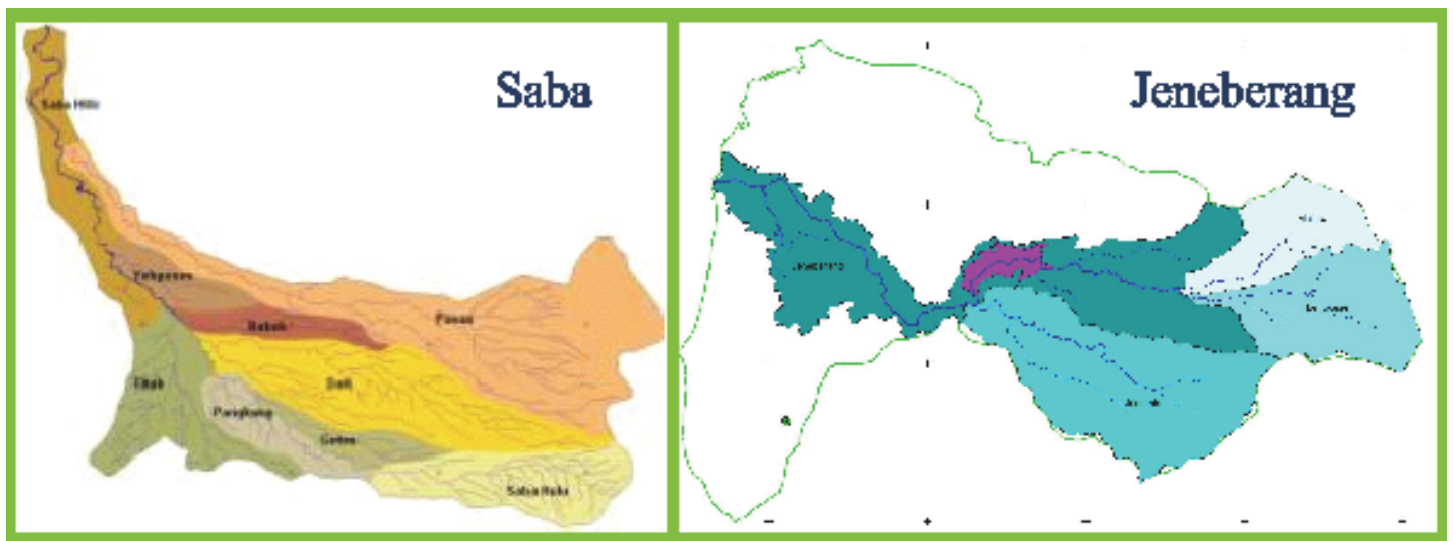


# FINAL PROCEEDINGS

## BALI WORKSHOP ON NURTURING LOCAL WISDOMS FOR FUTURABLE SOCIETY

Bali-Indonesia, September 5-6, 2012



Edited by:

Budi I. Setiawan, Masakazu Mizutani, Tsugihiko Watanabe,  
Gardjito, Satyanto K. Saptomo, Hisaaki Kato



Water Management Project of Research Institute for Humanity and Nature  
in Collaboration with  
Bogor Agricultural University, Hasanuddin University and Udayana University  
2012





# **Final proceedings of BALI WORKSHOP ON NURTURING LOCAL WISDOMS FOR FUTURABLE SOCIETY**

**Bali, Indonesia, September 5-6, 2012**

## **Editors:**

**Budi I. Setiawan  
Masakazu Mizutani  
Tsugihiko Watanabe  
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**Water Management Project(C-09-Init) of  
Research Institute for Humanity and Nature  
in Collaboration with  
Bogor Agricultural University,  
Hasanuddin University and Udayana University  
2012**



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- 4) Fadli, STP, MSi
- 5) Iin Yusliana, STP
- 6) Ida Bagus K Santika

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2. Assessing Climate and Landuse Changes on Water Resources in Jeneberang Watershed (**Fadli Irsyad**)
3. Assessing Climate and Landuse Changes on Water Resources in Saba Watershed (**Sutoyo**)

**The 1st day (Sep. 5th, 2012)**



**Welcome Address**  
**Dean of Faculty of Agricultural Technology**  
**Bogor Agricultural University**

The Honorable Local Government Heads of Bali Province  
The Honorable Local Government Heads of South Sulawesi Province  
The Honorable Dr. Tsugihiko Watanabe and Team  
The Honorable Prof. Dr. Budi I. Setiawan and Team, and  
All Participants of Bali Workshop.

Welcome to Pulau Dewata (Island of Gods), Bali.

First of all in this occasion let us be grateful to Allah s.w.t. who gives the opportunity for us to get together in this very important meeting. I also would like to thank to all of you who participate in this activity, either from the Local Government of Bali and South Sulawesi Provinces, Bogor Agricultural University Team, Hasanuddin University Team, or Udayana University Team; and of course thank to all friends from the Research Institute for Humanity and Nature, Utsunomiya University, Kanazawa University, Ritsumeikan University, Osaka Prefecture University, Ehime University dan Nihon Fukushi University in Japan.

Research collaboration involving various parties like what we are doing so far is a very good example of activity. Moreover, the topic that we raise is 'local wisdoms for futurable society', which has been proven to be very beneficial for sustainable farming activity for the local farmers. Nevertheless, we hope that the local wisdoms could be raised to a higher level so that it could be more beneficial for the local society; and better yet if it could be applied in other locations.

In the subsequent development, we hope that this activity not only results in applicable technology but also strengthen human resources that can implement and even develop further the technology. The strengthening of the human resources is not only for the implementers of this activity but also for government officials and even farmer society itself, of course at adjusted level.

I do hope that this activity could be conducted without any significant obstacle and be fruitful as we all hope. I also hope that this activity could be conducted sustainably so that we could guard the results up to the final destination that we all agreed.

Finally, I wish you all a very fruitful workshop and enjoy the beauty and hospitality of the society in *Pulau Dewata*, Bali.

Sam Herodian

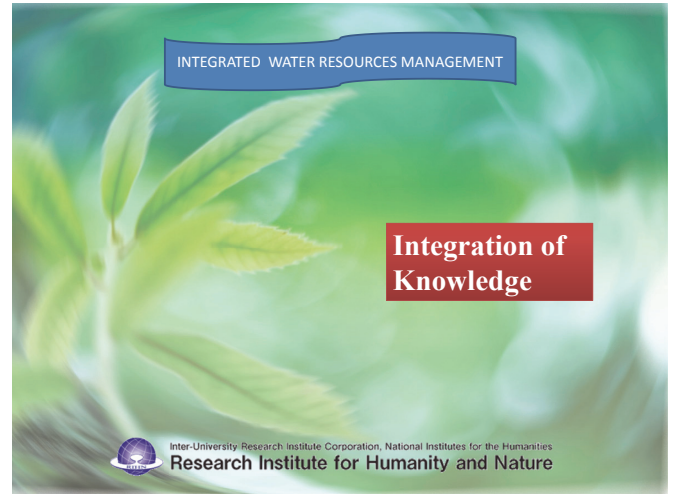




**RIHN**  
Research Institute for Humanity and Nature  
Water Management Project (C-09-Init)

**Environmental Humanities of the Earth System**  
—Introducing RIHN—

Bali Workshop on Nurturing Local Wisdoms for Sustainable Society  
2012/95-6  
TACHIMOTO Narifumi 立本成文



**The Philosophy of RIHN**

- Our basic understanding is that the root of so-called environmental problems lies in **human culture** in the broadest sense of the word, that is, in the human attempt to control nature.
- In addressing environmental problems, we therefore examine humanity in the midst of nature. Its English name aims to fulfill this mission to endeavor to understand the manifold **interactions between humanity and nature**. ⇒ relationship, pertalian, つながり (existence of tsuna=tali)

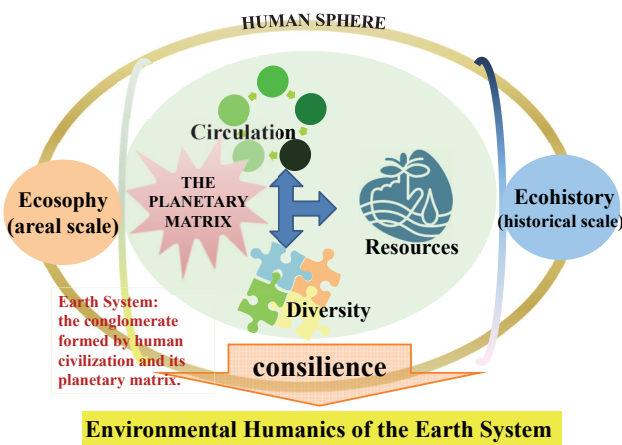
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総合地球環境学研究所

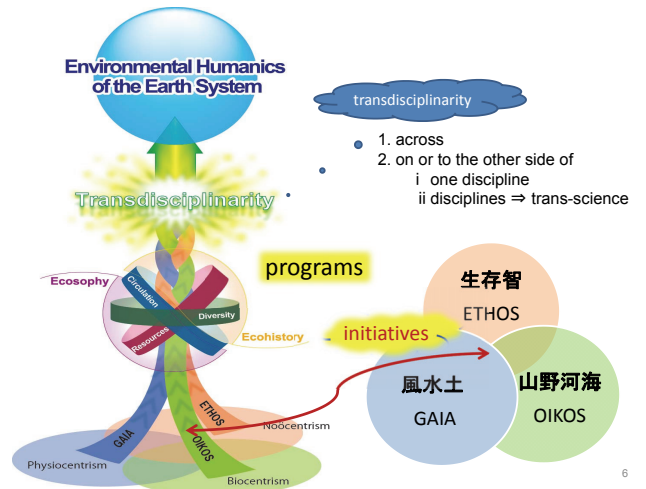
**Institute for Global Environmental Studies**  
⇒ **Environmental Humanities of the Earth System**  
(officially) **Research Institute for Humanity and Nature**  
**Lembaga Studi Terpadu Lingkungan Sedunia**

In order to contribute to solve global environmental problems, at RIHN, we use the term **futurability** (future + potential), which combines the ideas of 'future' and 'possibility.' This term has been used in preference to 'sustainability,' in order to express a wider range of possibility in future development for the survival of the human race.

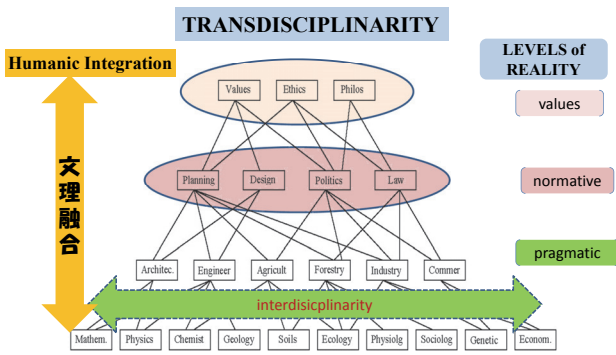
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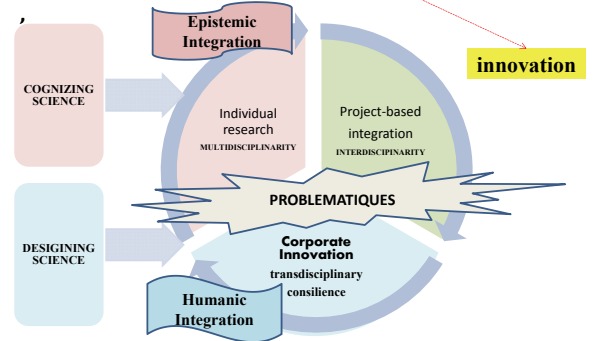


Graph 3. Transdiscipline. Reading the graph from bottom to top, the lower level refers to what exists. The second level to what we are capable of doing. The third to what we want to do. And finally, the top level refers to what we must do, or rather, how to do what we want to do. In other words, we travel from an empirical level, towards a purposive or pragmatic level, continuing to a normative level, and finishing at a value level. Any multiple vertical relations including all four levels, defines a transdisciplinary action.

(Mac-Neef 2005: 9 with some additions)

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**co-research:** recognizing singularities  
working synergistically  
innovative synthesis



## わける・つなぐ・くくる

to divide / to connect / to integrate

- わける論理 dividing logic⇒induction  
differentiation, analysis  
recognizing singularities
- つなぐ論理 connecting logic⇒abduction  
linkage, hypothesis  
working synergistically
- くくる論理 integrating logic⇒deduction  
summarization, synthesis  
integrative synthesis

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## Loci of Integration

In your brain!

An integrating synthesis is not achieved through the accumulation of different brains. It must occur **inside each of the brains**. (Max-Neef 2005: 5)

Singular parts, sharing the common world,  
**Weltanschauung, mandala or framework for togetherness, not for identity**



## The Earth System

$E = (N, H)$  (Schellnhuber 1999)

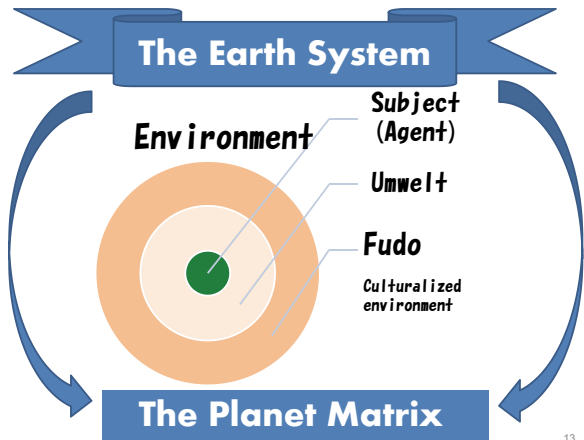
when  $N = (a,b,c,...)$ ;  $H = (A,S)$

(N) atmosphere; biosphere; cryosphere;

...

(H) A (anthroposphere); S (global subject)

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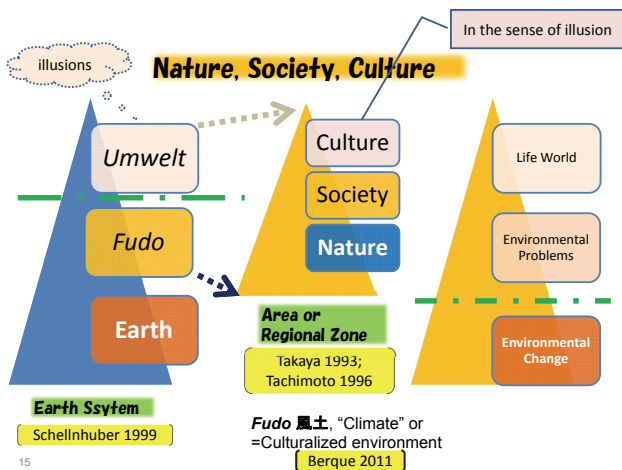


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## Subjective surroundings

- *Environment* in English ← French
- *Milieu* (center, surroundings); *environ* (about, around, peripheral); *ambiance* (atmosphere)
- *Umgebung* ← umgeben, in German
- *Umwelt* (since c.1800) → 環世界 Jacob von Uexkull  
Streifzüge durch die Umwelten von Tieren und Menschen  
⇒ the world lived with innate “illusions”
- *Environment* is a ‘subjective’ world or *Umwelt*.  
Human environment is different from *Umwelt*:  
Human-beings’ *Umwelt* + **mind, language, symbol or culture** ⇒ human **life world**

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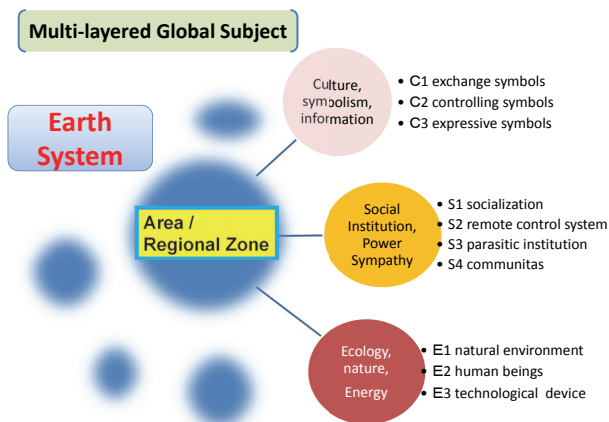


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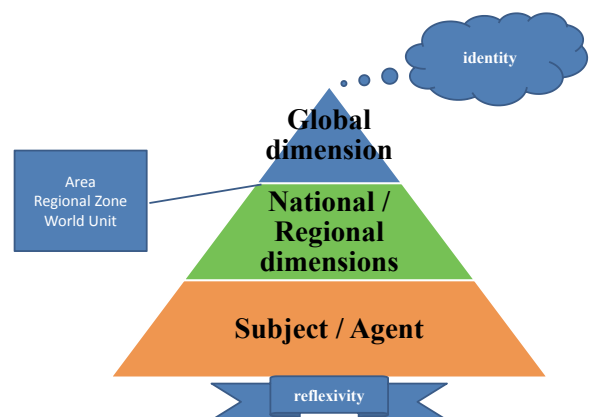
## Fu-do

- 風土 angin + tanah (butta, Mak.)
- 風水 angin + air (je’ne’, Mak.; uwa, Bugis), *fengsui*
- Climate = iklim, suasana, udara
- Tanah air 土 + 水
- Bumi, daratan 大地、陸地
- Wilayah, daerah, kawasan, tempat 地域  
area, region ⇒ **regional zone 地域圈**
- Lingkungan ~ lilit, keliling, gulung, lingkar
- 風水土 *Fu-sui-do* ~ angin + air + tanah  
*Gaia*

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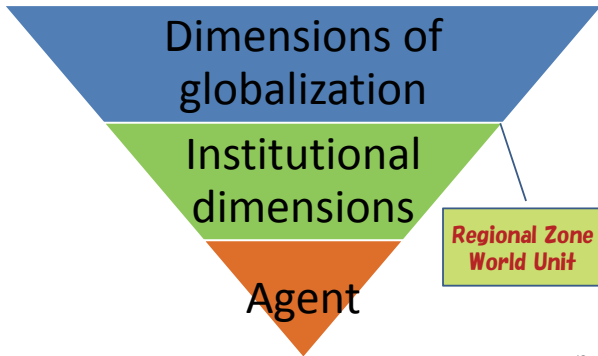


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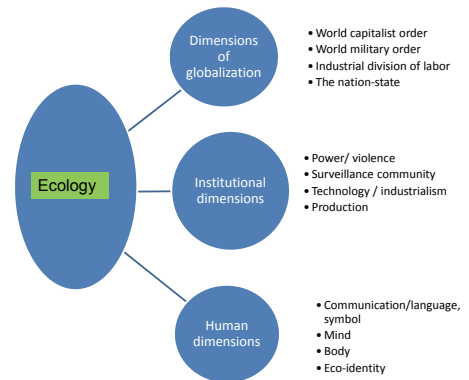


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Figuration of AREA (World Unit) as a medium of dimensions in three levels



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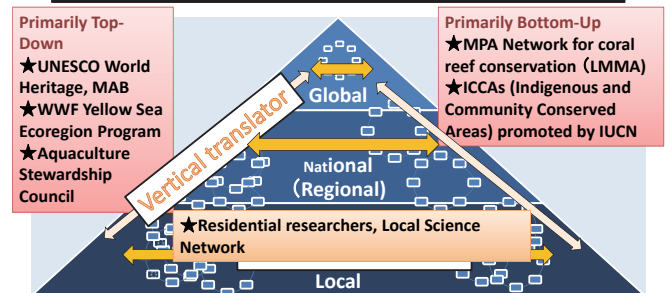
Introducing another initiative-oriented research project:  
**Creation and Sustainable Governance of New Commons through Formation of Integrated Local Environmental Knowledge**

**ILEK PROJECT 2012-**

PROJECT LEADER: **SATO TETSU**

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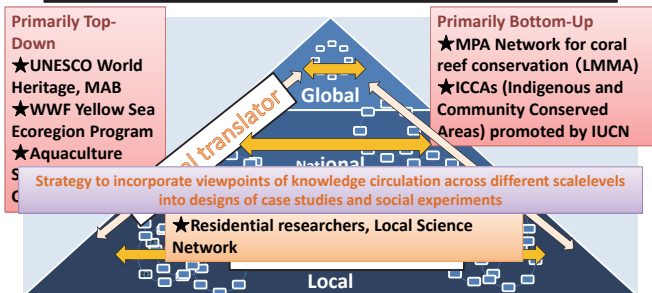
**Collection and Analyses for Cases of Multi-scale Translators**



•knowledge produced in multiple scales blended via circulation across different levels  
 •dynamically producing and circulating multi-scale knowledge used by stakeholders at different levels for multi-scale adaptive governance

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**Collection and Analyses for Cases of Multi-scale Translators**

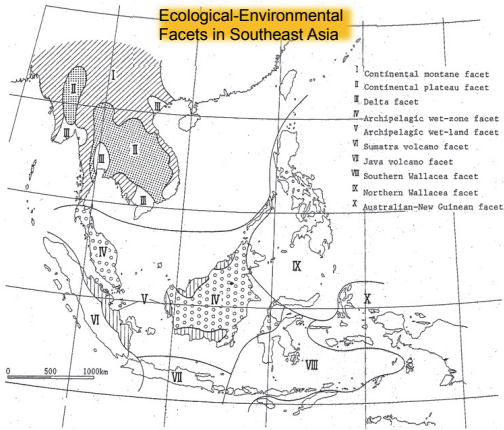


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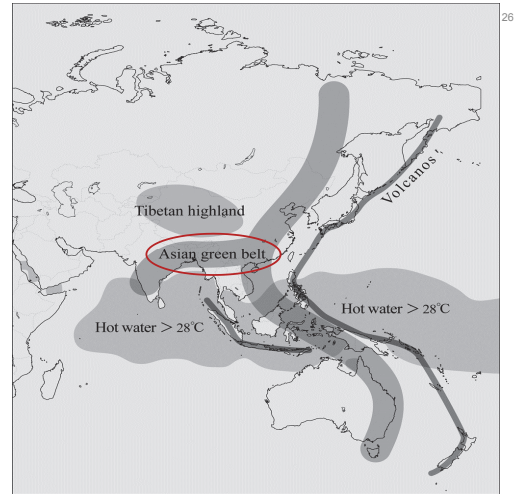
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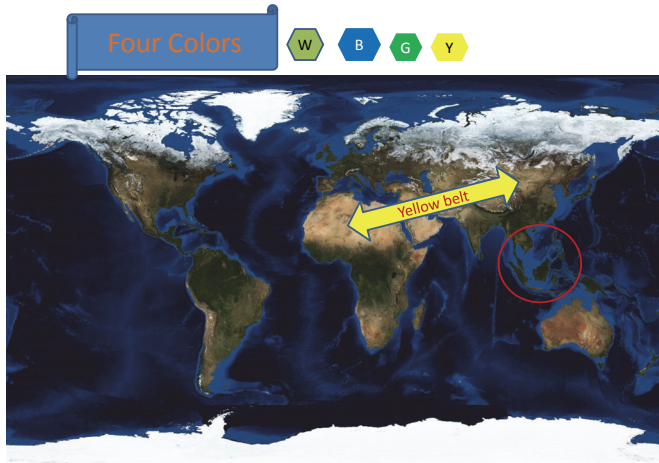
Inter-University Research Institute Corporation, National Institutes for the Humanities  
**Research Institute for Humanity and Nature**



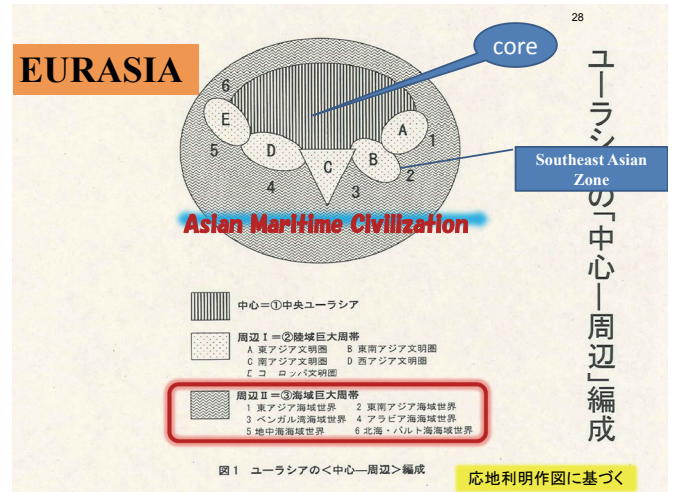
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**Objective Earth System**

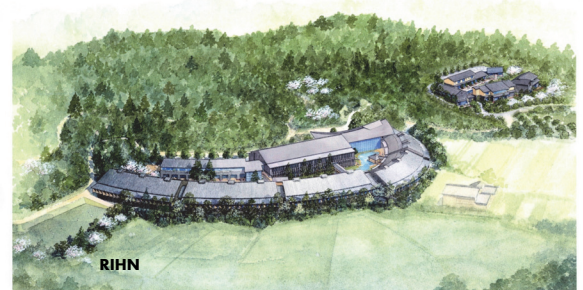


**Subjective Life-World**

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**Integrity!**

the quality of having strong moral principles  
the state of being whole  
the condition of being unified or sound in construction



Terima kasih atas kerjasama dan bantuan daripada pihak IPB, Unhas, dan Unud untuk Water Management Project

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# THE CONDITION OF CLIMATE, GEOMORPHOLOGY, AND TECTONIC IN BALI ISLAND

By:

I Wayan Suardana, SE,MM.

Head of Meteorological, Climatological, and Geophysical Agency Region III Denpasar

## ABSTRAK

Development planning in Province of Bali need comprehensive information related to the condition of natural and physical environment characteristics, such as climate, geomorphology, and tectonics conditions. Bali climate influenced by monsoon activity, so in Bali has two seasons, dry season and rainy season punctuated the transition season (pancaroba). Bali island has geomorphological conditions and varied landforms units, namely landforms origin of: volcanic, structural, denudasional, fluvial, marine, eolian, and solutional. The main tectonic influence in Bali island is dominated by the activity of the collision between the Indo-Australian and EuroAsia plate in the southern Bali island. This active plate collision caused epicenter in subduction zones as well as the epicenter of Bali back arc thrusting in the north island of Bali.

## 1. INTRODUCTION

Bali island, geographically located between  $114^{\circ} 25'$  ;  $115^{\circ} 43'$  E, and  $8^{\circ} 03'$  ;  $8^{\circ} 51'$  S. The total area of Bali province as a whole to achieve  $5.636,66 \text{ km}^2$  or 0,29 percent of the vast Indonesian archipelago. Bali province is divided into eight regency and one city: Jembrana, Tabanan, Badung, Gianyar, Klungkung, Bangli, Buleleng, Karangasem, and Kota Denpasar. Geographically, the island boundaries are as follows: in the north bordering the Sea of Bali, on the east by the Lombok Strait, on the south by the Indian Ocean, and on the west bordering the Strait of Bali.

Bali province have the human resources to support development. Based on the registration BPS Bali (2010), in 2009 recorded a population of 3,471,952 people in Bali as consisting of 1,739,526 people (50.10%) male population, and 1,732,426 people (49.90%) of the female population. The population in 2009 rose 1.82 percent from 3,409,845 inhabitants. With an area of  $5636.66 \text{ km}^2$ , the population density reaches  $616 \text{ jiwa/km}^2$ .

Besides having the potential of human resources, the province of Bali also has abundant natural resources. Land in the province of Bali has been largely used for agricultural activities, tourism, and housing. In addition, other natural resources are owned by forestry and plantation resource potential to be developed to support development in the province of Bali. Implementation of the management areas of the Province of Bali should be based on good planning. Planning is necessary for comprehensive information related to the natural conditions on the island of Bali. Some important information are the climatic conditions, geomorphology, and tectonics. The purpose of this paper is to identify the characteristics of the physical environment to support regional development in the province of Bali.

## 2. CLIMATE CONDITION

Area of tropical Bali in general, influenced by the monsoon activity. So, in Bali island have dry season and rainy season. June to September, winds blowing from Australia that do not contain water vapor, resulting in the dry season in Bali. While in December to March, the wind was blowing a lot of water vapor coming from Asia, resulting in the rainy season in Bali (Daryono dkk., 2003).

Distribution of annual rainfall shows in every year, the highlands of Bali experienced a high rainfall. Rainfall above 3,000 mm occur in three highland areas, such as Pupuan (3018 mm), Baturiti (3191 mm), and Besakih (3775 mm). The highest annual rainfall occurred in Bali island at Besakih of

3775 mm, while the lowest annual rainfall of 494 mm occurred in Sendang. Based on these data the wettest areas in Bali island is Besakih and driest area is Sendang (Figure 1).

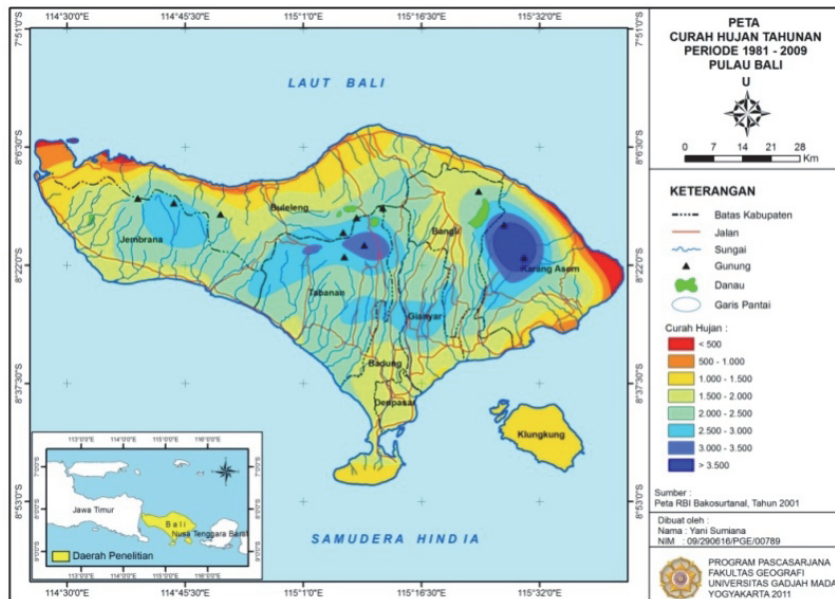


Figure 1. Distribution of annual rainfall in Bali island (Sumiana, 2012)

Area that has an annual rainfall between 1,000 and 3,000 mm spread in the transition area between the highlands and the coast. Transitional area between high and low plateau is situated at an altitude between 100 to 500 meters. Area that has an annual rainfall between 1,000 and 3,000 mm spread in some areas such as: Sukasada, Busungbiu, Bengkala, Bajera, Buruan, Kerambitan, Abiansemal, Kapal, Gianyar, Tampaksiring, Ubud, Bangli, Amlapura, Kahang-Kahang, and Bebandem.

Distribution of annual rainfall can also be recognized that these areas have low rainfall. Low rainfall of less than 1,000 mm / yr occurred in some areas of the north coast of Bali, such as: Celukanbawang (879 mm), Pejarakan (824 mm), and Sendang (494 mm). Based on the annual rainfall data, it appears that Sendang is the driest area in Bali (Sumiana, 2012).

### 3. CONDITION OF GEOMORPHOLOGY

Topography is the study on the shape the earth's surface. Generally, it presents a surface relief topography, three-dimensional model, and identification of the type of land. The condition of Bali island topography as shown in Figure 2, which is divided into three zones: zone of southern Bali, the central and northern zones of Bali (Arimuhaimin, 2010).

First, the topography of Bali's southern zone consists of a limestone plateau-plateau is formed by the removal of coastal and alluvial plain that is widely available around the Nusa Dua area and near the estuaries. On the rocky south coast limestone cliffs and there are many forms of abrasion forming very steep slopes. There are many outcrops of limestone hills of coral reef limestone rocks that contain fossils of the formation Palasari. Steep rugged coast, which occurs due to strong sea abrasion is rock of volcanic breccia. Beachridges beach and sanddunes located in the south coast of Bali.

Second, the middle area including young volcanic regions are Mount Agung, Mount Batur, Mount Lessung, and Mount Bratan. Steeply sloping and the appearance of tectonic lakes such as: Lake Batur, Beratan, Buyan and Tamblingan.



Figure 2. Physiography of Bali island according to data from NASA SRTM Team

Third, the area north of the alluvial coast of Bali with a slope of between 0-2% with a north south direction. In the southern part consists of hills with a height of 100-500 meters with a slope of 2-15%. In the area there is a fault Pulaki east west which already contains the alluvium material. There are also limestone hills with a height of 0-500 m and slope of 15-40%. Low hills composed of Tertiary age rocks are folded, the tertiary rocks are often covered by young volcanic deposits exposed.

Geomorphology is a study of the Earth's surface and the processes that occur to them. Broadly, the landforms associated with erosion of hard rock, but the form of construction is formed by the debris of rocks, and sometimes by the behavior of organisms in which they live. In Bali there are several types of landforms, such as: at landforms origin of fluvial, volcanic, aeoliomarine, denudational, and fluviomarine.

### 3.1 Landforms Origin of Volcanic

Landforms origin of volcanic origin are sourced from the land formed by volcanic activity, when the eruption appeared materials such as lava, agglomerate, bombs, lapilli, sand and tuffa. Based on the relief and topography, in the middle of the island lie the mountains that extends from west to east and between these mountains there is the cluster of volcanic Mount Batur and Mount Agung volcano and inactive like Mount Merbuk, Mount Patas, and Mount Seraya. The existence of these mountains cause Bali is divided into 2 (two) unequal parts namely North Bali with a narrow lowland and less sloping, and South Bali with extensive lowland and sloping.

Relief smooth to rough mountains, its rocks composed of volcanic deposits of Mount Buyan - Beratan and Mount Batur in the form of lava that is compact and volcanic rocks of Mount Agung in the form of tufa and lava that are nearly loose sediment. Surface erosion rate is small to large, while abrasion is still active for fine to medium. Northern and southeastern slopes of Mount Agung and Mount Batur approximately a disaster-prone areas. In some places, especially around the river valleys that disgorge on Mount Agung is the danger area, the cold lava flow with some of the areas where landslides are likely. Lava flow from Mount Agung spread on the beach north of the village until the village of Kubu Tianyar.

### **3.2 Landforms Origin of Structural**

Landforms origin of structural due to tectonic processes, these processes include the uplift, subsidence, and the folding of the crust, thus forming folds and faults. Then there was the usual horizontal structure is the original structure before experiencing the change. Some principles that need to be considered for the interpretation and identification of the underlying shape of the structure is the difference in durability, the nature of the break-out of water, the flow pattern in the structure formation. This layer causes the difference of positive and negative relief, a positive result in the form of a mountain or a hill while the negative result in the shape of the valley or basin. In Bali, the fault is located in Angseri village, Tabanan regency causes the hot springs, in the district of Banjar Buleleng namely in the area there are also hot water. This is because under a mountain of rocks that are impermeable or Watukaru impenetrable rock magma, geothermal energy out of the plates in the two regions.

### **3.3 Landforms Origin of Denudational**

Landforms origin of denudational is the formation of land denudational derived from the weathering, erosion, and movement of the rocks, and the deposition process. Rock weathering is due to the outbreak of the cooperation of all processes in rocks either mechanically or chemically. Weathering that occurs has not led to the displacement of particles of rock to another place, with the weathering is then the beginning of the evolution of landforms, especially starting from the evolution of the limiting slopes of the landforms. There are three main processes landforms that slope down, the main slopes of the main slope becomes smaller and shorter. In general, this situation occurred in Bali in areas with steep slopes, such as Kintamani and Busungbiu area.

### **3.4 Landforms origin of Fluvial**

Landforms origin of Fluvial formed by fluvial processes is the formation of land from erosion, transport and deposition processes. Erosion of the river can be a material stream scour, abrasion, and chemical weathering processes. Sediment transport caused by a force capable of transporting sediment flow with a certain diameter that depends on water flow, material flow and sediment. Various examples of the formation of the origin of fluvial processes such as alluvial plains, river bottom, back swamps, flood plains, natural levees, lacustrine, fluvial Ledok, scorched in the arch, fluvial terraces, alluvial fans, deltas, alluvial igir.

In general, in South Bali Denpasar and Badung as a flood plain area, because the area is low and the deposition of alluvial soil are used for rice fields. In Tabanan regency there are also many alluvial plains where there are deposits of volcanic soil erosion caused by the presence in the upstream region, an area known by the nickname Tabanan rice hull as most rice fields are at the Tabanan district by utilizing this alluvial plain.

### **3.5 Landforms origin of Marine**

Landforms origin of Marine formed by marine processes is a land formation that occurs in coastal areas due to tectonic processes, the result of volcanic eruptions, and changes in sea level. Based on morphology, coastal areas can be grouped into four kinds: (a) steep rugged coast. (b) ridges coastal. (c) brackish marshes (d) coral reefs. Ngurah Rai airport area to Jimbaran, a coastline that is connected with a local hill delinquent or brackish marshes where there are different types of mangrove forests. This area is formed by the presence of fine-grained sedimentary material and the relatively shallow beach. In the southern part of Bali has an exquisite beach phenomena such as Nusa Dua beach with white sand, this happens because the abrasion that occurs in karst rocks in the area. Unlike the case with

most beaches in the area of Bali which has black sand beaches. such as soft-shelled beach in Tabanan, Lovina in Buleleng.

### 3.6 Landforms origin of Aeolian

These landforms are formed by land from erosion by wind activity, such as the removal of fine sand. Rarely found in areas of Bali, at Bali because the wind was not so strong as in coastal areas Parangtritis, Yogyakarta. Vegetation cover in coastal Bali are generally very tight and other objects such as buildings and hills are a barrier to this aeolin process.

### 3.7 Landforms Origin of Solutional

Landforms origin of Solutional formed by the leaching process is a land formation that is formed in the limestone, because limestone rocks are easily dissolved. Several locations in Bali that have developed karst regions are: the southern island of Bali as the Pecatu, Jimbaran. On the island of Nusa Penida also karst areas because it has abundant limestone rocks. Shaped karst hills: cone, dome, and the ellipsoid. Bali is very fortunate to have the karst hills of Jimbaran area because not every region has the form of the landscape.

## 4. TECTONIC CONDITION

### 4.1 Tectonic Condition

Area of Bali is one of the earthquake-prone regions in Indonesia. To find out the potential dangers of earthquakes in this zone should be identified for certain items of potential hazards associated with earthquakes, which include the tectonic conditions, seismicity activity, historical earthquake and tsunami potential.

Based on its characteristics of tectonic regions, and supported the characteristics of existing geophysical data, the source of earthquakes that can affect Bali in 2 parts: the subduction zones in southern Bali and back arc thrusting in northern Bali. Earthquakes in the subduction zone are generally separated into two groups, namely the megathrust earthquake and earthquakes in the Benioff zone (Hamilton, 1979).

The main tectonic process to Bali island is dominated by the collision between the Indo-Australia plate and EuroAsia plate (Silver et al., 1986). Subduction process is active with a speed of 9 cm/year (DeMets, 1994) led to the emergence of earthquakes epicenter in subduction zones and earthquakes epicenter in back arc thrusting, north of Bali (Figure 3).

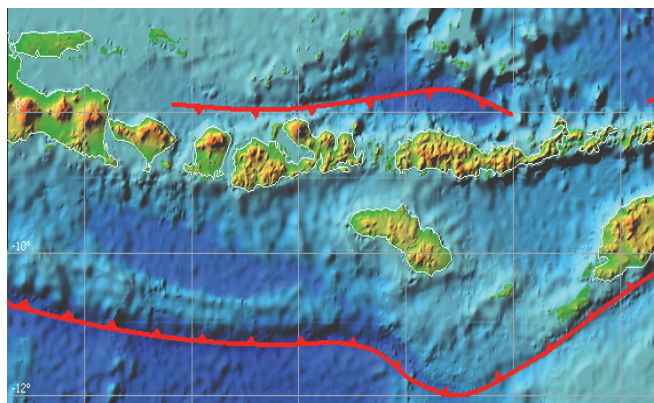


Figure 3. Earthquake generator in Bali island: subduction zone in the south and Bali back arc thrusting in the north of Bali Island

## 4.2 Seismic Activity

To reveal the high seismic activity in the area of Bali, is necessary to study aspects of seismicity. Seismic activity in the area of Bali seemed dominated by shallow earthquakes (less than 60 kilometers), and medium earthquakes (60-300 kilometers). Seismic activity of shallow earthquakes ( $M > 6.0$ ) were considered dangerous and can cause damage.

Distribution of intermediate depth earthquake is concentrated in the Indian Ocean and the southern coast of Bali. These earthquake is considered less harmful, due to not significant. Earthquake with a depth of over 300 kilometers judged to be dangerous given the very deep activity. Based on this conditions, it appears the area of Bali have a high level of seismic activity.

## 4.3 Seismic History

History of strong earthquakes since 1815 shows that the island of Bali is frequently shaken by earthquake damage. Several cases of strong earthquakes in Bali in the past, occurred in the area is not densely populated. Yet the number of victims remained in large numbers. Below are some examples of earthquake damage in the deadly Bali.

Earthquake disaster "gejer Bali" in November 22, 1815. This disaster killed 10 253 people. And further in May 13, 1857 a strong earthquake shook Buleleng, caused 36 people died. In January 21, 1917 earthquake damage occurred again, killing 1,500 people. This earthquake caused landslides in Bali so many houses destroyed. Bali earthquake that claimed considerable Seririt is July 14, 1976 earthquake resulted in 539 people died and 850 people injured, more than 3,200 people were slightly injured. We can imagine the amount of loss that arises when a strong earthquake occurred at this time.

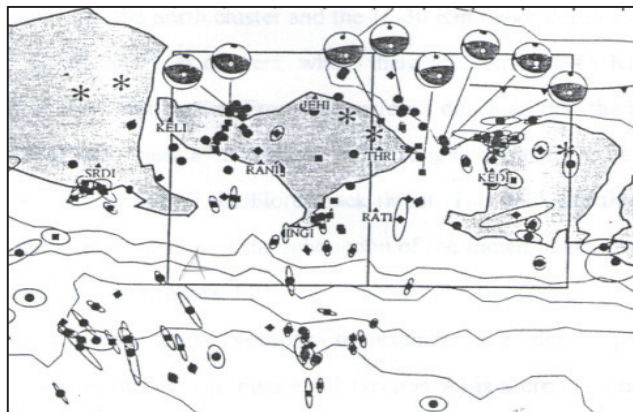


Figure 4. Seismic activity in Bali and its surroundings

## 4.4 Tsunami

Bali island is situated between two earthquake generator, causing the majority of earthquakes epicenter distributes in the sea. The high frequency of earthquakes in the sea it will magnify the risk of tsunami. It happens if the earthquake had magnitude 6.5 on the Richter scale, depth of less than 30 kilometers, and occurs in the zone megathrust.

