Public Preference for Ecosystem Services in the Danda River Basin, Nepal

A Choice Experiment Study

Samrat B. Kunwar, Alok K.Bohara, Jennifer Thacher

University of New Mexico

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Motivation and Background

- Freshwater systems have historically been the linchpin of urban centers; however, they are also considered to be the most endangered ecosystems in the world (Dudgeon et al., 2006).
  - "Flaming Cuyahoga River of Ohio," the Ganges River in India, and the Yellow River in China - encapsulate the global concern over urban risks to river systems.
  - Danda River, Nepal: Located in the Nepal-India border, and runs through the heart of the urban city of Siddharthangar.
- EIA Findings: Unregulated discharge of waste => excess deposits of chemicals like phosphates, nitrates and dissolved oxygen in the freshwater rivers (IUCN, 2012).

Motivation and Background

- Massive fish fatalities, river water unsuitable for domestic and recreational use or as a source of drinking water for wildlife.
- Various community segments, in particular the fishermen and the farming populations, have been forced to take up to new activities to sustain their livelihoods (IUCN, 2012)
- The Danda ecosystem constitutes a valuable natural resource, in economic, cultural, aesthetic, scientific, and educational terms to the Nepalese people.

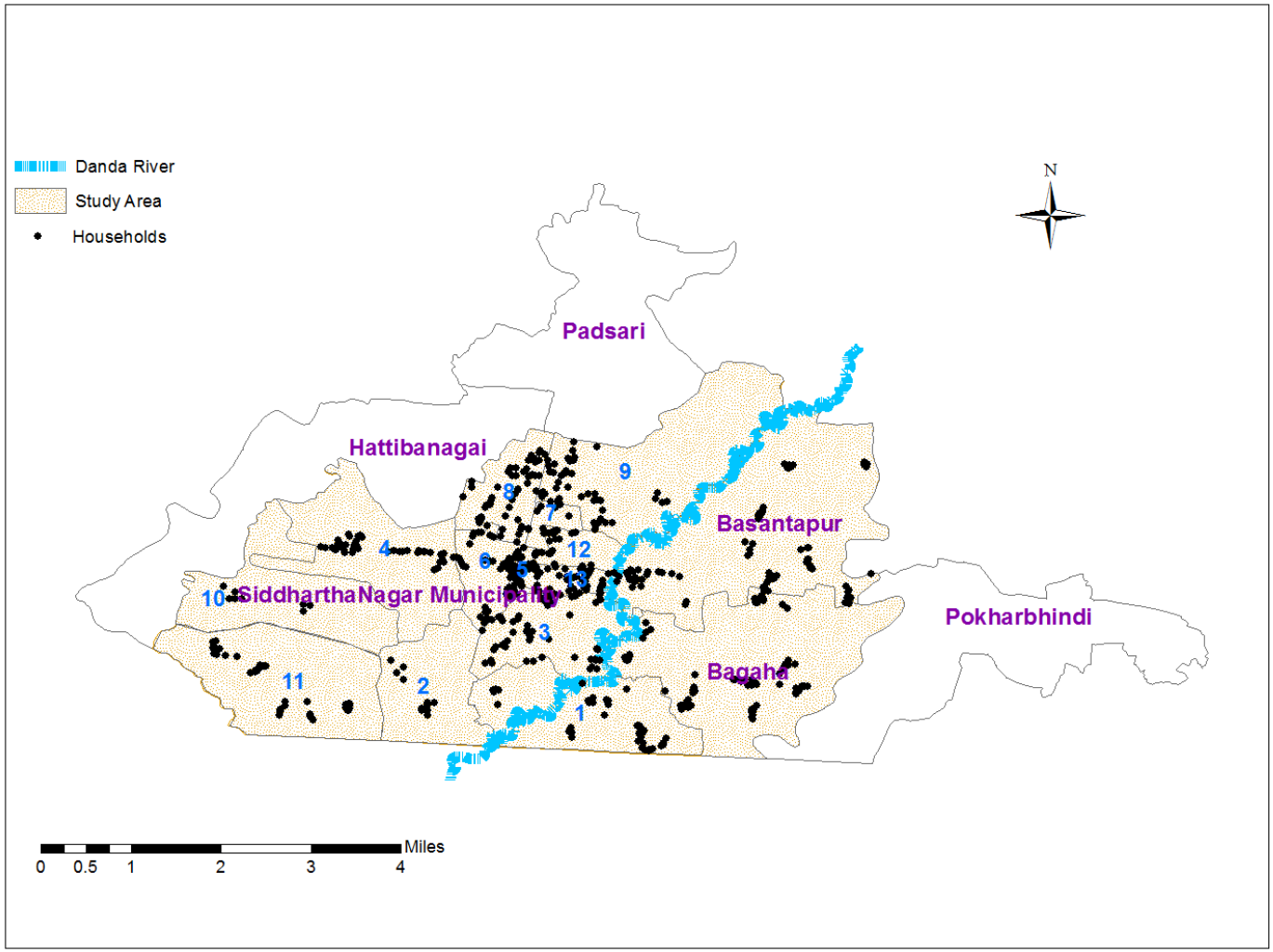
Research Question

- What is the Willingness to Pay (WTP) for improved ecosystem services in the Danda River Basin, Nepal?
  - How can we incorporate information regarding respondent's preference uncertainty in a choice experiment (CE) setting?
  - How can we use geo-coded household information to investigate localized spatial distribution patterns of WTP estimates?

Findings

- MWTP: \$17.06/year for the highest quality of water, \$3.15/year to protect the river banks to 300 feet, and \$13.46/year to introduce vegetation in the riverbanks.
- The inclusion of preference uncertainty => Improved model fit and produced tightened confidence intervals for the marginal MWTP estimates.
- Statistically significant hot and cold spot pockets for different ecosystem services, indicating local spatial heterogeneity.
  - Urban area = > derive benefits from the Danda for recreational activities, while the rural population => Improvement in Danda water quality for agricultural purposes.
