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Balinese Indigenous Knowledge about Water : A Way to Achieve Water Sustainability

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Abstract

For the Balinese, water is essential for their ritual-based culture. Water is an entity to complete Balinese everyday life, especially the spiritual aspects that need holy water for rituals. This study aims to analyze the influence of Balinese indigenous knowledge about groundwater management, membership of the indigenous organizations, perception of the catchment areas, and water resources alternatives to groundwater resource conservation amongst Balinese. To address this, a survey of a representative sample of 139 Balinese adults in SARBAGITA (Denpasar Regency, Badung Regency, Gianyar Regency, and Tabanan Regency) has been conducted. With logistic regression model, this study found that knowledge and method used in respondents' households when water is limited are the most significant factor that affects respondents' willingness to participate in sacred springs conservation program.

***Keywords*:** indigenous knowledge, water knowledge, water management, sustainability

I. Introduction

Water is essential for human life. Water is certainly a very peculiar substance of unmatched importance in all areas of human life. From each individual alone up to the entire society as a whole, from each economic activity up to the environment in all its strength and diversity, nothing can survive without the presence and appropriate availability of water (Akhmouch & Correia, 2016). In today's modern world, production and consumption become more complex. This complexity needs a generous amount of water to runs. This leads to water scarcity due to mismatch between supply and demand of water, and it became the usual problem in urban society (Luo et al., 2019; Pandey, 2021).

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The demand for new water management paradigms has arisen as a result of the requirement to ensure the future sustainability of freshwater supplies (Marlow et al., 2013; Vörösmarty et al., 2010). Traditional water management methods centered on guaranteeing a sufficient supply of water and providing sanitation through wastewater treatment (Zhang, 2018). Traditional techniques, on the other hand, have limited long-term viability in the face of climate change (Vairavamoorthy et al., 2015). Climate change poses a significant threat to the world's freshwater resources, reducing both water availability and quality (Schewe et al., 2014; Zhang, 2018). These problems are exacerbated by population expansion and urbanization challenges (Padowski & Gorelick, 2014; Ren et al., 2014; Vörösmarty et al., 2010).

It is no wonder then, water resource management, at all levels, attracts so much attention and is so much considered as a key element in so many levels and areas of public policy (Dean et al., 2016a; Dixit, 2009; Thielborger, 2014). It is important to have sustainable approaches to solve the complex problems. Sustainable water management approaches require broad community acceptance of changes in policy, practice, and technology, which in turn, requires an engaged community. A critical first step in building an engaged community is to identify community knowledge about water management, an issue rarely examined in the research (Dean et al., 2016a; Marlow et al., 2013).

Studies show various conditions that influence knowledge, attitude and practices in relation to water management (Oremo et al., 2019). Geographical experiences, such as knowledge on climate conditions and shifting river regimes, are among these conditions. Residency status (Spijkers et al., 2018) and psychological characteristics such as environmental identification and values (Dean et al., 2016a; Dean et al., 2016b) are also determinants of knowledge, attitude, and practices relate to water management. Although much research has been done on the

