CHALLENGES TO THE CONSERVATION OF SUBAK SYSTEM AS WORLD CULTURAL HERITAGE IN BALI

Nyoman Norken¹, Ketut Suputra², and Gusti Ngurah Kerta Arsana³

ABSTRACT

Subak in Bali is believed to have existed from earlier than the ninth century. Throughout this long period, Subak has been successfully utilized for irrigation water resources and has been recognized as World Cultural Heritage by UNESCO since 2012. Currently, however, the future sustainability of the system is a big concern. Some operational and maintenance aspects of Subak are alarming, namely: network deterioration; limited availability of maintenance facilities either from government or farmers. Sedahan and Sedahan Agung which are traditional government official who mentors and supervise Subak operations are no longer functioning. Despite this condition, the ritual tradition of Subak which is a core element to Subak operations is still carried out. The ritual traditions vary from one region to another. There are several challenges in regards to Subak conservation. First, reduction of the Subak area, consequently farmers have less area to work on, resulting in declining income. Second, it has to do with deterioration of quality and quantity of water resources. Third, from demographic point of view, the average age of farmers is above 40 years with a heavy financial burden. Lastly, there are no clear regulations to support Subak operations. This study suggests several steps in keeping the sustainability of Subak. These steps are re-functioning Sedahan and Sedahan Agung as government officials; providing government support to reduce cost levied to farmers; facilitating collaborations between farmers and other stakeholders; promoting alternative commodities beyond rice which have a higher financial value; preventing and repairing damages of upstream areas; controlling pollution; forming a coordination board at a provincial, regency and river basin level; building the Subak information systems; providing supervising mechanism, and encouraging academics and students to participate in an effort to preserve Subak.

Keywords: Subak in Bali, World Cultural Heritage, conservation, challenges, strategic steps.

1. INTRODUCTION

Subak is an irrigation system in Bali which has existed over several generations. Subak is a traditional irrigation system whose configuration is based on the socio-religious philosophy of Tri Hita Karana, and rooted in the traditions of Hinduism in Bali. Tri Hita Karana means maintaining a coherent and harmonious relationship between humans and God (Parahyangan), humans and other humans (Pawongan) as well as humans and nature and their environment (Palemahan). Subak existed before the IX century and is utilized to sustain the tradition of water management and various activities related to irrigation. Subak was recognized as a UNESCO World Cultural Heritage Site on June 29, 2012. Furthermore, the World Heritage Committee declared Subak as a World Heritage Property Cultural Landscape of Bali Province.

1 Professor at Department of Civil Engineering, Faculty of Engineering, University of Udayana, Jimbaran, Badung, Bali, Indonesia, E-mail: inorken@yahoo.co.uk
2 Senior Lecturer at Department of Civil Engineering, Faculty of Engineering, University of Udayana, Jimbaran, Badung, Bali, Indonesia, E-mail: suputra.rais@yahoo.com
3 Lecturer at Department of Civil Engineering, Faculty of Engineering, University of Udayana, Jimbaran, Badung, Bali, Indonesia, E-mail: kerta.arsana@yahoo.co.id
Although Subak receives national and international recognition for its irrigation system management, observers and researchers are concerned with its sustainability. Steve Lansing, a researcher on Subak since 1974, states that there is an extensive reduction of rice areas from year to year due to land conversion (Finlayson and Paramita, 2013). High rate of land sales by local farm owners, pushed by exposure to commercialism and capitalism, is one of the triggers of this conversion (Sukita 2014). As a result of a continuous depreciation of rice field and various problems faced by Subak nowadays, scientists are concerned with issues of Subak and farming systems. As a farming system is one of the bases of the Balinese culture, the erosion of Subak may contribute to the erosion of the Balinese culture also.

With such rapid changes occurring in the Subak system in recent decades, this paper attempts to examine the challenges and propose steps that need to be carried out now and in the future in order for Subak, as a world cultural heritage site, to be sustained and maintained wherever possible.

