

Temporal Reliability of Willingness to Pay for Payments for Environmental Services: Lessons from Lombok, Indonesia

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Willingness to pay (WTP) for payments for environmental services (PES) can be temporarily reliable if contingent valuation (CV) studies are embedded in an accurate survey population, yield low measurement errors, and are based on a correct assumption of no change in sociodemographic factors affecting buyer preferences. These pre-conditions are assumed in PES schemes applying temporal reliability of WTP. This study tests these conditions in CV-PES studies from 2001, 2003, and 2011 in Lombok, Indonesia, by comparing them with a new CV-PES study in 2015. Our results show that the CV-PES studies would not meet the pre-conditions due to inclusion of non-PES buyers, potential measurement errors implied by a lack of validating information and high WTP estimate, and/or failure to test the condition of no change of socio-economic factors. Results contribute to identifying pragmatic challenges and lessons for applying temporal reliability of WTP to PES implementation.

Keywords: Temporarily reliable willingness to pay; temporal variance; buyer demand; payments for watershed services; stated-preference technique.

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1. Introduction

A payment for environmental services (PES) scheme is a market-based mechanism that facilitates the trade of environmental services between service users (or buyers) and providers (or sellers) (Wunder 2015). Increasingly applied to the management of environmental services, PES schemes are considered as an alternative to command-and-control approaches and integrated conservation and development programs (Wunder 2015; Ezzine-de-Blas et al. 2016). In theory, a defining feature of PES is “conditionality” (Sommerville et al. 2009; Wunder 2015), meaning that sellers should not receive payments unless promised services are delivered. Conversely, buyers would not pay for services until satisfied. Thus, conditionality ensures cost efficiency in PES schemes (Ezzine-de-Blas et al. 2016). Based on these principles, quantification of environmental services and estimation of buyer preferences are prerequisites of cost-efficient PES schemes.

The contingent valuation (CV) method has been applied to market studies of PES schemes for the purpose of estimating potential buyers’ willingness to pay (WTP) for environmental services, such as protection of upstream watersheds to improve water quality and reduce risk of flood in downstream (Whittington and Pagiola 2012). CV is a stated-preference technique¹ developed to elicit respondents’ WTP for public goods (Mitchell and Carson 1989; Bateman et al. 2002; Haab and McConnell 2002). Because most environmental services are public goods with no explicit price information (Costanza et al. 2014), policy-makers and practitioners need to depend on the CV method to elicit service buyers’ demand for environmental services, conduct cost–benefit analysis, and politically rationalize PES schemes in case buyers have sufficient WTP for services (Whittington and Pagiola 2012). Thus, CV method has been a key tool in PES development.

Many empirical CV studies demonstrate that WTP estimates do not change over time; in other words, these estimates are temporarily reliable (e.g., Loomis 1989 1990; Kealy et al. 1990; Reiling et al. 1990; Carson et al. 1997; McConnell et al. 1998; Whitehead and Hoban 1999; Brouwer 2006; Bliem and Getzner 2012). To ensure the validity of this temporal reliability, however, not only should initial CV studies be robust — with an accurate sampling population and low measurement errors — but also there should be no change of socio-demographic factors affecting the relevant population’s preferences over time (Mitchell and Carson 1989; Kealy et al. 1990; Reiling et al. 1990) (Fig. 1(a)). Consequently, pre-conditions for applying temporal reliability of CV results in PES schemes

¹In addition to CV, there are other stated-preference techniques increasingly applied to PES development, such as choice experiments (Hensher 2014). However, these techniques are beyond the scope of this paper so it only focusses on temporal reliability of CV methods.

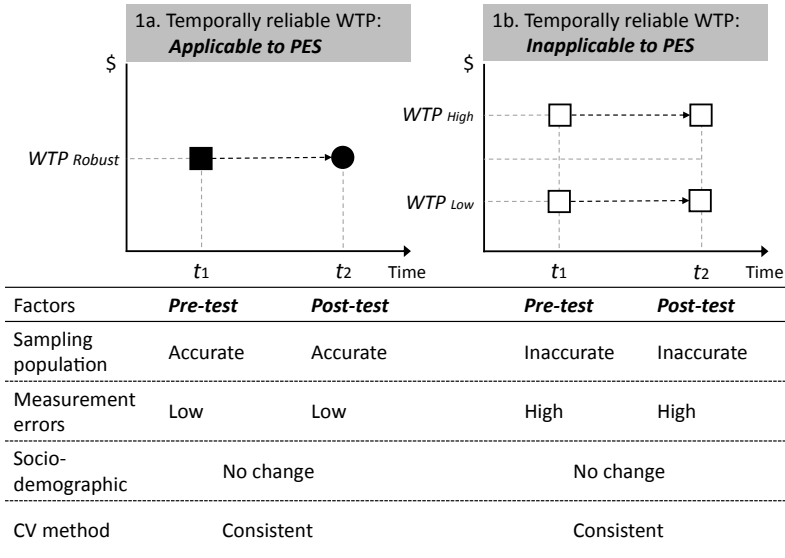


Figure 1. Factors Affecting Temporal Reliability of Willingness to Pay (WTP) Estimates in Payments for Environmental Services (PES) Schemes

include (1) an accurate sampling population, (2) low measurement errors, and (3) no change of socio-demographic factors. Without these conditions, the application may yield biased results, which could hamper the efficiency and effectiveness of PES schemes over time. Once these conditions are met, we can test temporarily reliable CV results by employing consistent CV methods in pre- and post-tests (Kealy *et al.* 1990; Reiling *et al.* 1990) (Fig. 1(a)). For instance, CV methods may be either “open-ended,” in which participants are asked to state their maximum WTP, or “referendum,” in which they are asked to vote yes or no on a pre-determined price (Bateman *et al.* 2002).