Megathrust zone of the southern arc of Java-Bali-Lombok-Sumbawa had triggered a tsunami in the south of Sumbawa (1977) and Banyuwangi (1994). Location of Bali are dealing with the Indian Ocean tsunami and is located between Sumbawa (1977) and tsunami Banyuwangi (1994) led to the southern zone of Bali is a potential tsunami zone.

Back arc thrusting in the north of Bali is a generator powerful earthquakes with shallow depths (Daryono, 2000). These conditions increase the chances of a tsunami in the north of Bali. Facts related

to the tsunami due to Bali back arc thrusting: (1) earthquake north Bali, November 22, 1815 which triggered a tsunami that killed 10 253 people, (2) earthquake triggered a tsunami 3.5 meters in Buleleng 1818, (3) earthquake north of Bali May 13, 1857 triggered a tsunami 3 , 4 meters killing 36 people, and (4) northern Bali earthquake January 21, 1917 triggered a tsunami of 2 meters and killed 1,500 people. The existence of Bali back arc thrusting will become a serious threat to coastal areas north of Bali.

Based on studies of earthquake mechanism to determine the pattern of earthquake faults around Bali is compiled by McCaffrey (1887), Yazid (1999) and (Daryono (2000) showed that the sea around Bali there are many faults spread and potential of tsunami. Based on some of these facts, and supported the existence of Bali which is located on the tsunami prone zone Map, then we can conclude that Bali is not only the earthquake-prone areas but also the tsunami-prone areas.\*\*\*

## 5. CONCLUSIONS

1. Distribution of annual rainfall shows that in each year, the highlands of the island of Bali is experiencing the highest rainfall. Meanwhile Sendang areas where the climate is the driest area of the island because of it has the lowest rainfall.
2. Topographic conditions of the Bali island can be divided into three zones: the southern Bali, the center of Bali, and Bali northern zone. The geomorphology condition of Bali island and its landforms have varied conditions, namely: Landforms origin of volcanic, structural, denudational, fluvial, marine, aeolian, and solutional.
3. Bali island that lies between the two earthquake generators, namely the subduction zone in the southern Bali and back arc thrusting in the northern Bali. It caused Bali as a highly vulnerable area of the earthquake and tsunami.

## REFERENCES

- Arimuhaimin. 2010. Deskripsi Bentang Geografi Pulau Bali. Dalam weblog: <http://arimuhaimin.wordpress.com/>
- Daryono. 2000. Identifikasi Patahan Aktif Daerah Bali Berdasarkan Seismisitas Lokal dan Solusi Bidang Sesar. Skripsi S-1. FMIPA Universitas Indonesia.
- Daryono, D.K. Suanda, dan I GA Mas Sri Agung. 2003. Evaluasi Zona Agroklimat Oldeman Daerah Bali Berdasarkan Pemutakhiran Data Curah Hujan Hingga tahun 2000. Jurnal Agritrop, Jurnal Ilmu-Ilmu Pertanian, Fakultas Pertanian Universitas Udayana. Vol. 22 No. 3 September 2003.
- Dekna Chicharito. 2012. Kondisi Geologi dan Topografi Pulau Bali, Webblog: <http://dexnachicharito.blogspot.com/2012/01/kondisi-geologi-dan-topografi-pulau.html>.
- Hamilton, W. 1979. Tectonic of the Indonesian Region. U.S. Geological Survey. Profesional Paper 1078, 345 pp.
- McCaffrey, R. and J.I Nabelek.1987. Earthquakes, Gravity and The Origin of The Bali Basin: An Example of A Nascent Continental Fold and Thrust Belt. Journal of Geophysical Research, 92, 441-460.
- Sugiarto, K.A. 2012. Geomorfologi Bali, dalam weblog: [//agussunthe.blogspot.com/2012/06/geomorfologi-bali.html](http://agussunthe.blogspot.com/2012/06/geomorfologi-bali.html)
- Sumiana, Y. 2012. Implikasi Perubahan Spasial dan Temporal Curah Hujan Terhadap Tipe Iklim Oldeman dan Pola Tanam di Pulau Bali. Tesis. Program Pascasarjana Fakultas Geografi Universitas Gadjah Mada (UGM).
- Yasid, M. 1999. Studi Seismotektonik Pulau Bali dan Sekitarnya Berdasarkan Relokasi Hiposenter dan Solusi Bidang Sesar.Tugas Akhir. Program Studi Geofisika, Jurusan Geofisika dan Meteorologi, Fakultas Matematika dan Ilmu Pengetahuan Alam, Institut Teknologi Bandung.



# SOCIAL STRUCTURE OF BALI

By  
I Wayan Ardika  
Udayana University

## 1. Introduction

Social structure is the term which is used in the social sciences to refer to patterned social arrangements in society that are both emergent from and determinant of the actions of the individuals. On the macro scale, it can refer to the system of socioeconomic stratifications, social institutions, or other patterned relations between large social groups. On the meso scale, it can refer to the structure of social network that ties between individuals or organizations. On the micro scale, it can refer to the way norms shape the behavior of actors within the social system. The basic components of social structure include suprastructure/ideology, social structure and infrastructure (Wikipedia, 1; Sanderson, 2000: 60).

The notion of social structure as relationships between different entities or groups or as enduring and relatively stable patterns of relationship, emphasises the idea that society is grouped into structure related groups of roles, which have different functions, meanings or purposes.

It should be noted that social structure may influence the importance of social systems including economic system, legal system, political system, cultural system, and others. Family, religion, law, economy and class are all social structures.

This paper will attempt to describe social stratifications, kinship systems and institutions in the Balinese society. Balinese culture is very much based on Hindu philosophy, therefore the social structure of the Balinese people is based on Hindu social system namely caste system. The caste systems in Bali consisted of groups of people such as *brahmana*, *ksatriya*, *wesya*, and *sudra*. These have been mentioned in Balinese inscriptions dated from the 11th century. The Hindu social system known as *catur warna* or caste system will be explored in this paper. In other words, how caste or *catur warna* system has been practiced by the Balinese.

Kinship is another important aspect of social structure in Balinese. Family is a basic component of kinship system in Bali. Several kinds of institutions or organizations are also discussed in this paper.

## 2. Caste System

The ideology of Hindu caste seems to have been known at least in the 11th century by the Balinese. Several Balinese inscriptions mentioned group of people include *Brahmana*, *Ksatriya*, *Wesya* and *Sudra*, who were not allowed to disturb the royal grants. Those people who disturb or manipulate the royal grants will be killed by God or bad spirits and forever they will suffer in their life time. It is not clear whether caste system has been practiced properly at that time. However, Covarrubias (1956: 52) states that caste system was not firmly implanted in Bali until after the conquest of Majapahit in the 14th century. The Hindu Javanese penetration did not reach many of the remote mountain communities, which remained outside the feudal territories. In the mountainous areas the Hindu caste system was not recognized and they retained primitive authorities namely the *pasek* and the *bendesa*. Both functionaries is considered as the old style of community institutions.

In the low land areas and around the royal courts the caste system is widely adopted by the Balinese. The Balinese divides themselves into four main groups: Brahmana, Satria (Ksatriya), Wesia (Wesya), and Sudra. In such classification more than 90% of the population falls into the fourth category or *Sudra*. More common division for everyday use is made between *Triwangsa*, the first three groups (*Brahmana*, *Ksatriya*, and *Wesya*) taken as a unit, and *Sudra non-Triwangsa* (Geertz, 1959: 996). Each group is then subdivided further in terms of the title system, the actual basis of the individual's rank in the society. The title for Brahmana is *Ida Bagus* (for man) and *Ida Ayu* (for woman); the titles for *Ksatriya* are *Tjokorda*, *Anak Agung*, *Dewa*, and *Ngakan*; *Wesya*'s titles are *I Gusti*, *Gusti* and *Gusi*; and for *Sudra* are *Jero*, *Gde*, *Putu* (Geertz, 1959: 997).

The social status in Balinese community is very much related with speech-level. When two strangers begin a conversation, one of the opening questions in Balinese is *Tiang nunasang antuk linggih?* What is (your) social position? ([I] beg your position) (Covarrubias, 1956: 51-53; Arka, 2005: 169). The expected answer is *Tiang anak jaba* 'I am a commoner' or *Tiang menak* 'I am a *menak* person'. (*Menak* is a term for medium or high castes/*triwangsa*). Such an answer allows the speaker to choose the appropriate register, *basa lumrah* (low register) or *basa alus* (high register/refine). The fact that words in Balinese carry information about different social relations (Arka, 2005: 180).

Today however, the Balinese people tend to use Indonesian in formal situation or for daily conversation. Indonesian as a national language is considered more neutral than the Balinese. In this situation, the government's policy on languages indicate that both languages namely Indonesian and Balinese being taught in the elementary school up to the high school. In order to preserve the Balinese language, the government of Bali conducts several programs such as speech contest, story reading, singing Balinese song, reading and writing Balinese script, and translating Balinese scripts to Latin or transcript, Latin to Balinese script (Sutjiati Beratha, 2012: 9).

### 3. Balinese Kinship System

The social status in Balinese society is patrilineally inherited, therefore marriage is strictly regulated in terms of status. The Balinese title system passing from father to child and attached to the individual's name as a term both of address and reference, that prestige is distributed (Geertz, 1959: 996).

Since Balinese social structure is based on the caste system, marriage ideally to be done between people of the same caste or having similar clan (*dadia*). In other words, marriage in Bali can be said as an endogamy (Bagus, 1976: 287). Marriage between clan (*tunggal kawitan*, *tunggal dadia*) in Bali will avoid conflicts or tensions within the clan itself. It is also considered as the way how to preserve caste system among the Balinese.

As already before noted that the number of *triwangsa* people in Bali is only 10% of the total population. It is difficult to avoid cross marriage between people from different castes, particularly, a woman from high caste *Triwangsa* to marry man from low caste non-*Triwangsa*. If the case happened, the woman will humiliate her family and the couple will be exiled (*maselong*) for a long time. However, since 1951 this kind of punishment has not existed any more (Bagus, 1975: 287). The man who marry woman from the higher caste has also need to make big ceremony which is considered breaking the regulation of old traditions. In modern time, cross married between people from different castes is more common now than before.

Each family in Bali has family's shrine call *sanggah kamulan* (*temple of origin*). In addition, particularly for those who live in a new place or neolocal, they have to build a new *sanggah kamulan*. Apart from family temple, the family also has kinship/clan temple or *pura dadia*. The family has responsibility to maintain and make ceremony annually or every six months for the kinship temple.

#### 4. Social Institutions in Bali

There are many social institutions in Bali. Those institutions may be based on kinship ties (*dadia*), common residence (*banjar*), ownership of rice land lying within a single watershed (*subak*), and membership of voluntary organization which is in Bali known as *pamaksan* (Geertz, 1959: 992; Bagus, 1975: 290-291).

It is interesting to note that every family in Bali becomes part of a clan (*dadia*). *Dadia* can be said as a social institution in Bali which is based on kinship. Every *dadia* has their own temple or kinship temple which is called *sangguh* or *pamerajan*, *pura dadia* or *pura paibon*. The concept of *pura Paibon* is constructed from *pa + ibu + an* which literary means the temple belong to the people from the same *ibu* or mother of similar origin. In other words, *Paibon* is a temple worshipped by people who have kinship ties.

*Banjar* is an organization or institution in Bali which is based on common residence. People who live in the same area become members of a *banjar*. Someone who is no longer lives in one *banjar* or move to another place, he/she can quits as a member of the *banjar* itself. The head of *banjar* is called *klian banjar* which is elected by the members of *banjar*. Each *banjar* in Bali usually has a meeting hall which names as *bale banjar*. The meeting of *banjar* is usually conducted every month.

It should be noted that several government programs nowadays have been implemented through *banjar* system for instance: family planning, social and other health programs. Bali is also known as the most successful family planning program in Indonesia through *banjar* system.

Apart from social sphere, *banjar* also functions as religious organization. Each *banjar* has its own temple calls *pura banjar*. Religious activities is usually carried out in the *banjar* hall such as preparing ceremony for Nyepi holiday or Saka new year, as well as cremation ceremony for the *banjar*'s members.

Nowdays, economic activities are also carried out in the *banjar*. For instance, *banjar* owns/runs shop, super market and bank. This particularly occur in the urban areas. This economic activity is importance to support the financial of the *banjar* itself.

*Subak* is an importance traditional institution in Bali. The words *suwak* and *kasuwakan* have been written in Balinese inscriptions at least from 11th century. If it is the case, *Suwak* or *subak* might have already existed in Bali at least from 11th century. The Balinese inscriptions also mentioned several activities related with rice cultivations such as *amabaki* (land clearing), *amaluku* (ploughing the land), *atanem* (to grow rice), *amantun* (cleared away the weeds), *ahani* (harvesting), and *amutu* (husking the rice)(Ginarsa, 1961: 4-8; Ardika and Sutjiati Beratha, 1998: 90). In addition, tax on water (*pa air*) and specialist on tunnel making (*pangarung*) are also mentioned in the Balinese inscriptions. These informations suggest that *subak* and rice cultivation have been practiced in ancient Bali.

As far as *subak* is concerned, this institution is established by the land owners which is irrigated from a single water source, i.e. a single dam and canal running from dam to fields—belong to a single *subak*. The head of *subak* is called *klian subak* which is elected by the members of the *subak* itself. Each *subak* in Bali has its own temple call *pura subak* or *bedugul* or *ulun suwi*. Several temples in Bali such as *Pura Batur* and *pura Ulun Danu Bratan* are considered as *pura subak* or *subak*'s temples (Lansing, 1991). *Pura Batur* and *Ulun Danu Batur* for instance are considered as *pura subak* in regencies of Gianyar, Klungkung, and Badung which obtain water from lake Batur. It is also similar case for *pura Ulun Danu Bratan* which is believed as a *pura subak* for several *subak* at Tabanan and Buleleng regencies. The *subak* members have obligations to donate rice, crop products, animals and money to support ceremonies and temple festivals for these tempels. It is believed that land and its products belong to the God and blessed by the God, therefore the *subak* members have obligations to donate to the temple or to the God.

*Subak* in Bali now facing a challenge due to modernization. About 1000 hectares of *subak* areas decrease every year. On the other hand, Unesco has decided to declare several *subak* in Bali as the world heritage sites

*Seka* is a voluntary organization which has specific purposes. Literary *seka* means “to be one” (Geertz, 1959: 999; Bagus, 1975: 291). There are several *seka* in Bali include *seka banjar*, *seka dadia*, *seka subak* etc. There are also *seka* for various kinds of agriculture works, musics, dances, dramas, singings and interpreters of Balinese poetry. However, there are several *sekas* which are no longer exist in Bali now. Individualistic appears to be more dominant in the Balinese society.

## 5. Conclusion

Balinese is a ranked society. Social structure of Balinese people mostly based on caste systems, kinships, common residence, and specific purposes. The social structure of Balinese is dynamic over times. Hinduism inspires the social structure of Balinese, therefore it has religious character.

## Bibliography

- Ardika, I Wayan dan N.L. Sutjiati Beratha. 1998. Perajin pada Masa Bali Kuna Abad IX-XI. *Laporan Penelitian*. Denpasar: Fakultas Sastra Universitas Udayana.
- Arka, I Wayan. 2005. Speech Levels, Social Predicates and Pragmatic Structure in Balinese: A Lexical Approach. *Pragmatics* 15:2/3. 169-203. 2005.
- Bagus, I Gusti Ngurah. 1975. Kebudayaan Bali. In Koentjaraningrat (ed). 1975. *Manusia dan Kebudayaan di Indonesia*. pp: 279-299. Jakarta; Djambatan.
- Covarrubias, Miguel. 1956. *Island of Bali*. New York: Alfred A. Knoff.
- Geertz, Clifford. 1959. Form and Variation in Balinese Village Structure. *American Anthropologist* (61).991-1012.
- Geertz, Clifford. *Person, Time and Conduct in Bali. The Social Nature of Thought*.  
[http://hypergeertz.jku.at/GeertzTexts/Person\\_Time\\_Conduct.htm](http://hypergeertz.jku.at/GeertzTexts/Person_Time_Conduct.htm). 20/07/2012.
- Ginarsa, I Kutut, 1961. Prasasti Baru Raja Marakata. *Bahasa dan Budaya*, 1-2. Lembaga Bahasa dan Kesusasteraan. Departemen Pendidikan dan Kebudayaan.
- Lansing, J. Stephen. 1991. *Priests and Programmers*. Princeton: Princeton University Press.
- Sanderson, Stephen K. 2000. *Makro Sosiologi. Sebuah Pendekatan Terhadap Realitas Sosial*. Jakarta: PT RajaGrafindo Persada.
- Social Interaction and Social Structure. <File:///C:/Users/Vaio/Documents/structure.htm>. 13/08/2012
- Social Structure. Wikipedia, the free encyclopedia.  
[File:///C:/Users/Vaio/Documents/Social\\_structure.htm](File:///C:/Users/Vaio/Documents/Social_structure.htm) . 13/08/2012.
- Sutjiati Beratha, N.L. 2012. Developing the Balinese Language in Global Era. Paper presented in International Conference. *Bali in Global Asia: Between Modernization and Heritage Formation*. Denpasar: 16-18th July 2012.

## SOCIAL STRUCTURE OF BALI

By  
I Wayan Ardika  
Udayana University

## RANKED SOCIETY OF BALI

- ▶ Balinese is ranked society
- ▶ This paper will explore the social structure of the Balinese society on the basis of caste systems, kinship systems, and social organizations

## CASTE SYSTEMS IN BALI

- ▶ Social structure of the Balinese society is based on Hindu social systems namely the caste systems
- ▶ Social groups of Brahmana, Ksatriya, Wesya, and Sudra have already been mentioned in the Balinese inscriptions dated from the 11th century. However, whether the caste systems were applied properly in Bali at that time is still not clear
- ▶ The caste system mostly have been applied in the low land areas and around the courts. However, in the mountainous villages traditional social systems are still being used such as *Pasek*, *Kubayan*, and *Bendesa*

## SOCIAL STATUS AND SPEECH LEVELS IN BALINESE

- ▶ When two strangers of Balinese make a speech or conversation to the people that they do not know yet in they will start the talk by asking question: what is your social status or in Balinese words *tiyang nunasang antuk linggih?*
- ▶ The Balinese will address in high register to the *Tri wangsa* (the three high caste; *Brahmana*, *Ksatriya*, and *Wesya*), and low register to the lower caste (*Sudra*) or non *Tri Wangsa*

## SOCIAL STATUS AND SPEECH LEVELS IN BALINESE (continuous)

- ▶ In formal situation Balinese tend to use Indonesian which is considered to be more neutral than the Balinese language
- ▶ The title system is also indicating that the individual rank in Balinese society such as *Ida Bagus* (man) and *Ida Ayu* (woman) are the title for *Brahmana*; *Cokorda*, *Anak Agung*, *Dewa* are the title for *Ksatriya*; *I Gusti* and *Gusti* are the title for *Wesya*
- ▶ Words in Balinese carry informations about different social relations

## BALINESE KINSHIP SYSTEMS

- ▶ The social system in the Balinese society is patrilineally inherited
- ▶ The Balinese title systems are passing from father to child and attached to the individual's name
- ▶ Marriages in Bali ideally are done between people of the same castes or having similar clans
- ▶ Each family in Bali has family's temple call *sangah kamulan* (temple of origin) and kinship's temple (*pura dadia/paibon*)

## SANGGAH KAMULAN / FAMILY TEMPLE / TEMPLE OF ORIGIN



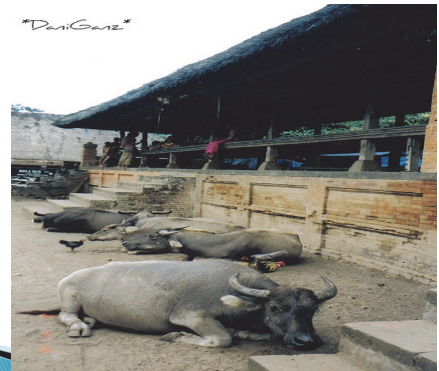
## SOCIAL INSTITUTIONS IN BALI

- ▶ *Banjar* is a social institution in Bali which is based on common residence. People who live in the same area become members of a *banjar*
- ▶ *Banjar* also functions as religious organization, and each banjar has its own temple (*pura banjar*) and a meeting place called *bale banjar*
- ▶ Several government programs such as family planning and other social welfare are implemented through *banjar system*

## BALE BANJAR / BANJAR HALL



## BALE AGUNG AT TENGANAN VILLAGE



## SUBAK SYSTEM

- ▶ *Subak* is an institution which is established by land owners which is irrigated from a single water source
- ▶ *Subak* leader called *klian Subak* which is elected by members of the subak itself
- ▶ Each Subak has its own temple call *pura Subak* or *Ulun Suwi* or *bedugul*
- ▶ Several temples in Bali are also considered as *pura Subak* such as Ulun Danu Batur, Ulun Danu Beratan
- ▶ The *Subak* members have obligations to maintain the subak's temple and to do temples festival

## SAWAH RICE TERRACE



## RICE TERRACE OF SUBAK



## AGRICULTURAL ORGANIZATIONS

- ▶ The subak members hold a meeting at *bale subak* or *subak's* meeting place
- ▶ There were several groups of agricultural organizations or *seka* in Bali such as: ploughing the rice fields, growing rice, harvesting rice etc. Such organizations do not exist in Bali at the present

## SUBAK MEETING



Open Course Ware  
November 2019 - 2020

## MUSIC AND DANCE ORGANIZATIONS

- ▶ There are several professional groups or *seka* of musics and dances in Bali
- ▶ *Banjars* and village customaries in Bali also have groups or *seka* of musics and dances such as *seka gong/gamelan orchestra*, *seka angklung*, *seka baris*, *seka barong* etc.

## SEKA GONG/ORCHESTRA GROUP

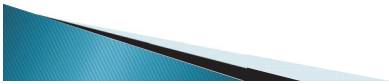


## DANCE GROUP



## FINAL REMARKS

- ▶ Social structures of the Balinese society are based on caste systems, kinship systems and institutions
- ▶ Title systems and speech levels can be used to recognize social structures of the Balinese society
- ▶ In formal situation the Balinese people tend to use Indonesian which is considered more neutral than the Balinese language
- ▶ Social statuses in the Balinese society are inherited patrilineally
- ▶ There are several social institutions in the Balinese society such as *banjar*, *seka* or interest groups



# BALI HINDU AND RITUAL CEREMONY

## I. Introduction

Indonesia consists of thousands of beautiful islands, however, Bali is better well known in the world even many foreigners call Bali as the island of thousands temples, the island of heaven, the island of God and others.

Based on the result of some researches, the uniqueness of the Balinese culture contributes to the fact that Bali for some foreigners becomes the most attractive island to visit. Those who come to Bali is more being attracted by its culture rather than the beauty of the scenery. Moreover, Bali becomes very unique because it is a small island so distances become very closed to each other. For instance, the direction between mountains and beaches become closer and so as cities and villages in a silent condition, with their agriculture, is also getting closer.

To support the uniqueness of the Balinese culture, potential natural resources becomes the main source. Natural resources inspire the civilization, creativity, design and art. They can also stimulate technology and all materials for education also becomes references for the religious life, fertilize the local genius and finally becomes the asset of economic for all over the years. Realizing it or not, preserving the natural environment becomes a must for a sustainable qualified civilized life. The balance of ecology provides a pathway for the maintenance of the culture civilization based on the environment and inspired by the Hindu religion.

Based on the morality awareness, keeping the balance of ecology of the local culture means that the potential of the natural resources will be able to give contribution for the qualified civilization. So, destroying the environment is a negative deed which can bring an impact to the environment itself and finally decreasing the quality of life.

To increase the prosperity of the Balinese people, there is a concept of *Tri Hita Karana* which is used as the guideline for the Balinese to reach the prosperity and happiness. *Tri* means three, *Hita* means prosperous, happy and healthy then *Karana* means the cause. So *Tri Hita Karana* is the three causes of the prosperity, happiness and health. Those are the harmonious relationship between the people and the God, the harmonious relationship among people and their relatives and the third is between the people and the environment or the nature.

## II. The Balinese Culture is Inspired by The Hindu Religion.

All people as well as cultural observer do realize that the Balinese culture is inspired by Hindu religion. The religion in form of the Hindu literature becomes eternal resources for the Balinese culture. Hindu literature has been inspiring the artists for all kinds of arts such as : dance, orchestra, carved art, literature, drama, statue, etc.

Also for the daily life of the Balinese people is in any way always inspired by the religious nuance, for example: their social intercourse, building the house and agriculture and others are full of religious nuance.

The emerge of the Hindu Balinese Culture is within a long process. It means that Hindu does not base on the Nihilistic concept, by means that there is no process of culture nihilistic. Then, Hindu is based on the association, integration, complementation and sublimation approaches. The coming of Hindu for the first time was through the process of culture association with the local culture. Then within a long period of living,

the process of integration or complementation followed. Integration process means that the Hindu teaching could unite with the local culture and for the complementation means that both Hindu and the local culture are completing each other and caused by their diversity they are completing dynamically. After integration and complementation process, there is a process of maintenance of the local culture and then becomes the source of the Hindu culture with its special culture. Then sublimation process is directed to enrich the local culture. It means that Hindu inspires the quality of the local culture so the glory takes place. The meeting of Hindu with the local culture becomes so dynamic and harmonious. In other words, association, integration, complementation and sublimation happens through the process of evolution results in the appearance of the Hindu culture which is always different in its outer layers but the inside would be very universal. Even though the Balinese culture and that of Hindu religion are very united, it is easier to divide them between the empirical aspect of the divine words and the empirical aspect of the human creation at implementing Hindu religion in a form of the Balinese culture.

### III. Hindu in Bali

Hindu has three principles called as *Tattwa, Susila and Upacara*. *Tattwa* is the principle about Hindu which is called as *PancaSradha* (believe in God, believe in the Spirit, believe in *Karmapala* (the deed effect), believe in reincarnation and believe in *Moksa* (the unity of the human spirit with the God after the dead)). Then *susila* concerns with the attitude or ethic known as *Tri Kaya Parisudha* (having good thought, good talk, and good act). At last is *Upacara* deals with the real implementation of the religion which is in a form of *PancaYadnya*.

“Yajna” derives from Sanskrit language which comes from the root of “yaj” means to worship, to pray. Generally, “Yajna” means holy sacrifice done sincerely. There are two forms of *yadnya*. They are material and spiritual (tangible and intangible). The implementation of *yadnya* can be done daily (*nitya karma*) and the second is done at certain days (*naimitika karma*).

It is understood that anything people do must have their own purposes and so does *yadnya*. The purpose of doing any *yadnya* is to reach any prosperity, happiness and *moksa*.

Base on *Manawa Dharma Sastra* VI, 35 it is mentioned that the thought can be directed toward on the release of the three debts. In Sanskrit, those three debts are called *Tri Rna*. The first is the moral debt to the God (*DewaRna*) deals with the awareness of the human to perform *yadnya* to the god in forms of *DewaYadnya* and *ButhaYadnya*. The second is the debt for the parents and the ancestor (*PitraRna*). It is done by implementing *Yadnyato* the parents as well as to the ancestors who have brought us up and this *yadnya* is called *Pitra and manusayadnya*. The awareness of having a debt to the priest (*RsiRna*) concerns with knowledge dissemination especially *Veda*. And finally, those three debts can be paid by doing *PancaYadnya*. There are also three levels of doing *yadnya*; *nista, madya, utama* (low, medium, high).

*DewaYadnya* in Bali is performed by doing ceremony in the temple of *KahyanganJagat* which is based on the Balinese year or *sasih* which falls based on the coming of the moon and also based on *pawukon*. The temple ceremony which comes based on *sasih* falls every year especially on the full moon or dark moon, however that of the temple based on *pawukon* falls every 210 days. *Pujawali* is *yadnya* dedicated to

the God. Then for the intangible form of DewaYadnya can be done by doing *Tapa, Brata, Yoga and Semadhi, Tri Sandya, Fasting, etc.*

*Bhutayadnya* is the implementation of DewaRna. This ceremony is conducted to preserved the universe, the forms of this ceremony ranges from the smallest one to the big one is *segehan, caru and tawur*. It aims to keep harmonious relationship between the people and the environment. The other forms of *BhutaYadnya* are taking care of animals and plantations.

*Pitrayadnya* is the implementation of *PitraRna* ; it is the ceremony of the dead ( cremation ) and *atmawedana* and finally placing the holy spirit of the dead at the family temple. Pitrayadnya can also be done during the parents alive. We must take care and love them during their live.

*Manusayadnya* is actually the implementation of *PitraRna*. *Manusayadnya* is conducted in relation to reincarnation. The new born children are the reincarnation of the ancestors. By providing them with the ceremony of *manusayadnya* is a form of dedication to the ancestor. Purifying them means to purify the ancestors, so *manusayadnya* is done from the new born up to the marriage. And this become the parents' jobs. Bringing them up, giving them better education and also giving help to the poor are also other forms of this kind of *Yadnya*.

*Rsiyadnya* is the actual form of *RsiRna*, it is a kind of *yadnya* done by showing our dedication and respect to the priest. The implementation is by serving *RsiBojana* ( a set of menu served to the priests ) to the priests after leading a ceremony, giving any help for the priests' daily life, showing respect by keeping their holiness, as well as taking care and studying a holy book.

Then *yadnya* is done because of the awareness of having such debt as mentioned above. They all must be done sincerely. Bhagavad-Gita mentions that studying and teaching sincerely with full of dedication to worship the God refers to *yadnya*, preserving the environment is also *yadnya*, controlling passion is another form of *yadnya*, even reading any holy books including Veda and loving each other and giving help to the poor are also *yadnya*. So *yadnya* is not only limited on ritual ceremony. Ceremony and the offering are parts of the *yadnya*. The value cannot be measured from the size of *yadnya* itself, however the holiness and the sincere of the people who perform *yadnya* play a very important role.

The implementation of *yadnya* in Bali by using offering is very dominant. And it is related to the name of Bali itself which means Banten( offering ). Manawa Dharmasastra III, 70 mention about “ *Balibhaurto* “ means that Bali's worship to *Bhuta*, and at sloka 74 “ *PrahutabhautikoBalih* “. *Prahuta* is ceremony in Bali is conducted on the land to *Bhuta* ( *PancaMahaBhuta : land, fire, water, wind and the sky* ), at sloka 81 it is mention about “ *Bali Karmanah* “ about *yadnya* dedicated to *Bhuta*. Referring to the meaning of Bali in Manawa Dharmasastra, Bali is an offering. The former I Gusti Bagus Sugriwa mentioned that Bali refers to offering. Offering for *Bhutayadnya* is called *caru* which means beautiful or harmonious. So the purpose of *BhutaYadnya* is to create *BhutaHita*, i.e. prospering the nature. Prosperous nature is the one that is beautiful or harmonious. Sarasamuscaya 135 mentions that prosperous nature is the main and the first aspect to reach the aim of life, i.e. Dharma, Artha, Kama and Moksa.

Ceremony in Sanskrit refers to to get closed to. The ideal aim of getting closed to is to create harmony. Dynamic and productive harmony leads to the balanced of the spiritual and material values. Offering as the media of the ritual ceremony in Bali aims to get closed to. Another meaning of *banten* or the offering in Sanskrit also refers

to friendliness. So *banten* or the offering as the symbol has three purposes; the first one is settling one's life in order to increase self quality, strengthening oneself for dedication to the God and the last is worshipping the God. The three purposes must be done by *Yadnya*.

*Yadnya* can also be in a form of fund, *tapa brata yoga and Samadhi*, ritual ceremony. The purpose of the ritual ceremony is to build an attitude and behavior that is closed to the God that can build a glorious behavior so being able to build a mental endurance to cope with the challenge and disturbance of life.

Referring to *LontarYadnyaPrakrti*, *banten* or offering is the symbol of oneself, the symbol of the God magnificence, also the symbol of the universe. As the *Lontar* mentions that *banten* or the offering is the means of creating the value and meaning of *yadnya* as the basic for the people's dedication to the God, to the others as well as to the environment. *Banten* as the media for Hindu people in Bali is actually has the most basic meaning of *tattwa*. Engaging the Hindus with the Veda's values can be done by various ways. The Veda's values can be realized to the philosophy of life. The philosophy of life can be described within the practical guidance of life so being able to develop people with high moral values and strong mental. Engaging the value can also be done by conducting a ceremony. So ritual ceremony has a very high value to Balinese people's life. One thing that is very essential at conducting a ceremony is the presence of the main values ,i.e. the Veda's values. Hindu ritual ceremony has a wide dimension, it is not a matter of being religious. As mention previously, it is a media to get closed to. Getting closed to is by means of *yadnya* done sincerely. By *yadnya*, people are able to get closed to the God, to the other people as well as to the environment. The means for the ritual ceremony is the offering. Generally, the offering is made together among the members of the society with the spirit of friendliness. Sincere, holiness is the basic to get closed to the environment, to the other and to the God. Having closed to by the media of offering is able to build harmonious dynamic which can increase the material and spiritual values needed for the life. And it is called *SatwikaYadnya* according to *Bhagavad- Gita*.

So all forms of the Balinese life are started with ceremony and the offering, and so for the agriculture system in Bali is managed by *Subak*. *Subak* as an organization that manage the irrigation, the members itself are the farmers with one special united areas. The areas is determined by the unity of one water resources but not by one united villages and therefore *subak* and the territory can be different.

#### IV. *Subak* as The Implementation of The Ceremony in Bali

Talking about agriculture in Bali cannot be separated from ceremony and the offering. Starting from making the dam as the irrigation, cultivating to the harvesting cannot be separated with ceremony and the offering even including in the activity of insect eradication.

Some of the ceremonies related to agriculture in Bali base on *Lontar Sri PurusaTattwa* are in detail as follows :

It is started with *Ngendag* ceremony, it is the start of working in the rice-field, it is completed with some offerings as well as mantras and then the start is marked by hoeing three times at upper course of the rice-field.

*Mawinihmuangnguritpadi* is cultivating the seed. Before cultivating the seed, it must be sprinkled with sandalwood water and flowery water and then followed with a ceremony and mantra. During cultivating the seed, when falling into a god day, there must be filled with some offering and mantra.

*Nandurpadi*( cultivating the paddy ) must be done on certain days which are based on the Balinese calendar and being good for the activity. It must also be begun with a ceremony and mantra.

Then the next ceremony is *mabuihin*, it is also followed with a ceremony then when the paddy is about 42 days, there is *kakambuhan* ceremony.

Cleaning the paddy's area from any wild grass is called *majukut*. It is also done with a ceremony and some mantras. And when the paddy has grown well, there is a *pengisehan* ceremony with some offering and mantra as well. Then *mekukunganpari* is done after the paddy is about 3 months old.

Before harvesting, there is *mecaru* ceremony and then *nyangketpari* is done for the harvesting. Taking the paddy to the rice barn must also be accompanied with a ceremony. And it is called *pamendakdewaningpari*( picking up the goddess of paddy ). And after the paddy is kept at the rice barn, the *mantenin* ceremony must be followed. After three days kept at the barn, then the paddy is allowed to follow the next process to be rice. And must also be sprinkled with holy water after being rice.

And those are all about the sequence of the agriculture ritual ceremony according to the *Lontar Sri PurusaTattwa*.

## V. Conclusion

1. Bali as a tourism destination is well known with the beauty of the scenery and the uniqueness of the culture inspires with the Hindu religion.
2. All kinds of the Balinese people activities ranges from their daily routines and activities on certain occasion are accompanied with ceremony and some offerings and so the activities are blessed with the God.
3. The Hindu ritual ceremony in Bali is done by doing *PancaYadny* both daily and occasionally. *Yadnya* is a media for engaging the philosophy and Veda's values to all people. Ceremony as the meaning to get closed to has the same meaning as banten or the offering which means serving with friendliness. Finally, ceremony with the offering means to get closed with friendliness. Getting closed to the nature, to the others as well as to the God.

KEPALA DINAS KEBUDAYAAN  
PROVINSI BALI,

**I KETUT SUASTIKA, S.H.**

Pembina Utama Muda

NIP. 19580105 198603 1 014

## Bibliography

*PancaYadnya*, 1996/1997, Pemda Tk. I Bali

Wiana, Ketut, 2004, *Mengapa Bali Disebut Bali*, Paramita

*Alih Aksaradan Alih Bahasa Lontar Sri Purana Tatwa*, 2004, Disbud


*Memahami Keseimbangan Alam Budaya Bali ( Majalah Lontar No. 21/VI/Triwulan II/2002 )*, Disbud Prov. Bali

*Akar Budaya Bali perlu Disiram Lebih Banyak ( Majalah Lontar No. 16 Triwulan IV/2000 )*, Disbud Prov. Bali


Suamba, Ida Bagus Putu, 1996, *Yajna Basis Kehidupan*, WHD

Sudarma, I Nengah, 1984, *Konsep Tri Hita Karana Dalam Pelestarian Eksistensi Desa Adat*, IHD

Sumarta, Ketut, 1992, *Subak : Inspirasi Manajemen Pembangunan Pertanian*




## Economic Development Plan In Bali Province




Oleh:  
BAPPEDA PROVINSI BALI

*Disampaikan dalam rangka:  
Seminar Nature, Culture And  
Economics In Bali Island*

**Denpasar, 5 September 2012**



## A. Gambaran Umum Daerah Bali



- Luas wilayah: 5.636,66 km<sup>2</sup> (0,29% dari luas kepulauan Indonesia).
- Terdiri dari beberapa pulau yaitu : Pulau Bali, Pulau Nusa Penida, Pulau Nusa Ceningan, Pulau Nusa Lembongan, Pulau Serangan dan Pulau Menjangan.
- Secara administratif terdiri dari 8 kab. 1 kota, 57 kec, 634 desa dan 80 kelurahan, 1.471 Desa Pakraman, 4.361 Banjar Adat dan 2.435 subak.
- Penduduk Provinsi Bali berdasarkan Sensus Penduduk Tahun 2010 adalah sebesar 3.890.757 jiwa

1

## B. KEBIJAKAN PEMBANGUNAN PROVINSI BALI

TERTUANG DALAM:

- **RENCANA PEMBANGUNAN JANGKA PANJANG DAERAH (RPJPD) TAHUN 2005-2025** (Perda Provinsi Bali No. 6 Tahun 2009).
- **RENCANA PEMBANGUNAN JANGKA MENENGAH DAERAH (RPJMD) TAHUN 2008-2013** (Perda Provinsi Bali No. 9 Tahun 2009).
- **RENCANA KERJA PEMERINTAH DAERAH (RKPD)** setiap tahun.




# PEMBANGUNAN JANGKA PANJANG (RPJPD 2005-2025)

3



Visi Pembangunan Daerah Provinsi Bali Tahun 2005-2025 adalah:  
**“ Bali Dwipa Jaya Berlandaskan Tri Hita Karana ”**



4

Dalam mewujudkan Visi Pembangunan Daerah Provinsi Bali tersebut, dijabarkan melalui 5 (lima) Misi Pembangunan Daerah Provinsi Bali sebagai berikut.

1. Mewujudkan masyarakat Bali yang unggul dengan mengedepankan pembangunan sumberdaya manusia yang berkualitas dan memiliki daya saing melalui peningkatan pendidikan, kesehatan, penguasaan iptek.
2. Melestarikan kebudayaan daerah Bali dengan memperkuat jati diri dan adat istiadat masyarakat Bali melalui pemberdayaan kelembagaan, pemantapan aktivitas seni budaya dan penerapan nilai-nilai agama yang dijiwai oleh Agama Hindu sesuai dengan tuntutan jaman.
3. Mewujudkan keamanan daerah dan masyarakat Bali yang berkeadilan serta demokratis dengan memperkuat sistem keamanan, meningkatkan peran masyarakat sipil, kesetaraan gender, budaya hukum, politik, dan memantapkan pelaksanaan otonomi daerah, serta penyelenggaraan pemerintahan yang baik.

5

lanjutan.....

- Mewujudkan masyarakat Bali sejahtera dengan meningkatkan pembangunan bidang ekonomi untuk mengurangi kemiskinan dan pengangguran serta meningkatkan pendapatan masyarakat.
- Mewujudkan pembangunan Bali yang lestari, handal dan merata dengan meningkatkan keseimbangan sumberdaya alam dan kelestarian lingkungan hidup, mengurangi kesenjangan pembangunan antarwilayah dan antarsektor, serta meningkatkan pembangunan infrastruktur termasuk kesiagaan untuk menghadapi bencana alam.



**PEMBANGUNAN JANGKA MENENGAH  
(RPJMD 2008-2013)**

**VISI DAN MISI PEMBANGUNAN JANGKA MENENGAH (RPJMD 2008-2013)**

**VISI**

**“Terwujudnya Bali yang Maju, Aman, Damai, dan Sejahtera”  
(Bali Mandara)**

**Bali Maju** adalah:

- Bali yang dinamis, yg terus bergerak menurut dinamika pergerakan dan perkembangan dunia dgn tetap menjunjung kesucian dan keiklasan demi tegaknya dharma.
- Bali yg harus tetap “metaksu” yg senantiasa meningkatkan kualitas dirinya sebagai daerah tujuan wisata yg handal, berkharisma dan religius.
- Bali yang modern menurut ukuran dan tuntutan nilai-nilai universal yg tidak menyimpang dan atau bertentangan dgn nilai-nilai agama Hindu (Bali) serta adat istiadat Bali. Kemodernan dalam rangka meningkatkan kualitas hidup dan peradaban sebagai masyarakat yang berada di perkampungan dunia yang terbuka.

**Bali Aman** adalah:

- Bali yg “dabdab” teratur sekala niskala yg memiliki keseimbangan antara korelasi kebutuhan hubungan antar manusia dgn manusia lainnya, hubungan manusia dgn alam lingkungannya, serta hubungan manusia dgn Tuhan-nya sejalan dgn konsep *Tri Hita Karana*.
- Bali yg terhindar dari ancaman intervensi virus-virus ideologi yg bertentangan dgn *Tri Hita Karana* seperti: terorisme, anarkisme dan virus *non traditional threat* lainnya yg mewarnai jaman Kali.

