# Benefit Estimation of Water Quality Improvement in Bagmati River Using Choice Modeling

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## Introduction

**The holy river**
Flows through the heart of the Kathmandu Valley
**Highly-polluted**
Solid waste and sewage, water is black and emanates a foul odor, no aquatic animals
**Impacts**
The surrounding environment, cultural and religious activities and, health of local residents
**Consequences**
Devaluation of property value, destruction of aesthetic values, adverse health impacts, ground-water aquifer contamination, and endangered livelihoods for farmers
**Use and non use values**
Agricultural, tourism, aesthetic, cultural, and religious
**Significant welfare loss due to pollution**
Benefit has rarely been investigated
**Government initiation of restoration program**
Bagmati Action Plant (2009-2014)

## Motivation

**National Wetland Policy 2003**
Conserve and manage wetland resources wisely in a sustainable way with local participation
**Bagmati Action Plan 2009-2014**
Comprehensive and integrated BAP
Proposal for generating funds
Intangible heritage linked with the river
9214 million for 2009-2014
**Estimating benefit and understanding preference**
Vital for the implementation of restoration program

## Objectives

Assessing public preferences and estimating benefits of improving quality of water in the river
• preferences on attributes of river health
• impact of location of HH on WTP
• impact of being close to the river on WTP
• the appropriate revenue-collection mechanism
• preference on the management mechanism
• impact of religious and cultural factors on WTP
• impact of knowledge/awareness on WTP

## Methodology

**Focus Group Discussions and Pretest**
Discussion with Key informants-Government official, Planners, NGOs, INGOs
   3 Focus Group Discussion-Upstream, Midstream, downstream
   Pretest - 40 households

**In-person interview**
Kathmandu, Lalitpur, Bhaktapur, Kirtipur, and Madhyapur Thimi
1200 households
40 Cluster, 30 households

**Choice Experiments**
Main effect orthogonal design
18 choice set
6 blocks
3 choice set to each respondents
3 alternatives in each choice set

**An Example of 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 | Water is black, emits a foul odor, and is not suitable for fish and other aquatic animals. Contact with water is dangerous to human health. |
| Riverside tree plantation | 40 percentage | 80 percentage | 20 percentage |
| Who is incharge of managing funding? | Municipality | Government | Not applicable |
| 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 |

**Model Estimation**
**The Conditional Logit Model**

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

**Willingness to Pay**

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

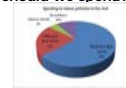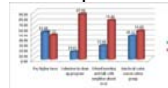## Results and Discussion

**Descriptive statistics**

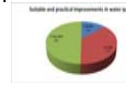| | |
|---|---|
| Age (>=18) | 35.69 |
| Monthly income (Rs/ per households ) | 19968 |
| Education | 11.95 |
| Sex (% of male) | 63.8 |
| Family Size | 5.71 |

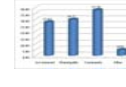**Preferences**
How much should we spend?

What can you do to improve health of the river?

Suitable improvements in the quality of water

Who should manage the clean up project?

**Regression Results**

| Variables | coefficients | Signifiance |
|---|---|---|
| ASC1 | -0.0747 | |
| W_QALITY2 | 0.4970 | *** |
| W_QALITY3 | 0.4563 | *** |
| PLANTATION | -0.0003 | |
| M_MUNICIPALITY | 0.0313 | |
| M_COMMUNITY | 0.2246 | *** |
| PAY | -0.3206 | *** |
| WTC | 0.1074 | * |
| INC | -0.0014 | |
| SOME_COLLEGE | 0.1577 | * |
| COLLEGE | -0.0008 | |

Signif. codes: 0.01 '***' 0.05 '**' 0.1 '*'

**Willingness to Pay**

| Quality of Water | | WTP (NRS) |
|---|---|---|
| W_QALITY2 (Suitable for fish, aquatic plants) | | 1550 |
| W_QALITY3 (Suitable for swimming) | | 1424 |
| Confidence Interval (WQ2) | (1.1801- 1.9954) | |

## Conclusion

**Positive WTP for improvement**
Kathmanduities are willing to pay
**No status quo**
Strong preference for improvements
**Preference on management**
Community preferred over municipal and government
**Tree plantation**
Not so important
**Socioeconomics**
Income effect - not significant
Education and knowledge- some colleges
Distance and spatial- not significant

There is significant loss of welfare to the society because of degradation of health of the river. Residents are willing to contribute their time and money for the improvement of quality of water in the river.

## Policy Implications

**Welfare estimates and attributes tradeoff**
Ministry, Municipal Authority
**CBA for long-term river management**
Wastewater treatment, riverside park
**Preference over payment and fund management**
Fund generation and management
**Participatory Management, Social Network**
Sustainable management of river

**Further Research**
Attitude & Behavior towards river restoration

## Acknowledgments

## For further information

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