Evaluating willingness to pay for rising agricultural and household water costs in a developing Himalayan economy: The case of Nepal

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Problems observed in Himalaya region

- Rising temperatures causing the retreat of glaciers worldwide including the Himalayan region (Aryal and Rajkarnikar, 2011; Erickson et al. 2009).

- Glacier retreat - rising temperatures lead to permanent decreases in glacier mass and volume.

- Uncertainty in projections of future changes in precipitation and temperature
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- Shifts in location and intensity of snow and rain over time can help forecast water flows in rivers and streams.

Problems and rational of the study in Nepal

- Rising temperatures ($avg\ annual\ increase\ 0.06^{oC}$)
- Sporadic rainfall-water flow in the rivers/creeks
- Retreating glaciers (landslides, floods & droughts)
- Decreasing water availability
- Low agricultural productivity
- Rising demand for water
- Rural-urban migration, specially from Hill and Mountain
- Smallholders 75% of total population – 33% of GDP
- Low investment capacity (40% population have <$1 day)

Recent problems in the research area

Water management practices in Nepal

- No efficient property right enforcement in water management
- Seller-buyer transaction of water rights is relatively uncommon in developing world (Young and Loomis, 2014).
- Community based water management emerging;
- Willingness to Pay (WTP) – may determine success of water management policies
- Riparian water right- exercise in rural areas
- Prior appropriation: very limited in summer/winter

Objective and Hypothesis

- To compare the willingness to pay of water users in two ecological zones in Nepal (Terai, Hill).
- To examine the impact of demographic and spatial explanatory factors that affect the differences in willingness to pay.
- **Residents of the three regions have positive willingness-to-pay for additional agricultural and household water**

Willingness to Pay and Water markets

- Increasing demand for water coupled with the development of new water sources will lead to water market development.
- When the market emerges, price will ideally reflect the equilibrium between minimum WTA (willingness to accept) of suppliers and the maximum WTP (willingness to pay) of buyers.