In practice, many PES schemes rely on a single CV study conducted in an early stage of PES development (Whittington and Pagiola 2012) but with limited attention to the pre-conditions for temporarily reliable WTP. These conditions might be absent in PES implementation due to administrative and institutional complexities that result in changes of stakeholders over time, or failure of CV-PES studies to report validating information (Whittington and Pagiola 2012). Additionally, CV application could be overly technical and complex to PES practitioners as it requires various efforts to minimize measurement errors, such as a CV method selection (e.g., open-ended versus referendum) and design of a credible payment vehicle (e.g., Arrow *et al.* 1993; Carson 2000; Bateman *et al.* 2002; Whittington and Pagiola 2012). In the literature, however, most CV studies testing

temporal reliability of WTP assume that the above-mentioned pre-conditions are common sense, paying little attention to whether they are in fact applicable in PES implementation.

This study examines the applicability of these pre-conditions for temporarily reliable WTP in PES implementation by re-estimating WTP for a PES scheme in 2015 and comparing its results with the previous CV studies in 2001, 2003, and 2011 in real WTP estimates in Lombok, Indonesia. The comparison cannot test the property of temporarily reliable CV-PES results as these studies employed different CV methods. However, it not only allows testing the pre-conditions in the previous CV-PES studies using the up-to-date 2015 study as a criterion, but also indicates whether it would be proper to apply the previous CV-PES results over time in the PES scheme. Thus, the study contributes to analyzing a gap between empirical studies and applications of temporal reliability of CV results and provides lessons for the proper application of CV methods in PES schemes.

2. Literature Review

Numerous studies address temporal reliability of CV results. In some ways, many studies share common features, such as testing and retesting WTP at two periods in time, using the same CV methods (e.g., open-ended or dichotomous choice) in both pre- and post-tests, and sampling the same population in these tests. Mostly conducted in high-income countries, such studies employ certain validation checks (e.g., a positive relationship between respondents' WTP and incomes). On the other hand, studies vary quite widely and analyze different perspectives on temporal reliability of WTP, such as looking at different time frames (e.g., from two weeks to five years); using identical or different samples from a population (Whitehead and Hoban 1999; Metcalfe and Baker 2015); examining different goods and services (e.g., from chocolate bars to ecosystem services); and employing various methodological approaches (e.g., testing an open-ended approach only or multiple approaches together). Moreover, some studies have control groups, other not (e.g., Teisl et al. 1995); nominal or real values of WTP are used for comparison (e.g., Teisl et al. 1995; Brouwer and Bateman 2005); and major influential events sometimes occur between pre- and post-tests (e.g., Reiling et al. 1990; Metcalfe and Baker 2015).

Most literature, much of it from the USA, supports the temporal reliability of WTP. In Alaska, for example, Carson et al. (1997) confirm the temporal reliability of residents' WTP for prevention of oil spills between 1991 and 1993. The study uses a dichotomous-choice CV method and different samples for the test and retest. In California, Loomis (1989) demonstrates temporarily stable WTP for protection

of Mono Lake as a bird habitat by surveying households and visitors to the lake. The study is based on a nine-month time gap from 1986 to 1987 and an open-ended CV method. Based on the same test settings, [Loomis \(1990\)](#) confirms temporal reliability of WTP from both referendum and open-ended methods. In New York State, [Kealy et al. \(1990\)](#) demonstrate that WTP for chocolate bars and a deacidification program for lakes were temporarily reliable, and there was no difference in the degree of temporal reliability of WTP between these private and public goods. The study uses a two-week time gap, a referendum method, and identical samples. In Maine, [Reiling et al. \(1990\)](#) demonstrate temporarily stable WTP for black fly control before and after the peak season of black flies in 1989. The study employs an open-ended method and different samples. By surveying Atlantic Coast anglers from New York to Florida, [McConnell et al. \(1998\)](#) identify temporarily reliable willingness to accept compensation to give up fishing activities along the east coast. The study is based on a two-month time gap in 1989, a referendum approach, and different samples. Other studies were conducted in Europe. In the Netherlands, for instance, [Brouwer \(2006\)](#) identifies temporarily reliable WTP for improvement of bathing water quality between 2002 and 2003. The study uses a referendum approach and different samples. In Austria, [Bliem and Getzner \(2012\)](#) confirm temporarily reliable WTP for restoration of rivers in the Danube National Park between 2007 and 2008. The study uses different samples and a payment card approach that is designed to estimate upper and lower bounds in WTP.

Only a few studies indicate a decrease in WTP over time. In East Anglia, UK, [Brouwer and Bateman \(2005\)](#) find a decrease in real WTP for preventing floods between 1991 and 1996. The study is based on a referendum approach and different samples. Also in the UK, [Metcalf and Baker \(2015\)](#) analyze temporal variance of households' WTP for improvement of water quality and watershed services before and after an announcement of economic recession by the government. Through a payment card approach, they identify a decrease in WTP, whereas referendum-based results indicate temporal reliability of WTP. In North Carolina, USA, [Whitehead and Hoban \(1999\)](#) discover changed buyer preferences and decreased real WTP for public programs to improve air and water quality between 1990 and 1995. However, through a comparison based on real values of WTP and different samples from a population, the study confirms temporarily reliable WTP based on adjusted buyer preferences.

