Productive Use of Domestic Rural Water Systems: The Kenya Case

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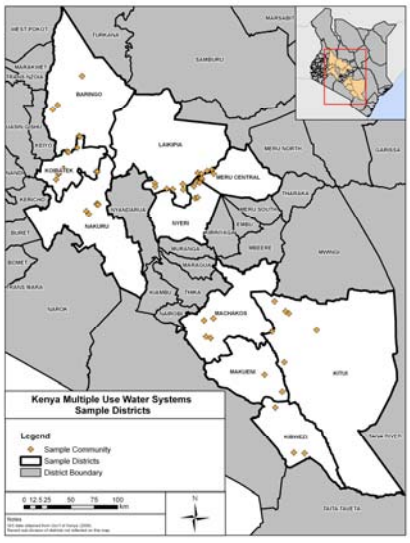
Study Site



- 10 districts in Rift Valley, Central, and Eastern provinces
- Stratified random sample of 50 water systems

Field Research Components (Kenya)

- Household Surveys: 1,916
- Engineering Assessments: 50
- Leader interview: 50
- Water committee interview: 50
- Water operator interview: 49
- Women's Focus groups: 15

Three Types of Piped Water System

- Surface water with gravity distribution systems (n=23)

- Groundwater, boreholes with pumped distribution systems (n=25)

- Surface water with pumped distribution systems (n=2)

Water Usage by Service Level

	Water consumption (LPCD)	
	Median	Mean (st.dev.)
Individual piped connection (n=389)	31	92 (305)
Piped connection in compound (n=82)	26	77 (189)
Neighbor's tap (n=269)	23	37 (82)
Public kiosk (n=435)	21	37 (52)
Other water sources (n=607)	16	30 (58)

"Intermediate" or "high" level prod. uses

"Basic" level prod. uses

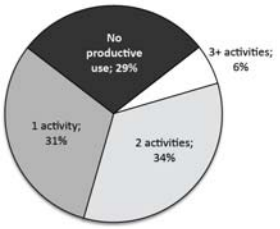
Weighted average of wet and dry season usage. "Other" includes Surface water, rain water, and wells.

Research Question 1

To what extent and under what conditions does productive use of domestic piped water occur?

Extent and Correlates of Productive Use

- 71% use water for productive activities (*all sources, income generating and HH consumption*)
- 54% use piped water
- 43% use piped water & earn income
- Small-scale agriculture & livestock
- 11% of total HH income earned through piped water using activities



Crop Cultivation, Livestock Rearing, and Income Generation by Principal Water Source

	Household water tap (n=418)	Compound water tap (n=76)	Neighbor's water tap (n=268)	Public kiosk (n=435)	Non-piped sources* (n=607)
% using indicated water source for irrigation	60	38	5	2	9
% earning income from crops (includes rainfed)	73	61	53	39	38
% earning income from crops irrigated with piped water in the dry season	52	39	10	<1	<1
% using indicated water source for livestock	90	76	58	53	72
% earning income from livestock	78	63	62	59	51
% earning income from livestock using piped water in the dry season	71	55	43	35	13

Note: Piped water categories are exclusive, i.e., households using multiple piped water sources (n=33) were excluded from analysis. Similarly, households in the "non-piped" category do not use any piped water source. *Includes open wells, borewells with handpumps, and surface water sources.

Extent and Correlates of Productive Use

Greater extent of productive use in villages with:

- Lower price / m^3
- Smaller share of HHs below poverty line
- Existence of an agricultural, health, microfinance, or W&S project in past 5 years

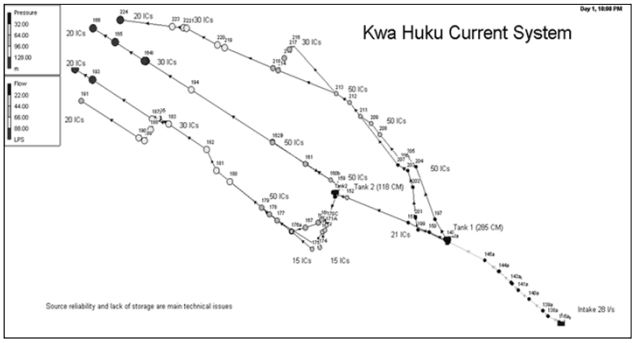
But: Negative association with all-weather road

Research Question 2

What are the incremental costs of, and expected income generated by, upgrading 'basic needs' systems to productive use capacity?

