

Leaflet No.13/2021

The Republic of the Union of Myanmar
Ministry of Natural Resources and Environmental Conservation
Environmental Conservation Department



**Relationships between Environmental and Health Perceptions and
Willingness to Pay Regarding Industrial Wastewater Discharge into
Dokehtawaddy River in Myanmar**



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December 2021

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Abstract

There is an ongoing problem of industrial wastewater contaminating the environment (in developing countries). To deal with solutions to this kind of pollution can be costly. This study examined how the associations between socio-demographic characteristics, river pollution awareness, and health risk appraisals impacted people's willingness to pay (WTP) for environmental solutions by surveying the people living near the Dokehtawaddy River in Mandalay City, Myanmar. Using interval regression analysis on the contingent valuation concerning people's WTP, a financial value for a hypothetical river water quality improvement project was estimated. A total of 310 local people were involved in questionnaire survey. Results obtained through structural equation modeling revealed that education and participation in environmental conservation activities increased people's ability to recognize pollution and the consequent health-risks, which in turn led to WTP. These findings indicate the importance of formal and informal education in raising on-site environmental awareness. They also suggest that there is a step-by-step psychological process in understanding pollution and its threats to human health that creates a sense of responsibility and a willingness to actually pay for a river water improvement project. The present study is one of the first to provide evidence regarding WTP estimation and the structural associations among socio-demographic characteristics, environmental attitudes, and WTP in river pollution management issues in developing countries.

Keywords: Industrial water pollution; environmental awareness; health risk perceptions; willingness to pay; level of education; contingent valuation method

ဒုဌာနတိမြစ်အတွင်း စက်မှုစွန့်ထုတ်အရည် စွန့်ပစ်ခြင်းအပေါ်ဒေသခံပြည်သူတို့၏
ပတ်ဝန်းကျင်နှင့် ကျန်းမာရေးဆိုင်ရာ သဘောထားအမြင်များနှင့်
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ဦးအောင်ကိုကို၊ ဦးစီးအရာရှိ
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စာတမ်းအကျဉ်း

ဖွံ့ဖြိုးဆဲနိုင်ငံများတွင် စက်မှုဇုန်များမှထွက်ရှိသည့် စွန့်ပစ်ရေဆိုးများကြောင့်ပတ်ဝန်းကျင်ညစ်ညမ်းမှုများကို ရင်ဆိုင်နေကြရလျက်ရှိပါသည်။ အဆိုပါညစ်ညမ်းမှုများကို ဖြေရှင်းရာတွင်ငွေကြေးကုန်ကျမှုများစွာ ရှိနိုင်ပါသည်။ ယခုစာတမ်းသည် ဒုဌာနတိမြစ်အနီးရှိ ဒေသခံပြည်သူ (၃၀၁) ဦး၏ လူမှုရေးဆိုင်ရာ အချက်အလက်များဖြစ်သည့် ပညာအရည်အချင်း၊ အလုပ်အကိုင်စသည်တို့သည် ဒုဌာနတိမြစ်ရေညစ်ညမ်းမှုနှင့် ကျန်းမာရေးထိခိုက်နိုင်မှုအပေါ် သဘောထားအမြင်များ၊ မြစ်ရေအရည်အသွေး ပိုမိုကောင်းမွန်လာစေရန် ထောက်ပံ့ပေးလိုမှု (Willingness to Pay) တို့နှင့်မည်သို့ဆက်နွှယ်နေသည်ကိုဆန်းစစ်ဖော်ထုတ်ထားသည့်စစ်တမ်းဖြစ်ပါသည်။ ဆန်းစစ်ချက်ရလဒ်များအရပညာအရည်အချင်းမြင့်မားသူများနှင့်ပတ်ဝန်းကျင်ထိန်းသိမ်းရေးလုပ်ငန်းများတွင်ဆောင်ရွက်နေသူများသည် မြစ်ရေညစ်ညမ်းလာနိုင်မှုကြောင့် ကျန်းမာရေး ထိခိုက်လာနိုင်ကြောင်းကို စိုးရိမ်မှုများ ဖြစ်ပေါ်လျက်ရှိကြပါသည်။ ထို့အပြင် အဆိုပါကိစ္စရပ်များအပေါ် စိုးရိမ်မှုမြင့်မားသူတို့သည် မြစ်အရည်အသွေးကောင်းမွန်လာစေရန်ထောက်ပံ့ပေးလိုမှု (Willingness to Pay) ပိုမိုမြင့်မားလျက်ရှိကြောင်း ဆန်းစစ်တွေ့ရှိရပါသည်။ ထို့ကြောင့် ဒုဌာနတိမြစ်အား ထိန်းသိမ်းရန် နှိုးဆော်တိုက်တွန်းရာတွင် စာသင်ကျောင်းများတွင်သာမက ကျောင်းပြင်ပများတွင်ပါ ပတ်ဝန်းကျင်ထိန်းသိမ်းရေး အသိပညာပေးလုပ်ငန်းများသည် အရေးကြီးကြောင်း လေ့လာတွေ့ရှိချက်များက ညွှန်ပြနေပါသည်။ ထို့အပြင် မြစ်ရေညစ်ညမ်းလာနိုင်မှုနှင့် အဆိုပါညစ်ညမ်းမှုကြောင့်ကျန်းမာရေးထိခိုက်နိုင်မှုအပေါ်နားလည်သိရှိနိုင်မှုတို့သည်ဒုဌာနတိမြစ်ကိုထိန်းသိမ်းရန်တာဝန်ရှိသည်ဟုခံယူထားရှိမှု၊ မြစ်အရည်အသွေးပိုမိုကောင်းမွန်လာစေရန် ထောက်ပံ့ပေးလိုမှုတို့နှင့် ဆက်နွှယ်နေကြောင်းဆန်းစစ်တွေ့ရှိရပါသည်။ ယခုစာတမ်းသည် ဖွံ့ဖြိုးဆဲနိုင်ငံများရှိ မြစ်ရေ ညစ်ညမ်းမှုအပေါ် စီမံခန့်ခွဲရာတွင် လိုအပ်သည့် ဒေသခံပြည်သူများ၏ လူမှုစီးပွားအခြေအနေ၊ ပတ်ဝန်းကျင်ဆိုင်ရာအမြင်သဘောထားများနှင့် ပိုမိုကောင်းမွန်သည့် ပတ်ဝန်းကျင်တစ်ခုဖြစ်လာစေရန်ထောက်ပံ့ပေးလိုမှုတို့၏ ဆက်စပ်ပတ်သက်နေမှုများကို လေ့လာဆန်းစစ်သည့်စာတမ်းများထဲမှ တစ်ခုဖြစ်ကြောင်း တင်ပြအပ်ပါသည်။

