiator and ANDAL Study Team

4.1.1 Initiator

The initiator of this project is Department of Settlements and Regional Infrastructure, Directorate General of Irrigation, Project of Bali Water resources development and Management.

1) Name of Project Leader : Ir. I Gusti Nyoman Sura Adnyana, MSc
2) Address : Jl. Beliton No. 2 Denpasar
3) Telephone : (0361) 244862

4.1.2 Andal Study Team

ANDAL study of Ayung Dam development plan is conducted by:

1) Name of the Company : PT. ASA CITRA
2) Address : Jl. Gunung Catur II E No. 6 Denpasar
3) Director : Ir. I Gusti Ngurah Ananda Dimitri

Table 4.1 ANDAL Study Team

No	Name	Position	Expertise
1	Ir. I Wayan Restu, MSi	Team Leader, Amdal A, and B	Biologic Environment
2	Drs. I Nyoman Sunarta, MS	Member, Amdal A,B	Hydrology
3.	Ir. I Wayan Rusna, MS	Member, Amdal A,B	Physiography, soil
4.	Drs. I Nyoman Wardi, MSi	Member, Amdal A,C	Socio-cultural
5.	Drs. I Ketut Sundra, MSi	Member, Amdal A,C	Terrestrial biology
6	Drs. I Nyoman Sunarta, MS	Member, Amdal A,B	Hydrology
7	Ir. I Dewa Gede Eka Suaputra	Member, Amdal A	Socio-economy
8	Ir. I Gusti Ngurah Oka Suputra, MT	Member, Amdal A	Civil Engineer
9	I Dewa Sura Darma, SKM	Member, Amdal A	Community's health

4.2. Purpose of Activity

The Ayung Dam development is purposed to take the benefit of water resources potential of abundant Ayung River's water on the rainy season and very limited on the dry season. Therefore, the development of Ayung Dam is purposed to raw water supply, potable water, irrigation, and electricity. It is predicted that the activity is able to fulfill the raw water requirement of 3,6 m^3/sec (potable water, sanitation and city flushing) and stabilize the irrigation water for 9.542 Ha of rice fields on Subak Kedewatan, Mambal, Singempel, Praupan and Oongan so that it is preserved. The dam development is prepared to produce Hydraulic Electricity Power of 12,3 MW. It is also expected that the dam development is

able to avoid erosion on the upstream, flood mitigation and also water resources development in Bali Province.

Development of Ayung Dam will cover river basin area ± 218.41 km^2 wide, 73.17 ha of inundation of dam water surface, reserve 10,562,600 m^3 of water at normal elevation water level ± 377,00 m and maximum elevation flood water level at ± 377,70 m.
Main Dam is made of concrete gravity with maximum high 104,00 m from the bottom of the structure. River bed elevation is 280,00 m with free board 2.40 m. Length of the crest 221,25 m, with peak dam elevation + 380.10 m. Width of the crest 6.00 m with filled volum 356,709.95 m^3 and foundation grouting 3.90 m at the up-stream slope vertical and downstream slope 1: 0.8
Spillway type of this planned dam is ogee complemented with gate in crest width 3 x 8 m.
Spillway crest elevation + 367.00 m with upstream slope 1 : 1 and downstream slope 1 : 0.8

Intake structure type is Vertical Sliding Gate with gate dimension 2.5 x 2.5 m, inlet ground elevation + 355.90 m, penstock length 120 m with steel construction and tunnel dimension 2.00 m.. Figure 4.1, 4.2, 4.3 are Detail Design of Ayung Dam.

