Demand for Environmental Quality in Kathmandu, Nepal: Evidence from Knowledge, Attitude, Behavior and Choice Experiment Survey

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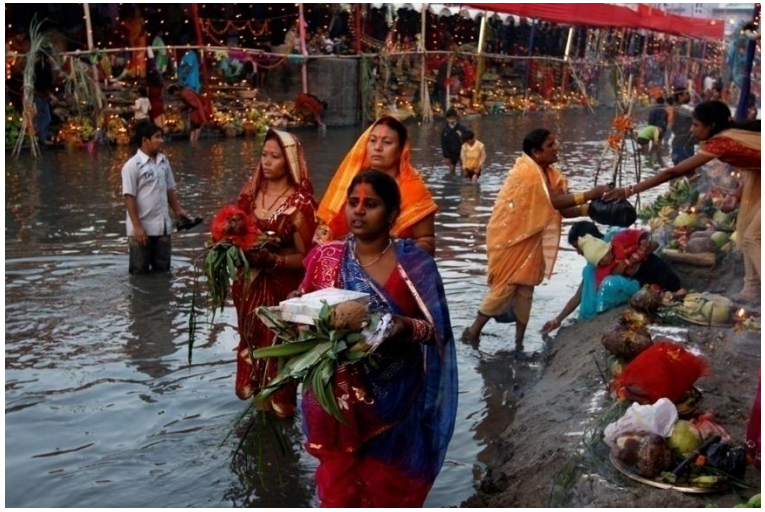
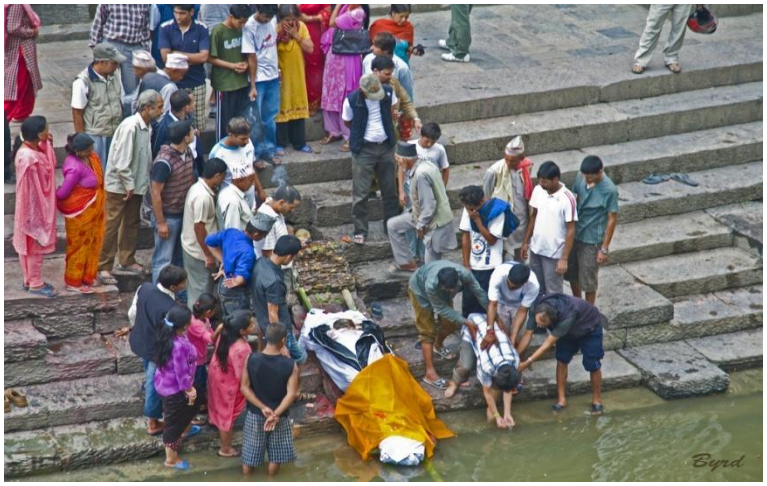
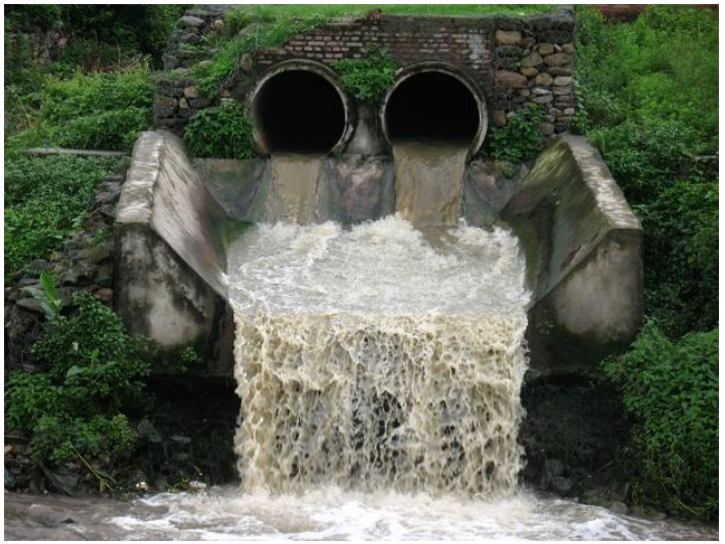
Aesthetic, Cultural, Religious and Agricultural uses