Relationships Between Environmental and Health Perceptions and Willingness to Pay Regarding Industrial Wastewater Discharge Into Dokehtawaddy River in Myanmar

1. Introduction

1.1 Industrial wastewater issue in Myanmar

In developing countries, wastewater from industrial and domestic sources is often discharged into the surrounding environment, such as rivers, without first being treated. This leads to serious environmental problems (Okereke, Ogidi and Obasi 2016). Discharged wastewater significantly impacts the quality of river water, as it may lead to eutrophication or create favorable conditions for waterborne pathogens. Moreover, people who use the infected water in their daily lives for drinking or other purposes may be at risk of water-related health issues (Kazmi & Absar 2005). Thus, effective management of wastewater discharge is necessary to reduce these risks. To reduce the discharge of untreated wastewater into water bodies, well-designed legislation, appropriate planning, adequate and suitable treatment, and regular monitoring are crucial (Okereke et al. 2016).

Myanmar has abundant water resources, with an estimated 1,000 km³ of renewable water resources annually (Asian Development Bank 2013). According to the population and housing census in 2014, nearly 70% of the population in Myanmar has access to safe water, while the rest still depend on raw water sources such as lakes, rivers, streams, rainfall, and unprotected wells. While the country enjoys an abundance of water resources, pollution from industrial sources often makes these water sources unsuitable for use in some parts of the country (Asian Development Bank, 2013).

The Dokehtawaddy River, a major tributary of the Ayeyarwady River running through Mandalay City in central Myanmar, serves as a water source for agricultural and domestic purposes for the communities that live along its course. The Mandalay Industrial Zone was established in 1990 with major extensions in 1998 and 2003 in the Pyigyitagon Township of Mandalay City with a total area of 7.37 km² near the Dokehtawaddy River basin. Mass fish deaths have been reported four times between 2008 and 2015 in Taungthaman Lake, mainly due to wastewater from the nearby industrial zone flowing into the lake. The media has reported that local people suffered from health issues such as itchy skin as a result of using the river's water (Phyo Wai Kyaw 2019). Although the government has implemented both short-term (for example, a discharge pipeline with pollutant settling tanks) and long-term (for example, a central treatment plant that is under construction but delayed due to land acquisition and administrative issues) initiatives (Mandalay City Development Committee, 2018; Ministry of Natural Resources and Environmental Conservation 2015), river water pollution remains and may become more serious as the operations in the industrial zone are expanded. The continued discharging of wastewater into the river without proper chemical treatment may have adverse impacts on the health of residents, water resources, and ecosystems in the long run (Ministry of Natural Resources and Environmental Conservation, 2015). It is thus crucial to develop and implement effective policies to improve the water quality and sustain the environmental services provided by the Dokehtawaddy River. To facilitate this, it is very important to understand the health risks due