2. SUBAK AND ITS DEVELOPMENT

Although Subak system in Bali is very old, the formal regulation of Subak was promulgated in 1972. The Provincial Regulation (Perda) No. 02/PD/DPRD/1972 concerning Irrigation, defines Subak as a religious socio-agrarian organization which was historically established to manage water utilization and other irrigation-related issues in a region. Many researchers have also provided a definition of Subak with various viewpoints such as: Geertz (1967) in Pitana (1993) defines Subak as rice field areas that obtain water from a single source. Sutawan et al. (1986) in Pitana (1993) explain that Subak is an organization of wetland farmers that obtains irrigation water from a common source. In relation to the Subak system, there is a temple or Pura called Pura Bedugul dedicated to worship Dewi Sri, the manifestation of God as the Goddess of Fertility. Grader (1979) in Griadhi, et al. (1993) states that Subak is a number of rice fields that receive water from the same channel or from the same branch of a canal and become one irrigation area.

In summary, Subak is a traditional and autonomous socio-religious community organization formed to regulate water from its source to irrigate rice fields. However Purwita (1993) and Griadhi et al. (1993) state that Subak organization was also formed to regulate agricultural farming in general not only limited to rice fields but also dry land farming known as the "Subak Abian".

In connection with the history of Subak, Purwita (1993) states that it is very difficult to trace the beginning of the existence of Subak in Bali, but it is believed to have existed since the first time rice fields were introduced in the 9th century (inscription Sukawana Al, 882 AD). The inscription of Klungkung in 1072 also mentioned the word "kasuwakanci" in Balinese language that can change into "kasubakanci" which means Subak organization or an irrigation area.

Relating to the management and development of Subak, Norken et al. (2010) mentions that after Bali came under the reign of the Majapahit Kingdom in 1343 AD, an Asedahan also called Pasedahan was appointed with the duty of organizing some Subaks. Asedahan, later changed into Sedahan, had the duty to collect suwinin or taxes levied on agriculture and to coordinate water distribution on Subaks. During the Dutch colonization era, the position of a Sedahan was strengthened by the appointment of another Sedahan at the district level and Sedahan Agung (the topmost position of a Sedahan) at the regency level. After Independence, Sedahan and Sedahan Agung were established as supervisors of Subak through a provincial regulation, but since the reformation in 2000, the Sedahan and Sedahan Agung has received lesser attention.
During its development, the number of Subak is also constantly changing, Purwita (1993) and Astawa (2014) noted that in 1971 there were 1193 Subaks, which grew to 1331 in 1991; to 1546 in 2009 and 1599 in 2013. Ironically, during 1997-2008, there has been a conversion of irrigation areas of 6,361 hectares, or an average of 579 hectares per year. The irrigation areas in Bali currently remain 82,095 hectares. In the last decade the decline of Subak areas due to land conversion to non-agricultural fields was estimated to be about 1000 ha per year (Finlayson and Paramita, 2013).

3. **SUBAK CURRENT CONDITION**

As an irrigation system, although Subak is a traditional management system that has existed for generations, it still operates. However, issues related to Subak’s current conditions can generally be described as follows:

3.1 **Network and Irrigation Structures**

Although Subak is a traditional irrigation system, but its network and structure system is not much different from the irrigation system that exists today. According to Sumarta (1992) in Suputra (2008), the network and the hydraulic structures include: empelan (weir) is a structure to raise river water level, bungas (intake), telabah (canal), tembuku (distribution structure/box) and complementary structures. Telabah consist of telabah gede (primary canal), telabah pemaron (secondary canal), telabah cerik (tertiary canal), talikunda (quarterly canal) and pengutangan (drainage canal). Telabah can also be in the form of aungan (tunnel), where canal breakthrough the hills. Tembuku (distribution structure/box) consists of tembuku aya (primary distribution structure/box), tembuku pemaron (secondary distribution structure/box) and tembuku cerik (tertiary distribution structure/box). Complementary structures consist of abangan (Water Bridge), pekiuh (side canal spillway), petaku (waterfalls structure), jengkuwung (culvert), keluwung (small culvert), titi (bridge) and telepus (siphon). Subak, as mentioned above, is also completed with Pura Temple (place of worship), which is called Pura Bedugul (Subak Temple) that generally exists at each Subak area. Pura Ulun Empelan is also located near the weir (empelan) as well as several other temples associated with the Subak.