- Public prefers community-based management of the Danda River. Policymakers should decentralize management to the local communities so as to enhance interest in conservation common pool resources like the Danda River.

Map of the study area



The CE Survey

- Conducted face-to-face interviews in 3 Municipality/Village Developement Committee (VDC) (Urban/Rural) in the greater Bhairahawa.
- Sample Size (n) = 637.
- Recorded GPS information of each respondent households.
- Attributes and Levels determined from focus group discussions debriefings and personal interviews.
- 24 choice sets blocked into 8 version of 3 cards (fractional factorial design).
- Survey: 3 choice sets with 3 alternatives (2 policy options and a status quo option).
- 6 Attributes (including the cost): 4*3*3*2*3*12 levels.

Attributes and Levels

Table 1. Attributes and levels used in the choice experiment

Attributes	Description	Levels
River water quality	This attribute refers to the potential uses that can be acquired from Danda River.	➢ Suitable for boating only. ➢ Suitable for boating and fishing only. ➢ Suitable for boating fishing and irrigation. ➢ Not suitable for boating, fishing or for irrigation*.
Riverbank protection	This attribute refers to the shoreline on both sides of the river that will be protected from any kind of urban encroachment.	➢ 50 feet* ➢ 150 feet ➢ 300 feet
Tree plantation along the riverbanks	This attribute refers to the introduction of a vegetated area on each side of the river to create a natural habitat for wildlife and birds.	➢ 20%*, ➢ 40% ➢ 80%
River monitoring and educational program	This attribute refers to a regular assessment of the river water quality through chemical tests by student volunteers. It serves to not only keep the river ecosystem in check, but also to foster a long-term data collection outlet to be used by researchers.	➢ Yes ➢ No*
Regulatory Mechanism	This attribute refers to the body responsible for overseeing the funds and management of the project.	➢ Community. ➢ Government. ➢ Municipality.
Cost	An annual payment for the "*Danda river management fee*" that households would pay for the next five years.	Rs.0*, Rs.10, Rs.35, Rs.75, Rs.125, Rs. Rs.200, Rs.400, Rs.700, Rs.1000, Rs.18 Rs.2500, Rs.3500.