to river water pollution and the benefits of the policies, not only in terms of physical improvements of river water quality but also the economic benefits that are seen among the primary beneficiaries, i.e., the people of Mandalay City.

1.2 Evaluating benefits of environmental improvement

The economic benefits of environmental policies can be evaluated by estimating the value of non-market commodities in the form of willingness to pay (WTP) (Carson, Flores & Meade 2001; Carson & Hanemann 2006). It is known that there are positive associations between key socio-demographic factors, such as age, education, income, knowledge, and WTP for environmental improvement (Carson et al. 2003; Carson 2000). For example, in the US, respondents' probability of agreeing to pay for improving the quality of lake water increased with education (Van Houtven et al. 2014). In Hidalgo del Parral, Mexico, respondents with higher household income had higher levels of WTP for safe drinking water than those with lower household incomes (Vásquez et al. 2009). In addition, farmers with proper knowledge and experience tended to provide economically reasonable WTP responses in a river restoration project in France (Amigues et al. 2002).

Psychological factors such as environmental awareness and risk perceptions are also known to be positively associated with the intention to engage for a better environment and WTP. For example, "environmentalist" respondents were willing to pay more for tropical river management in urban Australia than those categorized as "developers" (Zander et al. 2010). In a study on national parks in Spain, respondents with a deep environmental concern or nature tourists stated less protests in WTP elicitation questions and were willing to pay more to conserve biodiversity (García-Llorente et al. 2011). Moreover, WTP for protecting artificial lakes in Greece increased with high environmental awareness (Halkos & Matsiori 2016). Furthermore, environmental psychology research has developed behavioral models to test causal relationships between environmental awareness and pro-environmental behaviors. For example, Story and Forsyth (2008) proposed the awareness-appraisal-responsibility (AAR) model to investigate cleanup behavioral intentions in watershed conservation and preservation (Story & Forsyth 2008). This suggests that there can be a step-by-step psychological process that results in a willingness to financially contribute to solving river water ecosystem issues that have occurred under the pressure of human activities, including industrial manufacturing.

Several studies have investigated how respondents' socio-demographic characteristics, particularly education, are related to their concerns and awareness of environmental issues. A study found that people with higher levels of education were more concerned about climate change in European countries (Echavarren, Balžekienė and Telešienė 2019). According to national survey data in America, the elderly and less educated people's perceptions were that they had lower risks of skin cancer (Buster, You, Fouad and Elmets 2012). Both the level of education and environmental experiences are known to be positively associated with environmental awareness. A study in Costa Rica reported that customers who had participated in environmental group activities were more likely to be concerned with eco-friendly products than those who had not (Valenciano-Salazar, André, and Soliño 2021). While some characteristics such as income could directly determine WTP

because of the financial ability to pay, there could be mediating relationships between respondents' socio-demographic characteristics, such as education and participatory experiences, and their concerns and awareness of environmental issues in predicting WTP. However, few studies have been done on these structural associations and none in developing countries or in the context of river water quality improvement.

2. Objectives and hypotheses

The present study aimed to estimate the economic benefits of people's WTP, among the residents of Mandalay City, for the improvement of Dokehtawaddy River water quality when untreated industrial wastewater was discharged into the river. It also wanted to examine any hierarchical associations between the socio-demographic characteristics of the residents in terms of environmental awareness, risk appraisals, and WTP. Further the study wanted to determine the extent to which local people were concerned about this issue. The present study assumed that associations existed between the levels of education and WTP partially based on the AAR model by Story and Forsyth (2008), as shown in Figure 1. We set out three specific hypotheses to examine these hierarchical relationships.

H1. Education, either directly or through participation in environmental conservation activities, enhances river pollution awareness, health risk appraisals, and intentions for river water improvement action.

