Why Coping Cost is An Underestimate of Willingness to Pay? Some Theoretical Explanations Based on Forest Water Link

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ABSTRACT

One of the revealed preference approaches of finding peoples' willingness to pay to provide a resource conveniently, for an instance, piped water supply to a locality, is through coping cost estimation, where coping costs are costs incurred in different types of coping mechanism to adapt to a resource stress and live in harmony with the limited resource. However, empirical research shows that willingness to pay elicited through surveys is usually higher than the coping costs incurred for the same resource constraint, though the extent of diversion depends on many socio-economic and spatial locational factors. The present study tries to explain the differences theoretically taking the water scarcity in remote hilly areas as an example.

KEYWORDS: Coping cost, Household production function, Willingness to pay, Water

Introduction

Theoretically, coping cost and Willingness To Pay (WTP) are related as coping cost forms the base for WTP. Use of coping cost to estimate peoples' willingness to pay (WTP), before making a provision of a public service, is widely used in environmental and resource economics. Coping costs are costs incurred by households on different types of averting, mitigating and defensive activities to cope with a resource stress and by learning to live in harmony with the limited resource (Pereira *et al.,* 2009; Cook *et al.,* 2015; Ahile *et al*., 2015). Coping cost has been widely studied with respect to water stress in order to find out peoples' behavior and their willingness to pay to avail improved water supply. Drinking water supply is an important public policy issue, especially in developing countries, as access to clean potable water is limited only to some section of the population. Universal access to clean water constitutes the 6th Goal of Sustainable Development Goals and this is a mandate for all governments to achieve by 2030. Also reaching this goal would go a long way in reducing poverty and ensuring

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good health, which are other important Sustainable Development Goals along with goal 6 (UN, 2014). However, to design policies for improved municipal water services, it is crucial to have a clear and conclusive evaluation of social benefits which in turn depends on information about peoples' demand for improved water supply services (Whittington *et al.,* 2006). Coping cost analysis help in revealing a lot of information on peoples' water use related behavior and accordingly, help in policy formulations.

Globally people are seen to be engaged in different types of coping activities that can be clubbed into 6 major strategies (Whittington *et al.,* 1990; Mishra, 2006; Pattanayak *et al.,* 2005; Cook *et al.,* 2015):

i) Collecting strategies (collecting water from sources other than their in-house water connection);
ii) Pumping strategies (using groundwater through hand pumps or tube wells);
iii) Storing strategies (storing municipal water or water collected from other sources for longer use);
iv) Treating strategies (recycling or filtering unclean water through boiling or chemicals)
v) Forgoing strategies (either rescheduling or not doing some of the water-dependent activities);
vi) Purchasing strategies (purchasing water from vendors or neighborhood).

People incur the cost or suffer losses when they undertake such activities and these are called coping costs. There is also another coping costs called as "avoided illness cost". People can get ill due to the poor quality of water and therefore have to incur health costs. These are costs in terms of money spent on medicines, doctor's fee, earnings lost due to absence from work, etc. (Pattanayak *et al.,* 2005; Nauges and Whittington, 2006; Katuwala and Bohara, 2011).

