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OPEN ACCESS

INTERNATIONAL JOURNAL OF ENVIRONMENTAL & SCIENCE EDUCATION
e-ISSN: 1306-3065
2018, Vol. 13, No. 2, 173-185

Participatory Approach on Water Scarcity Solution of Tourism City: A Case Study of Hua-Hin Municipality, Thailand

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ABSTRACT

Water scarcity is one of the main problems for water resources management underpinning various Thailand's socio-economic development activities. In the past, expert judgment and scientific knowledge were conventional ways for Thai government to solve the problem. However, this approach is, to some extent, not optimal because proposed solutions may not gain acceptance from stakeholders resulting in conflicts during implementation. The participatory approach can thus help to develop more favorable water management strategies by including stakeholders' views in identification and selection of response measures. This study uses water scarcity in tourism city as a case study to show the benefit of inclusion of participatory processes. Analytic Hierarchy Process (AHP) was used to prioritize the most preferable choices of response. The result reveals that different stakeholder groups suggest a number of similar options while some solutions are preferred by one group but not by the others. This implies that agreeable options should be the first priority for implementation while disagree solutions may need further enabling factors to make them acceptable. Therefore, local information obtained by participatory approach is an indispensable input to identify better strategies, leading to successful water management that well respond to the local contexts.

Keywords: participatory approach, analytic hierarchy process (AHP), water scarcity, tourism city

INTRODUCTION

Water resource is important for human well-being and livelihood, there have direct and indirect effects on human activities (Cai et al., 2016). The freshwater is 3% of the world's water but only 1.5% is accessible. The water supply crisis is rise with the increasing rate of population (Global Water Partnership, 2000). It is widely accepted that water scarcity is currently affecting worldwide. The water scarcity especially in human activities becomes a serious problem in the central Asia, the East Asia and other regions (IPCC, 2013).

The tourism is the main human activities that is increasing water demand in the any places (Gabarda-Mallorquí, Garcia & Ribas, 2017). United Nations World Tourism Organization Anural Report, tourism is a key driving force for socio-economic progress. The tourist arrivals reached 1138 million, they turnover more than US$1200 billion, in 2014. There is making 235 million worldwide jobs that is 5% of direct global Gross Domestic Product (GDP) (UNWTO, 2016). While tourism can bring economic prosperity to the area, it is not without its negative impacts on environment. Conflicting with other water users such as agriculture in the same watershed, urbanization from economic wealth attract more people leading to congestion and water resource problem.

Article History: Received 4 October 2017 ◆ Revised 17 December 2017 ◆ Accepted 10 February 2018

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The water resources are direct effects on tourism sector, that are many stakeholders, they are interaction in water resources management (Michailidou, Vlachokostas & Moussiopoulos, 2016). Integrated water resources management (IWRM) is a process, is coordination of water, land and related resources for sustainable development and management (Global Water Partnership, 2000). It is the best way to optimize water resources management and to decrease conflicts between stakeholders (Bhadwal et al., 2013). Water is a subject in which everyone is a stakeholder that is participatory approach (Jeong et al., 2017).

Participatory approach was the important processed for finding the appropriate solutions, is well respond to the local contexts (Tauhid Ur Rahman et al., 2017). The real participation is local stakeholders, they are part of the decision-making process, can make water management and use them choices (Global Water Partnership, 2000). They are many adaptation choices, depend on them area, that are sustainable water management (Qian et al., 2017; Safavi, Golmohammadi & Sandoval-Solis, 2015).

This research focus on tourism city that are the water resources problems that were used the participatory approach (Ceccato, Giannini, & Giupponi, 2011). It was the important processed for finding the appropriate solutions which was used the Analytic Hierarchy Process (AHP) (Orencio & Fujii, 2013; Saaty, Peniwati & Shang, 2007). AHP is a multi-criteria analysis. The local stakeholders were choosing the solutions and the adaptations strategies that were identified by social commitment (Orencio & Fujii, 2013). The AHP were prioritized the solutions which were consistency index for approved the results (Saaty, 2008). The information is helpful to add appropriate strategies and adaptations ways to reduce water scarcity problem (Ceccato, Giannini, & Giupponi, 2011) Therefore, this research was found the agreement between facts and public concern will lead to successful sustainable water management (Tekken & Kropp, 2015).