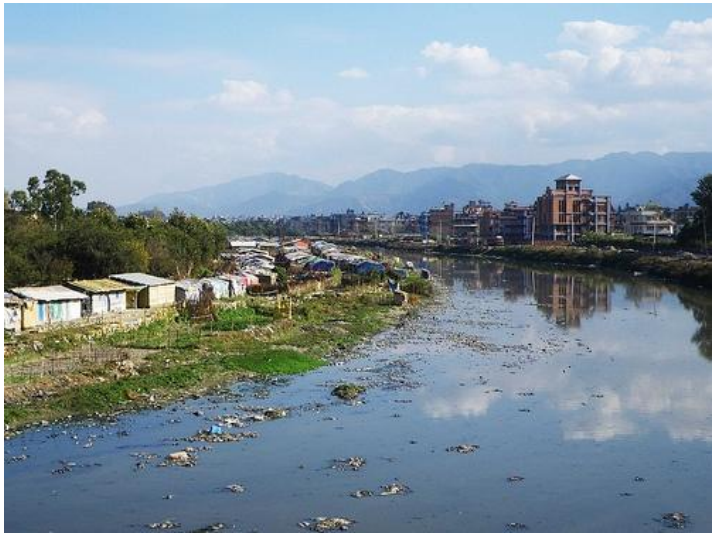




Highly Polluted

- Sewage and waste water discharge
- Solid waste disposal





Motivation

- Lack of studies that assess public preferences and estimate benefits of improving water quality

- Long term river rehabilitation and restoration program e.g. Bagmati Action Plan

My Contribution to Literature

- One of very few studies on choice experiment in developing countries
- First of its kind in Nepal to estimate benefit of improving river water quality using comprehensive choice experiment survey
- Information on preferences towards improved river water quality

Outline

1. The Survey
2. Choice Experiment study (ch2)
3. KAB river water study (ch3)
4. Drinking water treatment behavior study (ch4)
5. Future Research

Objectives and Research Questions

- Understanding public preferences towards river
- Estimate benefit of improving river water quality
- Relationship between knowledge, attitude and participation behavior towards river
- Determinants of drinking water treatment behavior

Preview of the Results

- Kathmanduities are willing to pay NRS 1600 (US$1=NRS75) a year for the improvement of river water quality

- Attitude is positively associated with environmental participation. However, there are some determinants that influence attitude in one direction but the participation in opposite

- Exposure to information, knowledge, and community participation play an important role in influencing treatment behavior.

The Survey

Focus group and pretest

- Discussion with key informants
- 3 – Focus group discussions
- Pretest (40 households)

In-person survey

- 1200 households
- 40 Cluster, 30 households
- Respondents 18+ year
- Response rate 75%

Sample Profile

Variables	Mean	CBS(2005)	Whittington	Pattanayak et al
Income (000 NRS/month)	19.99	-	12.5	229/m
Male	0.65	-	*.63*	*.63*
Age of the respondents	35.83	-	34	36.7
Edu. level of respondents	11.95	-	10	-
No of yrs in the community	8.95	0	-	
Size of the family	5.7	4.7	-	
Home Owners	0.72	.59	.88	86
Newar	0.45	.29	.61	
Brahmin	0.22	.23	-	
Kshetri	0.16	.18	-	.

Public Preferences and Willingness to Pay for Improving Water Quality in Nepal's Bagmati River: Evidence from Choice Experiments

- Identification of important attributes of river health
- Estimation of benefit of improving water quality using CE data

Choice Modeling on River Water quality

Large literature in developed world

- Adamowicz et al. 1994, Carlsson et al. 2003, Hanley et al. 2006, Bateman et al. 2006, Birol et al. 2006

Very few studies in developing world

- Othman et al. 2004 - Matang, Malaysia,
- Do et al. 2008 - Mekong delta, Vietnam,

An Example of a Choice Set

Attributes	Alternative A	Alternative B	Alternative C- Current situation
Water quality	**Walkable on the riverbank**	**Walkable on the riverbank, suitable for fish and plants and, suitable for swimming and bathing**	**The water is black, emits a foul odor, and is not suitable for fish and other aquatic animals. Contact with the water is dangerous to human health.**
Riverside tree plantation	**40 percentage**	**80 percentage**	**20 percentage**
Who is incharge of managing funding?	**Municipality**	**Government**	**Current**
My annual payment for 5 years	**Rs 3000 per year**	**Rs 600 per year**	**Rs 0 per year**
Time Contribution per year	**10 days**	**15 days**	**0 days**

Which do you prefer?