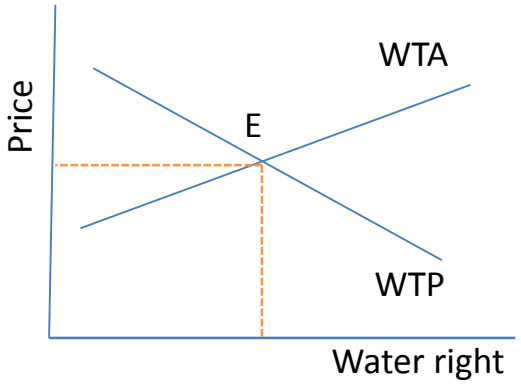


Fig. Market for water right

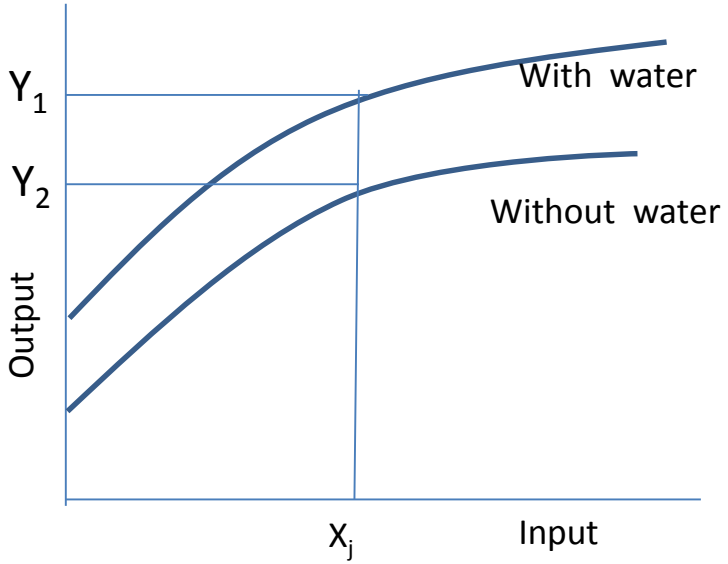


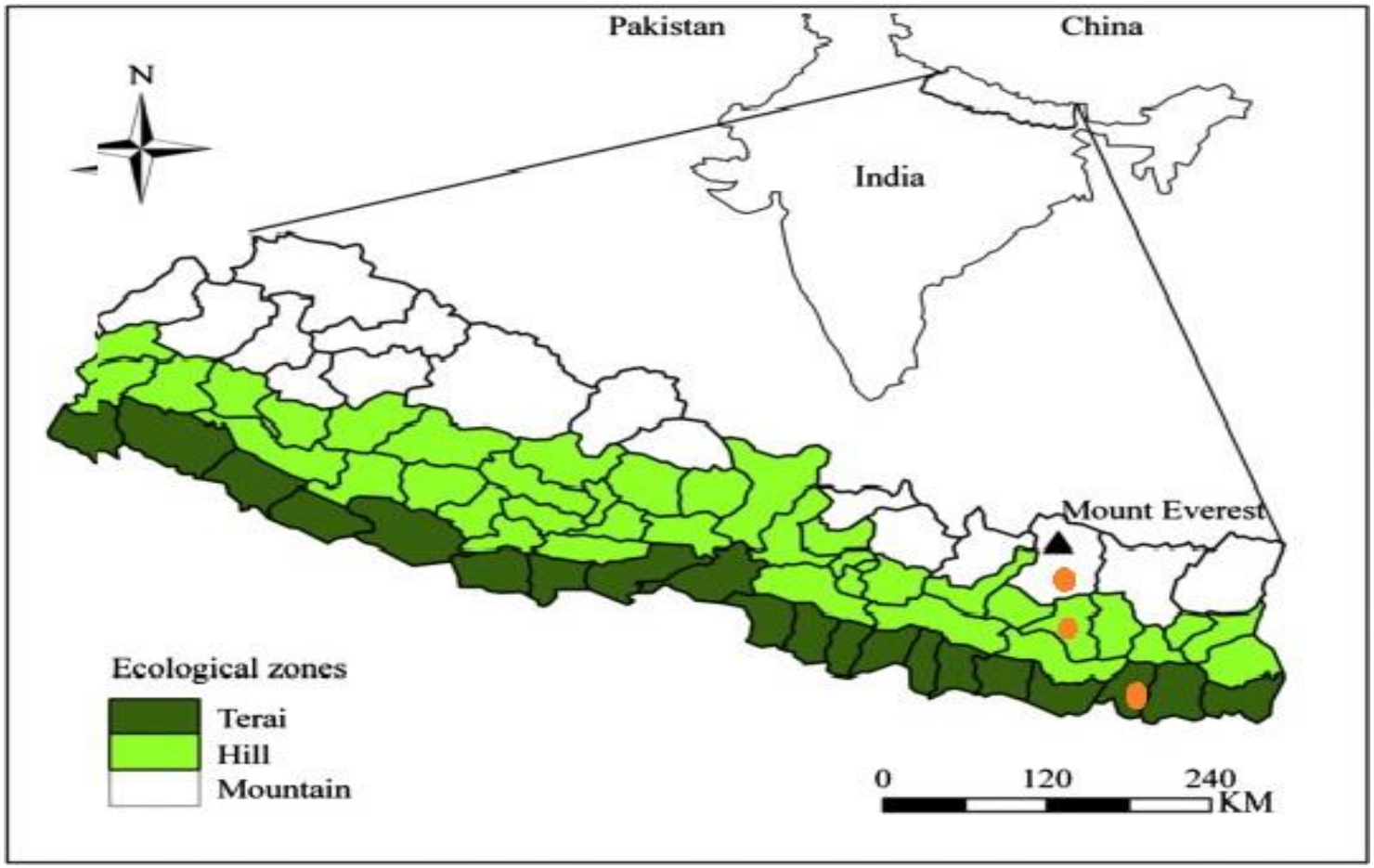
Fig. Hypothesized effect of water on farm yield

Cont..

- For non-marketed goods including water in some cases, WTP is the theoretical basis on which shadow prices are best calculated (Young and Loomis, 2014).
- VMP of water resource derived from any production function that incorporates water as a decision inputs approximately reflects the maximum WTP by producers.
- Scarcity-alternative uses- market develop- marginal value
- Examples of leasing and sale of water rights- in the arid and semi-arid western USA ; china, Australia, Chile (Brewer et al. 2008)
- Markets for water rights are relatively uncommon in the developing world (Young and Loomis, 2014)

Research sites and data

A. Study area selection: 2 different ecological belts



Study areas:

Sampling (frame, unit and size)

- Koshi river basin: Biggest, 720 km,
  61,000 km^2 basin area
- originates from the northern slopes of the Himalayas (Tibet), drain via Nepal through Northern India- confluences to Gang
- carries silt during monsoon and floods the Terai region of Nepal
- 3 ecological belts (Mountain, Hill & Terai)
- 2 VDCs from each regions
- Primary data from 300 HH survey (150 from each ecologies): ***simple random sampling technique***
- Pre-tested semi structured questionnaire (IRB approved)
- Face-to-face HHs interviews.
- Participatory tools: Focus Group Discussion(FGD), Key Informant Survey (KIS)

Variables definition and measurement

Variables	Unit	Definitions (…for farm j)
Age	Year	Age of household head
Education(Illiteracy =1)	1,0	1 if the household head is illiterate
Household size	No. of person	Number of individual in a family
Gender	1,0	1 if the farm manager is male, 0 otherwise
Residence area	1,0	1 if respondents lives in city/town, 0 otherwise
Water cost	Rs/Lit.#	Cost of water used in farms and household
Farm size	Ropani*	Area of the agricultural farming land
Residence area	1,0	1 if respondents lives in rural village, 0 otherwise
Distance Ag water source	Km	Distance of water sources for agricultural usage
Distance HH water source	Km	Distance of water sources for household purposes
Water used	Lit/day	Amount water used in crop, livestock and household
Livestock size	Number	Number of livestock (cattle, goat and pig)
*One Ropani = 511.14291 m^2. # Rupees, a Nepalese currency and Rs1 = $US (1/86).		

