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Household's Willingness to Pay for Watershed Protection Services in Langat Basin, Selangor Using Contingent Valuation Method

Kesanggupan Membayar oleh Isi Rumah bagi Fungsi Perlindungan Kawasan Tadahan Air di Lembangan Langat, Selangor dengan Menggunakan Kaedah Penilaian Kontingen

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ABSTRACT

The significance of having a payment scheme for ecosystem services (PES) for the purpose of watershed protection in order to develop a sustainable forest management is globally recognised. PES is an advanced financial tool to foster a platform for generating a source of income from ecosystem service users to ecosystem providers. More importantly, the involvement of households is vital for the successful implementation of PES programmes. Thus, this study aims to examine the willingness to pay for watershed protection services among households in the Langat Basin. Households around upstream, middle-stream and downstream segments of the Langat Basin were selected randomly to be studied and involved in face-to-face interviews. The Probit and Logit models in Contingent Valuation Method (CVM) were employed to assess household's WTP towards watershed protection efforts of the Langat Basin. The mean for WTP of Upstream household is RM30.01 while middle-stream household's WTP is RM33.07 compared to that of the downstream household, which is RM32.41. The households' WTP shows an increasing trend from upstream to downstream households. These results offer a new insight and discernment between PES programmes and households' WTP so as to develop a sustainable management for water-based ecosystem services.

Keywords: Mechanism; environment; ecosystem; valuation; watershed; household

ABSTRAK

Kepentingan mempunyai skim bayaran (PES) bagi fungsi perlindungan kawasan tadahan air untuk pembangunan pengurusan hutan secara mapan diiktiraf secara global. PES merupakan alat kewangan yang terkehadapan bagi untuk memupuk platform untuk menjana sumber pendapatan daripada pengguna perkhidmatan ekosistem kepada ekosistem pembekal. Lebih penting lagi, penglibatan isi rumah adalah penting untuk kejayaan pelaksanaan program PES. Oleh itu, kajian ini bertujuan untuk mengkaji kesanggupan membayar untuk perkhidmatan perlindungan kawasan tadahan air dalam kalangan isi rumah di Lembangan Langat. Isi rumah sekitar huluan, pertengahan dan hiliran di Lembangan Langat telah dipilih secara rawak untuk dikaji dan terlibat dalam temu bual bersemuka. Model Probit dan Logit dalam Kontinjen Kaedah Penilaian (CVM) telah digunakan untuk menilai WTP isi rumah ke arah usaha-usaha perlindungan kawasan tadahan air di Lembangan Langat. Min WTP isi rumah di bahagian huluan ialah RM30.01 manakala WTP isi rumah di bahagian pertengahan adalah RM33.07 berbanding dengan isi rumah di bahagian hiliran, iaitu RM32.41. WTP isi rumah menunjukkan trend yang meningkat dari bahagian hulu ke hiliran. Keputusan ini menawarkan wawasan baru dan pengertian antara program PES dan WTP isi rumah bagi membangunkan pengurusan mampan bagi perkhidmatan ekosistem berasaskan air.

Kata kunci: Mekanisme; alam sekitar; ekosistem; penilaian; tadahan air; isi rumah