**Bali Damai** adalah:

- Bali yg diselimuti atmosfer kesejukan lahir bathin serta selalu dalam kondisi “tis” dan kondusif.
- Bali yg menggambarkan adanya komunitas masyarakat Bali, baik di perkotaan maupun pelosok pedesaan yg kental dgn suasana “*briyag-briyug, pakedek pakenyem*”. Hal tsb sbg indikator optimisme masyarakat dalam menatap masa depan yang menjanjikan.

**Bali Sejahtera** adalah:

- Bali yg *Sukerta Sekala Niskala*, sbg akumulasi diperolehnya kemajuan, keamanan, dan kedamaian.

**MISI**

**Pertama: Mewujudkan Bali yang Berbudaya, Metaksu, Dinamis, Maju dan Modern**

**Tujuan:** Meningkatkan dan mutu pendidikan, kesehatan, IPTEK, peran perempuan, kelestarian budaya Bali, daya saing, kecerdasan masyarakat dalam berpolitik serta pemerintahan yang bersih dan berwibawa

**Kedua: Mewujudkan Bali yang Aman, Damai, Tertib, Harmonis, serta Bebas dari Berbagai Ancaman**

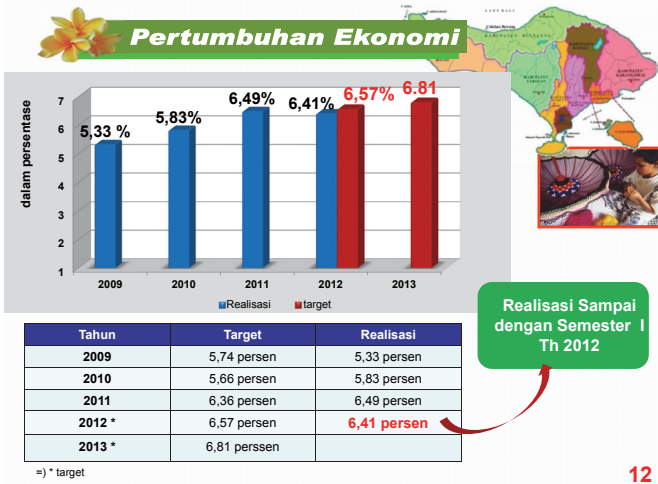
**Tujuan:** Mewujudkan pengaturan tata ruang, pelestarian lingkungan alam dan meningkatkan fungsi kawasan lindung, pengendalian dan pengaturan pertumbuhan serta persebaran penduduk, meningkatkan toleransi dan kerjasama antar umat beragama serta mewujudkan sistem keamanan yang berstandar internasional.

**Ketiga: Mewujudkan Bali yang Sejahtera dan Sukerta Lahir Bathin**

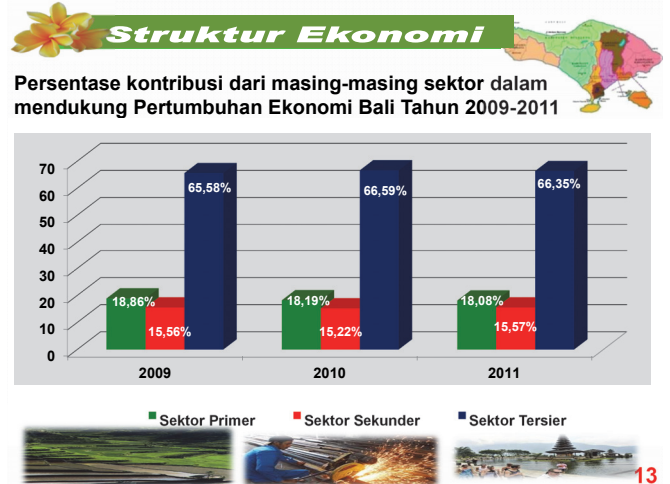
**Tujuan:** Meningkatkan daya beli masyarakat melalui pembangunan ekonomi kerakyatan yang tangguh, pengembangan industri kecil dan rumahtangga, serta industri pengolahan pertanian, kelautan, perikanan, dan pariwisata yang saling mendukung, serta pengembangan prasarana dan sarana publik.

**Pembangunan Ekonomi**

Provinsi Bali tidak seperti provinsi lain di Indonesia yang memiliki sumber daya alam yang potensial seperti pertambangan dan hutan, sehingga pembangunan di bidang ekonomi, Provinsi Bali bertumpu pada tiga sektor unggulan yaitu:



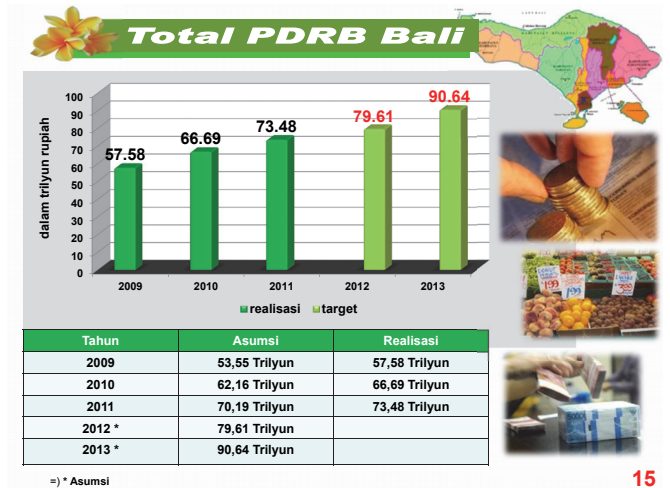
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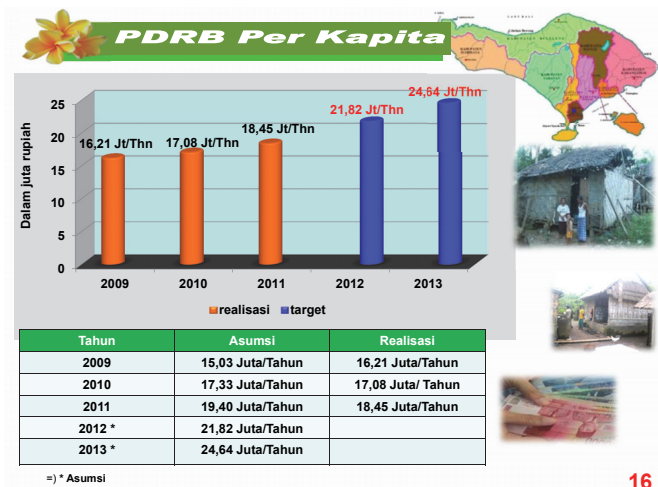
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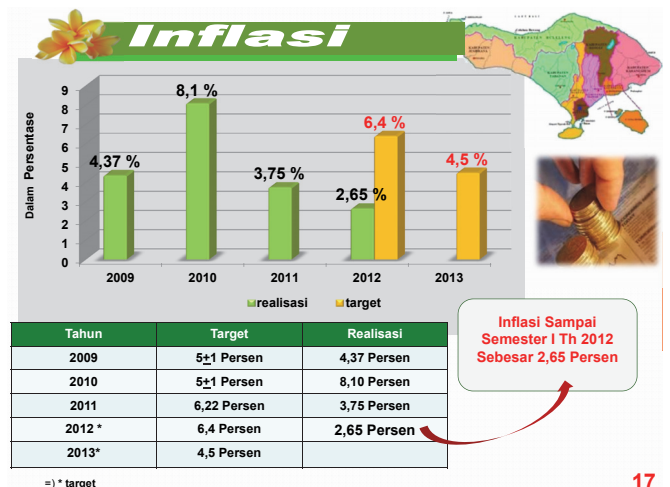
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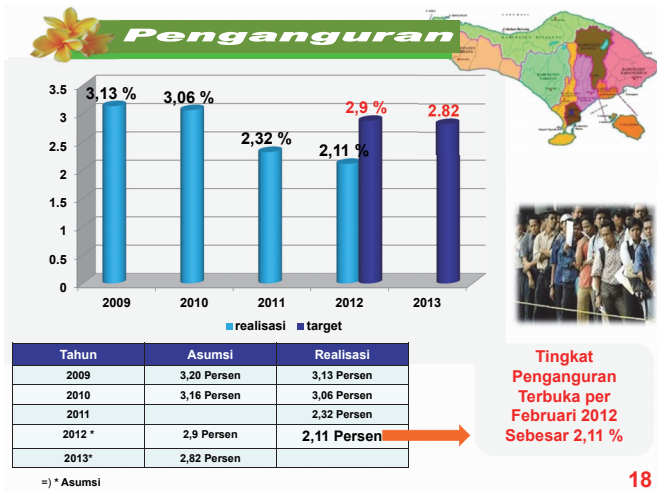
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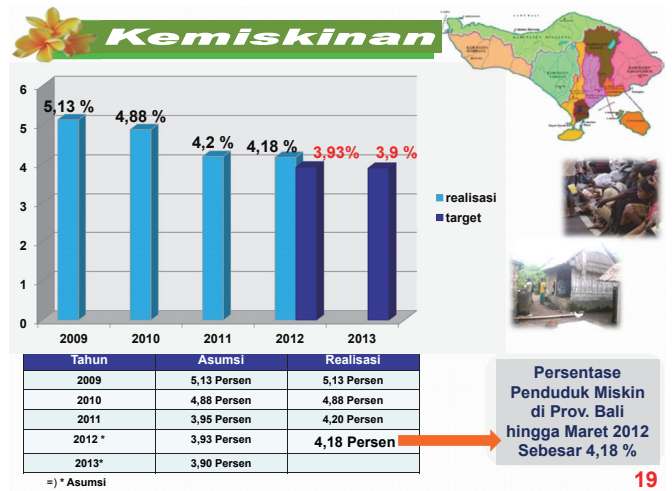
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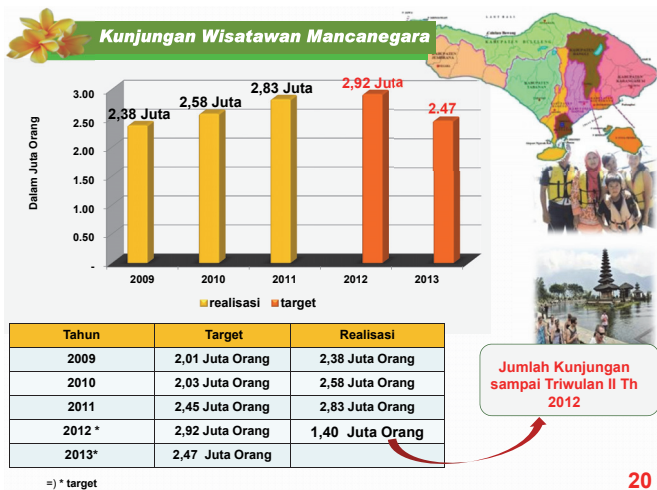
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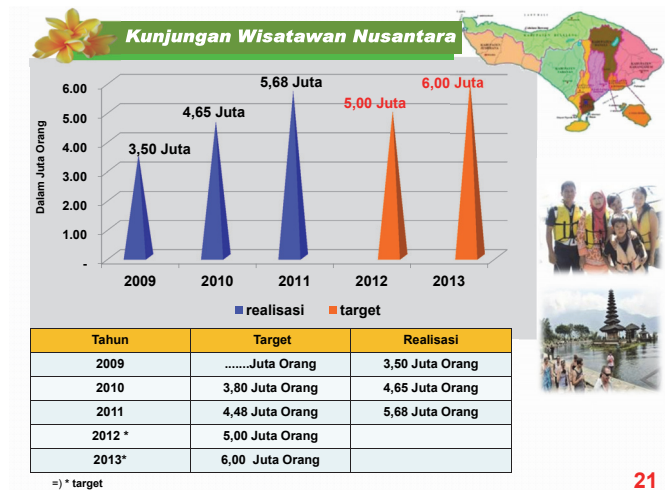
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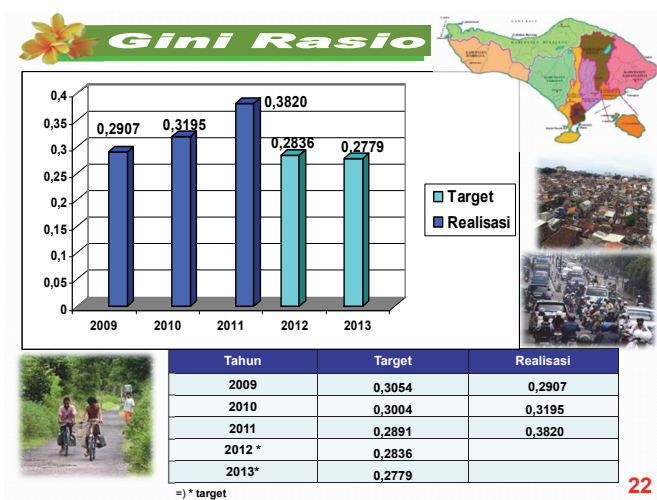
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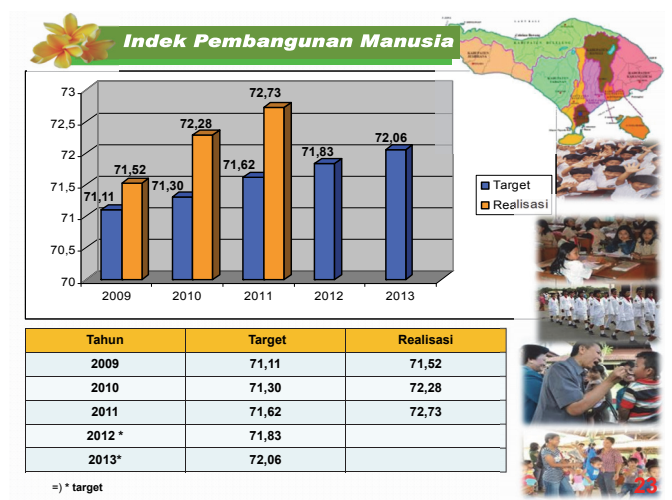
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## PROGRAM PRIORITAS BALI MANDARA

- Pendidikan
- JKBM
- Simantri
- Bedah Rumah
- Infrastruktur
- Lingkungan Hidup  
(Bali Clean and Green)
- Jamkrida
- Gerbang Sadu Mandara



Lampiran 1

## Bappeda Prov. Bali

### KEBIJAKAN PEMBANGUNAN

1. Dalam rangka mempercepat penuntasan wajib belajar 12 tahun
  - Penambahan ruang kelas baru,
  - Pemberian Biaya Operasional Pendidikan (BOP),
  - Pendirian Unit Sekolah Baru (USB).
2. Untuk meningkatkan akses dan mutu layanan kesehatan:
  - Peningkatan ruang puskesmas,
  - Penambahan kamar kelas III di RSUD Kab./Kota, dan
  - Peningkatan bantuan pengadaan obat-obatan (vaksin anti rabies).
  - JKBM



Lampiran 2

## KEBIJAKAN PEMBANGUNAN...

3. Dalam rangka mempercepat penurunan angka kemiskinan dan pengangguran:

- Peningkatan anggaran utk program Pro-Rakyat di Bali, al : PNPM Mandiri, Kredit Usaha Rakyat (KUR), Program Keluarga Harapan (PKH), Program Bedah Rumah untuk rumah tangga miskin dan penguatan permodalan UMKM (Jamkrida).

4. Dalam bidang infrastruktur :

- a. Bidang Perhubungan dan Transportasi :
  - Pemb. Lanj. pelabuhan Tanah Ampo, di Kab. Karangasem;
  - Pemb. pelabuhan penyebrangan Gunaksa - Nusa Penida, di Kab. Klungkung;
  - Pembangunan Jembatan Serangan - Tanjung Bena; dan
  - Penataan Persimpangan (Simpang Dewa Ruci);
  - Penyediaan Angk. Umum SARBAGITA



Lampiran 3

## KEBIJAKAN PEMBANGUNAN.....

b. Bidang Air Minum :

- Pemb. Lanj. jaringan distribusi penyediaan air bersih Telaga Waja di Kab. Karangasem;
- Penyediaan air minum Bali Selatan (SPAM-SARBAGITAKU), Khususnya dlm pemb. Instalasi Pengelolaan Air (IPA), Reservoir dan jaringan distribusi dari Tukad Penet di Kab. Badung, Tukad Petanu di Kab. Gianyar, dan Tukad Unda di Kab. Klungkung;
- Bantuan utk penyediaan air bersih perdesaan (Terutama untuk Daerah-daerah Krisis Air bersih di Kab. Karangasem, Bangli dan Klungkung);

c. Bidang Sumber Daya Air.

- Normalisasi Alur Tukad Unda, untuk mendukung pembangunan pelabuhan penyebrangan Gunaksa - Nusa Penida di Kabupaten Klungkung;
- Pembangunan Bendungan Titab di Kabupaten Buleleng;
- Pengamanan Pantai dan Sungai seluruh Bali;



Lampiran 4

## Bappeda Prov. Bali

### KEBIJAKAN PEMBANGUNAN.....

5. Untuk mengatasi ketimpangan pembangunan antar kabupaten/kota, kebijakan pembangunan diarahkan agar terjadi pemerataan Investasi Pemerintah dan Investasi Swasta ke Bali Utara dan Bali Timur;

6. Dalam rangka revitalisasi sektor pertanian diupayakan:

- a. Adanya regulasi yang mengharuskan hotel-hotel untuk memanfaatkan hasil-hasil pertanian lokal.
- b. Meningkatkan subsidi pupuk, bibit unggul dan pengembangan teknologi berbasis sumber daya lokal dan organik.
- c. Memantapkan Program Pertanian Terintegrasi (Simantri) dengan bantuan sarana prasarana, peningkatan kualitas SDM, dan pengembangan Iptek.



Lampiran 5

## Bappeda Prov. Bali

### KEBIJAKAN PEMBANGUNAN.....

7. Mengingat abrasi Pantai di Bali cukup parah dan kualitas lingkungan hidup cenderung menurun, diperlukan peningkatan anggaran untuk program pengamanan pantai dan program penghijauan.

8. Dalam rangka peningkatan pengamanan Bali terkait dengan seringnya penyelenggaraan event-event nasional dan internasional di Bali, terus diadakan penambahan sarana dan prasana pengamanan Bali.

Lampiran 6



**Terimakasih**



# AGRICULTURAL ACTIVITIES IN RELATION WITH THE CONSERVATION OF BALINESE NATURE AND CULTURE\*

By

**Dewa Ngurah Suprapta**

Faculty of Agriculture, Udayana University, Jl. PB. Sudirman Denpasar Bali Indonesia

Email : [biop@dps.centrin.net.id](mailto:biop@dps.centrin.net.id)

\* Paper presented in Seminar on Nature, Culture and Economics in Bali Island” organized by Bogor Agricultural University (IPB) and Research Institute for Nature and Humanity (RIHN) Kyoto University, Japan, to be held at Grand Mirage Nusa Dua Bali on September 5, 2012.

## SUMMARY

Humans cannot deny the fact that they are part of natural ecosystems and are greatly dependent on the functioning of natural ecosystems. The Balinese people are like other societies; in meeting their needs depend on the effort to manage the natural environment through agricultural activities. The interaction between the people of Bali with the environment gave birth to the knowledge that eventually shapes the culture of Bali. Indeed, Balinese culture is derived from agricultural culture. Traditional Balinese people have knowledge of agriculture inherited by their ancestors such as agricultural technology systems, community organizations, and religious ceremonies. Technology systems that exist in traditional farming systems such as irrigation systems, planting pattern arrangements, provision of seeds, control of pests and diseases, including post-harvest handling. This knowledge is generated based on the results of intensive interaction with the nature of Bali. A lot of local knowledge which is known as the "local knowledge" generated through this interaction and is part of Balinese culture. Local knowledge is growing and developing in general inspired by various Hindu religious values. Organization that works to support, preserve and develop local knowledge in the field of agriculture, especially related to the agricultural fields called "*Subak*" (traditional, social religious irrigation organization). The philosophy underlying the *subak* organization is "*Tri Hita Karana*" is the welfare generated by a harmonious relationship between man, nature and God. This philosophy was adopted into the culture of Bali and is applied in various aspects of life. Thus, agriculture is associated with many aspects of life, or in other words, agriculture has a multifunctional.

Based on the above explanation, agriculture should be properly developed and managed in such a way that on one hand can meet human needs for food, industrial materials, ingredients, and conserve ecosystems and maintain the culture of Bali on the other. To be able to do this, the agricultural development agencies should not rely solely on agriculture and farmers, but it must be supported by all sectors and all parties. Agricultural infrastructure such as irrigation systems and water supply; farm roads for the transport and marketing of agricultural products; provision of seeds, fertilizers and pesticides; financial support; support research and development to

produce new technologies in accordance with local resources; agricultural extension services and so on, must be proportionally conducted. Partiality by all walks of life to agriculture and farmers is needed to create a comfortable atmosphere for farmers to keep their jobs as farmers. Through this way, agriculture and culture of Bali is expected to be conserved.

**Key words:** agriculture, multifunctional, *Tri Hita Karana*, the Balinese culture.

## INTRODUCTION

The existence, progress and human welfare is strongly determined by the way how humans interact with the surrounding natural environment. Human interaction with the surrounding natural environment to maintain their existence and improve the quality of life requires people to develop knowledge and technology systems. Systems of knowledge and technology developed for the first time is a system of agricultural knowledge and technology that gave birth to the culture of agriculture. Greek philosopher and historian, Xenophon (427-355 BC; in Sinjal, 2006) states that "Agriculture is the mother and protect all other cultures". When farming went well, other cultures around would be prosperous, when it was abandoned, then all the other cultures would be destroyed".

In conception, the Balinese Hindu philosophy has laid a very noble about how humans should interact and manage natural and its contents as stated in the stanza 135 of Sarasamuscaya. "Seek the welfare of beings therefore it is not any mercy to all creatures, because their existence assured the upholding of "*caturwarga*" the *dharma*, *artha*, *kama* and *moksha* (Kajeng, 2005). It means that the Balinese should consider the existence and welfare of other living things when you want to achieve physical and spiritual welfare. Human is part of the "biotic" that inhabit this universe and all living things on earth depends on the nature and the environment around it.

As described also in the theory of ecosentrism, humans are not only seen as a social creature, but first must be understood as being the biological and ecological beings. Humans can only live and grow as a human being and full, the creature whose life depends on and is closely related to all other life in the universe. Without nature, no other living creatures, humans will survive, because man is only one entity in the universe. So humans are in nature and are bound and depend on the nature and all its contents (Keraf, 2002).

Therefore, to preserve living creatures, natural surroundings must be preserved. Nature, people and culture of Bali is a unity of inter-related and dependent on each other. Defective nature will not be able to provide welfare for humans and other living things. Therefore nature must be maintained in order to function optimally in a sustainable manner to support the entire life of living beings including humans and their culture.

Farming systems developed by farmers in traditional Balinese farming system is based on observation and experience of many years of community and the surrounding natural environment. They develop knowledge and technology cultivation, livestock, etc. to preserve plants and animals. When viewed from the facts of history, it is evident that the traditional farming systems are developed based on local culture for centuries and it demonstrates its ability to support life and the welfare of farmers from generation to generation. It is undeniable that Bali culture is developed as an actualization of the teachings of Hinduism. A very important role in the creation of the dominant culture of Bali over the livelihood of the population was carried out by farmers. Organization developed by farmers, namely *Subak* is an organization that provides a lot of contribution to the development of the Balinese culture as a whole. *Subak*, through the concept of *Tri Hita Karana* laid the foundations of Balinese culture is passed down up to the present time. Conception of man's relationship with another man in social life with a variety of democratic principles, culverts cooperation, justice, tolerance, mutual trust, dedication, sacrifice, self-development and so on. Conception of human relationship with nature that contains the various principles of how natural resources such as land, water, plants, animals should be managed in order to provide optimum benefit in a sustainable manner. Conception of man's relationship with God gives the basic principles of how humans should realize the Hindu Balinese sense of gratitude and thanks to the Creator of the Universe and its contents on the life and the life that He has given (Wiana, 2007). It is no exaggeration, when agriculture of Bali could be called "The mother culture of Bali", which gave birth to, raised, maintained and protected the culture of Bali. If we agree that agriculture is the mother culture of Bali, it is appropriate all the components of the community must come together to preserve and protect agriculture and the peasant of Bali to sustain the stable of Balinese culture.

Field plots made by the farmers, serve as natural ponds or small dams to hold the rain water before the water flows into water bodies such as rivers, lakes. The function of this field is very important because it can reduce the peak flood discharge at the downstream of a watershed.

Rice terraces with embankment serves to hold the water in the plot, so that soil erosion can be significantly reduced. Erosion of soil from a paddy field is lower than 2 tones / ha / year, and is roughly as low as the erosion of primary forest.

The beauty of the countryside with panoramic expanse of fertile agricultural land with a variety of activities on it, such as the activity of plowing, planting, hoeing, harvesting, various religious activities related to the fields was the inspiration for the paintings and objects of world famous painters who work in Bali. In addition, agricultural land environment is also a habitat for many species of birds, insects, small animals and microorganisms as they provide abundant food for life and their multiplication, as well as a beautiful tourist attraction that can be enjoyed by tourists.

Balinese Hindu community ancestors bequeathed various local wisdoms, such as the conceptions of an appreciation of plants and animals. Every 210 days (6 months in Balinese calendar) Hindu community conduct an offering specifically intended to plants, the day falls on Saturday (*Saniscara wuku Wariga*) and the day is well-known as “*Tumpek Uduh* or *Tumpek Bubuh*.” At *Tumpek Uduh* or *Tumpek Bubuh*, the Balinese Hindu communities make upakara (offerings) with one of its components is " marrow porridge " (porridge of glutinous rice is given a natural green color of the *Kayu Sugih* leaves, sprinkled with grated coconut and given brown sugar ( palm sugar). *Tumpek Uduh* not a day to worship the plant, but the day to ask God (*Ida Sang Hyang Widhi Wasa*) that via the plant, humans could be given the prosperity and safety and kept away from disasters.

### **Meaning of Agriculture for Community Life**

Agriculture is not merely the production activities as part of economic activity, but more than that, agriculture has multiple functions or multifunctional. Understanding of multifunctional agriculture is very important at all levels of society, so that there is overwhelming agreement on the role and functions of agriculture in its broadest sense, then determine a reasonable attitude and behavior towards agriculture and farmers.

Agriculture serves to support all forms of life, not just as providers of food, clothing and shelter for the needs of human life, but also plays an important role in the conservation of natural resources, supporting the economy in crisis; maintain social values and culture of rural as well as a support system of harmonious life all the time. In summary, agriculture serves to 1) maintain

an environment such as: preventing flooding, controlling soil erosion, maintain soil water supply, absorb carbon, or serves as an air freshener, absorbing organic waste, maintaining biodiversity, 2) preserve the traditions, culture and social life of rural , 3) provider of employment, 4) The basis for food security and national stability, and 5) the basis for economic growth (contributing approximately 18% Bali gross regional domestic product (GRDP) in 2010) (Salikin, 2003; Reijntjes *et al.*, 1999; Wibowo, 2000; BPS Bali, 2011). Unfortunately, up to the present day multifunctional agriculture has not been addressed or are still not fully understood by most people, or if they understood but it is often neglected.

The possibility of this fact is due to the existing market system has not taken into account the costs and benefits provided by farming on the environment and preservation of cultural values of Bali. Policies also tend to focus on activities that have short-term economic benefits and have not been touched multifunctional agriculture. Marginalization of agriculture and farmers until recently, are partly due to a lack of understanding of the multifunctional agriculture (Suprapta, 2005).

People not only use plants, but use different types of animals ranging from ruminants such as cows, buffaloes, goats, chickens birds, ducks and the like, various kinds of fish in both freshwater and at sea to meet the demand for animal protein. Animal protein is needed by humans for growth and development in order to live healthily. Creations and innovations to take advantage of animals for the sake of human life bring about the culture of husbandry and fisheries. Plants are very useful for many kinds of animals, on the contrary animals are very useful, not only for humans but also for plants. For example, in the process of pollination to produce fruit or seeds, different types of plants greatly have the process on insect activity that frequently visits the flowers. Various types of small animals in the soil and micro-organism in the soil are very useful to decompose organic material and release various types of soil nutrients as nutrients for plants. Some animals such as cattle and buffalo are also used for land preparation, although today the use of cattle for land preparation has been gradually replaced by tractors. There are at least 85 animals from four legged animals such as cattle, goats, buffalo, pigs, dogs, birds, freshwater fish in the river and in the rice fields, fish; forest animals and various types of insect or animal species inventoried as offering component for the community Hindu Bali (Institute for Community Service of Udayana University, 2007).

Thus the importance of animals to humans, so the Balinese Hindu society held a special ceremony for the animals on day 210 days that comes on Saturday of *Uye* (*Saniscara Uye*), known as the day *Tumpek Kandang*. On the day of *Tumpek Kandang*, various types of offering done to invoke the safety of various types of animals that can grow faster, healthier and bring prosperity to the people.

Balinese Hindu religious life cannot be separated from the agricultural and farming activities. Prostrate devotion and gratitude of Balinese Hindu society in general are carried out through various forms of religious ceremony, in which each religious ceremony is made in a means of "*Banten*" or offering. If you see the elements of offerings, it briefly comprises of the universe elements that is the product of agricultural activity. There are elements of the plants (roots, stems, leaves, fruits, flowers, seeds); there are elements of the animal (in the form of live animals, meat, eggs). According to a study conducted by the Institute for Public Service at Udayana University since 2001, at least as many as 280 plant species inventoried that are used as a means of offerings. The most common components of fruits and should be there is a banana. To the needs of at least 130,000 tons of bananas per year is needed for the purposes of making offerings in Bali. So farms and farmers' play important role for the life of the Balinese people, including maintaining nature and culture of Bali.

### **Bali Agricultural Conditions Today**

Bali has an area of approximately 5,636 km<sup>2</sup>, inhabited by about 3.5 million people (BPS Bali, 2011). Total agricultural land in Bali is 355,271 ha, consisting of 81,908 ha paddy field and 273,363 dry land. The total number of farmers' are 672,204 or approximately 31% of the total workforce in Bali in 2010 (BPS Bali, 2011). Agricultural land area cultivated by the farmers of Bali is very narrow, the average of 0.38 ha. With such a narrow area, it is very difficult to increase farmers' income and welfare when only relies on traditional farming systems.

The narrowness of the average ownership of land, the disruption of plant pests and diseases and natural disaster (drought or flood), low education, low mastery and access to technology, low capacity of the capital and access to capital, low agricultural prices and tends to fluctuate quite sharply and the lack of access and market information led to the welfare of farmers' incomes and relatively continuous decline. This condition is exacerbated by the increasing prices of inputs in the form of seeds, fertilizers and pesticides along with the rising

cost of living led to the exchange of agricultural products are declining and the ability of the farmers declining from year to year. In the period of the 1960s to the 1980s, many farmers are able to send their children to school from the farm. Many Bachelors, Doctors, and even the Professor were the son of farmers, living and attending school of agricultural products produced by their parents. This is very rare condition found in the present. Let alone to send their children to college, to meet the day-to-day life (clothing, housing and health) of most farmers are still difficulties and most of them are still classified as poor people.

Image of agriculture and farmers continue to experience deterioration. Farmers are identical with the figure of an old man, poor, shabby, and resigned to fate. When the government abolished subsidies on fertilizers and pesticides, and increase fuel prices (in 2005 the average fuel price increases of more than 100% and in 2008 approximately 28%) which trigger an increase in all prices of basic commodities, raising the highest retail price of fertilizer, not accompanied by policies to ensure a market for agricultural products at a reasonable price resulted in the fate of farmers and the welfare level declined. Not only that, work as a farmer by most people is considered to be the kind of work with the lowest social status. For example, there is a saying among the people of Bali are "*tani kelen*" is a phrase that are mocking someone who is perceived as less advanced, or the simple old-fashioned. Using the word "peasant" for the expression to mock can certainly be interpreted as an insult, not a profession of respect for farmers. When the price of agricultural output has increased for example an increase in prices of rice, soybeans or corn, then the government's policy always gives preferential option not to the farmers as producers but to consumers through import and market operation mechanism. As if farmers do not have the right to increase prices and do not have the right to live in prosperity. This profile is certainly very far from the plume, so most young people do not want to inherit their parents work. Parents direct their daughters and sons not to work in the agricultural sector.

Conditions as mentioned above are a very serious threat to the survival of agriculture in Bali. As long as farmers and their family are not prosperous and have not been able to get out of poverty, for the length of the time agricultural development can be said to have not been successful so there needs to be continuous real effort to revitalize agriculture of Bali.

## **How to Promote Agriculture**

In the history of human civilization, there is no nation in the world can be large and sustained without the support of agriculture. Until now, the advanced industrial countries such as Japan, South Korea, the United States and European countries still preserve the agriculture.

If we agree that agriculture is very important for the Balinese people, nature and culture of Bali, the farm should be built in order to move forward. Many argue that Indonesian agriculture has not developed, compared with neighboring countries in Southeast Asia. Yes, this is indeed a reality, and thus we must give priority to work on a planned manner, and truly massive. To develop agricultural cannot be simply imposed on the department of agriculture with the farmers, but must be supported by all sectors of development such as infrastructure, transportation, education, energy, industry, banking, commerce, law, research, and the preferential option for the agricultural community and farmers. Agriculture has not developed, as other sectors directly related to the agricultural development have not been optimally developed. The sectors have not been able to synergize with the agricultural sector, even becomes a burden on the agricultural sector.

Every effort should be made to build and raise farm. Revitalization of agriculture should be conducted in a planned, in earnest and to encourage large-scale infrastructure development, human resource development, capital investment that focused on agriculture, from cultivation to industry and marketing. We need more attention on developing farm roads, irrigation networks, ports that support the marketing, storage facilities and so on. We need to build advanced seed production system, to produce superior seeds independently. Local initiatives to produce fertilizers and pesticides based on local raw materials need to be continually nurtured and encouraged. Agricultural research should be intensified to produce agricultural science and technology to be competitive and in accordance with the requirements and conditions of Bali. Agricultural extension needs to be intensified so that farmers have a companion in solving agricultural problems directly at the field level. Regulation in the field of industry, commerce and finance should protect and stimulate the agricultural sector. Incentive scheme in the provision of agricultural investment with low interest rates is needed to encourage investment in agriculture, since agricultural development will not succeed if the investment in agriculture is less enthusiastic.

## **Early education on Agriculture**

When the author was in high school (around 1967) there were school programs that cater to gardening or farming activities which are called creed days. To support these activities, the school developed the school garden. Through the school garden pupils were taught to be familiar with plants and crops, and taught how to give raise to, how to plant, how to nurture it, harvest it and how to cultivate it until it can be consumed. The pupils experience themselves, how to process and severity of farming and gardening to produce food stuff. How sweat running must pass to produce food. Through the school garden the pupils know about the season, when to plant what, to farming success. Unfortunately, the activities of the school garden and the creed day have long no longer been held. Not infrequently children are not familiar with the environment, are less familiar to plant species, and ultimately less appreciate its benefits. Even the pupils not understand how the agricultural products were produced from the sweat running farmer. It's good that school gardens and agriculture education program to be revived to an understanding of the crop, livestock and farming methods and, more importantly understand and appreciate the multifunctional of agriculture to maintain the continuity of life since an early age. "Home Stay" program in the farmer family to provide direct experience to the students early and provide opportunities for them to feel how hard and at once noble to be farmer as applied to farming in the country of Japan, seems to be necessarily adopted in Bali. Knowledge and understanding of the true will result in a correct and proper attitude towards agriculture and farmers in the end we expect to behave in a correct, proper and fair to agriculture and farmers.

Educational process as above, it certainly cannot be handled by the Ministry of Agriculture, but by the Ministry of National Education is also possible by cooperating with the Ministry of Agriculture in developing curriculum and programs.

## **Concluding Remarks**

Throughout human life, they depend on plants and animals, during which people depend on agriculture and farmers. Agriculture should be seen as a sector that has a multifunctional, not only economic function that produces food, clothing and shelter but also has the function of ecological and social functions of cultural and social politics. Hence, agriculture must be constructed so that Bali is more advanced and can provide a decent life for farmers as the main actor.

Bali agricultural development can not only be charged to farmers and agricultural workers because agriculture has a very close relationship with other sectors including the participation of the entire community. Agricultural production facilities and infrastructure such as provision of seeds, fertilizers, pesticides, irrigation, water supply, agricultural roads, means of information and communication should be established to support agricultural development. In addition, processing infrastructure and marketing results should also be developed in line with market needs, both locally, nationally and internationally. Legislation that promotes investment in agriculture coupled with agricultural financing investment schemes that is conducive is needed, because it is hard to build a farm without investment in agriculture.

Early education to children of multifunctional agriculture for the preservation of all life in nature and in preserving Balinese culture needs to be done in a structured, so that they have the right knowledge about agriculture for the next act and behave in a fair on agriculture and farmers.

## References

1. Anonim. 2001. Subak. Bali Province Cultural Office (in Indonesian language).
2. BPS Bali. 2011. Bali in Figure. Bali Province Statistics Agency (in Indonesian and English).
3. Kajeng, I.N. 2005. Sarasamuscaya. Penerbit Paramita Surabaya (in Indonesian language).
4. Keraf, A.S. 2002. Environmental Ethics. Penerbit Buku Kompas. Jakarta (in Indonesian language)..
5. Institute for Community Service of Udayana University. 2007. Animals for Offering : materials for Balinese Hindu Religious Ceremony (in Indonesian language).
6. Salikin K.A. 2003. Sustainable Agricultural System. Penerbit Kanisius. Yogyakarta (in Indonesian language).
7. Sinjal, D. 2006. Agriculture is mother of all types of culture. Opini. Sinar Harapan. Harian Umum Sore, Kamis 10 Agustus 2006 (in Indonesian language).
8. Suprpta, D.N. 2005. Agriculture of Bali is Respected, but Farmers are Still Poor. Penerbit Taru Lestari Foundation dan Buku Arti Foundation in Indonesian language).
9. Reijntjes, C., Haverkort, B. dan Waters-Bayer. 1999. Agriculture in the Future. Penerbit Kanisius. Yogyakarta (in Indonesian language).

10. Wiana, I K. 2007. Tri Hita Karana According to Hindu Conception. Penerbit Paramita Surabaya (in Indonesian language).
11. Wibowo, R. (Ed.) 2000. Agriculture and Food : opinions towards food security. Pustaka Sinar Harapan, Jakarta (in Indonesian language).



## Agricultural Activities in Relation with the Conservation of Balinese Nature and Culture



## Outline of presentation

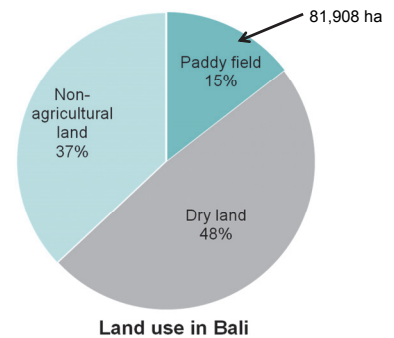
1. Introduction
2. Conception behind Bali agriculture
3. Existing condition of Bali Agriculture
4. How to promote agriculture in Bali
5. Concluding remarks

### Bali Island, Indonesia

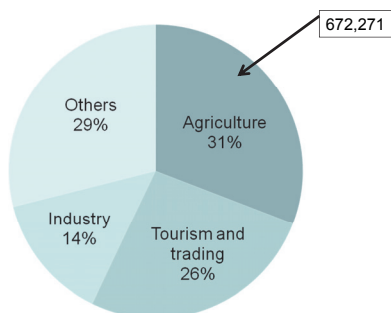


Population in 2010 : 3.5 millions. In 2012 : 3.9 million  
 Total area : 5,636.66 km<sup>2</sup> : density : 672/km<sup>2</sup>

Total area : 563,666 ha



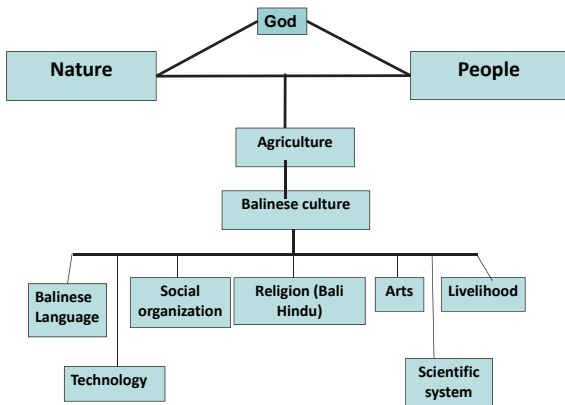
Total work force : 2,177,538



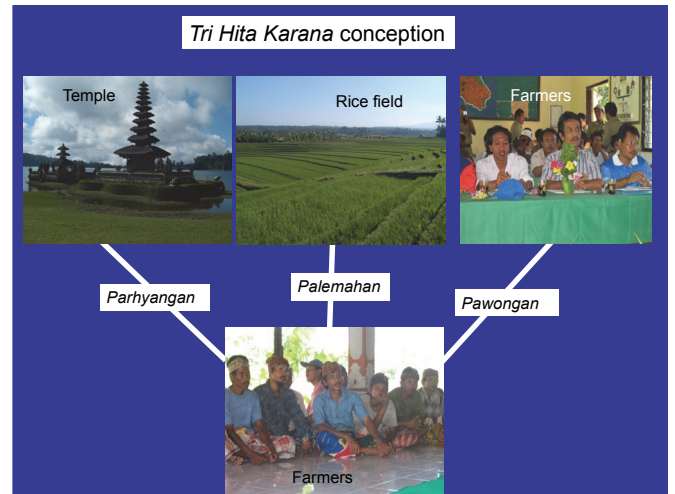
Distribution of working force in Bali

## Conception behind Bali Agriculture

Human being is part of nature. Their lives and welfare are depend on how they are interact with and manage the nature and its contents  
 (Saracamuscaya holly book stanza 135)



Conception of Balinese people on Nature, People and Agriculture

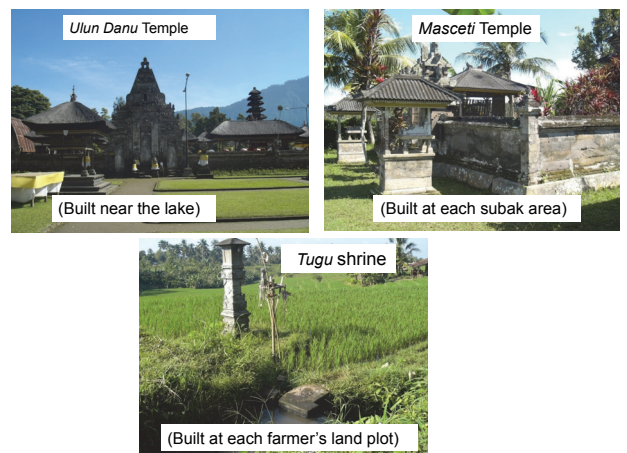


Implementation of *Parahyangan* :

1. Establishment of temples : place for worship of God
  - *Ulun Danu* temple : at four lakes in Bali
  - *Ulun Suwi* temple : at one region or several subaks.
  - *Bedugul* temple : built at dam or division of water
  - *Masceti* temple : built at each subak.
  - *Tugu* shrine : built at each farmer's rice field plot.