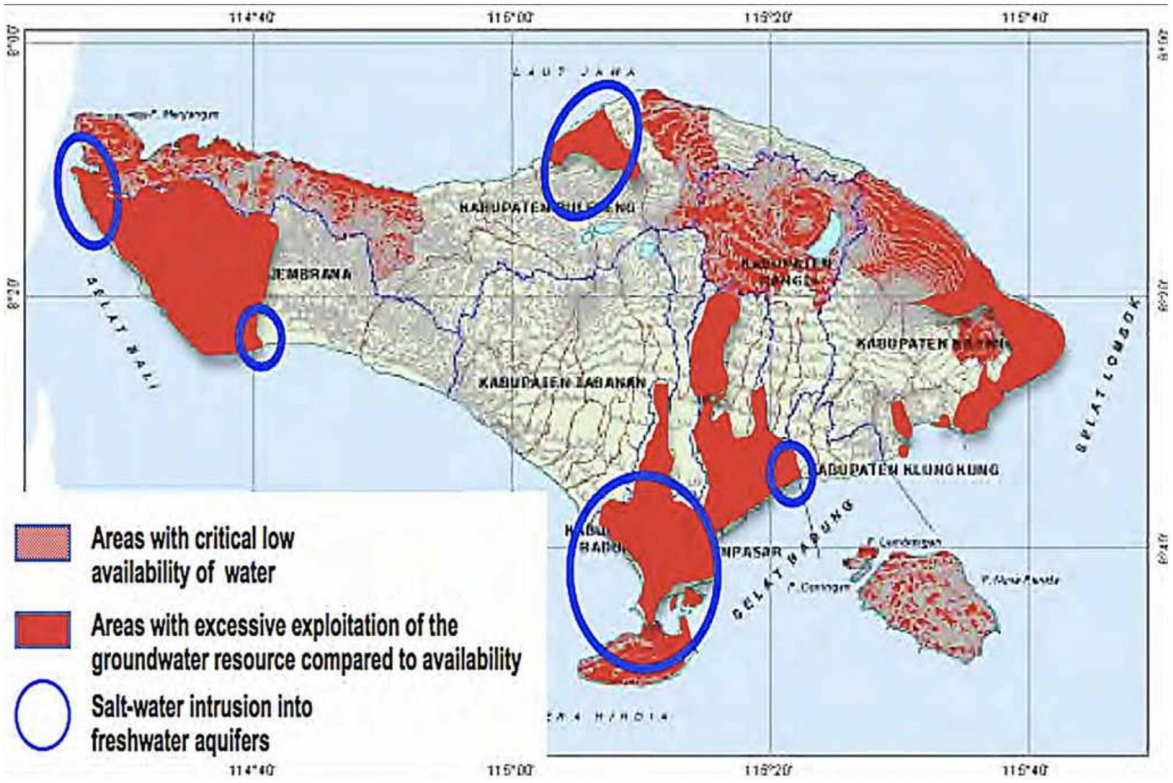
relationship between knowledge and support for water reforms and sustainable practices (Dean et al., 2016a; Dean et al., 2016b; Oremo et al., 2019), little is known about how indigenous knowledge of water resources management influences their attitudes and practices, and how policies can address knowledge and practice gaps.

As for the Balinese, water is essential for their ritual-based culture. Water is an entity to complete Balinese everyday life, especially the spiritual aspects that need holy water for rituals (Paramita, 2015). The Balinese have procedures to conserve water sources in Bali, both naturally *(sekala)*[2] and supernaturally *(niskala)*[3]. A natural approach is taken by planting and maintaining trees around water sources. Prohibiting the felling of trees as stipulated in customary regulations *(awig-awig)*[4] or village regulations. Saving water sources with spiritual approach is also carried out through ritual/ceremonies to the beach or the lake (Paramita, 2015).

Sustainable development goals (SDG) number six (6) stressing water and sanitation for all by promote inclusive water management, bringing together different sectors and stakeholders at all scales from local to transboundary (Sadoff et al., 2020). It became important to acknowledge indigenous knowledge to modern science especially water management. In the other hands, before COVID-19 pandemic, Bali has suffered from over-tourism. Over-tourism characterized by water shortage, environmental degradation, sanitation issues, over-crowded destinations, loss of authenticity, and higher cost of living. The presence of 6 million annual international and domestic tourists has placed immense pressure on the limited resources of the small island (Sperling, 2020). Tourism contributes toward 80 percent of Bali's economy but about 85 percent of it is in the hands of non-Balinese investors (Cole, 2012).

