International Journal of Business and Economics Research
2022; 11(4): 250-256
http://www.sciencepublishinggroup.com/j/ijber
doi: 10.11648/j.ijber.20221104.16
ISSN: 2328-7543 (Print); ISSN: 2328-756X (Online)

Determinants of Households' Willingness to Pay for Rehabilitation of Horuwa Watershed: The Case of Gombora District, Hadiya Zone, Southern Ethiopia

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To cite this article:
Shiferaw Teshale Erango. Determinants of Households' Willingness to Pay for Rehabilitation of Horuwa Watershed: The Case of Gombora District, Hadiya Zone, Southern Ethiopia. *International Journal of Business and Economics Research*. Vol. 11, No. 4, 2022, pp. 250-256. doi: 10.11648/j.ijber.20221104.16

Received: July 5, 2022; **Accepted**: August 16, 4478; **Published**: August 31, 2022

Abstract: Communities benefit from a variety of ecosystem services provided by watersheds, which are often provided for free. Although these services have no monetary value, their economic value is debatable. As a result, natural resources are not used to their full potential, resulting in watershed deterioration. As a result, the purpose of this study is to apply the Double Bounded contingent valuation method, followed by open-ended questions, to assess households' willingness to pay for the rehabilitation of the Horuwa watershed. The study focuses on analysing households' willingness to pay decisions in order to elicit smallholder households' willingness to pay in terms of cash and labour, as well as to investigate determinants that influence smallholder households' maximum willingness to pay. Tobit regression models were used to assess data acquired via questionnaires, focus groups, and face-to-face interviews from 170 randomly selected households. The results showed that the first response is shared by 74.7% of Yes and 25.3% of No responses for watershed conservation in the double bounded contingent valuation of sampled households. According to the Tobit model, education level, household size, and annual income had a significant and positive effect on maximum willingness to pay, whereas non-farm income and initial bid had a significant and negative effect. As a result, the findings of the study imply that a household's perception of total watershed resource degradation is linked to Willingness to Pay. The findings suggest that policymakers at both the national and local levels should consider education level, annual income, household size, non-farm income, and initial bid variables when designing watershed conservation practices.

Keywords: Contingent Valuation, Rehabilitation, Tobit, Watershed, Willingness to Pay

1. Introduction

Watersheds are natural assets that provide society with a continuous supply of goods and services. Commercial markets, on the other hand, only value these services in partial, if at all. Watersheds connect terrestrial, freshwater, and coastal ecosystems and provide a variety of valuable services, including freshwater supply and purification, irrigation water supply, habitat protection for fisheries and biological diversity, carbon sequestration to help mitigate climate change, and support for recreation and tourism [13, 17]. Watershed protection that is insufficient results in downstream dependents receiving less clean, reliable water and other services. Watershed degradation comprises depletion of water supplies, soil erosion and land degradation, loss of vegetation cover, and infrastructure damage [1]. Degradation of watersheds threatens the livelihoods of millions of people in many developing nations, limiting governments' ability to create a healthy agricultural and natural resource base.

Deforestation of forest resources, biodiversity loss, and soil erosion suggest sedimentation in the Horuwa watershed, resulting in significant maintenance costs for downstream users. As a result of the sedimentation, infrastructure has been damaged, and the land's product and productivity have been impaired. Upstream communities produce watershed preservation services at an opportunity cost to alleviate these issues. As a result, the purpose of this study is to address the issue of irrigation water valuation and to establish the value of the Horuwa watershed in the study area.

Payment for environmental services (PES) is a soft method that has been in use and debate for more than 30 years [4]. PES is a direct conservation technique that aims to sustain positive environmental externalities by transferring payments from those who benefit from environmental services (downstream) to those who provide these services (typically upland populations) [16]. It's a market-based method that connects environmental service providers with those who will benefit from them [21]. As a result, the strategy attempts to ensure that individuals who profit from environmental services pay for the benefits they have received.