Coping activities are visible and coping costs can be measured to find out how strongly people feel about the water or resource scarcity whereas willingness to pay (WTP), the amount of money a person will be willing to pay for improved water services, is invisible and has to be estimated indirectly. WTP can be accessed by analyzing how much households spend to cope with the situation of water stress. Demand for water has been studied by both stated preference and revealed preference studies, both approaches having their own limitations. While stated preference studies, such as contingent valuation and conjoint method studies, that directly measure households' willingness to pay for contingent or hypothetical improvements in water are more comprehensive, they are vulnerable to validity threats and usually overestimate the true economic benefits. Revealed preference studies, like avoided or coping cost studies, on the other hand, measure the economic benefits by examining the actual preventive behaviour of people when faced with water stress. Such studies measure either the prevention costs incurred to cope with poor water or the savings in prevention costs resulting from improvements in water availability. However, it has been argued that these measures usually underestimate the true economic benefits of a given intervention because they do not capture the economic value of a lowered risk of death or of reduced pain and suffering (Pattanayak *et al.,* 2010). Rightly so, empirical analysis on enhanced water provisioning has shown coping cost to be lower than the willingness to pay for improvements in water supply in most of the cases (Whittington *et al.,* 1990; Pattanayak *et al.,* 2005; Cook *et al.,* 2015). Though many studies have shown that coping cost underestimates the WTP (McConnell and Rosado, 2000; Pattanayak *et al.,* 2005), it has also been found that WTP can be lower than the coping cost in some cases (Mishra, 2006)[2]. It is argued that coping costs deviate downwards from the true WTP if "coping behaviors are suboptimal, inefficient, or incomplete for reasons such as information costs, uncertainty, or limited property rights to draw water sources", though coping cost has a positive correlation with WTP (Pattanayak *et al.,* 2005). Present study follows the revealed preference method and examines the coping behavior of people when faced with water stress to explain the components that make WTP deviate from coping cost. The coping cost approach is commonly applied in the context of water stress as it is easier to observe the coping strategies adopted by the households as compared to other stresses like air pollution where seemingly coping activities (buying air purifier) may be induced more by economic factors rather than the stress. In such cases, health cost may be a more appropriate indicator of air pollution cost.

The motivation of this paper is to elaborate the theoretical reasons for WTP being different from the coping cost. The extent of diversion between them is highly dependent on the type of stress, the socio-economic and location factors of the suffering households. This has been elaborated more clearly in the next section. This study uses a simple household production function model to bring home the points. It focuses on a community in a remote hilly area who faces water stress, has no market access to purchase water, and thus, is dependent on the nearby forest for its water needs. The paper explains how and why the coping cost is an underestimate of WTP for such a community. Needless to say, mitigating water stress is the primary activity of the community since access to water is crucial and necessary for the survival and reproduction of their bodies. Below we summarize some of the global findings on coping cost to water stress and then explain the theoretical model in the subsequent section.

Studies on Coping Cost and Willingness to Pay

There are many studies across developed and developing countries that assess the various coping strategies adopted by people and the costs borne by them. Coping costs can be different for the same type of households depending on the nature of the threats. Averting expenditures for safe drinking water was found to range from $153 to $483 per month, for Pennsylvania (Harrington *et al.,* 1989), whereas the cost of coping, when there is water contamination, was found to vary between $6 and $32 for the same region (Laughlin *et al.,* 1993). Collins, *et al.,* (1993) did a study on rural West Virginia and found that, on an average, the monthly cost to the household for averting activities ranged from $32 to $36 to deal with contaminants, though there were no attempts to estimate the WTP in these studies.

[2]This was however, valid only for non-domestic or commercial water user units.

In case of developing countries such as Nepal, the monthly coping cost for water scarcity was estimated to be $2.94, but the WTP was found to be much higher, $17.36, for getting regular water (Pattanayak *et al.,* 2005). Wu and Huang (2001) did a study on Taiwan using the contingent valuation method to compare the actual averting expenditure and the stated WTP. The final averting expenditure for each household, on average, was estimated to be NT $617.24 for every 2 months. The mean willingness to pay was measured from the utility difference model and expenditure difference model and estimated to be NT $599.52 and NT $634.64 respectively (Wu and Huang, 2001). In case of India, a study on Delhi reveals that the average monthly coping cost of households is Rs 187 or around Rs 10 per kiloliters of water consumed whereas, taking all categories of households together, the WTP is about Rs 215 per month in case of authorized colonies and in case of underserved areas, excluding the JJ clusters, it is about Rs 163 per month. Though lower than the coping cost, these are higher than the average water bill which is nearly Rs 140 per month (Misra and Goldar, 2008). These findings bring out the role of paying capacity and nature of residential areas in deciding the WTP and its relation to coping cost. Haq *et al.,* (2008) did a study in Abbottabad district in Pakistan and concluded that there is the statistically significant effect of location on WTP that, in urban areas, households have more WTP for improved water services. The study also found that sources of water have a significant effect on WTP i.e. the households who have their own source are willing to pay in the higher range (Haq *et al.,* 2008).