MATERIAL AND METHODOLOGY

Description of the Study Area

Hua-Hin Municipality is a favorite seaside tourism place in the western part of Thailand with fast increasing economic growth due to its close proximity to the capital city, Bangkok (**Figure 1**). Since 2012, there has been high investment in tourism industry including hotels, department stores, golf courses, theme parks, houses and condominiums. In addition, the Hua-Hin Municipality 3-years development plan (2016-2018) anticipated the central government investment in high-speed train linking Bangkok and Hua-Hin further stimulating economic growth in this area. The flourishing economy leads to growing population and urbanization. During the period of 2004 to 2016, the population has increased 3%, however, the water users by household has increased at 6.8% resulted from a change in household structure to smaller households (**Figure 2**). The rate of water consumption of Hua-Hin Municipality population were 440 liters per capita per day which were much higher than the rate of water consumption in city used by the Royal Irrigation Department at 200 liters per capita per day. Meanwhile, the number of tourists were increased 30% between 2011 and 2016 reaching nearly 5 million people in 2016 (**Figure 2**). Hua-Hin municipality income was increased 33% reaching 30 Billion Baht per annum, 40% of which came from tourism. The average length of stay for tourists were 3 days bringing the rate of water consumption of tourists to 29 liters per capita per day.

Water supply are important for economic growth. However, Hua-Hin Municipality depends on external water resources primarily from Pranburi reservoir via piping system and occasionally from Kaeng Krachan reservoir via irrigation canals (**Figure 1**) when supply from the first source were not sufficient especially during dry months from November to May. In 2004-2016, Pranburi reservoir water storage were 250.8 x 10^6 m^3 in November (start dry season). Kaeng Krachan reservoir water storage were 530.25 x 10^6 m^3.

The municipality has a reservoir with storage capacity of 280,000 m^3. To meet the demand of households and tourism industry, Hua-Hin Municipality supply about 12.5 x 10^6 m^3 per year. Between 2004 and 2016, water supply for tourism industry were increased 5.9% per year, while water supply for urban were increased 8.8% per year (**Figure 3**). Water demand often reaches peak consumption in May and December, when many holiday-makers visit the city. To support the population and economic growth, in 2013 the Municipality increased its water supply capacity by two-folds (**Figure 3**) by building new water plants and reservoirs. In addition, engineering technology were used to increased water pumping efficiency from Pranburi reservoir and increased water transboundary from Kaeng Krachan reservoir. Future plans include building permanent piping system from Kaeng Krachan reservoir, building reservoirs around the city for reserve raw water for water supply, and increasing water supply efficiency by expanding and increasing water supply plant.