However, it is unknown whether all downstream irrigation water users in the Horuwa watershed are capable of and willing to pay higher tariffs for watershed services. It's also unclear how well downstream water users understand the importance of the watershed in ensuring a reliable agriculture water supply. The operational manner of payment, as well as the factors that influence maximum willingness to pay (MWTP), are still unknown. As a result, our research is an attempt to close these gaps. As a result, this research was carried out to determine households' willingness to pay for the rehabilitation of the Horuwa watershed in Gombora district, southern Ethiopia. This study answers the following questions: are households willing to pay for rehabilitation, how much they are willing to pay, and what factors influence their households' maximum willingness to pay for Horuwa watershed rehabilitation.

2. Materials and Methods

2.1. Description of the Study Area

The study was conducted in Gombora district of the Hadiya Zone in Southern Ethiopia. The district is located about 259 km south of Addis Ababa. It has total area coverage of 48,325ha and is geographically located between 70 33′ and 70 37′ northern latitude and 370 35′ and 370 40′ eastern longitudes. The altitude ranges between 1400m to 2400 m.a.s.l. The mean annual rainfall and mean temperature vary between 1800-2200mm and 150°C-25°C respectively. The major economic activities of the area are mainly rain-fed subsistence mixed crop and livestock production associated with trees grown either in wood lots or in farm plots, and some kebeles use irrigation. Minor income activities include trade, renting land or livestock, timber (wood and bamboo) sales and migrant remittances [10]. The total projected population for 2016 is based on the 2007 census of 110,877, with 55,533 men and 55,344 women [5].