[2] Sekala means "tangible", "visible"
[3] Niskala means "intangible", "occult"
[4] Awig-awig means a set of customary regulations that define the obligations of a particular village, banjar, subak and sekaa organization

It has been quoted as much as 65 percent of the island's groundwater is poured into the tourism industry, drying up 260 out of more than 400 Balinese rivers (Cole & Browne, 2015). Groundwater over-extraction has lowered the island's water table by some 60 percent, risking irreversible saltwater intrusion. It can be seen on Figure 1. Changes in the lifestyle of the Balinese people have also become a source of water problems, the household waste that is generated every day exceeds the capacity of the landfill which ultimately causes further problems in the form of excessive waste being simply dumped into rivers or empty areas, mostly close to water sources (Brooijmans et al., 2019).



Source : PNB & IDEP (2018)

Figure 1. Map Depicting Bali Water Scarcity

The groundwater over-extraction due to over-tourism, economic growth, and urbanization become much bigger problem to Balinese because it is related to the presence of sacred spring (groundwater discharged) that also known as *Patirthan*[5]. Tirtha or holy water is very important for religious rituals in Hindu Bali (Hooykaas, 2013; Lanus, 2018). The rituals itself based on three (3) norms known as the *Tri Hita Karana* (THK) concept (Atmadja, 2020; Ramstedt, 2014; Suamba, 2017).

Several previous studies have emphasized the influence of knowledge about water management as a determining factor for individual and indigenous community behavior towards the conservation of water sources and the sustainability of the existence of water as a whole. Wilson & Inkster (2018) stated in their study that indigenous peoples often consider water to be a living being or a relative to whom they owe a sacred duty. This viewpoint often clashes with the view of water held by settler communities as a ‘‘resource’’ that can be owned, managed, and exploited. Using perspectives from critical Indigenous studies, post-humanism, and water governance, their study investigates the ‘‘political ontology" of water. As a result, in the spirit of (Hunt, 2014) and (Watts, 2013) their study respond to four Yukon First Nations calls to "respect water" as more than a repository of ideas, but as a dynamic body of knowledge lived and practiced by Indigenous peoples with whom we share reciprocal responsibilities.

While Dean et al. (2016a) mention that a key element of transitioning to more sustainable water management is building an engaged citizenry. Engagement in water-related issues is multifaceted, incorporating (i) cognitive engagement–knowledge and awareness; (ii) emotional engagement–concern and supportive attitudes; and (iii) behavioral engagement–adoption of civicand household that promote sustainable water management.

Based on previous research, this study intend to confirm the importance of Balinese indigenous community knowledge for water management initiatives. And also to provide considerations for policymakers regarding the inclusion of Indigenous knowledge elements in planning, implementing, and evaluating policies regarding water resources governance and management. Sharing knowledge between indigenous people, researchers and government is a must towards water resource conservation, water sustainability, and resiliency of a culture.

II. Data and Methodology

2.1. Study Area

This study was conduct in Sarbagita area from May-June 2021. Sarbagita area is a name forthe system of cities in Bali Province (South Bali) which consists of several areas such as Denpasar City, some part of Badung regency, Gianyar regency, and Tabanan regency. The area is the backbone of the economy of Bali Province and the national government is mainly related to three important sectors (tourism, agriculture, and supporting industries of tourism). By becoming a tourism buffer area, Sarbagita had experienced water scarcity, environmental degradation, sanitation issues, over-crowded destinations, loss of authenticity, and higher cost of living.

2.2. Data Collection

The data was gathered in the Sarbagita region. To choose where and who to conduct the questionnaire survey, we employed a combination of multi-stage sampling and basic random sampling. A total of 139 Balinese adults from the Sarbagita district were chosen at random as respondents. Face-to-face interviews and an online survey employing semi-structured questionnaires were used to conduct the survey. The survey was carried out by well-trained university graduates. Additionally, the respondents were assured that their responses and personalinformation would be confidential.

Water resource management concerns are exacerbated by a lack of knowledge and information about water issues, and solving these issues necessitates a greater grasp of what is known, believed, and done in the field of water management. In this study, knowledge of water issues refer to indigenous knowledge about sacred springs (groundwater discharge). The replies were distinguished by 1 (Yes) and 2 (No), with 1 being 'know about sacred springs' and 2 being 'do not know about sacred springs'. The term attitude was defined as a willingness to engage in certain sustainable water resource management strategies such sacred springs conservation. The responders were given two options and asked to choose one. Options 1 is willing to participate, Option 2 is neutral. The knowledge and attitude variables were adapted from established literature (Dean et al., 2016a; Nguyen & Ross, 2017; Okumah et al., 2019; Paneque et al., 2018).

