Water management systems and its impact on employment opportunities in small and medium sized cities (SMCs) in Asia

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Abstract

Water is a critical element that is needed to create and maintain jobs across all sectors of the country economies. In the Asian perspective, maximum of the industries driving economic growth depend upon a reliable supply of freshwater for large parts of their production processes and whereas, failure to secure an adequate and reliable supply of water leads in the loss of generating jobs. This paper examines how the sustainable water management technologies influences employment opportunities in the small and medium sized cities in Asia. For this, we try to elucidate by using spatial analysis in the selected case study of watershed management technologies in Asia. The study finds that the distribution of land use changes; risk drivers and local governance play a key role for the sustainable water management technologies in the formation of different effects on employment opportunities.

Keywords: water management systems, subak, employment, SMC`s, Asia

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1. Introduction:

Watershed management is the method of classifying and directing land, water, and other natural resources used in a watershed and to deliver the suitable goods and services, whereas mitigating the impact on the watershed resources. It comprises socio-economic, human-institutional and biophysical inter-relationship among water, and land use. The management of natural resources at watershed scale produces multiple benefits in terms of increasing agriculture production, safeguarding environment along with biodiversity concerns. In recent years, they rapidly grow by engaging in other sectors such as industry and service, and the concentration of population has led to form a metropolitan area called “mega city” (Fang et. al. 2017) On the other hand, if we take a look at small and medium sized cities (SMCs), would maintain a certain population to form an economic zone where the primary industry and the tourism sector utilizing historical and environmental resources are the main industries, although population outflow is significant. The economic zone in rural areas is significantly affected by changes in the availability and the form of natural resources, and it is a challenge for them to survive without coexisting with nature. Especially, the quality and quantity of water significantly influence the economy and where the society to coexist with nature. However, it has stronger indigenous characteristics and are naturally well entrenched in institutional and economics structure that are located in the regions (Hoppe et al. 2016; Giffinger et al. 2007).

As the pressure of water resources by a changing of climate, rapid urbanization and increasing population growth threatens freshwater resources. Presently, a number of cities, particularly SMCs are on the serious condition of water shortage and water wasting in Asia. Furthermore, most of the cities are located in the delta region surrounded by rivers, and the cities developed through engaging in agriculture. Economic activities in urban and industrial areas along with agriculture and other industrial sectors in rural areas depend on water, and thus ensuring the sufficient quantity and quality of water has a direct effect on the productivity as well as the quality and the diversity of products. Access to a secure and clean supply of water at present is enormous challenge to rapidly growing mega cities and SMCs; particularly there are big gaps in service between urban and rural areas. Suitable management of water resources and sustainable development of water infrastructures are crucial with regards to addressing the issues raised in the expansion of local economies lead to creation of more jobs and improve their standard of living (WWAP, 2016). The distribution of water resources and the provision of water services to different economic sectors would largely command the growth potential for creating jobs at local level further it has also provided an incentive for private investment, whereas the rural poor access to the services and markets available to the urban population (Vries et al. 2001, WWAP, 2016).

On the other side, the conflicts of interest in the use of water resources, particularly for the needs of households, hotels, restaurants and other tourism industry have an influence on the lack of irrigation water supply. Besides, it can be disturb to decline the food supply (Lanya et. al 2015). For instance, the subak water management system in Bali is a traditional water system and also defined as a traditional organization for water and crops management, particularly rice crop at the farm level from socio-agricultural societies. Nevertheless, there are several factors are currently threatening the sustainability of subak rice culture including attention of youth in rural areas to find a job in the farming sector; area under rice fields switching to non-agricultural lands and increasing clashes in the uses of water resources (Sutawan 2004, Budiasa 2015). Therefore, it is really necessary to investigate the current situation of subak water management systems and their key causal factors

influencing on it. This paper attempts to address the subak water management systems in Bali province as a case study in one of the SMCs in Indonesia.

In the next section, the paper is structured as follows. In section 2 the current situation of land use pattern in Bali Province and Denpasar regency is presented followed by the changes of rice area under subak systems and this section ends with the introduction of subak water management systems. In section 3, the methodology is presented, and results and discussions are exhibited in section 4. The paper ends with conclusions.