1. Alternative A 2. Alternative B 3. Status quo C

Attributes and Levels

Attributes	Levels
Water quality	Current, Walkable (WQ1), Fishable (WQ2), Bathable (WQ3),
Plantation	20%, 40% , 60%, 80%
Management	Current, Community, Municipality, Government
Cost (Rs per yr)	0, 600, 1200, 1800, 2400, 3000
Time contribution (days per yr)	0, 5, 10, 15

Design and Implementation

- Main effect orthogonal design
- D- optimal design (Kuhfeld, 2009)
- Total of 18 choice sets
- 6 set of questionnaires
- 3 choice set to each respondents
- 3 alternatives in each choice set

Theoretical Framework & Econometric Estimation

Random Utility Model, McFadden (1986);

$$\Pr_i(j) = \Pr(U_{ij} > U_{ik}); \forall j \neq k$$

The Conditional Logit Model;

$$LogL = \sum_{i=1}^{n} \sum_{j=1}^{J} d_{ij}.Log \Pr_i(j)$$

Marginal Willingness to Pay;

$$MWTP = -\frac{\beta_j}{\beta_C}$$

Estimation

$$V_A = b_1 * W\_QUALITY2 + b_2 * W\_QUALITY3 + b_3 * PLANTATION + b_4 * (PLANTATION)^{1/2} + b_5 * MUNICIPALITY + b_6 * COMMUNITY + b_7 * COST + b_8 * WTC + b_9 * (WTC)^{1/2}$$

$$V_B = b_1 * W\_QUALITY2 + b_2 * W\_QUALITY3 + b_3 * PLANTATION + b_4 * (PLANTATION)^{1/2} + b_5 * MUNICIPALITY + b_6 * COMMUNITY + b_7 * COST + b_8 * WTC + b_9 * (WTC)^{1/2}$$

$$V_C = ASC$$

Conditional and Random Parameter Logit Model

Conditional Logit Model

$$U_{ji} = V(X;b)_{ji} + e_{ji}$$

V is the deterministic component of the utility

e_{ji} random error

Random Parameter Logit Model

$$U_{ji} = V(X;\beta)_{ji} + [\varepsilon_{ji} + \eta_{ji}]$$

Descriptive Statistics

Variables	Definition	Mean
W_QUALITY2	Water quality level that is suitable for fish and aquatic life (1=Yes, 0=No)	0.24
W_QUALITY3	Water quality of level that suitable for swimming (1=Yes, 0=No)	0.2
PLANTATION	Percent of area on bank of the river covered with trees	27.39
M_MUNICIPALITY	The clean-up program is managed by Municipal authority (1=Yes, 0=No)	0.22
M_GOVERNMENT	The clean-up program is managed by Governmental authority (1=Yes, 0=No)	0.22
COST	Cost (Thousand NRS per year)	1
TIME	Time contribution for the clean-up program (days per year)	6.84
INCOME	Monthly income of the household (Thousands NRS)	19.99
MALE	Respondent is male (1=Yes, 0=No)	0.65
AGE	Age of the respondents	35.83
AGRI	Visit river for agricultural purposes (1=Yes, 0=No)	0.03
OWN	Own home (1=Yes, 0=No)	0.72
COLLEGE	Education level (1=Yes, 0=No)	0.05
NEWAR	Caste (1=Newar, 0=Others)	0.45
BRAHMIN	Caste (1=Brahmin, 0=Others)	0.22
KSHETRI	Caste (1=Kshetri, 0=Others)	0.16
MID_INCOME	Income Level (1=Middle Income, 0= Others)	0.22
HIGH_INCOME	Income Level (1=High Income, 0= Others)	0.17