In a World Bank study that analyses water-related coping cost in 10 states of India (Andhra Pradesh, Karnataka, Kerala, Maharashtra, Orissa, Punjab, Tamil Nadu, Uttar Pradesh, Uttarakhand, and West Bengal), it has been found that in rural areas the average monthly coping cost per household is Rs 81 (US$1.8), ranging from Rs 32 (US$0.7) to Rs 287 (US$6.5) across the states. Most of these costs are due to time spent in collecting water from other sources which are located at far distances so that household members have to travel quite a distance and wait in long queues (Misra, 2008). Pattanayak *et al.,* (2010) examine the impact of water supply and sanitation program in four rural districts of Maharashtra, India. They found that on average, time costs of water collection per month was US$ 31.94 in the dry season and US$ 38.76 in the rainy season in 2005. In 2007, these costs fell to US$ 30.24 in the dry season and US$ 20.10 in rainy season, after some improvement in water provisioning through institutional interventions. In rural Kenya, the coping cost on an average has been estimated to be $38 per month and the majority of it is attributed to the time cost of water collection. It has also been revealed that more than half of the population spends more than 10% of reported cash income as coping cost. (Cook *et al.,* 2016).

In urban areas, while households are more connected to water markets and are able to better cope with water stress, low-income households are at a greater risk when there is irregular water supply (Zerah, 2000; Dutta *et al.,* 2005). For rural dwellers, if one source dries up or gets contaminated, they have to search for another source. Sometimes, it may be difficult to find other sources due to limited alternatives (Ahmad *et al.,* 2005). Thus, it is the poor and the people in rural areas that become worse off. This is reflected in findings of Vasquez (2012) from Nicaragua that shows almost 80%

of households to use at least one storage device on which they spend an average 0.87% of their income. Another study by Vasquez in Mexico indicates that households are willing to pay from 1.8% to 7.55% of reported household income above their current water bill for safe and reliable drinking water services (Vasquez, 2009).

Thus studies show that the costs incurred differ depending on the region, the degree of water stress, and socio-economic characteristics of a household. The type of strategy that is used to cope with water stress – collect water from different sources, purchase water, whether to boil or filter, depends on various factors such as income, education, gender, occupation, geographical location, number of household members etc. (Larson and Gnedenko, 1999; McConnell and Rosado, 2000; Pattanayak *et al.,* 2005; Jalan *et al.,* 2009). Table 1 in appendix summarizes some of the studies by putting together the coping strategies and the cost incurred with remarks.

There are very few studies that look into coping costs incurred by households in remote areas where access to water market is limited (Pattanayak *et al.,* 2010; Kremer *et al.,* 2011; Jessoe, 2013; Cook *et al.,* 2016). This study models the coping costs of people living in remote hilly areas who are dependent on forests, for most of their requirements including water and they suffer when forest quality deteriorates leading to water scarcity.

Theoretical Analysis

To better understand households' behavioural decisions around coping with scarce water supply, we begin with a household production function approach, based on Pattanayak *et al.,* (2005) and Pattanayak and Pfaff (2009). Utility maximization under a household production function framework provides a complete understanding of this concept (Pattanayak *et al.,* 2005; McConnell and Rosado, 2000).

The descriptions below show the WTP of a forest dweller household to restore back the changes in forest quality which can be either deforestation or spread of invasive species in place of native trees that has resulted in a reduced flow of many provisioning services including water to the household.

The Theoretical Model

A utility-maximizing household allocates his/her time and income to leisure (T1), health (H), some primary production (P) at home like livestock keeping, vegetable farming, etc. and consumption of a composite commodity (Z) from the market. The household also undertakes to cope activity (C) if faced with water stress. The quantity and quality of water enter into the utility function through health as health is dependent on water and on primary production at home. The following variables and the model explain the theoretical approach to the derivation of the coping costs.