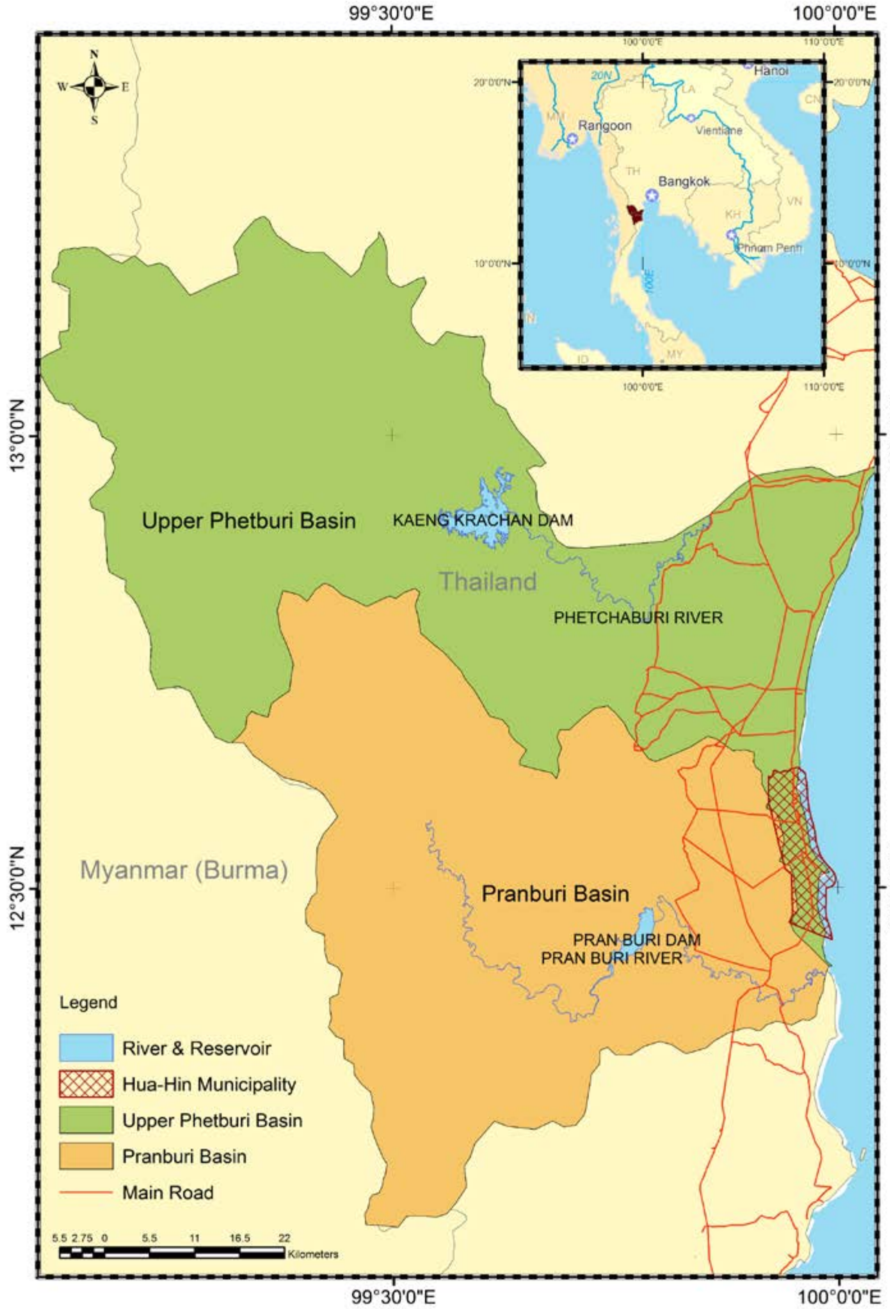
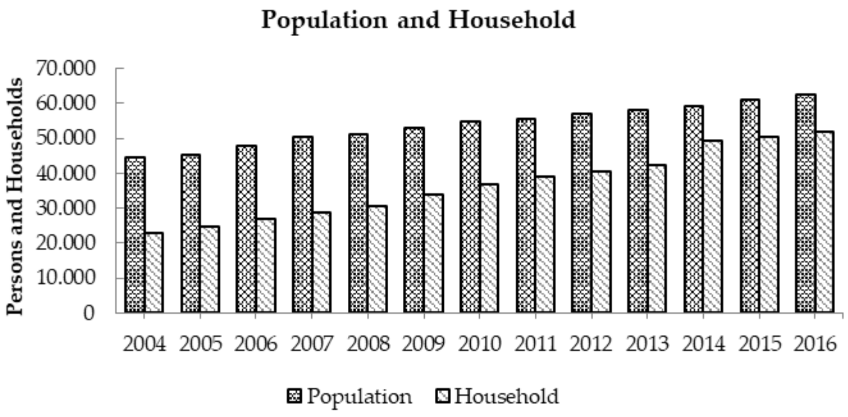
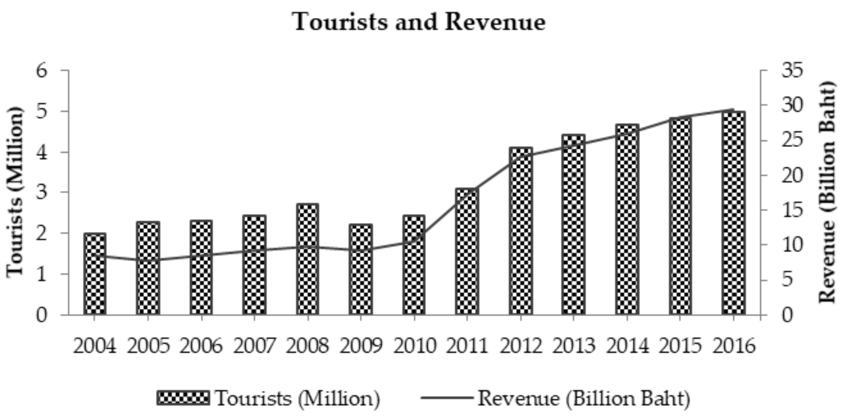


Figure 1. Hua-Hin Municipality area
Source: The Land Development Department, 2016



(a)



(b)

Figure 2. Population and economic
Source: Hua-Hin Municipality annual report (2016)

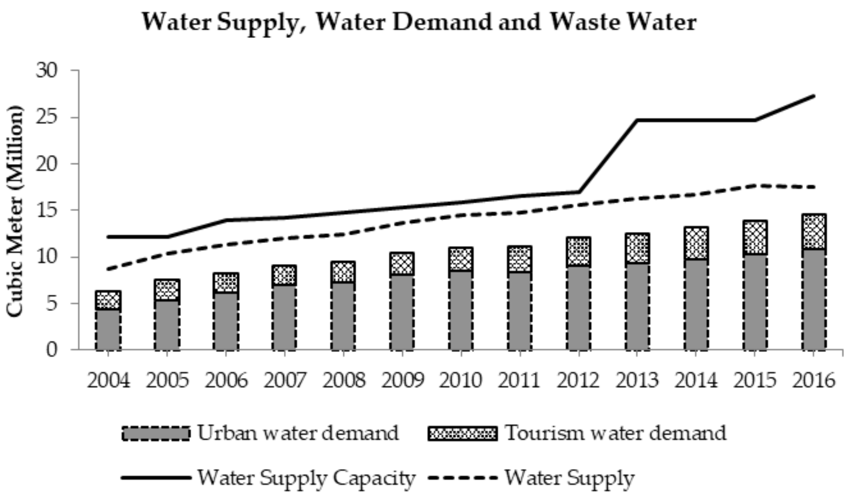


Figure 3. Water Supply, Water Demand and Waste Water
Source: Hua-Hin Municipality annual report (2016)