Despite the large volume of studies, no study has examined temporal reliability of WTP in the context of PES implementation. Unlike the studies mentioned earlier, CV-PES studies are largely conducted in low-income countries and address specific challenges in PES implementation, such as institutional uncertainty ([Whittington and Pagiola 2012](#)). However, many PES schemes implicitly assume

temporal reliability of WTP and rely on a single CV study. Therefore, it is critical to test temporal reliability of WTP in the context of PES schemes and to analyze its feasibility as used in CV-PES analyses.

3. Methods

3.1. Study site

The study site is located in West Lombok, Indonesia, where a PES scheme has been implemented since 2010 (Fig. 2). The West Lombok PES is well known and the subject of many studies (e.g., Markum and Mukhtar 2005; Prasetyo et al. 2009; Pirard 2012; Fauzi and Anna 2013; Pirard et al. 2014; WWF 2014; Jaung et al. 2016; Diswandi 2017). The scheme aims to support upstream communities and protect their forests. The watershed in the forests provides water to a local water company (Perusahaan Daerah Air Minum, or PDAM) who supplies piped water to the residents in the districts of West Lombok and Mataram City (Diswandi 2017). Due to deforestation, 43% of the main springs disappeared between 1992 and 2002 (Pirard 2012). Since then, development of the PES scheme was initiated by non-governmental organizations, such as KONSEPSI (Markum and Mukhtar 2005).



Figure 2. Study Site, Lombok, Indonesia

A number of CV studies have been conducted on the scheme (e.g., Afifah *et al.* 2013; WWF 2014; Yakin 2005), allowing comparison of results over time.

The West Lombok PES scheme has three major stakeholder groups: buyers, intermediaries, and sellers. *Buyers* are PDAM water users in West Lombok and the Mataram municipal government. PES fees have been charged to PDAM users in West Lombok since 2009: household buyers pay Rp. 1,000 per month (or USD 0.07), and business buyers pay Rp. 2,000 per month (WWF 2014). As of 2015, there were approximately 35,000 households using PDAM water users in West Lombok (or 8% of the total population). These fees are enforced by the local PES regulation and charged to water bills of PDAM as a flat rate. PDAM collects the ecosystem service fees and delivers them to PES intermediaries. The Mataram government also has provided annual funding to the PES scheme on behalf of water users in Mataram city; nonetheless, these funds are not disbursed regularly and water users in Mataram city do not directly participate in the PES scheme (WWF 2014). *Intermediaries* belong to a multi-stakeholder institution (Institusi Multi Pihak or IMP) developed in 2007 for independent management of the PES scheme and funding. The members of IMP include local government agencies, PDAM Giri Menang, WWF-Nusa Tenggara, academics, and the IMP office. *Sellers* are upstream communities who manage forestland in the watershed. Eligible sellers submit a forest restoration proposal to the IMP and accepted proposals are funded by the IMP.

3.2. CV studies in Lombok

We identified three previous CV studies conducted for the PES scheme in Lombok (Table 1). The studies estimate WTP for protection of Rinjani mountain based on different sampling populations (e.g., West, East, and Central Lombok provinces or Mataram City), different water user groups (e.g., household versus business), and different PES stages (e.g., before or after 2009 when the PES payment started to be charged to water users).

In 2001, Yakin (2005) conducted a CV study to elicit Lombok residents' WTP for the protection of Rinjani Mountain. Because the study was conducted at the very early stage of the PES development, it analyzes various groups of water users in Lombok. The study surveyed 246 participants from Western, Central, and Eastern Lombok. Survey respondents consisted of households, businesses, governments, NGOs, religious leaders, and academics. Employing an open-ended CV survey, the study estimated that participants' mean WTP was Rp. 2,674 per month with a standard deviation of 4,060.19. From this result, the lower and upper bounds of 95% confidence intervals of this mean WTP can be calculated as Rp. 2,156 and

Table 1. Description of Contingent Valuation (CV) Studies for the Payment for Environmental Services in Lombok

References	Studied Non-Market			Participant Type	CV Method	Sample Size
	Study Year	Goods	Study Scope			
Yakin (2005)	2001	Protection of Mount Rinjani	West, East, and Central Lombok provinces	Households and businesses	Open-ended	236
A Rinjani economic valuation study (Fauzi et al. 2005; Prasetyo et al. 2009; Fauzi and Anna 2013; WWF 2014)	2003	Protection of Mount Rinjani for watershed services	Mataram City and West Lombok province	Households and businesses	NA	1,500
Afifah et al. (2013)	2011	Protection of Mount Rinjani to protect piped-water sources	A sub-village in West Lombok province	Households	Open-ended	117
Current study	2015	Protection of Mount Rinjani to protect piped-water sources	West Lombok province	Households	Dichotomous choice	594

Rp. 3,192. Through a regression model, the study also shows that incomes and education levels of participants positively affected WTP.

In 2003, an economic valuation study on the Rinjani watershed² was conducted by KONSEPSI (Fauzi and Anna 2013; WWF 2014). The study surveyed 1,500 PDAM users in Mataram City and West Lombok province (Fauzi *et al.* 2005) including both households-level and business-level users (Prasetyo *et al.* 2009). Based on an open-ended method, their WTP estimates for upstream forest conservation were between Rp. 500 and Rp. 5,000 (Fauzi and Anna 2013; WWF 2014). However, information was not available on whether these estimates were based on a mean or a median.