2. Ceremonies :

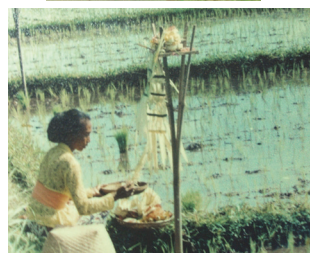
- Collective/group ceremony
- Individual ceremony by each farmer : from land preparation to the harvest



Collective ceremony at *Ulun Danu* Temple  
(*Magpag Toya* ceremony)



Individual ceremonies, from seedling preparation (*ngurit*), transplanting (*nandur*) and 2-3 week before harvest (*biyukukung*)



## Special ceremonies related to plants and animals

1. Tumpek Bubuh, Tumpek Bubuh, Tumpek Wariga : conducted every 210 days. Worship for the healthy and productive growth of plants (25 days before Galungan day).
2. Tumpek Kandang : worship for the welfare of animals, so they can support the livelihood of human being.

## Agriculture and Balinese Hindu Ceremony

1. Ceremony is part of agricultural activity
2. Agriculture is provider for various necessities to conduct ceremony



Three the most important agricultural produces to maintain Balinese culture :

1. Rice
2. Coconut
3. Banana

More than 90 cultivars of banana are needed as components of offering in Bali



Animal as components of offering

Implementation of *Palemahan* :

There are six efforts which must be done to conserve the nature called *Sad Kertih* :

1. *Atma Kertih* : an effort to conserve and purify the *Atma* (human spirit and soul).
2. *Samudera Kertih* : an effort to conserve the ocean resources that having multifunction in human life.
3. *Wana Kertih* : an effort to conserve the forest along with its biodiversity
4. *Danu Kertih* : an effort to conserve fresh water resources such as spring, lake, river.
5. *Jagat Kertih* : an effort to conserve the harmony of truth-based dynamic and productive social relation.
6. *Jana Kertih* : an effort to develop human inner prosperity and human morality.



Implementation of *Pawongan* :

Existence of Subak : organization developed by farmers to manage, maintain and preserve the water and land resources and social harmony.

- Subak management : by Pekaseh (head of Subak)
- Subak rules (awig-awig)
- Subak meeting
- Subak activities



One of Subak activities : to maintain water flow in tertiary canals.



Subak meeting : to decide programs and activities

## Bali Agricultural Condition today

- ❖ Total farmers : 672,204
- ❖ Average farming size : 0.38 ha per farmer
- ❖ Family size : 4 persons
- ❖ Age : more than 50 years
- ❖ Education : 80% graduated elementary school
- ❖ Lack of financial access
- ❖ Lack of market access
- ❖ Low productivity
- ❖ Land conversion is high



Land conversion problem

## How to promote agriculture

1. Protection to the agricultural land
2. Affirmative action to the farmers :
  - Taxation policy
  - Access to technology
  - Financial support
  - Market access and price policy
3. Strengthening R & D and education in agriculture
4. Early education on multifunctional of agriculture among young generation

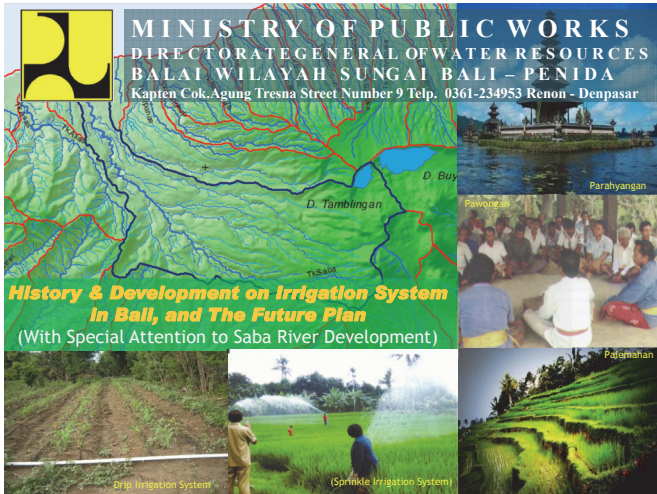
## Concluding remarks

- ❖ Agriculture in Bali is thought to be the first culture developed by Balinese people, and it influences all components of culture including economic, social, politic and ecological.
- ❖ Agriculture activity in fact is activity for the conservation of Balinese nature and culture, thus its existence should be maintained in a sustainable way.



Thank you





## Order of Presentation

- Preliminary
- Irrigation system in Subak
- History and Development of Subak in Bali
- Subak Organization
- Irrigation Activities of BWS Bali-Penida in the Watershed of Saba River
- The Future Plan of BWS Bali-Penida to Develop The Irrigation Area in Saba River

## Preliminary

- Dealing with local issues concerning food security due to population growth and agricultural land-uses high with global climate change, intensification of agriculture and plantation in Bali should be enhanced through integrated management of the irrigation system on a single stream (one river one management) based **Tri Hita Karana** .
- Based on Government Regulation 20 of 2006 on irrigation, there are two irrigation systems in Bali, namely:
  1. Surface Irrigation System
  2. Groundwater Irrigation Systems

Groundwater irrigation system does not exist in Tukad Saba, this is due to surface runoff Tukad Saba is enough to irrigate the surrounding area irrigation.



Ground Water Irrigation System developed in the Buleleng, Jembrana and Karangasem which have little surface water potential.

## Irrigation system in Subak

- In traditional societies, social relationships play a major role keyword is actually a success in irrigation technic owned Subak. This is one reason why the subak irrigation system **difficult to implement** outside of Bali different areas of social life and culture, although irrigation engineering systems for a similar topography can be replicated. The difference lies in the social and cultural system that has been entrenched. Technology products can be meaningless stuff, if social conditions do not match the wearer, especially not to accept it. Experience in the construction of the development on the Balinese Subak irrigation can be used as an example, that the building is less become familiar by the wearer, since they do not correspond to their social and environmental conditions.

## Irrigation system in Subak (advance)

- The concept of " **melu handarbeni** " (sense of belonging) not simply be applied if they are not involved from the beginning to the completion of the process, especially technology products will be their responsibility to operate and maintain it.
- The concept of **Tri Hita Karana** is a unified system like the human body does not want any defects. Any change requires a new balance, physical (scale) and non-physical (abstract). The existence of defects is actually unwanted by every human being, because it brings unhappiness to the purpose Subak Hindu.
- **The conclusion** is in the development of new technologies, which caused a change in the system, it is necessary to balance the new physical and non-physical, and sought no defects.

## History and Development of Subak Irrigation in Bali

- Prior to the Indian government - the Dutch government developed in Bali, all the irrigation network has been built and developed by Subak itself independently with existing technology built and developed by Subak itself independently with the technology they have. Since the Dutch Government expand in Bali, several buildings Subak a vital and important fixes attention mainly on the main building. From then on the developing technology and building materials water hydraulics of the couple stone, and iron. These conditions continued until 1969, and since the introduction of Five Year Development Program (Pelita), development of irrigation in Bali who have rehabilitation, repair, improvement and refinement.

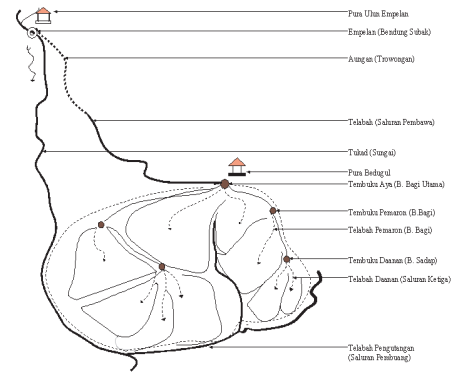
## History and Development of Subak Irrigation in Bali (advance)

- With permanent dams on the river have an influence on river water system, because there is no flow of water through leaks emergency channel, all water in the upstream weir flow into irrigation canals. Subak felt downstream water shortages. These conditions impact of social change, in the form of merger-Subak Subak irrigation in a region or in a stream. Grow coordination called Forum Subak SUBAK GEDE or SUBAK AGUNG to a stream, river, to coordinate water management for the wider region.



## Glance of SUBAK SYSTEM

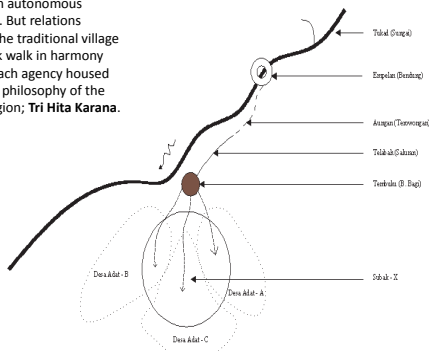
The concept of Subak irrigation networks is very complete ranging from the building of decision (empelan), building splitter (Temuku aya), the building taking in the channel (Temuku) to plot the distribution channel to the rice terraces;



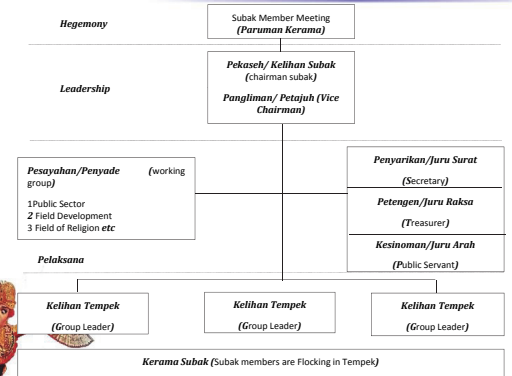
## Glance of SUBAK SYSTEM

Irrigation channels can traverse multiple administrative regions. Therefore subak membership is not limited to a single administrative region. (according to the hydrological and topographical region).

Subak is an autonomous institution. But relations between the traditional village with subak walk in harmony because each agency housed within the philosophy of the Hindu religion; **Tri Hita Karana**.



## SUBAK ORGANIZATION



Basically subak as an association of organizations of farmers in Bali is a permanent and autonomous institution, and not much rely on village government and local government.



## SUBAK AS THE MANAGER OF AN IRRIGATION SYSTEM

Overall wisdom contained in subak organization, the categorical consists of;

- religious wisdom → beliefs about the divine, spiritual, which is the spirit of life subak organization
- cultural wisdom → cultural energy that includes ethics, logic, and of practical → maintain the tri hita karana
- ecological wisdom → conservation, environmental balance and sustainability
- institutional wisdom → organizational integrity of subak
- economic wisdom → businesses that are creatively and productively
- legal wisdom → Legality aspek
- technology wisdom → technological capabilities
- security wisdom → securities peasant farming life



## Water Regulation

- Under no circumstances is not enough water to irrigate simultaneously across paddy fields, irrigation water is set in rotation. Rotation can be carried out by the group in the Subak and within each group.
- Water regulation turn to the subak (tempek) in one Subak regulated and supervised by each kelihan Tempek (Group Leader). For the group receiving the initial turn-called "NGULU", the group receiving the second turn called "MAWONGIN" and for the last third or so-called "NGASEP". Water management is also done by regulating the cropping pattern and cropping rotation.



## Proposed BWS-Penida Bali for Handling Irrigation Area of Saba River (3.887 ha)

Based on Revision of Ministerial Decree of Public Works no : 390/KPTS/M/2007 due to Bali as nationally strategic river areas and to support an increase in food BWS Bali Penida proposed changes status irrigation management authority of some areas to be bws bali-penida, authority one exception is in Irrigation Area of Saba River.



## Irrigation Activities of BWS Bali-Penida in the Watershed of Saba River

### PTGA Activity (1991– Present)

- Activities carried out in order to improve the quality of human resources in the management of Water Resources for irrigation purposes.
- PTGA activity has started since 1991, ie since the development of subak museum was built in 1981 to Mandala Mathika.
- PTGA activities in the Saba watershed began in 1993 with the number of members of the subak (P3A) that as many as 226 people received training subak members are divided into 5 generations.
- Until now PTGA activity has trained as many as 13,253 members divided into 476 subak generations.

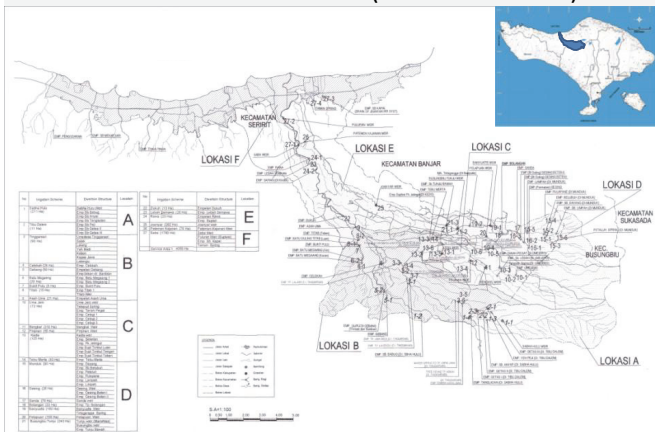
### DISIMP 1 Activity (2006 – 2009)

- Is a transition from activity SSIMP phase III to activity DSIMP (*Decentralized Irrigation System Improvement Project*)
- One area of activity is the watershed of Saba River
- Activities include rehabilitation of irrigation infrastructure as well as the development and implementation of guidelines for participatory irrigation management at irrigated area in the Saba watershed

### Irrigation Area Rehabilitation Tukad Saba in Buleleng (Year 2012)

Rehabilitating irrigation infrastructure in Saba irrigated areas, Pelapuan irrigated areas, Trngarsari irrigated areas, Busungbiu Tunju irrigated areas and Kedis irrigation areas.

## Regional DISIMP 1 Activity in Watershed of Saba River (Year 2006 - 2009)



## The Future Plan of BWS Bali-Penida to Develop The Irrigation Area in Saba River

Tangible manifestation role of BWS Bali-Penida in developing Subak irrigation systems, particularly in Saba River, among others:

### Construction of Titab Dam

DI Saba and DI Puluran is 2 DI at a lower-Tukad Saba, Saba debit intake weir and the weir Puluran low in the dry season can be enhanced by the Titab Dam. Debit suplesi Titab Dam planned increase cropping intensity DI Saba and DI Puluran of 169% and 275%.



### Continuing PTGA activities in the watershed Saba

Providing irrigation management training was updated to subak members (PP implementation, 20th 2006 on irrigation), and then monitor its implementation in the field. These activities also facilitate the formation of Subak Gede for a group of similar interests.



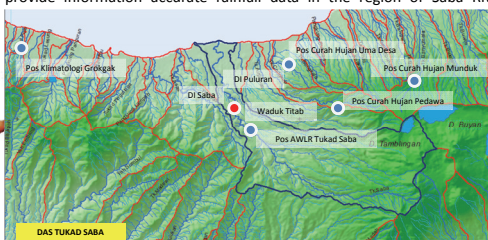
## The Future Plan of BWS Bali-Penida to Develop The Irrigation Area in Saba River (Advance)

### Preparation of Management Patterns of Water Resources Rivers Region Bali-Penida, Phase I

Inventory of water resource data and policy matrix water resources policy including cropping pattern and water allocation procedures appropriate for the irrigation networks in Bali

### Post Hydrology Maintenance

Through the rationalization of postal activities hydrology in order to provide information accurate rainfall data in the region of Saba River



## The Future Plan of BWS Bali-Penida to Develop The Irrigation Area in Saba River (Advance)

### Water Resources Information System

Water Resources Information System, in which there is a software operation PDSDA-PAI (Data Processing Resources Water - Irrigation Asset Management). Input data assets will be combined with data irrigation hydrology and climatology at a watershed in order to get the availability of discharge (dependable flow) and climatological conditions are widely accessible (on-line) by all levels of society (especially by farmers).



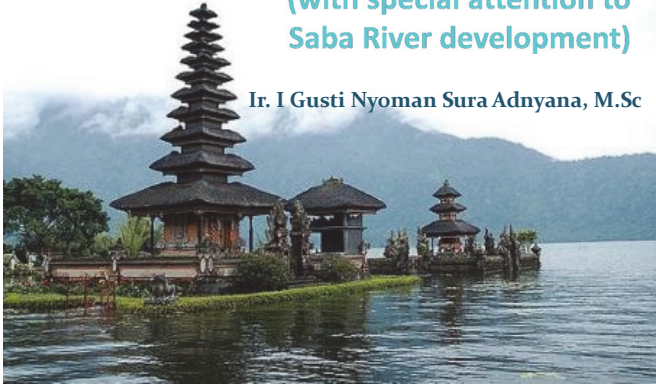
**THANK YOU FOR YOUR ATTENTION**



**OM SANTIH SANTIH SANTIH OM**

## HISTORY AND DEVELOPMENT ON IRRIGATION SYSTEM IN BALI (with special attention to Saba River development)

Ir. I Gusti Nyoman Sura Adnyana, M.Sc



## INTRODUCTION

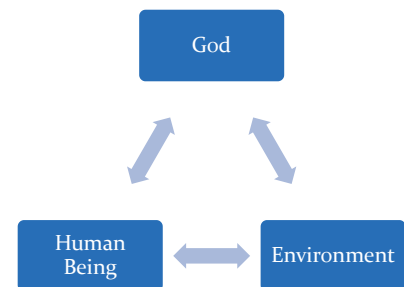


- Surface irrigation system in Bali is known as Subak System which is quite famous in the whole wide world.
- Ground water irrigation system → Not exist in Saba River
- The main purpose of subak is managing the irrigation among their own members, whom each of them is equally, transparently and fairly treated in achieving the welfare

## Characteristics which differing subak from other irrigation systems:

- The philosophy of Tri Hita Karana
- The norms of collectiveness and justice which are performs in proportional division structure
- Topography of the land that allows gradual and continuous water usage (and reuse of irrigation water)

Tri Hita Karana means ways to achieve happiness, through harmonious relationships among Three components : God, Environment and Human Being itself



- Human being and God is actualized on holy structures as well as the ceremonial systems
- Human being and the environment such as rice fields, water sources, catchment area as well as its management.
- Among human beings, in form of subak organization and the organization norms

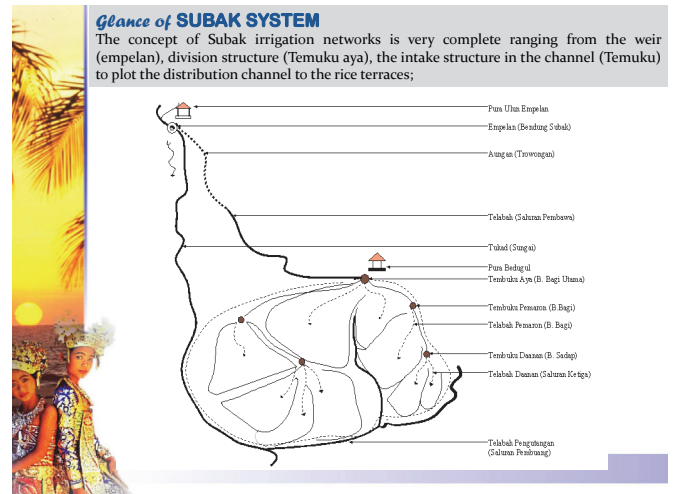
## History of Subak

- No certain years stated the *Subak* founding. However, according to the written evidences, Dr. Gorris estimated 600 AD (1,400 years)
- On Majapahit era (1300 AD), The King charge an *Asedahan* to coordinate some Subak and collect agricultural taxes
- The *Asedahan* is now known as *Pasedahan*
- During the Dutch Government in Bali some irrigation structure were improved using masonry and concrete.

- After the Republic era, the Government continuing its roles on irrigation system
- Various irrigation facilities and trainings for subak has been established, so that there are changes on the technical condition and the operational system of the Subak facilities.

### Glance of SUBAK SYSTEM

The concept of Subak irrigation networks is very complete ranging from the weir (empelan), division structure (Temuku aya), the intake structure in the channel (Temuku) to plot the distribution channel to the rice terraces;



## ORGANIZATION

- SUBAK is led by *Kelian Subak* or *Pekaseh*.
- But there are vary of terminologies for this position in each region.
- Other subak management are : secretary (*penyarikan*), treasures (*petengen*), and messenger (*kasinoman*)

- Based on the intake structures, several subak are grouped into Subak Gede, and led by Pekaseh Subak Gede or Kelian Subak Gede
- In the past, Sedahan Agung was responsible to manage and supervise the entire subak in one regency.
- Currently some governmental agencies which hold the Subak, those are : Agriculture Service, Culture Service, Financial/ Revenue Service and Public Work Service

## MEMBERSHIP

Subak membership is categorized in to:

1. Sekehe Yeh : they who are directly involved on attempting water (active members)
2. Kerama Pengoot : they who are not involved on attempting water but obliged to pay (inactive members)
3. Leluputan : they who do not need to work on attempting water and not obliged to pay (Pemangku, Bendesa Adat, Board of Subak)

## WATER SOURCES

- Rainfall → annual rainfall : 1000 mm-3000 mm
- Lake & Rivers → - 4 lakes  
- 165 main rivers, 401 branch rivers  
- 4 dams + 1 underconstructions
- Springs : 1,273 (Q > 10 lt/dt → 359)
- Ground Water

## OPERATION AND MAINTENANCE

- Before the development of permanent weir by the government, all the operation and maintenance activities are conducted by Subak.
- Since the weir being permanent, half of this responsibility is taken over by the government staff.
- In worst conditions, farmers also performs their participation through collective working, material or money
- Meanwhile on the tertiary canal, operation, maintenance and scheme reparation are conducted by each "tempek" related to that particular scheme

## WATER RIGHT FINANCE

- The division structures or off-takes structures are partially broad crests with a width proportional to the number of subak members, or to the rice fields area downstream
- A portion of irrigation water is then paid in form of yields called suwinih

In case that available water is not sufficient to the entire subak area, three models could be implemented:

- Each Subak member receives a proportional water and reduced their cultivated land.
- The planting period of subak area is scheduled gradually, "Ngulu" (take first) ; "Maongin" (secondly) and "Ngasep" (the last) → staggering in rice planting.
- Implementing rotation cropping pattern.

## Financial Sources for OM

- Suwinih (fee in nature)
- Pengoot (payment for gotong-royong work substitution)
- Dedanda (payment for meeting or gotong-royong absence)
- Government aid.
- Others

## The Future of Subak

### External Threaten

Subak s extremely stressed by:

1. Land for agriculture is now decreasing due to the acquisition by non-agricultur purpose.
2. Water demand for non-agriculture sectors are increasing.
3. Trade-off between wet land yields to manufacturing products is getting lower.

### Internal Threaten

Several weakness of Subak:

1. The very small land cultivated by farmers.
2. Low education and financial capacity reduce their agricultural business as well as applying new technology or inovation.
3. Farmers motivation to maintain their wet-land activities are decreasing especially in young generation.

## SUBAK STRENGTHENING AND EMPOWERING

Agriculture is still hoped to run and exist.

- Several strategic action are proposed:
  1. Empowering subak bargaining to prevent land and acces to water resource through Subak Union and or Subak Federation
  2. Involve Subak or farmers delegation on water resource management in river basing level
  3. Allowing Subak to manage their own river area which its compotions of water usage dominated by wet land agriculture
  4. Conserve all of the irrigation scheme functions and and service areas through strategic policy in the spatial planning
  5. Guidance and training

## Development Activities of BWS Bali-Penida in the Watershed of Saba River

### PTGA Activity/ Water Management Training (Year 1993)

- Activities carried out in order to improve the quality of human resources and to empower the Subak farmer itself to know their needs, their problem, and efforts to overcome the problems by discussion, participatory, dialogue.
- PTGA activities in the Saba watershed began in 1993 with the number of members of the subak 226 people trained, divided into 5 group.
- PTGA activity in Bali has started since 1991, since the establishment of Subak Museum in Kediri Tabanan. Up until now PTGA has trained 13,253 members divided into 476 group.

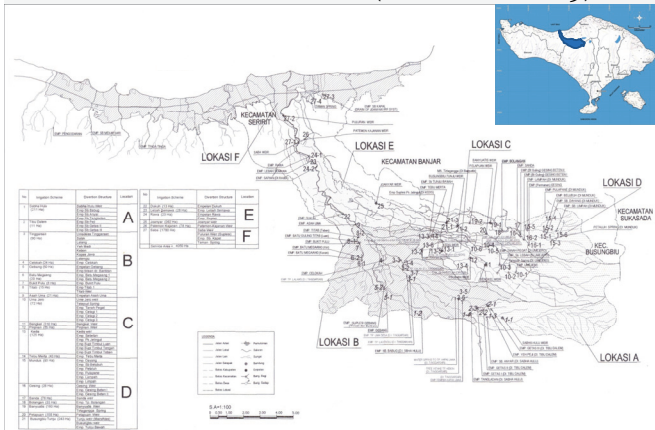
### DISIMP 1 Activity (Year 2006 – 2009)

- Is a transition from activity SSIMP (Small Scale Irrigation Management Project) phase III to activity DISIMP (Decentralized Irrigation System Improvement Project)
- One area of activity is the watershed of Saba River
- Activities include improvement of irrigation system as well as the development and implementation of participatory irrigation management at irrigated area in the Saba watershed → introducing of paddy SRI (System of Rice Intensification) technology

### Rehabilitation of Saba River Irrigation Area in Buleleng Regency 159 ha (Year 2012)

- Rehabilitating irrigation infrastructure in Saba irrigated area (426 ha), Pelapuan irrigated area (157 ha), Tingarsari irrigated area (96 ha), Busungbiu Tunju irrigated area (300 ha) and Kedis irrigation area (180 ha).

## Regional DISIMP 1 Activity in Watershed of Saba River (Year 2006 - 2009)



## Proposed BWS-Penida Bali for Handling Irrigation Area of Saba River (3.887 ha)

Based on Revision of Ministerial Decree of Public Works no : 390/KPTS/M/2007 due to Bali as nationally strategic river areas and to support an increase in food BWS Bali Penida (MDG's Issue) proposed changes status irrigation management authority of some areas to be BWS Bali-Penida authority, including Irrigation Area of Saba River.



### Construction of Titab Dam

Titab Dam planned to increase cropping intensity in Saba and Puluran irrigation area from 169% to 275%. The Titab Dam also control the flood caused by high water flow during rainy season.



### Continuing PTGA activities in the watershed of Saba

This year, PTGA also in Saba river watershed (Subak Bukit Pulu, Titab, Telaga, Batu Megaang, Sepang and Sepang kelod). Beside giving training, these activities also facilitate the formation of Subak Gede for a group of subak with similar interests.

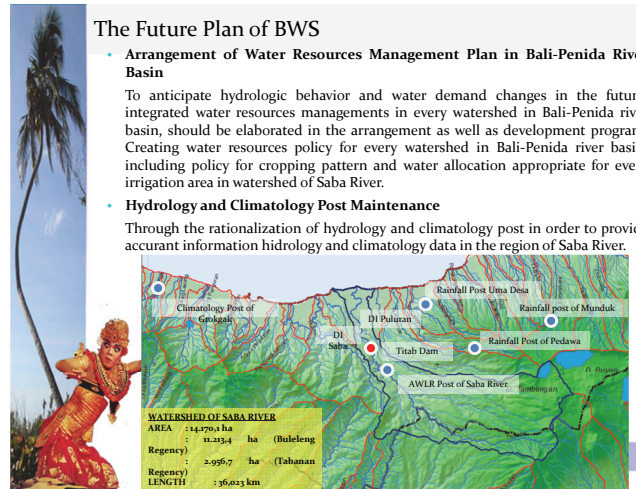
## The Future Plan of BWS

### Arrangement of Water Resources Management Plan in Bali-Penida River Basin

To anticipate hydrologic behavior and water demand changes in the future, integrated water resources managements in every watershed in Bali-Penida river basin, should be elaborated in the arrangement as well as development program. Creating water resources policy for every watershed in Bali-Penida river basin, including policy for cropping pattern and water allocation appropriate for every irrigation area in watershed of Saba River.

### Hydrology and Climatology Post Maintenance

Through the rationalization of hydrology and climatology post in order to provide accurate information hydrology and climatology data in the region of Saba River.





- **Water Resources Information System**

Water Resources Information System, in Data Processing Water Resources - Irrigation Asset Management. Input data assets will be combined with data irrigation hydrology and climatology at a watershed in order to get the availability of discharge (dependable flow) and climatological conditions are widely accessible (on-line) by all levels of society (especially by farmers).





# **SUBAK IRRIGATION SYSTEM IN BALI**

***Wayan Windia***

*Lecturer at Faculty of Agriculture, Udayana University, Denpasar, Bali.*

***Gede Sedana***

*Lecturer at Faculty of Agriculture, Dwijendra University, Denpasar, Bali*

## **INTRODUCTION**

Subak irrigation system was firstly created by the holy priest called Rsi Markandya before year 1071. Old inscriptions and artifacts suggest that subaks in Bali were in existence as far back as 1071, or around ten centuries ago. He came to Bali from East Java with 800 person followers, and occupied the area after cutting forest in Taro Village, Regency of Gianyar, around 50 kms northeastward from Denpasar. They further made irrigated land (*sawah*) that was organized by the *kesuwakan* organizations, and now called subak. The existence of subak system in Bali is noted since year 1071, or needed 393 years of time since agricultural system was developed in Bali (Windia, 2006).

Actually, the previous monarchy involved in subak system development in which the farmers group was allowed to construct temporary dams on the rivers in order to irrigate the existence dry land. Even, the Monarchy gave freely some land tax for the farmers in order that farmers had strong motivation to grow rice on irrigated land.

Since the Dutch administrations, the head of subak (*pekaseh*) was instructed by the Dutch to collect land tax from the farmers (subak members). It is important to note that subak has specific activity that is ritual ceremonies which might not be found in other irrigation systems in Indonesia (even in the world). Ritual ceremonies of subak have been performed on the basis of rice growth process (started from land preparation/water fetching until harvesting time).

Aside from this, subak is also a farmer managed irrigation system, which is an autonomous organization, that manages particular irrigated area (*sawah*), gets irrigation water from certain (one) source, and responsible for at least one subak temple. Recently, subak has been used by the government for the agricultural development programs and activities. Such as rice intensifications, cooperative development, etc.

Owing to the tourist activities and scarcity of water in Bali, many irrigated areas (*sawah*) have conversed for non-farming activities. Based on statistical record, there is decreasing sawah area in Bali, around 650 hectares/year. Now, the existence of sawah in Bali is still around 70,000 hectares. It is a big problem that must be solved by the government and other stakeholders especially in facing food security, ecological aspect and others. Some alternative efforts or policies should be done by government, such as providing subsidy of land tax for the farmers. This might be an incentive for farmers to continuously work on farm activities and thus the subak system could be preserved to be sustainable system.

## TRI HITA KARANA (THK) CONCPET

Presently, the availability of water at the source level has been scarce, including for irrigation system. In the future, the needs of water much more complex as many sectors are using water at the same period. It makes strong competition among the users and the subak that is usually being the loser. Regarding this problem, it cannot be solved by the formal regulation only. Therefore, it is needed an institutional solution that can combine the formal regulation and the socio-cultural aspects such as religious and social norms. This is strongly related to concept of *Tri Hita Karana* (THK) as an operational rules of subak. The main objective of THK is to create the harmonious relationship and collectiveness of subak management activities. The philosophy of THK is based on Hindu Religion. The future challenge is how to maintain and sustain the existence of a traditional institution like subak system in the dynamic process of human life, especially in the global orientation of the human development.

Subak as an irrigation system consists of three subsystems such as culture, social, and artifact. There is an inter-relationship among the subsystems as well as the balanced relationship with the environment. The religion of Hindu which is followed by most of the Balinese, actually strongly influence all of the socio-cultural elements of the society, including the institution of subak that has activities under the THK concepts. THK is a concept as a guidance for Balinese to get happiness, where the people should create the harmony relationships with the God (*parhyangan* concept), harmony relationship with the environment/territory (*palemahan* concept), and harmony relationship with the other people (*pawongan* concept).

The real activities of subak relating to *parhyangan* concept are clearly implemented in the form of ritual ceremonies, such as offering activities in subak temples. Meanwhile, *pawongan* concept are implemented by performing social interaction among the members of subak and outsiders for some activities such as working together on maintaining irrigation facilities/canals, maintaining subak temple, and contributing materials or cash money for subak after harvesting time. The *palemahan* concept is implemented by subak members in keeping good environment conditions such as sawah terrace, water division, canal, and others. Irrigation canal that is clean might help farmers in avoiding pest disease, such as rat attack.

The concept of harmony relationship in subak system is incorporated in *awig-awig* (internal regulations) of subak that regulates the entire of subak activities. This comprises the implementation of all subsystems in subak system, so that it covers cultural aspect and technological aspect as well. Because of technological development and the change of human life, there are possibilities for transformation of subak as technological system that have been developed as a part of cultural society.

Subak system is basically a customary law community with socio-agrarian-religious characteristics which manages irrigation water on the irrigated land (*sawah*). The social aspect of subak is indicated on the social interaction of members within its

organization with some natures of local condition. The technical aspect of subak is indicated by implementation techniques of water distribution and allocation among members of subak on the irrigation division structure in order to support the objectives of the organization and another technology for agricultural. Meanwhile, the religious aspect of subak is indicated by the existence of some temples (*pura*) at the subak area, that are fully believed as a spiritual control instrument on irrigation management at subak system. The existence of temple constitutes a realization of the *parhyangan* concept of the THK, so the violation of the regulations (*awig-awig*) that has been agreed can be avoided, and then the goals of the organization can be optimally achieved.

## TASKS OF SUBAK IRRIGATION SYSTEM

Coward (1980) stated that the main tasks of irrigation system are (i) managing and distributing of irrigation water; (ii) managing farmer resources; (iii) maintaining of irrigation canal; and (iv) managing of conflicts solution. In subak irrigation system, however, there is another task, namely performing of ritual activities. So, there are five tasks of subak irrigation system, compared with only four tasks of irrigation system cited above. In line with this, there are some opinions in Bali that subak is not only an irrigation system, but irrigation system plus. Plus means there are ritual activities that must be continuously implemented by subak. It is noteworthy that the existence of temple and ritual activities performances in subak are exactly the important element to strengthen subak organization, beside the need of irrigation water together as well.

**First**, the task of subak is to manage and distribute irrigation water. This is shown by the activities of subak in managing water in sawah, canal, water division, and sometime even in the dam. The management for distribution and allocation of water happens at the individual, subsubak and subak level (within large subak, there is some subsubaks). In subak system, there is local genius that is very important in water management and allocation, called *tektek* concept. *Tektek* concept is a concept to allocate water to each subak members (farmers) proportionally, based on the wide of existing canal where the water division would be constructed. Sometime the farmers intentionally make wider the previous canal in order to make water division much more wide and water can flow fluently through the water division. No waste to disturb the water flow.

If the irrigation water is scarce, the subak has borrowing water system among members, or among sub-subaks, or may be among subaks system in one river (Sutawan, et al, 1989 and 1991). A farmer is allowed to borrow irrigation water from another farmer based on their agreement. The one who borrow water must report the head of subak that on the particular day there will be water borrowing. Each subak has particular mechanism for water management, including the agreement on planting schedule, planting patterns and others. .

**Second**, the task of subak is to manage farmers' resources in the form of labor, materials and cash money. These are regularly implemented in subak. In case of renovation activities on infrastructure/facilities of subak such as on canal system and temple, subak would have meeting to prepare the action plan for works scheduling,

budgeting and others. Aside from this, in the performance of ritual ceremonies at the subak temples, there will be an agreement to have fund raising among the members. In order to strengthen the collectiveness, subak members always work together for the social and physical works even though they have already paid some contributions, such money and materials as well. Subak members regularly pay some contributions after paddy harvesting time (particularly during wet season). The number of contribution is dependent on the kinds of activities and subak agreement.

**Third**, the task of subak members is to maintain the irrigation canal through the operation and maintenance irrigation system. This is usually done before rice planting time. Before preparing the land, subak members will check the all irrigation facilities and maintain and repair as well. This activity is aimed at having clean irrigation canal, proper water division in other to keep water flow good enough to members. The new policy of government in the relation to operation and maintenance is the responsibility at the main system is government, while the subak still has responsibility at the farming system level (tertiary system).

**Four**, the task of subak is to manage conflict solution. This is conducted if there are conflicts among farmers that are usually about irrigation problems. The most case is stealing irrigation water from the water division and canal. In that case, the head of subak (*pekaseh* or *kelian subak*) will punish those who stole water. The amount of punishment is usually noted in subak regulation (*awig-awig*), based on subak agreement. In particular case, the punishment is not only money, but performing ritual ceremony as well.

**Five**, the task of subak is to do some ritual activities. This is implemented when subak begin to get water from the dam, called getting-water ceremony (*magpag toya*). Sequence ceremonies will be continued in line with the growth period of rice farming until the harvesting time. The ritual ceremonies are performed at some levels of temples, such as at the individual level, subak level and higher levels (subdistrict and regency levels). All ritual ceremony activities are organized and coordinated by the head of subak, except ritual activities conducted by individual farmers (each farmer has his own individual temple located near the inlet of irrigation water). The cost of those ritual ceremonies are dependent on the farmers (and subak) financial conditions. They can make small ceremonies or bigger as the ceremony activities in Bali are very flexible.

## **SUBAK ORGANIZATION**

Subak is an autonomous organization. So, the form of subak organization is different among subaks in Bali. But, generally the structure of subak organization in Bali is similar as shown in Figure 1.

About year 1970's, there was Sedahan institutions in each sub-regencies, and Sedahan-Agung institutions in each regencies. The task of Sedahan was to coordinate some activities of subak, to help the head of subak to solve their problems, and as officer in charge to collect land-tax from farmers (subak members). While, Sedahan-Agung was a officer of the head of regency who coordinates of Sedahan in other to help subak to

solve their problems. So, subak still had an officer in which they could send or announce their problems.

Currently, due to a new policy and regulations, the Sedahan and Sedahan Agung were eliminated as a officers for subak matter. Therefore, no more officer who able to adopt the problems of subak institution. Nowadays, subak has no one specific institution. That is the one of the reasons why subak in Bali now is marginalizing.

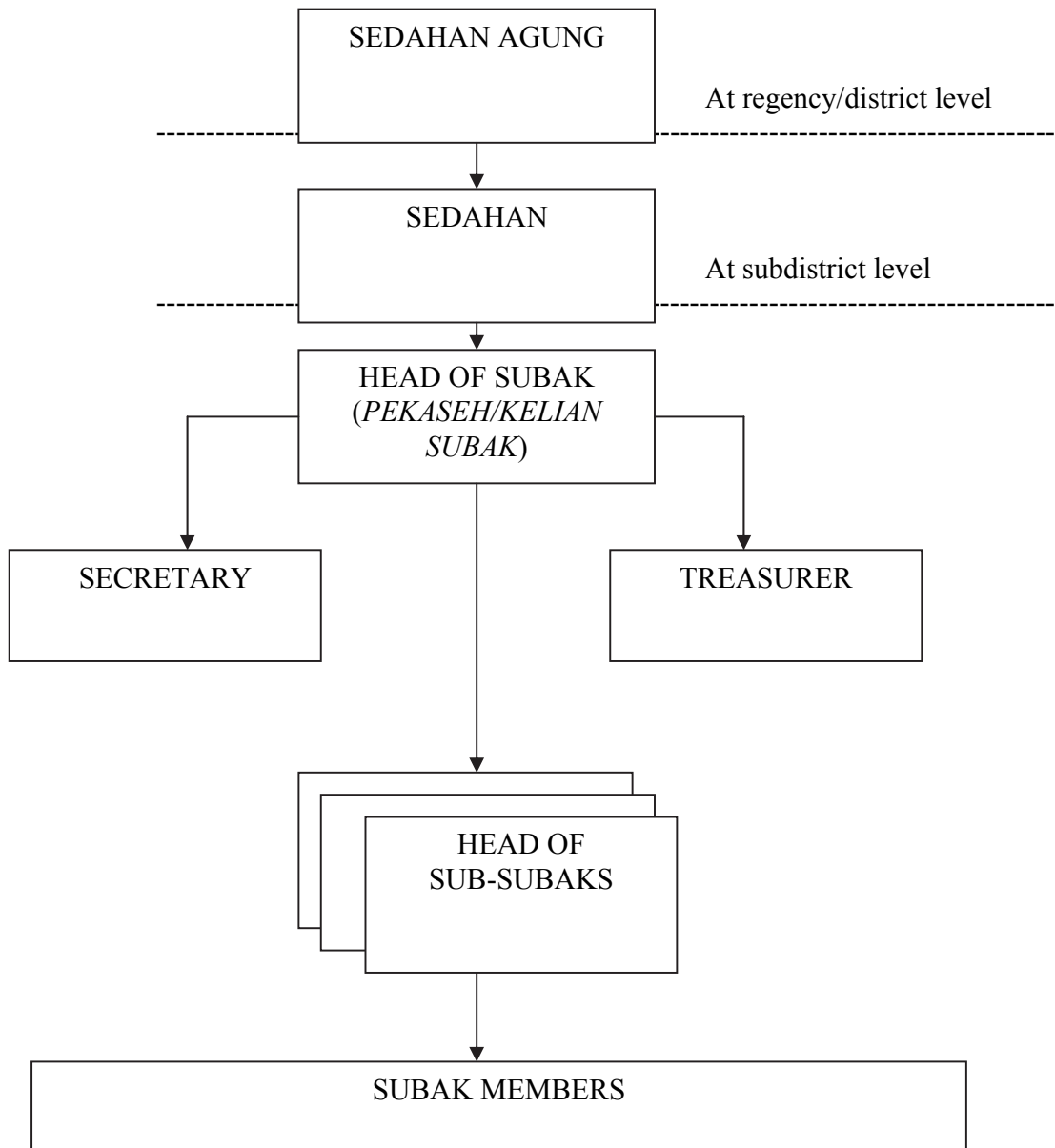


Figure 1. Subaks structure in Bali.

Another interesting of subak system is its members could be from one or some villages since the area of subak could cover one or some villages. The boundary of subak is natural border based on hydrological aspect, such as river. It is found that a subak is located within two villages, even within two subdistrict or regencies.