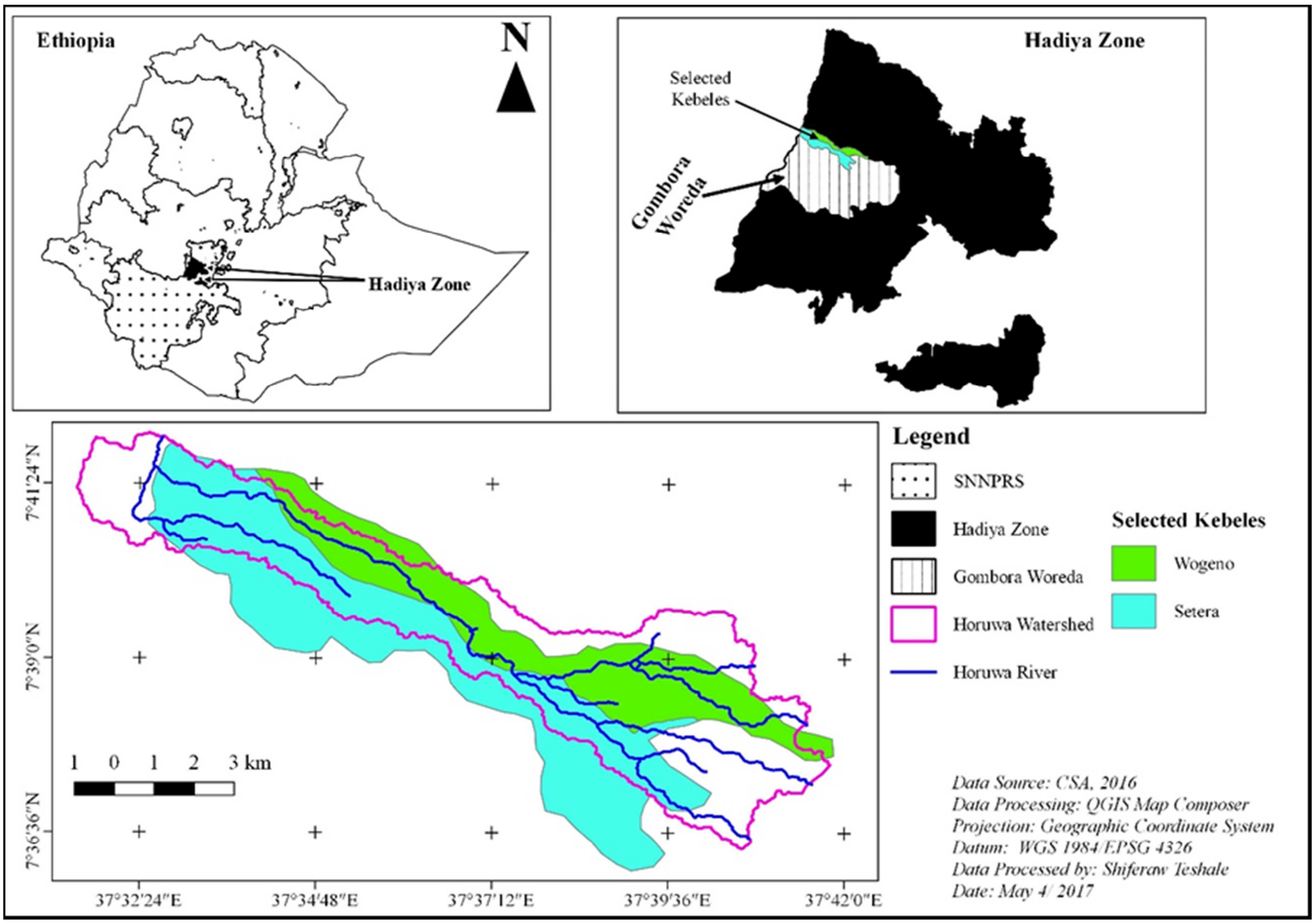

Figure 1. *Study area map.*

2.2. Sampling Design and Techniques

A multistage sampling technique was used when selecting respondents. In the first stage, Gombora district was selected purposively based on where the Horuwa watershed is within this woreda. In the second stage, two kebeles, Setera and Wogeno, were purposefully selected based on their proximity and the level of dependence on the watershed for irrigation use. In the third stage, the sample household heads for interview were selected by using stratified random sampling techniques based on the wealth status (better off, medium, and poor) of the households in the study area. Finally, from each stratum, proportional sample households were selected randomly. The total sample size was determined from the given population size based on the rule of thumb, N ≥ 50 + 8m which is developed by [7], where, N, is sample size and 'm' is the number of explanatory variables (Xi) where i=1, 2…m. According to the formula, 154 respondents and, with 10% contingency, a total of 170 respondents were selected.

2.3. Methods of Data Collection

The primary data were collected from sampled respondents via face-to-face interviews with smallholder households using a structured questionnaire. Focus group discussion and key informant interviews were also conducted as part of the data collection method for qualitative primary data. Moreover, secondary data was collected from published and unpublished materials. The questionnaire was designed into two sections. The first section contains the demographic and socio-economic characteristics of household respondents on their perception of watershed services, existing watershed problems, and watershed degradation. The second section consists of contingent valuation (CV) questions about the household's WTP for watershed rehabilitation. Then, well-trained enumerators who have good experience in surveys were employed to gather the data required for this study.

A pre-test survey with open-ended questions, according to [12], can serve to provide some information about the bounds of respondents' WTP. As a result, a pre-test was conducted with 12 smallholder households selected at random. The pre-test produced significant information to make several changes to the final survey questionnaire's design. A focus group discussion and a key informant interview were done in addition to the pre-test survey to determine starting point prices/bids in terms of cash and labour using an open-ended contingent valuation format. As a result, the starting bid for the actual survey was 50, 100, and 150 birr per year and 12, 24, and 36 man-days per year, followed by open-ended questions. Furthermore, WTP in labour days was converted to Ethiopian Birr based on the research area's minimum labour cost, calculated at 100 ETB/man/day, to ensure uniform measurement in the model analysis. The respondents were asked a yes/no question after the bids were designed to gauge their willingness to pay. If he or she said yes, the next larger number was asked to state their answers. Finally, respondents were asked to declare their maximum willingness to pay for both bounded and unbounded values using open-ended questions. If he/she said no, the next minimum amount was asked, followed by an open-ended question to get his/her maximum amount.

2.4. Analytical Methods

The descriptive statistics and Econometric model were used to analyse the qualitative and quantitative data acquired. To examine the acquired data, descriptive statistical methods such as frequencies, means, percentages, and graphs were used together with the econometric model. The Tobit model was employed in the study. The variance inflation factor (VIF) was used to test the multicollinearity between continuous explanatory factors before the Tobit model was used to analyse the effect of explanatory variables on maximum willingness to pay.

It was computed as:

$$\mathrm{VIF} = \frac{1}{1-\mathrm{R}_i^2} \quad (1)$$

Where, R_i^2 is the coefficient of determination in the regression of one explanatory variable (X) on the other explanatory variables (Xj). If there is no collinearity between repressors, the value VIF is 1. Collinearity exist if VIF > 5. A VIF value of a variable exceeds 10, which happened when R_i^2 exceeds 0.90, and that variable is said to be highly collinear [9].