2. Land use changes in Bali Province and Denpasar

Agriculture, particularly rice crop growing, has been the main economic foundation in Bali (Mitchell, 1994). Bali Province is an Island of the Republic of Indonesia consisting of 563,666 ha, which includes 79526 ha (14.1 %) of rice fields managed through 1,548 subak systems 273,965 ha (48.6%) of other agricultural fields; and 210175 ha (37.3%) of non-agricultural land Based on statistical data from 2017 (http://bali.bps.go.id). Over period 20 years (1997−2016), approximately 8,327 ha of rice fields were converted into non-agricultural land with an annual conversion rate of approximately 438.3 ha (0.5%).

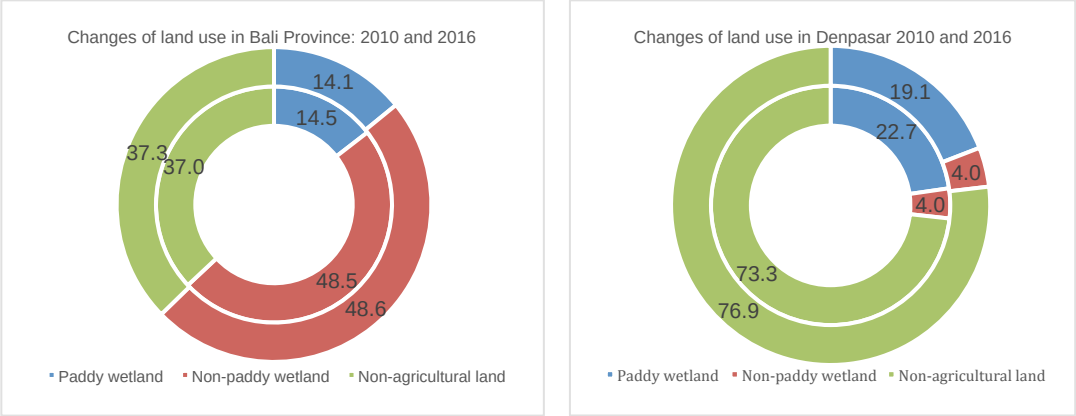

Figure-1: Land use changes in Bali Province and Denpasar, Indonesia

The top three out of nine regencies experiencing land conversion in Bali were Denpasar, Tabanan and Buleleng with an annual conversion rate of 7.1 per cent (27 ha), 4.5 percent (143 ha), and 3.5 percent (54 ha) respectively (BPS, 2017) in Table-1.

Table-1: Subak rice fields' situation in Regencies of Bali Province (in ha)

No	Regency/City	Area of Subak (Rice) Fields (Ha)						Percentage (%) / Rank
		2010	2012	2013	2014	2015	2016	
1	Jembrana	6,836	6,836	6,811	6,798	6,775	6,757	-1.2
2	Tabanan	22,455	22,388	22,184	21,962	21,714	21,452	-4.5 (2)
3	Badung	10,227	10,195	10,144	9,984	10,006	9,976	-2.5
4	Gianyar	14,790	14,729	14,706	14,575	14,420	14,376	-2.8
5	Klungkung	3,876	3,843	3,843	3,843	3,843	3,844	-0.8
6	Bangli	2,910	2,910	2,910	2,916	2,886	2,876	-1.2
7	Karang Asem	7,140	7,166	7,157	7,166	7,151	7,142	0.0
8	Buleleng	11,042	11,039	10,904	10,789	10,789	10,660	-3.5 (3)

9	Denpasar	2,632	2,519	2,506	2,509	2,479	2,444	-7.1 (1)
Bali		81,908	81,625	81,165	80,542	80,063	79,526	-2.9

Source: Bali Dalam Angka statistics (Various Issues)

Therefore, we considered Denpasar regency as our target SMC since the land conversion in this regency is significantly very high, for instance, the area under paddy wetland reports 2,902 ha (22.7 percent) in 2010 and for 2016 it was 2,444 ha (19.1 percent). On the other side, the area under non-agricultural land accounts 9,360 ha (73.3 percent) in 2010, and 9,824 ha (76.9) in 2016 that evidently shows the conversion of agriculture land switches into non-agricultural activities (Figure-1).

2.1 Causes of conversion of subak areas (paddy) in Denpasar

Land conversions are the key cause for the loss of subak systems and have been more intense in the upstream, central, and downstream areas of several watersheds. Particularly, numerous rice fields have slowly transformed into other land use types over the past two decades. Figure-2 shows that paddy wetland fields have been converted into other land, which are 188 ha of rice fields from 2010 to 2016. The average annual loss of paddy wetlands under subak systems in Denpasar is about 1.5 percent/year. These rice fields were converted into houses, tourism-related infrastructure, offices, public yards, and other private business. According to Budiasa et al., 2015, the main motives behind these changes were mainly economic reasons related with differences in land prices; high demand for land to build houses or private business including tourism related activities; limited irrigation water supply during dry season; lack of labor force during peak season for rice farming; lack of appropriate balancing policies for traditional rice farmers; and finally, the current legal framework is not strict enough to avoid the conversion of rice fields within the prescribed zones for non-farming actions (Sutawan 2005, Sophie 2011, Norken, 2016).