CE Example Set

Figure 2. Choice set example

Which Danda river management package do you prefer?
You are given three different Danda ecosystem management service packages: Management Package A, Management Package B and Management Package C. Among the three packages, please choose the one that you prefer. If you are satisfied with the current situation of Danda River, you can choose Management Package C "Status Quo", which is the current situation of the river ecosystem. If none of the options exactly matches your expectations, please choose the one that you dislike the least. While choosing your answer, please consider benefits of the proposed program and your net income since the packages have different fees associated with them.

		Management Package A	*Management Package B*	*Management Package C: "Status Quo – Current Plan"*
River water quality		Water will be suitable for boating and fishing.	The water is full of algae and it emits foul odor. **Not suitable for boating, fishing or for irrigation**.	The water is full of algae and it emits foul odor. Not suitable for boating, fishing or for irrigation.
River bank protection		**150 feet** on both sides	**300 feet** on both sides	**50 feet** on both sides
Tree Plantation along the riverbanks		**20%** of the bank planted with trees	**80%** of the bank will be planted with trees	Currently **20%** of the banks are planted with trees.
River monitoring and educational program		**No** monitoring and educational program	**There will be** a monitoring and educational program.	Not applicable
Regulatory mechanism		Municipality	Community	Currently not available
Management fees		Rs. 1800/year (for 5 years)	Rs. 125/year (for 5 years)	Rs. 0
Which package do you prefer (choose one only)		**I choose package A** ☐	**I choose package B** ☐	**I choose 'current situation': package C** ☐

- How certain are you of your choice?

Very uncertain	Somewhat uncertain	Neither certain nor uncertain	Somewhat certain	Very certain
1 ☐	2 ☐	3 ☐	4 ☐	5 ☐

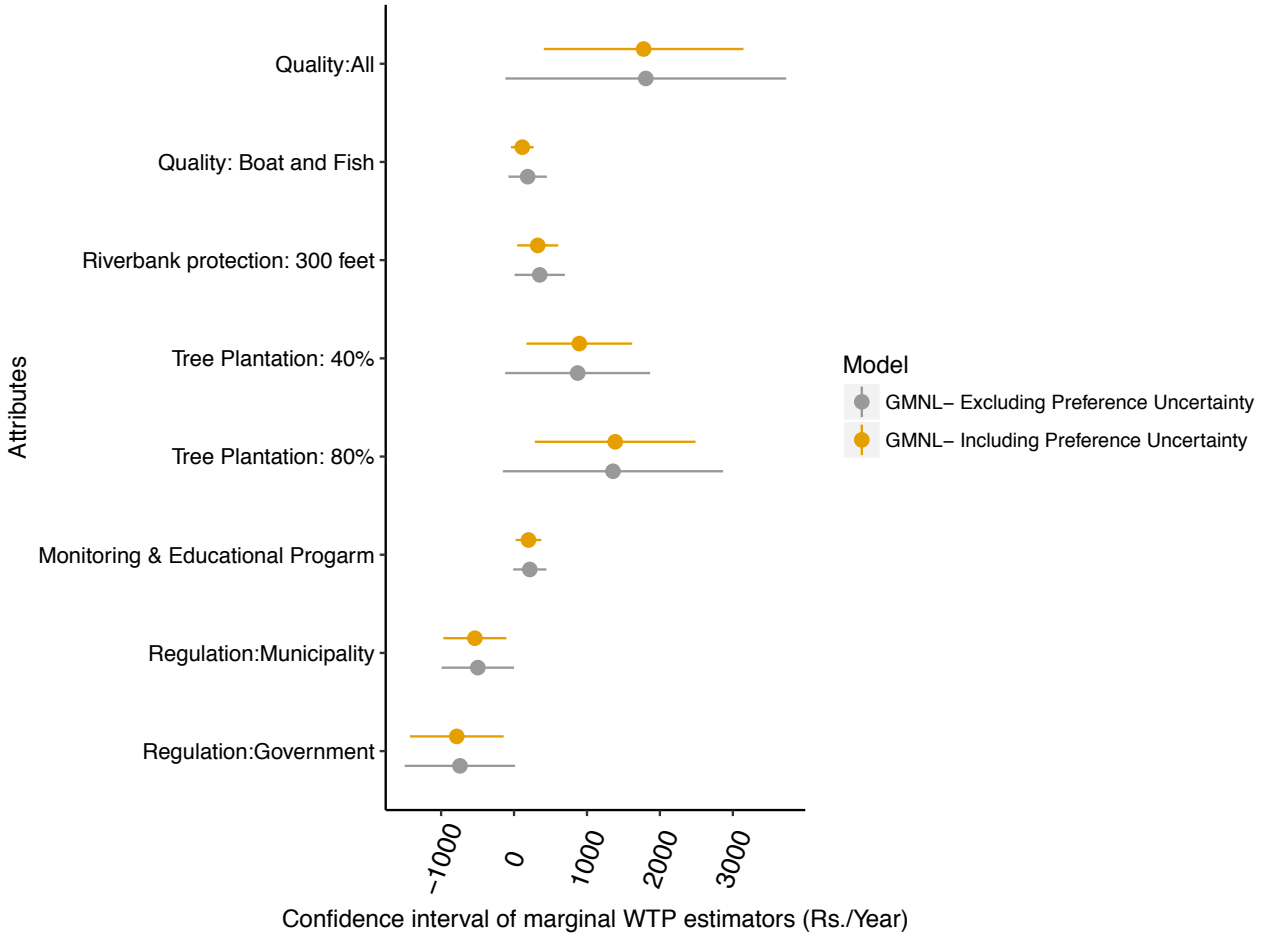
Regression Output (Only Main Results)