Water Scarcity Index

This research are two main indexes for assess the water scarcity that were Falkenmark index is water stress index (WSI) and Criticality ratio (CR). the indexes were initial indicators for water quantity impacts (Zeng, Liu & Savenije, 2013).

The WSI for water quantity assessment (Savenije, 2000) by using the water level at starting dry season (November) divided by population and, which unit is cubic meter per capita per year (m3/cap/year) (Equation 1).

$$WSI = \frac{WA}{P} \quad (1)$$

Where WSI is the water stress index (m3/cap/year), WA is the water availability, and P is the population in the area. Criterial of water stress index are include; water stress is between 1,700 and 1,000, water scarcity are between 1000 and 500, and absolute scarcity are less than 500 cubic meters per person per year.

The CR is ratio between water withdrawal and water availability (Oki & Kanae, 2006), which use the water discharge in dry season divided by water level at starting dry season (November) (Equation 2).

$$CR = \frac{W}{WA} \quad (2)$$

Where CR is the criticality ratio, W is the water withdrawal, and WA is the water availability. Criterial of Criticality ratio are include; very high-water stress is more than 0.8, high water stress is between 0.8 and 0.4, mid water stress is between 0.4 and 0.2, low water stress is between 0.2 and 0.1, and no water stress is between 0.1 and 0.

Participatory Approach

The participatory approach is key methodology to find the water scarcity adaptation that were used the focus groups Ceccato, Giannini, & Giupponi, 2011). The objectives of focus groups were proposed to identify and prioritized the responses and solutions.

Participants were discussed on the impacts from water scarcity and concern factors based on data in previous time, in present and in the future. The results from discussion were found alternative way for adaptation plan. Which the plan was selected in categories for prioritized. Participants were prioritized by using AHP (Orencio & Fujii, 2013). Then, they were discussed with experts to approve the plan. The results were showed the appropriate adaptation plan and solutions for solved the problems and decreased water scarcity impacts.

The focus groups were conducted by coordinated with Hua-Hin Municipality, which were communicated with stakeholder. Then, the number of participants were depended on the water community groups that the total participant were 69 persons. The criterial for chose the participants were collected from 3 groups included;

- Local Actors (LA) were 58 persons that were selected from leader of local communities, leader of business groups, and leader of water users.
- Policy Makers (PM) of Hua-Hin Municipality were 5 persons which were mayor and directors.
- Experts (EP) were 6 persons which were water management expert and climate change adaptation expert.

Analytic Hierarchy Process (AHP)

AHP was important alternative criteria for decision making that were identified by using pairwise comparisons and ratio-scale measurement (Orencio & Fujii, 2013). The results were prioritized the alternative or criteria that were improved by statistical methods. The number of pairwise comparison were calculated by the equation 3.

$$n(n-1)/2 \quad (3)$$

where n is the number of alternative or criteria $(a_1, a_2, \dots, a_n)$ in the prioritization.

We explained the pairwise comparison by The Matrix A that when participants decided that alternative i was equally important to another alternative j, a comparison represented by $a_{ij} = a_{ji} = 1$ was expected. On

Table 1. Pairwise comparison scale

Scale	Definition	Explanation
1	Equally important	Both criteria / alternative contributes equally important
3	Moderately important	The criteria / alternative is more slightly important over the other
5	Strongly important	The criteria / alternative is more strongly important over the other
7	Very strongly important	The criteria / alternative is more very strongly important over the other
9	Extremely important	The criteria / alternative is the highest importance of all
2, 4, 6, 8	Intermediate preferences between adjacent scales	Used to represent compromise between the priorities listed above

another hand, when alternative i was considered extremely important compared with alternative j, the calculation matrix score was based on $a_{ij} = 9$ and $a_{ji} = 1/9$ (Saaty, 2005) (Equation 4).

$$Matrix\ A = [a_{ij}] = \begin{Bmatrix} 1 & a_{ij} & \cdots & a_{1n} \\ 1/a_{ij} & 1 & \cdots & a_{2n} \\ \vdots & \vdots & \cdots & \vdots \\ 1/a_{1n} & 1/a_{2n} & \cdots & 1 \end{Bmatrix} \tag{4}$$

where Matrix A $= [a_{ij}]$ are presentation of the intensity of the participant's preference for one over another compared alternative a_{ij} and for all comparisons $i, j = [1,2, \dots, n]$.