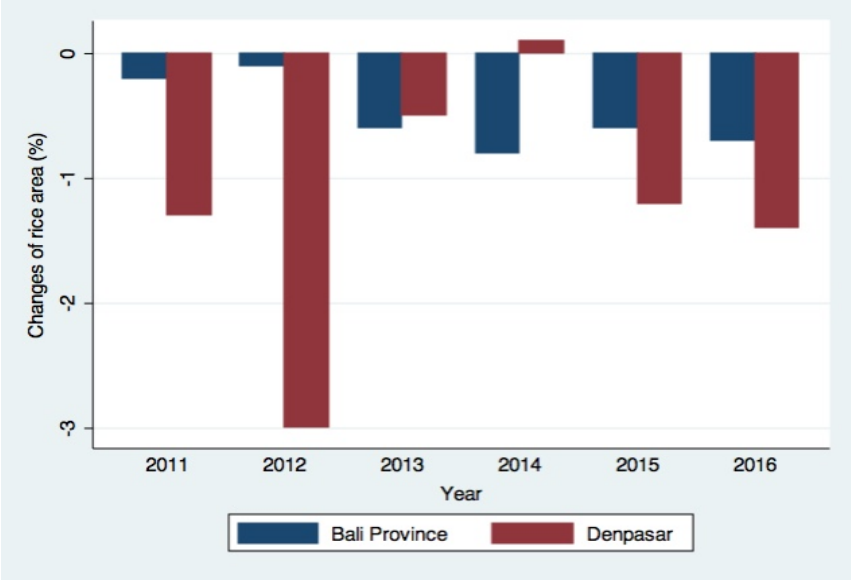

Figure-2: Changes of rice area under subak systems

These continuous trends appears frightening of rapidly increasing use of land and water resources for non-agricultural purposes (human settlement, tourism) have become a major threat to the continued existence of the subak irrigation systems in many areas of Bali (Sutawan, 2004). Without Subak water management systems

preservation of agricultural culture in Bali will disappear and more Balinese culture will be threatened.

2.2 Population growth and capacity of water resources

Population growth and tourists are feasible contributors to the land use changes from the agricultural land to other land uses in Bali (Budiasa et al 2015). A significant growth of high population density and tourism infrastructure, water supply is considered critical. From the past 10 years, the water tables across Bali have dropped up to 50m; and 60 percent of its watershed are declared dry (Wright, 2016). However, the consumption of water is envisaged to rise in all districts by 70 percent by 2025, particularly in the south (Bali Advertiser 2005; ESWZ et al. 2005; Sutawan 2005, Sophie 2011). Water allocations are caused by competition between the highly important economic sectors of tourism and agriculture. The commercialization of water has led to its allocation to priority sectors based on short-term financial prospects, regardless of the paramount importance of agriculture for Denpasar and Bali.

The PPLH department from Udayana University and P3E Bali-Nusra has been estimated the carrying capacity of water for Bali and their regencies for 2009, 2013 and 2016 by considering the environmental factors that affect the amount of water availability and level of water demand. An average number of foreign and domestic tourists visiting to Bali in a year are included as one of the factors (population) that influence the capacity of water resources. The results from Table-2 exhibits that the value of carrying capacity of water of the Province of Bali is less than 1.0, which specifies deficit water for the years 2009, (0.86); 2013, (0.57); 2016, (0.68).

Table-1: Water resources situation in Regencies and Province of Bali

Regency	Rate of water capacity			Status of water sources		
	2009	2013	2016	2009*	2013*	2016**
Jembrana	1.15	0.82	2.44	Surplus	Deficit	Surplus
Tabanan	1.59	0.79	1.46	Surplus	Deficit	Surplus
Badung	0.67	0.35	0.27	Deficit	Deficit	Deficit
Gianyar	0.70	0.37	0.65	Deficit	Deficit	Deficit
Klungkung	0.68	0.53	0.65	Deficit	Deficit	Deficit
Bangli	1.48	1.16	0.64	Surplus	Surplus	Deficit
Karangasem	1.02	0.98	0.47	Surplus	Deficit	Deficit
Buleleng	0.81	0.55	0.78	Deficit	Deficit	Deficit
Denpasar	0.61	0.08	0.12	Deficit	Deficit	Deficit
Bali Province	0.86	0.57	0.68	Deficit	Deficit	Deficit