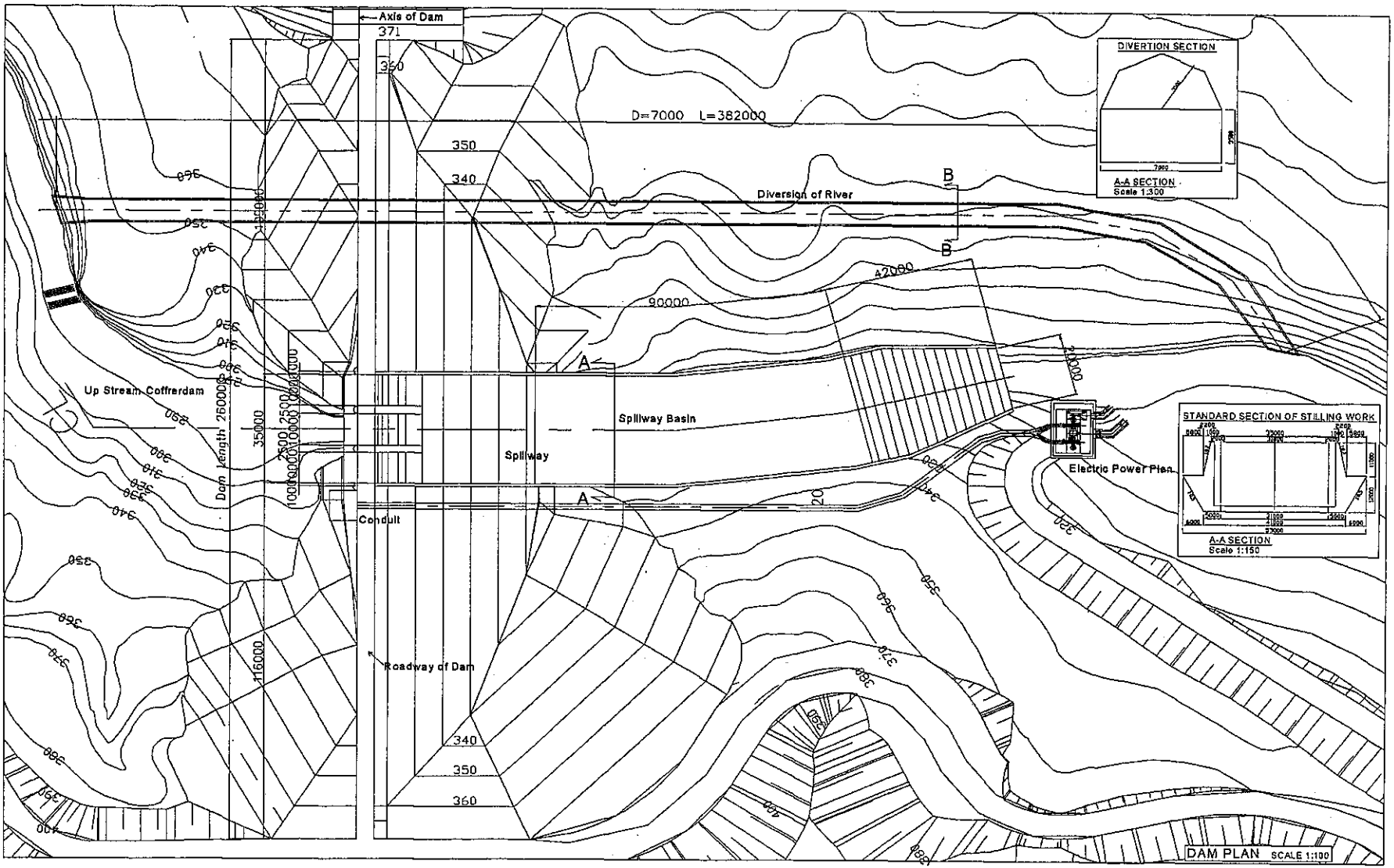

Figure 4.1 Layout of Ayung Dam Plan

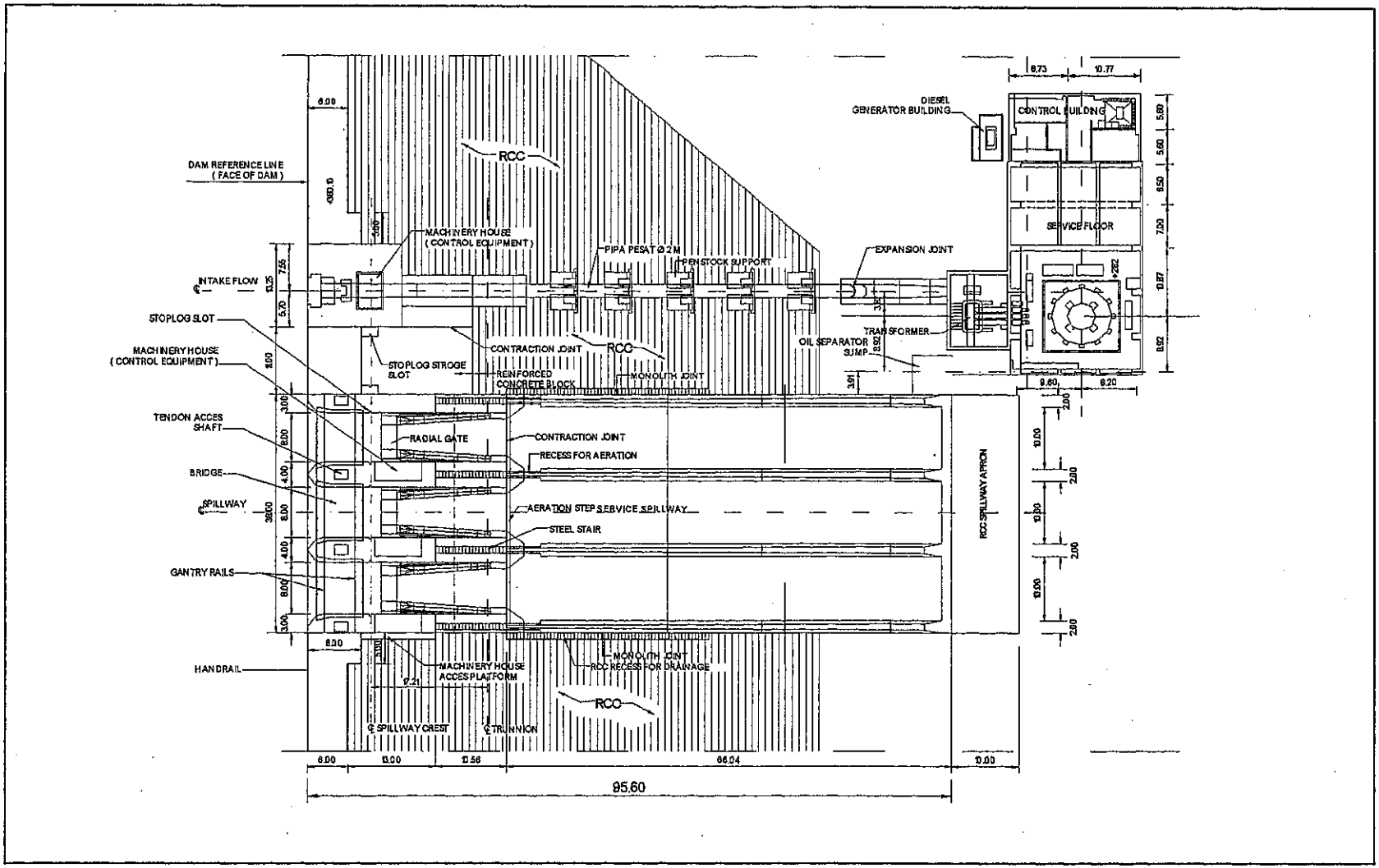

Figure 4.2 Spillway Layout of Ayung Dam

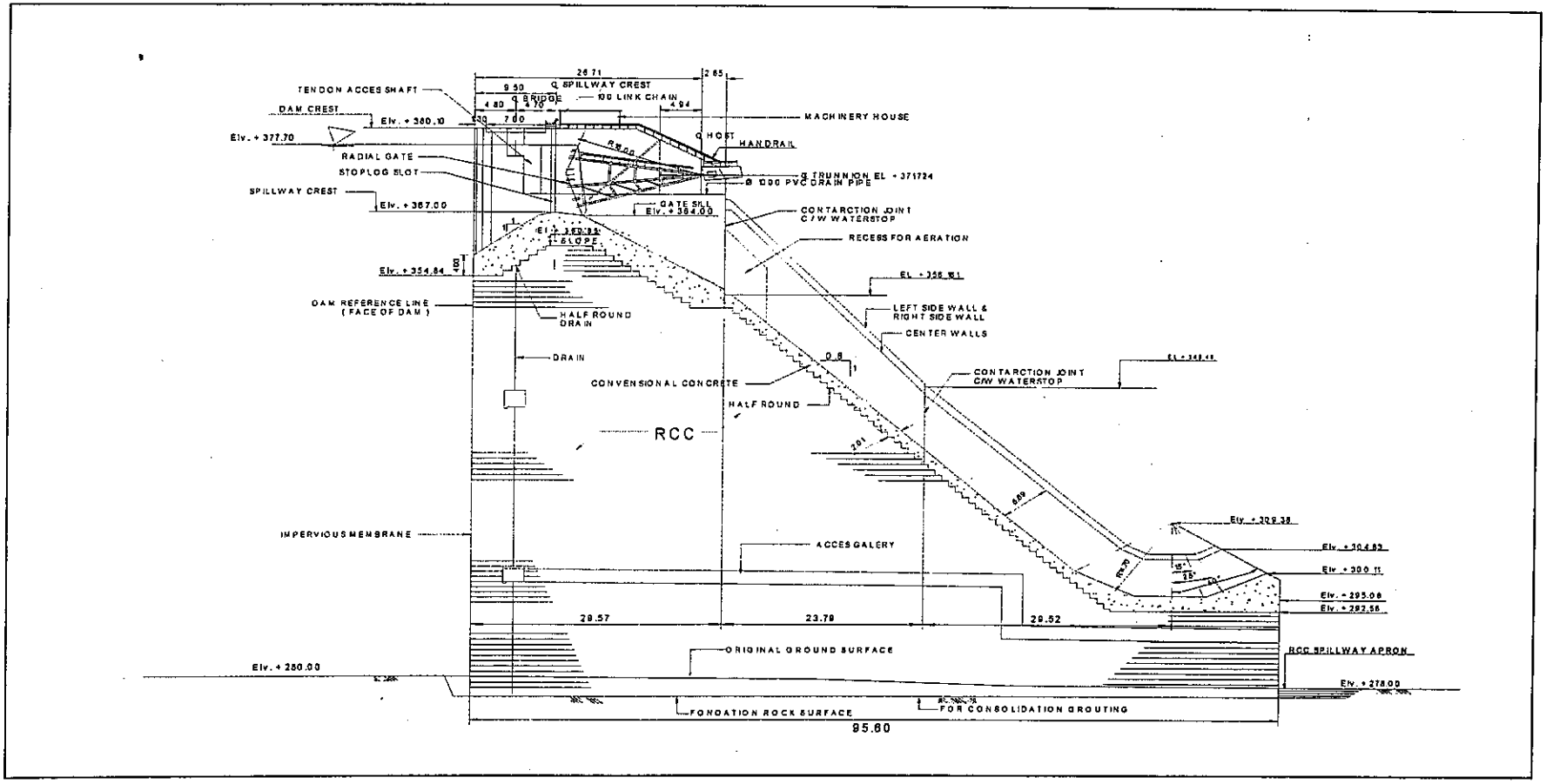

Figure 4.3 Cross Section of Spillway

4.3 Phases of Activity

4.3.1 Component of Activity Phases

1. Pre-construction Phase

On this phase, socialization is made to inform following subject:

a. Determination of plan activity location borders by field measurement
b. Land aqcuitition that will beused fror Ayung Dam development activities.
c. Socialization about plan of activity implementation phases such as pre-construction, construction and post construction phase.
d. Erection of information board for construction planning and announcement on local media about EIA study
e. Finishing of envionment feasibility document and other documents which support the activities

2. Construction Phase

On this phase, activities consists of:

a. Equipment , material and manpower (employee) mobilization.
b. Access road making.
c. Base camp erection.
d. Land clearing and stripping
e. Cut and filled for cofferdam, maindam, and spillway.
f. Grouting
g. Stone composing and concrete
h. Earth material transporting in or out from the site.
i. Quarry management including material cutting in the river bodies out of project site, and
j. Dam instrument instalation.
k. Construction high hydro-electropower.
l. Equipment and manpower (employee) demobilization.