2.3. Data Analysis

Data was analysed using R Studio statistical software and the analysis entailed descriptive statistics for the socio-economic characteristics of the respondents.

2.3.1. Binary Logistic Regression

The attitude components of the knowledge and attitude study always have binary outcome variables coded as either a '1' for a yes or 'else' for a no response; therefore, binary logistic regression was employed to help identity factors that influence these components of the study, and the directions they take. Binary logistic regression is a statistics technique for the case of dependent variables of two outcomes. It expresses the probability of the occurrence of a dependent variable as a function of the independent variables. Mathematically, logistic regression takes an equation of the form:

$$log(p) = b_0 + b_1X_1 + b_2X_2 + b_3X_3 + \cdots + b_kX_k$$

where p is the probability of presence of the

characteristic of interest.

This study considered two categorical variables (method to use in household when the amount of water is limited, and residence location), and five binary variables (willingness to participate in sacred springs conservation, knowledge of the sacred springs, gender, membership of indigenous organization, and water supply limitations) for regression analysis (Table 1).

Table 1. Variables used for regression analysis.

Variable	Type	Questions
Method to use in household	Categorical	Method to use in respondents household when the amount of water is limited (1: Save water usage beyond need, 2: Using water saving tools, 3: Reducing behaviors that can pollute waterways, 4: Looking for alternative water sources (springs, rivers, etc.))
Residence location	Categorical	Residence location of respondents (1: Urban, 2: Sub-urban, 3: Rural)
Willingness to participate	Binary	Choice to participate in sacred springs conservation (1: Yes, 2 : Neutral)
Knowledge	Binary	Does respondents know about sacred springs around their home? (1: Yes, 2: No)
Gender	Binary	Gender of Respondents (1: Male, 2: Female)
Membership	Binary	Does respondents enrolled as a member of indigenous organization in their village? (1: Yes, 2: No)
Water supply limitation	Binary	Does respondents ever experienced water supply limitation in their household during this year? (1: Yes, 2: No)

III. Result

3.1. Socio-Demography of the Study Population

A total of 139 respondents were interviewed. Respondents residence location spread evenly between urban, sub-urban and rural area (Table.2). 50.4 % of respondents are male. And 50.4%

respondents is a member of indigenous organization. While 79.2% respondents never experience water supply limitation during this year.

Table 2. Socio-economic and demographic characteristics of the respondents

Characteristic	Description	Proportion (%)
Residence location	Urban	38.1
	Sub-urban	28.05
	Rural	33.8
Gender	Male	50.4
	Female	49.6
Membership	Member of indigenous organization	50.4
	Non-member of indigenous organization	49.6
Water supply limitation	Ever experience	20.8
	Never experience	79.2

3.2. Willingness to participate in sacred springs conservation program

From the total 139 respondents, 79.8% respondents willing to participate in sacred springs conservation program. While 19.04% choose to have a neutral position and only 1 respondent or 0.07% from total respondents choose not willing to participate in sacred springs conservation program.