INTRODUCTION

In developing countries, forests play a crucial function in the well-being of humans and other living organism (Langat & Cheboiwo 2010). With rapid globalization and vast population, significant interest is being showed in forest ecosystem services (ES) in order to provide sufficient benefits for one's livelihood. Over the past 25 years, actions taken to protect forests and ecosystems have increased, as acknowledged by FAO's Global Forest Resources Assessment (Vincent 2016). The engagement between ES and policy makers focuses on social involvement and implementation of market-based tools (Verburg et al. 2016). Inconsistency in providing forested watershed services may lead to imbalance in human life and negative impact to the environment. The big four environmental services are watershed protection, landscape beauty, carbon sequestration and biodiversity conservation. Among these environmental services, water services have been receiving increased attention in relation to human and ecosystem well-being (Brauman et al. 2007; Seckler et al. 1998). Forested watershed protection function ensures constant water supply services to households as well as global access to fresh water for domestic, agricultural, industrial and ecological needs. Apart from production of logging, public responsiveness towards forest ecosystem continues to increase as well with evidence of protective efforts for conserving forests worldwide (Miura et al. 2015). Therefore, payment for ecosystem services (PES) has been introduced as an innovative tool to develop a sustainable management of forest resources. Payments for Ecosystem Services (PES) have been developed with a widely used conservation instrument to serve this purpose. However, pertinent assessment alongside other direct conservation strategies remain disjointed (Curran et al. 2016). It is also known as the most efficient environmental tool which combats hasty decision-making on ecosystem services that lead to sustainable forest management. However, PES is still at its initial stage in Malaysia. Literature has shown that ample amount of WTP studies has been carried out on ecosystem services. For instance, water services, biodiversity conservation, recreational service and studies on medicinal plants. Besides that, very little research has been conducted on the payment system for watershed protection services and ways to measure various households' WTP globally. The objective of this study is to estimate and examine the willingness to pay (WTP) among households in terms of forested ecosystem services such as payment for water supply. The information can aid towards developing a sustainable management of water supply as well as overcoming scarcity of natural resources.

METHODOLOGY

THE LANGAT BASIN WATER CATCHMENT AREA

The Langat Basin study area (Figure 1) converged in the Gunung Nuang in the Hulu Langat district of Selangor and stream into bordering states of Negeri Sembilan and the Federal Territory of Putrajaya. The Langat Basin has been recorded as a macro-size basin with a total area of 2938 km^2 and the river has a mainstream length of 200 km and ends in the Straits of Malacca. Langat River Basin is a convergence spot for three major tributaries such as Langat River, Semenyih River and Labu River. Furthermore, the basin can be distributed into three distinct zones (Elfithri et al. 2002). The first zone is a mountainous zone, followed by a hilly area and a zone which is also known as flat alluvial plane. Langat Basin is a substantial water catchment area supplying raw water resources and other amenities to relatively 1.2 million people within the basin's surrounding areas. Crucial municipalities that the Langat Basin provides for include towns such as Cheras, Kajang, Bangi and Putrajaya, among others. Apart from its water supply function, the Langat Basin is also a prominent reservoir for recreation, fishing, effluent discharge, irrigation and even sand mining.