3. Post Construction Phase

On this phase, socialization is made to inform following subject:

a. Cut off plugging canal and reservoar impounding.
b. Dam / intake gate operation which consist of water distribution for irrigation and water supply.
c. Maintaining the structure function, such as sediment excavation, mechanical oiling, broken equipment exchange when it is broken, and others.
d. Conservation area maintaining for ecologycal, drainage, ergonomic and aesthetic purpose.
e. Recreation services. As commonly water structure and width water view always interesting for the people for recreation.
f. Administration services consist of dam operation and maintaining purpose, for young people education purpose, even for recreation services.
g. Security guardiance of dam structure and area from crime, sabotage, and visitor security or orderlines of the visitor.

4.3.2 Volume of Works

Type and works volume describe as below :

Table 4.2 Type and Works Volume

No	Type of Works	Description	Volume
1	Preparation	Feasibility study, DED, environmental study, tender and administration preparation.	1 LS
2	Construction	Width of river basin	218,41 Km
		Width of inundation of dam water surface	73.17 Ha
		Efectif storage	10.562.600 m3
		Water level elevation	377 m
		Flood level elevation	377,70 m3
		Maximum high	104,00 m
		River bed elevation	280 m
		Free board	2,40 m
		Lenght of the crest	221,25 m
		Peak dam elevation	380,10 m
		Width of the crest	6 m
		Filled volume	356.709,95 m3
		Fondation grouting	3,90 m
3	Operational	Irigation water supply	9.542 Ha
		Plant intensity	280 %
		Production	4.74 ton/Ha
		Raw water flow	3.600 lt/sc
		Electricity	12,3 MW

4.3.3. Time Schedule

Time schedule of Ayung Dam Development will start on 2003 to 2005, it is divided into three phases : preparation, construction and maintenance.

4.3.4. Works Method, Equipment and Material

Ayung Dam development plan of works gradually implemented appropriate with standard of works procedure including equipment and material..

Types of equipments which are commonly used are the heavy equipments for the resemble physical projects. The common heavy equipments are:

1. Equipment

Ayung Dam development using certain equipment :

- Buldozer : 8 Unit
- Excavator : 8 Unit
- Motor Grader : 10 Unit
- Loader : 4 Unit
- Tandem Roller : 4 Unit
- Vibro Roller : 4 Unit
- Driving Machine : 4 Unit

- Dump Truck : 35 Unit
- Compressor : 10 Unit
- Tire Roller : 4 Unit
- Water Tank : 35 Unit

The implementation appropriate with suitable technology, time and target.

2. Material

Material using on project can be grouped as below :

a. Material on location, can be using for piling up.
b. Material from outside, those material are using for dam structure fondation, such as limestone and material for supported building, such as sand, gravel, river stone and cement. While strengthening material are mix-designed material such as mix-concrete for dam

3. Number of Workers and Qualification

Workers needed are high qualification workers from pre-construction phase such as surveyor and planner ; construction phase such as force labour, skilled labour, head of skilled labour, foreman, supervisor, equipment operator and management skilled. Numbers of workers are 150-300 workers. The using of workers depends on job description, technology, and works volume and shift arrangement.

4.4 The relation between the project with the other activities

Location of Ayung Dam development plan and its surroundings are a mixture area (natural and cultivation) which have beautiful view, wavy topography of land, steep ravine and intersting terrace. Some main activities around the location which should be considered in analysing the environment impact include:

1. Ricefield and dry land agricultural activities. Agricultural activities are dominant in the area around dam site, particularly at the upstream and catchments area of the dam. The high activity portion is predicted will give significant impact to the dam ecosystem after inundation. Agricultural wastes as nutrient element (Total Nitrogen, Total Phosphorous, organic wastes, pesticide, and sedimentation Total Suspended Solid and Total dissolved solid), directly or indirectly will be in and stored at the dam through the flow of Ayung and Siang River and the estuaries at the catchments area.

2. Tourism activities take the advantage of Ayung River's flow. There are seven rafting companies at Petang Subdistrict (Bali Fantasi Rafting, Mary Rafting, Bali Adventure Rafting, Bahama rafting, Mega Rafting, BMR Rafting, Ayung Resort Rafting) and one at Payangan Sub district (Sobek Rafting) that use the flow of Ayung as the main part tourism attraction provided. This tourism activity is closely related and will be disturbed even its sustainability will be in danger due to the dam development activities. Most of the predicted impact is some rafting activities at the upstream of dam cannot be operated because of the inundation and disturbance during construction as well as temporarry ceasing of activity on the inundation, especially for the rafting companies at the downstream of dam site

3. Activities of tourism service as Trekking, hiking or bicycle riding through paths in the villages. Several travel agents in Denpasar and Badung have tourism package as going through the village and river side of Ayung. The relation between this activity with the project is relatively small. There will only be a bit disturbance on traffic, noise and tourism comfort.

4. Community's religious activities which are using the flow of Ayung as well as its campuhan, such as *melasti/mekiyis*. This problem related to the activities of the project is quite complex. It needs to do accurate approaches to formulate the solution toward the disturbed local values, even there will be removal of certain elements.

CHAPTER V
EXISTING ENVIRONMENT CONDITIONS

5.1 Geophysics – Chemical Component

5.1.1 Climate

Bali Province is situated in tropical zone, southern earth between 8°.03'.40" South Latitude - 8°.50'.48" South Latitude and 114°.25'.53" East Longitude - 115°.42'.40" East Longitude. Its climate, particularly, affected by the annual moving of Inter Tropical Convergence Zone (ITCZ) and related to the changes of monsoon wind pattern.

North West Monsoon Wind begins to blow since September until April, it is when high air pressure in Asia goes to the south east and turn to the east while goes through equator. This wind contains vapours while passes Indian Ocean, and 80 % of average annual rainfall will be on September to April. From May to October, when the air pressure is returned, South East Monsoon brings less humidity and rather colder.

All of the climate datas used are secondary data obtained from various sources under the coordination of Meteorlogy and geophysics bureau Area III represents Candikuning, Baturiti and Petang station for West area, and Tampak Siring Gianyar and Pangotan Bangli for East area (because there is no climatology at the study area). While data of air quality and noise are primary data obtained from the measurement result and direct test at the location and its surrounding, in coordination with Balai Hiperkes and Keselamatan Kerja Daerah Bali.

1. Type of climate

According to Schmidt and Ferguson Classification system, the location of Ayung River multifunction dam development plan belongs to C-A (rather wet area – very wet area with tropical forest vegetation), this is shown by the ratio between dry month average and wet month average (Q) of 0 % - 57,14 %. Wet month (BB) is months which have rainfall more than 100 mm and dry month (BK) is months which have less than 60 mm rainfall (Handoko, 1993). This type of climate is calculated based on the rainfall obtained from Candikuning Climatology Station period 1974-2003; Baturiti, Petang, Tampak Siring, and taro Kintamani Station on 1992 – 2001.