Each a pairwise comparison product was considered an expression of the participant's relative preferences for a_i or a_j over another based on the pairwise comparison scale composed of values from 1 to 9 (**Table 1**).

The AHP score were calculated the element weights that were comparison scores of alternative criteria in each row of the Matrix A. Then we took the n root of that product generated the element weights for each alternative (Equation 5).

$$Element\ weight = \sqrt[n]{a_{ij} \cdots a_{nj} \cdots a_{nn}} \tag{5}$$

The weights in a column were summarized that were used to obtain the normalized eigenvector w_{ij} for that alternative (Equation 6).

$$w_{ij} = \frac{Element\ weight}{\sum Element\ weight\ in\ column} \tag{6}$$

When Matrix A was multiplied by the vector w_{ij}, the resulted in a new priority vector nw_{ij}. A similar nw_{ij} value was obtained when w_{ij} was multiplied by the maximum eigenvalue λ_{max} (Equation 7).

$$nw_{ij} = \sum_{ij=1,2}^{n} a_{ij} w_{ij} \tag{7}$$

In a consistent, nw_{ij} values for each alternative became weights, which were prioritized the alternatives, respectively.

The prioritized of alternatives scores, were nw_{ij} values, which were accepted when were pass the level of consistency, include as; Consistency Index (CI) (Equation 8) and Consistency Ratio (CR), were computed by follow as:

$$CI = (\lambda_{max} - n)/(n - 1) \tag{8}$$

where λ_{max} is the maximum eigenvalue computed by averaging all individual eigenvalue λ, and n is the number of alternative or criteria to a prioritization (Equation 9). Each individual λ was dividing the nw_{ij} by their normalized values w_{ij}

$$\lambda = \frac{nw_{ij}}{Normalized\ w_{ij}} \tag{9}$$

The CI score was compared with a random consistency index RI (**Table 2**) of the generated paired comparison matrix to the consistency ratio CR that were showed in equation 10. The CR scores were accepted: < 0.10.

$$CR = \frac{CI}{RI} \tag{10}$$

Table 2. The order of the random index of consistency with a number of alternatives. Alonso-Lamata RI values and standard deviation (for 100000 and 500000 matrices) (Alonso & Lamata, 2006).

n	3	4	5	6	7	8	9	10	11	12	13	14	15
RI	0.52	0.88	1.11	1.25	1.34	1.41	1.45	1.49	1.51	1.54	1.56	1.57	1.58

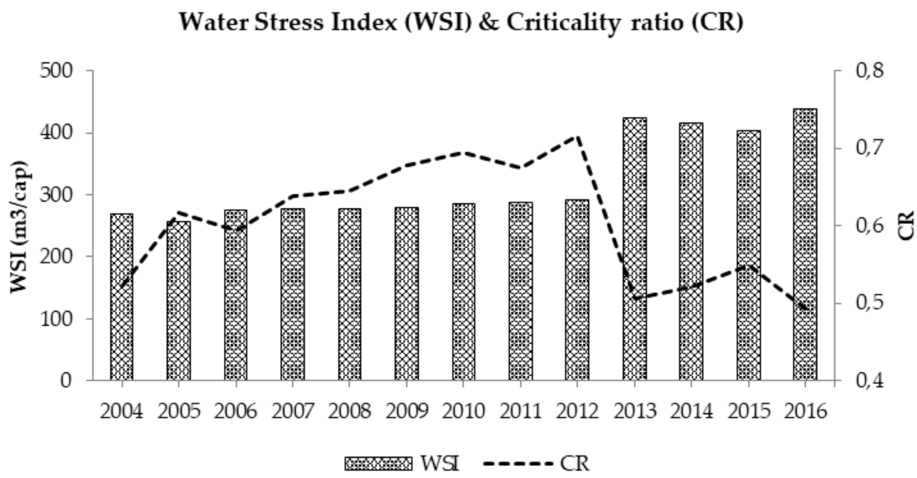


Figure 4. Water Stress Index (WSI) and Criticality ratio (CR)