T : Total time available to a household
T1 : Leisure
T2 : Time spent on coping activities
T3 : Time spent on primary production at home
Z : Consumption of market good whose price is normalized to 1

M : Inputs for coping activities
I : Inputs for primary production
H : Health status measured as a number of sick days. It is a function of Coping Activities (C) and primary production at home (P). Water supply (W) affects Health status indirectly through C and P.
C : Coping activities which is a function of T2 and M
W : Water supply which is a function of Government Policies (G) and forest type (F)[3]
P : Primary production at home which depends on time used in it (T3) and some inputs (I).
θ : Household specific preference parameter
N : Non-wage income
w : Wage rate
p1 : the price of coping goods
p2 : the price of inputs of primary production at home

In the context of the study area, we make some specific assumptions like water availability in any season to be depending on only forest and government policies are unchanged in the short run. Next, we assume time allocation to activities (T1, T2, and T3) to depend on water and so also M, the input need for coping activity (say, storage items). This is because, in a remote area, the strategies to mitigate water stress are limited. There is no developed market where they can purchase sufficiently reliable and potable water and instead, engage themselves in other activities of their choice like wage employment or home-based production or even leisure.

It is in keeping in line with this specific context where mitigating water stress is the primary and foremost activity, that this paper takes all other activities like time spent as leisure (T1), time spent in coping activities (T2) or time spent in home-based production (T3) as all dependent on the water supply. In simple words, it is the quality and quantity of water supply that becomes the principal parameter for a household to allocate time on various activities. They may even have to compromise on their employment or sacrifice their leisure in order to adapt to water stress and live in harmony with the scarce water resource. This is a very simple and unsophisticated model and incorporating further complications is a future scope of this paper. Input I, input requirement for primary production (fodder for livestock), in turn, is assumed to depend only on the forest nearby. Last, the objective of a household is to maximize utility subject to time, health and income constraint.

In functional forms:

$$T = T_1 + T_2 + T_3 \tag{1}$$

$$T_1 = l(W) \tag{2}$$

$$T_2 = c(W) \tag{3}$$

$$T_3 = p(W) \tag{4}$$

[3]The assumption is that good forest help in recharge of water that help in better provision of water.

$$M = M(W) \tag{5}$$
$$I = I(F) \tag{6}$$
$$W = W(F, \overline{G}) \tag{7}$$
$$P = P\{I(F), T_3(W)\} \tag{8}$$
$$H = H[C\{T_2(W), M(W)\}, P\{I(F), T_3(W)\}] \tag{9}$$

The Utility function of a household depends on the leisure he gets (T1), consumption of market commodities which is taken as exogenous (Z), his health (H, measured in the number of sick days) and a preference parameter (θ)[4] as shown below:

$$U = U(T_1, H, \overline{Z}; \theta) \tag{10}$$

The budget constraint for a household is defined as:

$$Y = N + w(T - T_1 - T_2 - T_3 - H) - p_1 M - p_2 I - Z \tag{11}$$

Such that the expenditure on consumption items, whose prices are normalised to 1 (Z), household's coping activities (M) and household's primary production at home (I) should not be greater than total income, which is a sum of Non-wage income (N) and wage income with wage rate w.

The Lagrangian of Utility Maximization (ϕ) under health production and income constraint is presented in the following equation where μ is the Lagrangian multiplier representing marginal utility of income and Utility is conditional on preference parameter, θ:

$$\begin{aligned} &\Phi_{T_1,T_3,T_3,P,Z,C} = \\ &MaxU\ [T_1(W), Z, H\{C\{T_2(W), M(W)\}, P\{I(F), T_3(W)\}\}; \theta] \\ &+ \mu\ [N + w[T - H\{C\{T_2(W), M(W)\}, P\{I(F), T_3(W)\}\} \\ &- T_1(W) - T_2(W) - T_3(W)] - p_1 M(W) - p_2 I(F) - Z] \end{aligned} \tag{12}$$

The corresponding utility maximizing minimum expenditure function (Ω) necessary to attain utility level U* is defined as:

$$\begin{aligned} &\Omega_{T_1,T_3,T_3,P,Z,C} = \\ &Min\ w\ \left[H\{C(T_2(W), M(W)), P(I(F), T_3(W))\} + T_1(W) + T_2(W) + T_3(W)\right] \\ &+ p_1 M(W) + p_2 I(F) + Z - wT + \\ &\lambda[U^* - U\{T_1(W), Z, H\{C(T_2(W), M(W)), P(I(F), T_3(W))\}; \theta] \end{aligned} \tag{13}$$

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[4]Although preferences may vary for each of the goods T, H and Z since the focus here is the coping cost, we have tried to simplify the model by using a single preference parameter.