Table 3. Preferences for Danda ecosystem services: Conditional Logit (CL), Random Parameter Logit (RPL) & Generalized Multinomial Logit (GMNL) model

Attribute	Conditional Logit	Random Parameter Logit	GMNL - No uncertainty	GMNL - Uncertainty
	(1)	(2)	(3)	(4)
Cost	-0.001***	-0.002***	-0.019**	-0.017**
	(0.0001)	(0.000)	(0.010)	(0.007)
Quality: *All*	1.895***	2.866***	33.428**	30.269**
	(0.134)	(0.414)	(18.172)	(11.896)
Quality: *boating & fishing*	0.907***	1.328***	13.697**	13.216**
	(0.118)	(0.259)	(7.867)	(5.556)
Quality: *boating only*	0.153	0.217	3.458	1.926
	(0.125)	(0.191)	(2.491)	(1.350)
Riverbank:150	0.249**	0.362*	1.904	1.505
	(0.104)	(0.197)	(1.361)	(1.559)
Riverbank:300	0.323***	0.558***	6.517**	5.533**
	(0.101)	(0.199)	(3.254)	(2.454)
Tree plantation: 40	0.963***	1.457***	16.145*	15.253**
	(0.103)	(0.238)	(9.380)	(6.300)
Tree plantation: 80	1.444***	2.389***	25.099*	23.627**
	(0.113)	(0.380)	(14.250)	(9.568)
River Monitoring	0.353***	0.485***	3.994*	3.377**
	(0.080)	(0.163)	(2.144)	(1.532)
Regulation: *Municipality*	-0.534***	-0.889***	-9.186**	-9.148**
	(0.117)	(0.238)	(4.685)	(3.761)
Regulation: *Government*	-0.906***	-1.537***	-13.725*	-13.374**
	(0.123)	(0.337)	(7.139)	(5.586)
ASC	0.551***	0.864***	1.642***	2.868**
	(0.155)	(0.243)	(0.442)	(1.236)
Scale Parameters				
tau			1.771***	1.300***
			(0.235)	(0.133)
gamma			0.213***	0.673***
			(0.075)	(0.087)
Scale Parameter function				
Certain				0.460***
				(0.177)
Uncertain				-0.646**
				(0.311)
Model Statistics				
Log-likelihood	-1230	−1210	−1150	−1140
AIC	2488	2458	2352	2339
BIC	-	2585	2490	2489
N	1855	1855	1855	1855
Halton Draws	-	1000	1000	1000