In running subak activities, the acts or behaviors of members always based on subak regulations (*awig-awig*). This usually contains things what must be done and what must not be done with the sanctions aside from the membership, management board, right and obligations, ritual activities, etc. Beside *awig-awig*, subak has some consensus or subak members agreement called *perarem* defines the definitions that have not been yet noted in the *awig-awig*.

## **SUBAK PROBLEMS**

As mentioned above and regarding the marginalization of agricultural sector in Bali, it directly influences to the performance of subak organization particularly on its sustainability as subak and agricultural sector are interlinked matters in Bali. As known that all of land irrigated area (*sawah*) in Bali are managed by many subak organizations. Also, *sawah* and subak in Bali is a part of Bali culture. Many people in Bali believe that the destruction of *sawah* and subak in Bali will influence to the Bali culture itself. So, the government must protect the agricultural sector and subak organizations in Bali.

Many people mention that most of tourists coming to Bali because of the very interesting Bali culture. If no *sawah* and subak activities in Bali, so the tourist visits would be decreased. Therefore, the government must prepare and implement some policies concerning the control of *sawah* conversion to the other functions. Recently, several heads of regencies in Bali have been implementing some policies, namely land tax subsidy to help farmers through capital grant, introducing cooperative in subak activities in order to push farmers/subak on socio-economic activities, etc.

However, due to the income gained from agricultural activities is still lower than the other sectors, especially tourism sector, the young people do not have good interest to involve or work in agricultural sector. Its consequence is *sawah* conversion to the other function has been still high. This condition is very dangerous for sustainability of subak in Bali, thus it is also very dangerous for tourism sustainability in Bali as well.

Some alternative solutions should be taken to sustain culture on the basis of agricultural sector through the establishment subak sustainability. It might be in making better link between agricultural sector and the tourism sectors. As a culture, subak also needs supports from the other sectors (not only tourism), such as Department of Public works (responsible for irrigation physical system), Department of Agriculture (responsible for the good agricultural practices and agribusiness), Department of Trade (responsible for marketing of agricultural products), Department of Cooperative (responsible for cooperative unit), and Department of Culture (responsible for sustain the concept and values of THK), and others. These sectors must be integrated in implementing their own programs for subak sustainability.

If the integration is very well, the sustainability of agriculture, subak, tourism, and even the economic of Bali, will be more guaranteed to achieve. Some suggest government to make regulation to push the tourism sector connected with agricultural sector, to establish agro-tourism activities in subak systems, etc. But this is still in the form of plan, and its implementation is still unclear.

## **CLOSING REMARKS**

Subak as an irrigation system has a THK concepts that guide for its members to get happiness in which this suggest people to have harmony relationships with the God (*parhyangan* concept), harmony relationship with the environment/territory (*palemahan* concept), and harmony relationship with the other people (*pawongan* concept). Recently, subak has some problems that influence its sustainability, thus makes an effect to one of the Bali's culture, that is subak.

Some alternative solutions should be taken to sustain the culture on the basis of agricultural sector through the subak sustainability. It might be in making better link between agricultural sector and the tourism sectors. As a culture, subak also need supports from the other sectors (not only tourism), such as Department of Public Works, Department of Agriculture, Department of Trade, Departement of Cooperative, and Department of Culture, and others. These sectors must be integrated in implementing their own programs for subak sustainability.

## **REFERENCIES**

- Coward, E.W. 1980. *Irrigation development : institution and agricultural development in Asia* ( ed: E.W. Coward Jr), Cornell Univ. Press, Ithaca and London.
- Sutawan, N; M. Swara; W.Windia; and W.Sudana. 1989. *Laporan akhir pilot proyek pengembangan sistem irigasi yang menggabungkan beberapa empelan subak di Kab. Tabanan dan Kab.Buleleng, (Final report on pilot development project that grouping several subaks dam in Tabanan Regncy and Buleleng Regency)*, kerjasama DPU Prop. Bali dan Univ.Udayana, Denpasar.
- Sutawan, N; M. Swara, W.Windia; G. Sedana; and IGM Putra Marjaya. 1991. *Laporan akhir penelitian aksi pembentukan wadah koordinasi antar sistem irigasi (Subak Agung) di Kab.Tabanan dan Buleleng, (Final report of action research forming coordination body among irrigation system/Subak Agung, in Regency of Tabanan and Regency of Buleleng, kerjasama antara DPU Prop. Bali dan Univ.Udayana, Denpasar.*
- Windia, W. 2006. *Transformasi sistem irigasi subak yang berlandaskan Tri Hita Karana, (Transformation of subak irrigation system based on Tri Hita Karana Concept)*, Pustaka Bali Post, Denpasar, Bali.





## SUBAK IRRIGATION SYSTEM IN BALI

Wayan Windia  
Gede Sedana

## INTRODUCTION

Subak institutions (and the traditional village) are two of the Balinese cultural heritage institutions. As a cultural heritage, both institutions are often regarded as Bali's cultural buffer.

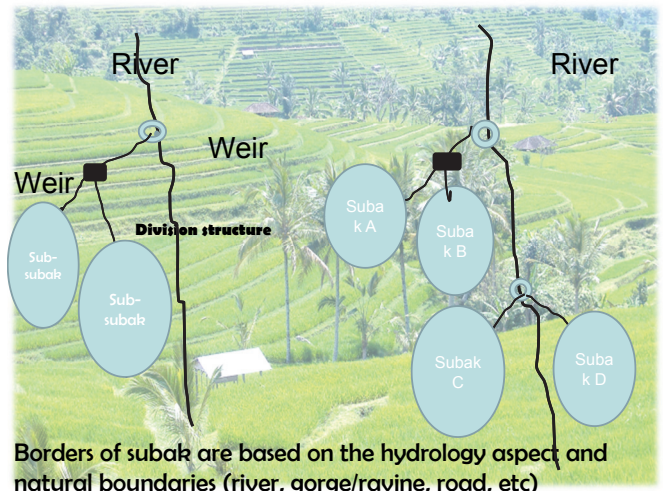


Subaks function to manage the irrigation and agriculture systems based on hydrological boundaries, while traditional villages (desa adat) manage the traditional village customs and religious activities in rural areas within administrative boundaries

What subak is.....

Subak is a farmers managed irrigation system in Bali with a particular activity, namely ritual activities

- In certain rice field, subak has natural boundaries or hydrological boundaries
- It gets water from certain source (at the river level or a division structure)
- It has at least one temple
- It has autonomous authority



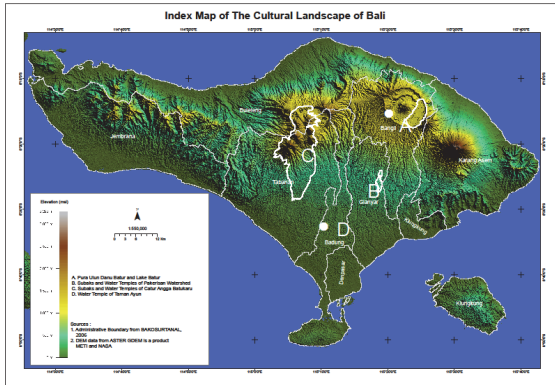
## SUBAK SYSTEM IN BALI

- Based on harmony and togetherness
- *Tri Hita Karana* Concept
- *Tri* (three), *Hita* (happiness), and *Karana* (cause)
- Harmony between the people and The Creator, the other people, and the environment

## IMPLEMENTATION OF *TRI HITA KARANA* IN SUBAK SYSTEM

- I. Harmony with The Creator.
  - Ritual activities, started from the land preparation until harvesting.
- II. Harmony with the nature.
  - Making paddy field, following the slope of land.
- III. Harmony with the others.
  - Managing water distribution through proportional system (*tektek* concept)
  - Borrowing water irrigation system.
  - Regulation (*Awig-Awig*).

**CULTURE LANDSCAPE OF BALI PROVINCE: The Subak System as an Manifestation of the Tri Hita Karana**



**RITUAL CEREMONY AT THE INDIVIDUAL TEMPLE**



**RITUAL CEREMONY AT THE SUBAK LEVEL**



**TEMPLE OF SUBAK AT THE REGENCY LEVEL, LAKE BERATAN**



**SUBAK MEETING**

**RICE, FIELDS : LONELY AND MANAGED BY SUBAK. CAN BE SUSTAINABLE ?**





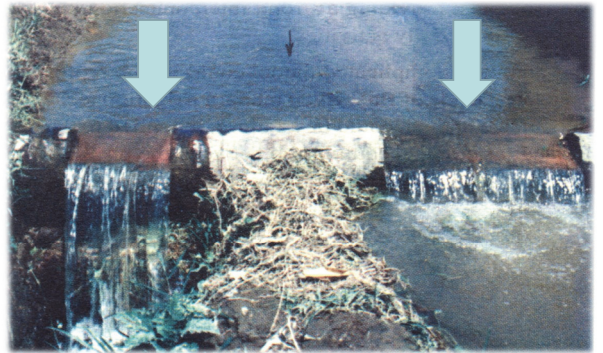
Generally the structure of subak organization in Bali is similar as shown in Figure



## TASKS OF SUBAK

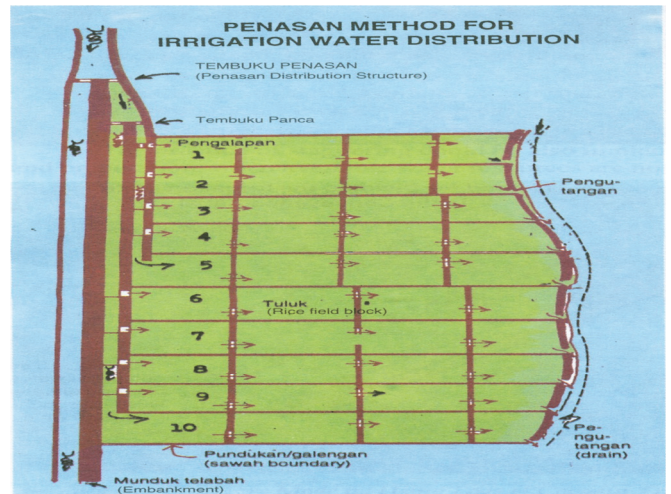
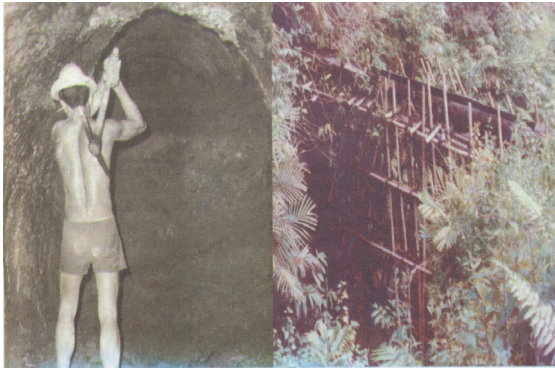
- Water distribution and allocation
- Resources mobilization (man power and money)
- Operation and maintenance of irrigation facilities
- Conflict solution
- Ritual activities

TRADITIONAL DIVISION STRUCTURE- CONTINUOUS SYSTEM



PERMANENT STRUCTURE CONTINUOUS SYSTEM (NON-PU AND PU)





## SUBAK PROBLEMS

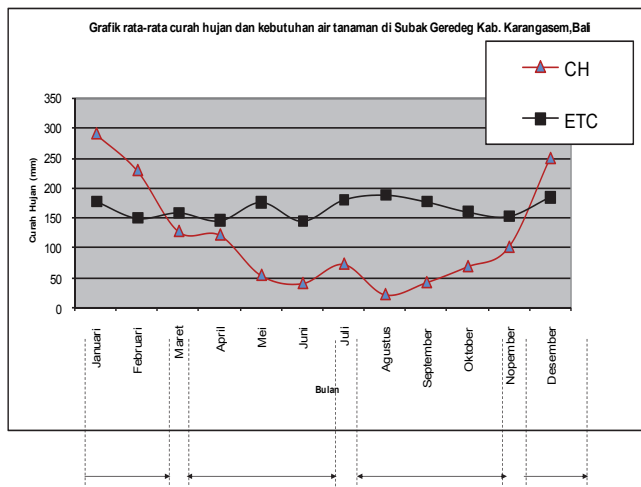
- Paddy fields conversion
- Scarcity of water and water competition
- Quality of irrigation water (from the source, and the canal)
- Marginalization of agriculture (young generations do not interested in agriculture)



## SUBAK BENEFITS

- Manage scarce water in dry season, via shift planting (head, middle, and tail).
- Still have production/income in dry season.
- Maintain and protect cultural activities
- Support rural economics
- Maintain environmental aspects
- others

Grafik rata-rata curah hujan dan kebutuhan air tanaman di Subak Geredeg Kab. Karangasem, Bali



THANK YOU



## Introduction on Nature, Culture and Economics of SULAWESI

DR. Ir. Agnes Rampisela MSc

## Geography of South Sulawesi

Sulawesi Island is one of the major islands of Indonesia, with around 17.3 million inhabitants.

Provinces and Provincial Capitals

- West Sulawesi (Mamuju)
- North Sulawesi (Manado)
- Central Sulawesi (Palu)
- South Sulawesi (Makassar)
- South East Sulawesi (Kendari)
- Gorontalo (Gorontalo)



## Geography of South Sulawesi

- Area Size: 174.600 km<sup>2</sup>
- Time Zone: Central Indonesian Time (UTC+8)
- Coordinates: [2°S 121°E](#)
- Largest city: Makassar

## Demographics

- Population: **17,359,398 (2010)**
- Ethnicities:
  - Makassarese
  - Buginese
  - Mandar
  - Minahasa
  - Gorontalo
  - Toraja
  - Bajau
  - Mongondow

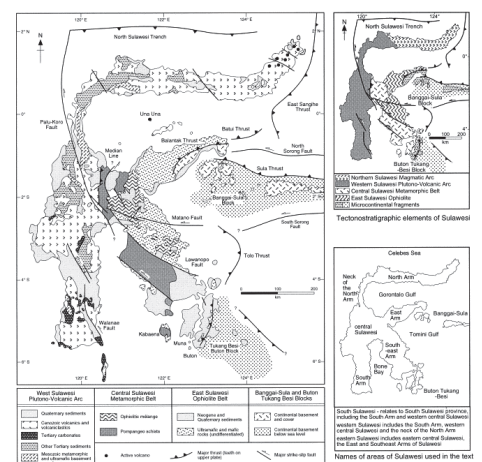


## Demographics

Province	Area in sq.km	Population (2010 Census)	Density per sq.km
South Sulawesi	46,717.48	8,032,551	171.9
West Sulawesi	16,787.18	1,158,336	69
Central Sulawesi	61,841.29	2,633,420	42.6
Southeast Sulawesi	38,067.70	2,230,569	58.6
Gorontalo	12,215.44	1,038,585	85
North Sulawesi	13,851.64	2,265,937	163.6
Sulawesi	189,480.73	17,359,398	91.6



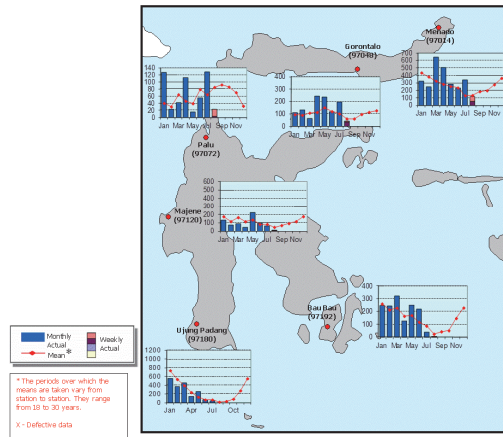
## Geological Map of Sulawesi



## Climate of Sulawesi

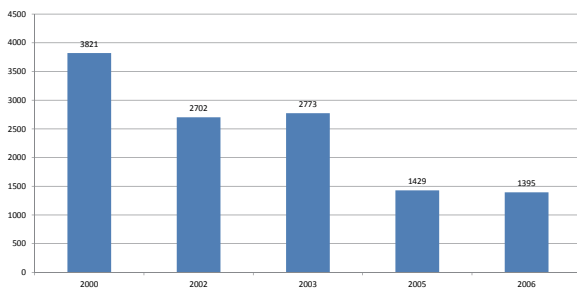
Rainfall Rate Averages by Province	(mm)	Year
South Sulawesi (Maros, Hasanuddin, Maritim Poetere)	4108	2010
West Sulawesi (Majene)	2549.5	2010
North Sulawesi (Manado)	3963	2010
Central Sulawesi (Palu)	863.8	2010
Southeast Sulawesi (Pasar Wajo (Buton), Raha (Muna), Bau-Bau, Pomalaa (Kolaka), Andoolo (Konawe Selatan), Kota Kendari)	3273.87	2010
Gorontalo	2312	2010

## Rainfall Barcharts for Sulawesi

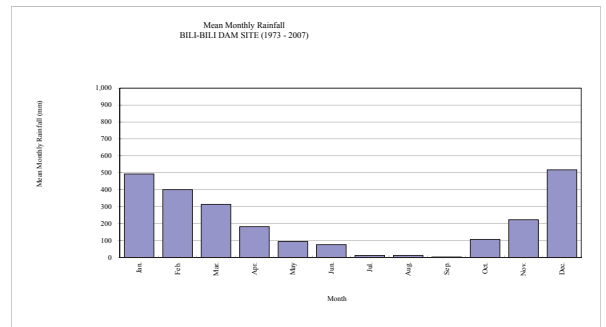


16.4

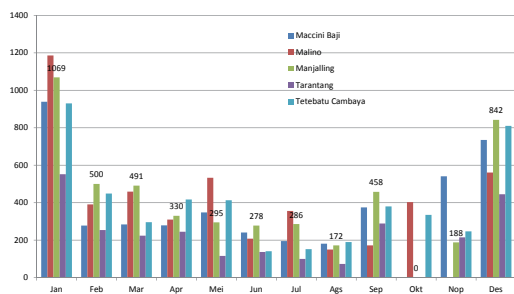
## Annual Rainfall Rate from 2000- 2006



## Mean Monthly Rainfall at Bili-bili dam site 1973-2000



## Monthly Rainfall rate at several stations inside the Jeneberang Watershed



## Agriculture of Sulawesi



Rice is the primary staple food in Indonesia. An average Sulawesi consumes **135 kg of rice**, (compared to only 60 kg per person in Japan, 63 kg in Malaysia, and 100 kg in China).

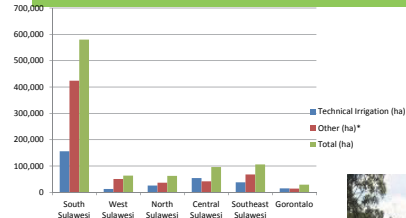
As such, local rice cultivation in Sulawesi mirrors this fact. In 2011, Sulawesi's total rice production amounted to around 7.5 million tons of dried-and-milled rice. This is about 11.5% of Indonesia's 65.76 million ton yield.

## Paddy Field Area

Technical Irrigation vs Rain-fed Rice Cultivation in Sulawesi by Province	Technical Irrigation (ha)	Other (ha)*	Total (ha)	Year
South Sulawesi	156.000	424.000	580.000	2011
West Sulawesi	12.838	50.729	63.567	2011
North Sulawesi	25.740	36.665	62.405	2011
Central Sulawesi	54.314	41.784	96.098	2011
Southeast Sulawesi	38.113	67.908	106.021	2010
Gorontalo	15.007	14175	29.182	2011

\* This category includes , semi-technical, self-funded irrigation, tidal-fed, other irrigation methods and rain-fed

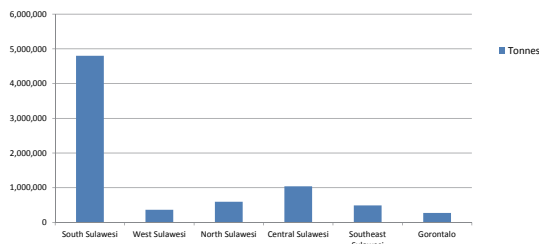
## Paddy field Area



## Rice Production by Provinces in Sulawesi



Rice Production by Province year 2011



## Rice Production



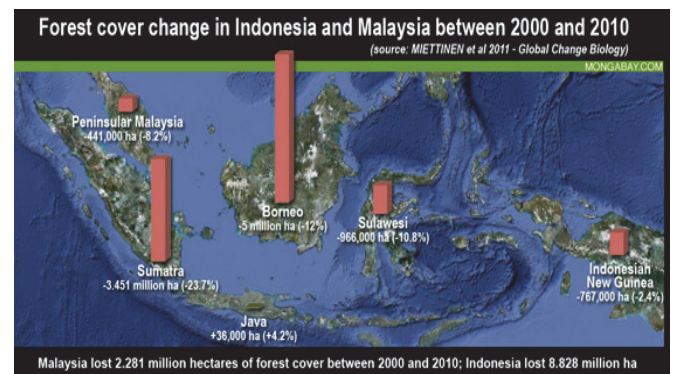
Rice Production by Province	Tonnes
South Sulawesi	4.800.000
West Sulawesi	365.683
North Sulawesi	596.223
Central Sulawesi	1.041.789
Southeast Sulawesi	491.567
Gorontalo	273.921

## Economic Growth of Indonesia by Province

Provinsi/Province	Produk Domestik Regional Bruto Gross Regional Domestic Product (Triliun Rp/Trillion \$)		Peranan PDRB/GDP Share (persen/percent)		Provinsi/Province	Produk Domestik Regional Bruto Gross Regional Domestic Product (Triliun Rp/Trillion \$)		Peranan PDRB/GDP Share (persen/percent)	
	Migas Oil and Gas	Tanpa Migas Non-oil and Gas	Migas Oil and Gas	Tanpa Migas Non-oil and Gas		Migas Oil and Gas	Tanpa Migas Non-oil and Gas	Migas Oil and Gas	Tanpa Migas Non-oil and Gas
Aceh	77,5	64,6	1,5	1,3	Bali	64,6	64,6	1,2	1,3
Sumatera Utara	275,7	273,5	5,3	5,7	Nusa Tenggara Barat	60,5	60,5	1,0	1,3
Sumatera Barat	87,2	87,2	1,7	1,8	Nusa Tenggara Timur	42,5	42,5	0,8	0,9
Riau	342,7	214,5	6,5	4,5	Kalimantan Barat	58,5	57,9	1,1	1,2
Kepulauan Riau	71,6	66,5	1,4	1,4	Kalimantan Tengah	121,0	187,9	6,1	3,9
Jambi	19,8	45,1	1,0	0,9	Kalimantan Selatan	36,8	36,8	0,7	0,8
Sumatera Selatan	157,8	112,4	3,0	2,3	Kalimantan Timur	8,0	8,0	0,2	0,2
Kepulauan Bangka Belitung	25,7	25,1	0,5	0,5	Sulawesi Utara	36,1	26,4	0,7	0,9
Bengkulu	18,0	18,0	0,3	0,4	Gorontalo	117,8	117,6	2,2	2,4
Lampung	107,3	106,0	2,0	2,2	Sulawesi Tengah	11,0	11,0	0,2	0,2
DI Jakarta	802,2	805,5	16,4	17,8	Sulawesi Selatan	28,4	28,4	0,5	0,6
Jawa Barat	770,7	717,7	14,7	15,3	Sulawesi Barat	49,4	49,4	0,9	1,0
Banten	149,0	149,0	2,8	3,1	Sulawesi Tenggara	27,7	27,7	0,5	0,6
Jawa Tengah	444,4	390,6	8,5	5,1	Maluku	5,1	6,0	0,2	0,2
DI Yogyakarta	45,6	45,6	0,9	1,0	Maluku Utara	5,4	5,4	0,1	0,1
Jawa Timur	778,5	775,2	14,8	16,1	Papua	89,4	89,4	1,7	1,9
					Papua Barat	22,5	13,7	0,4	0,3
					<b>Total PDRB/Total GRDP</b>	<b>5.255,3</b>	<b>4.813,8</b>	<b>100,0</b>	<b>100,0</b>

Sumber: Produk Domestik Regional Bruto Provinsi di Indonesia menurut Lapangan Usaha, BPS  
 Source: Gross Regional Domestic Product of Provinces in Indonesia by Industrial Origin, Statistics Indonesia  
 Catatan/Note: \* Angka sangat sementara/Very preliminary figures

## Forest Cover Change



Malaysia lost 2.281 million hectares of forest cover between 2000 and 2010; Indonesia lost 8.828 million ha

## Percentage of forest cover change



**The 2nd day (Sep. 6th, 2012)**



# Main Topic 1: A research on Establishing Process of P3A/Subak in Bali and South Sulawesi

Prof. Masakazu Mizutani, Ph.D.

Utsunomiya University

Sep.6, 2012

1



2

## Sub title of research

**1-A: A study on the fundamental structure of new subak in the lower basin of Saba river, Bali Province**

**1-B: A study on the role of P3A and Mandro Je'ne for implementation of dry season irrigation in the Bili-Bili Irrigation Project, South Sulawesi Province**

3

**Sub Title: 1-A  
A study on the fundamental structure of new subak in the lower basin of Saba river, Bali Province**

4



## I. Pre-research Results of 1-A

### 1. Saba Dam

- 1981 Construction of modern dam and expansion of intake discharge
- 1990 Exploitation of a new main canal
- 1991 Start to establish new subak

### 2. Subaks in the lower basin of Saba river

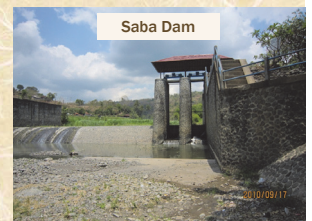
conventional subak\*:

- Umedesa (92ha)
- Tengal Intaran (12ha)
- Bonjek Cukli (14ha?)
- Banymati (69ha)
- Yeh Anakan (62ha)

new subak\*:

- Pangkung Kuniyit (91ha)
- Banjar Munduk (16ha)
- Tegallenge (125ha)
- Tukad Sumaga (50ha?)

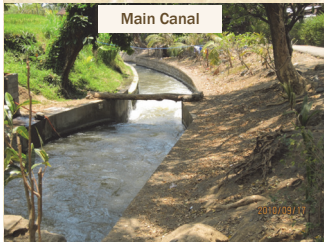
\*Source: Infomasi Data Pertanian Dan Peternakan Kabupaten Bulelen Tahun 2010



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### 3. Establishing new subak, Pangkung Kunyit

- A conventional subak with 2 tempek (18ha) joined together with 5 new tempek (74ha)
- Each tempek build up 5 tertiary canals in 1991
- Tertiary canal layout was planned by subak member
- Gotong Royong was conducted for a new 350m tertiary canal construction; 20 heads, 100 days, from 7:00 to 10:00 am
- Reclamation of new paddy field and quaternary canal was done by individual farmers



Main Canal



New Secondary Canal

### 4. Irrigation practice of new subak, Pangkung Kunyit

- Rotational irrigation is carried out by 48-hour interval to 5ha block
- Staggering irrigation has started in new 4 subaks from 2011 wet season
- Cropping pattern: paddy (early Nov-Mar)-paddy(Apr-Jul)-palawija(Aug-Oct)
- Palawija irrigation: 5 times for maize and 3 times for green-bean
- Tek-tek system is not applied because of high percolation rate

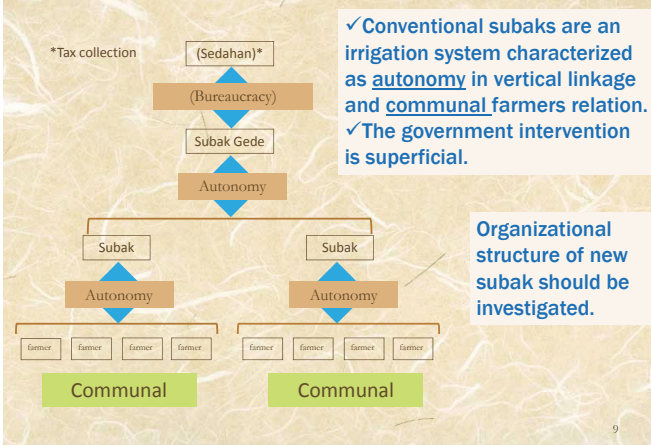


Tertiary Canal



Green bean

### 5. Organizational structure of conventional subak



### II. Research Objectives of 1-A

1. to clarify detailed process of new subak establishment
2. to grapes the fundamentals of irrigation water management in the both new and conventional subak
3. to analyze cooperative relation between new and conventional subak under subak-gede leadership, and
4. to classify the organizational structure of new subak



Based on the results derived from above investigation, the causes of success in new subak formation and local wisdoms for sustaining irrigation system will be derived.

### III. Methodology of 1-A

By interview with new subak, conventional subak and farming house hold, and field observation

Data collection: awig-awig, etc.

### VI. Research Schedule

#### 1. Field survey

- ✓5 days in Feb, 2013
- ✓5 days in Jul, 2013

#### 2. Data collection to visit PU and other office

- ✓2 days in Feb, 2013
- ✓2 days in Jul, 2013

### Sub Title :1-B

A study on the role of P3A and Mandro Je'ne for implementation of dry season irrigation in the Bili-Bili Irrigation Project, South Sulawesi Province

Canal layout and tertiary/quaternary units in the research area of 289ha

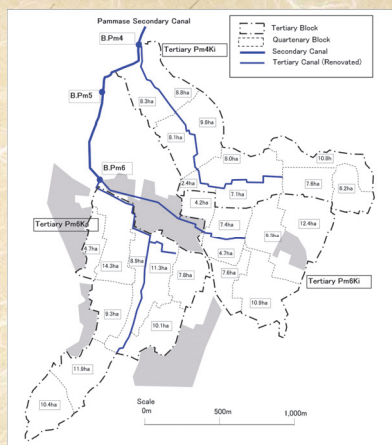


図 7 モデル地区の3次水路と4次水路ブロック

## I. Review of reports\* by JICA experts

### 1. Implementation of double cropping of rice

	2004	2005	2006
Average yield (t/ha)	3.5	4.4	4.7
Area planted (ha)	158	194	more than 200
Production (t)	553	854	more than 940

Remarks: yield and production represent un-husked rice

- ✓ Dry season irrigation has started from 2003.
- ✓ Farmers were eager to produce rice twice a year.
- ✓ Rice production will be doubled in 5 years.

References: Mizutani M, Report of short-term expert in 2005, 2006.  
Usuki N, Report of long-term expert in 2004

14

## 2. Tertiary canal maintenance by farmers

	Binabbasa	Renggang
Canal length (m)	247	1,881
Gotong royong length (m)	247	1,575
No. of Gotong royong (times)	5	2
Participant (person)	79	203

- ✓ Farmers recognized the necessity of canal cleaning.
- ✓ Motivation to participate in O&M is somewhat different in villages.

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## 3. Collection of Ase Mandro (remuneration) in dry season

Binabbasa	2004	2005
Area planted (ha)	19	32
Collected Ase Mandro (kg)	350	280
Renggang		
Area planted (ha)	44	59
Collected Ase Mandro (kg)	660	1,505

- ✓ Amount of Ase Mandro collected was unstable.
- ✓ Special effort was needed to encourage Mandro Je'ne.

16



Mandro je'ne with canal cleaning tools: They are parent and child appointed by P3A.



Rice sack to store collected rice

Bucket used for irrigation fee (paddy) collection



## 4. CM meeting in the tail-end P3A in dry season, 2006

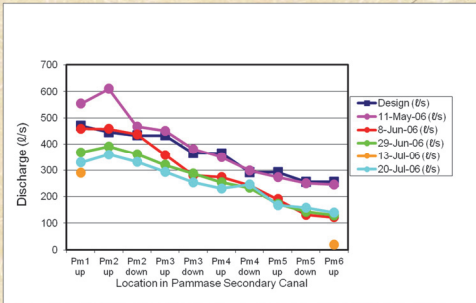
	Binabbasa	Renggang
No. of CM (Person)	10	12
No. of meeting (times)	3	4
Total No. of joined (person)	22	30
Participation ratio (%)	73	63

Remarks: CM means Committee Member of P3A

- ✓ Regular CM meeting was carried out with high participation ratio.
- ✓ Solid sense of responsibility was confirmed in P3A leaders.

18

### 5. Flow condition of secondary canal in dry season, 2006.



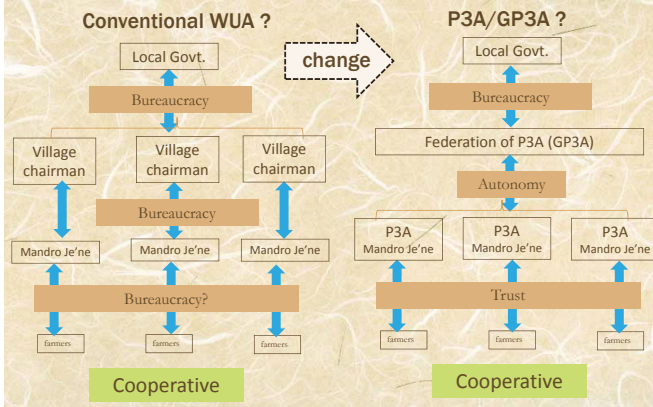
✓The flow size of the secondary canal was less than designed, which in turn short supply to tertiary canal.

### 6. Activities for irrigation water management

- ☐ Water use activities
  - off-farm water distribution   ▶ Juru and PPA (Local Govt.)
  - on-farm water distribution   ▶ Mandro Je'ne, P3A chairman
- ☐ Control structure activities
  - tertiary canal construction   ▶ Farmers by *Gotong Royong*
  - tertiary off-take operation   ▶ Mandro Je'ne, P3A chairman
  - tertiary canal maintenance   ▶ Mandro Je'ne, *Gotong Royong*
- ☐ Organizational activities
  - remuneration collection   ▶ Mandro Je'ne
  - conflict management   ▶ P3A chairman
  - decision making   ▶ CM meeting, general meeting

✓Mandro Je'ne and P3A chairman were key person in irrigation activities.

### 7. Organizational structure of water users association



### II. Research objectives of 1-B

1. to grasp the transforming process of the conventional WUA to P3A for implementation of dry season irrigation
2. to clarify the role of Mandro Je'ne and P3A chairman for irrigation water distribution and O&M activities
3. to analyze organizational structure of conventional WUA and P3A



Based on the results derived from above investigation, the causes of success in the transformation of WUA and local wisdoms for sustaining irrigation system will be derived.

### III. Methodology of I-B

By interview with officials of Local Govt., NGO staff and farmers, and field observation

Data collection

### IV. Research Schedule

#### 1. Field survey

- ✓4 days in Feb, 2013
- ✓3 days in Jul, 2013

#### 2. Data collection to visit PU and other office

- ✓2 days in Feb, 2013
- ✓2 days in Jul, 2013

Thank you for your attention!  
Terimakasih!



## 4. Organizational classification of irrigation system

View point:

- Vertical linkage
  - Who holds the authority and responsibility?
  - Bottom-up or top-down?
  - Centralized or Decentralized?
- Horizontal relation
  - Relationship between water users (farmers)

**Organizational classification is an useful tool to understand the property of irrigation system.**

25

## Definition of vertical linkage

### Bureaucracy

Authority and responsibility of irrigation management is retained by the central / local Govt., and water users do not have any participation in decision making.

### Autonomy

Water users have the authority and responsibility of irrigation management and control irrigation by themselves.

### Contract

Water users make contract with water supplier to acquire irrigation water under volumetric charge.

### Trust

Water users have the authority and responsibility of irrigation management and irrigation control is conducted by a group of engineers on the trust basis.

26



Main Topic 2:  
FUNCTION of MANDORO' JENE in local water management

## Interview of MANDORO' Jene (Water Masters)

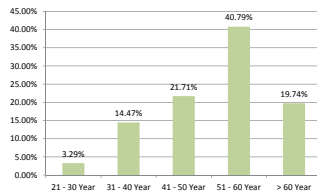
304 Water Masters

### Total Targets Interviewed at Each Irrigation Area

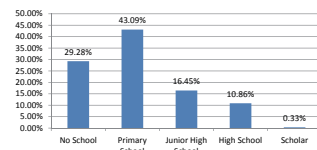
No.	FWUA	Dates of Interviews	Number of Days	Number of Interviews
<b>Bili-Bili Irrigation Area</b>				
1	Sombu Opu	2, 9 August	2	6
2	Bulukana	27 July, 2, 3 August	3	8
3	Baji minasa	27 July, 2 August	2	5
4	Parappunganta	27 July, 2, 12 August	3	5
Subtotal			10	24
<b>Kampili Irrigation Area</b>				
5	Minasa Baji	1, 7 March, 18 April, 29 May 27 July	5	8
6	Tubaranta	2 March 3, 11 May, 11 July	4	7
7	Assamaturu	2, 14, 21 March, 10 April, 3 May, 19, 20 June, 11, 12 July	9	17
8	Jatia	3, 11, 17, 19 April, 21 June, 23 June, 4, 10 July	8	22
9	Pallangga	27 March, 5, 9 April, 26, 28 June, 12 July 5, 13, 20 April, 23, 27 June, 4, 6, 17, 18 July	6	14
10	Kalakuang	9 February, 28 June, 12 July	9	17
11	Galesong Utara	29, 30 March, 12, 13, 20, 27 April, 22 June, 18 July	3	7
12	Passereanta	10, 16 February, 29, 30 March, 12, 13, 20, 27 April, 22 June, 18 July	10	23
13	Paraitatte	3 February, 1, 21 March, 27 April	4	6
14	Sirammuang	1, 17 February, 1, 2, 4, 10, 16 May 1, 14 March, 26 April, 6, 20 June, 11 July	7	19
15	Sipakainga		6	11

No.	FWUA	Dates of Interviews	Number of Days	Number of Interviews
<b>Bissua Irrigation Area</b>				
16	Abbulosibatan 8	10 February, 7, 28 March, 24 May, 6, 19, 21, 26 July	7	13
17	Wiratani	8 February, 12, 13 July	3	10
18	Harapan Tani	14 June, 13, 19 July	3	6
19	Hasanuddin	2 February, 7 March, 12 June, 13, 16 July	5	10
20	Bontosallang	3, 14 February, 9, 13 March, 15 June, 12 July	6	18
21	Assamaturu 1	7 February, 16, 20, 28 March, 10, 19, 26 April, 25 May	8	16
22	Abbulosibatan g 1	7, February, 28 March, 4, 20 April	4	5
23	Pantang	15 February, 6, 8 March, 7, 8 June 7, 14, 15 March, 11, 17 April	5	15
24	Pajongga Dg. Ngalle	26 April, 29 May, 23 June, 3 July	5	8
25	Stallassi		4	11
26	Tunas Baru	27 March, 5, 6 July	3	10
27	Tolawa	22 March, 18 June	2	7
28	Matmopdalle		2	7
Subtotal			55	129

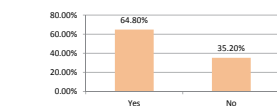
### Age / Year of Birth



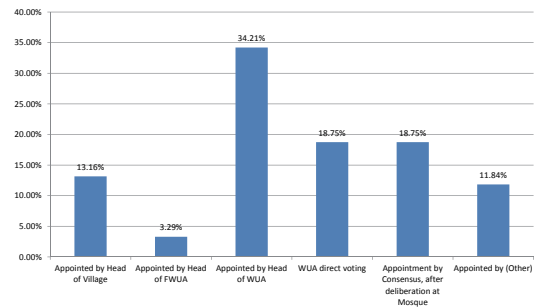
### Level of Education



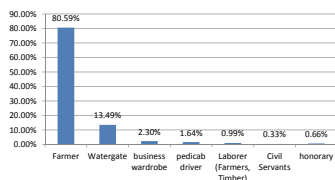
### Literacy



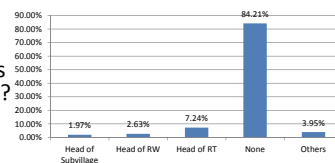
### How did you come to be employed as Water Master?



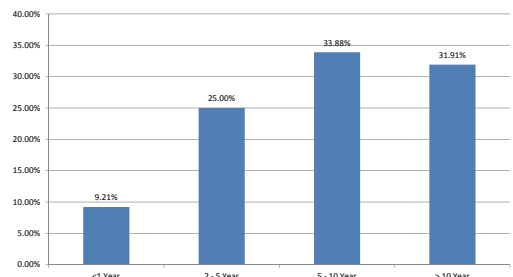
### You profession prior to becoming Water Master



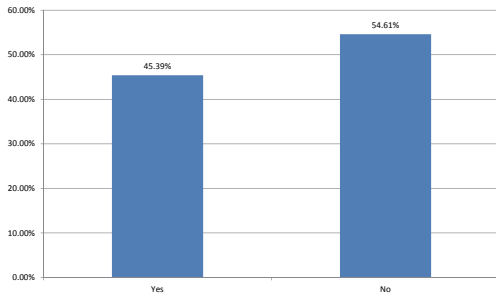
### Do you hold other positions other than as Water Master?



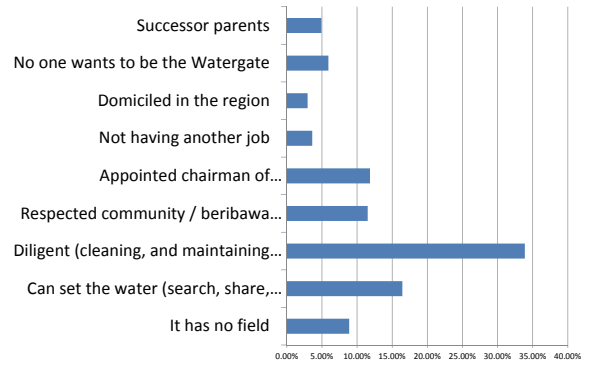
### You have been employed as Water Master since year



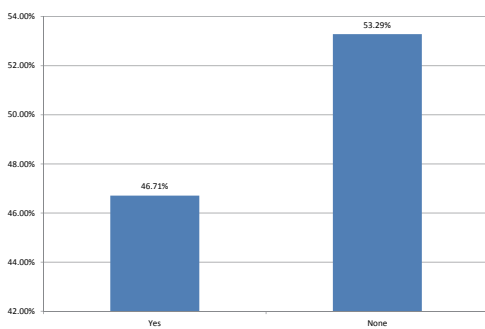
### Have you ever participated in trainings?



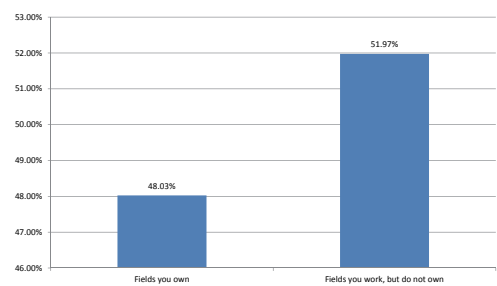
### In your opinion, why were you employed as Water Master



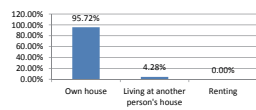
### In the past two years, have there been any coordinating meetings in your WUA?