In 2011, Afifah *et al.* (2013) conducted a CV study in Kerandangan, a sub-village in West Lombok province. Using an open-ended method, they surveyed 117 households using PDAM. Their study shows that households were willing to pay Rp. 8,100 per month for the PES scheme. However, the study does not report confidence intervals — or a standard deviation — of the WTP estimate. Using a regression model, the study identifies the following factors positively affecting the household WTP: income, water consumption, perception of the importance of water conservation, male, and education.

3.3. Survey design and administration

We designed a dichotomous CV study using a referendum format in order to estimate households' WTP for the PES scheme in Lombok. Although the previous CV-PES studies in Lombok used an open-ended CV method, this study decided to employ the referendum CV method because it is not only theoretically consistent with the theories of welfare economics (Bateman *et al.* 2002) but also recommended by CV guidelines of the National Oceanic and Atmospheric Administration (NOAA) (Arrow *et al.* 1993); thus, the referendum method was considered to be more suitable for this study since one of its objectives was testing low measurement errors of the previous CV-PES studies, and it did not intend to test temporal reliability of these studies' results.

Before developing a CV questionnaire, a focus group discussion was conducted with members of an association of PES buyers in Lombok. The results of the focus group discussion were used for development of a bid range for the CV survey and

²Study information was gathered from several articles addressing about the study results since the original study and its reference were not available. Unfortunately, some information from these articles was inconsistent, such as the study year (2003 or 2004) and WTP estimates (Rp. 500–Rp. 5000 or Rp. 1000–Rp. 5000). In this case, we selected information that is either more cited or from key PES stakeholders in Lombok (e.g., the WWF).

questionnaires on respondents' perceptions and socio-economic conditions. The bid range included values of Rp. 1,000, 4,000, 7,000, 10,000, 13,000, and 16,000. The final CV questionnaire was printed out with a blank bid, and we randomly assigned a particular bid value to each survey using a dice (e.g., 1 for Rp. 1,000 and 6 for Rp. 16,000). The referendum CV question was designed as follows: "*West Lombok government plans to increase the current ecosystem service fee of the PES scheme from Rp. 1,000 to Rp. x per month and if this new fee will be applied in next month, would you agree or disagree with the new fee?*" When a selected bid is equal to the current PES fee (or Rp. 1,000), participants were asked: "*West Lombok government plans to charge Rp. 1,000 for an ecosystem service fee for the PES scheme next month. If you had a chance to vote on it, would you agree or disagree with this fee?*" Before the survey, each respondent received a brief presentation about a development history and main objectives of the current PES scheme. The CV survey consisted of three parts: the first part investigated respondents' water use experiences and environmental perceptions; the second part asked their WTP; and the last part asked their socio-economic conditions. The initial CV questionnaire was also pre-tested and revised in West Lombok.

In order to reduce measurement biases, the study made various efforts following CV guidelines (e.g., [Arrow et al. 1993](#); [Carson 2000](#); [Bateman et al. 2002](#); [Whittington and Pagiola 2012](#)). First, *sufficient training on CV* was provided to all the enumerators, including information on the risk of overestimation in CV studies. All enumerators could speak both Indonesian and Sasak, a local language in Lombok. Secondly, *a consent form* was provided to participants before the survey. Only those who agreed participated in the survey. The consent form informed them that their information would not be shared with a third party and that study results would be anonymized through statistical analysis. Thirdly, *a payment vehicle* was designed as the current PES fee charged on participants' water bills. When the PES fee was described, enumerators tried to use participants' own water bills so that participants would recognize the reality of the fee. Fourth, *visual aids* were used when the PES scheme was presented, and all participants received the presentation before the CV question (Fig. 3). Fifth, "*a cheap talk*" was employed. The enumerators informed participants that the study is conducted in collaboration with decision makers of the PES scheme, so that their responses would likely change their PES fees. Sixth, *acceptance of saying "no"* was emphasized by the enumerators before and during the CV questions. The enumerators emphasized that the main objective of this study is to know their true preferences, so that saying "no" would be acceptable as a response to the CV question. Seventh, *an emphasis on high-level bids* (e.g., bids > Rp. 10,000) was made by enumerators when participants said "yes" to high-level bids. Eighth, *debriefing questions* were asked

2 Payment for environmental services (PES) in Lombok

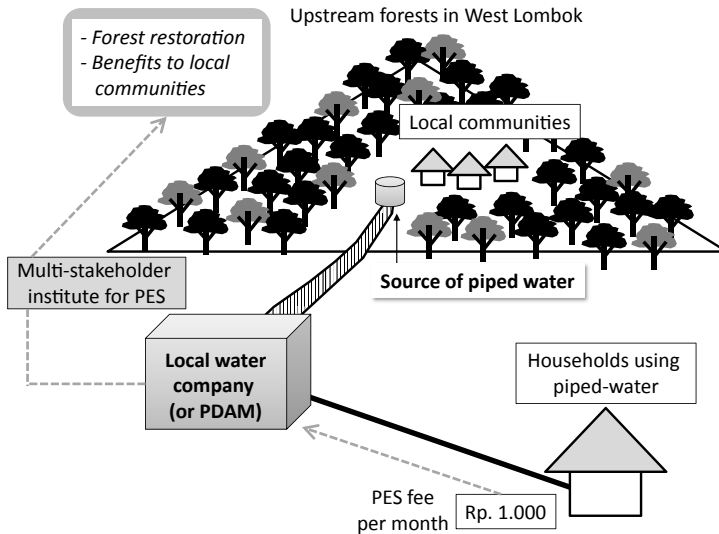


Figure 3. An Example of the Presentation Slides Used for the Contingent Valuation Survey in Lombok

to participants after the CV question to record their reasons for saying “yes” or “no.” Lastly, *a correlation between participants’ incomes and their WTP* was tested in the CV analysis. This correlation was demonstrated to be statistically significant by the CV model.