As previous studies (Buster et al., 2012; Echavarren et al., 2019) suggest, education should enhance individuals' understanding of environmental degradation, potential risks to health and life, and a sense of necessity for solving the issue. In the same way, as implied by Valenciano-Salazar et al. (2021), participating in environmental activities should nurture an appropriate choice for a better environment. In the present study, we assumed that education, both formal and informal, would increase firstly the levels of concern about river water pollution due to industrial wastewater discharge, secondly increase awareness of the perceived health risks affecting local people, and thirdly create an awareness that improvements to the river water quality were needed.

H2. River pollution awareness enhances health risk appraisals and river water improvement intentions.

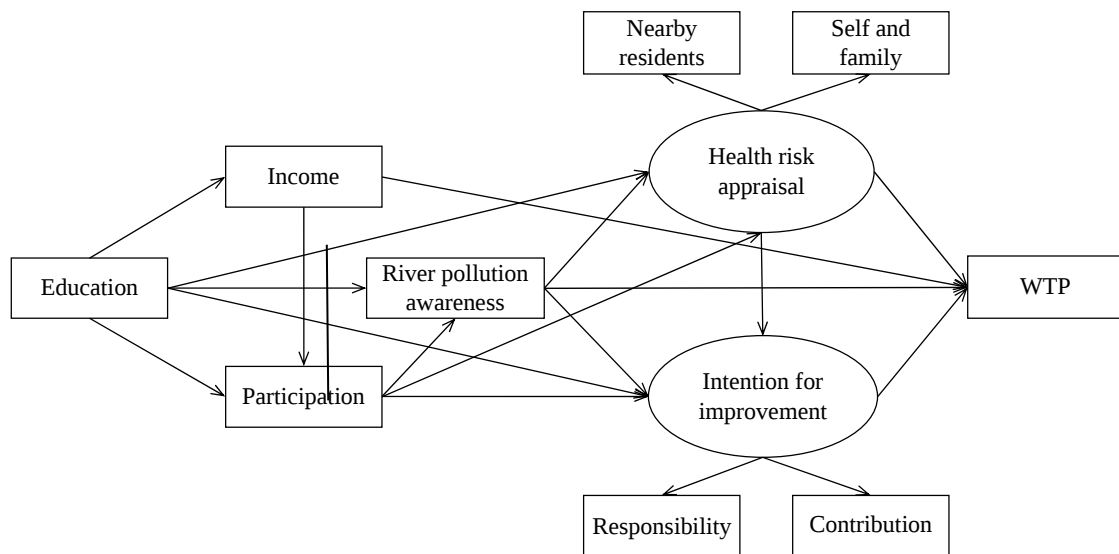
The second hypothesis touches on the intermediate process of willingness to pay for river water improvement. It is generally known that recognizing and becoming concerned about problematic situations in the environment can lead to more awareness of the potential and actual risks that can affect humans and ecosystems and this in turn creates a psychological motivation to avoid those risks (Bronfman et al. 2015; Story and Forsyth, 2008). In the present study, we assumed that respondents who consider rivers to be polluted due to industrial wastewater discharge tend to perceive higher risks of diseases, leading to stronger feelings of responsibility for improving river water quality and contributing to future river water initiatives. We also assumed that there was a path between river pollution awareness and an intention to act. In the present study, health risk appraisals consisted of two

target groups, namely residents living near the pollution source along the river, and respondents and their families who do not necessarily live near the pollution source but could potentially be affected.

H3. WTP increases with river pollution awareness, health risk appraisals, and the intentions to effect river water improvement.

This hypothesis was created to examine the most important parts of our study: what directly determines WTP. We assumed that all three psychological factors (awareness, appraisal, and intention defined as taking responsibility and a willingness to contribute) would enhance the intention to take a specific action such as contributing by paying their own money towards a hypothetical river water quality improvement project. In our hypothesis model, income was used as the mediating variable between education and participation on the one hand and education and WTP on the other hand. The former paths assumed that being highly-educated and thereby earning a higher income and being financially comfortable would lead to participation in environmental conservation. The latter was based on strong previous findings that financial ability alone determines WTP.

Fig. 1 Hypothesis model



3. Materials and Methods

3.1 Study area and data collection

This study collected data through a survey with anonymous responses from the residents in Amarapura and Pyigyitagon Townships of Mandalay City, Myanmar, during January and February 2021. Due to movement restrictions under the COVID-19 pandemic that had spread in the country during the survey period, the survey was conducted predominantly online in a convenient sampling format instead of the on-site random sampling that had initially been planned. On-site data collection was partially performed to avoid an online sampling bias. A total of 382 responses were collected, of which 302 were from the

online survey and 79 from the on-site survey. The analysis used 301 valid responses (online, n = 225; on-site, n = 76) after eliminating responses with missing or invalid data.