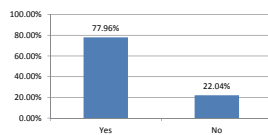
### Name all the fields that you work at, whether your own or someone else's



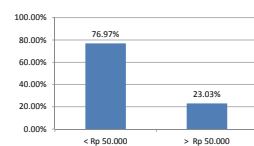
### Your own house?



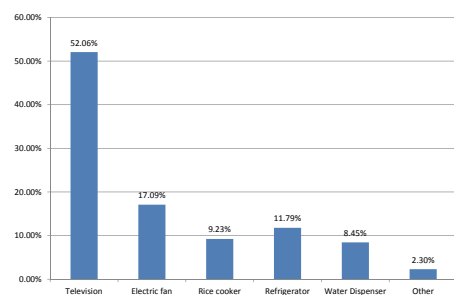
### Is your residence fitted with an electricity meter?



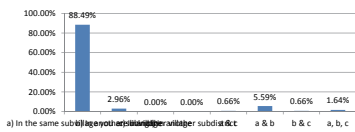
### How much was your electricity bill last month?



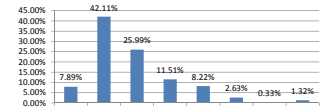
### Do you own electronic appliances, such as.....



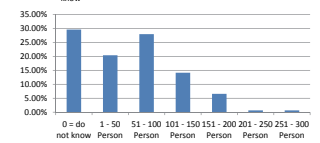
In which work area have you been stationed so far?



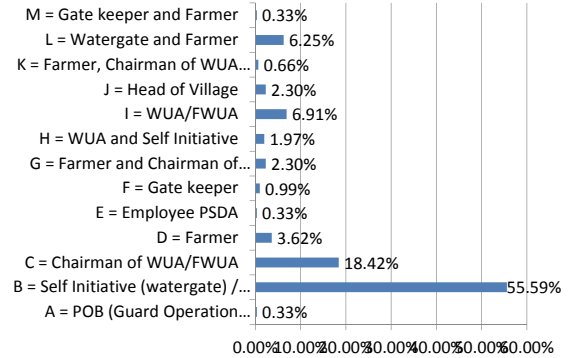
How large is your work area?



How many farmers are in your service coverage?

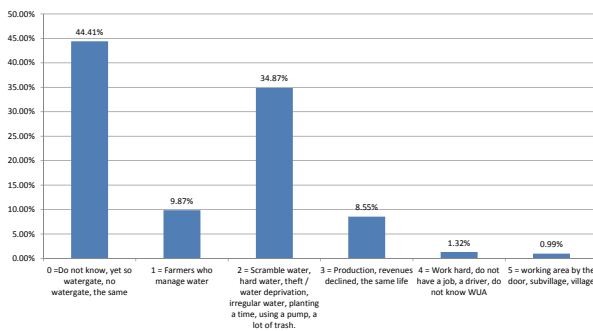


Who directs your duties in your distributing of irrigation water?

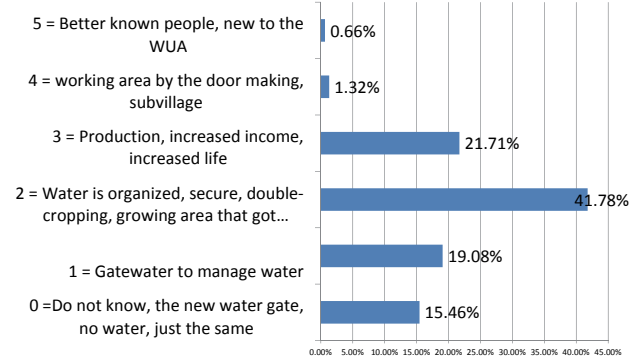


What has changed in the roles of Water Master?

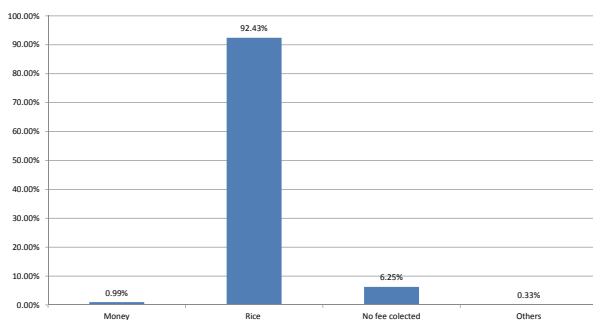
59a- Prior to Bili-Bili Irrigation Availability



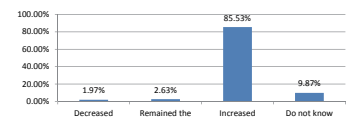
After Bili-Bili Irrigation Availability



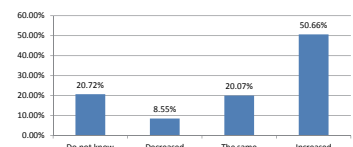
In what form is the water fee paid?



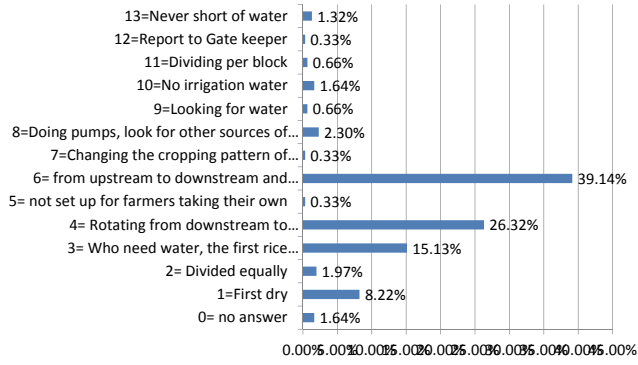
After establishment of Water Master, would you say that crop yields have...



Compared to prior to construction of Bili-Bili Dam, would you say that fee collected has increased or decreased?



### How do you manage water distribution during water shortage?



## Activities of RIHN-Hasanuddin University Project in Sulawesi

### 1. Measurement of primary and secondary channel discharge rate

- Observation of Flow Rate at the Beginning of Water Distribution
- Measurement along the Primary Channel



### 2. Land Re-identification Activity at each WUA



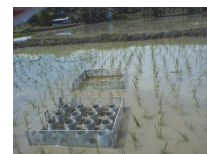
### 3. Facilitating FWUA Meeting



### 4. Interview with Water Masters



### 5. Research on water requirement in WUA Renggang area



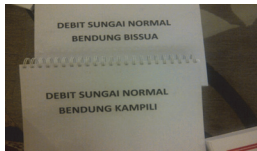
## 6. Research on Physical Characteristics of Soils Bili-Bili, Kampili and Bissua Irrigation Areas



## 7. Water Master Training Activities



## 8. Collection of Secondary Data



## 9. Monitoring of Irrigation Water Coverage in Dry Paddy Season of 2012



## List of data

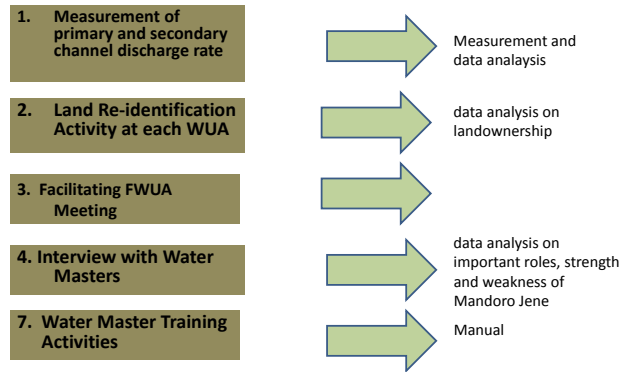
1. Results of discharge Measurement along Primary Channel
2. Results of discharge rate Measurement along Secondary Channel
3. Results of Water Height Measurement along Borong Boddii Secondary Channel (Control Area)
4. Invitation, Presence List, Minutes of Meetings.
5. Resulting water distribution schedule of FWUA Sirannuang

6. Questionnaire utilized in the interview is available
7. List of Interviewees
8. Report on Research on water requirement of WUA Renggang
9. Report on Research on Physical Characteristics of Soils Bili-Bili, Kampili and Bissua Irrigation Areas
10. Detailed Attendance Summary, List of Attendance, and Training Materials

**Book :**

- 1. Detailed results of interviews are available in the Water Master Interview Input Data Report
- 2. Normal discharge rate Record Data in Kampili dam
- 3. Normal discharge rate Record Data in Bissua dam

**NEXT STEP : SEPTEMBER 2012- MARCH 2013**



5. Research on water requirement in WUA Renggang area → continue

6. Research on Physical Characteristics of Soils Bili-Bili, Kampili and Bissua Irrigation Areas

8. Collection of Secondary Data → continue

9. Monitoring of Irrigation Water Coverage in Dry Paddy Season of 2012 → continue

**terima kasih**



## Water balance and water quality issues in Bili-Bili watershed and in Saba watershed

Hiroki Oue  
Takao Nakagiri  
Satyanto Krido Saptomo  
Agnes Rampisela  
Sartika Laban  
Sanz Grifrio Limin  
Hisaaki Kato

## Objectives

- Understanding local wisdoms of water use (agricultural and domestic)
- Finding point of issues for improving water use management and water quality
- Taking climatic change into account
- >
- Actual situation of water resources and water quality in the two watersheds  
+ Land use analysis
- Clarifying causes of water shortage
- Prescribing for improved water managements



## Contents 1: Water balance

### Saba

- Whole Saba river watershed
- Micro-watershed in the upstream of Saba

### Bili-bili

- Bili-bili irrigation system scale
- P3A scale
- Plot scale

## Contents 1: Water balance

- Evapotranspiration for water balance analysis
- Meteorological measurements in Renggang P3A in the lower reach of Kampili system
- > Applied for water balance in the P3A
  - > ET modeling
  - > Estimating areal ET by general meteorol conditions

## Contents 1: Water balance

- Discharge for water balance analysis

## Contents 2: Water quality

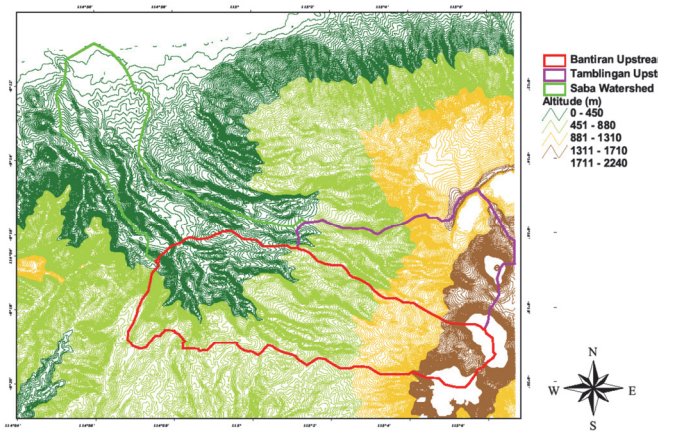
- Saba river watershed
  - 9 points from mid to lower reach
- Bili-bili irrigation system
  - Surface sampling points are to be decided including groundwater

## Contents 3: Land use mapping

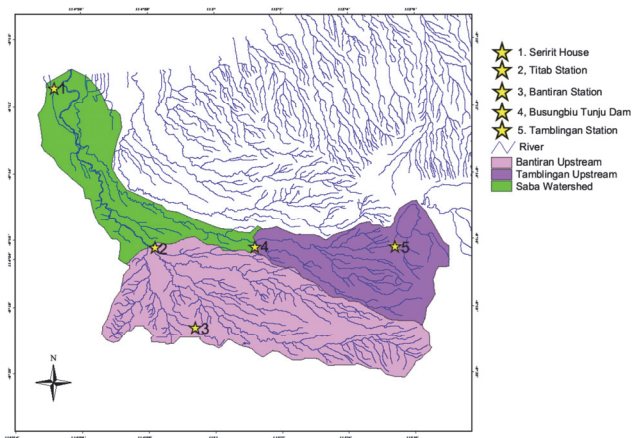
### Water balance in two watershed in the upper-stream in Saba (Oue & Sanz)

#### Objectives

- Clarifying water balance by modeling
- Evaluating functions of natural forest and plantation land use



Saba river watershed



### (1) Two watershed in the upper-stream in Saba

- Tamblingan, Munduk, Banyuatis, etc.

Met data in a flower garden at Tamblingan  
Discharge at JCT of Saba and Panas (Plan)

Land Use	Area (hectares)	Percentage
Building	1	0.01%
Forest	912	23.98%
Freshwater Body	153	4.01%
Grass / vacant land	21	0.55%
Irr. Paddy Field	190	4.99%
Moor land	55	1.45%
Plantation	2288	60.18%
Residential	130	3.42%
Shrub	54	1.41%
<b>TOTAL</b>	<b>3803</b>	

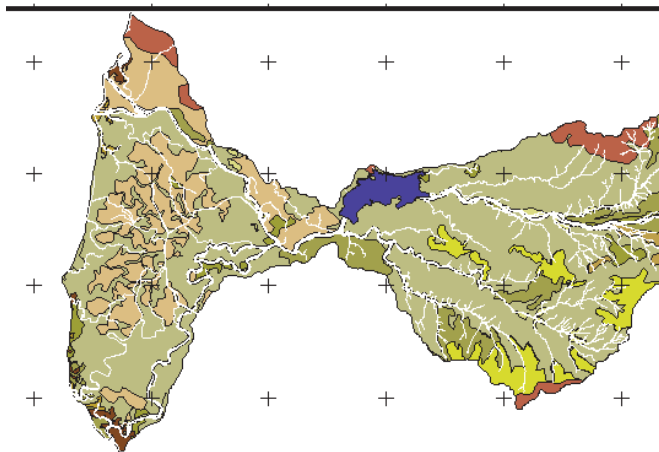
(2) Two watershed in the upper-stream in Saba  
 - Pujungan, Pupuan, Umajero, Bengkel, Bantilan, etc.  
 Met data in a paddy field at Bantilan  
 Discharge at JCT of Saba and Titab (Plan)

Land Use	Area (hectares)	Percentage
Building	1	0.01%
Forest	827	11.20%
Freshwater Body	0	0.00%
Grass / vacant land	7	0.10%
Irr. Paddy Field	346	4.69%
Moor land	22	0.30%
Plantation	4883	66.19%
Rain Paddy Field	412	5.58%
Residential	174	2.36%
Shrub	705	9.55%
<b>TOTAL</b>	<b>7377</b>	

Water balance in the plot scale and  
 P3A scale in the lower reach  
 in Bili bili irrigation system  
 (Oue, Sartika & Agnes)

### Objectives

- Clarifying water balance in rice paddy and upland fields
- Clarifying water distribution in dry seasons





## Water Use for Rice Cultivation in P3A Renggang in the 1<sup>st</sup> Drying Season

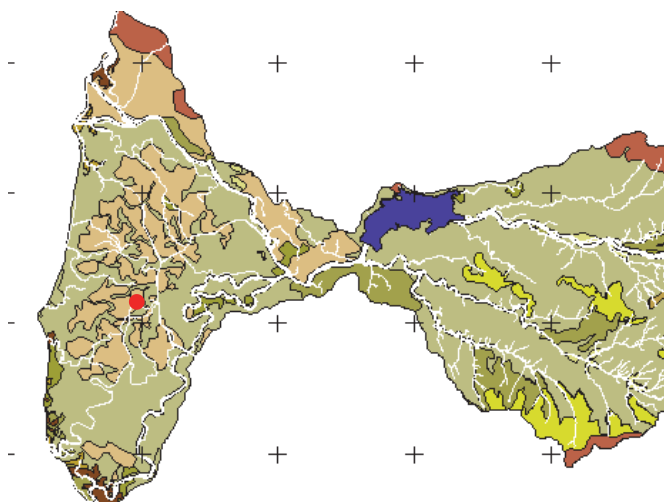
Hiroki Oue(Ehime Univ)

Sartika Laban(United Grad School, EU)

Agnes Rampisela (UNHAS)

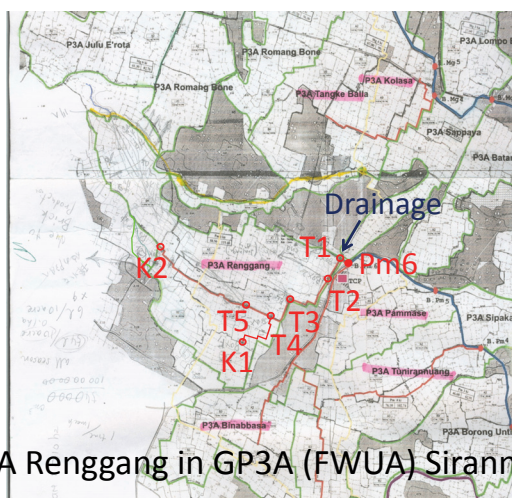
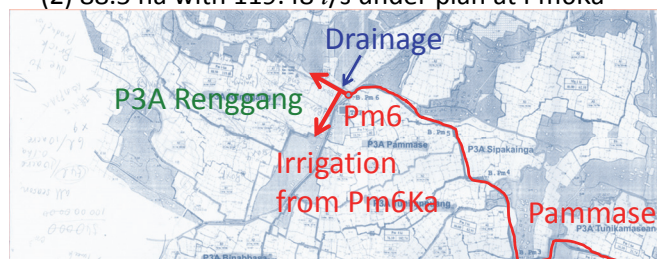
## Background of the study

- Well arranged agricultural water use system
  - Empowered P3A function
  - Confidence, discussing and working
  - But still, lacking in irrigation water in dry season
- > Present situation of water balance
- Plot scale
  - P3A scale

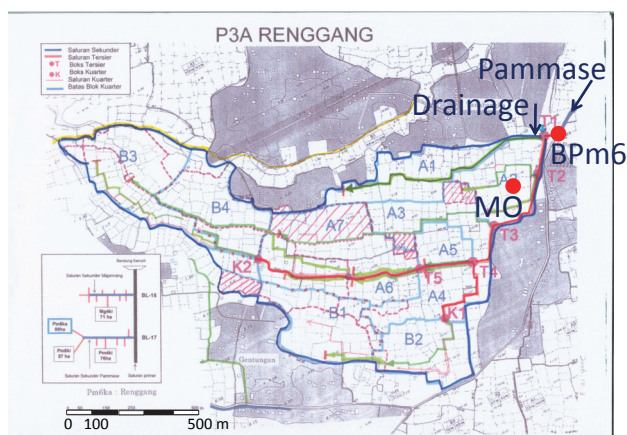


## Specification of P3A Renggang in GP3A (FWUA) Sirannuang

- (1) Irrigated by 2<sup>nd</sup> Pammase through Pm6Ka and drainage water from P3A Sappaya, etc.
- (2) 88.5 ha with 119.48 l/s under plan at Pm6Ka



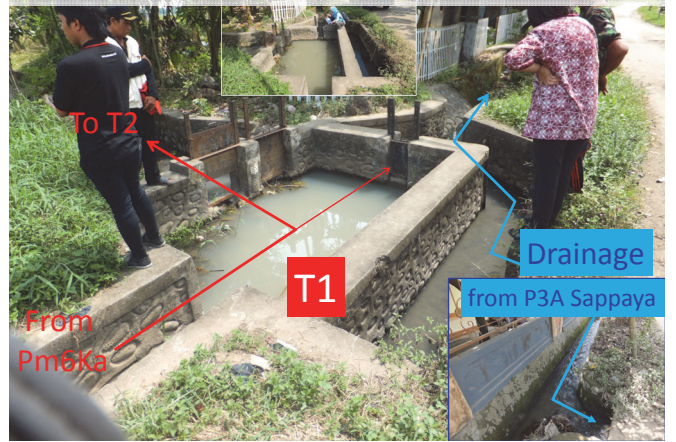
P3A Renggang in GP3A (FWUA) Sirannuang



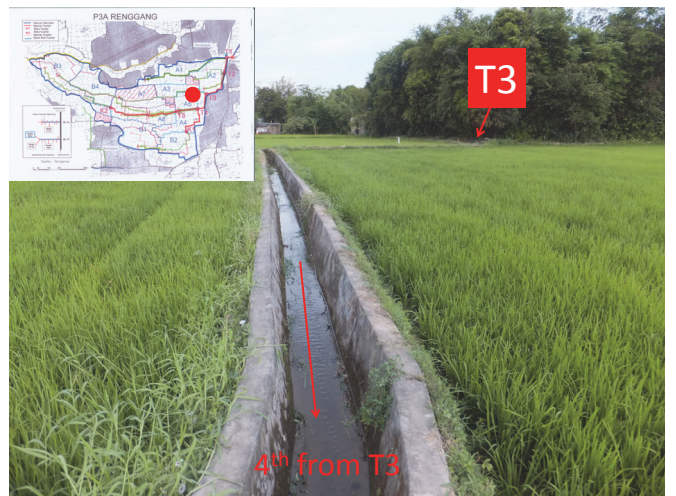
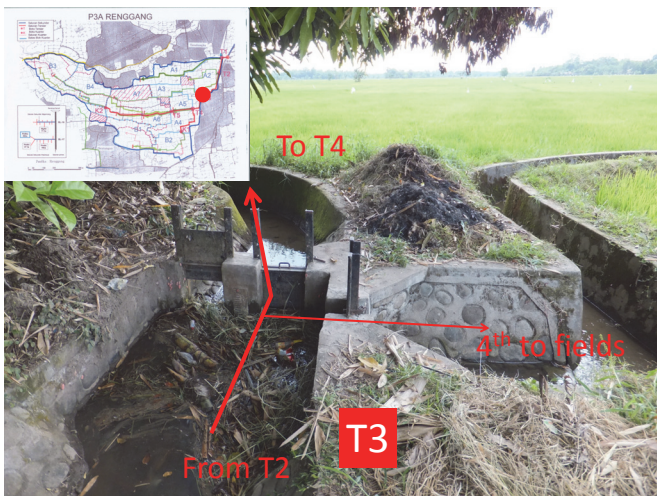
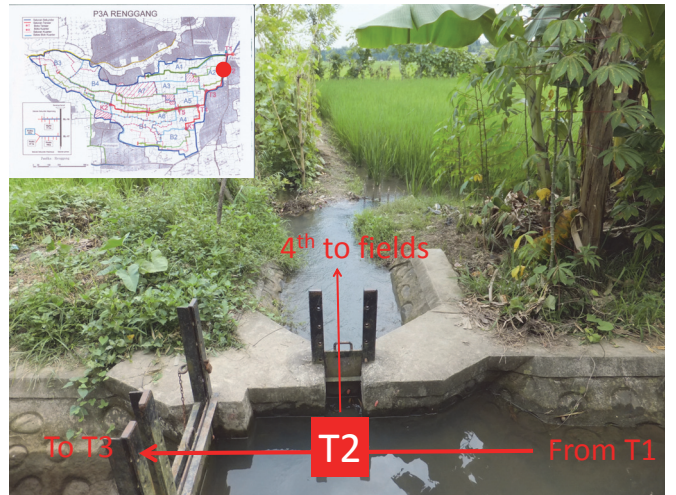


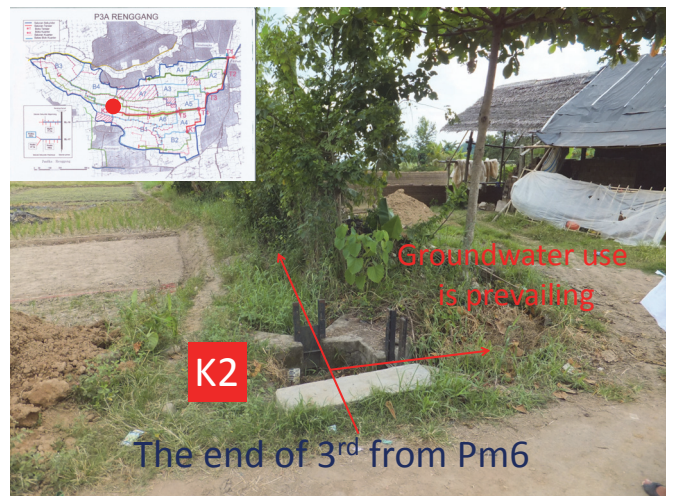
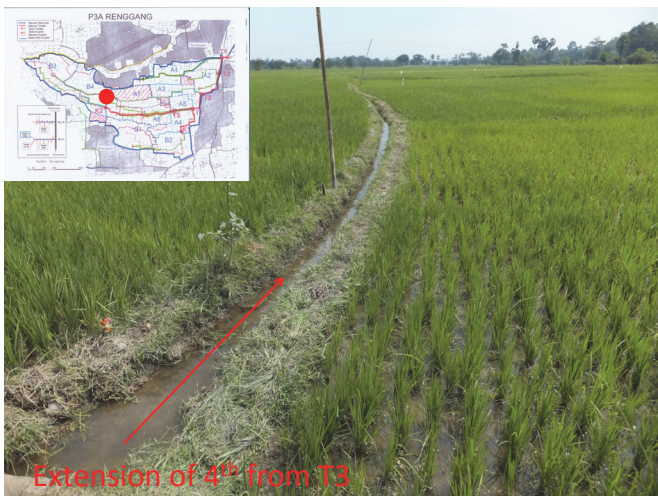
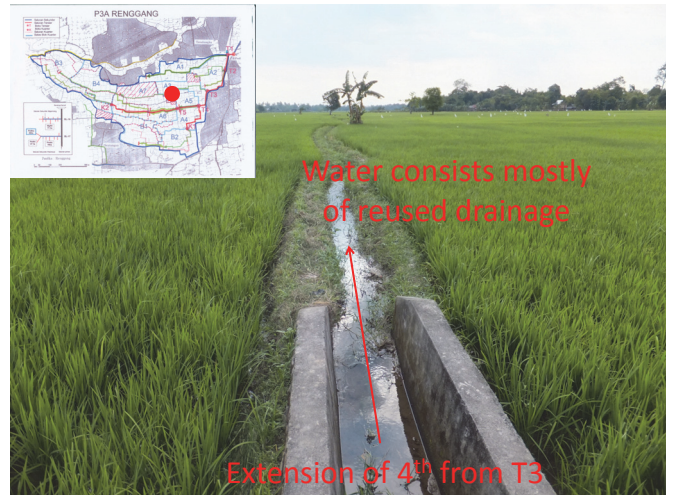
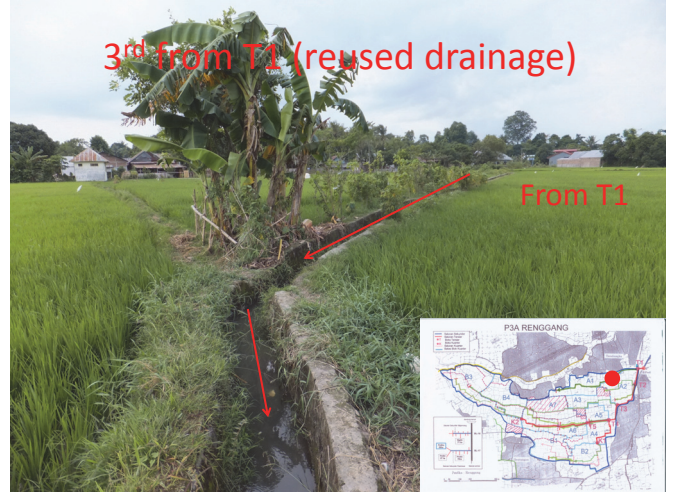
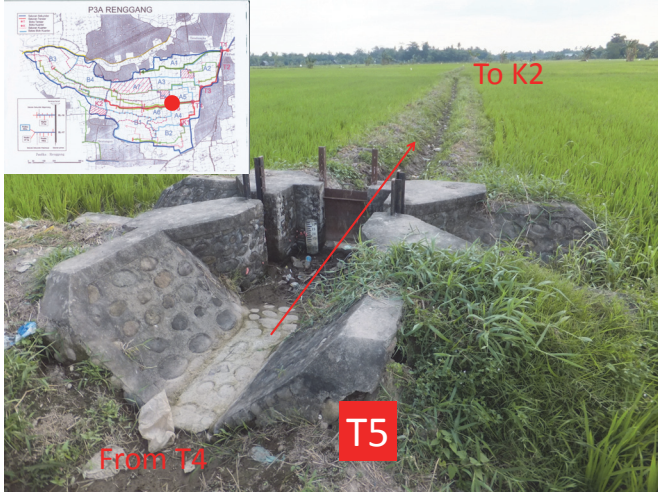
**Pm6 has been under repair**  
 (One of reasons of insufficient water in this season in Renggang)

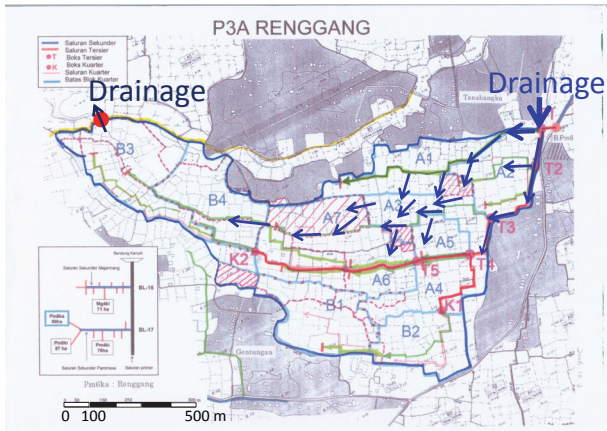
**Important role of Reusing drainage water**



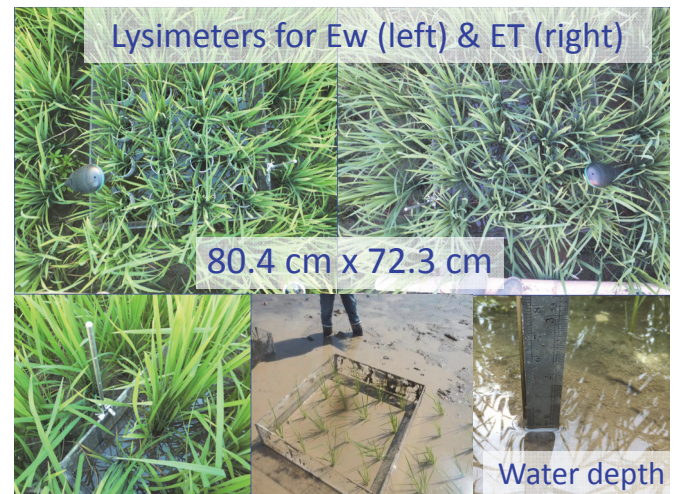
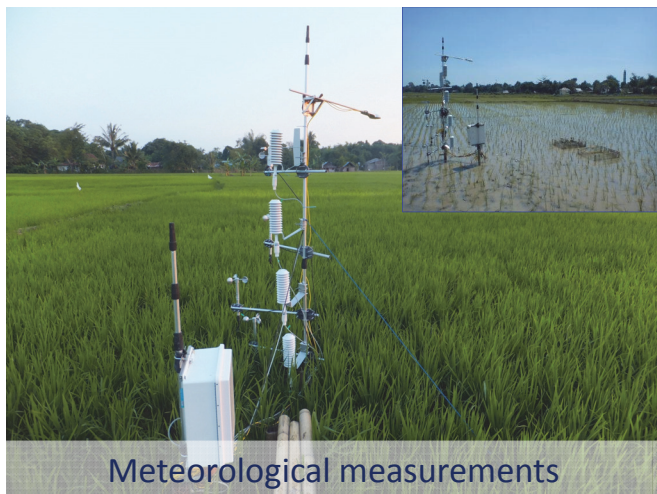
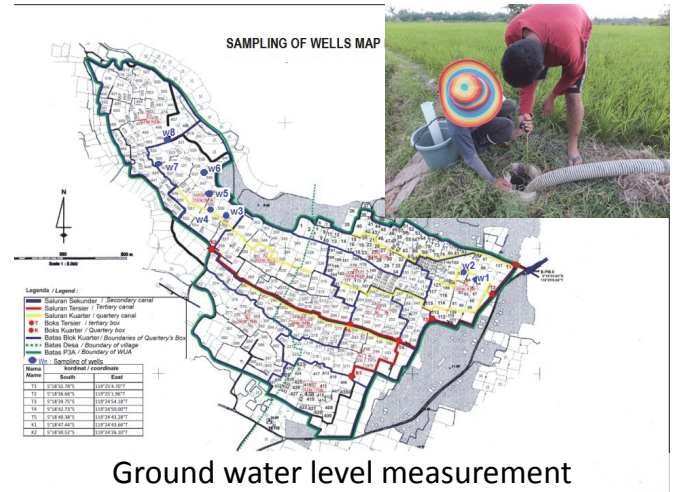
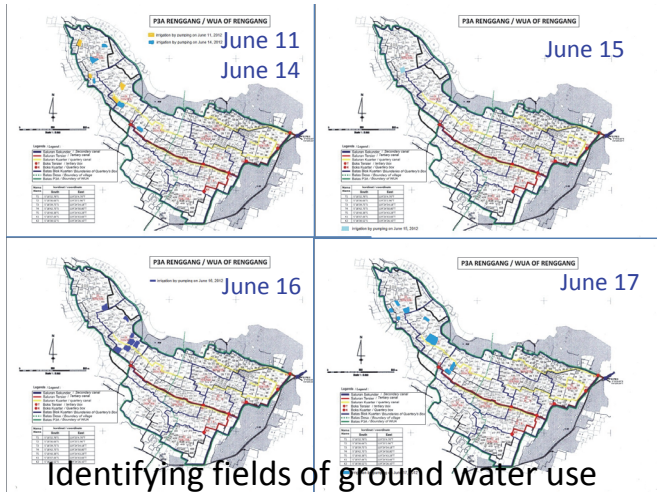
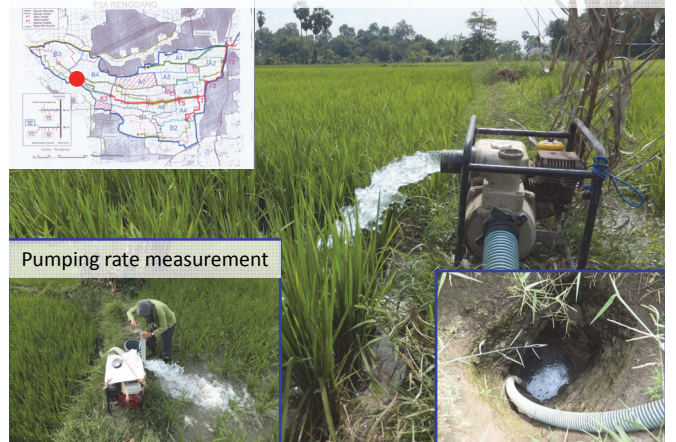
**Observing flow rate for getting discharge**

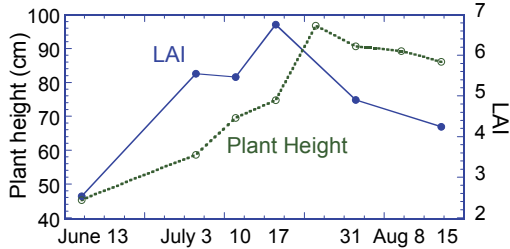




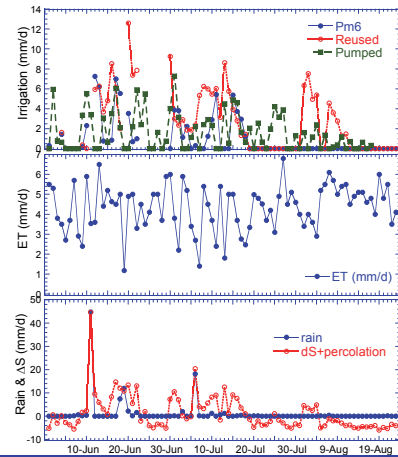


**Important role of ground water use in downstream**

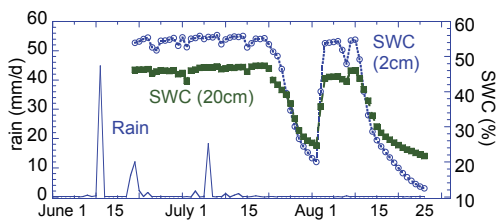




Variation of plant height and LAI in Renggang  
(Transplanted from 8 to 22 May)



Daily variation of water balance terms in Renggang



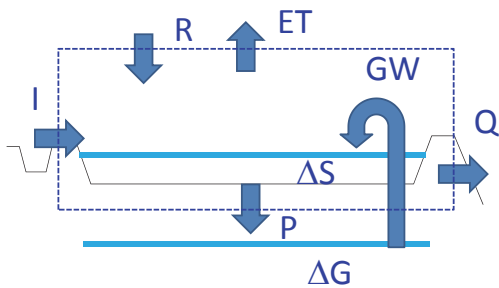
Daily variation of rain and soil water content in Renggang



W2 on 3-Jun                      W8 on 30-Jun  
 $k = 1.4 \text{ E-4 (m/s)}$                $k = 2.9 \text{ E-5 (m/s)}$

Hydraulic conductivity obtained by pumping practice

Water balance in P3A-scale

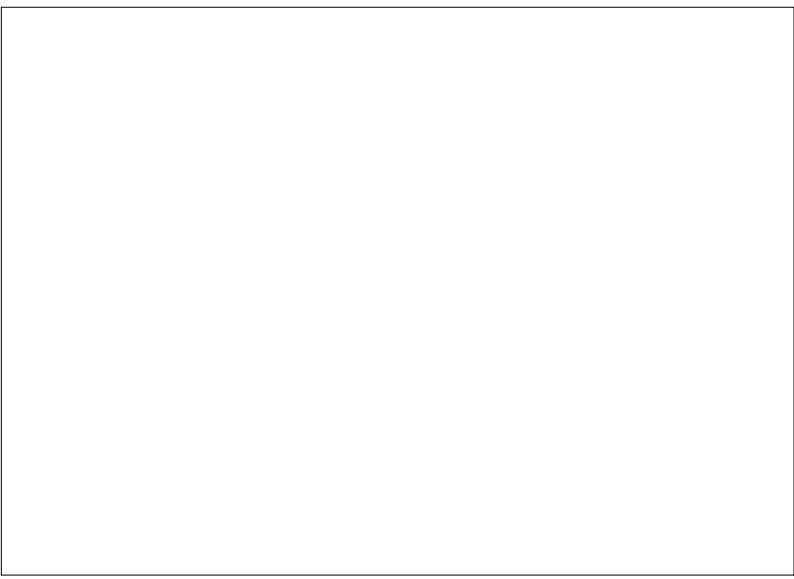


$R + I + RU + GW = ET + P + Q + \Delta S$   
 Taking long period WB makes  $\Delta S = 0$

Table Measured and estimated water balance in Renggang P3A

	rain (mm)	Irrigation (mm)		Pump (mm)	ET (mm)	Percolation (mm)
		Pm6	Drainage			
June	69.60	37.67	76.41	57.38	130.87	110.20
July	25.00	34.25	70.46	58.09	125.29	62.51
Aug	0.80	0.00	37.83	9.93	109.20	-60.65
Sum	95.40	71.92	184.70	125.41	365.36	112.07

	rain (%)	Irrigation (%)		Pump (%)	ET (%)	Percolation (%)
		Pm6	Drainage			
June	28.87	15.63	31.70	23.80	54.29	45.71
July	13.31	18.24	37.52	30.93	66.71	33.29
Aug	1.65	0.00	77.90	20.45	224.91	-124.91
Sum	19.98	15.06	38.69	26.27	76.53	23.47





## Background

- Precise water quality information is very important as well as water volume for water resources management.
- But, in Bali and South Sulawesi, there are very little data about water quality, especially its spatial distribution and temporal variation in a basin level.

## Background

- In Bali, it is very common that water in irrigation canals is used for daily domestic purpose, such as bathing, washing clothes, and so on.



## Background

- The water in the river and irrigation canals contains much return flow from the upper area, and is used several times both for irrigation and domestic use.
- So the irrigation water quality should be managed not only for agricultural use but also for domestic use.

## Background

- In South Sulawesi, the lower area of the Jeneberang River Basin (= the beneficial area of Bili Bili Dam Reservoir) is large plane land, where farmland, mainly paddy field, and residential area are located mixed.
  - The residents in this area use ground water from wells in their house site for their daily life.
  - Thus, the quality of the well water might be strongly influenced by irrigated water to the farmland, especially percolation from the paddy field.
  - And they also use the water in irrigation canals for domestic use as well as in Bali.
- ▼
- The monitoring of water quality in the both study areas is very important for sustainable water resource management.

## Research Objectives

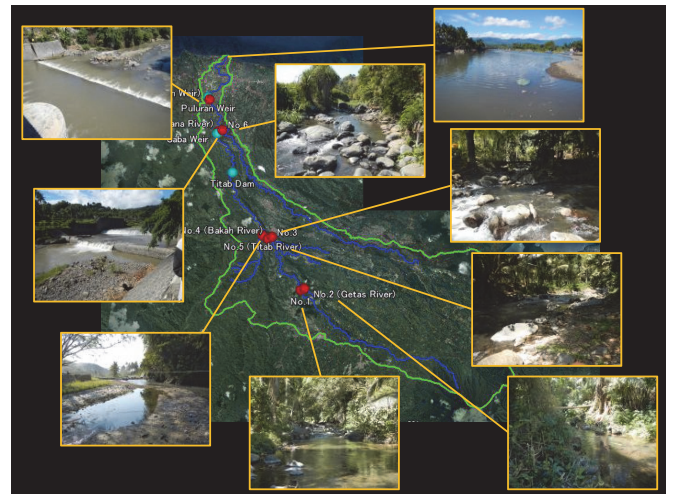
- To assess the present situation of water environment in the both study area from the view of water quality
- To obtain water quality data

## Materials and Methods

- Necessary data

Category	Items	Methods
Water quality	Total Nitrogen (TN) Total Phosphorus (TP) Chemical Oxygen Demand (COD) Total Organic Carbon (TOC) pH EC	1. Water sampling at several points in the river or the canals. 2. On-site measuring and laboratory analysis
Water flow	Cross sectional area of flow Flow velocity	On-site measuring

- To make water quality distribution map for the both study areas



## Schedule and Budget of Field Survey in JFY 2012 and 2013

- Survey frequency: 2-3 months interval = 4 to 6 times a year
- Necessary days: 3 days for the Saba River Basin  
2 days for the Bili Bili irrigation area in one survey
- Total cost: US\$2,000 for water quality analysis
- IPB team basically carry out this survey and analysis.
- Dr. Satoko Watanabe will also take water samples to Japan and analyze.