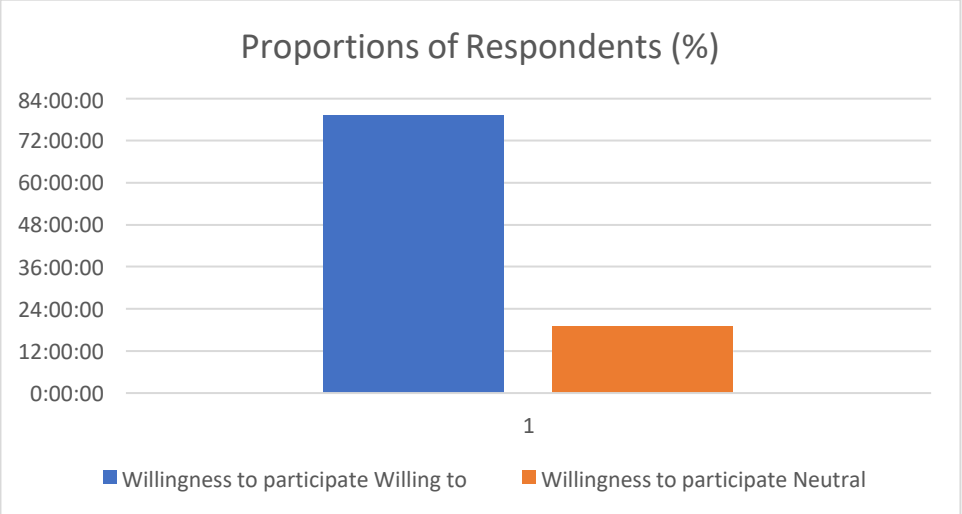


Figure 2. Willingness to participate in sacred springs conservation program

3.3. Method to use in household

When deal with water supply limitation, 56.1% respondents choose to save water usage beyond need, 2.8% use water saving tools, 12.2% reduce polluting behavior and 28.7% respondents choose to looking for alternative water sources (springs, rivers, etc).

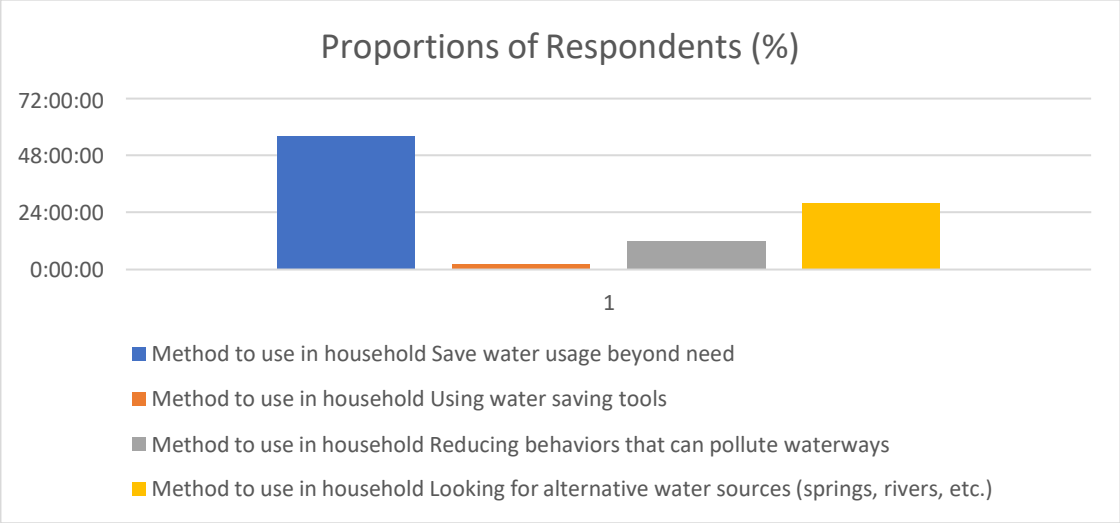


Figure 3. Method to use in household when water supply is limited

3.4. Knowledge about sacred spring

In terms of their knowledge about sacred springs, from total 139 respondents, 65.4% respondents know about the sacred springs and the spiritual attribute related to the terms while 34.5% respondents do not have the knowledge.