3.2 Questionnaire design

The questionnaire consisted of four parts. The first part asked respondent's socio-demographic characteristics such as age, gender, income, education attainment, years of living in Mandalay City, participation in environmental conservation activities. The second part asked respondent's awareness about water quality and pollution situations in Dokehtawaddy River due to direct wastewater discharge from the pipeline from the Mandalay Industrial Zone. In this part, respondents were asked their concerns about the river water pollution using a 4-point Likert scale ranging "not at all" to "very much". The third part asked respondent's appraisal of health risks and their intention for river water improvement. There were two questions on health risk levels that respondents perceive on residents living near the wastewater discharge point along the river and the respondent themselves and their family primarily living in suburban and urban areas in the surveyed townships using a 4-point Likert scale ranging "not at all" to "very much". As to intention for river water improvement, respondents were asked two items to measure their attitudes toward solving the issues, namely "I am responsible for improving the conditions of this river" and "I can partly contribute for better improvement of this river" using a 5-point Likert scale ranging "strongly disagree" to "strongly agree".

The final part was the WTP question section based on the contingent valuation method (CVM). This section first explained the issue of river water pollution in the industrial zone and nearby residential communities and then introduced a hypothetical project to improve the river's water quality. The hypothetical project consisted of three components: strict restrictions on when wastewater could be discharged so as not to interfere with the river water use by the residents, monthly monitoring of river water quality including monitoring heavy metal content, and financial and other necessary support for ensuring the completion of the central wastewater treatment plant in the industrial zone that is currently planned but has suffered significant delays. The assumed facilitator of this hypothetical project was the government. The payment vehicle for the WTP question was set as a monthly fee to be paid by individuals. The respondents were asked whether they were willing to pay and then to choose the amount they would prefer to pay from 11 options ranging from 500 Kyats (0.33 USD) to 5,000 Kyats (3.33 USD). Respondents who declined to pay in the earlier question were asked a follow-up question regarding their reasons for declining.

3.3 Analysis

The present study performed data analyses in two ways. First, the mean monthly individual WTP was estimated based on an interval regression analysis using payment card responses. WTP was elicited using the data with and without protest zero responses. Protest zero occurs when respondents deny some aspects of a hypothetical scenario by reporting zeros, although they accept that the scenario has positive benefits. WTP refusals based on the reason that the government is responsible for the hypothetical project was classified as protest zero in this study. The second part of the analysis tested the structural associations between socio-demographic variables and the psychological variables of awareness, appraisals, and

intentions with WTP, as described in the hypothesis model (Figure 1), based on structural equation modeling (SEM). The variable of participation in environmental conservation was entered as binary data (1 = yes, 0 = never). All data processing and analyses were conducted using Stata 15.0 (Stata Corp.).

4. Results

4.1 Demographic and psychological characteristics of the respondents

The key characteristics of the respondents are summarized in Table 1. About half of the respondents (54.15%) in the survey were female. The mean age of the respondents was 31.73 years old (SD = 10.87). Nearly three-quarters of the respondents (74.75%) had completed a university degree. About a third of the respondents (32.23%) were government employees. The mean individual monthly income was 259,302 Kyats (approximately 170 USD, SD = 207,195). About half of the respondents (54.48%) had lived in Mandalay City for 21 years or more. Just under a third (28.57%) of the respondents had participated in environmental conservation activities.

When it came to awareness, almost all the respondents (96.01%) had concerns regarding river pollution in the study area, with a mean score of 3.41 (SD = 0.83) out of 4. Furthermore, a higher proportion of respondents (99.67%) were concerned about health risks, due to river pollution, to residents living near the industrial wastewater discharge area (3.58 out of 4, SD = 0.66), while approximately 90% of them perceived health risks to their families and themselves (3.14, SD = 1.04). Respondents had overall high degrees of intentions for river water improvement (for responsibility, 4.24 out of 5, SD = 0.44; for contribution, 4.24, SD = 0.69).