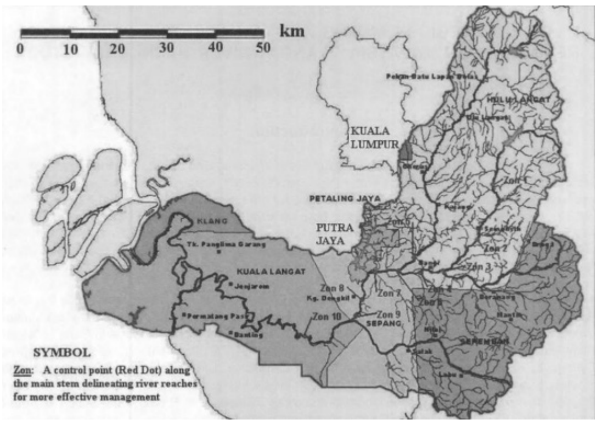

FIGURE 1. The Langat Basin

METHOD OF STUDY

The CV method has been the preferred approach and is most widely used to assess the value of use and non-use goods. This CV method has been widely employed in various research endeavours such as studies on renewable energy (Lee & Heo 2016), air pollution and smog mitigation (Sun et al. 2016) and wetland conservation efforts (Siew et al. 2015). The previous WTP estimation researches for watershed protection services found that there are two types of approaches employed: conjoint analysis and CV method. Researchers measure additional amount from consumers with regard to watershed protection services. However, Contingent Valuation Method has been used to measure WTP of households towards the protection of watershed services of Langat Basin because it has been frequently used as the preferred technique in economic valuation studies when dealing with non-marketable environmental goods. Some studies conducted in Malaysia have analysed WTP for recreational and eco-tourism services using CVM such as in the case of Manukan Island with a WTP of RM5.02 per person (Radam & Abu Mansor 2005) and Damai Beach with a WTP of RM11.75-RM15.10 per person, (Radam et al. 2002), Damai recreational site with a WTP of RM11.64 per person, and Bako National Park with a WTP of RM7.77 per person (Mohd Shahwahid 2008). Freeman (2003) found that use and existence values of environmental goods could be measured through surveys. The CV approach has an advantage of encouraging the calculation of the Hicksian demand, surplus fairness and payment via outcomes from a survey instead of a demand function (Lee 2016). CV empirical studies employ single bounded, double bounded and multiple bounded models. For the purpose of this study, single bounded questions were used because it was more convenient to be applied in data collection especially. Single bounded modelling introduced because it's easy to deal with the respondents (Haneman et al. 1991). The willingness to pay estimates for environmental conservation and management of Moo Koh Similan Islands marine parks, Thailand has been calculated using CVM method (Tapsuwan 2005) and willingness to pay of domestic water users Tuguegarao City for watershed protection services (Amponin et al. 2007). The CVM questionnaire was prepared with 540 survey forms distributed and face-to-face interviews were conducted using a random sampling technique which involved residents aged 18 and above in the state of Selangor. Face to face approach applied due to the determined advantages primarily to measure complex range of ecosystem services (Verbič & Slabe-Erker 2008). Mechanism to watershed protection service include investments by trust funds and direct payment to service provider (Brauman et al. 2007).

The payment vehicle used in this study was a one-time lump sum contribution to a trust fund designed for a PES project. The questionnaire was pre-tested to examine understanding of questions and design of bid amount before the main survey was conducted. The bid was designed as 5MYR, 10MYR, 15MYR, 20MYR, 25MYR and 30MYR. The Probit and Logit models' results were generally similar with a slight difference in distribution of errors. This process of conducting a CVM study and face-to-face interviews was followed by an NOAA panel data (Arrow et al. 1993).

Derivation of Watershed Protection Payment (WTP) Model

The dependent variable for this regression model was calculated based on the 'Yes' responses to bid amounts presented to respondents in the research questionnaire. The Logit model employed in the studies is with a dependent variable that is binary (Klieštik et al. 2015) as well as the Probit model. In the Logit and Probit regression analyses, the binary dependent variable can be 'one' or 'zero'. The dependent variable can be derived from the probability of the 'yes' responses to the answer for the bid amount. Response for WTP can either be a dummy variable where a 'yes' response is coded as one while a 'no' response is coded as zero. The Logit model used in this study predicts the probability of 'yes' responses as answers to the bid amount (B) and other explanatory variables such as bid, maximum payment, yes_PES, total earner, gross income and source of water. The general equation for a logistic regression is as follows;

$$\text{In (odds)} = \alpha + \beta 1X1 + \beta 2X2 .... \beta kXk + ℨi$$

The 'odds' probability of event/1- probability of event, β1........βk are the estimated coefficient parameters. X1 is the bid amount, X2 is the independent variable that influences the WTP amount and ℨ is for the standard error distribution.

Predicted probability of 'yes' and 'no' responses were calculated by;

$$Py = P(y = 1) = \frac{1}{1 + e^{-(a + b\,1X1 + b\,2X2 + b\,kXk)}}$$

Where Y = 1 if it is a 'yes' response and 0 otherwise. The equation is simplified as

$$Py = \frac{1}{(1+e^{-2})}$$

Cameroon (1988) used this equation given to estimate the mean of a WTP.

$$\text{Mean WTP} = [\beta 0 + (\Sigma\beta 2X2 .... \beta kXk)] / (\beta 1)$$

Where β0 is estimated as constant, βk is the estimated parameter of the coefficients, Xk are the mean values of explanatory variables and B1 is the estimated coefficient of the bid.

RESULTS AND DISCUSSION

DATA DESCRIPTION

The CVM estimation data were collected through face-to-face interviews, with the involvement of randomly selected respondents who live in residential areas surrounding Langat Basin. This study involved 540 households along upstream, middle-stream and downstream areas of the Langat basin. The respondents were between ages of 18 to 65. This study surveyed for the responses starting from April to July 2014. Essentially, the questionnaire of this study suggested 6 bids: RM5, RM10, RM15, RM20, RM25 and RM30 based on a pre-test that was conducted prior to this study. The estimation results identified that the bid prices and "yes" responses were conversely proportional and partially fluctuating.