A contingency coefficient also estimated to see the degree of association between the dummy explanatory variables. A value of 0.75 or more indicates a stronger relationship between the two variables. The contingency coefficient (C) was compute as:

$$\mathrm{C} = \sqrt{\frac{X^2}{N+X^2}} \quad (2)$$

Where

C= coefficient of contingency, χ^2= Chi-square test and N= total sample size.

The type of econometric model is determined by the nature of the dependent variable. As a result, the goal of this study was to examine at the factors that influence households' maximum willingness to pay for watershed rehabilitation. The open-ended question was utilized to generate continuous values of the dependent variable, including zeros, using double-bounded contingent valuation. As a result, there were zero and non-zero values for this dependent variable.

Ordinary least square estimates become biased and inefficient as the number of zeros in the data set grows in relation to the number of observations [19]. Following this, [18] highlighted that in more recent research when some observations in the sample lacked data or had zero values for the dependent variable, Tobit has been the preferred method. This is especially true in the case of the willingness to pay data set. As a result, the Tobit model is appropriate for such dependent variables. In line with this, the Tobit model was used to investigate the factors that influence households' maximum willingness to pay for watershed rehabilitation.

The model is specified by [14, 15] as:

$$Y^* = \beta 0 + \beta i Xi + \varepsilon i$$

$$Y = Y^* \text{ if } Y^* > 0)$$

$$Y = 0, \text{ if } Y^* \leq 0$$

Where, Y = the maximum willingness to pay in terms of cash and labor,

β_i = coefficients of explanatory variables,

Xi = Explanatory variables and

εi = Error term.

Maximum willingness to pay that respondent will be asked to state for improved scheme in Ethiopian Birr (open ended question) is dependent variable of the Tobit model. Thirteen potential explanatory variables, which are hypothesized to influence smallholder households' maximum willingness to pay, were selected based on the findings of past studies, existing theoretical explanations, and the researcher knowledge.

3. Result and Discussion

3.1. Demographic and Socio Economic Characteristics of Respondents

From the total 170 samples, 162 samples were used for statistical analysis. Eight were discarded from the analysis due to incomplete responses.

From the total sampled households, 135 (83.3%) were male and 27 (16.7%) were female. 77.7% and 66.7% of male and female respondents were willing to pay cash, labor or both respectively. The share of willing male respondents is higher than the share of willing female respondents. The reason may be males have more aware, decision-making power and more educated relative to female. From total sampled respondents, 88.9% were married and 77% of the married respondents were willing (table 1).

Table 1. *Descriptive statistics of some socio-economic characteristics of respondents.*

Variables	Description	Willing (123)	Not willing (39)	Total (162)	X^2
Sex	Male	105 (77.7%)	30 (22.3%)	135 (83.3%)	.00
	Female	18 (66.7%)	9 (33.3%)	27 (16.7%)	
Marital status	Married	113 (78.5%)	31 (21.5%)	144 (88.9%)	.00
	Widowed	10 (58.8%)	7 (41.2%)	17 (10.5%)	
	Separate	-	1 (100)	1 (0.6%)	

Table 2 results revealed that the average age was 41.7 years, with a minimum of 25 and a maximum of 75 years. The average household size was 5.65 people, ranging from 2 to 13 people per household. The average year of schooling was 5.09, with a minimum of 0 and a maximum of 15 (12+3). The average annual income of the household was birr 14,369, with a minimum annual income of birr 1,700 and a maximum annual income of birr 38,000. And the average cultivated size was 1.21 ha, with a minimum of 0.25 ha and a maximum of 2.5 ha.