Using envelope theorem, the first derivative of expenditure function with respect to forest type (F) [5]can be written as follows:

$$\frac{\partial\Omega}{\partial F}=\left[w\frac{\partial T_1}{\partial W}\frac{\partial W}{\partial F}+w\frac{\partial T_2}{\partial W}\frac{\partial W}{\partial F}+w\frac{\partial T_3}{\partial W}\frac{\partial W}{\partial F}+p_1\frac{\partial M}{\partial W}\frac{\partial W}{\partial F}+p_2\frac{\partial I}{\partial F}\right]$$
$$+w\frac{\partial H}{\partial F}-\lambda\left[\frac{\partial U}{\partial T_1}\frac{\partial T_1}{\partial W}\frac{\partial W}{\partial F}+\frac{\partial U}{\partial H}\frac{\partial H}{\partial F}\right] \tag{14}$$

Where,

$$\frac{\partial H}{\partial F}=\frac{\partial H}{\partial C}\left[\frac{\partial C}{\partial T_2}\frac{\partial T_2}{\partial W}\frac{\partial W}{\partial F}+\frac{\partial C}{\partial M}\frac{\partial M}{\partial W}\frac{\partial W}{\partial F}\right]+\frac{\partial H}{\partial P}\left[\frac{\partial P}{\partial I}\frac{\partial I}{\partial F}+\frac{\partial P}{\partial T_3}\frac{\partial T_3}{\partial W}\frac{\partial W}{\partial F}\right] \tag{15}$$

By rearranging the terms, we get

$$\frac{\partial H}{\partial F}=\frac{\partial W}{\partial F}\left[\frac{\partial H}{\partial C}\frac{\partial C}{\partial T_2}\frac{\partial T_2}{\partial W}+\frac{\partial H}{\partial C}\frac{\partial C}{\partial M}\frac{\partial M}{\partial W}+\frac{\partial H}{\partial P}\frac{\partial P}{\partial T_3}\frac{\partial T_3}{\partial W}\right]+\frac{\partial H}{\partial P}\frac{\partial P}{\partial I}\frac{\partial I}{\partial F} \tag{16}$$

Thus, the effect of a change in the forest on health outcomes come through two different channels: (i) indirectly through the water availability that affects time allocation and investment for coping activity and time allocation to primary production at home. (ii) Directly through the input availability for primary production. Putting the equations 16 in equation 14 and rearranging the terms, we get:

$$\frac{\partial\Omega}{\partial F}=\frac{\partial W}{\partial F}\left[\begin{array}{l} w\frac{\partial T_1}{\partial W}+w\frac{\partial T_2}{\partial W}+w\frac{\partial T_3}{\partial W}+p_1\frac{\partial M}{\partial W}+ \\ w\left[\frac{\partial H}{\partial C}\frac{\partial C}{\partial T_2}\frac{\partial T_2}{\partial W}+\frac{\partial H}{\partial C}\frac{\partial C}{\partial M}\frac{\partial M}{\partial W}+\frac{\partial H}{\partial P}\frac{\partial P}{\partial T_3}\frac{\partial T_3}{\partial W}\right] \\ -\lambda\{\left[\frac{\partial U}{\partial T_1}\frac{\partial T_1}{\partial W}\right]+\frac{\partial U}{\partial H}\left[\frac{\partial H}{\partial C}\frac{\partial C}{\partial T_2}\frac{\partial T_2}{\partial W}+\frac{\partial H}{\partial C}\frac{\partial C}{\partial M}\frac{\partial M}{\partial W}+\frac{\partial H}{\partial P}\frac{\partial P}{\partial T_3}\frac{\partial T_3}{\partial W}\right]\} \end{array}\right]$$
$$+[p_2\frac{\partial I}{\partial F}+w\left[\frac{\partial H}{\partial P}\frac{\partial P}{\partial I}\frac{\partial I}{\partial F}\right]-\lambda\frac{\partial U}{\partial H}\frac{\partial H}{\partial P}\frac{\partial P}{\partial I}\frac{\partial I}{\partial F}] \tag{17}$$

Equation 17 is the change in the minimum expenditure of the household due to the change in forest cover in the watershed as the household is completely dependent on the forest ecosystem. This should be his equivalent willingness to pay (WTP) to bring in improvement in forest type or quality to improve water supply. We divide this into two component, the first part is his/her WTP for water stress (the terms within

[5] We derive change in expenditure due to forest change as we are considering a forest dependent household who gets his basic requirements from the forest so that any change in forest quality shatters his budget.

the big bracket) and the second component is WTP due to the direct dependency on the forest for input requirements like fodder, fuel wood etc.