2. Rainfall and Rain Day

According to the data obtained from Meteoroloy and Geophysics Bureau Area III Denpasar for five areas at the upstream (catchments area) with the annual rainfall average of 2.313,95 mm - 3.152,0 mm and highest monthly average rainfall on February and the smallest is on August. While total of average rain day in a year is 95.3 -165 days, with highest average rain day per month is January and smallests are on June and August. Data of rainfall at the activity location and around the activity sites are shown on Table 5.1.1 and Figure 5.1.

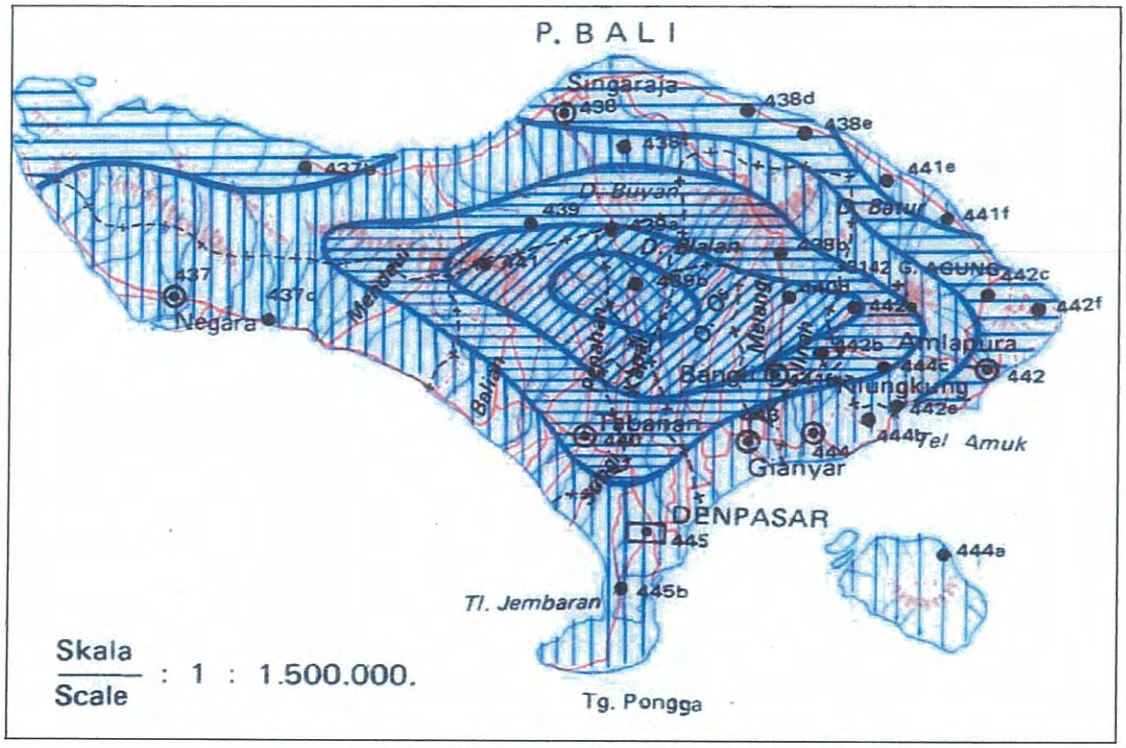

Figure 5.1 Figure of Rainfall within a year in Bali

Table 5.1 Rainfall at the location of Ayung Dam Development Plan and Upstream Area (Catchment Area)

Month	Candikuning		Baturiti		Stasiun Petang Badung		StasiunTampak Siring Gianyar		Stasiun Catur Kintamani Bangli	
	CH (mm)	HH (day)	CH (mm)	HH (day)	CH (mm)	HH (day)	CH (mm)	HH (day)	CH (mm)	HH (day)
January	452	24	528	19	430,05	16,7	378,3	15,2	486,9	18.8
February	619	22	517	19	455,85	15,7	310,9	14,3	619,5	17.1
March	373	20	426	17	381,35	13,6	203,65	12,6	333.7	12.2
April	275	17	305	14	305,65	10,9	138,05	10,2	262.1	11.9
May	76	8	123	10	161,1	6,7	79,25	6,3	69.0	3
June	44	5	76	9	79,85	6,8	82,60	6,7	19.9	1.8
July	50	6	60	7	72,25	8,7	109,5	9,1	15.7	0.8
August	34	5	76	7	48,4	6,1	76,4	5,8	10.4	1.2
September	57	6	69	6	72,9	5,5	119,3	5,2	28.7	1.4
October	166	11	214	10	228,8	11,6	260,55	10.2	115.7	4.5
November	322	19	375	14	357,25	14,2	285,05	14,4	283.3	10.9
December	287	20	409	18	393,95	14,9	270,4	14,1	319.5	11.7
Total	2.755	165	3.152	150	2.987,4	131,4	2.313,95	124,1	2.564.4	95.3
Total of BK	4		1		1		0		4	
Total of BB	7		8		8		8		7	
Schmidt & Ferguzon Climate type	C (Rather wet area with forest vegetation)		A (Very wet area with tropical forest vegetation)		A (Very wet area with tropical forest vegetation)		A(Very wet area with tropical forest vegetation)		C(Rather wet area with forest vegetation)	

Source : Bureau of Metereology and Geophysics Area III Denpasar

Explanation : CH (Rainfall), HH (rain day)

1) Candikuning Climatology Station period 1974 – 2003
2) Baturiti Monitoring Station period 1993-2003
3) Petang Badung, Tampak Siring Gianyar and Catur Kintamani Bangli Stations period 1992-2001.

3. Temperature and Air Humidity

The condition of monthly average temperature around the location is between 17,3°C up to 19,1°C with annual average temperature of 18,5°C. Highest maximum temperature is on April (23,8°C), and lowest minimum is on July and August each of 14.3°C.

The annual average humidity is 89,8%. The highest relative humidity is on February (85,0%-91,8%) and the lowest is on August (76% - 85,2%). For more detail temperature and humidity as well as air pressure is shown on Table 5.1.2.

Table 5.2 Average temperature and humidity at the upstream area period 1974 – 2003 (Gianyar and Badung Data 2002).

No	Bulan	Temperature (o C)			Humidity (%)			Preesure (mB)	
		Max	Min	Average	Candi kuning	Gianyar	Badung	Gianyar	Badung
1	January	23,3	16,7	19,0	91,0	83	84	1.008,20	1.008,20
2	February	23,4	16,5	19,0	91,8	85	85	1.008,60	1.008,60
3	March	23,7	15,9	19,1	91,0	85	85	1.008,30	1.008,30
4	April	23,8	15,6	19,0	85,7	82	81	1.008,80	1.008,80
5	May	23,7	15,4	18,7	91,0	81	81	1.009,40	1.009,40
6	June	23,0	14,8	18,0	91,0	78	77	1.010,30	1.010,30
7	July	22,1	14,3	17,4	91,2	78	76	1.011,60	1.011,60
8	August	22,4	14,3	17,3	85,2	76	76	1.011,80	1.011,80
9	September	23,7	15,9	18,6	89,6	84	82	1.012,50	1.012,50
10	October	23,7	16,6	19,0	88,4	83	81	1.010,50	1.010,50
11	November	23,5	16,2	19,0	91,2	82	81	1.009,20	1.009,20
12	December	23,3	15,6	18,5	91,0	83	81	1.009,00	1.009,00

Sourcer : Bureau of Meteorology and Geophysics Area III Denpasar

4. Wind Direction and Velocity

Pattern of wind movement is important for a certain area in order to know the pollutant spread as a consequence of an activity development. The analyzed wind data in this activity includes data of maximum daily wind direction and velocity in Bali for more or less 15 years, from 1988 to 2003, obtained form Ngurah Rai Meteorology Station, Denpasar.