Source: * PPLH Universitas Udayana, ** P3E Bali-Nusra

The regencies that have the status of carrying capacity of surplus water from the higher values to the lower values are Tabanan, Bangli, Jembrana and Karangasam. Whereas, the regencies, who have deficit rate of water status are Buleleng, Gianyar, Badung, Klungkung and Denpasar. Certainly, it is a crucial phase to take an appropriate measure for the sustainable water resources and subak water management systems.

2.3 The subak water management systems:

The subak water management systems can be stated as an irrigation system in a way corresponding with the structure of the socio-cultural community, attaining its goals based on harmony and togetherness based on tri hita karana (THK), and preserving balance with its environment (Sutawan et al, 1989; Pusposutardjo, 1997 and Arif, 1999). Furthermore, subaks are individually named units and contains of all the rice terraces irrigated from a single water canal (Geetz, 1971). Interestingly, the systems are gravity-fed, and the source of water streams receive from springs and mountain lakes (MacRae, 2006). There are 1,283 independent subak organizations having with different irrigation infrastructure and regulations, however the area covers under each organization may vary from 10 ha or even lesser up to 800 ha depending on the topographical situations (Gany, 2007).

Subak irrigation systems, Bali

Rice Terrace, Bali

The role of subak organization includes to manage irrigation water and distribute equally to member farmers within group; maintenance of irrigation system; mobilization of resources; handling conflicts; organize ritual activities, which is a very unique role in the subak irrigation system. The coordination agency among the subak systems could be established in the subaks acquiring irrigation water from the same source such as dam, or water divider, such coordination agency is called Subak Gede. On the other hand, it can also be set up a coordination agency among the subak systems for accessing one or more rivers called Subak Agung (Windia, 2010).

The subak systems have very many capabilities to mobilize and manage the available local resource and employment opportunities. Importantly, these systems born and rooted in the village level by using local resources and technologies in diverting, conveying and distributing of water (Susanto et al 1999).

3 Methodology:

The research case study Denpasar regency selected as one of the appropriate SMCs in Bali Province, Indonesia. It has experiencing the highest economic growth compared to other regencies and having productive wetland agriculture zone and dynamic land use. For measuring the changes of areas under subak irrigation systems in Denpasar, and how its influencing on employment. The shape file data from 2012 and 2016 for paddy wetland and subaks mapping are collected from PPIDS Udayana University and Geospatial information Agency (BIG). The data about land use changes, labor force, paddy wetlands, population growth and regulations, water systems were taken from the various Bali Dalam Angka statistics, (https://bali.bps.go.id), review of literature and research reports. The data were analyzed using descriptive quantitative technique and spatial analysis (using GIS software).

4 Results and discussion:

4.1 Spatial distribution of land use conversion under subak water management systems

The results exhibit in Figure-3 that the changes of subak areas in 2012-2016 in Denpasar regency experienced land conversion of 619 ha (17 %). The subak land conversion largely occurred in western part of Denpasar followed by eastern, northern and southern. These subak lands are transformed into buildings, tourism