A total of 594 households were surveyed based on two-stage cluster random sampling from March to May 2015. Data on households participating in the PES scheme were collected from Mataram City and district offices of PDAM Giri Menang. The first random selection was based on sub-villages in West Lombok. The second random selection was based on households in selected sub-villages. As a result, the survey was conducted in 63 sub-villages (or *dusun*) and 44 villages (or *desa*) in West Lombok. Survey participants are described and compared with the previous CV studies in 2001 and 2011 in Table 2.

3.4. CV modeling

A log-logistic model was established to estimate participants’ mean WTP for the PES scheme and to examine factors affecting their WTP. A log-logistic model assumes non-negative WTP (Bateman *et al.* 2002), supporting our assumption that survey participants’ WTP for the PES scheme would not be lower than zero as they were already paying an ecosystem service fee for the scheme. We established a water user’s utility model by assuming that she would be willing to pay for the PES

Table 2. Descriptive Statistics of Survey Participants of the Contingent Valuation Studies in Lombok

Variable	2001 Study ^a		2011 Study ^b		2015 Study	
	Mean	Std.	Mean	Std.	Mean	Std.
Age (year)	39	9.78	—	—	37.41	11.57
Education (year)	11.52	4.49	—	—	9.58	4.43
Household members (no.)	3.43	2.38	—	—	4.42	1.50
Monthly nominal income (Rp.)	1,218,351	971,045	1,499,500	—	1,936,000	2,586,308
Monthly real income (Rp. in 2015)	3,663,360	971,045	1,882,200	—	1,936,000	2,586,308
Monthly real income (USD in 2015)	275	73	141	—	145	194
Monthly water bill (Rp.)	—	—	—	—	52,883	38,997
Female (1: yes, 0: no)	—	—	0.32	—	0.65	0.51
Urban resident (1: yes, 0: no)	—	—	—	—	0.25	0.43
Aware of a PES fee (1: yes, 0: no)	—	—	—	—	0.30	0.46
Well in house (1: yes, 0: no) ^c	—	—	—	—	0.34	0.47
PDAM shortage (1: low–5: high) ^d	—	—	—	—	1.86	0.98
Water conflict (1: low–5: high) ^e	—	—	—	—	1.60	1.07

Notes: ^aYakin (2005).

^bAfifah et al. (2013).

^cExistence of a well in a participant's house.

^dExperience with piped water (PDAM) shortage.

^ePerception on a degree of upstream water conflicts in Lombok.

scheme if a watershed service increases her utility (Carson and Hanemann 2005; Aizaki et al. 2014):

$$V(s_1, y_0 - t) + e_1 \geq V(s_0, y_0) + e_0, \quad (1)$$

where V is her indirect utility observable to researchers, s_1 indicates a service, s_0 indicates no service, t is a service fee (or a bid), y_0 is income before paying a bid, e_1 is an unobservable random utility with a service, and e_0 is an unobservable random utility without a service. Later, we specified the indirect utility model as:

$$V_j = \beta_{0j} + \beta_{1j}x_{\text{uni}} + \beta_{2j}x_{\text{well}} + \beta_{3j}x_{\text{shortage}} + \beta_{4j}x_{\text{conflict}} + \gamma_j y_j + e_j, \quad j = 1, 0, \quad (2)$$

where x_{uni} indicates whether a water user had a bachelor's degree or not, x_{well} indicates whether she has a well in a house or not, x_{shortage} indicates a frequency of her experience of PDAM water shortage, x_{conflict} indicates her perception on the degree of social conflicts in the upstream communities, and j indicates with (or 1) and without (or 0) a service (Table 3). The model was a best-performing model among all potential models. The selection criteria included AIC, BIC, pseudo- R^2 , and t -tests of variables of these models. A water user would say “yes” if:

$$\begin{aligned} V_1 - V_0 &\geq 0, \\ [B_1 + \gamma_1(y_0 - t) + e_1] - [B_0 + \gamma_0 y_0 + e_0] &\geq 0, \\ (B_1 - B_0) - r_1 t + (e_1 - e_0) &\geq 0, \end{aligned} \quad (3)$$

Table 3. Description of Variables Used in the 2015 Contingent Valuation (CV) Study in Lombok

Variable	Description
Income	Monthly household income (Rp.)
Univ	Bachelor's degree or above (1: yes, 0: no)
Well in house	Existence of a well in a house (1: yes, 0: no)
PDAM shortage	Experience of piped water shortage (1: low–5: high)
Water conflict	Perception on the degree of upstream water conflicts (1: low–5: high)
Bid	CV bids (Rp. 1,000, 4,000, 7,000, 10,000, 13,000, and 16,000)

where B_j indicates vectors of variables from β_0 to β_4 . If $(e_1 - e_0)$ is distributed as log-logistic random, a probability of receiving a response of “yes” with bid t becomes:

$$\text{Prob}(\text{yes}) = \frac{1}{\exp[-(B_1 - B_0) + \gamma_1 \ln(t)]}. \quad (4)$$