The annual wind rose analysis shows that east wind is a dominant wind with frequency of 34.69 %, followed by the second dominant from South East with the frequency of 29.41%. While for West and South West wind with each frequency of 18.53% and 11.19%. Dominant velocity is in range of 9 – 11 m/sec with the frequency of 12.45% from West. While the maximum wind velocity more than 11 m/sec, generally from the East and South East (±11%) followed West Wind (9%). For more detail please look at Table 5.3 and Figure 5.2.

Table 5.3 Distribution of daily wind frequency in percent, period 1988-2003

Direction	Wind Velocity (m/sec)							
	Calm	1 – 3	3 – 5	5 – 7	7 – 9	9 – 11	>11	Total
North	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00
North East	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00
East	-	0.00	0.00	1.21	2.26	4.44	1.81	10.08
South East	-	0.00	0.00	0.40	1.21	1.21	0.40	3.23
South	-	0.00	0.00	0.40	1.41	1.41	0.20	3.43
South West	-	0.00	0.00	2.42	7.26	10.69	8.87	29.23
West	-	0.00	0.00	2.42	7.26	9.48	29.64	48.79
North West	-	0.00	0.00	0.40	1.41	1.10	2.02	4.84
Total	-	0.00	0.00	7.66	21.17	28.23	42.94	100.00
Cuumulative	-	0.00	0.00	7.66	28.83	57.06	100.00	100.00

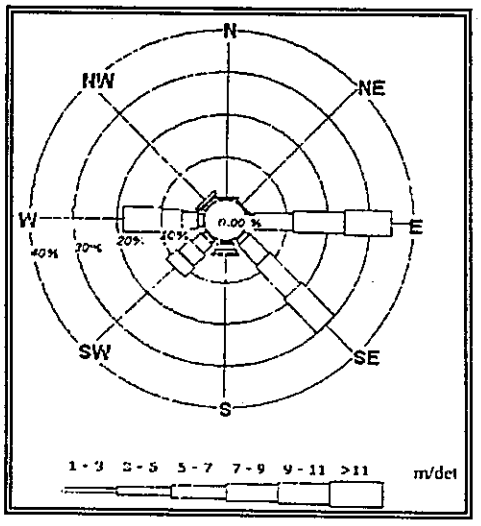

Figure 5.2 Daily wind rose period 1988 – 2003

5. Illumination

Illumination is a term of sunshine to the earth within one day period. One day period is oftenly called as length of day, it is a term when the sun is at the horizon. The term of sun shine is very various, depends on brightness of atmosphere at the location and its surroundings. Table 5.4 shows that monthly average sun shining term is between 31,0% up to 67,2% with annual average of 51,7%. The longest shining of the sun is on May of 62,4 % and on June of 67,2 %, while the shortest occurs on January (31 %) and February (32,8 %), those are the rainy months as shown on table 5.4.

Table 5.4 Term of shining of the sun, Candikuning Climatology Station, period 1974 – 2003

No	Month	Term of sun shining (%)
1	January	31,0
2	February	32,8
3	March	46,0
4	April	46,2
5	May	62,4
6	June	67,2
7	July	55,4
8	August	65,0
9	September	64,8
10	October	61,8
11	November	46,8
12	December	40,6
Average		51,7

6. Disaster Periodic Data

Bali Island lies on the earthquake line which stretches out the islands, but it does not include a very big vibration. The earthquake which was more than 6,0 MB occurred in 1911 until 2000 where the centre of earthquake was 300 km from the city at the study area as included Table 5.5 below.

Table 5.5 The earthquake with Vibration more than 6,0 MB

Tanggal	Waktu			Lokasi		Kedalaman	Getaran		Pusat Gempa
	jam	menit	detik	Lintang	Bujur	(km)	MB	MS	
05-07-1991	18	40	6	7,50 LS	117,50 BT	370,00	6,80	7,00	300 km sebelah Timur Timur Laut Denpasar
11-11-1916	6	30	36	9,00 LS	113,00 BT	100,00	6,90	7,20	200 km sebelah barat Denpasar
20-06-1929	18	22	33	8,50 LS	114,00 BT	60,00	6,40	6,20	Pulau Jawa bagian Timur
08-05-1930	12	47	18	8,00 LS	117,20 BT	-	6,20	-	250 km sebelah Timur Denpasar
17-05-1932	12	56	30	8,50 LS	115,00 BT	80,00	6,40	6,20	Bagian Selatan Pulau Bali
10-04-1934	10	22	58	6,50 LS	116,00 BT	33,00	6,70	6,88	250 km sebelah Utara Timur Laut Denpasar
11-04-1934	21	56	2	7,00 LS	116,25 BT	33,00	6,30	6,00	200 km sebelah Utara Timur Laut Denpasar
12-02-1936	9	34	30	6,00 LS	116,00 BT	600,00	6,50	6,50	300 km sebelah Utara Timur Laut Denpasar
11-08-1937	0	55	52	6,50 LS	116,50 BT	543,00	7,30	7,80	300 km sebelah Timur Laut Denpasar
29-10-1938	22	53	0	9,00 LS	116,00 BT	90,00	6,50	6,50	Ujung Selatan Pulau Lombok
17-08-1953	3	14	36	6,80 LS	115,10 BT	33,00	6,30	6,00	200 km sebelah utara Denpasar
10-06-1957	0	59	54	9,00 LS	117,00 BT	-	6,70	6,80	Ujung Barat Daya P. Sumbawa
30-03-1967	2	8	3	11,06 LS	115,40 BT	33,00	6,00	-	300 km sebelah Selatan Denpasar
30-03-1967	2	28	2	11,00 LS	115,50 BT	33,00	6,00	-	300 km sebelah Selatan Denpasar
14-07-1976	7	13	24	8,20 LS	114,90 BT	40,00	6,20	6,50	Belahan Utara Pulau Bali
30-05-1979	9	38	53	8,21 LS	115,95 BT	24,00	6,10	5,80	Ujung Timur Pulau Bali
20-10-1979	1	41	10	8,25 LS	115,85 BT	38,00	6,00	6,20	Ujung Timur Pulau Bali

Source : Meteorology and Geophysics of Bureau, Tuban 2001

Based on the earthquake list data which had been damaging Bali in 1821 – 1993 (BMG, 1998), there were three earthquakes which caused damage in Bali. **First,** on January 21, 1917 there was horrifying earthquake with maximum intensity IX according to earthquake power scala (Modified Marclli Intensity, 1931). The impacts were cracking land and slide were appeared in some places, there were many houses broken and approximately 1.500 people died caused by the landslide. **Second,** on April 27, 1930 there was earthquake with maximum intensity V, the impact occurred in southern Bali as form cracking wall due to the big shake in Denpasar and Tabanan, cracking land at Benoa. **Third,** on October 30 1938 there was an earthquake with maximum intensity VII or 6,6 skala richter with the earthquake centre was 8,9 South Latitude and 115,8 East Longitude. The impact was damage on community's residents.

From the disaster data, apparently in the area of Ayung River Dam Development plan there was potential of earthquake which needs to be anticipated in the dam development. The other earthquakes around Denpasar were at Buleleng (1862), Negara (1890), Seririt and Busungbiu (1976), Bangli (1977), and Karangasem (1979). Those earthquakes were in intensity of VI-VIII which caused serious damage and victims.

5.1.2 Air Quality

1. Air Quality Component

Analysis toward the physics-chemical sub component as air quality needs to be implemented, because of the interaction between activity plan and air quality component, by the construction or operational (post construction) phase.