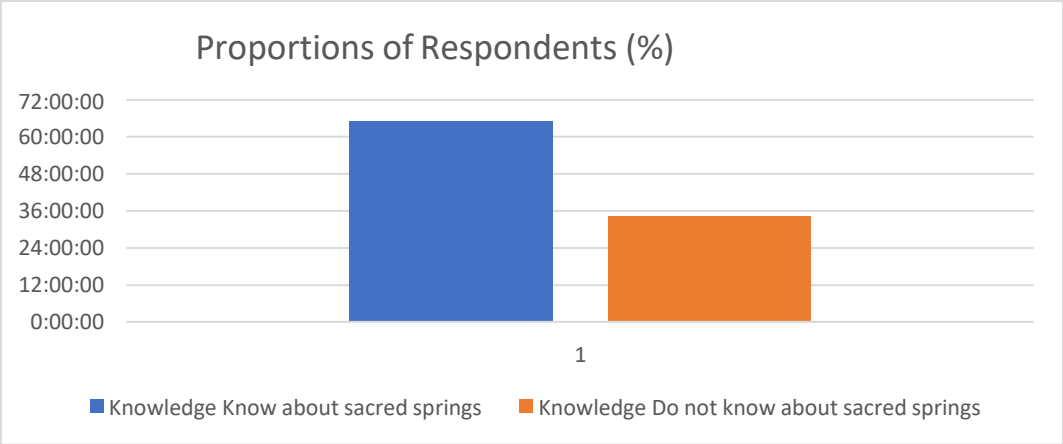


Figure 4. Knowledge about sacred spring

3.5. Respondents Attitude towards Groundwater Resource (Sacred Springs) Conservation According to the descriptive crosstab analysis, there was a significant difference in expressing desire to participate in groundwater (sacred springs) conservation programs between persons with knowledge and those without the knowledge. 81 persons (72,9%) who knew about water were willing to participate in the conservation program, compared to 30 people (27,1%) who expressing the desire but didn't have the same knowledge. While respondents membership in indigenous organization also take into account, 56.7% from 111 respondents who willing to do conservation program are a member of indigenous organization. This findings is supported by previous studies (Dean et al., 2016a; Dean et al., 2016b; Jacobs & Buijs, 2011; McDuff et al., 2008).

Our findings imply that being a part of a indigenous community network can help people learn more about water challenges. Participating in indigenous community networks can help raise awareness of issues and build support for water policy, technology, and practices. Low social capital, on the other hand, has a considerable but negative impact on social learning and

information sharing. These findings are in line with previous research (Dean, Fielding, et al., 2016; Gilbertson et al., 2011; Oremo et al., 2019) that shows how knowledge about water issues may be effectively communicated through social networks.

Results from the binomial regression model of the the determinants of attitude (Willingness to Participate) towards groundwater resource (sacred springs) conservation are presented in figure

```
Call:
glm(formula = WTParticipate ~ Method + Residence.Location + Knowledge +
    Gender + Membership + Supply.Limitation, family = "binomial",
    data = train)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-1.4942  -0.7132  -0.3635  -0.1806   2.1515

Coefficients:
                  Estimate Std. Error z value Pr(>|z|)
(Intercept)        -5.4883     2.1128  -2.598  0.00938 **
Method             -0.6492     0.2652  -2.448  0.01436 *
Residence.Location  0.0502     0.3286   0.153  0.87859
Knowledge           1.4365     0.5545   2.590  0.00959 **
Gender              0.5836     0.5563   1.049  0.29414
Membership          0.9600     0.5666   1.694  0.09024 .
Supply.Limitation   0.4234     0.6455   0.656  0.51193
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 120.425  on 114  degrees of freedom
Residual deviance:  92.324  on 108  degrees of freedom
  (3 observations deleted due to missingness)
AIC: 106.32

Number of Fisher Scoring iterations: 5
```

Figure 5. Model I

Model I analysed respondents willingness to participate in conservation program influenced by method to use in respondents household when the amount of water is limited, Residence location of respondents, knowledge about sacred springs, gender, membership in indigenous organization, and water supply limitation. There are only two variables that significant influencing willingness to participate, which is Method (p.value = 0.01436 < 0.05) and Knowledge (p.value