Descriptive statistics

Variables	Tearai	Hill
Farm size	25.34(15.9)	12.6(5.31)
Distant from river basin		
River	4.82(3.96)	2.81(2.11)
Creek	0.93(0.8)	0.52(0.33)
Water used		
Crops	121.54(115.3)	51.63(68.54)
Livestock	90.62(35)	53.45(26.63)
Household	87.23(26.49)	66.46(36.36)
Water cost		
Crop/Livestock	0.1(0.09)	0.21(0.12)
Household	0.11(0.1)	0.26(0.15)
Distant to water sources		
Agricultural water	1.13(0.85)	0.51(0.28)
Household water	0.019(0.018)	0.19(0.15)

Respondents in Hill and Terai are willing to pay 62.24 and 76.33 percent more at the base period per unit price of water.

water demand fulfillment in study area (percent/sector)

Sectors	Terai	Hill
Agriculture	34.87(33.95)	27.15(20.61)
Livestock	67.92(23.50)	45.49(23.97)
Household	76.06(25.99)	42.92(16.31)
Total	59.62(33.28)	38.52(22.04)

Percent water loss in creek over the period of 5-7 years

% loss of water	Hill	Terai
50 %	4(2.67)	11(7.33)
75%	113(75.33)	109(72.67)
100%	33(22)	30(20)

Feasible approach to water resource management

Approaches	Hill	Terai
Collective	108(72)	128(85.33)
Private	30(20)	43(28.67)
Public	87(58)	63(42)
PPP	68(45.33)	95(63.33)

Binary probit estimates for WTP for increasing crop and livestock water costs (Terai region)

Parameter	DF	Estimate	S.Error	t Value	Pr > |t|
Intercept	1	363.33	3.63	100.22	<.0001
Gender	1	-1.59	1.14	-1.39	0.1636
Age	1	0.29	0.24	1.21	0.2279
Education (Illiteracy =1)	1	-186.58	3.62	-51.59	<.0001*
Rural area	1	-105.30	3.61	-29.15	<.0001*
Water cost (crop, livestock)	1	-312.62	0.22	-1444.1	<.0001*
Distance Agri water source	1	-24.71	0.90	-27.40	<.0001*
Distance HH water source	1	-1188.88	0.18	-6586.4	<.0001*

Binary probit estimates for WTP for increasing household water costs (Terai region)

Parameter	DF	Estimate	S.Error	t Value	Pr > |t|
Intercept	1	284.29	3.63	78.39	<.0001
Gender	1	-1.59	1.14	-1.39	0.1637
Age	1	0.29	0.24	1.21	0.2282
Education (Illiteracy =1)	1	-133.49	3.62	-36.89	<.0001*
Rural area	1	-80.48	3.62	-22.25	<.0001*
Water cost (household)	1	-456.75	0.22	-2106.70	<.0001*
Distance Ag water source	1	-17.46	0.90	-19.33	<.0001*
Distance HH water source	1	-1029.51	0.18	-5696.20	<.0001*

Binary probit estimates for WTP for increasing crop and livestock water costs (Hill region)

Parameter	DF	Estimate	S.Error	t Value	Pr > |t|
Intercept	1	-141.94	0.69	-205.88	<.0001
Gender	1	-77.17	0.68	-113.87	<.0001*
Age	1	10.02	25.62	0.39	0.6957
Education (Illiteracy =1)	1	-182.45	0.01	-15103.00	<.0001*
Rural area	1	-188.72	0.69	-273.83	<.0001*
Water cost (crop, livestock)	1	50.67	0.07	721.58	<.0001*
Distance Ag water source	1	367.61	0.14	2700.07	<.0001*
Distance HHwater source	1	-90.31	0.27	-329.39	<.0001*

Binary probit estimates for WTP for increasing household water costs (Hill region)

Parameter	DF	Estimate	S.Error	t Value	Pr > |t|
Intercept	1	-122.21	0.82048	-148.95	<.0001
Gender	1	-65.723	0.76394	-86.03	<.0001*
Age	1	8.58747	31.0536	0.28	0.7821
Education (Illiteracy =1)	1	-155.94	0.0569	-2740.7	<.0001*
Rural area	1	-162.19	0.82025	-197.73	<.0001*
Water cost (household)	1	55.916	0.08496	658.18	<.0001*
Distance Ag water source	1	314.442	0.15563	2020.4	<.0001*
Distance HH water source	1	-76.561	0.31987	-239.35	<.0001*

Major findings

- Terai region - negative effect on WTP for increased costs for Ag and HH use.
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- Hill region - positive effect on WTP for increased costs for Ag and HH use.

- ***Reason?*** - Hill region – higher marginal benefit from additional unit of water for high value-low volume cash crops (medicinal crops), off-seasonal vegetable production.

- Improved farm income enables a possibility for higher WTP towards both Ag and HH use.

Conclusion and Policy suggestions

- Climate change and urbanization present challenges for effective water resource management in Nepal.
- Expected solutions necessitate inter-disciplinary approaches and cross-sectorial partnerships.
- Evaluated differences in WTP among water users for increase in Ag and HH water costs in Terai and Hill.
- Future work - economically feasible and viable water management policies from the perception of stakeholders.