In the past, irrigation structures were made from very simple materials such as heaps of stone for weir, pieces of coconut palms or banana trees for distribution structures, while the irrigation canal was made in the form of natural or excavated soil. Repair and maintenance of networks and irrigation structures were carried out by all farmers (members of Subak) which was conducted continuously before the intervention of the government.

(a) **Network and Irrigation Structures Condition**

Although lately there has been assistance from the government with many improvements, some network has been damaged. For example, a number of damaged and unutilized canals and structures in the irrigation area of Mambal in Badung Regency demand a serious attention of the local government to providing fund for the operation and maintenance (Yuswari 2010). In addition, Norken et al (2015) point out that the damaged irrigation networks is partly in the form of excavated soil and partly structures that were made from masonry. For example, in the regency of Bangli in 2015 damaged irrigation canals that were within the responsibility of the government reached some 38 km, in Buleleng the damage reached 199 km and the deterioration of 721 irrigation structures. Besides, many tertiary canals managed by the farmers are also damaged. This has occurred almost in all areas of Bali. Most of the network is still in poor condition due to the limited ability of the local government and farming communities to conduct maintenance.
(b) Maintenance of Network and Irrigation Structures

Maintenance of network and irrigation structures is carried out by the government and farmers’ participations. During the enactment of the Indonesian Government Regulation No. 20 of 2006, which is a derivative of National Law No.7 of 2004 regarding Water Resources (lifted in February 2015), describes the rights and responsibilities of the Central and Local Government as follows: irrigation area over 3000 ha is under the rights and responsibilities of the Central Government, irrigation area ranging from 1000 to 3000 ha is under the rights and responsibilities of the Provincial Government, and areas smaller than 1000 ha is under the authority and responsibility of Regency/City Government. In addition, the primary and secondary networks are the responsibility of the government, while the tertiary network is the sole responsibility of the farmers (Wahyudi, et al. 2015). Based on the division of the authority in the operation and maintenance of the irrigation networks, the responsibility of the Regency/City Government is quite heavy, due to handling extensive Subak irrigation areas, while the ability of the Regency/City Government to provide maintenance costs is limited.

Although the government has taken the responsibility in accordance with the assigned duties, most networks and irrigation structures are not yet properly maintained. Until now, most canals which are in bad condition are at the tertiary level where the members of Subak perform maintenance of irrigation networks with limited resources. The maintenance includes several activities, for example, mutual cooperation (called gotong royong), raising funds, and other businesses such as a formation of cooperatives and levies to ducks breeders in order to perform maintenance activities (Norken et al. 2012; Norken et al. 2015).

3.2 Organisation

Generally, each Subak in Bali has a name and organization. Although the organization structure is sometimes very simple, but it is quite effective in regulating the activities undertaken by farmers. The organisation structure consists of members of Subak (Kerama Subak) and administrators (Prajuru Subak). Pitana (1993) describes that a small Subak is only led by a chairman called Kelihan Subak or Pekaseh. A larger Subak consists of Prajuru (administrators) whose position is divided into Pekaseh (Chairman), Petajuh (Deputy Chairman), Penyarian or Juru Tulis (Secretary), Kasinoman or Juru Arah (Information Division) and Saya (a special assistant related to religious activities). A very large Subak containing several Subaks is called Subak Gede (Big Subak), and chaired by the Pekaseh Gede (Big Pekaseh), and Vice Big Pekaseh. The year 1980 was the beginning of the formation of Subak organization that covers the river catchment area which is called Subak Agung (Grand Subak) led by Pekaseh Agung (Grand Pekaseh). Subak can also be subdivided into smaller portions called tempek led by a Kelihan Tempek and a Kelihan Tempek is under Pekaseh.

In the past, Subak supervising and mentoring was undertaken by the so-called Sedahan at district level which was also a tax collector clerk, while the regency level conducted by Sedahan Agung (Grand Sedahan) as the supreme mentor. The supervisor of Subak was usually directly headed by the Head of the Regency Revenue Office. One of the most prominent roles of the Sedahan and Sedahan Agung was to regulate water distribution among Subaks or water intakes or weirs and conducting coordination with other government agencies. Generally, the members of Subak strongly adhered to the decision of Sedahan and Sedahan Agung in managing water. Sedahan and Sedahan Agung were very respected by the members of Subak.