## Research Plan

S.K. Saptomo

## Questions

1. Is water sufficient ?
2. Is it ALWAYS sufficient?
3. If questions 1 and 2 's answers are NO, how can we manage to turn both answers to YES?
4. How to estimate whether water is sufficient or not?
5. Can we suggest ways that will ensure water is sufficient?

## Answers

1. Quantifications of all water and weather related components :
  1. Measurements
  2. Estimations
2. Modeling of water balance : one spot, one plot, one area, one basin.
3. Simulation with various weather conditions and irrigation practices (water management)

## Research Objectives

1. To quantify water balance components and understand the field water status under current climatic condition and water management practices
2. To model the water balance and distribution and estimates or simulates water balance simulation with various weather conditions and irrigation practices (water management)
3. To determine which water management practices is best to adapt current and future conditions.

## Methods

- #1
  1. On-site continuous measurement
  2. Develop software and process the data
  3. Analyze all water balance components and the site's water balance
- #2
  1. Monitoring of water inflow to and outflow from the field
  2. Development water balance and distribution model for the field and calibrate with measure data
  3. Simulation of water balance and distribution
- #3
  1. COOPERATION WITH OTHER MEMBER

## Activities

## Field monitoring system for measurement of water and weather related variables

Weather stations (Davis)

1. Solar radiation ( $W/m^2$ ) and UV index ( $\lambda$ )
2. Rainfall (mm)
3. Air temperature ( $^{\circ}C$ ) and RH (%)
4. Wind speed (m/s) and direction ( $^{\circ}$ )
5. Barometric Pressure (kPa)
6. Eto (mm) derived by console



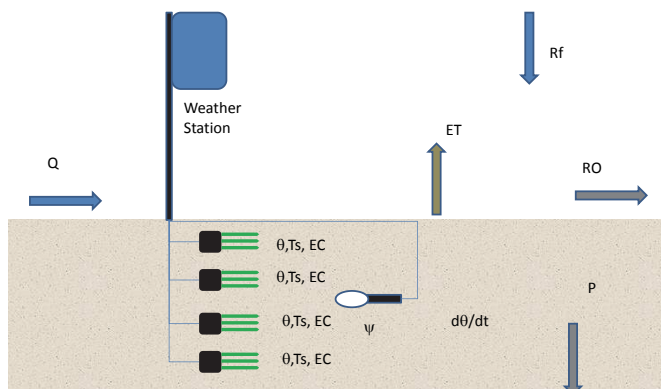
## Field monitoring system for measurement of water and weather related variables

Soil monitoring data logger (Decagon EM50 datalogger)

1. Soil moisture/volumetric water content ( $m^3/m^3$ ) : 5TE
2. Soil Electroconductivity (mS) : 5TE
3. Soil temperature ( $^{\circ}C$ ) : 5TE
4. Soil matrix potential (kPa) : MPS-1

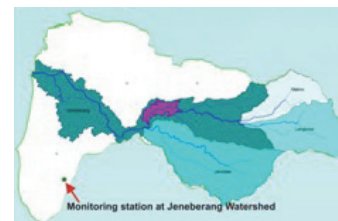


## Monitoring Scheme

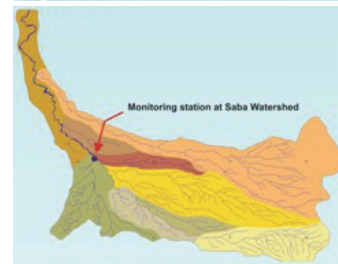


## Location

1. South Sulawesi



2. Bali

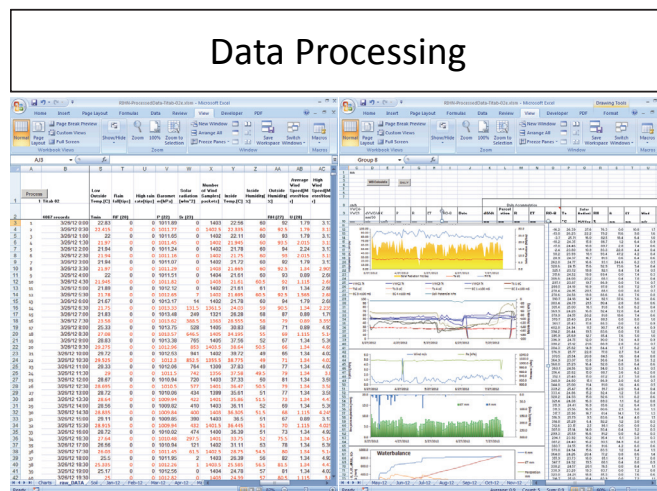


## Data Processing

- Conversion 30 minutes to daily, monthly, annual
- Derived all water balance component :

$$Rf + Q = P + Ro + ET + dS/dt$$

## Data Processing





## Thank You

Water Management Project of Research Institute for Humanity and Nature  
in Collaboration with  
Bogor Agricultural University, Hasanuddin University and Udayana  
University 2012

### Enhancing Water Productivity In The Context of Climate and Land Use Change On-site Field Monitoring in Saba and Jeneberang Watershed

B. I. Setiawan, S. K. Saptomo, I.W. Budiassa, A. Rampisea, Sutoyo, F. Irsyad, Gardjito, T. Watanabe, and M. Mizutani

## Introduction

Uncertainties about the impacts of climate change and land use changes on river discharge has been a challenge to agriculture water management. One effort to adapt to this situation is by increasing water use efficiency, or further the water productivity.

In order to study the water productivity, detailed observation of water balance component at the site should be done. On-site monitoring system had been set up at paddy field in Titab, Saba Watershed, Buleleng, Bali and Bon 8, Jeneberang Watershed, Gowa, South Sulawesi.

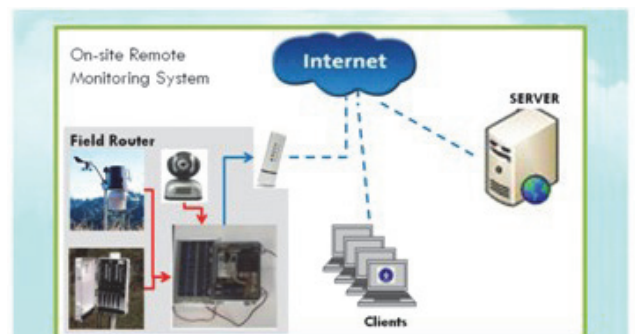
The on-site field monitoring system is powered by solar energy and battery and can be placed in remote location far from electricity line, integrated, easy to maintain, minimizing unnatural changes to the field and disturbance to plant grows and farming activities.

WATER MANAGEMENT PROJECT OF RESEARCH INSTITUTE FOR HUMANITY AND NATURE  
In Collaboration with  
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2012

## Instruments

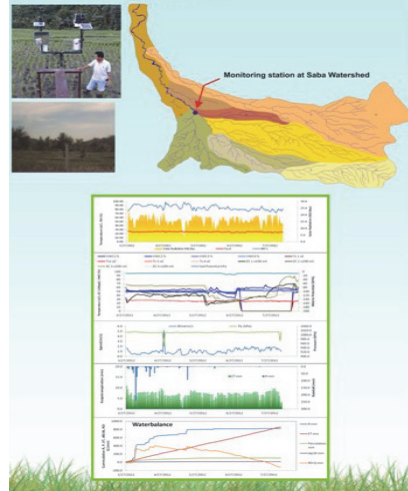
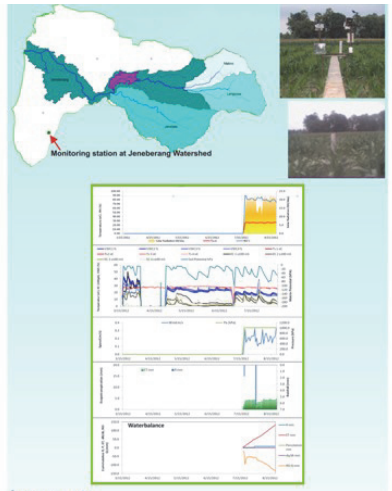
Soil : 1 sensor for soil water potential (suction/pF) 4 sensors for 3 parameters at once soil volumetric water content ( $m^3/m^3$ ), temperature ( $^{\circ}C$ ) and Electro-conductivity (S) at different level of depth beneath the soil surface.

Weather : air temperature ( $^{\circ}C$ ), air relative humidity (%), solar radiation ( $Wm^{-2}$ ), ultraviolet index ( $\lambda$ ), rainfall (mm), barometric pressure (kPa), wind speed (m/s) and wind direction ( $^{\circ}$ ), evapotranspiration (mm). Using these two systems the analysis of water balance can be done as well as more detailed analysis of soil



## Remote Monitoring System

The two measurements systems are connected to data server through internet connection by using Field Router remote monitoring system. Data are regularly downloaded and uploaded to the server. Additionally pictures from the site are taken for the visualization of the situation at the site



Thank You

Water Management Project of Research Institute for Humanity and Nature  
 in Collaboration with  
 Bogor Agricultural University, Hasanuddin University and Udayana  
 University 2012



## Land use analysis using satellite data

Presented by  
**Takao Nakagiri**  
Osaka Prefecture Univ.

### Background

#### Bali:

- Decreasing of green area including a lot of paddy field due to urbanization in the southern area of the island.
- Progressing land use conversion from paddy to others (hotels, restaurants, etc.), especially in middle hilly area with very fine view sight.
- Concerning of land degradation such as soil erosion due to high intensity rainfall in wet season

### Background

#### South Sulawesi:

- Insufficient irrigation water delivery in the Bili Bili irrigation project area; water shortage is occurring in farmland in the lower area of tertiary canals in dry season.
- Difficulty of grasping the actual situation due to largeness of the area (23,602ha) and lack of data.
  - What is the reason of water shortage?
  - In which plot and from when water shortage occurs?
  - How is the situation changing?

### Research Objectives

- To assessment the global land use change in Bali island
- To investigate the land conservation function of Subak (hypothesis)
- To identify the farmland with insufficient water in dry season in the Bili Bili irrigation project area
- To develop a decision making support tool for water resources management
- To transfer remote sensing technologies to Indonesian staffs

### Materials and Methods

#### Fundamental procedure;

1. Obtaining satellite data (images) for associated area
2. Mosaicking and cutting out of satellite image
3. Adjusting the projection
4. Calculating the Indices
5. Smoothing (Denoising)
6. Classification of land use category
7. Verification with ground truth data
8. Statistical analysis

### Materials and Methods

1. Obtaining satellite data;
  - Some data can be obtained without payment.
    - Low resolution temporally or spatially
    - Landsat/TM, ETM: 30m × 30m, 2 images for past 20 years
    - Terra/Modis, : 500m × 500m, 23 images/year
  - High resolution data is still expensive.
  - Free data has still many possibility of effective usage with researcher's ideas.

## Materials and Methods

### 2. PC Software;

- ENVI ver.4.8 (ITT)
- ArcGIS ver.10.3 (ESRI)

### 3. Indices;

- EVI (Enhanced Vegetation Index)

$$EVI = 2.5 \times \frac{NIR - Red}{NIR + 6.0 \times Red - 7.5 \times Blue + 1.0}$$

where NIR, Red, Blue are surface reflectances.

### 4. Verification with ground truth data

- Use of high resolution satellite data
- Old photograph
- Interview from residents
- On-site measuring

## Schedule and Budget of Field Survey in JFY 2012 and 2013

- Collecting satellite data ;
  - Basically free data will be used.
  - Some pay data might be required for verification. (e.g. SPOT data with 2.5m resolution ; US\$4/km<sup>2</sup>, 300-500km<sup>2</sup> for Saba, 100km<sup>2</sup> for Kampili)
- Processing data with software
- Collecting ground truth data
- Making a manual for Indonesian staff

## Interim report of the research - Land use analysis with satellite data -

Presented by  
Takao Nakagiri  
Osaka Prefecture University

## Status of this research

- Examining of the possibility of this research
- Trial for satellite data analysis

## Used satellite data

- Time-series of satellite data
- Satellite/Sensor: Terra/MODIS
- Resolution: 250m x 250m, every 16 days
- Data period: From 2001 to 2011 (23 images/year)
- Index: EVI (Enhanced Vegetation Index)
- Denoising: Hants algorithm
- Supported by Dr. Akihiko Kotera in Kobe univ. (a member of Turkey team)

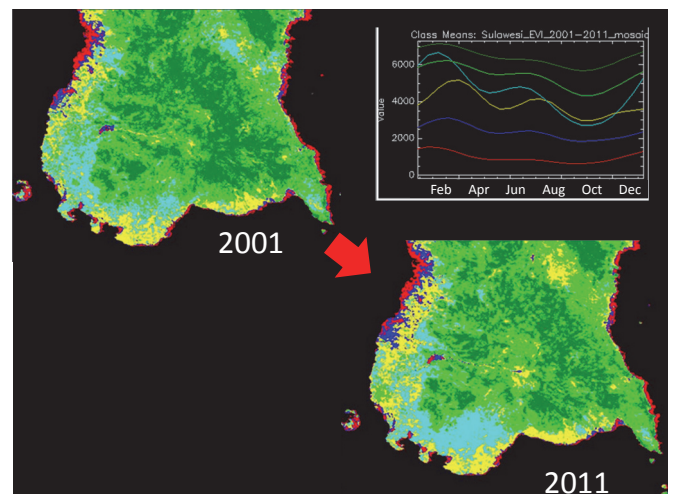
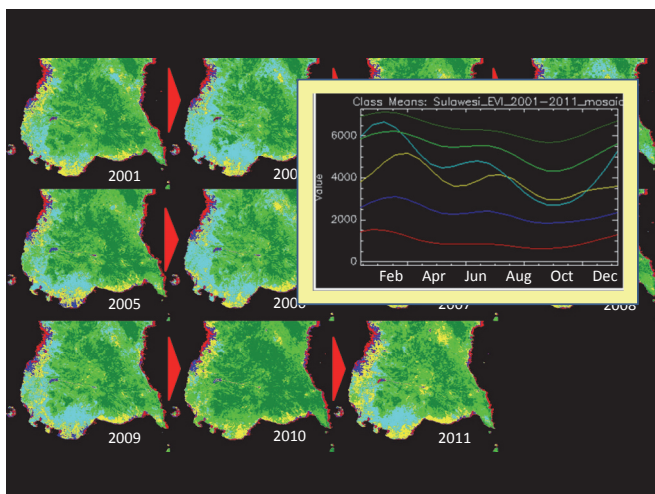
## EVI (Enhanced Vegetation Index)

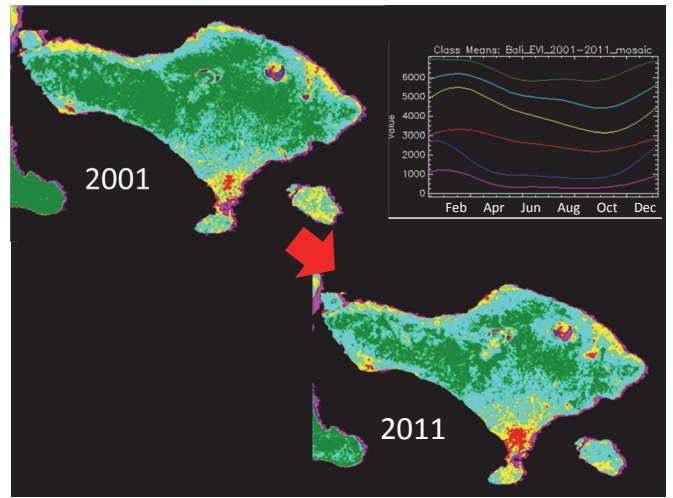
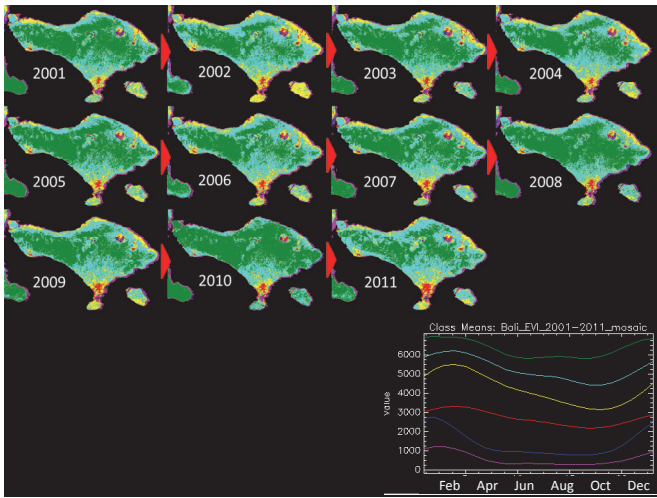
- Designed to enhance signal with improved sensitivity in high biomass region
- EVI is computed by:

$$EVI = 2.5 \times \frac{NIR - Red}{NIR + 6.0 \times Red - 7.5 \times Blue + 1.0}$$

where NIR, Red, Blue are surface reflectances.

- Being popular than NDVI (Normalized Difference Vegetation Index)
- Distributed for free by USGS LP DAAC (U.S. Geological Survey the Land Processes Distributed Active Archive Center)
- EVI value: High vegetation → High  
Low vegetation → Low





## Prospects

- For South Sulawesi, there is high possibility of MODIS data to be effectively used for land use analysis.
- For Bali, MODIS data might be difficult for detail land use analysis.
- Further consideration is required continuously.

## The role of farmer group and subak abian on soil & water conservation practices

### Researcher:

Dr. M Yanuar J Purwanto (Bogor Agricultural University)

Dr Asep Sapei (Bogor Agriculture University)

Mr Made Sudharta

Material for Workshop on Local Framework for IWRM

RIHN, Kyoto, September 5-6, 2012

## RESEARCH PLAN

1. Research Objective and Hypothesis.
2. The current farmer group and subak abian on land & water conservation practices
3. The Methodology
4. Research Schedule and Budget (2012-2013)

## RESEARCH OBJECTIVE

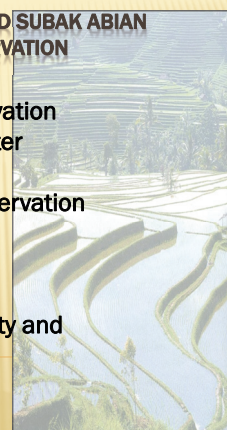
1. Identify the existing farmer group and subak abian on soil & water conservation practices
2. Assessment and field experiment on farmer group and subak abian on soil & water conservation practices
3. Propose Possible adaptation of soil and water conservation with more role of farmer group and subak abian

### HYPOTHESIS:

“the improved Role of farmer group and subak abian make better soil and water conservation performance”

## THE EXISTING FARMER GROUP AND SUBAK ABIAN IN SOIL & WATER CONSERVATION

- a) Traditional soil and water conservation
- b) Cooperative works in soil and water conservation practices
- c) Constrains in soil and water conservation practices:
  - i. Improper hydrology unit
  - ii. Incomplete structure
  - iii. Farmers budget without society and government contribution



## THE METHODOLOGY: I. SCOPE OF STUDY

1. Identify the existing farmer group and subak abian on soil&water conservation in Indonesia (2012-2013)
  - a. The current soil&water conservation practices
  - b. Constrains and improvement need of conservation
2. Assessment and field experiment on soil & water conservation practices (2012-2014)
  - a. Participatory Assessment The current Activity of on soil & water conservation practices (2012-2013)
  - b. Field experiment The current Activity of on soil & water conservation practices (2013-2014)
3. Propose Possible adaptation of conservation (2013-2014)
  - i. **proper hydrology unit with complete structure**
  - ii. **Integrated budget with society and government contribution**

## THE METHODOLOGY: II. DATA COLLECTION AND ANALYSIS

1. Field survey on legal aspect of the existing conservation
  - a. Interview and Questioner
  - b. Field Observation for component of conservation
  - c. Focus Group Discussion
2. Field survey on current role in conservation
  - a. Interview and Questioner
  - b. Field Observation for component of conservation
  - c. Focus Group Discussion
3. SWAT Analysis for the impact soil & water conservation
  - a. Focus Group Discussion on the Propose criteria of IWRM
  - b. SWAT model performance of proposed local framework of IWRM

### Budget Plan (2012-2013)

No	Description	Activities	(IDR)		Vol.	Total
1	Plane ticket (return), tax and taxi	4 times 2 researchers (Bogor- Bali)	2500000	Is	8	20.000.000,00
2	Rent Car	4 x 5 days	700000	unit/day	20	14.000.000,00
3	Accomodation	4 researchers x 4 days	700000	night room	16	11.200.000,00
4	Workshop Focus Group Discussion	2 times	10000000	Is	2	20.000.000,00
5	Research materials	paper, copy, computers and reporting	25000000	Is	1	25.000.000,00
<b>Total</b>						<b>90.200.000,00</b>

### RESEARCH IMPEMENTATION PLAN (SUBJECT TO DISCUSS)

1. Field survey on legal aspect of the existing conservation
  - a. Interview and Questioner (Oktober-December 2012)
  - b. Field Observation for component of conservation (Oct.-Dec. 2012)
  - c. Focus Group Discussion (January-February 2013)
2. Field survey on current role in conservation
  - a. Interview and Questioner (Oktober-December 2012)
  - b. Field Observation for component of conservation(Oct-Dec. 2012)
  - c. Focus Group Discussion (January-February 2013)
3. Report document (January - February 2013)
4. SWAT Analysis for the impact soil & water conservation
  - a. Focus Group Discussion for SWAT implementation(June-August 2013)
  - b. SWAT model performance modelling(eptember-December 2013)
5. Report document (January - February 2014)

Arigatou Gozaimashita  
Thank you

## The existence of P3A/Subak in the Current IWRM

### Researcher:

Dr. M Yanuar J Purwanto (Bogor Agricultural University)

Dr. Makasazu Mizutani (Prof, Utsunomiya University)

Dr Nurlita (Makasar State University)

Dr Rifqi (Makasar State University)

Material for Workshop on Local Framework for IWRM

RIHN, Kyoto, March 1, 2012

## RESEARCH PLAN

1. Research Objective and Hypothesis.
2. The current P3A/ WUA on land & water management
3. The Methodology
4. Research Schedule and Budget (2012-2013)

## RESEARCH OBJECTIVE

1. Identify the existing IWRM in Indonesia
2. Identify the Existing Activity Of P3a/Subak in the IWRM
3. Propose Possible Improvement of IWRM mechanism with more role of P3a/Subak

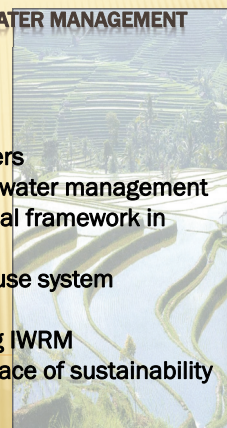
### HYPOTHESIS:

“Role of P3a/Subak make better IWRM performance “

## THE CURRENT P3A/WUA ON LAND & WATER MANAGEMENT

### Participation in IWRM:

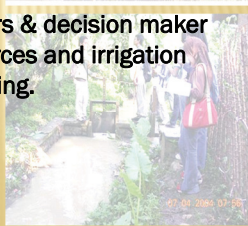
- a) WUA as local institution
- b) WUA covers land and water matters
- c) WUA is extensively discussed in water management
- d) as sample for core element of local framework in IWRM study, representing :
  - i. Local management of a land use system
  - ii. Local water management
  - iii. To be evaluated in the existing IWRM
  - iv. To be evaluated in its performance of sustainability



## THE CURRENT P3A/WUA ON LAND & WATER MANAGEMENT

### Best Progress in WUA performance:

- a) expand their capacity in both water and agribusinesses:
  - Efficient water distribution
  - achieve water saving
  - increase their income.
- b) Participatory in IWRM
  - understandings among farmers & decision maker
  - new regulation in water resources and irrigation considering these understanding.
  - Multi sector progress



## THE METHODOLOGY: I. SCOPE OF STUDY

1. Identify the existing IWRM in Indonesia (2012-2013)
  - a. The existing legal and current mechanism of IWRM
  - b. Constraints and improvement need for effective IWRM
2. Identify Existing P3a/Subak in the IWRM (2012-2013)
  - a. Identify Existing P3a/Subak in the IWRM
  - b. Farmers Criteria on sustainable role of P3A/Subak in the IWRM
3. Propose Possible Improvement of IWRM mechanism with more role of P3a/Subak (2013-2014)
  - a. Proposed criteria of IWRM
  - b. Recommendation on local framework of IWRM

**THE METHODOLOGY:  
II. DATA COLECTION AND ANALYSIS**

1. Field survey on legal aspect of the existing IWRM
  - a. Interview and Questioner
  - b. Field Observation for component of IWRM
  - c. Focus Group Discussion
2. Field survey on current role in IWRM
  - a. Interview and Questioner
  - b. Field Observastion for component and criteria of P3A/Subak in the IWRM
  - c. Focus Group Discussion
3. Dynamical Analysis of the IWRM
  - a. Focus Group Discussion on the Propose criteria of IWRM
  - b. Dynamic Modelling on the performance of IWRM


**Budget Plan (2012-2013)**

No	Description	Activities	(IDR)		Vol.	Total
1	Plane ticket (return), tax and taxi	4 times Bogor-Makasar-BiliBili	3000000	Is	4	12.000.000,00
2	Rent Car	4 x 5 days	700000	unit/day	20	14.000.000,00
3	Accomodation	4 reseacrher x 4 days	700000	night room	16	11.200.000,00
4	Workshop Focus Group Discussion	2 times	10000000	Is	2	20.000.000,00
5	Research materials	paper, copy, computers and software	25000000	Is	1	25.000.000,00
<b>Total</b>						<b>82.200.000,00</b>

**RESEARCH IMPEMENTATION PLAN (SUBJECT TO DISCUSS)**

1. Field survey on legal aspect of the existing IWRM
  - a. Interview and Questioner (October-December 2012)
  - b. Field Observation for component of IWRM (Oct.-Dec. 2012)
  - c. Focus Group Discussion (January-February 2013)
2. Field survey on current role in IWRM
  - a. Interview and Questioner (October-December 2012)
  - b. Discussion for component and criteria of P3A/Subak in the IWRM (October-December 2012)
  - c. Focus Group Discussion (January-February 2013)
3. Report document (January – February 2013)
4. 4. Dynamical Analysis of the IWRM
  - a. Focus Group Discussion on the Propose criteria of IWRM (June-August 2013)
  - b. Dynamic Modelling on the performance of IWRM (September-December 2013)
5. Report document (January – February 2014)

Arigatou Gozaimashita  
Thank you



RIHN C-09-Init Research Project on "Designing Local Framework of Integrated Water Resource Management"

Topic 6  
STUDIES ON WATER AVAILABILITY AND PRODUCTIVITY IN THE CONTEXT OF LANDUSE AND CLIMATE CHANGES

## RESEARCH TEAM

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1. Budi I. Setiawan (Team Leader)
2. Satyanto K. Saptomo (Saba/Jeneberang)
3. I Wayan Budiasta (Saba)
4. Agnes Rampisela (Jeneberang)
5. Sutoyo (Saba)
6. Fadli Irsyad (Jeneberang)
7. Chusnul Arief (Saba/Jeneberang)
8. Gardjito (Saba/Jeneberang)
9. Daryono (BMKG-Saba/Jeneberang)

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## BACKGROUND

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- Population and welfare increase.
- Increase demand for food and other agricultural products.
- Decrease of arable land due to land use competition.
- Uncertainty of available water due to climate change.
- Shifting of cultivation calendar.
- Decrease number of farmers.
- Have to produce more food and other agricultural products with less and less water.
- Need to manage the available water wisely in order to increase water productivity.

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## WATER PRODUCTIVITY

(Water for Food Water for Life, IWMI 2007)

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- Water productivity (WP) is a ratio of the net benefits from crop, forestry, fishery, livestock, and mixed agricultural systems to the amount of water required to produce those benefits.
- WP reflects the objectives of producing more food, income, livelihoods, and ecological benefits at less social and environmental cost per unit of water used.
- WP means growing more food or gaining more benefits with less water.
- Physical WP is a ratio of the mass of agricultural output to the amount of water used.
- Economic WP is the value derived per unit of water used.
- WP is also sometimes measured specifically for crops (crop water productivity) and livestock (livestock water productivity).

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## DAILY WATER CONSUMPTION

(Water for Food Water for Life, IWMI 2007)

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Estimated daily water consumption from primary dietary components for Ethiopia, Thailand, and Italy				
Product	Description	Ethiopia	Thailand	Italy
Cereals*	Calories per person per day	1,253	1,180	1,166
	Water use (liters per kilogram)	1,576	3,523	949
	Daily per capita use (liters)	573	1,141	428
	Share of diet (% of total calorie intake)	68	50	32
Animal products*	Calories per person per day	102	295	950
	Water use from grazing land (liters per kilogram)	23,289	2,486	1,474
	Daily per capita use (liters)	2,238	605	1,611
	Share of diet (% of total calorie intake)	6	12	26
Fruits*	Calories per person per day	13	108	172
	Water use (liters per kilogram)	507	851	440
	Daily per capita use (liters)	10	144	239
	Share of diet (% of total calorie intake)	2	5	5
Total	Total calories supplied per person per day	1,838	2,383	3,603
	Total daily water consumption (liters)	3,143	2,955	3,236

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## YIELD & EVAPOTRANSPIRATION

(Water for Food Water for Life, IWMI 2007)

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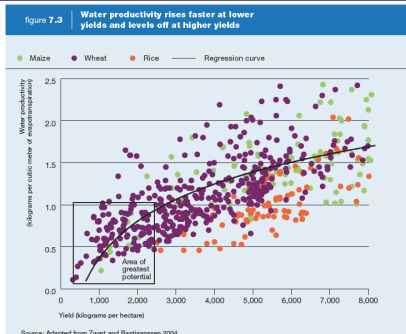


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## YIELD & WATER PRODUCTIVITY

(Water for Food Water for Life, IWMI 2007)

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## OBJECTIVES

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1. To know the water demand and its future trend in Saba and Jeneberang Watershed.
2. To know the water availability and its future trend in Saba and Jeneberang Watershed.
3. To find effective and proper methods to increase water productivity for rice production in Saba and Jeneberang Watershed.
4. To enhance farmers capability in producing rice with less water in Saba and Jeneberang Watershed.

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## SUB-TOPICS

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- A. Assessing landuse and climate changes, and their impacts on water availability (Sutoyo/Fadli)
- B. Assessing water use and water productivity in paddy fields (Satyanto & Chusnul).
- C. Optimising water use to enhance water productivity paddy fields (Satyanto & Chusnul).
- D. Empowering farmers to enhance their capabilities in managing water resource (Gardjito).

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## METHODOLOGY

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- Locations: Saba and Jeneberang watersheds.
- Land use mapping using GIS.
- Assessing water availability in watershed using SWAT.
- Modelling water consumption in paddy fields using a dynamic water balance equation.
- Online measurements of climate and soil variables in paddy fields.
- Measurement soil hydraulic properties.
- Collecting secondary data and information on climate, biophysics and statistics.

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## RESEARCH STAGES

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NO ACTIVITIES	STAGES OF RESEARCH ACTIVITIES				
	1 2011/2012	2 2012/2013	3 2013/2014	4 2014/2015	5 2015/2016
1 Landuse mapping	STY & FAI				
2 Installing field monitoring system	SKS & CHA				
3 Establishing database and information system	SKS & CHA				
4 Collecting climate and statistical data	IWB & AGR				
5 Farmer empowerment			GRD		
6 Analysing landuse change		STY & FAI			
7 Analysing climate change			STY & FAI		
8 Analysing water balance in paddy fields		SKS & CHA			
9 Analysing rice and water demand			IWB & AGR		
10 Analysing water availability				STY & FAI	
11 Analysing water productivity in paddy fields			SKS & CHA		
12 Optimizing water use to enhance WP				SKS & CHA	
13 Designing frameworks to enhance WP					ALL

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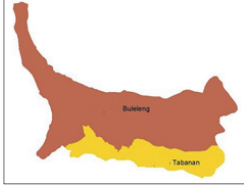
## PROGRESS REPORT

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1. Assessing Climate and Landuse Changes on Water Resources in Saba Watershed (Sutoyo)
2. Assessing Climate And Landuse Changes On Water Resources in Jeneberang Watershed (Fadli)
3. Enhancing Water Productivity in the Context of Climate and Land Use Change (Satyanto)
4. Training on SRI Organic Rice Cultivation (Gardjito)

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## ADMINISTRATIVE MAPS OF SABA WS



Regency	District	Sub-district	Area (ha)		
Banjar		Manduk	1812		
		Geang	1276		
		Banyasin	226		
		Kayuwah	199		
		Gubag	84		
		Total	3597 (26%)		
		Buleleng		Uisero	3100
				Panoksan	842
				Tanggapan	761
				Keds	602
Bangdi	566				
Buarangbu	523				
Pelapuan	381				
Subak	379				
Tauh	353				
Kekran	233				
Telaga	88				
Total	5709 (41%)				
Seririt		Chasen	351		
		Rangbu	299		
		Kalipana	254		
		Pateon	197		
		Ganagsan	137		
		Serit	83		
		Pengastuhan	62		
		Kangbu	55		
		Mayeng	46		
		Banda	34		
Total	1570 (11%)				
Sukasada		Pancasan	176 (1%)		
		Papuan	312 (2%)		
Tabanan		Bastian	672		
		Papuan	277		
TOTAL AREA			14019 (100%)		

Source: Map of Badan Informasi Geospasial 2000 (IndoMed)

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## SUBAK & POPULATION

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District	Subak Sawah	Subak Abian	Total
Seririt	40	16	56
Buleleng	20	23	43
Banjara	33	21	54
Sukasada	64	13	77
Pupuan		24	24
Total	157	97	254

Source: Buleleng dalam Angka 2011 and Tabanan dalam Angka 2011

District	Regency	Area (km <sup>2</sup> )	Population	Density per km <sup>2</sup>	Area Inside Saba Ws (km <sup>2</sup> )	Population in Saba Ws	
Banjara	Buleleng	172,60	67.762	393	35,97	14.122	
Buleleng	Buleleng	196,62	44.765	228	57,09	12.998	
Seririt	Buleleng	111,78	78.809	705	15,17	10.695	
Sukasada	Buleleng	172,93	71.769	415	1,76	730	
Pupuan	Tabanan	179,02	40.451	226	30,21	6.826	
						140,20	45.372

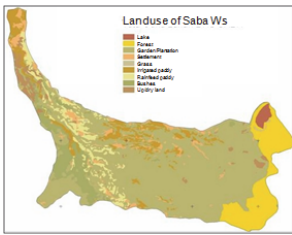
Source: Buleleng dalam Angka 2011 and Tabanan dalam Angka 2011



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## LANDUSE 2000

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Type	Area (ha)	Percentage
Garden/Plantation	8267	59%
Forest	1670	12%
Irigated paddy fields	1047	7%
Bushes	990	7%
Rainfed paddy fields	807	6%
Settlement	645	5%
Up/dry land	434	3%
Lake	134	1%
Grass	25	0%
Total	14019	100%

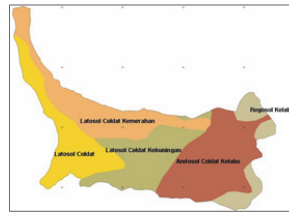
Source: Data was processed based on Map of Badan Informasi Geospasial 2000



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## SOIL TYPES

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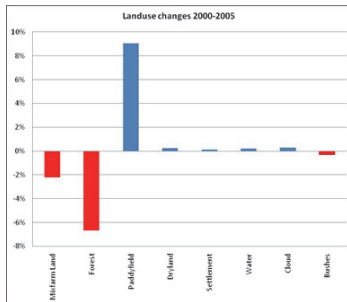
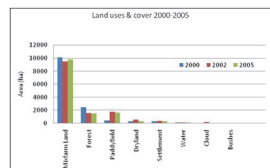


Types of Soil	Area	Percentage
Brown Grey Andosol	4114	29%
Reddish Brown Latosol	3186	23%
Brown Latosol	2721	19%
Yellowish Brown Latosol	2789	20%
Grey Regosol	1210	9%
Total	14019	100%



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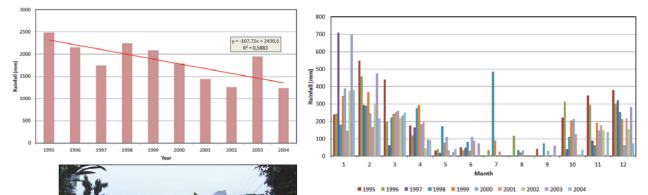
## LANDUSE CHANGES 2000-2005



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## RAINFALL 1995-2004

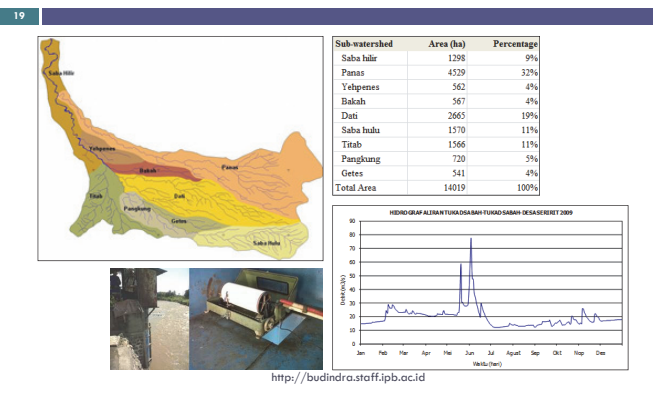
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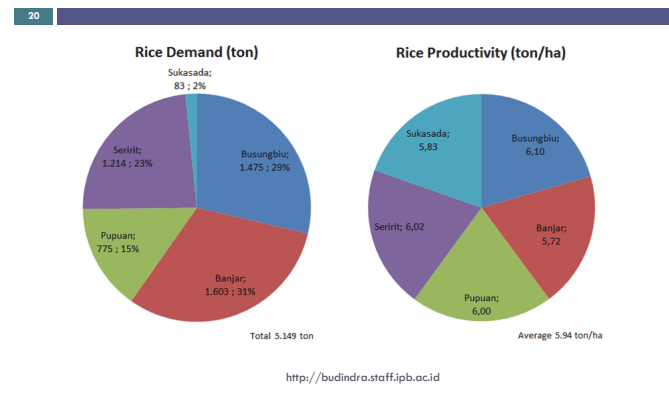
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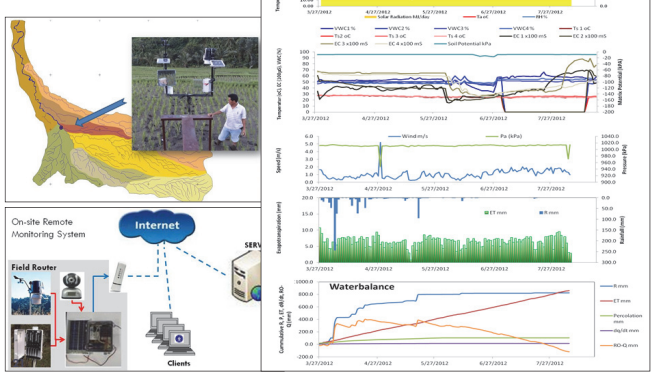
# RIVER & SUB-WATERSHED



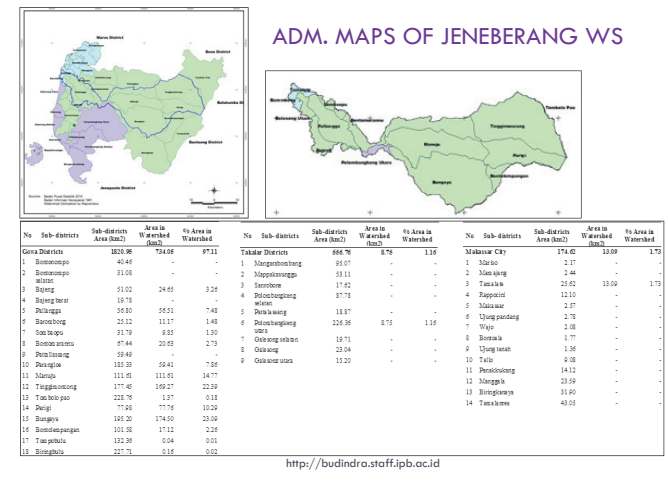
# RICE DEMAND & PRODUCTIVITY



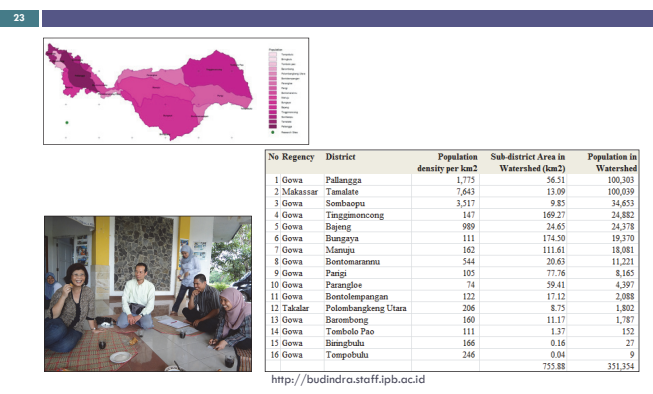
# MICRO-CLIMATE & WATER BALANCE



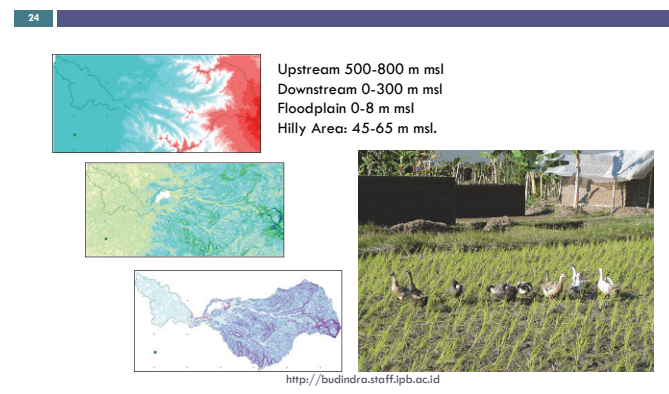
# ADM. MAPS OF JENEBERANG WS



# POPULATION

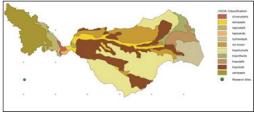


# ELEVATION, SLOPE & TOPOGRAPHY



## LAND SYSTEMS AND SOILS

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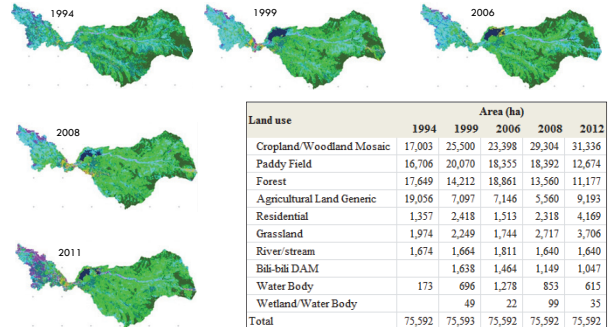
Land System Name	Area (Ha)	Soil Taxonomy USDA 1975		
Bukit Balang	22,481	Dystropepts	Humitropepts	Tropohumults
Air Hitam-Kanan	15,384	Dystropepts	Haplothox	Tropudults
Makasar	10,526	Tropaquepts	Fluvaquents	Ustropepts
Bukit Ayun	7,385	Dystropepts	Tropohumults	Not Known
Tanggamus	5,076	Dystrandepts	Humitropepts	Hydrandepts
Bakunan	4,058	Tropaquepts	Tropofluvents	Eutropepts
Barong Tongkok	3,206	Dystropepts	Eutropepts	Tropudults
Bukit Masung	2,538	Dystropepts	Tropudults	Troporthents
Bontosapri	2,291	Ustropepts	Haplustults	Haplustalfs
Sungai Mampi	1,691	Dystropepts	Tropudults	Not Known
Buhdowang	472	Haplustults	Dystropepts	Chromusterts
Lantang	344	Dystropepts	Paleustults	Haplustults
Ujung Petang	136	Ustipsamments	Tropaquepts	Not Known



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## LANDUSE CHANGES 1994-2011

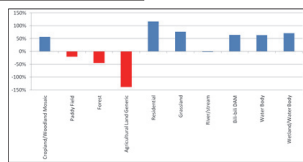
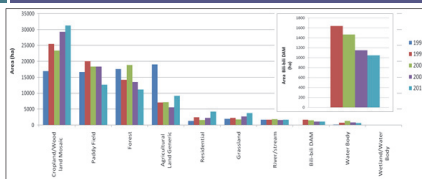
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## LANDUSE CHANGES 1994-2011

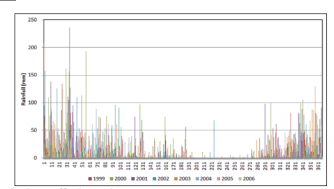
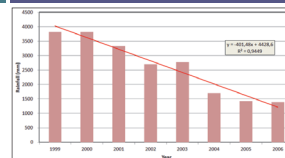
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## RAINFALL 1996-2006

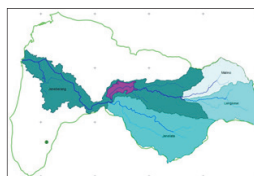
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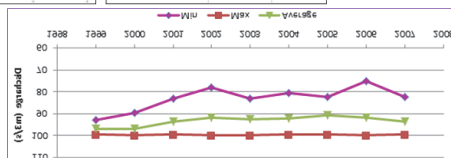
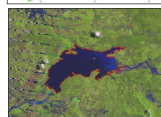
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## RIVER & SUBWATERSHED

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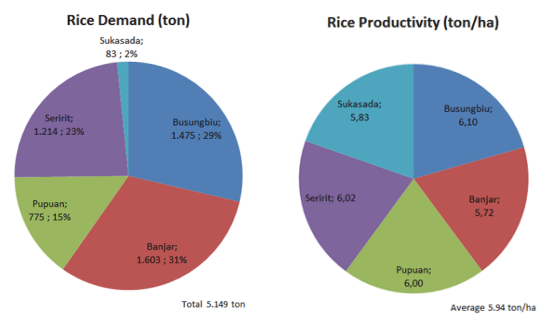
Sub-watershed	Area (ha)	Percent
Jeneberang	31,091	41%
Jenelata	22,952	30%
Lengkese	12,915	17%
Maino	8,634	11%
<b>Total</b>	<b>75,591</b>	<b>100%</b>



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## RICE DEMAND & PRODUCTIVITY

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# MICRO-CLIMATE & WATER BALANCE



1st SRI Training, 4 days in NOSC, Sukabumi, West Java, May 28 – 31, 2012.  
3 Farmers from Saba, 3 for Jeneberang and 3 Research Members



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ARIGATO ITADAKIMASU

## Investigation of the cause of water shortage in farmland and proposal for optimal water delivery in Bili Bili irrigation project

Presented by  
Takao Nakagiri  
Osaka Prefecture Univ.

