Environmental and Development Economics
Module 4 - WTP for Environmental Quality in LMICs

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Lecture 6

WTP for Environmental Quality in Developing Countries

Housekeeping

- State things that are due.

Today

- **Guiding question:** what is the WTP for environmental quality in LMICs?
- Today's focus: How do we even measure this?
  - Behavioral models
  - Revealed preference approaches
- Next time: why is WTP so low in developing countries?

Measuring Willingness To Pay

- Slides on Logit and Mixed Logit

How is this implemented in practice?

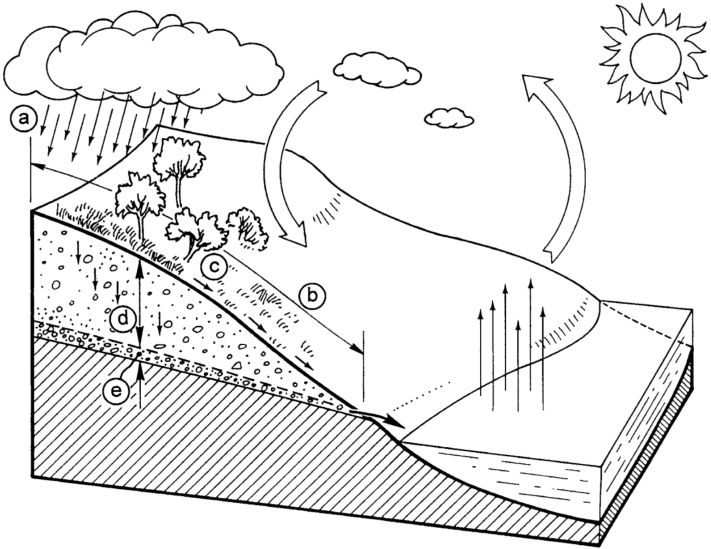
Kremer et al. (2011): WTP for Clean Water in Kenya

- **Research Question:** What is household WTP for clean water in LICs?
  - What are health impacts of water quality improvements? (we will skip this)
- **Setting:** 1,354 households in Kenya
- **Intervention:** Improve water quality at source for 184 natural springs
- **Empirical Strategy:** RCT + Revealed preference valuation
- **Results:** Clean water valued at $USD 2.96 per hh ($800 VSL)

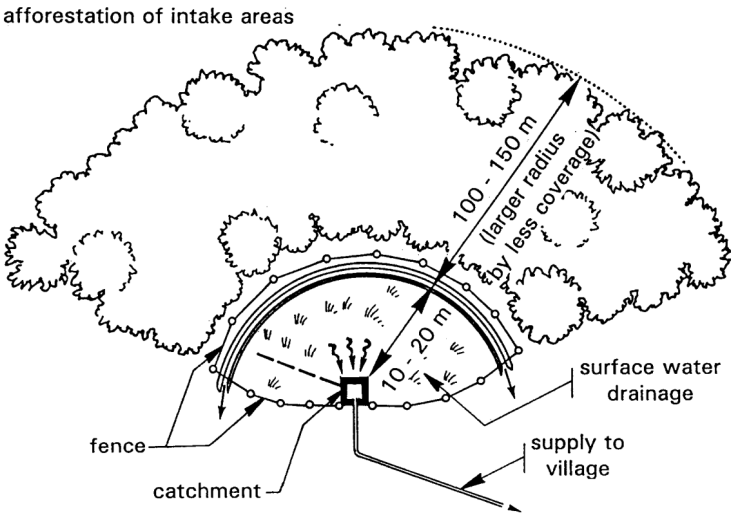
Spring Protection

- Spring water is crucial drinking water source in Africa
  - But vulnerable to contamination when people dip vessels
  - Runoff introduces animal/human waste
- Spring protection common in Africa to improve water quality at source
- Seal off spring at source by encasing in concrete
  - Water flows out of pipe rather than ground, avoiding contamination
- Nothing can "break' ' $\rightarrow$ less maintenance than wells/pumps
- How much are hh WTP for spring protection?

Spring Protection



Spring Protection



Spring Protection

Spring Protection

Figure 1: Source: USAID

Study Sample

- Sample frame: list of all unprotected springs in Busia and Butere-Mumias districts
- Treatment: 184 randomly selected for protection
  - 1,345 households selected that use springs
- Phased design: all springs eventually protected
  - Round I (Jan-Apr 2005); 47 springs, 350 households
  - Round II (Apr-Nov 2005); 46 springs; 349 households
  - Round III (2005-2006); 91 springs; 685 households
- 7-8 households from each spring select from "user list''

Data Collection

- Water quality measured at each spring based on EPA protocols
  - Measure: E.Coli (log of # bacteria per 100ml)
- Household survey
  - Diarrhea
  - Anthopometrics
  - Water collection behvavior
  - Socioeconomic data
- No difference in baseline water quality between treatment/control springs

Water Quality and Health

- Impact of spring protection on water quality:

$$W_{jt'}^{SP} = \alpha_t + \phi_1 T_{jt} + X_j^{SP'} \phi_2 + (T_{jt} \cdot X_j^{SP})' \phi_3 + \epsilon_{jt}$$