Results – Conditional Logit Model

Variables	Model1	Model2
ASC	-2.4319***	-2.6844***
W_QUALITY2	0.5094***	0.3091***
W_QUALITY3	0.4463***	0.2626
PLANTATION_C	-0.0104	0.0464*
PLANTATION_C^.5	0.1237	-0.4616
M_GOVT	-0.2415***	-0.0936
M_MUNICIPALITY	-0.2001***	-0.1138
PAY_THOU	-0.3185***	-0.3184***
WTC	-0.1347*	-0.1204*
WTC^.5	0.8911**	0.8205*

Significance codes: '***' 0.01 '**' 0.05 '*' 0.1

Results – Conditional Logit Model

Variables	Model1	Model2
ASC	-2.4319***	-2.6844***
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WTC	-0.1347*	-0.1204*
WTC^.5	0.8911**	0.8205*

Significance codes: '***' 0.01 '**' 0.05 '*' 0.1

Results – Conditional Logit Model (condt)

Variables	Model1	Model2
W_QUALITY3:AGRI	-	0.641**
W_QUALITY2:OWN	-	0.2887***
W_QUALITY3:OWN	-	0.4658***
W_QUALITY3:COLLEGE	-	0.321
W_QUALITY3:AGE_10	-	-0.1141***
W_QUALITY3:NEWAR	-	0.2768*
W_QUALITY3:BRAHMIN	-	0.4274***
W_QUALITY3:KSHETRI	-	0.0987
PLANTATION_C:AGE_10	-	-0.015***
PLANTATION_C^.5:AGE_10	-	0.1542***
M_GOVT:OWN	-	-0.2177*
M_MUNICIPALITY:OWN	-	-0.1378
WTC:MID_INC	-	0.01
WTC:HIGH_INC	-	-0.0222

Significance codes: '***' 0.01 '**' 0.05 '*' 0.1

Results – Random Parameter Logit Model

Variables	Model3	Model4
ASC	-2.8294**	-3.1603***
W_QUALITY2	0.5567***	0.3357***
W_QUALITY3	0.5299***	0.3016
PLANTATION_C	-0.02	0.0422
PLANTATION_C^.5	0.2516	-0.3673
M_GOVT	-0.2717***	-0.1371
M_MUNICIPALITY	-0.2433***	-0.1835
PAY_THOU	-0.377***	-0.3791***
WTC	-0.049	-0.0271
WTC^.5	0.3885	0.2682

Significance codes: '***' 0.01 '**' 0.05 '*' 0.1

Random Parameter Logit Model (contd)

Variables	Model3	Model4
W_QUALITY3:AGRI	-	0.8054**
W_QUALITY2:OWN	-	0.3208***
W_QUALITY3:OWN	-	0.575***
W_QUALITY3:COLLEGE	-	0.4155
W_QUALITY3:AGE_10	-	-0.1472***
W_QUALITY3:NEWAR	-	0.3685*
W_QUALITY3:BRAHMIN	-	0.5739**
W_QUALITY3:KSHETRI	-	0.137
PLANTATION_C:AGE_10	-	-0.0165**
PLANTATION_C^.5:AGE_10	-	0.1628**
M_GOVT:OWN	-	-0.2002
M_MUNICIPALITY:OWN	-	-0.1054
WTC:MID_INC	-	0.015
WTC:HIGH_INC	-	-0.0234
sd.W_QUALITY2	0.0013	-0.0012
sd.W_QUALITY3	1.2766**	1.3123**

Marginal Willingness to Pay

Attributes	Basic CLM	Basic RPL	CLM Interaction	RPL Interaction
ASC	**-7.68** (-13.65, -1.90)	**-7.53** (-13.55, -1.58)	**-8.48** (-14.27, -2.94)	**-8.35** (-14.46, -2.31)
W_QUALITY2	**1.61** (1.24, 2.03)	**1.50** (1.13, 1.99)	**1.63** (1.03, 2.28)	**1.52** (0.95, 2.20)
W_QUALITY3	**1.41** (1.02, 1.85)	**1.42** (1.01, 1.89)	**1.45** (0.32, 2.63)	**1.47** (0.22, 2.83)
PLANTATION	**0.00** (-0.11, 0.11)	**0.01** (-0.10, 0.14)	**0.00** (-0.15, 0.15)	**0.01** (-0.16, 0.19)
M_GOVT	**-0.76** (-1.11, -0.43)	**-0.73** (-1.08, -0.40)	**-0.79** (-1.41, -0.19)	**-0.75** (-1.38, -0.18)
M_MUNICIPALITY	**-0.63** (-0.97, -0.31)	**-0.65** (-0.99, -0.32)	**-0.67** (-1.29, -0.08)	**-0.69** (-1.33, -0.09)
TIME	**0.11** (-0.32, 0.55)	**0.05** (-0.58, 0.55)	**0.11** (-0.32, 0.55)	**0.05** (-0.59, 0.57)