## Background

- Insufficient irrigation water delivery in the Bili Bili irrigation project area in South Sulawesi. Especially, in farmland in the lower area of tertiary canals water shortage is occurring in dry season.
- Difficulty of grasping the actual situation due to largeness of the area (23,602ha) and lack of data.
  - What is the reason of water shortage?
    - Insufficient intake water from weirs?
    - Huge water conveying loss?
    - Inappropriate water delivery?
    - Topographical problem?
  - In which plot and from when water shortage occurs?
  - How is the situation changing?

## Research Objective

- To identify the cause of water shortage occurrence in the farmland in Bili Bili irrigation project.
- To develop a simulation model to consider intake from weirs in the Jeneberang River, diversion to the tributary canals, conveyance time through each canal, and intake to paddy plots in Bili Bili irrigation project area.
- To propose of optimal water delivery system to reduce the water shortage area through the model simulation.

## Materials and Methods

- ◆ Identification of the cause of water shortage
  - Selection of the study area (primary – secondary – tertiary canals and paddy plot) for a precise investigation and modeling.
  - Implementation of on-site survey in dry season
    - Water flow (the product of cross sectional area and velocity of the flow) measuring at several points in irrigation canals
    - The present situation of plot to plot irrigation
    - Topography of paddy plot
  - Calculation of water loss in the canals.
  - Estimation of paddy water requirement.
  - Finding out the cause of the water shortage

## Materials and Methods

- ◆ Modeling & Simulation
  - Establishment of a prototype model.
  - Application of the model to the study area.
  - Implementation of model simulation.
  - Proposing of optimal water delivery system to reduce the water shortage area.

## Schedule and Budget of Field Survey in JFY 2012 and 2013

- Field Survey for water flow measurement
- Selection of model application area
- Developing a prototype model



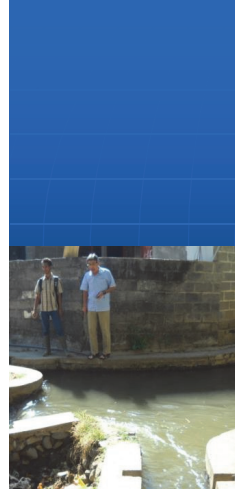


Main Topic 8

## Optimization of Irrigation Water Management in Bali and South Sulawesi

Dr. I Wayan Budjasa (Leader)  
 Dr. Makasazu MIZUTANI  
 Dr. Takao NAKAGIRI  
 Dr. Agnes Rampisela  
 Dr. Satyanto Krido Saptomo  
 Dr. Ken'ichi NAKAGAMI  
 Sutoyo, S.TP, M.Si

RIHN C-09-Init Chapter Indonesia Seminar, Nusa Dua September 5-6, 2012



### Contents of the Presentation

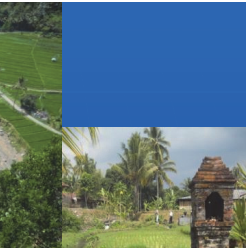
- Research Title
- Research Objectives and Hypothesis
- Research Method
- Research Schedule and Budget of Field Survey (JFY2012 and 2013)



## RESEARCH I

**Research I Title:**

" THE PERFORMANCE OF IRRIGATION SYSTEM ON RICE FARMING: Comparative Study between Saba River Basin(Bali) and Bili-Bili Irrigation System (South Sulawesi)"



### Research I Objectives

1. To describe the mechanism and fairness of irrigation water distribution in one irrigation area
2. To evaluate the performance of the irrigation system on the rice farming especially seen from water sub-system (productivity, equity, efficiency)



### Hypothesis

"Based on the productivity, equity, and/or efficiency indicators, the performance of irrigation system in each irrigation area is not optimal yet"



### Research I Methods

**Research Location & Sampling Method**

Subak Gede Sri Amertha  
Saba/Saba Irrigation  
Area=1,915 ha  
→11 subaks  
(Downstream of Saba River Basin, North of Bali)

↓

Proportional random sampling is used to choose 45 farmers on three subak samples

GP3A Sirannuang  
→18 P3A= 800.8 ha  
(Downstream of Kampili Irrigation Area, Jeneberang River Basin, South Sulawesi)

↓

Proportional random sampling is used to choose 45 farmers on three P3A samples

## Research I Methods

### Data Requirement and Collection Method

**PRIMARY DATA**, collected by using SURVEY method:  
 irrigated paddy field (ha),  
 harvested area (ha),  
 rice productivity (kg/ha),  
 irrigation water volume (m<sup>3</sup>),  
 % of total planting area (0.01 ha) contributed by section,  
 % of total rice production (kg) contributed by section,  
 % of total water flow (100,000 l) contributed by section,  
 flow water debit (l/s) in each canal level,  
 water quality,  
 soil condition-land suitability,  
 current input (IDR), labor (man-days),  
 capital service (IDR), input-output prices of rice farming (IDR/unit)

**RRR method:**  
 Role of institution in distributing water

**SECONDARY DATA:**  
 Irrigation scheme,  
 irrigation water volume from weir,  
 actual need of operation and maintenance costs data, irrigation water requirement on the paddy field level, and others from appropriate sources

## Research I Methods

### Data Analyses

#### Productivity performance (Rao, 1991)

- Area utilization (Au) = AH/TA**; (0 ≤ Au ≤ 1), where AH = the harvested area and TA = theoretically serviceable area
- Yield Top Yielders-based (Yt)** utilizes the highest farmer yields within the system. If TY is the average yield of 10 or 20 percent of the top yielders and IY is the system's average yield, so **Yt = IY/TY**; (0 ≤ Yt ≤ 1)
- Irrigation Water Output (IWO) = IY/(W/A)**; where IY is the system's average yield, W is total volume of irrigation water per season, and A is total area harvested

## Research I Methods

### Data Analyses

#### Equity performance (Rao, 1991)

- Production Distribution (PD)**  
 $PD = 1 - \sum |(\%As - \%Ps)|$   
 $= 1 - dp$ ; 0 ≤ PD ≤ 1; 0 ≤ dp ≤ 1
- Flow Distribution (FD)**  
 $FD = 1 - \sum |(\%As - \%Fs)|$   
 $= 1 - df$ ; 0 ≤ FD ≤ 1; 0 ≤ df ≤ 1
- Production Flows Distribution (PFD)**  
 $PFD = 1 - \sum |(\%Ps - \%Fs)|$   
 $= 1 - dpf$ ; 0 ≤ PFD ≤ 1; 0 ≤ dpf ≤ 1

where:  
 %AS = % of total planting area contributed by section;  
 %Ps = % of total rice production contributed by section;  
 %Fs = % of total water flow contributed by section;  
 dp = absolute value of summation of deviations of % total production from % total area harvested for each section into which system is divided  
 df & dpf = analog to dp

## Research I Methods

### Data Analyses

#### Efficiency performance:

- Conveyance efficiency (Rao, 1991)**  
 CE (%) = downstream flows debit (l/s) ÷ upstream flows debit (l/s)
- Price/allocation efficiency** based on profit function under Cobb-Douglas production function (Yotopoulos & Nugent, 1976):  
 $\pi = Py \cdot Y - \sum Pxi \cdot Xi$

where:  $Y = A \cdot I^{\beta_1} R^{\beta_2} C^{\beta_3} L^{\beta_4} CP^{\beta_5} e^{\epsilon}$   
 Each parameter is estimated by OLS method with software Shazam under the formula:  
 $\ln Y = \beta_0 + \beta_1(\ln)LD + \beta_2(\ln)IR + \beta_3(\ln)CI + \beta_4(\ln)LB + \beta_5(\ln)CP + \epsilon$   
 Y= rice production (kg); LD= irrigated paddy field (0.01 ha); IR= irrigation water (100,000 l); CI= cost for current input (seed, fertilizer, pesticide) (IDR000); LB= labor use (man-days); CP= capital service (IDR000);  $\beta_0$ = intercept;  $\beta_1$ = regression coefficients; Py= rice price (Rp/kg); Pxi = input prices

**Necessary condition to maximize profit:**  
 $Py(\partial Y/\partial Xi) = VMPxi = Pxi$  (value of marginal product of input i is equal to the input price)  
 Generally:  $VMPxi = ki \cdot Pxi + \epsilon$   
 Criteria:  
 $VMPxi / Pxi = ki = 1$  → efficient input use  
 $VMPxi / Pxi = ki > 1$  → input use is not efficient yet (the input is needed to increase)  
 $VMPxi / Pxi = ki < 1$  → input use is not efficient (the input is needed to decrease)

## Research I Schedule

No	Alur Kegiatan	2012-2013									
		April 2012	Augt 2012	Sept 2012	Oct 2012	Nov 2012	Dec 2012	Jan 2013	Feb 2013	Mar 2013	
1	Field orientation	█									
2	Proposal preparation		█								
3	Seminar proposal			█							
4	Instruments preparation			█							
5	Choosing research location & sampling farmers			█							
6	Data collection				█	█					
7	Data analyses: (a) Productivity, equity, efficiency analyses (a) Water and soil analysis						█	█			
8	Reporting								█	█	
8	Seminar & Publication									█	█

## Research I Budget

No	Item	Cost (IDR)
1	Honorarium researchers & surveyor	29,000,000
2	Instruments and tools costs	20,000,000
3	Transportation costs for field surveys ?????	25,000,000
4	Data tabulation and analyses, Reporting, Seminar, and Publication, etc	26,000,000
Total cost		100,000,000

# RESEARCH II

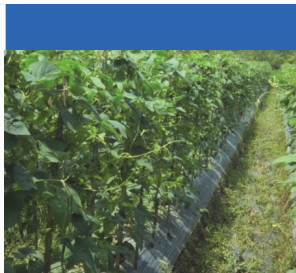


## Research II Title:

**"OPTIMIZATION OF IRRIGATED FARMING SYSTEM ON PADDY FIELD TOWARDS SUSTAINABLE AGRICULTURE AT DOWNSTREAM OF SABA RIVER BASIN"**

## A brief concept of sustainable agriculture

- **Definition & criteria:** a holistic farming system development that is economically viable, ecologically sound, socially just, and culturally and technically appropriate
- **Components:** soil nutrients management (soil nutrients balance), irrigation management (water distribution & pricing), innovative farming system (diversified FS, Crop Livestock System), crop rotation
- **Sustainability** is a constrained optimization to maximize benefit subject to natural resource base maintenance (Dixon & de Los Reyes [Widodo, 1993])
- **Farming system research** is very helpful & useful in achieving the goals of SA through optimizing farming system by using linear programming (LP) analysis (Widodo, 1993)
- **LP analysis** can be used to test the on-farm efficiency of resource use (Standen, 1972)



## Research II Objectives

1. To analyze the **optimization** of irrigated farming system at household level with the aid of linear programming analysis and then to assess its sustainability
2. To analyze the **effect of change** in irrigation water constraint to the optimal and sustainable condition of farming system



## Research II Methods

### Research location:

In one subak in downstream of Saba River Basin, purposively chosen, where farmers held diversified farming system on their paddy field

### Sampling method:

30 farmers by simple random sampling



## Research II Methods

### Data and collection method:

- Primary data by farm survey: crops and livestock type, farm size, farm productivity, farm input included irrigation, input-output prices, cropping pattern and crops rotation, cash and labor supplies into farm
- Soil and water sampling to know soil condition and irrigation water quality
- Secondary data: subak existence, farming system development, irrigation scheme at tertiary level, operation and maintenance cost of irrigation system



## Research II Methods DATA Analysis

- BLPX88 (Eastern Software Product, Inc., 1984) was used to solve the problem
- LP Specification

Maximizing Gross Margin:  $Z = C_1X_1 + C_2X_2 + \dots + C_nX_n$

subject to:

$$a_{11}X_{11} + a_{21}X_{21} + \dots + a_{n1}X_{n1} \leq \text{Farm land}$$

$$a_{12}X_{12} + a_{22}X_{22} + \dots + a_{n2}X_{n2} \leq \text{Maximum land for each enterprise}$$

$$a_{13}X_{13} + a_{23}X_{23} + \dots + a_{n3}X_{n3} \leq \text{Stock of input/irrigation}$$

$$a_{14}X_{14} + a_{24}X_{24} + \dots + a_{n4}X_{n4} \leq \text{Stock of output}$$

$$a_{15}X_{15} + a_{25}X_{25} + \dots + a_{n5}X_{n5} \leq \text{Stock of labor supply}$$

$$a_{16}X_{16} + a_{26}X_{26} + \dots + a_{n6}X_{n6} \leq \text{Maximum hired labour}$$

$$a_{17}X_{17} + a_{27}X_{27} + \dots + a_{n7}X_{n7} \leq \text{Cash inflow}$$

$$a_{18}X_{18} + a_{28}X_{28} + \dots + a_{n8}X_{n8} \leq \text{Cash outflow}$$

where:  $X_1, X_2, \dots, X_n \geq 0$ ;  $Z$  = the objective function;  $X$  = activities of the system;  $C$  = prices coefficient; and  $a_{1, \dots, 8}$  = matrix (input-output) coefficients





### The variable, indicator, parameter and measurements for Research II

Variable	Indicators	Parameters	Measurements
FS income (GM)	Farm land	✓ Arithmetic mean of farm land	ha
	Production	✓ Arithmetic mean of crops production	ha
		✓ Arithmetic mean of cattle production	unit of cattle
	Purchasing /hiring input	✓ Arithmetic mean of input used	kg, l, m3
		✓ Arithmetic mean of hired labor	man-days
	Selling output	✓ Arithmetic mean of output sold	kg
	Cash	✓ Arithmetic mean of cash (inflow/outflow)	Rp000
	Revenue	✓ Arithmetic mean of revenue	Rp000
	Expenditure	✓ Arithmetic mean of variable cost	Rp000

### RESEARCH II SCHEDULE

No	Alur Kegiatan	2012-2013					
		Sep 2012	April 2013	May 2013	June 2013	July 2013	Augt 2013
1	Research planning and field orientation	█					
2	Choosing location and sampling farmers		█				
3	Instrument and tools preparation		█				
4	Farm survey			█	█		
5	Soil and water sampling				█		
6	Data analyses						
	(a) Soil analysis (suitability, fertility, erosion level) and water quality analysis				█		
	(a) Actual farming income analyses for each commodities					█	
	(a) Linear programming analysis					█	
7	Reporting, Seminar, and Publication						█

### RESEARCH II BUDGET

No	Item	Jumlah Biaya Tahun I (Rp)
1	Honorarium researchers & field surveyor	20,000,000
2	Instruments and tools costs	9,000,000
3	Transportation costs for field surveys ?????	6,000,000
4	Data tabulation and analyses, Reporting, Seminar, and Publication, etc	20,000,000
Total cost		55,000,000

matur suksema



## Main Topic8. Optimization of irrigation water management in Bali

20120906/Bali

Prof. Dr. NAKAGAMI Ken'ichi  
Ritsumeikan University  
Visiting Prof. RIHN



<http://www.ritsumei.ac.jp/~nakagami/>

Prof. Dr. NAKAGAMI Ken'ichi  
<http://www.ritsumei.ac.jp/~nakagami/>

- **Present Position:**
- +Prof. Dr. of Environmental Economics & Policy, College of Policy Science, Ritsumeikan University
- +Adviser, Ritsumeikan Center for Sustainability Science
- +1981, Feb., Dr. Eng. in Environmental Engineering, Osaka University, Doctor Thesis: "The Evaluation of the Regional and Water Environmental System using Multiattribute Utility Function Theory"
- **Specialty**
- Environmental Economics & Policy, Water Resources & Environmental Policy, Urban & Regional Environmental Policy, River Basin Resources / Environment Management & Planning, Integrated Water Management and Water Security, Environment Business
- **Research Topics**
- Global Environmental Conservation and Sustainable Development/Integrated Water Management and Water Security/Sustainability Science for Strategic Innovation
- **Previous Position:**
- +1976-1979 Research Associate, Kyoto Research Institute of Economics, Kyoto University
- +1994-2000 Professor, College of Policy Science, Ritsumeikan University
- +2000-2007 Professor, College of Asia Pacific Studies, Ritsumeikan Asia Pacific University
- +2004-2007 Vice President Ritsumeikan Asia Pacific University
- +2007-Present Professor, College of Policy Science, Ritsumeikan University
- +2008-2012 Executive Trustee for Financial Affairs, The Ritsumeikan Trust
- **Books and Research Papers:**
- "Strategic Adaptation towards Water Crisis and IWRM," 2011, "Sustainability and Water Resources & Environment", 2008, "Environmental Economic System", 1986 and 32 books, and 220 academic papers published in Japan which concerned about Environmental Economics & Policy Studies, Water Resources & Environment Management
- **Academic Activity**
- + President, Association for Policy Informatics, + President, Japan CIREC/+Vice President Society of Environment and Technology, Director, Society of Water Resources and Environment,

### Nakagami's Mission for RIHN Project

- **Theoretical Framework**
- Gap Assessment
- IWRM
- Local Water Management
- **Model & Evaluation**
- Water, Environment, Economic, Social
- **Global Observation and Climate Change**
- H-08, Climate Change (Vulnerability & Strategic Adaptation)
- **Regional Case Study**
- Turkey, Egypt, Indonesia, Japan, China, Mekong
- **Publication and Networking**
- **Visiting Professor /RIHN**

## Main Topic8. Optimization of irrigation water management in Bali

(8-n1)

Comprehensive Evaluation of PEMBANGUNAN WADUK TITAB on Saba river

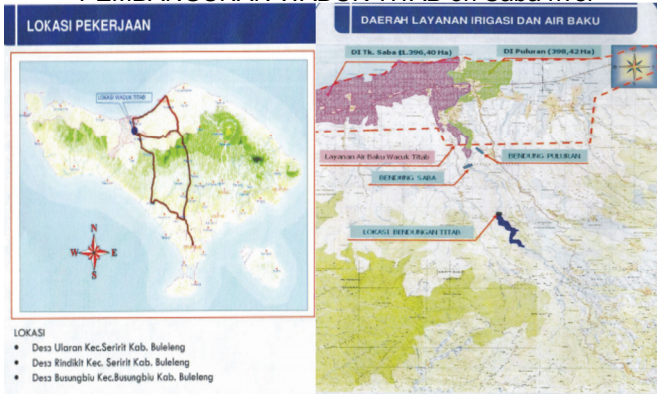
(8-nb)

Vulnerability & Strategic Adaptation Towards Climate Change in Bali Island, Indonesia

(8-nc)

Local Management Framework on Saba river

### (8-n1) Comprehensive Evaluation of PEMBANGUNAN WADUK TITAB on Saba river



PEMBEBASAN TANAH						
KESEPAKATAN BERSAMA MOU (Memorandum Of Understanding) ANTARA KEMENTERIAN PEKERJAAN UMUM Pemerintah Provinsi Bali DAN PEMERINTAH KABUPATEN BULELENG Nomor : HK.02.03-DA/558 ; 075/15/KB/B.PEM/2010 ; 075/479/PEM/2010 Tanggal 6 Juli 2010						
TOTAL LUAS TANAH	MOU	TH 2010	TH 2011		DINYAPKAN TUNTAS TH 2012	
			LUAS	DAWA YG TERSEDIA	LUAS	REKULTIVASI DANA
138 Ha	HEMERTRAMPU	50%	69.00 Ha	-	900 Ha	Rp. 13.000 M
	PEM PROV. BALI	30%	41.30 Ha	4.00 Ha	4.30 Ha	Rp. 4.300 M
	PEM KAB. BULELENG	19%	26.70 Ha	3.075 Ha	5.50 Ha	Rp. 5.500 M
<b>JMLAH</b>	<b>100%</b>	<b>137.00 Ha</b>	<b>3.075 Ha</b>	<b>19.80 Ha</b>	<b>19.80 Ha</b>	<b>Rp. 115.800 M</b>

CATATAN : Harga Tanah Tahun 2010 ditetapkan sebesar Rp. 1 Milyar / Ha



## Optimum Fresh Water Price at TITAB Reservoir, Bali Province of Indonesia

Ussy Andawayanti<sup>1,\*</sup>, Rispiningtati<sup>1</sup>, and I Gusti Ngurah Antariza<sup>2</sup>

<sup>1</sup>Department of Water Resources, Faculty of Engineering, University of Brawijaya, Malang of Indonesia

<sup>2</sup>Master Program of Water Resources, Faculty of Engineering, University of Brawijaya,  
Malang of Indonesia

Titab reservoir was located at Sub unit of River Basins (Sub SWS) of Bali Penida, Buleleng Regency and it was administratively concluded 4 villages including Telaga, Ularan, Busungbiu, and Ringdikit. The number area of watershed at dam location was 69.54 km<sup>2</sup> with river length of 25 km. Titab Dam was functioned as 1) Water irrigation supply at Saba with number area of 1,396.40 ha and Puluran with number area of 398.42 ha; and 2) drinking water supply and hydro electrical power of 398.42 ha. Map of location was as in Figure 1 below.

Based on the objective of water demand as described above, the dam was designed with the height of 59.8 m from river bed, effective storage of 10.37 millions m<sup>3</sup> that was between High Water Level (HWL) at elevation of 156.00 m and Low Water Level (LWL) at elevation of 131.20 m. The condition of water supply at North and East of Bali was not good compared with at West and Centre of Bali. It caused rice field at North of Bali was dependent on rain and traditional irrigation. On the other hand it was demanded to optimize the potency of water resources due to that some population had saved their income from agriculture and plantation.

Nowadays, fresh water demand at Buleleng was needed for fulfilling the needs of domestic and industry that was 15 m<sup>3</sup>/s. This data was recorded by Regional Company of Drinking Water (PDAM) at Buleleng Regency. It was predicted continuously increasing in the future as well as the development of Buleleng Regency. There was alternative effort to anticipate this cases that was to function groove of Tukad Saba as long storage for fresh water storage. This long storage was made by building Titab reservoir at the downstream of Tukad Saba river.

Table 1 Projection of population growth at Buleleng Regency

No	Year	Number of population
1	2011	917,400
2	2012	980,958
3	2013	1,048,920
4	2014	1,121,589
5	2015	1,199,294
6	2016	1,282,382
7	2017	1,371,226
8	2018	1,466,225
9	2019	1,567,807
10	2020	1,676,425
11	2021	1,792,569
12	2022	1,916,759
13	2023	2,049,554
14	2024	2,191,548
15	2025	2,343,380

### Economical analysis

Analysis of Benefit-Cost Ratio was carried out based on interest Bank of Indonesia of 12% in 2008 and life time of Titab Reservoir was 60 years. It was obtained total of cost at present was Rp 774,848,487,402.-; and benefit was Rp. 130,680,082,750.-; so that analysis of BCR was as follow:

$$BCR = \frac{Rp1,087,781,088,814}{Rp774,848,487,402} = 1.404 > 1$$

B/C of Titab reservoir was more than 1 (> 1), it could be said that this project was economically feasible or the project exceeded the break event point.

### Analysis of fresh water price

The analysis of fresh water price was due to the most critical condition when benefit was down to 10% and the cost was up to 10%, so that minimum water sale price could be charged to consumers and project of Titab Reservoir was really feasible. At this condition: B/C = 1.126; B-C = Rp 256,754,029,530.-; IRR = 15.203%; rate of interest = 12%; the average of fresh water demand = 0.493 m<sup>3</sup>/s; fresh water demand per-year = 0.493 x 365 days x 24 hours x 60 minutes x 60 seconds = 15,547,248 m<sup>3</sup>/year. Then fresh water price was as follow

$$= \frac{Rp.256.754.029.530}{15.547.248 \times (8.324) \times (1.1761)} = Rp. 1,127/ m^3$$

### Analysis of electrical price

The life time of hydro electrical power project was 60 years and interest rate of 12%. Project cost of Titab Reservoir for hydro electrical power was Rp. 11,425,875,700.00; annual cost of Titab Reservoir for hydro electrical power (A/P, 12, 60) was Rp. 1,372,642,444.-; cost of electrical energy per-kWh was Rp. 2416.-; value of electrical sale at Block I was Rp. 663,042; benefit of electrical energy per-kWh was Rp. 1,752.-; Benefit of electrical energy per-year was Rp 995,036,136.00

### Benefit of agriculture

Benefit of project was obtained from the increasing of agricultural product before and after project building of Titab Dam. This kind of benefit was as tangible one. Cropping pattern included rice-second crop-wine was planned at location of study. Effective rainfall used in this study was of 50% dependable probability and cropping start was on November 1. Project of Titab Reservoir would directly influence irrigation water supply on dry season, so that would increase the harvest and economy of society. This kind was as intangible benefit.

Analysis of Benefit Cost Ratio used present value method. Rate of interest used in this study was 12% as described above. Life time of Titab reservoir was 60 years. The analysis was as follow: Total of cost at present was Rp 744,848,487,402.-; Benefit total of irrigation at present was Rp. 154,150,729,909.-; Construction cost at present was Rp 1,283,150,675,758.-, so that BCR was as follow:

$$BCR = \frac{Rp1,283,150,675,758}{Rp774,848,487,402} = 1.656 > 1$$

### Determination of irrigation water price

The analysis was carried out based on the most critical condition that was when benefit was down to 10% but cost was up to 10%, so that minimum water sale price could be charged to consumers and project of Titab Reservoir was really feasible. On the condition of benefit was down to 10% and cost was up to 10%, water sale price was analyzed as follow: B/C ratio was 1.55; B-C was Rp.449,776,631,758.-; IRR was 16.648%; interest of bank was 12%; total of irrigation water demand was 407,652,010.26 m<sup>3</sup>/year; price of irrigation water was

$$= \frac{Rp.449.776.631.758}{407.652.010 \times (8.324) \times (1.1761)} = Rp.88,69 m^3/year$$

The result of cropping start on January 1 presented that inflow of reservoir was 101,388,636 m<sup>3</sup>, number area of Saba irrigation: cropping pattern-1 was 1,396.4 ha; cropping pattern-2 was 1,186.94 ha; and cropping pattern-3 was 1,256.76 ha, number area of Puluran irrigation: cropping pattern-1 was 398.42 ha; cropping pattern-2 was 338.657 ha; cropping pattern-3 was 358.578 ha, fresh water supply was 0.526 m<sup>3</sup>/s; volume of total storage was 12.795 million m<sup>3</sup>; maximum elevation of reservoir water level was 156 m; maintenance flow was 0.29 m<sup>3</sup>/s; discharge of hydro electrical power for interconnection supply was 0.77 m<sup>3</sup>/s; maximum hydro power was 3.15 MW and the minimum power was 1.36 MW.

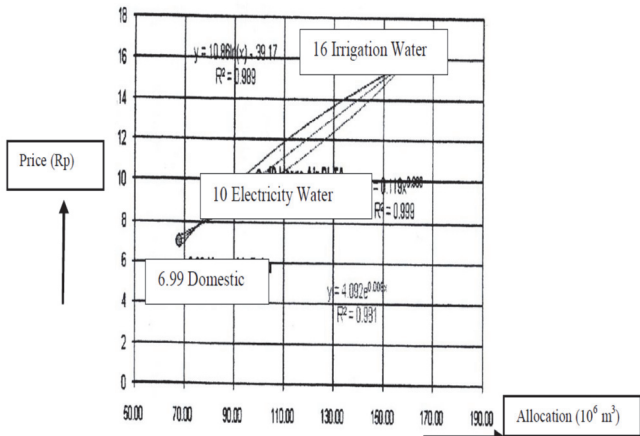


Figure 3 Allocation and Water Price (January 1)

## Conclusion

- Fresh Water
- B/C Ratio 1.31, Price, 1,127Rp/m<sup>3</sup>
- Irrigation Water
- B/C Ratio 1.55, Price, 89Rp/m<sup>3</sup>
- Electric Price

Electrical price at Buleleng regency was included the analysis as follow: average price of social was 466.60, household was 708.81, business was 758.80, industry was 589.00, government and lighting of public road was 792.00, and price of total average was 663.02. Therefore the income during 1 year was Rp 7,956.- per-kWh





## Research Plan

- Background of the Problem and it's meanings  
**Development /Irrigation/Society/Water**
- Problem Structure and Research Statement  
**Environmental Assessment and Economic**
- Research Objectives & Questions  
**Economic/Environmental/Social/Impact**
- Hypothesis(General & Specific)  
**Social Involvement , Central & Regional Governance**
- Methodology and Data

(8-n1) Comprehensive Evaluation of  
PEMBANGUNAN WADUK TITAB on Saba river

### Central Questions

- What are essential conditions or requisites for **framework of local water management?**

### Research Questions

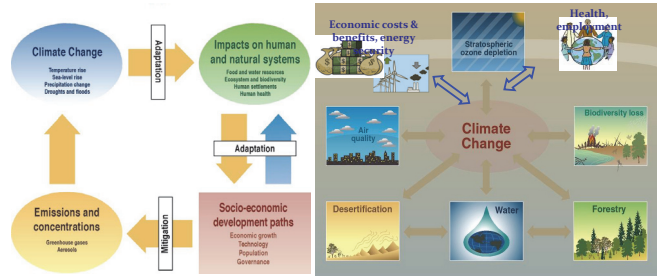
- What is the **desirable/effective management** of water?
- How can we **evaluate appropriateness** of irrigation?
- What is **convivial cooperation** for effective water management?
- How can we establish, share and take over the **wisdom/information of land and water management?**

(8-nb) **Vulnerability & Strategic Adaptation  
Towards Climate Change in Bali Island, Indonesia**

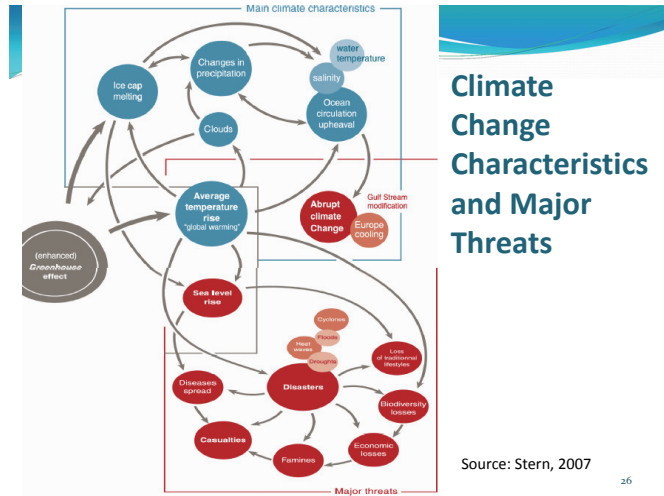
Climate change is one of the greatest environmental, social and economic threats that the world faces today including Bangladesh.

- **The main characteristics of climate change are:**
- increases in average global temperature (Global Warming);
- changes in cloud cover and precipitation particularly over land;
- melting of ice caps and glaciers and reduced snow cover and
- increases in ocean temperatures and ocean acidity – due to seawater absorbing heat and carbon dioxide from the atmosphere

# Climate Change on Environment



- Overall Ultimate Objective of UNFCCC
  - Stabilize atmospheric GHG concentration to prevent dangerous levels
  - Enable economic development to progress in a sustainable manner and ensuring that food production is not threatened



# Climate Change Characteristics and Major Threats

Source: Stern, 2007

# Vulnerability and Adaptation

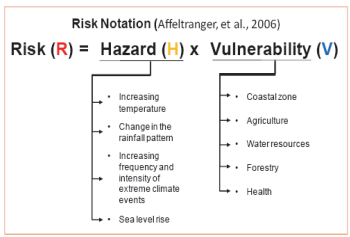
- The extent to which changing climate is constituted as a threat, is determined by Vulnerability.
- The IPCC defines vulnerability as 'the degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes' is Vulnerability (IPCC, 2007).
- Adaptation is defined by the IPCC as 'adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities' (IPCC, 2007).

# Research Methodology

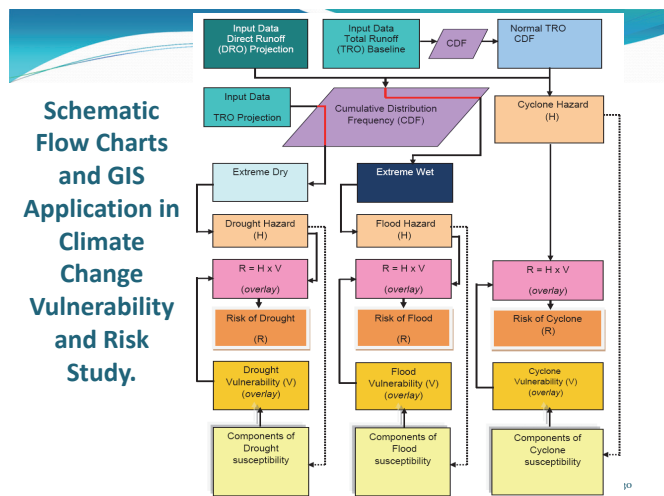
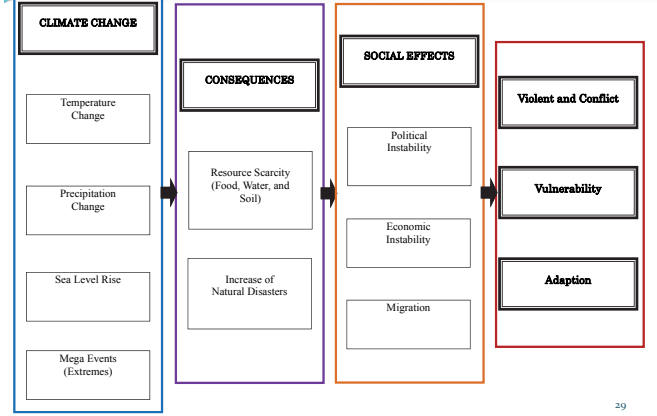
Affeltranger, et al. (2006) proposed a risk notation (Risk), as a function of Hazards and Vulnerability using the formula:

$$\text{Risk (R)} = \text{Hazards (H)} \times \text{Vulnerability (V)}$$

- 1) Hazard due to climate change is a function of characteristic, magnitude, and rate of climate change and variability.
- 2) Vulnerability of a system to climate change is a function of exposure, sensitivity and adaptive capacity.



# Conceptual Framework



## Water Vulnerability

H pot	HAZARDS (H)	VULNERABILITY OF WATER SECTOR (V)		
		Comp	Type	Code
Change in precipitation pattern, increasing temperature, increasing intensity and frequency of extreme climate event, SLR, sea water soaking	Decreasing in WATER AVAILABILITY	E	Density of population (spatial), landuse (spatial)	d, tgl
		S	Water demand, soil/rock type, distribution of precipitation (spatial)	ka, gl, ch
		AC	Prosperity of population (spatial), infrastructure of irrigation	ks, inf
	FLOOD	E	Density of population (spatial), landuse (spatial)	d, tgl
		S	Degree of land degradation of catchment area, degree of land degradation of protected forest, distribution of precipitation (spatial)	kr_ssws, kr_hl, ch
		AC	Prosperity of population (spatial), infrastructure of irrigation	ks, inf
	DROUGHT	E	Density of population (spatial), landuse (spatial)	d, tgl
		S	Water demand, distribution of precipitation (spatial), degree of protected forest, slope (spatial)	ka, ch, kr_hl, kl
		AC	Prosperity of population (spatial), infrastructure of irrigation	ks, inf

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## Components of Water Sector Vulnerability

*H: hazards, Pot: potential, T: temperature, SLR: sea level rise, Comp = vulnerability component; E: exposure, S: sensitivity, AC: adaptive capacity, spatial: types of information with more-detailed accuracy levels or spatial-units*

POTENTIAL H	HAZARD (H)	Water Sector Vulnerability (V)	
		Comp	Type
Changes in the rain pattern, increase in T, SLR, immersion	Decreased Water supply	E	1. Population density (spatial) 2. Land use (spatial)
		S	1. Water needs 2. Type of soil / rock (spatial) 3. Rainfall distribution pattern (spatial)
		AC	1. Population welfare (spatial) 2. Irrigation infrastructure
	Flood zone	E	1. Population density (spatial) 2. Land use (spatial)
		S	1. Criticality level of SSWS areas 2. Criticality level of protected forest area 3. Rainfall distribution pattern (spatial)
		AC	3. Population welfare (spatial) 4. Irrigation infrastructure
	Drought	E	1. Population density (spatial) 2. Land use (spatial)
		S	1. Water needs 2. Rainfall distribution pattern (spatial) 3. Criticality level of protected forest area 4. Land slope (spatial)
		AC	1. Population welfare (spatial) 2. Irrigation infrastructure

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### (8-nb) Vulnerability & Strategic Adaptation Towards Climate Change in Bali Island, Indonesia

## Central Questions

- What are essential conditions or requisites for **Vulnerability & Strategic Adaptation Towards Climate Change in Bali Island** ?

## Research Plan

- Background of the Problem and it's meanings  
**Climate Change/Impact/Adaptation**
- Problem Structure and Research Statement  
**Impact Assessment and Strategic Adaptation**
- Research Objectives & Questions  
**Economic/Environmental/Social/Impact**
- Hypothesis (General & Specific)  
**Possibility and Capability towards Bali Risk**
- Methodology and Data

### (8-nc) Local Management Framework on Saba river

#### Central Questions

- What are essential conditions or requisites for **framework of local water management**?

#### Research Questions

- What is the **desirable/effective management** of water?
- How can we **evaluate appropriateness** of irrigation?
- What is **convivial cooperation** for effective water management?
- How can we establish, share and take over the **wisdom/information of land and water management**?

### (8-nc) Local Management Framework on Saba river

- Project Evaluation**
- Effectiveness/Impact
- Validity
- Efficiency
- Sustainability

(8-nc) **Local Management Framework on Saba river**

- Comparative Study of Local Management
- Turkey
- Egypt
- Indonesia
- Japan

## Research Plan

- Background of the Problem and it's meanings  
**Local Management/Past and Future**
- Problem Structure and Research Statement  
**Changing System**
- Research Objectives & Questions  
**Economic/Environmental/Social/Impact**
- Hypothesis(General & Specific)  
**Possibility and Capability towards Bali Subak**
- Methodology and Data