Financial Analysis of Productive Use System Designs

- Comparing incremental (capital and) O&M costs of system capacity expansion (to 50 LPCD) to anticipated incremental income that could be generated (*not a full CBA*)



Financial Analysis of Productive Use System Designs, cont.

- 44% of systems (22) could be upgraded to supply 50 LPCD
- Mean capital cost of upgrades for gravity systems is US$14 *pc*, *versus* US$4 for pumped systems
- Mean annual incremental O&M cost for gravity systems is US$4 *pc*, *versus* US$7 for pumped systems
- Over all upgradable systems, incremental O&M costs are US$0.50 - $1.50 / m^3
  - These values roughly double the unit costs of water

Financial Analysis of Productive Use System Designs, cont.

- Where water is available, incremental income expected from upgrades generally exceeds incremental costs

RCBR: 10 yr, 15%		Productive supply (50 LPCD) (*n*=22)			Repayment period with universal cost recovery (years)	
		Median	Mean	St.dev.	Mean (St.dev.)	Min. (Max.)
Ground - water, pumped (n=17)	Kiosk, gross water income	7.8	12.5	13.6	2.1 (1.7)	0.1 (5.6)
	Current piped water expenditure	1.4	2.9	4.2		
	Opportunity cost, water collection	1.9	3.9	5.0		
Surface water, gravity (n=22)	Household tap, gross water income	16.4	22.7	20.3	0.7 (0.6)	0.3 (3.4)
	Current piped water expenditure	0.6	2.5	6.3		
	Opportunity cost, water collection	1.6	2.4	10.5		

Research Question 3

What evidence exists regarding the financial sustainability of piped water systems used for income-generating activities?

Financial Sustainability

- **Financial sustainability**
  - % of recurrent costs (modeled) covered by user fees (OLS)
- Positively associated with:
  - % of piped water allocated to income generation (p=.06)
  - Price (p=.07)
  - Water committee received training in past 2 years (p=.04)
- Negatively associated with:
  - % of total income attributable to water-using activities (p=.02)

Technical Sustainability

- **Technical sustainability**
  - Indices of breakdown rate/duration, condition of infrastructure
- Negatively associated with:
  - Taps per 1000 persons (*i.e., technical sustainability decreases with greater # of private taps)*
  - Population served by system

Research Question 4

Who benefits when piped water supply systems are used for productive purposes?

Distribution of Benefits from Productive Use

- Low-income (but not lowest) HHs more dependent on productive use than high-income HHs
- Higher-income (but not highest) HHs capture disproportionate share of productive use income
- Causal direction between wealth and productive use unclear
- No evidence that more piped water leads to income gains for women once other HH-level characteristics are taken into account

Features that Increase the Likelihood that a HH will Earn an Income from Productive Activities (Logit)

	Exp(B)
Earns commercial income (dummy)	1.4
Earns income from growing crops (dummy)	2.1
Earns income from raising livestock (dummy)	8.3
1+ adult(s) in household has salaried employment (dummy)	0.6
Earns income from service provision (dummy)	2.5
Has a household water tap (dummy)	4.0
Has a compound water tap (dummy)	2.5
Annual household income less than US$108	0.1

All $p \leq 0.01$. Quasi r2=0.54. N=1166

Implications for Planning

- Extent of productive use is associated with penetration of individual connections—not the predominant model for rural water investments in Kenya (11-12% coverage between 1990-2008)
- Water source development necessary to upgrade at least half of sampled water systems
- Households deriving the largest share of their income from productive activities are neither the poorest nor wealthiest families
- Facilitating closer, cheaper water may be insufficient to support (spur) productive use; ancillary investments needed, outside water sector