RESULTS AND DISCUSSION

During the past ten years, the population and economic growth of Hua-Hin Municipality have been expanding which inevitably cause an increase in the water demand. However, with finite water resource from upstream area, water supply was occasionally not sufficient to support all sectors of water users. This study uses two key indicators in water scarcity assessment, i.e. water stress index (WSI), a ratio between water availability at the beginning of dry season and population, and Criticality ratio (CR), a ratio between water withdrawal and water availability. Generally, these two indices vary inversely with somewhat different implication; WSI simply considers water quantity per person while CR also considers a contribution of water infrastructure in water scarcity. **Figure 4** shows that WSI was less than 300 m^3/cap/year before 2012 then became a little more than 400 m^3/cap/year afterwards. This slight increase was resulted from an increase in water supply by Hua-Hin Municipality and an improvement in water pumping efficiency from Pranburi reservoir and Kaeng Krachan reservoir in 2013. However, the WSI below 500 m^3/cap/year threshold still indicates that the city has been in absolute water scarcity. Similarly, CR was increased from 0.5 to 0.7 during 2004 to 2012 then decreased to 0.5 afterwards. The decreased CR in 2013 was due to an increase in water availability. Nevertheless, CR between 0.4 and 0.8 indicates that the city has been in high water stress. The reason that WSI indicate more severe condition of the City water stress when compared to CR is because CR was calculated from real water consumption while WSI was estimated from the population. In addition, the decrease in CR since 2013 may cause a false water security. This is because Hua-Hin Municipality relies on water from two upstream areas which also need to support other activities such as agriculture and environmental protection, although water demand for urban use often has the highest priority, the City urgently need sustainable solutions to water scarcity.

In this study, participatory process was used to identify and prioritize the appropriate responses to water scarcity. Stakeholders were classified into 3 groups, i.e. Local Actors, Policy Makers and Experts. Focus groups activities and interviews were conducted in two steps. At the beginning, each stakeholder group was asked to identify the impact of water scarcity and relevant contributing factors to the problem; the results of which showed that growing population, tourism and urbanization were among the top contributors. Responding measures to water scarcity were then solicited from the focus groups and were subsequently categorized into 5 main approaches: resource, technology, management, education and policy, each approach consists of two measures resulting in ten measures overall (**Figure 5**). The proposed solutions from stakeholder focus groups address both demand and supply sides. For demand side, measures comprise of regulating water usage

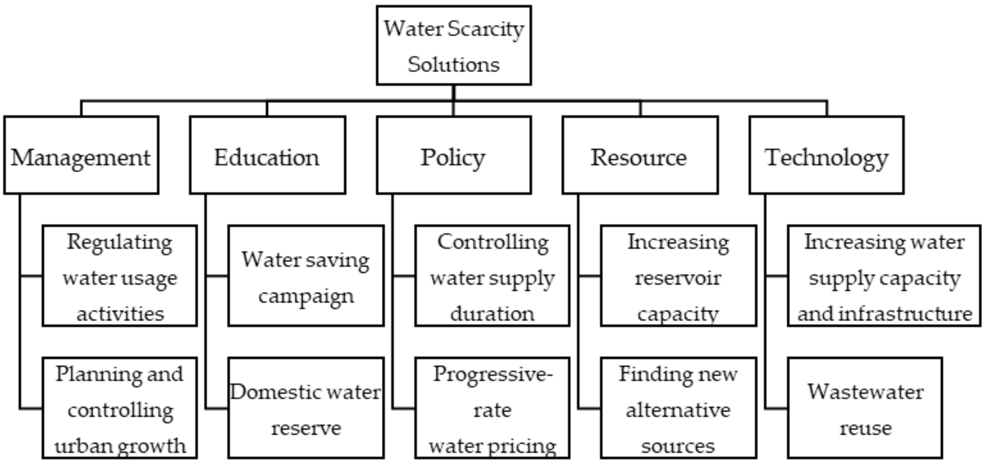


Figure 5. Decisions tree of water scarcity solutions for participants prioritized by focus group

activities (management), planning and controlling urban growth (management), promoting water saving campaign (education), capacity building on domestic water reserve (education), controlling water supply duration (policy) and progressive-rate water pricing (policy). For supply side, measures consist of increasing existing reservoir capacity (resource), finding new alternative sources apart from two reservoirs currently being used (resource), increase Municipality water supply capacity and infrastructure (technology) and wastewater reuse (technology).

Next, each stakeholder group was asked to prioritize the ten proposed water scarcity solutions by pair-wise comparisons according to Analytic Hierarchy Process (AHP). Essentially the results from the process show favourable choices chosen by each group while such choices must be simultaneously self-consistent (**Table 3**). It is clearly seen that all groups rated management approach as the top priority. Interestingly, Local Actors gave education as equally important as management approach reflecting their inclination toward building more adaptive capacity. Policy Makers gave Resource as their second priority, unsurprisingly, due to this approach falls within their responsibility, while gave lowest priority to Policy as this approach is sensitive to their political popularity in their electorates. Likewise, Local Actors gave Policy as their lowest priority as this approach predictably will affect their convenience and affordability. In contrast, Experts' choices appear to be more balance in coupling all dimensions of the approaches.