Table 2. *Socio-economic characteristics of sample Households.*

Variables	description of the variables	Mean	Std. dev.	Min.	Max.
Age	Age of respondents	41.71	10.12	25.00	72.00
Education	Educational level of HH	5.09	3.75	.00	15.00
Household size	Total household size	5.65	1.88	2.00	13.00
Land size	Own cultivated land size	1.21	.527	.25	2.5
Income	Annual income (birr)	14,369	6433.7	1700	38,000
Extension service	Access to extension service	8.30	3.15	1.00	18.0

3.2. Households Willingness to Pay for Watershed Rehabilitation

Individuals were asked if they would pay anything before the elicitation question, as [11] suggested. As a result, yes-or-no questions were created to determine respondents' willingness to pay in cash and labour. According to the findings, 123 (75.93%) of the sample respondents were willing to pay cash, labour, or both for the rehabilitation of their watershed, whereas 39 (24.07%) were not willing to pay anything at all. 40 (32.52%), 49 (39.84%), and 34 (27.64%) of willing respondents were willing to pay cash only, labour only, or both (cash and labour) for conservation efforts, respectively (table 3).

Table 3 shows the sample households' aggregate responses to the first and second minimum or maximum bids. According to the results, 88 (54.3%) of respondents were willing to pay the maximum amount over and beyond the declared offers (yes-yes). On the other side, 39 responders (24.07%) declined to pay both the first and second minimum bids (no-no). A total of 21 (12.97%) of sample respondents were willing to pay the first offered amount but refused to pay the next maximum amount; 14 (8.64%) of respondents, on the other hand, declined the initial bid but agreed to pay the next minimum bid.

Table 3. *Frequency of Willingness to pay.*

	Responses	Frequency	Percentage
WTP category	Yes-Yes	88	54.32
	Yes-No	21	12.97
	No-Yes	14	8.64
	No-No	39	24.07
Contribution type	Cash	40	32.52
	Labour	49	39.84
	Both	34	27.64

3.3. Determinants of Households' Maximum Willingness to Pay Responses

Before estimating the econometric model, independent variables where tested for the presence of multicollinearity. The result showed that there were no multicollinearity problems between the variables. The value for Contingency Coefficient (CC) for the dummy variables were less than 0.75 and the value of Variance Inflation Factor (VIF) for the continuous variables were less than 5; which are clearly the indicators for the absence of multicollinearity (table 4).

When we use cross-sectional data we may encounter problem of heteroscedasticity [8]. In order to correct the heteroscedasticity problem we can estimate the robust standard errors instead of the usual standard errors [20]. Thus, the econometric models which are used in this study are corrected for heteroscedasticity problem using the robust command in Stata.

Table 4. *Contingency coefficient and Variance inflating factor of variables used in regression.*

	Sex	non-farm income	Slope of parcel	credit access	awareness	Corporation	
Sex	1.0000						
Non-farm income	0.1215	1.0000					
Slope of parcel	-0.0247	-0.1524	1.0000				
Credit access	0.0146	-0.1624	0.3096	1.0000			
Awareness	0.0944	0.0045	0.1449	0.1885	1.0000		
Corporation	-0.0178	-0.0041	0.3715	0.2174	0.166	1.0000	
Variance Inflation Factor for the continuous variable							
Variables	Income	Land size	Education	Age	Initial bid	Household size	Extension service
VIF	1.9	1.89	1.55	1.55	1.44	1.16	1.25

Tobit model was used to estimate the coefficients of explanatory variables for the open-ended questions to analyze factors that affect households' MWTP for watershed rehabilitation and conservation to assure improved irrigation water supply. The result of Tobit model was presented in as follows.

Table 5. *The Tobit results of the maximum willingness to pay.*

Variables	Coef.	Std. Err.	T	P>t	Mean
Age	-1.757	1.0805	-1.63	0.106	41.709
Sex	13.562	23.9	0.57	0.571	0.834
Education	4.8855	2.877	1.7	0.092*	4.772
Household size	6.5933	3.948	1.67	0.097*	6.65
Annual income	0.0038	0.002	2.05	0.043**	14368.52
Non-farm income	-0.0047	0.0023	-2.02	0.045**	2978.086
Cultivated land size	7.1675	16.809	0.43	0.67	1.21
Slope of parcel	-18.7497	27.161	-0.69	0.491	0.87
Credit access	-4.0777	23.919	-0.17	0.865	.8272
Extension service	0.3544	2.9293	0.12	0.904	8.136
Awareness	6.8243	28.497	0.24	0.811	0.88
Env'tal cooperation	28.3215	21.6	1.31	0.192	0.685
Initial bid	-0.9524	0.062	-15.29	0.00***	219.63
_cons	-48.6851	60.45	-0.81	0.422	
Sigma	97.0765	6.2536			
Number of obs= 162	Pseudo R^2= 0.1314		Log likelihood = -783.82951		
LRchi^2 (13)=237.22			Restricted log likelihood = -892.49069		

***, ** and * represents the significance level of 1%, 5% and 10% probability level respectively.

Education, household size, annual income, non-farm income, and initial bid are statistically significant variables in the Tobit model, as shown in table 5, and are the major determinants of MWTP for watershed rehabilitation and conservation to ensure improved irrigation water supply, while the remaining variables are either insignificant or unexpected signs.