Up to a certain point, Subak organizations still function well. However, since the introduction of Regional Autonomy Government at the regency level in the 2000s, Sedahan and Sedahan Agung as the mentor of Subak from government officials have
unclear functions and existence. This condition causes confusion among members of a Subak that needs guidance and consultation relating to various problems faced by subak itself (Norken et al. 2010). This situation was confounded by the fact that Bali Province Regulation No. 9 of 2012 on Subak, which suggested a new institution called Majelis Subak (Subak Assembly) whose duty is very different from Sedahan and Sedahan Agung. Until today, the actual Subak Assembly has not yet been established. Currently, the mentor of Subak is undertaken by the Department of Culture at regency level. In this situation, again, it is very difficult for Subak handling problems related to water resource management as well as issues related to agriculture in general. This is simply because the officials of this department do not have any understanding about Subak system. In addition, currently there is a strong decline of the young people's interest to work in the agricultural sector, especially in Subak wetlands, impacting the age of the farmer members of Subak who are generally aged above 40 years even the majority of them are over 50s. Consequently, the members of Subak workforce are certainly working with less energy and productivity which impacts the overall Subak productivity (Norken et al. 2012).

3.3 Regulation

The regulations of Subak organisation is called awig-awig, which govern the activities, organizations, and rights and obligations of the members of the Subak. Awig-awig can be expanded and supplemented with additional rules, called pasuara. Pasuara is usually created to adapt to changes that may occur to meet the demands of the farmers as members of Subak. Awig-awig is usually written in Balinese language and endorsed by the Government as Subak mentor at the regency level. However, not all awig-awigs of Subak are made in writing. Nevertheless, Subak regulations or the awig-awigs are always respected and followed by its members. In addition to awig-awig which governs Subak internally, Bali Provincial Government also issued a regulation relating to general water control system in the form of Provincial Regulation (Perda), such as Bali Provincial Regulation No.02/PD/ DPRD/1972 on Bali Provincial Irrigation which is then amended by Provincial Regulation of Bali No. 9, 2012 regulating Subak. The most important thing in the Regulation No.02 /PD/DPRD/1972 is the reinforcement of duties and functions of government officials or Subak mentors. Another regulation related to Subak is the Provincial Regulation No. 9 of 2012. This regulation still suggested a Subak Assembly whose members consist of Pekasehs. The suggested Assembly’s duties are different from Sedahan and Sedahan Agung. The position of Sedahan and Sedahan Agung (Grand Sedahan), is no longer appointed as government officials to supervise and mentor Subak. Historically, Sedahan and Sedahan Agung already had a long track record in protecting the existence and sustainability of Subak in Bali (Norken et al. 2010; Norken et al. 2015). At the national level, Subak is recognized by the Central Government Regulation No. 20 of 2006 on Irrigation, which is now not valid and does not have its amendment, because the Law No. 7, 2004 on Water Resources along with its derivatives has been lifted since February 18, 2015 by the Constitutional Court of the Republic of Indonesia. The Government Regulation No. 20 of 2006 regulates a board which is named Irrigation Commission which functions as a coordinating body supervising water user farmers, which more or less has the same function as Sedahan and Sedahan Agung in Subak. While at the international level, UNESCO recognizes Subak as a World Cultural Heritage Site on June 29, 2012, and has been followed up by the publication of the Decree of the Governor of Bali No. 11/03-H/HK/2014 on Coordination Forum of Management of World Heritage Landscape and Cultural of Bali Province. Thus, Subak does not only belong to the people of Bali, but also to the people of the world. It is believed that the key factor of maintaining the sustainability of the Subak system is the Sedahan and Sedahan Agung themselves. However, the new regulations do not even support the (re-)appointment of the Sedahan and Sedahan Agung These conditions eventually become counterproductive and naturally weaken the efforts to preserve Subak.
3.4 Water Distribution and Management