Table 1 Descriptive statistics of the respondents (n=301)

Variables	Mean, %	SD	Min	Max
Gender (female %)	54.15			
Age (years)	31.73	10.80	24	65
Education (university degree %)	74.75			
Occupation (government staff %)	32.23			
Monthly individual income (Kyats)	259,302	207,195	0	1000,000
Years of living in Mandalay (% of more than 20 years)	54.48			
Participation in environmental conservation activities (yes %)	28.57			
River pollution awareness	3.41	0.83	1	4
Health risk appraisal on residents living near the pollution source	3.58	0.66	1	4
Health risk appraisal on self and family	3.14	1.04	1	4
Intention for river improvement (responsibility)	4.24	0.44	1	5
Intention for river improvement (contribution)	4.24	0.69	1	5

Note: 1USD = 1,500 Kyats.

4.2 WTP estimation

Table 2 shows WTP responses for improving the water quality of the Dokehtawaddy River. Among a total of 301 respondents, 207 (68.77%) respondents were willing to pay for the hypothetical river water improvement project, while 94 (31.23%) respondents declined to pay. Among the respondents who were willing to financially contribute, 65 (21.59%) respondents selected the payment card option of 1,000 Kyats, which was the most popular choice among the respondents followed by 5,000 Kyats ($n = 39$, 12.96%) and 3,000 Kyats ($n = 37$, 12.29%). Twenty-eight (9.3%) respondents selected 500 Kyats or below while 13 (4.32%) respondents selected more than 5,000 Kyats. The mean monthly individual WTP for the hypothetical river water improvement was estimated as 1,461.995 Kyats (0.98 USD) based on the interval regression analysis.

Of the 94 respondents who declined to pay for the hypothetical project, 44 (46.81%) refused to pay because they could not afford to, followed by 35 (37.23%) who believed that the project was the responsibility of the government. A further 12 (12.77%) believed that the project was the responsibility of both the government and the polluters. Three (3.19%) refused to pay because they were satisfied with the current conditions of the river. The present study classified 47 respondents that indicated the responsibilities of the government (and polluters) as protest zeros. After excluding the protest zeros, the mean monthly individual WTP was estimated at 1,739.982 Kyats (1.16 USD).

According to the General Administration Department (GAD), the population of Amarapura and Pyigyitagon Townships in 2019 were 200,765 and 159,086, respectively, totaling 359,851. They can be considered the beneficiaries of the river water improvement project because they live relatively close to the study area and could be directly or indirectly affected by the industrial wastewater discharge due to their use of this water. Based on this assumption and by applying the estimated WTP, the annual total economic benefits of the proposed project for the entire population of the two townships is estimated as 6,313,204,352.94 Kyats (approximately 4.21 million USD) with protest zeros and 7,513,611,152.184 Kyats (approximately 5.01 million USD) after omitting protest zeros.

Table 2 WTP responses

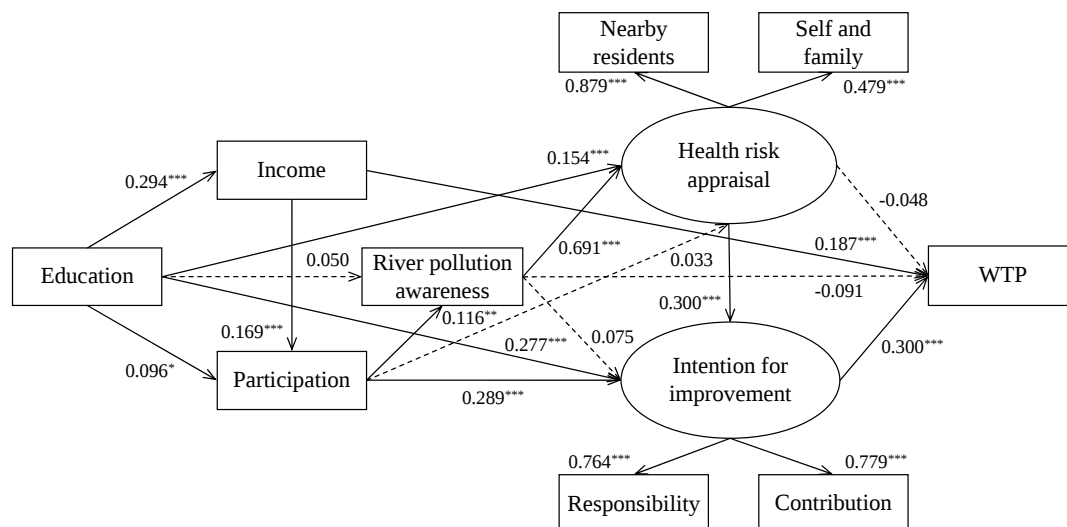
Payment (Yes/No), bid level (Kyats)	Number of respondents	% in Yes (in total)
Yes	207	100 (68.77)
500 or below	28	9.30
1,000	65	21.59
1,500	2	0.66
2,000	17	5.65
2,500	2	0.66
3,000	37	12.29
3,500	2	0.66
4,000	1	0.33

4,500	1	0.33
5,000	39	12.96
More than 5,000	13	4.32
No	94	(31.23)
Total	301	(100)

Note: 1USD = 1,500 Kyats.