Numbers in parentheses indicate 95% confidence interval

Discussion

Strong preference for improvements

Attributes

- Prefer improvements but not significant difference between fishable and swimmable
- Prefer community management but not significant difference between municipal and government management

Attributes and socioeconomic characteristics

Water Quality

- Purpose of visit, education, age, caste

Willingness to contribute

- Income

Policy Implications

- Welfare estimates
  - Benefit cost analysis for river management
- Preference over payment and fund management
  - Fund generation and management
  - Bagmati Action Plan

➢ Estimated cost for five years - Rs 9214m (US$122.85m)

➢ Estimated benefit from this study- Rs 13212m (US$176.16)

Knowledge, Attitude and Behavior towards River

- Incorporation of human dimension
- Attitude and behavior towards river
- Voluntary participation towards river conservation and rehabilitation

Theoretical Framework

- Voluntary participation-
  - private provision of public goods(Andreoni et al 1990, Brekke et al., 2003, Andreoni, 1990)
  - PARTICIPATION- frequency of self reported participation

$$P_i = p(w_i, \alpha, A_i)$$

- Attitude and behavior towards river
  - (TBB, Fishbein & Ajzen, 1975)
  - ATTITUDE- towards the quality of water

$$A_i = A(K_i, I, C_i; \theta)$$

- Joint estimation of attitude and behavior

Descriptive Statistics

	Definition	Mean
PARTICIPATION	Voluntary Participation (0= Never, 1=Rarely, 2=Sometimes, 3=Frequently)	0.30
ATTITUDE	Construct index of attitude	2.21
KNOW_SCIENTIFIC	Construct index of scientific knowledge	0.70
KNOW_ENV	Construct index of environmental knowledge	0.70
KNOW_PUBHEALTH	Construct index of public health knowledge	0.80
INFORMATION	Exposure to information (0= Never, 2=Sometimes, 3=Frequently)	0.97
CULT_ATTACH	Frequency of last month's visit to Bagmati for cultural and religious purpose	0.92
L_INC	Log of yearly income of the household	9.67
FEMALE	Gender (1=Female, 0=Male)	0.36
HHSIZE	Number of members in the household	5.71
EDU_MAX	Education level of the member with maximum level of education	13.81
EDU_RESP	Education level of the respondent	11.95
AGE	Age of the respondent	35.69
PROFESSION_HEALTH	Association with health profession (1=Yes, 0=Not)	0.11
DISTANCE	Distance of the household from the closest river (Km)	1.22
RESIDENCY	No of years living in the community	8.95
NEWAR	Caste (1 = Newar, 0= Others)	0.46
OWN	Ownership of the household (1=Owned, 0=Rented)	0.72

Regression Result

Variables	PARTICIPATION	ATTITUDE
ATTITUDE	0.8302***	
KNOW_SCIENTIFIC	0.3603	0.2266
KNOW_ENV	0.0141	1.2755***
KNOW_PUBHEALTH	-0.9364***	1.3526***
INFORMATION	0.3652***	-0.1087
CULT_ATTACH	0.0022	0.0277*
L_INC	0.1446	-0.0522
FEMALE	-0.5201***	0.1698*
HHSIZE	-0.0164	0.0286

Significance codes: '***' 0.01 '**' 0.05 '*' 0.1

Regression Result

	PARTICIPATION	ATTITUDE
EDU_MAX	-0.0043	0.0445**
EDU_RESP	-0.0460**	0.0329*
AGE	-0.0014	0.0094**
PROFESSION_HEALTH	-0.2082	0.1273
DISTANCE	0.0165	-0.0574*
RESIDENCY	-0.0046	-0.0414
NEWAR	0.0696	0.3440***
OWN	0.6050***	-0.5583***
Observations	1009	
Log lik.	-1741	
Chi-squared	240***	