The source of water for Subak is generally from rivers or springs, and diverted through a free intake to canal (telabah) or tunnel (aungan). As the traditional irrigation systems were built long time before the (modern) irrigation system is technically known, water has been divided and distributed using traditional ways. For the distribution of water in the distributing structure (tembuku), Subak system uses a ratio of area of the rice fields and a measurement that is called ayahan, which is a measurement standard based on the amount of seeds used. In addition, ayahan unit means one unit of labor (people) to be incurred when farmers Subak members conduct activities such as repairing canals, distribution structures, or other activities. Ayahan unit is equivalent to the size of the seed used and approximately the same as the area of rice fields that needs rice seeds. Ayahan unit is estimated equal to the rice field that requires about 25 kg of seeds or equivalent to about 0.3-0.5 hectares of rice field. One ayahan is entitled to water at the amount of one tektek or one kecoran. One unit tektek or kecoran is water that flows continuously through a simple spillway structure which has a width of approximately 8-10 cm, with a depth of approximately 1 cm. One tektek is not always the same as other Subak (Norken, 1993). The basic principle of water distribution system in Subak is the emphasis of fairness in obtaining water. Therefore, tektek unit is still supplemented by the agreement of the Subak members through deliberation. The consideration which is supposed to be made during deliberation involves the distance of the rice fields being watered from a water source and the porosity of soil.

If the water flow is not enough to irrigate the whole area of rice fields included in one Subak, the water distribution is carried out using a rotation. In the rotation system, Subak is divided into a smaller portion called tempek (e.g. one subak is divisible into 2 or 3 tempeks). Subsequently rotation of water distribution is directed to each tempek. The rotation pattern is usually supervised by a patelik or a pangliman (an officer appointed to observe the rotation of the water).

Besides water rotation, the other water management system in Subak is known as nyorog (adjusting planting time) or nugel bungbung system (water scheduling). Subak with a large area or some Subak with a water source from a weir (empelan) is divided into three blocks/parts (upstream, midstream and downstream). Subak which is located in the upstream obtains water first (called ngulu). Subak located in the middle obtains water after the upstream rice field finishes the preparations of land (called maongin). The downstream Subak obtains water after midstream finishes preparations of land (called ngasep). Differences in the provision of water for each area range from 2 to 4 weeks. In terms of setting the cropping pattern, generally it is dependent on the availability of water and the season. During the rainy season rice is planted simultaneously (called kerta masa) whereas during the dry season, when the supply of water decreases (called gadon), it is done by adjusting the planting schedule or rotations. Subak organizations schedule the cropping patterns in detail, through time limit for starting to sow the seeds (ngurit) and starting to plant the rice (nandur) up to the deadline. Furthermore, the type of rice to be planted is also scheduled such as, rice with a long lifespan (Balinese rice (called tebak/tebek taur) or rice with a short lifespan (tebak/tebek cicil). Setting the cropping pattern is manifest in the regulation (awig-awig) or by agreement (perarem) over the Subak member meeting (paruman). This meeting is carried out before rice planting is undertaken. If it is violated, then the farmers concerned will be subject to sanctions such as fines in accordance with the stipulation in awig-awig or in perarem (Norken et al. 2015).

In terms of organising water in Subak, water management is made by the leaders of Subak in the region or between regions through an agreement. In the event of a disagreement between the leaders or among different Subaks, the Sedahan and Sedahan Agung as a Subak Supervisor plays a very important role in coordinating and distributing the use of water between the Subaks. Although the water
management in Subak system has been carried out as fairly as possible, the problem today is the decline of water availability during the dry season. It is suspected as a result of deteriorating condition of the upstream forest. This situation further results in a frequent crop failure. Besides water scarcity, a crop failure might also be caused by various types of rice crop pests such as rats, leafhoppers, etc. Thus, it boils down to an income reduction of farmers which is already very low due to very small land holding of no more than 0.5 ha on average per farmer (Norken et al. 2012; Norken et al. 2015). In anticipating this situation, there is an initiative from the government to help farmers in some areas by providing water pumps in an effort to use ground water as a source of irrigation water for Subak, but since the cost of its operation and maintenance is imposed on the farmers, it is considered very burdensome.

3.5 Religious Tradition

The series of religious rituals in Subak cannot be separated from the implementation of the Parahyangan element of Tri Hita Karana. The purpose of the religious ceremonies is based on the Hindu religion in Bali wishing Lord Vishnu (the manifestation of God the Almighty the Preserver of Life) and Dewi Sri (the manifestation of God Almighty as the Goddess of Fertility) to bless prosperity and and abundant agricultural yields (Pitana 1993).