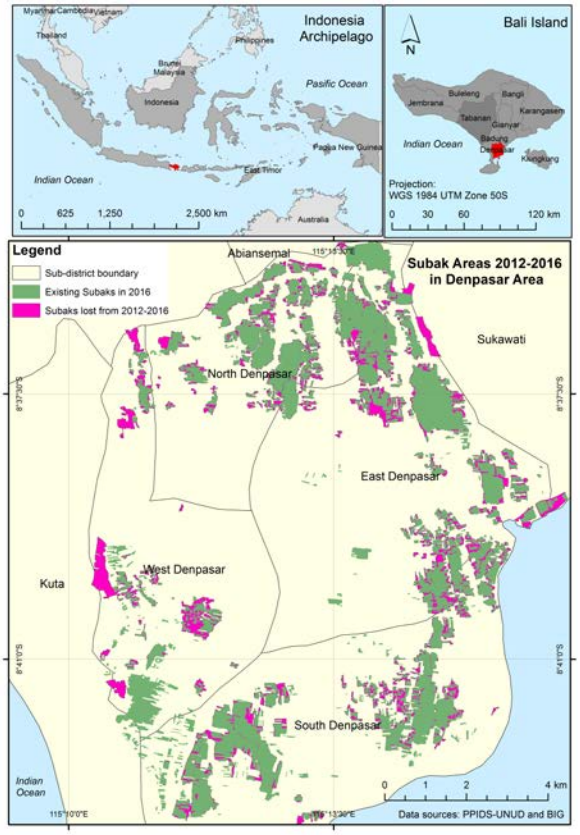

Figure-3: Changes of Subak areas 2012-2016

etc. The increasing number of tourist triggers the rapid development of the nearby villages and it causes to the conversions that poses serious threat to subak water management systems in Bali. According to Cole 2012, approximately 65 percent of water used for the tourism sector throughout the season including dry season that associated with peak tourist season and the same time water requires for agriculture farming. Nevertheless, land use change is the main reason for the disappearance of subak systems in the upstream, central, and downstream areas of watersheds (Budiasa, 2015). For instance, the overexploitation of water resources in the region of South Bali, close by one of the islands tourist centres is demonstrated by a subak in Sanur at the tail end of an irrigation system that indicates lack of coordination of the different water users as the main reason for irrigation failure, which make way for urbanization and tourism associated forms of land use (Sophie, 2011).

4.2 Employment workforce and water management systems

From figure-4, shows that the trends of work labor force under different sectors in Bali. As expected the tourism and associated industries are the most important

economic sectors in Bali in terms of employment and resource consumption, the sector represented by the 'Trade, Hotel and Restaurant' has recorded as highest employment workforce, which accounts 31.7 percent and supporting further with associate sectors as 58.3 percent thus contributing 22.7 percent of Bali's GDP (Picard 1997:182; Pitana 2005:252, BPS 2016). Although many Balinese have benefited from tourism, it is anticipated that 85 percent of the economy related to tourism is in the hands of non-Balinese, who might not be directly affected by tourism's negative effects comprising the deteriorating quality and quantity of water.