Significance codes: '***' 0.01 '**' 0.05 '*' 0.1

Discussion

- Strong and positive relation between attitude and participation behavior
- Environmental knowledge is strong determinant of attitude and behavior
- Factual knowledge is not significant towards attitude and behavior
- Cultural attachment towards the river enhances attitude but the probability of participation does not change with increase in cultural attachment

Knowledge, Information and Water Treatment Behavior of Residents in the Kathmandu Valley, Nepal

- Demand for clean drinking water
- Determinants of treatment behavior
- Impact of knowledge and information towards treatment

Theoretical Framework and Econometric Estimation

- Avoidance Behavior (Bartik, 1988, Larson et al., 1999)

$$\Pr(Y^*) = Y(p, I, S_0 : X)$$

- Probit model for treatment behavior
  - Who treats and who does not?
  - TREATMENT=1 if at least one treatment method was adopted, and 0 otherwise)

Descriptive Statistics

Variables	Definition	mean
TREATMENT	Households treats water(1=yes, 0 = no	0.74
INCOME	Monthly income in thousands	19.80
EDU_MAX	Education level of the member with maximum level of education	13.81
KNOWLEDGE	Construct index of knowledge	0.67
INVOLVEMENT	Community involvement	0.12
INF_EXPOSURE	Exposure to information (0= Never, 2=Sometimes, 3=Frequently)	0.97
PRIVATE	Connected to the private pipe (1=Yes, 0=Ono	0.63
HEALTH_PROFESSION	Association with health profession (1=Yes, 0=no)	0.08
HHSIZE	Number of members in the household	5.71
FEMALE	Gender (1=Female, 0=Male)	0.36
CHILDREN	Children under the age of 5 (1=Yes, 0=No)	0.39
RESIDENCY	No of years living in the community	8.95
NEWAR	Caste (1 = Newar, 0= Others)	0.46
OWN	Ownership of the household (1=Owned, 0=Rented)	0.72
DIARRHEA	Frequency of occurrence of diarrhea during the last month	0.31
Observations		1200

Probit Regression Result

Variables	TREATMENT
INCOME	0.0058
EDU_MAX	0.0909***
KNOWLEDGE	0.5395**
INVOLVEMENT	0.5999***
INFORMATION	0.1549*
PRIVATE	1.0126***
HEALTH_PROFESSION	-0.0143
HHSIZE	-0.0513**
CHILDREN	-0.0309

Significance codes: '***' 0.01 '**' 0.05 '*' 0.1

Probit Regression Result (contd)

Variables	TREATMENT
RESIDENCY	-0.0942**
NEWAR	0.2361**
OWN	-0.1784
DIARRHEA	0.0757
Constant	-0.5993
Observations	1043
Log lik.	-464
Chi-squared	233***
AIC	956
BIC	1025

Significance codes: '***' 0.01 '**' 0.05 '*' 0.1

Marginal Effect

Variables	TREATMENT
INCOME	0.0016
EDU_MAX	0.0251***
KNOWLEDGE	0.1487**
INVOLVEMENT	0.1654***
INFORMATION	0.0427*
PRIVATE (d)	0.3059***
HEALTH_PROFESSION (d)	-0.0040
HHSIZE	-0.0141**
CHILDREN (d)	-0.0086

Significance codes: '***' 0.01 '**' 0.05 '*' 0.1

Marginal Effect

Variables	TREATMENT
RESIDENCY	-0.0260**
NEWAR (d)	0.0643**
OWN (d)	-0.0474
DIARRHEA	0.0209
Observations	1043
Log lik.	-464
Chi-squared	233***
AIC	956
BIC	1025

Discussion

- Drinking water is a major issue not only in rural areas but for urban setting as well

- Despite of being connected to water supplies network, consumers do not have access to safe water because of quality dimension

- In addition to household characteristics, knowledge about water borne diseases and community participation play an important role in influencing treatment behavior.

Future Research

- Including and comparing CE data from policy makers and managers with household level data
- Combine choice experiment data with attitude and behavior data
- Combine choice experiments data with revealed preference data
- Application of choice modeling in health, climate change and mitigation behavior

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