All members of subak conduct eleven joint ceremonies every year. It starts from the ceremony, signaling diverting water from the water source to the irrigation canal called Mapag Toya or Mendak Toya, and ends with the ceremony called Pakelam together with the entire Subak Chairmen within a regency. Mapag toya or mendak toya ceremony is performed at Ulun Empelan Temple which is located near the weir or the water source, while other ceremonies are performed at Subak's Temple (Pura Bedugul) which is located within the subak area. Pakelam ceremony is conducted at the Ulun Danu Temple, located at the Lake Beratan in Tabanan regency or in other similar temple in Bali (Pitana 1993; Sushila 1987).

Besides the joint ceremonies, there are also ceremonies conducted by the individual members of the Subak starting from a ceremony of channeling water from a canal to a rice field called ngendagin to a maintainin ceremony in which an offering is given to the rice stored in a barn located at home of rice fields owner called lumbung. A ritual by a land owner is performed at the temple of ulun carik or sangghah catu or sangghah pengalapan, which is located at the upstream of the fields and at the entrance of a water intake. The series of religious rituals until now are still being carried out by Subak members, although the procession, type, and magnitude of the rituals slightly vary between one Subak to another (Norken 2015).

4. CHALLENGES OF SUBAK PRESERVATION

Based on the above condition, the present and the future challenges in the preservation of Subak at can be presented as follows:

Reduction of Subak area due to land conversions may exceed 1000 ha every year, due to pressure on paddy land by development or expansion of residential, commercial, and tourism. This will reduce the farm holding size, making it difficult for the farmers to earn a decent livelihood from mainly wet land farming.

The irrigation infrastructure are in poor condition due to lack of operation and maintenance funds and a decline in the quantity and quality of water resources due to forest destruction and pollution, causing crop failures and conflicts over water with other sectors.

The financial burden to the farmers is heavy. It includes land tax, cost of land preparation, fertilizers, repair of irrigation networks, religious activities and others,
while income from farming is relatively low and the age of farmers is generally more than 40 years. This causes farmers difficulty in innovating and improving productivity.

Then there is a lack of coordination and supervision from the government due to discontinuation of the position of Sedahan and Sedahan Agung as official mentors and supervisor in coordinating the management of water.

5. STRATEGIC STEPS FOR SUBAK PRESERVATION

The challenges to Subak system will be more difficult in future. Measures must be taken both by the government and other stakeholders in order for Subak to be admired throughout the world. As described by Norken (2016), and in many groups of discussions and seminars related to Subak in Bali. The measures are:

The government may introduce agricultural insurances to protect the farmers against loss of crop due to natural disasters. Further, a continuous support (subsidies) is required to ease the farmers’ financial burden in repairing and maintaining irrigation networks. It may facilitate farmers to plant commodity beyond rice that have a higher economic value such as watermelons, soybeans etc. It has to strengthen the presence of Subak cooperatives business and facilitate partnerships between Subak and parties such as tourism, businesses etc, to mutually benefit.

The government should revive the position of Sedahan and Sedahan Agung as Subak’s mentor from the government through regional regulation (regency and provincial levels) that are compatible with the intention and spirit of Subak preservation. At the national level, it is necessary to regulate the traditional irrigation system more comprehensively so that Subak becomes a local wisdom.

The government may start intensive coordination with Subak stakeholders in an effort to prevent and repair damages of the upstream regions (forest and cultivated areas), and control water pollution through a community approach.

The Government may provide mechanism of coaching for Subak and other traditional institutions continuously in an effort to preserve as local wisdom for a competitive advantage of Balinese community, and provide data of Subak activities by building Subak information systems in Bali.

Finally, Universities in Bali should encourage academics and students to make Subak a place to perform activities in implementing the three higher education services (education, research and community services). Then Subak as a traditional irrigation system will flourish in the era of globalization.

6. CONCLUSIONS

Subak is a traditional irrigation system in Bali, recognized as World Cultural Heritage by UNESCO, but its existence and its sustainability is uncertain. Subak condition is alarming due to the facts that a number of irrigation networks and structures are in poor condition and there is a limited fund available with both the government and farmers to maintain irrigation networks. At present, Subak organizations is still running but since 2000, the position of Sedahan and Sedahan Agung as government officials as Subak mentors did not exist any longer.