TABLE 1. Bid distribution and responses

Bid Price	Upstream				Middle stream				Downstream			
	Yes (N)	%	No (N)	%	Yes (N)	%	No (N)	%	Yes (N)	%	No (N)	%
RM5	21	70	9	30	24	80	6	20	25	83.3	5	16.7
RM10	16	53	14	47	22	73	8	27	22	73.3	8	26.7
RM15	20	67	10	33	24	80	6	20	20	66.7	10	33.3
RM20	18	60	12	40	16	53	14	47	18	60	12	40
RM25	11	37	19	63	13	43	17	57	22	73.3	8	26.7
RM30	13	43	17	57	17	56.7	13	43.3	21	70	9	30
Total	99	55	81	45	116	64.4	64	35.6	128	71.1	52	28.9

N= Household

Table 1 shows the distribution of the bid prices as well as 'yes' and 'no' responses given by the households involved. Out of the 180 respondents from the upstream areas of the Langat Basin, 55% indicated 'yes' responses while 45% respondents demonstrated 'no' responses towards bid prices offered to them. From the middle-stream areas of the basin, 64.4% respondents revealed 'yes' responses while 35.6% respondents showed 'no' responses on the bid prices. Furthermore, downstream respondents expressed 71.1% of 'yes' responses while 28.9% of the respondents revealed 'no' responses. The bid acceptance among respondents showed an increasing trend from upstream to downstream areas along the Langat Basin. The higher the suggested price was, the fewer the number of respondents who answered 'yes' for the offered bid. Out of a total 540 of respondents that have been involved in the survey, 4.4% respondents in the downstream area did not agree with the watershed protection of the Langat Basin. In other words, this figure reflects a small percentage of respondents who were not aware of the Langat Basin as well. Due to that, the data interpreted that the respondents who were not aware of the availability of an ecosystem service were not willing to get involved in a conservation programme that would be carried out in a specific area of study. Table 2 shows the socio-demographic background of the respondents involved in this study.

TABLE 2. Socio-demographic factors (N=540)

Variables	Mean	Standard Deviation	Min	Max
Upstream				
Age	39.4167	11.6666	18.0000	70.0000
Gender	0.477778	0.500899	0.000000	1.00000
Marital Status	1.77778	0.490759	1.00000	3.00000
Education	3.71667	1.57946	1.00000	6.00000
Total household	4.88889	2.15823	1.00000	14.0000

Middle stream				
Age	36.6167	9.66435	19.0000	62.0000
Gender	0.522222	0.500899	0.000000	1.00000
Marital Status	1.75000	0.505556	1.00000	3.00000
Education	3.88889	1.55312	1.00000	6.00000
Total household	4.52222	0.000000	1.80767	11.0000
Downstream				
Age	37.2500	9.44900	19.0000	65.0000
Gender	0.461111	0.499876	0.000000	1.00000
Marital Status	1.89444	0.490094	1.00000	3.00000
Education	4.06667	1.56284	1.00000	6.00000
Total household	4.56667	1.95508	1.00000	13.0000

ESTIMATION RESULTS

Table 3 and 4 present the estimation results of upstream households using the Probit and Logit models. The Probit model is statistically more suitable to be used with variables compared to the Logit model. With the data collected from upstream households using the Probit model, estimation results in Table 4 recorded ‘drink_wd’, ‘yes_prob’, ‘bid1’, ‘maximum payment’ and ‘household income’ as statistically significant at a 5% level.