  - where W_{jt} is water quality for spring j at time $t \in 0, 1, 2, 3$
  - T_{jt} is treatment status (=1 after protection)

- Impact on health

$$Y_{ijt} = \alpha_i + \alpha_t + \phi_1 T_{jt} + X_{ij}' \phi_2 + (T_{jt} \cdot X_{ij})' \phi_3 + u_{ij} + \epsilon_{ijt}$$

  - where Y_{ijt} is whether child i had diarrhea in the past week

Results: Impact of Spring Protection on Water Quality and Health

Water Quality

- Huge improvement in water quality: 66% ↓ in E.coli
- No heterogeneity by baseline hygiene knowledge or education
  - Hypothesis: educated hh may maintain spring better
- Improvement in home water quality: 24% ↓ in E.coli
  - Why is the effect smaller?

Health

- Diarrhea incidence ↓ by 4.7pp (20% reduction compared to control)
- No impact on child weight
- Positive effect on BMI

What if control households choose to use treatment springs?

Revealed Preference: Valuing Clean Water in Kenya

- Let valuation of water from source j be Z_j
  - reflects health and non-health attributes (e.g. ease of collection)
- β_i: indirect utility from protection (T_{jt}) at j at time t
- $C_i > 0$ is time cost of household i
- $C_i D_{ij}$: Travel cost for additional trip to j where D_i is round-trip distance
- Each trip affected by unobserved factors (weather, queue, errands, mood)

Revealed Preference Approach

- Household indirect utility from one trip to j at time t is:

$$u_{ijt} = \beta_i T_{jt} + Z_j - C_i D_{ij} + e_{ijt}$$

  - where e_{ijt} is iid type I extreme value distributed

- i chooses j over k if:

$$\beta_i(T_{jt} - T_{kt}) + (Z_j - Z_k) - C_i(D_{ij} - D_{ik}) + (e_{ijt} - e_{ikt}) \geq 0$$

- Using CDF of EV Type I error, prob. of choosing j over alternatives h:

$$P(y_{ijt}|X) = \frac{exp(X'_{ijt}\beta)}{\sum_h exp(X'_{iht}\beta)} \equiv \rho_{ijt}$$

Mixed Logit

- Follow-up survey gives list of alternative water sources
- What is ratio of coeff. on T_{jt} to coeff. on walking time?
- Add preference heterogeneity with mixed logit:

$$P(y_{ijt}|X) = \int_{\beta} \rho_{ijt} f(\beta) d\beta$$

  - where $f(\cdot)$ is the mixing distribution
- Maximize log-likelihood to estimate mean and s.d. of these distributions

WTP results

- Conditional logit estimates: how do we interpret these?
  - Coefficient on walking distance ($C_i D_{ij}$) = -0.055
  - Coefficient on spring protection (β_i) = 0.51
- Can β_i entangle other amenity values?
- Households with kids under 3 find walking more costly
  - Coeff. on interaction b/w T_{jt} and child is positive (insignificant)
  - Households with kids value water quality more

WTP for spring protection

- Ratio of mixed logit coefficients: 2.95/0.21
- Households value clean water by willing to walk 14 extra minutes
- Average hh takes 48 trips per week (see Descriptive Stats)
- Total extra minutes per year = 14 x 48 x 52 = 35,078 minutes
- Assuming 8-hour workday $\rightarrow$ **mean value of clean water is 73 workdays**
  - Note: in paper, it is 32.4 workdays!

Comparison with Stated Preference Values

Converting WTP to dollars

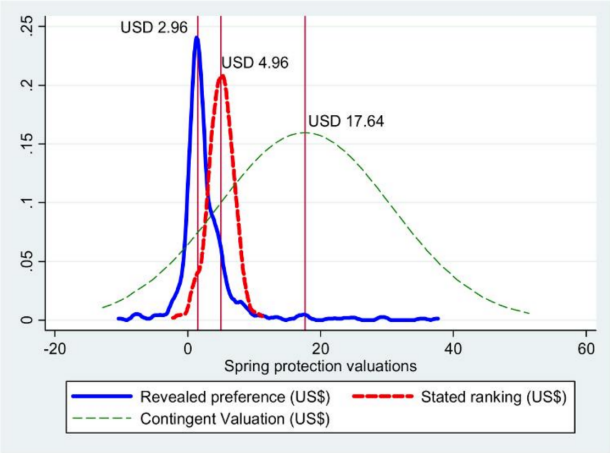
Survey evidence

- Subset of 104 respondents
- Contingent valuation: are you WTP $5 to walk 1 less minute? $10?, etc
- Divide WTP (in terms of time) by money value of time
- Regress time value on household characteristics, and predict on full sample
- Mean value of time = $USD 0.088 per 8-hour day (7% of ag wages)

Wages

- $USD 1.26 for 8-hour day (Suri, 2009)
- Time cost = 25% of average workday wage

Distribution of Household Values of Clean Water (Mixed Logit)



- Why is stated preference values larger? Why is CV distribution wider?