The study also assumed that participants could not pay more than their incomes for the PES scheme so the WTP distribution was truncated at the level of participants' incomes (Bateman *et al.* 2002; Aizaki *et al.* 2014). About 95% confidence intervals of mean WTP were estimated by the Krinsky–Robb method (Krinsky and Robb 1986) with 1,000 simulations. Statistical computations were conducted by R 3.2.3 with support of DCchoice package (Aizaki *et al.* 2014; Nakatani *et al.* 2015).

3.5. Calculation of real WTP

In order to compare CV-PES results in different years, real WTP was calculated based on their real values in 2015. The calculations were based on inflation rates in Indonesia from 2001 (201%), 2003 (126%), and 2011 (26%) to 2015. Inflation rates were obtained from the World Bank Open Data³ on the consumer price index in Indonesia.

4. Results

4.1. CV modeling

The selected CV model had high goodness of fit, supported by 0.43 of pseudo- R^2 (Table 4). The variables of income, well in house, water conflict, and bid were significant at the 5% level after t -tests. The variables of Univ. and PDAM shortage were significant at the 10% level. Participant's responses to the CV question were positively related to income, education level, and experience of water shortage

³World Bank Open Data (12 July 2016). Retrieved from <http://data.worldbank.org/>.

Table 4. Contingent Valuation Model from the 2015 Study

Variable	Model (<i>n</i> = 594)	
	Coeff.	Std. Error
Intercept	17.859***	1.618
Income	0.093**	0.043
Univ.	0.652*	0.368
PDAM shortage	0.246*	0.129
Well in house	−0.654**	0.283
Water conflict	−0.327**	0.140
log(Bid)	−2.196***	0.186
Pseudo- <i>R</i> ²	0.43	
LL	−204.209	
AIC	422.418	
BIC	453.126	

Note: *, **, and *** are significant at the 10%, 5%, and 1% significance level, respectively.

from piped water (or PDAM). The positive coefficient of the income variable supports the robustness of the CV model as it indicates that participants’ responses were in logical and not random (Bateman et al. 2002). The positive coefficient of the variable of water shortage experience (or PDAM shortage) indicates that those experienced with water shortage were more supportive of the scheme. On the other hand, participants’ responses were negatively related to their ownership of a house well (or Well in house), their perceptions of the degree of water-related conflict in the upstream (or Water conflict), and the degree of the PES fee (or log(Bid)). The negative coefficient of the water conflict variable implies that respondents considering a high degree of upstream water conflict might have doubts as to the effectiveness of the PES scheme, making them less supportive of the scheme. The negative coefficient of the well-in-house variable shows that those having alternative water sources are also less supportive of the scheme.

The study recorded respondents’ reasons for their responses to CV questions (Table 5). The dominant reasons to say “no” included that the amount of the bid was too expensive and that there is a lack of transparency in the use of PES

Table 5. Participants’ Reasons for YES and NO to Contingent Valuation Bids in the 2015 Study

Reasons for NO	Reasons for YES
• Too expensive • Lack of transparency in PES fee use • Lack of transparency in PES impacts	• To protect upstream forests • To protect water sources • To support upstream communities • Affordable

Table 6. Comparison of WTP Estimates from Four Contingent Valuation Studies in Lombok

Study Year	Nominal Value (Rp.)		Real Value in 2015 (Rp.)	
	Mean	CI ^a	Mean	CI
2001	2,674	2,156–3,192	8,040	6,483–9,598
2003	2,750 ^b	500–5,000	6,219	1,131–11,308
2011	8,100	NA	10,167	NA
2015	4,439	3,981–4,924	4,439	3,981–4,924

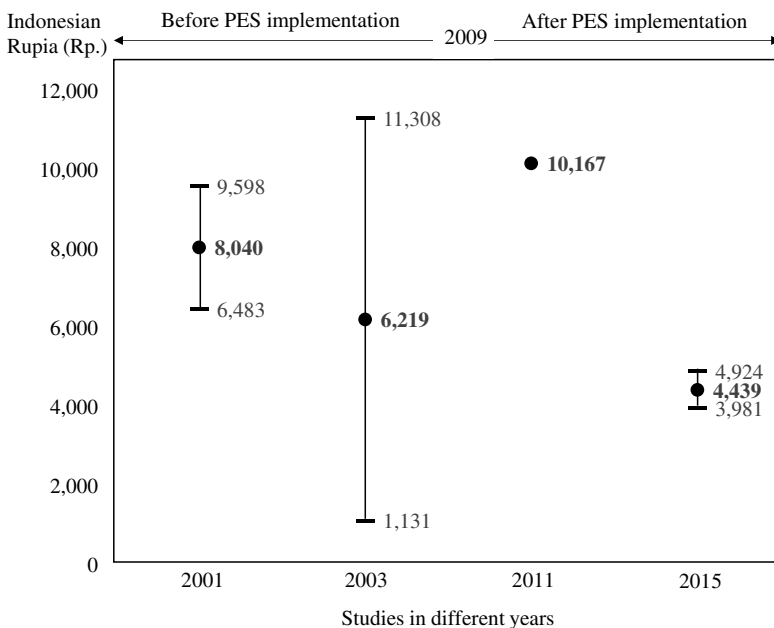
Note: ^aCI, confidence interval.