4.3 Structural associations between socio-demographic factors, pollution concerns, health risk perceptions, environmental awareness, and WTP

Figure 2 shows the SEM results on associations between socio-demographic factors, pollution awareness, health risk appraisals, and the intentions to achieve a better river environment in terms of willingness to pay for improving the water quality in the Dokehtawaddy River. Goodness of fit statistics indicate a reasonably high acceptable level of model fit (RMSEA = 0.059, CFI = 0.968, (16) = 32.88, $p < 0.01$). Education was found to be positively related to income ($\beta = 0.294$, $p < 0.01$) and participation in environmental conservation activities ($\beta = 0.096$, $p < 0.1$). Participation was also predicted by income ($\beta = 0.169$, $p < 0.01$). Education was found to be positively associated with health risk appraisals ($\beta = 0.154$, $p < 0.01$) and an intention to improve ($\beta = 0.277$, $p < 0.01$), but not with river pollution awareness ($p = 0.386$). Participation was found to be positively associated with river pollution awareness ($\beta = 0.116$, $p < 0.05$) and an intention for improvement ($\beta = 0.289$, $p < 0.01$), while not significant in health risk appraisals ($p = 0.524$). Positive associations were also found between river pollution awareness and health risk appraisals ($\beta = 0.691$, $p < 0.01$) and between health risk appraisals and intentions to improve ($\beta = 0.300$, $p < 0.01$). When it came to WTP, income ($\beta = 0.187$, $p < 0.01$) and intentions to improve ($\beta = 0.300$, $p < 0.01$) were found to be positively associated. Paths from river pollution awareness and health risk appraisals to WTP were not significant ($p > 0.300$).



Notes. N = 301. RMSEA = 0.059, CFI = 0.968, (16) = 32.88, $p < 0.01$. The bold and dotted lines indicate significant and insignificant paths, respectively. Significant at * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. For clarity of visual presentation, covariances of error terms are not shown.

Fig. 2 Structural associations of demographic factors, pollution and health risk perceptions about the Dokehtawaddy River as related to WTP

5. Discussion

The present study estimated WTP for a hypothetical river water quality improvement project in the Dokehtawaddy River due to industrial wastewater discharge. It also examined structural associations between socio-demographic and psychological factors that contributed towards WTP among local residents. The estimated monthly individual WTP after omitting the protest zeros was 1,739.982 Kyats (1.16 USD). This is equivalent to 0.6% of respondents' mean monthly individual income. This value is similar to other CVM studies, for example, a meta-analysis on income elasticity in WTP estimations of water ecosystem restoration in EU countries ranged from 0.6% to 1.7% (Tyllianakis and Skuras, 2016). The estimated value is also equivalent to the purchase price of bottled water for drinking, which is commonly seen among people living in Mandalay City. Water costs between 500 and 700 Kyats per bottle, which adds up to 1,500 to 2,100 Kyats per individual, per month. Thus, the WTP level estimated in the present study can be related to the daily-life expenditure for basic needs.

This study included three specific hypotheses in the hypothesis model. Regarding the first hypothesis (H1), it was found that the level of education directly facilitated health risk appraisals and river water improvement intentions and indirectly facilitated river pollution awareness through participation in environmental conservation. Participation also facilitated the intentions to improve. These results are in line with previous findings (Buster et al., 2012; Echavarren et al., 2019; Valenciano-Salazar et al., 2021). Our study's results are of interest when taking into consideration the benefits of education and experience, in the form of environmental conservation activities, on attitudes toward environmental issues. That is, education, which is defined as school-learning in the present study, may not trigger an awareness of pollution in a specific area, but learning about environmental issues through on-site conservation activities would directly enhance the sense of pollution and awareness that the issue needs to be solved. This suggests that it is important to nurture environmental attitudes among lay people through both formal education and on-site experience to better understand local environmental problems.