Economic Interpretation of the terms

WTP for water stress is the change in expenditure due to the change in the water supply as a result of changing forest type. It comprises of 3 components;

***Monetary burden*:** It is the coping cost through labour reallocation and purchase of inputs. It is the sum of the values of coping activities to take care of water stress, i.e., the opportunity cost of lost leisure, cost of extra labour spent on coping activity and on primary production at home and value of extra inputs purchased for being used in mitigating activities related to water stress.

$w\frac{\partial T_1}{\partial W}$ = Opportunity cost of leisure

$w\frac{\partial T_2}{\partial W}$ = Opportunity cost of extra time spent in coping activity

$w\frac{\partial T_3}{\partial W}$ = Opportunity cost of extra time spent in primary production at home

$p_1\frac{\partial M}{\partial W}$ = Monetary value of expenditure on coping goods

Cost of Illness (or illness avoided) due to water: It is the imputed lost income or wages lost or saved due to change in health conditions as a result of a change in water availability resulting from a change in forest type. It is the summation of the following terms:

$\frac{\partial H}{\partial C}\frac{\partial C}{\partial T_2}\frac{\partial T_2}{\partial W}$ = Health impact (illness) avoided (or suffered) due to change in time allocated to coping activities

$\frac{\partial H}{\partial C}\frac{\partial C}{\partial M}\frac{\partial M}{\partial W}$ = Health impact avoided (or suffered) due to change in expenditure on coping inputs

$\frac{\partial H}{\partial P}\frac{\partial P}{\partial T_3}\frac{\partial T_3}{\partial W}$ = Health impact avoided (or suffered) due to change in time allocated to primary production

Though the net effect on health is difficult to say as the household tries to avoid the health impacts through coping activities and primary production, they may not be enough to neutralize the negative consequences of water stress. The net effect on health is multiplied by wage rate to monetize the impact by measuring the loss (or gain) in income.

Pain and Suffering faced by a household: It is the utility loss due to the pain and suffering incurred by a Household. It is imputed through the following terms, all multiplied by –λ, the Lagrange multiplier or the marginal utility of money:

$\frac{\partial U}{\partial T_1}\frac{\partial T_1}{\partial W}$ = Change in utility due to change in leisure time

$\frac{\partial U}{\partial H}\frac{\partial H}{\partial C}\frac{\partial C}{\partial T_2}\frac{\partial T_2}{\partial W}$ = Change in utility due to illness suffered [or avoided] due to time re-allocation to coping activities

$\frac{\partial U}{\partial H}\frac{\partial H}{\partial C}\frac{\partial C}{\partial M}\frac{\partial M}{\partial W}$ = Change in utility from suffered [or avoided] illness due to expenditure on coping inputs

$\frac{\partial U}{\partial H}\frac{\partial H}{\partial P}\frac{\partial P}{\partial T_3}\frac{\partial T_3}{\partial W}$ = Change in utility from suffered [or avoided] illness due to time reallocation to primary production at home

Similarly, WTP for restoring direct benefits from forest consists of the following three components:

$p_2\frac{\partial I}{\partial F}$ = Cost of inputs purchased for primary production

$w[\frac{\partial H}{\partial P}\frac{\partial P}{\partial I}\frac{\partial I}{\partial F}]$ = Income loss avoided [or suffered] due to purchase of inputs to use in primary production

$[\frac{\partial U}{\partial H}\frac{\partial H}{\partial P}\frac{\partial P}{\partial I}]$ = Change in utility due to purchase of inputs used in primary production at home that used to be available free before

The above calculations make it clear that the WTP for forest restoration to avoid both water stress and input requirements has two components each, one is the monetary component and the other is the psychological or utility component. The monetary component is the coping cost of the household, which is a visible item on how the family is trying to cope up with the stress. The utility component is a positive item as the decrease in utility is multiplied by a minus λ. Thus, the WTP is higher than the coping cost or coping cost is only a lower bound of WTP. The divergence between WTP and the coping cost will depend on the number of uses of the resource (water) in household as utility loss will vary accordingly.