Table 5.6 The Result of Air Quality measurement at Petang Sub district

No	Parameter	Unit	B.M.*	Sampling Location		
				I	II	III
1	SO_2	□g/Nm^3	900	18,4	10.2	9.8
2	CO	□g/Nm^3	30.000	568	232	168
3	NO_2	□g/Nm^3	400	62	23	20
4	O_3	□g/Nm^3	235	26	18	16
5	Debu	□g/Nm^3	230	68	48	40
6	Pb	□g/Nm^3	2	0,0	0,0	0,0
7	HC	□g/Nm^3	160	8.4	5.5	5,0

Location I : Road in front of Petang head of Sub district's office
Location II: Road in front of Buangga Assistant Local Government Clinic
Location III : Riverside of Ayung Dam Location

Dust parameter at the road to Ayung Dam development, especially at the main road of Petang Subdistrict and surroundings, entirely is still below the environment quality standard of 230 μg/Nm^3. This High Volume Sample measurement shows that the existence of dust, generally, generated by the land condition and open road shoulder towards the blowing wind and motorized vehicles.

Dust particles in the atmosphere have specific characters, it can be solid substance or liquid aerosol suspension. The particle materials can be from condensation process, particular material dispersion. According to the size, generally, the particle can be as coarse particlewith diameter of > 10 micron, dust particle, vapor, smoke with the diameter below 1-10 micron, and aerosol with the diameter of under 1 micron.

There were some pollution source which produces pollutant and categorized as primary and secondary pollutant which are classified as sulphur, nitrogen, carbon, oxide carbon, halogen, solid particle compound and radioactive material. The community at study area is relatively rare. The source which contribute the most pollutant is from transportation activity, rubbish burning, and other natural activities, From the data of measurement result, Table 5.7 compared with environment quality standard for ambient air based on Decree of Governor of Bali Province No. 515, 2000 considering Environment Quality Standard, still below the determined quality standard.

Table 5.7 Result of Air Quality Measurement at Payangan Sub district

No	Parameter	Unit	B.M.*	Sampling Location		
				I	II	III
1)	SO_2	□g/Nm^3	900	144	104	68
2)	CO	□g/Nm^3	30.000	5.992	3.455	1.125
3)	NO_2	□g/Nm^3	400	45	38	25
4)	O_3	□g/Nm^3	235	38	30	18
5)	Debu	□g/Nm^3	230	102	98	56
6)	Pb	□g/Nm^3	2	0.1	0.0	0.0
7)	HC	□g/Nm^3	160	12	11.5	8,8

Location IV : In front of Payangan Market
Location V : Road to Buahan Village
Location VI : River side of Ayung (Susut)

The air quality profile at the study area shows that the air quality parameter is far under the national ambien air quality standard or local environment quality standard based on Decree of Governor of Bali Province No 515, 2000. The explanation of air quality is as followed:

a. Dust

The highest measured dust parameter is 102 □g/Nm^3 in front of Payangan Market and the lowest is at the dam plan area of 40 □g/Nm^3. The ambien air quality standard according to Decree of Minister of Environment No.Kep-02/MenKLH/I/1988 is 230 □g/Nm^3 with 24 hours measurement by thegravimetric analysis method with High Volume Analyser. While the quality standard for Bali according to Decree of Governor of Bali Province No. 515, 2000 of 230 □g/Nm^3 for 24 hours measurement. Generally, the dust content at the study area is still below the environment quality standard, however it needs to be considered that the dust content profile during construction's impact is increased for health.

b. Lead (Pb)

Lead (Pb) content in the air can be detected between 0,1 s.d. 0,0 □g/Nm^3. The measured timbal concentration is still under the environment quality standard according to Decree of Governor of Bali Province No. 515, 2000 of 2 □g/m3. Pb content at the measure location possibly comes from the vehicle's gasoline and other substances which contained Pb.

c. NO_2

NO_2 Gas is collected by absorping the air at sample area and put into the liquid which contained trietanolamina, o-metoksifenol, and natriummetabisulfit. This liquid then is reacted with ANSA reagent to know the NO_2 concentration in quotation.

The highest NO_2 content at the study area is between 45 □g/Nm^3 and it is still under the ambien air quality standard according to Decree No. 515/2000. The nitrogen compound content possibly comes from the disentangling reaction of compounds which contain nitrogen as rubbish decaying, and wastes, as well as other natural factors.

The pollution effect of Nox towards the human health, especially due to the ability to form MethHb (Meth hemoglobin) in the blood so that it disturbes the blood functions. There will be swollen and lungs fibrosis due to the NO2 which is over limit. NO2 can be reacted in photochemical way and produces NO and radical O and will give global effect as hole on the ozone and increase of atmosphere temperature. On the higher concentration, this compound is able to cause acid rain which can damage things which are not acid resistant.

d. Carbonmonoxyde (CO)

CO measurement is conducted by using portable instrument (portable CO-measurement kit). The measured CO content at some locations shows the concentration between 158 until 5592 □g/Nm^3. Most of the source of CO are coming from the using of transportation vehicles and other ignitions. The ambien quality standard based on Decree of Minister of Environment No.Kep-03/MenKLH/I/1997 as much as 20 ppm for 8 hours measurement time, or 30.000 □g/Nm3 according to Decree of Governor of Bali Province No. 515, 2000.

The effect caused by CO pollution for human is the ability to block transfer function of HbO2 and increase HbCO in the blood. Then, this ability will damage the heart's muscle and central nerve system.

2. Noise Component

The sources of noise during construction phase at the project are land clearing activity, dam structure development, and development of multifunction dam supporting facilities, apart from that, the activities of vehicles which transport the project materials and other routine activities are also contributing noise to the environment. The measurement of noise level was conducted on October 2003, to compare the existing environment condition at the study area.

On some measurement locations as on the acces road to the project location, the noise level (67.8 up to 68.8 dB) is above the noise quality standard for settlement area (55 db). The average is between 56,4 up to 57,9 dB and still below the noise level quality standard for recreation area (73 dB).

Table 5.8 Noise Level at Petang Subdistrict

Noise Parameter	Distance m	Unit dB	Location I			Location II		
			min	max	*R*	min	max	*R*
	0	dB	46.4	68.8	57.6	46.4	68.8	57.6
(L_{TMS})-Day	5	dB	45.2	68.2	56.7	45.2	68.2	56.7
	10	dB	45.1	67.8	56.45	45.1	67.8	56.45

The noise level profile at some locations in the area show that the noise level which is still below the environment quality standard for public area. The measurement is using Precision Sound Level Meter type 2.232 which has main equipment of a microphone, amplifier, detector with frequency and time variable. The measurements are conducted on three spots, the distances of 0 meter, 5 meter and 20 meter from the noise spot and conducted within two time intervals.

Table 5.9 Noise Level at Payangan Subdistrict

Noise Parameter	Distance m	Unit dB	Location I			Location II		
			min	max	*R*	min	max	*R*
	0	dB	46.4	68.8	57.6	49.4	68.8	59.1
(L_{TMS})-Day	5	dB	46.2	68.2	57.2	48.2	68.2	58.2
	10	dB	46.1	67.8	56.95	48.1	67.8	57.95

Source : The Result of Measurement on August 2003

The noise parameter at the project location does not effect community's activity surround it, due to the settlement is situated quite far from the location. The average value during the measurement is still below the noise parameter quality standard limit based on Decree of Minister of Environment No 48/Men-LH/11/1996 date of November 28th, 1996 considering Noise Level Standard for commerce and service (70 dB), recreation area (73 dB), harbour (70 dB), and industry (70 dB) however the values are better than the noise quality standard for settlement, school, hospital, and house of worship (55 dB) and green open area (50 dB).