Regarding the second hypothesis (H2), river pollution awareness was found to be significant and positive in determining health risk appraisals and indirectly influenced the intentions to improve river water. Hypothesis 3 (H3) on the associations between psychological factors and WTP was verified only on the path from intention to WTP. These results do not fully support the hypotheses but imply an intriguing insight into the step-by-step process of psychological factors when dealing with environmental issues. The current results demonstrate that river pollution awareness raises the perceived health appraisals of people living close to and further away from the pollution source, which consequently enhances a sense of responsibility and a willingness to contribute towards improving river water quality that then leads to an increased willingness to pay (i.e., economic benefits) for the recommended solutions. This finding is consistent with previous findings that investigated causal relationships of awareness, appraisal, and behavioral intention (Bronfman et al., 2015; Story & Forsyth, 2008). These relationships have been tested in several studies,

but mostly in developed societies, and mainly with practical behavior such as conservational activities rather than a willingness to contribute financially. To the best of our knowledge, the present study is the first to examine the structural associations of socio-demographic characteristics and psychological factors (i.e., awareness, appraisal, and intention) with regards to WTP for river environmental improvements in developing societies.

Income was found to be a significant factor in predicting WTP. This result supports many previous findings that WTP for preferable changes in environmental conditions increases with income. In the present sample, nearly half of the respondents who refused to pay mentioned unaffordability as their reason. Indeed, financial affluence can crucially determine an individual's ability to pay, regardless of their environmental attitude.

There are few studies that have estimated non-market values of environmental services in Myanmar. The present study is one of the first to provide economic values for water environmental improvement in the country. This can contribute to a better understanding of the social benefits of environmental policies not only among policymakers but also among general citizens and scientists. The findings of the current study are also helpful in expanding the sequential influences of demographic and psychological characteristics of beneficiaries when evaluating the benefits from water quality improvement of the Dokehtawaddy River. This aids the design of future awareness-raising programs that would effectively synergize the links from education, on-site engagement, and awareness with the intentions to contribute to river water management. Because rivers serve as water resources for local communities and are also used for recreational purposes by local people and visitors, the present findings also help implement effective sustainable river utilization policies in a wider context.

The present study had some limitation. We initially planned to conduct a face-to-face questionnaire survey based on random sampling in communities that lived along the river near the pollution source. However, due to the COVID-19 pandemic, we had to compromise to conduct mixed online and on-site survey models based on convenience sampling. This may have caused a sampling bias as the respondents were likely to be younger, more educated, and living in relatively urban areas. It was therefore excluding older, illiterate populations. The responses in our survey indicated relatively high levels of pollution awareness, health risk appraisals, and, in particular, intentions to improve. While these indicated that local people were indeed deeply concerned about river water pollution, they may have contributed to insignificant results in some paths in the SEM analysis due to the skewing of data distribution at the top. This needs to be examined in a further study with more detail that can measure awareness and other psychological factors.

6. Conclusion

The present study aimed to estimate the WTP for river water improvement in the Dokehtawaddy River in Mandalay City, Myanmar, due to industrial wastewater being discharged into the river. It sought to examine the associations between socio-demographic characteristics, river pollution awareness, health risk appraisals, and the perceived benefits of the local people's intentions to improve (i.e., WTP). The interval regression analysis collected on payment card responses, that were based on a contingent valuation questionnaire survey ($n = 301$), showed that the mean monthly individual WTP for the hypothetical river water quality improvement project was estimated at 1,739.982 Kyats (1.16 USD) without protest zeros. SEM results revealed that education and participation in environmental conservation activities nurtured river pollution awareness, health perception appraisals, and intentions to improve (i.e., responsibility and contribution). In addition, river pollution awareness enhanced health risk appraisals and thereby intentions that led to WTP. These findings indicate the importance of education, both formal and informal through on-site experiences, to raise environmental awareness. They also suggest that there is a step-by-step psychological process of understanding the occurrence of pollution and the potential and actual threats to human health, and a sense of responsibility and willingness to contribute in order to take a specific action in the form of willingness to pay for a river water improvement project. The present study is one of the first to provide evidence for WTP estimations and structural associations among socio-demographic characteristics, environmental attitudes, and WTP in river environmental management issues in developing countries.

Acknowledgements

This study was supported by the Japan International Cooperation Agency (JICA) and the Ministry of Natural Resources and Environmental Conservation, Myanmar. We thank the staff of Environmental Conservation Department for their assistance in the questionnaire survey implementation and the anonymous survey respondents for their contributions. We acknowledge Lei Zhongfang and Akinobu Murakami for their valuable comments on this study.

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