= 0.00959 < 0.05). So the next step will be excluded other variables except Method and Knowledge to analyse the model once again.

```
Call:
glm(formula = WTParticipate ~ Method + Knowledge, family = "binomial",
    data = train)

Deviance Residuals:
    Min       1Q   Median       3Q      Max
-1.2187  -0.6186  -0.3355  -0.2445   1.9945

Coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept)  -2.5637     0.9259  -2.769  0.00563 **
Method       -0.6462     0.2584  -2.501  0.01239 *
Knowledge     1.6533     0.5100   3.242  0.00119 **
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for binomial family taken to be 1)

    Null deviance: 120.425  on 114  degrees of freedom
Residual deviance:  97.322  on 112  degrees of freedom
  (3 observations deleted due to missingness)
AIC: 103.32

Number of Fisher Scoring iterations: 5
```

Figure 6. Model II

In this second model, all of the variables are significantly affecting respondents willingness to participate in sacred springs conservation program. The logistic regression model will be :

Y = -2.5637 -0.6462 Method+ 1.6533 Knowledge + e

The logistic regression coefficients give the change in the log-odds of the outcome for a one unit increase in the predictor variables. The interpretation of the logistic regression coefficients will be :

a. For every unit of change in method, the log-odds of willing to participate in sacredsprings conservation program (versus non-willing to participate) decrease by 0.6462.
b. Knowledgeable respondents log-odds of being willing to participate in sacred springsconservation program are higher by 1.6533

The prediction model's accuracy in logistic regression is 0.7377049, which translates to a prediction accuracy of 73.77%. The Goodness of Fit of the logistic regression model can show if the model is fit or not. Because the findings obtained in the logistic regression model used in thisinvestigation are 9.620602e-06, or a very small value, it can be concluded that the logistic regression model utilized in this study is a fit model.

This study findings have shown that individuals with poor topic knowledge may also have poor information-processing skills or a lack of personal interest in the topic, which diminishes thelikelihood of information detection and retention. This is supported by a study by Dean et al (2016), that stated, information-only engagement initiatives that do not address the larger social environment or deliberately target disengaged subgroups may fail to produce meaningful changes in behavior.

Other factor that need to be highlighted in this study is the method that use by respondents to overcome the decline of water supply in their household. Multiple water sources are routinely used to supply household water needs in many developing countries, according to reports. Implementers, development groups, and researchers, on the other hand, tend to focus only on the "main source of drinking water." (Elliott et al., 2019). Multiple household water sources are routinely used in environments with varying precipitation patterns, water resources, piped water supply, and so on. For example, it has

been recorded in countries around the globe (Coulibaly et al., 2014; Elliott et al., 2019; Foster & Hope, 2017; Foster & Willetts, 2018; Özdemir et al., 2011). In many households, multiple water resource use is a common yet under-reported practice. As evidence of this practice emerges in a rising number of situations, the time has come for researchers and implementers to assess, analyze, and incorporate it in a way that will help communities flourish and adapt to climate change.

There are a number of limitations in this study. Our assessment of water-related knowledge was limited to a few topics. Although the items we included do not represent the definitive content of water-related knowledge, members of the water sector identified them as important. While we focused on one aspect that determines the success of indigenous community participation, it's crucial to note that organizational characteristics like confidence in institutions (indigenous institutions) can also have an impact. Finally, because our study was cross-sectional, it was impossible to determine the causality of these connections. The impact of knowledge-building interventions on policy support and greater engagement should be evaluated in future studies.

IV. Conclusion

This study has analysed how respondents knowledge and attitude regarding water resource management (sacred springs) is being impacted by demographic, and socio-economic factors. Binary logistic regression model was used to assess willingness to participate in sacred springs conservation program. The results show that willingness to participate are being impacted most significantly by indigenous knowledge and method applied when water supply is limited. Because knowledge of water management issues informs attitudes, better awareness, and targeted extension support are required in the formation and execution of policy decisions

on indigenous water resource management, they must be developed and implemented. Although this study has underlined the need for targeted extension services and awareness, future education-based interventions must focus on specific policy decisions and indigenous groundwater management methods rather than just sharing knowledge and creating awareness to achieve water sustainability.

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