Table 3. The prioritized results of the water scarcity solutions

Approaches		Measures	Local Actors		Policy Makers			Experts	
			Weight	Total Weight		Weight	Total Weight		Weight	Total Weight
Management	0.28	Regulating water usage activities	0.62	0.176	0.31	0.5	0.154	0.3	0.48	0.147
		Planning and controlling urban growth	0.38	0.109		0.5	0.154		0.52	0.157
Education	0.28	Promoting water saving campaign	0.63	0.18	0.17	0.5	0.087	0.21	0.5	0.103
		Capacity building on domestic water reserve	0.37	0.104		0.5	0.087		0.5	0.103
Policy	0.11	Controlling water supply duration	0.53	0.059	0.09	0.5	0.047	0.18	0.3	0.054
		Progressive-rate water pricing	0.47	0.051		0.5	0.047		0.7	0.126
Resource	0.16	Increasing existing reservoir capacity	0.75	0.118	0.27	0.5	0.136	0.15	0.57	0.087
		Finding new alternative sources	0.25	0.039		0.5	0.136		0.43	0.067
Technology	0.16	Increasing Municipality water supply capacity and infrastructure	0.72	0.117	0.15	0.7	0.106	0.15	0.35	0.054
		Wastewater reuse	0.28	0.046		0.3	0.045		0.65	0.1
*Consistency Index (CI)			0.016		0.036			0.05		
*Consistency Ratio (CR)			0.014		0.032			0.045		

Figure 6 illustrates relative preference of measures given by three stakeholder groups. Measures which received high priority by all groups suggesting their significance and approval are regulating water usage activities and planning and controlling urban growth. Apparently, controlling water supply duration is not favour by any of the groups possibly due to its ineffectiveness in solving the problem as well as its inconvenience this measure may incur to the users. While promoting water saving campaign obtained high weight from Local Actors and Experts, but comparatively less weight by Policy Makers suggesting that this measure should receive more support from Policy Makers as it can reduce water demand and it is relatively economical in implementation. In contrast, some measures are only advocated by one group but not by the other two groups implying their likely usefulness but also their strong criticisms which need to be resolved before implementation. As can be seen from **Figure 6**, only Policy Makers favour finding alternative sources of raw water. In addition, only Experts advocate progressive-rate water pricing to decrease water demand and wastewater reuse to support increasing water consumptions, yet Local Actors and Policy Makers were less enthusiastic because they concerned about household affordability and water quality.

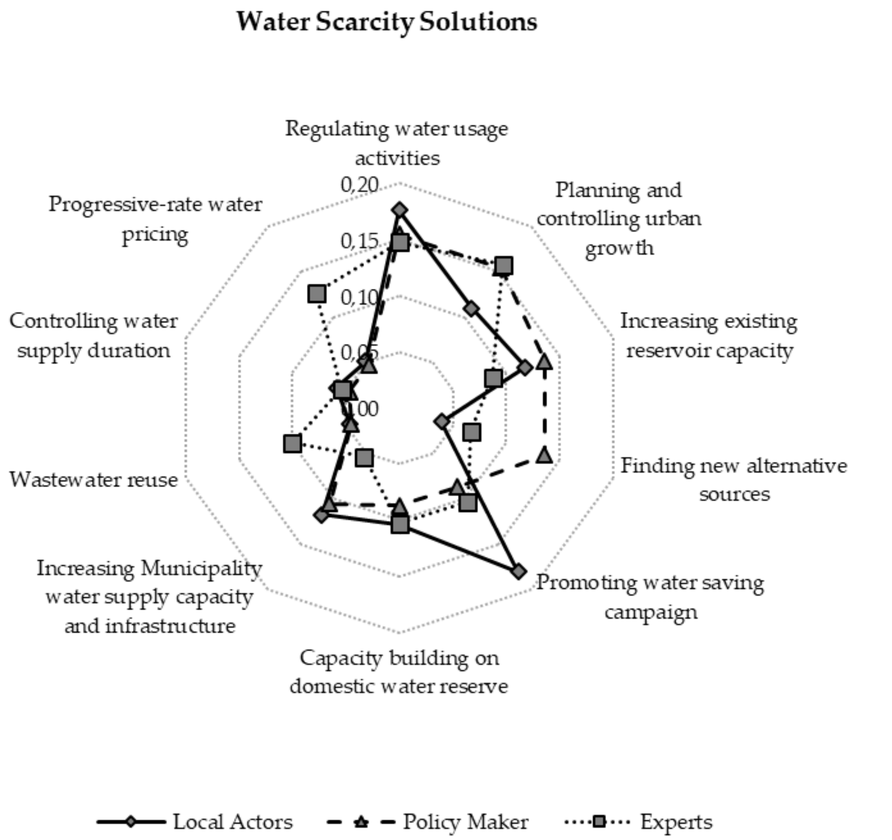


Figure 6. Comparison between the focus group results were chose by 3 groups of participants for water scarcity solutions

As illustrated in the previous sections, participatory processes facilitate identification and prioritization of water scarcity solutions. It is insightful to investigate options that are not agreeable by different stakeholder groups as this often suggest existing weakness of the solutions. One of such measures is finding new alternative sources of raw water. This solution is pertinent to Hua-Hin Municipality as it currently relies on water resources from two water basins. However, drawing water from trans-boundary is becoming difficult and unsustainable due to possible conflicts with other water users from upstream area.