5.1.3 Physiography

Physiography is land formings on the earth surface, by the land or below the water surface, which differs based on forming process and it evolution (LREPP II part C, 1990). From the definition above, so that the physiography is closely related to the condition and geology, stratigraphy, litology, climate, organism, relief (topography) and land forming above it. Bali Island is an island which stretches out from the west – east, geomorphologically it can be divided into north aluvial land physiography, physiography of volcanoes complex which stretch out at the middle part, south aluvial land physiography and limestone hills physiography. Ayung River Multifunction Dam Project is situated at the physiography of volcanoes complex and South aluvial land physiography. This physiography is covered by tuff and lava sedimentation from Beratan, Buyan a dn Batur.

1. Morphology

Topography which is a condition of altitude of a region on the earth's surface, based on the difference of altitude and slope declivity. According to the definition above, topography of Bali Island can be differed into two parts, those are north and south part. The topography of north part is in a steeper condition with narrow low land compared with the south part topography. Ayung River which is on the southern topography, has the upstream at the southern of Beratan Mountain and South West of Batur Mountain, with a very steep slope. The upstream of this river has some estuaries with parallel branching pattern. Generally, this river form can be divided into two parts, those are one with V shape at the upstream and the other is with U shape at the downstream. This condition leads to the topography of upstream of Ayung river basin has a very steep slope declivity (> 75 %) with the back or narrow ***lungur volcan.*** On the south (downstream) of ***lungur volcan,*** it gets wider with slighter slope on the middle and flat on the downstream.

According to its morphology, Ayung river basin can be divided into three parts:

- Upstream area is hilly and mountanious area, with very complex slope declivity between 8 - > 75 %.
- Middle part is lower hilly area with declivity between 6 – 30 %.
- At the downstream area, the slope is slighter and wavy, with declivity between 3 – 8 %.

Topographically, Ayung Dam site plan is located at the existing slope declivity or valley approximately of 70^0. At the Dam Axle, the steeply slope on its right and left side have the declivity of > 70^0. The elevation of riverbed at the project site based on the mapping result is 170 meter above the sea surface with meandering flow. Generally, the dam plan has a shape with narrow pool and elevation approximately of 185 meter and then gets wider on the upper elevation, therefore the obtained storage capacity curve is inclined to be vertical at the bottom and relatively horizontal at the top.

Ayung River has meandering shape, as an indication that it has a relatively mature stadia. But the relatively steep area's morphology, also the sedimentation of river terrace in form of gravel and boulder which spread at the top of the steeply sloping riverbanks indicates that Ayung has experiencing rejuvination or elevation due to continuous volcanic process at this area. Due to the area has been rejuvinated, Ayung River has swift stream and very erosive, however the sedimentation of river's gravel boulder alluvial is oftenly found here.

2. Geology

According to Bali geology map 1971, it is recognized that Ayung river basin is covered with tuff and lava sedimentation from Beratan, Buyan and Batur which are in the quarter age. Based on the field monitoring result, gravels are from Beratan, Buyan and Batur which consist of tuff, volcanic dust, breccia and pumice.
Volcanic dust and pumice are kind of dominant volcanic rocks at the upstream, from Plaga to the peak of Catur Mountain. Beside that, from the peak of Catur Mountain to the east, pumice is found at Banjar Lampu, Penulisan Mountain, Kintamani, and Kalang Anyar.
At the distance of Petang and Getsan Village, it is dominated by volcanics, such as tuff, lapili and *sinder*. Soft tuff is beneath Banjar Buangga.
Breccia which has been corrosion, will be dark brown, while breccia which has not been corrosion is greenish dark grey. This breccia is dominated by cube boulder to round cube boulder. The corrosion lapili becomes yellowish brown, while for those which has not corrosion yet are blueish grey.
Specifically, technical geology research for Ayung river basin which was conducted by P3SA in 1981 showed that generally the study area is covered by non compact river sedimentation:

- Deposit Terracce Sedimentation
- New and old river alluvium

While for basic boulders is volcanic breccia, which is generally rather compact. In this location it is not anymore developed, because the reservoir is too small, and the foundation of dam boulders are relatively free and thick (10 m).
On a relatively steep slope from the riverbed, generally, there are a lot of *Tuff Breccia* enclosed which are not really compact or moderate compactness, they are generally light brown to dark brown or black if it is corrosion, it is a mixture of *tuff* period and fragments of *andesith*, *lapili* and *tuff* it self which entirely consolidated as *Tuff Breccia* boulder.

The measure of breccia fragment has many variations, from 2 cm to bolder andesit 0,5 cm, Subangular and relatively hard. Then as the consequence of the hardness differences between the hard "breccia fragment" and in the tufa period which does not get the compact cement it leads to broken *drilling core.*

From the Permeability Test through drilling hole and "Water Pressure Test" method with maximum pressure of 2kg/cm^2, and also "Pneumatic Air Packer" which is used to be packer

stopper, it is able to obtain the number of water passing coefficient number of 2,1* 10^{-4} cm/sec to 7,3* 10^{-4} cm/sec with lugeon of 20 to 37.

Sandy Breccia is found under the *Tuff Breccia*. This boulder is never has been disclosed on the earth surface, it only can be known through drilling. It is dark grey, rather compact, generally, is in form of rough sized sand, and average size of andesith subangular is 2cm. From the drilling data, it is not able to get the indication of rocks layering system, and relation between *Tuff Breccia* and *Sandy Breccia* is non harmonious relation.

From the *permeability test* with water pressure test method as it is done to *Tuff Breccia*, the water passing coefficient number is between 1,4* 10^{-4} cm/ sec to 2,4* 10^{-4} cm/sec, with lugeon between 17 until 26.

According to the geology age comparable, the sandy grave rocks can be equal to the *Jembrana breccia* rock formation with the age of under the Below Quarters, however the *Tuff Brecia* is as the result of Upper Quarters volcanic activity. On the top of the *Tuff Breccia*, can be found the *over burden* in the form of soft black clay, and are often mixed with the *gravel* and *bolder andesit*, which makes the *terrace deposit*. From the "*Falling Head Test*" data, the water passing number at the over burden is between 2, 2*10^{-5} cm/sec to 7, 1*10^{-5} cm/sec. While based on the laboratory test data, with the example that is taken from the drilling hole BLD1 and test pit D1, can be obtained the result as shown on Table 5.10.

Table 5.10 The summary of Laboratory Test at Ayung Dam Plan Location

No	description	symbol	unit	Hole No BLD 1 (0,5-1,00	Test Pit No D 1 (0,5-1,00)
1	Grain size				
	- Clay		%	39	37
	- Slit		%	45	44
	- Sand		%	14	16
	- Gravel		%	2	3
2	Specific Gravity	G	-	2.686	2.701
3	Natural Water Contect	Wn	%	40.54	39.5
4	Natural Uni Weight	t	Ton/m³	1.792	1.764
5	Dry Unit Weight	d	Ton/m³	1.006	1.067
6	Liquid Limit	LL	%	62.2	65.1
7	Plactic Limit	PL	%	39.55	41.47
8	Placticity Index	PI	%	22.65	23.63
9	Coefficien of Permeability	k	cm/sec	3.889×10^{-7}	2.512×10^{-7}
10	Triaxial Compression (CU)				
	- Internal friction angle		$\ldots\ldots^{0}$	17	18.5
	- Cohession	C	Kg/cm^2	0.4	0.25
11	Standart Proctor for Compaction				
	-OMC (Optimum Moin-sture Contect	W_{ome}	%	39.05	39.35
	-Maximum Dry Density	$_{dmax}$	T/m^3	1.292	1.291

Source : PT. Purnajsa Bima Pratama 2005

In the middle of the river, hard boulder andesith are found in size of 1/2 up to 2 meter, in average of 0.6 meter, and gravel andesith in size of 2 – 5 cm. Sand is very rarely found in the river sedimentation. The river thickness is very thin, or approximately 1 m, even less than that. In the research, there is no geology structure weakening eventhough the existing steeply sloping riverbank is relatively steep. Even at the steeply sloping riverbank, there is no slide or potential area for slide.