The present and future challenges of Subak preservation are reduction of Subak area due to land conversion, farmers with a small income cannot enjoy a decent life, a deterioration in the quantity and quality of water resources and pollution, aging subak members farmers, the financial burden borne by farmers to operate the Subak system, unclear regulation and lack of support from regional and national levels.
Strategic steps suggested to ensure the sustainability of *Subak* are: *Sedahan* and *Sedahan Agung* as mentors and supervisors of *Subak* need to be revived, the government support is still needed to lighten the load of farmers’ financial burden, the partnership between *Subak* and other stakeholders, exploration of alternative commodities outside rice, prevention and preparation of damages in the upstream areas as well as pollution control, establishment of a coordinating board for water resources management, formation of *Subak* information systems, providing guidance mechanism for *Subak* development and encouraging to academics and students to make *Subak* a place to implement the higher education services.

**REFERENCES**

Astawa, I., P. 2014 Bali Development Data 2013, Goverment of Bali Province, Denpasar.

Finlayson, R., and Paramita, E. 2013. Subak, Bali Irrigation System, Being on the Verge of Destruction, [http://worldagroforestry.org](http://worldagroforestry.org).

Griadhi, I. K. W., Sirtha, I. N., Suasthawa, D. I. M. 1993 Subak in Law Perspective. In Pitana I G. (Ed), Subak Traditional Irrigation System in Bali. Upada Sastra, Denpasar.

Norken, I N. 1993 Subak and Water Resources Development in Bali. In Pitana I G. (Ed), Subak Traditional Irrigation System in Bali. Upada Sastra, Denpasar.

Norken I.N., Suputra, I.K and KertaArsana, I.G.N. 2010 The History and Development of Sedahan as A Coordinator of Water Management for Subak in Bali. A paper presented on ICID Conference, Yogyakarta, Indonesia.

Norken I.N., Suputra, I.K and Kerta Arsana, I.G.N. 2012 Subak Member Participation in Maintenance of Irrigation Networks: Case Study on Subak Pecelengan Pedukuan at Mendoyo District, Jembrana Regency. Study Report, Univ. of Udayana, Denpasar.

Norken I.N., Suputra, I.K and Kerta Arsana, I.G.N. 2015 Aspects of Traditional Religious Activities on Subak: Case Study on Subak Piling, Penebel District, Tabanan Regency. Study Report, niversity of Udayana, Denpasar.

Norken I.N., Suputra, I.K and Kerta Arsana, I.G.N. 2015 Water Resources Management of Subak Irrigation System in Bali, J Applied Mechanics and Materials. 776, 139-144.

Norken, I N. 2016 Subak Management: Problem and Solution. A paper presented on National Seminar at University of Ngurah Rai, Denpasar.

Pitana, I G.1993 Subak, Traditional Irrigation System in Bali, A General Description. In Pitana I G. (Ed), Subak Traditional Irrigation System in Bali. Upada Sastra, Denpasar.

Purwita, I B P., 1993 History of Subak in Bali. In Pitana I G. (Ed), Subak Traditional Irrigation System in Bali. Upada Sastra, Denpasar.

Suputra, I K, 2008 Effectiveness of Water Resources Management for Subak Irrigation Water Needs in Denpasar. Master Thesis, Univ. of Udayana, Denpasar.

Sushila, J. 1987 Typical Characteristics of Subak Irrigation System in Bali. Public Works Department of Bali Province, Denpasar.

Sutika, I K. 2014 Concerns of Disappearance of Subak System in Bali [http://www.antarabali.com](http://www.antarabali.com).

Ukirsari, M. 2012 UNESCO Plaque, Recognition Subak as a World Heritage 2012. [http://nationalgeographic.co.id](http://nationalgeographic.co.id).

Wahyuadi, I M A., Norken I N., Suputra I K. 2015 Participation of Stakeholders in Operation and Maintenance of Irrigation System in Unda Irrigation Area in Klungkung District, J Spektran. 3, 37-46.

Yuswari, M N. 2010 Farmer Community Participation (Subak) on Operation and Maintenance of Irrigation in Mambal Irrigation Area in Badung. Master Thesis, University of Udayana, Denpasar.