TABLE 3. Estimation Results of Upstream Household Using Logit Model

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Water	0.00063747	0.00096353	0.662	0.5082	-875.022222
Water_Co	-0.01037557	0.01590295	-0.652	0.5141	24.8111111
Drink_WD	9.14704720	6.04626125	1.513	0.1303	1.00000000
Yes_Prob	0.00840636	0.00570947	1.472	0.1409	51.9222222
BD1	-0.59218049	0.11423695	-5.184	0.0000	17.5000000
Max_Pay	0.52588722	0.10293711	5.109	0.0000	30.0055556
Age	-0.02812660	0.02579936	-1.090	0.2756	39.4166667
Gender	0.03225461	0.56548238	0.057	0.9545	0.47777778
Linc	-0.97078723	0.66032411	-1.470	0.1415	8.51635780

However, in the Logit model estimation results in Table 3, ‘bid1’ and ‘maximum payment’ were statistically significant.

TABLE 4. Estimation Results of Upstream Household using Probit Model

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Water	-0.00053556	0.00129791	-0.413	0.6799	-941.555556
Water_Co	0.03517169	0.02025496	1.736	0.0825	52.3722222
Drink_WD	-5.18181355	5.69357904	-0.910	0.3628	1.00000000
Yes_Prob	0.01438899	0.00754992	1.906	0.0567	50.1666667
BD1	-0.38565981	0.09138795	-4.220	0.0000	17.5000000
Max_Pay	0.34687753	0.07384174	4.698	0.0000	33.0722222
Age	0.00284686	0.03459174	0.082	0.9344	36.6166667
Gender	-1.81430280	0.70026177	-2.591	0.0096	0.52222222
Linc	0.37458408	0.66415717	0.564	0.5728	8.37196693

Subsequently, from the middle-stream data, the Probit model in Table 6 highlighted 'water consumption', 'yes_prob', 'bid1', 'maximum payment' and 'gender' as statistically significant. Likewise, the Logit model estimation result in Table 5 showed 'yes problem', 'bid1', 'maximum payment' and 'gender' variables as statistically significant.

TABLE 5. Estimation Results of Middlestream Household using Logit Model

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Water	-0.00029196	0.00077492	-0.377	0.7064	-941.555556
Water_Co	0.02140438	0.01108541	1.931	0.0535	52.3722222
Drink_WD	-3.70974745	3.14305896	-1.180	0.2379	1.00000000
Yes_Prob	0.00854375	0.00418431	2.042	0.0412	50.1666667
BD1	-0.19056555	0.04064209	-4.689	0.0000	17.5000000
Max_Pay	0.17540688	0.03199769	5.482	0.0000	33.0722222
Age	0.00594929	0.01983244	0.300	0.7642	36.6166667
Gender	-1.06412035	0.39218998	-2.713	0.0067	0.52222222
Linc	0.26185753	0.36992033	0.708	0.4790	8.37196693

TABLE 6. Estimation Results of Middle Stream Household using Probit Model

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Water	0.00058134	0.00046691	1.245	0.2131	-875.022222
Water_Co	-0.00904703	0.00892705	-1.013	0.3108	24.8111111
Drink_WD	7.48490501	3.02440422	2.475	0.0133	1.00000000
Yes_Prob	0.00594656	0.00308410	1.928	0.0538	51.9222222
BD1	-0.23667808	0.03882335	-6.096	0.0000	17.5000000
Max_Pay	0.19597590	0.03082775	6.357	0.0000	30.0055556
Age	-0.02181549	0.01341975	-1.626	0.1040	39.4166667
Gender	0.02789852	0.30021509	0.093	0.9260	0.47777778
Linc	-0.74392802	0.33360855	-2.230	0.0258	8.51635780

Next, based on downstream data, the Probit model result in Table 8 stated that 'drink_wd', 'bid1', 'maximum payment', 'gender' and 'household income' as statistically significant variables compared to that of the Logit model result in Table 7, as only that 'drink_wd', 'bid1', 'maximum payment' and 'household income' as statistically significant. A Probit analysis is a useful alternative to the Logit method. The main difference between the Logit and Probit models is that the normal distribution of independent variables is assumed in the model (Klieštik et al. 2015).