^bAveraged confidence intervals.

funding and its effectiveness. The dominant reasons to say “yes” were that participants preferred to protect upstream forests and water sources; participants preferred supporting upstream communities; and the bid was affordable.

4.2. Comparison of real WTP

The mean WTP of the 2015 study was compared to WTP estimates from the previous CV studies conducted in 2001, 2003, and 2011 (Table 6). The WTP estimates were compared as real values in 2015 (Fig. 4). The comparison

**Figure 4.** Comparison of Real Values of WTP from the CV-PES Studies in Lombok over Time

demonstrated variance among the real WTP estimates. The 2001 WTP estimate featured the widest intervals (Rp. 1,131 to Rp. 11,308). The 2011 WTP estimate featured the highest value (or Rp. 10,167). The 2015 WTP estimate featured the lowest value (Rp. 4,439) and the narrowest confidence intervals (Rp 3,981 to Rp. 4,924). There was also a significant difference between the 2001 and the 2015 WTP estimates: the 2015 WTP estimate (Rp. 4,439) was significantly lower than the 2001 WTP estimate (Rp. 8,040).

The studies had both common and different findings on factors affecting respondent preferences for watershed protection in the upstream. The studies in 2001, 2011, and 2015 demonstrate that respondents' income and education were positively related to their preferences. In contrast, gender (male = 1) and water consumption level positively affected respondent preferences only in the 2001 study; meanwhile, gender (female = 1) and monthly water bills (related to a water consumption level) did not play significant roles in the 2015 CV study, so these variables were excluded from the study. Gender (female = 1) also did not significantly affect respondent preferences in the 2001 study.

5. Discussion

Study results imply that the pre-conditions for temporarily reliable WTP were absent in the past CV-PES studies in Lombok. Their real WTP estimates varied compared with the 2015 study result that satisfied the pre-conditions (Fig. 4), likely as a result of the differences in sampling populations (i.e., inclusion of PES site versus non-PES site), water user groups (i.e., household versus business), stages of PES implementation (i.e., before or after PES payment), and CV methods (i.e., referendum versus open-ended). Consequently, although these studies made valuable contributions to the development of the Lombok PES scheme, their results currently would not meet the pre-conditions for several reasons: the 2001 study included non-PES buyers; the 2003 study included non-PES buyers and indicated potential measurement errors from a broad range of confidence intervals; and the 2011 study indicated potential measurement errors from the high WTP estimate (Table 7). These results imply challenges of properly applying temporal reliability of WTP for PES schemes owing to: (1) the changing scope of PES schemes over time, (2) limited validation information on WTP estimates, and (3) various CV methods applicable to PES schemes.

The changing scope of PES schemes over time is a challenge to the proper application of temporal reliability of WTP in PES schemes. For the proper application, CV results should be able to represent preferences of the current buyers. However, scope of buyers is changeable during PES development as buyer

Table 7. Evaluation of the Pre-Conditions for Temporally Reliable WTP from Previous CV-PES Studies in Lombok

	Pre-Conditions	2001 Study	2003 Study	2011 Study
1	Accurate survey populations	Not met (included non-PES buyers)	Not met (included non-PES buyers)	Met (only PES buyers but with narrow scope)
2	Low measurement errors	Met (sufficient survey information)	Not met (broad confidence intervals)	Not met (high WTP estimate)
3	No change of socio-demographic factors	Not applicable (due to non-PES buyers)	Not applicable (due to non-PES buyers)	Partially met (no significant difference in incomes)
	Temporarily reliable WTP for the current PES scheme	Not reliable	Not reliable	Not reliable

participation is subject to multiple-party negotiations and political processes among various stakeholders of ecosystem services. In 2001, for example, the scope of PES buyers in Lombok was not defined so that water users from all of Lombok were potential buyers (e.g., [Yakin 2005](#)). From 2003 to 2007, the scope of PES buyers was narrowed down to water users in Mataram City and West Lombok province in Lombok, when the PES scheme was in its early development stage ([Pirard 2012](#); [Fauzi and Anna 2013](#); [WWF 2014](#)). After PES fees were enforced in 2009, however, only water users in West Lombok province participated in the scheme ([WWF 2014](#)). This history of PES development in Lombok demonstrates the possibility of a change in buyer scope and, in turn, the limitation of a CV study conducted in the early project stage to reflect preferences of buyers in the later stage. In this case, moreover, it is hard to test no change of socio-demographic factors of the buyers over time since the buyer scope changed.

Limited validation information on WTP estimates makes it difficult to verify the low measurement errors of CV-PES studies. Although measurement of true buyer WTP might never be feasible, various indicators can be employed to validate the design and results of CV, such as use of a concrete payment vehicle and cheap-talk scripts, sampling the current buyers in the market, provision of adequate and sufficient information to respondents, and a test of a correlation between incomes and WTP ([Arrow et al. 1993](#); [Carson 2000](#); [Bateman et al. 2002](#); [Whittington and Pagiola 2012](#)). Unfortunately, such information is not available in many CV-PES studies ([Whittington and Pagiola 2012](#)), making it difficult to determine whether their WTP estimates would be applicable over time or not.