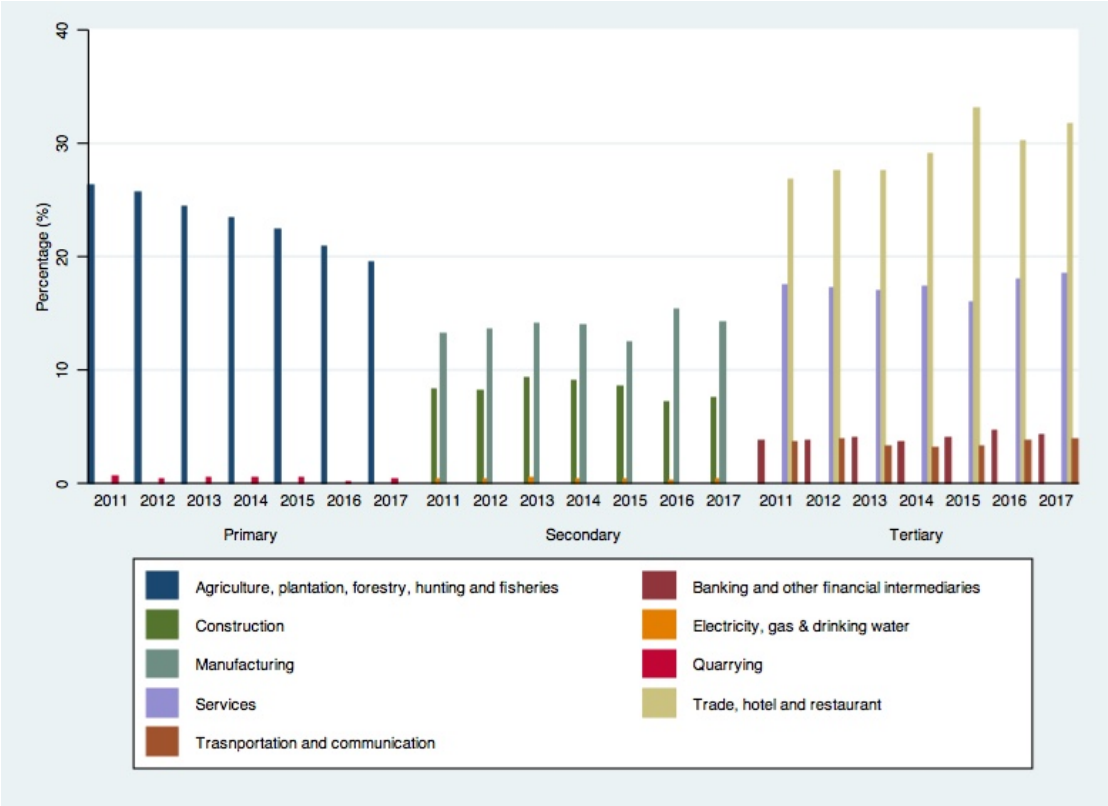

Figure-4: Laborforce situation in Bali province

However, within the political and socio-economic context that tourism sector reports for 65 percent of water consumption (Merit, 2010, Cole 2012, MacRae, 2010), which is high pressure on water resources. On the other hand, the secondary sector includes manufacturing and construction sectors are slightly increasing the labor workforce from 21.7 percent in 2011 and 22.0 percent in 2016. Nevertheless, the agriculture is one of the major important economic sector particularly agriculture (rice farming) for Balinese people, but due to different causes like water allocation problems, lack of farm labor, low income in agricultural farming compare with highly generating income from tourism leads to declining the work labor force of primary sector from 26.8 percent in 2011 from 19.7 percent in 2016, which is not a positive indication for the sustainable subak water management systems and for their rich Balinese culture.

4.3 Effectiveness of policies towards subak systems

The current regulations are not so strong enough for the sustainable subak water management systems. For instance, the new regulations of subak systems did not

support to re-appoint appoint of Sedahan and Sedahan agung who is supervise and mentor subak (Norken et al 2016). Sriartha et al 2015, documented the drawbacks of regional regulations that are mainly Number 3 of 1992, concerning Green Line Regions is considered to have expired and it is not in accordance with the real conditions of current development. The drafting of regulatory document is from top-down approach without an involvement of local communities. Incentives and encouraging policies must be expanded for the farmers and local institutions. Furthermore, one of the major water policies for Bali is that in sum the exploitation rates are unrestrained and there is no authority with an impression of the multiple agents that use water for different purposes (Sophie, 2011).

Table-2: Assessment of the effectiveness of the policy and program on Subak systems

Community	N	Assessment of the effectiveness of the policy and program (Number)			
		Very Effective	Effective	Less Effective	No Effective
Leader of Subak	69	2	10	44	13
Farmer	45	4	9	22	10
Leader of village	54	5	8	27	14
Total	168	11 (6.55)	27 (16.07)	93 (55.36)	37 (22.02)

Source: Peneliti, 2015; Sriartha, 2015

A few studies have explored the effectiveness of regulations to control and conversion of subak systems. One of the recent studies, Peneliti, 2015, conducted a community level opinion survey on current regulations focused on the existence of regulations on the area of subak systems; community involvement in making regulations, implementing supervision and implementation sanctions, permits, subsidies and tax breaks to farmers, and violations etc. Around 77.38 percent of the community people considered that the implementation of the policy to control the conversion of rice area under subak systems is ineffective, while 22.59 percent considered effective or very effective (Table-3). The ineffectiveness of policies and programs to control the conversion of subak areas by the government has the consequences of the need for the government to implement a bottom-up approach by involving local communities in planning, implementing and evaluating control program for subak area conversion and water management systems including safeguarding of employment opportunities (Sriartha, 2015; Peneliti, 2015; Norekn, 2016; Budiasa, 2015; Windia, 2010).

5. Conclusions:

Development of the Bali in the form of land conversion and tourism expansion that drives rapidly is threatening the sustainability of subak water management systems in the SMC Denpasar Regency. The agriculture sector is the major important economic sector particularly rice farming for Balinese people, but due to various problems like declining quantity and quality of water resources and pollution, indistinct regulation, lack of support from government, lack of farm labor, aging subak member farmers, low income in rice farming compare with tourism activities leads to declining the work labor force of agriculture, which is not a positive sign for the sustainable subak water management systems and for their rich Balinese culture. The subak systems presenting high potential for the development of integrated agro-

tourism strategies should be emboldened and economically support by the central and local governments, and eventually designed and managed by the local society, including young people (Budiasa et al, 2015, Norken, 2016). Therefore, strengthen to promote the interest of young people towards subak system and the protection of subak is to control over wetland function and ensure sufficient irrigation water management are very important for the sustainable subak water systems and as well as rice Balinese culture, which is directly and indirectly supports to employment workforce.

The regency Denpasar and Bali, who have deficit rate of water status in 2009, 2013 and 2016 exposes in a critical phase for sustainable water resources. Therefore, the government needs to implement a bottom-up approach by involving local communities in planning, implementing and evaluating control program for subak land conversion and water management systems including protection of employment opportunities.

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