TABLE 7. Estimation Results of Downstream Household using Logit Model

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Water	0.00148546	.00153012	0.971	0.3366	-908.288889
Water_Co	-.01287945	.03121241	-0.413	0.6799	49.7055556
Drink_WD	22.8290056	7.95009962	2.872	0.0041	1.00000000
Yes_Prob	-0.01001715	0.00742205	-1.350	0.1771	50.2500000
BD1	-0.39716520	0.10975467	-3.619	0.0003	17.5000000
Max_Pay	0.48771941	0.10244425	4.761	0.0000	32.4166667
Age	0.03761409	0.04278538	0.879	0.3793	37.2500000
Gender	-1.55107182	0.73157774	-2.120	0.0340	0.46111111
Linc	-2.85118044	0.93199550	-3.059	0.0022	8.15981880

TABLE 8. Estimation Results of Downstream Household using Probit Model

Variable	Coefficient	Standard Error	b/St.Er.	P[|Z|>z]	Mean of X
Water	0.00067324	0.00071557	0.941	0.3468	-908.288889
Water_Co	-0.00989683	0.01620559	-0.611	0.5414	49.7055556
Drink_WD	11.5298860	3.88954462	2.964	0.0030	1.00000000
Yes_Prob	-0.00431585	0.00376850	-1.145	0.2521	50.2500000
BD1	-0.14852010	0.03476484	-4.272	0.0000	17.5000000
Max_Pay	0.21545343	0.03460677	6.226	0.0000	32.4166667
Age	0.03433147	0.02281087	1.505	0.1323	37.2500000
Gender	-1.00189773	.38743797	-2.586	0.0097	0.46111111
Linc	-1.51657132	.46578474	-3.256	0.0011	8.15981880

WILLINGNESS TO PAY

The mean WTP of estimated upstream households' WTP is RM30.01 while the mean of middle-stream household's WTP is RM33.07 compared to downstream household's WTP which is RM32.41. The estimated results appear to be lower than previous WTP studies conducted on hydrological services provided in Opequon watershed. The WTP for Opequon watershed protection is RM192 per month (Collins et al. 2006). On the other hand, WTP for Flagstaff watershed is $4.89 (RM19.56) monthly (Mueller 2012), Dejen Woreda watershed is 28.48 Birr (RM63.24) annually (Ebrahim 2014), WTP for Wondo Genet forested watershed is 30-35 ETB (RM6.54) monthly (Ayenew & Tesfaye 2015) and willingness to pay for improved watershed services of the Layawan watershed in Oroquieta City is 57.48php and 53.89php (RM4.66 and RM4.98) (Calderon et al. 2012). Besides, willingness to pay for restoration of highly urbanized coastal watershed is $132.72 annually per household (Nicosia et al. 2014). The differences in WTP for watershed protection indicated that a household's quality of life, income and awareness of watershed protection services as well as effectiveness of management of payment collection are factors that influenced WTP. Higher WTP based on the estimation results indicated a greater concern among households towards environmental awareness and watershed protection services in the Langat Basin. In this context, this study showed a higher WTP compared to Costa Rica's PES project. Therefore, it is well understood that the possibilities of developing effective payment mechanism for the Langat Basin is high among households. Extensive promotion and PES education among households will lead to the development of a robust PES scheme because 2.8% of households with no prior knowledge on PES in this study possess RM8 WTP annually based on a clear hypothetical market.

CONCLUSION

There is an extensive interest in conserving and developing the watershed protection service scheme in Malaysia. We found an increasing trend in WTP within the upstream and middle-stream areas along the Langat Basin that was utilised to develop a payment scheme for the Langat Basin watershed protection services from a household's perspective. Local community membership should be promoted in order to increase households' participation in a PES programme. This study has its share of limitations because it only focused on the upstream, middle-stream and downstream areas along the Langat Basin. PES policies together with government involvement along with better understanding among stakeholders such as households involved in the study and decision makers play an important role in creating a successful payment mechanism for the water catchment areas of the Langat Basin. The results obtained from the households' WTP for watershed protection programmes are favourable. A payment mechanism for watershed protection services has a high potential of creating a new source of income to conserve ecosystem services in the Langat Basin. Finally, this study can aid decision makers in developing a suitable and practical payment mechanism for watershed protection services for the Langat Basin.

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