3. Type of Soil

According to the Bali investigation soil map 1970, Ayung river basin consists of Andosols (Andisols), Latosols (Inceptisols and Alfisols) and Regosols (Entisols). Based on the field monitoring's result, Andisols is dominant at the upstream, where this soil is developed from volcanic dust and pumice. Inceprisols and Alfisol are dominantly at the middle part of Ayung river basin, while Entisols is at the area nearby the river and at th coastal area. Soil classification up to and including sub group level is shown on Table 5.11.

Table 5.11 Soil Classification Based On Soil Taxonomy

Ordo	Sub Ordo	Group	Sub Group
Andisols	Vitrands	Udivitrands	Typic Udipitrands
	Udands	Hapludands	Vitric Hapludands
			Typic Hapludands
Inceptisols	Aquepts	Petraquepts	Plintic Petraquepts
			Typic Petraquepts
		Endoaquepts	Typic Endoaquepts
	Udepts	Eutrudepts	Andic Eutrudepts
			Typic Eutrudepts
		Dystrudepts	Andic Dystrudepts
			Aquic Dystrudepts
			Typic Dystrudepts
Alfisols	Aqualfs	Plintaqualfs	Typic Plintaqualfs
		Endoaqualfs	Typic Plintaqualfs
	udalfs	Hapludalfs	Typic Hapludalfs
Entisols	Aquents	Psammaquents	Typic Psammaquents
		Pluvaquents	Typic Pluvaquents
	Psamments	Udipsamments	Typic Udipsamments
	Pluvents	Udipluvents	Typic Udipluvents

Table shows that there are 4 ordos of soil, 9 sub ordos, 15 groups, and 20 sub groups. From those 4 soil ordos, two of them are very sensitive to the erosion, those are Entisols and Andisols. Inceptisols is more stable compared with Entisols and Andisols. Alfisols is the most stable among those ordos. Andisols (Typic Udipitrands) is Andisols' soil which have andic characteristic, with water retention of 1500 k Pa, less than 15 % for air dry soil. This soil is found on upstream humidity regime, that is a humidity regime with soil's humidity control section which its part is randomly not dry for 90 cummulative days in normal years. Vitric Hapludands is andisols soil which has udik humidity regime, and on group level, such soil is out of Andisols group classification. On sub group level, vitric characteristic is soil which has water retention of 1500 kPa less than 15 % for air dry land and less than 30 % for non air dry sample, and also it has andic characteristic between 25 – 100 m depth from the land surface. Typic Haplulands is another haplulands which are not suitable or out of the above sub group's qualification or other sub groups.

Inceptisol is the soil which have been developed, indicated by the *horison kambik*. On sub ordo level, this soil consists of aquepts and udepts. Aquepts is aquik soil, while udepts is soil which has udik humidity regime. On aquepts group level, it consists of two types of soil, petraquepts and endoaquepts. Petraquepts is soil which has plintit horizon or segmented horison. Udeptds consists of eutrudep and Dystrudepts. Eutrudepts is soil which has base saturation more than 60 %.

Alfisol is soil which has argilic horizon already. It consists of two sub ordos, Aquafs and Udalfs. Aqualfs is alfisol which has aquik characteristic, while udalfs is Alfisols sub ordo which has udik humidity regime. Aqualf consists of two groups, Plintaqualfs and Endoaqualfs. Plintaqualfs is soil with plintit horizon or segmented horison. Udalfs have one group, Hapludalfs, with typic Hapludalfs as its sub group.

Entisols is young soil which have not been experiencing horizon development, indicated by none of land structure. This soil consists of Aquents, psamments and pluvents subordos. Aquents is Aquik antisols, psamments is soil with sand master material which has not corrosion yet. Pluvaquents is entisol soil which is the deeper the land the lesser the organic substances in it. On the level of aquents group, it consists of Psammaquents and Pluvaquents. Psamaquent is aquik entisol with sand texture. Pluvaquents is aquik soil which is the deeper the land the lesser organic substances in it.

4. Erosion

Erosion is an event of removal or soil transporting from a certain place to the somewhere else by the natural media. Erosion is a natural process which cannot or be difficult to be disappeared, especially for the exerted land for agricultures. Things that can be done is exerting that the erosion will not be more than land forming, in other words it is exerted that erosion is not more than the land formed by master substance corrosion.

The magnitude of an erosion in a particular place is affected by some factors. Those are rainfall intensity, land erodibility, slope declivity, length of slope, sort of land usage and conservation acts toward the existing land and water. Basec on the factors above, therefore the erosion prediction is calculated according to the determination of the erosion with the formula below:

$A = K * R * L * S * C * P$

Where : A = magnitude of erosion Ton/ha/year
K = land erodibility
R = rain erosifity
L = length of slope
S = side slope
C = Crop factor
P = Management Factor

To be able to implement this formula, therefore the research area needs to be applied a land unit based on the similarity of the factors above. In this case, the most dominant factors in determining the magnitude of erosion are slope factor and land use factor.

In accordance to the Mardani and Rusna research (1994), there are 7 kinds of main land use and 7 class of slope. Those seven land uses are rice field, dry land, settlement, mixed plnatation, coffee plantation, bushes and forest, while 7 types of slope classes are 0 - 3 %, 3 - 8 %, 8 – 15 %, 15 - 256 %, 25 – 40 %, 40 - 65 % and > 65 %. From the combination of land use and slope classes, there are 34 land units at the entire Ayung river basin. The magnitude of erosion prediction at the entire Ayung river basin is shown on Table 5.12.

Table 5.12 Magnitude of Erosion at Ayung river basin

Land Unit	Slope Class (%)	Land Use	Erosi ton/ha/year	EDP ton/ha/year
1	0 - 3	Settlement	33,38	58,14
2	0 - 3	Rice field	0,06	51,30
3	0 - 3	Mixed Plantation	26,14	54,72
4	8 -15	Rice field	0,74	51,30
5	0 - 3	Dry land	2,37	58,14
6	0 - 3	Bush	42,35	41,04
7	3 - 8	Settlement	10,58	52,50
8	3 - 8	Rice field	0,12	51,30
9	3 - 8	Dry land	6,47	41,04
10	3 - 8	Mixed plantation	59,30	42,00
11	>65	Thick forest	40,87	42,00
12	25 - 45	Rice field	3,86	49,60
13	8 -15	Settlement	248,74	24,50
14	8 -15	Mixed plantation	86,71	24,50
15	>65	Mixed plantation	658,18	42,00
16	15 -25	Settlement	649,22	42,00
17	15 -25	Dry land	324,08	42,00
18	8 -15	Dry land	47,01	42,00
19	40 - 65	Dry land	223,16	42,00
20	15 -25	Rice field	4,67	52,50
21	40 - 65	Mixed Plantation	1051,95	49,00
22	25 - 45	Dry land	1178,59	45,00
23	25 - 45	coffee	633,13	42,00
24	40 - 65	Thick forest	70,76	38,50
25	25 - 45	Mixed plantation	548,41	39,20
26	40 - 65	Coffee	1528,36	52,50
27	25 - 45	Thick forest	39,64	21,00
28	15 -25	Mixed Plantation	611,54	24,50
29	15 -25	Mixed Plantation	28,12	38,50
30	3 - 8	Coffee	13,68	31,50
31	40 - 65	Forest	8,32	39,20
32	>65	Forest	7,85	39,20
33	8 - 15	Coffee	90,33	42,00
34	25 -40	Forest	12,50	42,00