Conclusions

This study derived the WTP of a forest-dependent household living in a remote area to improve forest quality that will ensure better availability of water. Water is assumed to be used for primary production at home other than uses like cooking, drinking etc. WTP is found to be consisting of two broad components, the coping cost which is the visible component and the pain and suffering to the household, which is the invisible component. The pain and suffering are due to loss of leisure as the household spend more time in water collection, more time in doing primary production, indirect health impacts due to water scarcity, and loss of utility as the households have to buy inputs from the market, even though they are freely available from the forest. These invisible pain and suffering components explain why the coping cost is lower to the WTP of the household. Though this is a theoretical paper without any empirical analysis, nonetheless, it uses examples from studies in many parts of the world to provide empirical support to the study.

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Appendix

Table 1: Coping Strategies to Water Stress and Coping Cost in Selected Countries

Country and reference	**Coping Activities**	**Total coping cost or willingness to pay**
Kenya (Cook *et al.,* 2015)	(a) Collection (b) Storage (c) Rainwater Harvesting (d) Purchasing (e) Cost of treating diarrhoea (f) Treatment or boiling	Dry Season: Mean- KSh 3380 per month ($39) Median: KSh 1777 per month ($20) Rainy Season: Mean: KSh 2137 per month Median: KSh 855
Maharastra, India (Pattanayak *et al.,* 2010)*	(a) Collection (b) Filter (c) Boiling (d) Chemical (e) Storage (f) Sanitation (g) Medical Expenses	Dry season: $6.98 per month Rainy season: $0.37 per month + Medical expenses of $1.25 per month in dry and $0.11 per month in the rainy season
Dhaka, Bangladesh (Alam and Pattanayak, 2009)	(a) Installation and maintenance of point water sources (b) Purchase (c) Collection (d) Storage (e) Treatment	Tk 1873 per month (i) 45% of total coping cost accrues to collection cost only. (ii)Coping cost is proved to be lower for the poor population.
Urban India (Jalan *et al.*, 2009)	(a) Straining water with an ordinary cloth (b) Using alum tablets (c) Ordinary filter (d) Boiling water (e) Electronic filter	Mean WTP: Rs. 125 p.a. Median WTP: Rs. 92 p.a. (i)Focuses only on water treatment as coping cost. (ii) Awareness proxy measures have significant effects on different purification methods used and on WTP

Mexico (Vasquez, 2009)	(a) Bottled water (b) Home-based Treatment (c) Storage	WTP is 1.8% to 7.55% of income above water bills
Delhi, India (Mishra, 2006)	(a) Borewell (b) Ground level Reservoir (c) Overhead Tank (d) Underground Reservoir (e) Internal Pipeline (f) Filters	<u>Authorised Colonies</u>: Rs. 226 per month <u>Unauthorised Colonies</u>: Rs. 181 per month <u>Non-domestic Units:</u> Rs. 360 – Rs. 741 (i) For non-domestic units, WTP is less than the coping cost
Kathmandu, Nepal (Pattanayak *et al.,* 2005)	(a) Collecting (b) Pumping (c) Treating (d) Storing (e) Purchasing	<u>With Piped water connection:</u> $3.3 per month <u>Without Piped water connection:</u> $2.79 per month (i)Coping cost is found to be lower bound for WTP. It is also statistically correlated with WTP and several households' characteristics.
Kenya (Whittington *et al.,* 1990)*	(a) Buying from vendors (b) Collecting from kiosks (c) Collecting from open wells	Cost of buying from vendors = $30.2 Cost of collecting from kiosks = $13.7 Cost of collecting from open wells = $ 8.2
Nigeria Whittington *et al.,* 1990*	(a) Buying from vendors	Cost of buying from vendors = $21.4 to $34.2

* These values reported are adjusted for purchasing power parity and inflated to 2007 United States dollars