The diversity of CV methods available to PES schemes is an obstacle to testing temporarily reliable WTP in PES schemes. This is not problematic for academically designed tests of CV since both pre- and post-tests are consistently administered by researchers. However, CV-PES studies are often conducted by various third-party agencies, such as consulting companies, NGOs, and academics (e.g., Whittington and Pagiola 2012), and these agencies could change over time. Furthermore, CV is only a part of stated-preference techniques, and lately the choice experiment has become another popular technique (e.g., Hensher 2014), which further expands the range of tools to measure buyer preference. Thus, there is a high chance that PES schemes would end up employing different stated-preference techniques over time, particularly when different agencies conduct these studies.

This study contributes to the literature by identifying a gap between empirical studies and on-the-ground application of temporarily reliable WTP and by providing lessons for improving such application. For example, the study results provide the following questions that serve as indicators for the existence of the pre-conditions for temporarily reliable WTP in PES schemes (e.g., Fig. 1). A “yes” answer to any of these questions would indicate a potential challenge of meeting the pre-conditions.

Indicator 1: *“Were there any changes in scope of PES buyers between previous and post CV-PES studies?”* If their scope changed, a WTP estimate from a previous study would not be valid to test temporal reliability of WTP in PES schemes as this study obtains bias from non-PES buyers.

Indicator 2: *“Do previous and post CV-PES studies involve high measurement errors?”* Any CV-PES results with high measurement errors would result in biased WTP estimates. These estimates are inapplicable to PES schemes over time. Moreover, all CV-PES studies need proper validation strategies, and these strategies should be reported (Carson 2000; Whittington and Pagiola 2012) as such information helps to validate low measurement errors in CV-PES studies.

Indicator 3a: *“Have socio-demographic factors of PES buyers changed since a previous CV-PES study?”* If these factors have changed, buyer preferences for a PES scheme might have changed as well. Because of this possibility, it is necessary for all CV-PES studies to demonstrate socio-demographic characteristics of PES buyers, including means and standard deviations, so that a future CV-PES study can test any changes in their characteristics.

Indicator 3b: *“Have PES buyer preferences for a PES scheme changed since a previous CV-PES study?”* This change could be directly examined as well. For instance, a CV-PES study could ask buyers about the importance of a PES scheme in a Likert scale (i.e., 0: no importance and 10: maximal importance) considering their current incomes (e.g., USD \$10,000 per year). Their responses can be used

for directly testing a change in their preferences for a PES scheme over time by a future CV-PES study.

Indicator 4: “Do previous and post CV-PES studies employ different CV methods?” If they use different methods, a robust comparison of their results would be challenging. Thus, a test of temporal reliability of WTP in PES schemes would require an additional study that employs a CV method consistent with either a previous or post CV-PES study.

In addition, this study contributes to evaluating a robust WTP estimate for the PES scheme in Lombok and a future test of temporarily reliable WTP. The 2015 WTP estimate indicates up-to-date preferences of household-level water users participating in the PES scheme. If the buyers do not change, the 2015 study would support testing temporarily reliable WTP in the PES context as a previous CV-PES study.

Finally, the authors recognize the limitations of this study. First, the study is limited to testing temporal reliability of WTP estimates of the previous CV-PES studies in Lombok due to different CV methods and different sampling populations, even though the study identifies that these previous studies do not meet the pre-conditions for temporarily reliable WTP. Secondly, the study employs only one CV method — or a single-bounded dichotomous referendum method — among various stated-preference techniques. For example, even a dichotomous method can be designed as either single-bounded or double-bounded (Bateman *et al.* 2002; Aizaki *et al.* 2014). A choice experiment would be another robust method to measure buyer preferences. Thus, future studies need to analyze whether other stated-preference techniques would support the pre-conditions for temporarily reliable WTP better in PES implementation. Thirdly, the study only examines household buyers, although business buyers are also within the scope of the PES scheme (WWF 2014). The current ecosystem services fee for business buyers (Rp. 2,000) is higher than the household fee (Rp. 1,000), so it is important to test whether the current fee for the businesses reflects their preferences. All of these limitations imply the need for future studies on analysis of the pre-conditions for temporarily reliable WTP in PES schemes, including the Lombok scheme.

6. Conclusions

This study examines pre-conditions for temporal variance of WTP in CV-PES studies by comparing real WTP estimates from four CV-PES studies conducted in 2001, 2003, 2011, and 2015, in Lombok, Indonesia. These pre-conditions include an accurate sampling population, low measurement errors, and no change of socio-demographic factors. The study results imply that these conditions would have been absent in the previous CV-PES studies owing to inclusion of non-PES buyers,

potential measurement errors implied by a lack of validating information and high WTP estimate, and/or the limitation of testing no change of socio-economic factors. These results contribute to the CV literature by providing implications for improving application of temporarily reliable WTP to PES schemes, estimating a robust WTP for the PES scheme in Lombok, as well as supporting a test of temporarily reliable WTP in the scheme.

Furthermore, there is the need for future studies. Although many academic studies confirm temporarily reliable WTP, these studies mostly focus on high-income countries, whereas the majority of CV-PES studies take place in low-income countries. These academic CV studies are limited in addressing the administrative complexity embedded in PES implementation. Therefore, it is important to test temporal reliability of WTP in the context of PES implementation in order to analyze gaps between academic analysis and pragmatic application of CV results in PES schemes. These gaps must be considered in designing a test of reliable WTP estimates over time in PES schemes.

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