Water rights trading issue is important in near future it has conflict in some country (Philpot, Hipel & Johnson, 2016; Satoh, 2015). but it is the best way to reduce conflicts between upstream and downstream (Wang et al., 2017). There is one of choice for water resources management (Zhang, Liu, & Jia, 2010). That is sharing weight of water owner by using water pricing (Wang et al., 2016).

Increasing water supply price solution that were changed water pricing, were main cost of tourism industry (Grafton et al., 2014; Griffin & Mjelde, 2011). Provincial Waterworks Authority (PWA) is Thailand water supply governance. They were increased Pattaya and Phuket Cities, the two largest tourist coastal cities in Thailand. Household's water price was up to 30%, Small business was up to 100%, and large business and industry were up to 85% of previous price. When we compared the water consumption ratio 2005-2010 and 2011-2015, Phuket City. Water consumption was still significantly increased with numbers of water users (R^2= 0.95). This implied that water pricing has no effect on water consumption rate in both cities. One reason may due to the price is still significantly low compared with income of these cities. This finding is similar to Chile, the water pricing were not effect to the water demand because it had many driver factors (Molinos-Senante & Donoso, 2016). The water price seemed to reduce water consumption in Ghana. However, the real water consumption did not reduce because most of the consumption was according to agriculture. The water from other non-pricing sources such as groundwater was used instead (Aidam, 2015). The overexploitation of groundwater may increase drought via desertification (Li & Rodell, 2015). In other case, the high-income cities such as Australia and English, the water price reflects real cost (Grafton et al., 2014; Molinos-Senante, Maziotis & Sala-Garrido, 2016), while the water in developing countries are heavily subsidized by the government. Therefore, in Thailand water pricing does not affect responsiveness of water consumption in tourist cities.

Reuse wastewater solution were the second difference points, it could be supported increasing water consumptions. In 2014-present, Wastewater Management Authority (WMA) was corroborated with 8 municipality in Thailand, were used water from wastewater treatment for support agriculture sector in dry season. That were decreased water scarcity impact to agriculture in them area. The wastewater was important resource for support water demand when water resources were not enough (Garcia & Pargament, 2015; Manios & Tsanis, 2006). The reusing urban wastewater from hotels and households. Patong municipality (Phuket province), was corroborated with the private company, built wastewater treatment plant for reusing urban wastewater in 2016. This project was accepted from hotels but was not accepted households because they concerned the water quality control. But the reusing urban wastewater from support hotels and households were the best choice (Hocaoglu, 2017; Wells et al., 2016).

Water scarcity solution scenarios were difference conditions and results but all of scenarios were made from local stakeholders. In Iran, they integrated water resources planning scenarios for projection uncertainty in the future (Safavi, Golmohammadi & Sandoval-Solis, 2016). Therefore, we should be integrated all scenario solutions that were decreased problems and decreased conflict to find the appropriate solutions for water resource management. And the finding water resource must be assessed water balance of the basin because the water resource of that basin is not enough that will conflict with the local people. Example, Bolivia and Mexico were used local adaptation scenarios for policies and strategies that were protected areas and beyond (Ruiz-Mallén et al., 2015). Future works need to estimate results of all scenario solutions by using system dynamic models that can be project the future water balance system and show water scarcity probability in each solution.

CONCLUSION

This research is advantage of this approach use real governmental data and real situations, are couple participatory approach. That can be improve successfully government water resources planning that are increase water resources management efficiency, government and stakeholders and have been developing new integrated management that are appropriate planning. There are many water scarcity solutions, are limit from local stakeholders. The local knowledge base is important for present alternative solutions. The government confident is main concern and point of decision that are consistent with some results.

Acknowledgements

This research was supported by the 90th Anniversary of Chulalongkorn University Scholarship. The authors would like to thank the Regional Irrigation Office 14, Royal Irrigation Department, and Hua-Hin Municipality for their contribution in focus group meetings and data supports. We acknowledge Thai Meteorological Department, Department of Provincial Administration, National Statistical Office, Land Development Department, and Southeast Asia START Regional Center for their data contribution.

Disclosure statement

No potential conflict of interest was reported by the authors.

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