As the level of education increases, so does the amount of money that households are willing to pay, suggesting that educated people are more aware and know the value of improved watershed services. Thus, as expected, education was affecting the households' MWTP positively and was statistically significant at 10% level. This means that a farming population with educated household heads can pay more than a farming population with uneducated household heads. There is a 4.7 unit increase in WTP for better watershed services for every one grade increase in a household head's education level.

Household size has a positive impact on the MWTP and is statistically significant at a 10% level. The reason might be that if the watershed is rehabilitated or conserved, the irrigation farming households will have more labor input that can utilize the increased water availability.

As expected, annual income has a positive impact on the household heads' MWTP and is statistically significant at a 5% level. Households with higher annual income have been more likely to be willing to pay the maximum amount of money for this conservation program. Thus, the annual income of the households is one of the important factors in the respondents' MWTP for watershed rehabilitation and conservation for the improvement of existing irrigation water. Similar study was reported by [2].

Non-farm income had a negative and significant effect on households' MWTP for watershed rehabilitation and conservation at the 5% significance level. Non-farm income exceeds the number farm income, as expected, and respondents' unwillingness to pay for better watershed services is consistent.

The initial bid's result has a negative sign and is statistically significant at the 1% levels. According to the law of demand, as the initial bid amount increases, respondents will give fewer responses to the households' maximum amount of money they are willing to pay. This study is similar with [3].

According to [6] the mean WTP for the open-ended CV survey responses of the MWTP figures reported by households is simply the average of their MWTP amount.

$$\text{Mean WTP} = \mu = \sum Ti/n,$$

Where 'Ti' is the reported MWTP amount by surveyed households and 'n' is the sample size.

$$\text{Mean WTP} = \mu = 48190/162 = 297.47$$

3.4. Aggregating the Willingness to Pay

By multiplying the mean willingness to pay amounts by the number of household heads who are directly committed to the watershed, the overall willingness to pay for the Horuwa watershed is calculated. Aggregation's purpose is to get from the sample's mean willingness to pay to the population's total willingness to pay. The population of interest, for which the willingness to pay was aggregated, consists of families that directly benefit from the Horuwa watershed. Because both kebele (Setera and Wogeno) are direct beneficiaries of the Horuwa watershed, their households were used to assess the aggregate willingness to pay. The overall size of relevant households in 2020, according to the Setera and Wogeno kebele administrative offices, was 1,808.

The aggregate WTP can be calculated:

$$\text{Aggregate WTP} = N \times \text{MWTP}$$

Where N is the number of individuals in the population and MWTP refers to the mean willingness to pay.

$$\text{Aggregate WTP for open-ended} = \text{Mean WTP} \times \text{Total number of households} = 297.47 \times 1{,}808 = 537{,}825.76$$

Then, the aggregate yearly WTP by the all households of study area for open-ended question were 537,825.76 birr per year.

4. Conclusion and Recommendation

The paper has assessed the WTP for rehabilitation of watershed and identified the determinants of MWTP practices in Horuwa watershed, southern Ethiopia. The study provides evidence that, education of households, household size, annual income, non-farm income, and initial bid value were the most important covariates that affects local community decision of MWTP. The mean WTP was 297. 47 birr per year with an aggregate benefit of 537,825.76 birr per year for the open ended format. According to the study result, household's perception of overall watershed resource degradation is positively related to the probability of WTP for rehabilitation of watershed. Therefore, policy maker and decision maker should consider those important factors, like level of education, household size, annual income, non-farm income and, initial bids that determine watershed rehabilitation and sustainable conservation of watershed and need to have honest information about economic values of environmental resources before they plan to introduce decisions that directly or indirectly influence the watersheds.

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