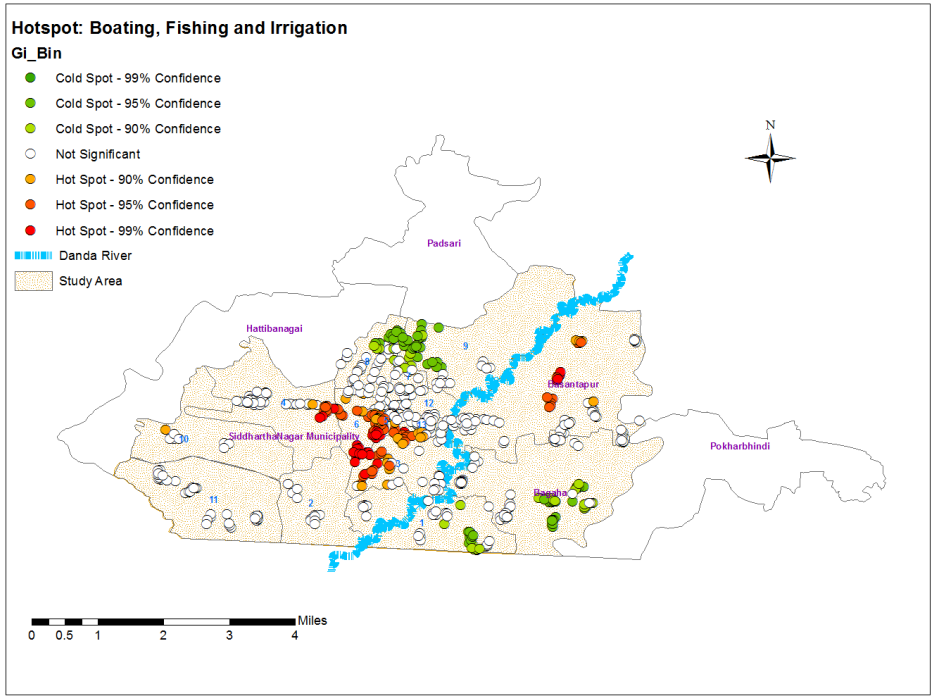
Marginal WTP Estimates - Figure

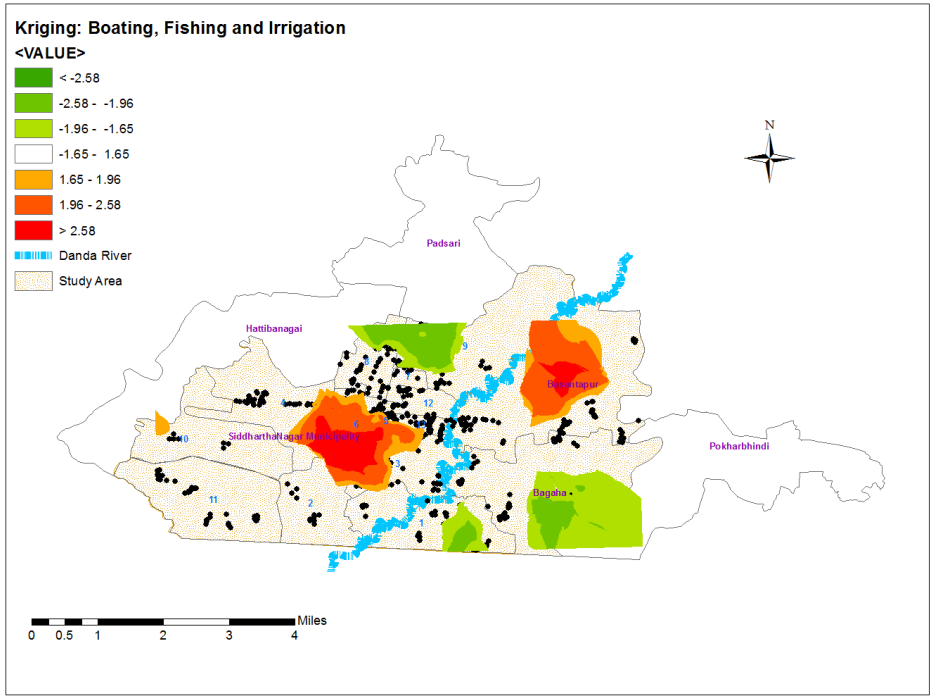
Figure 3. MWTP estimates and 95% confidence interval for the two GMNL models: (i) GMNL with preference uncertainty, and (ii) GMNL without preference uncertainty.



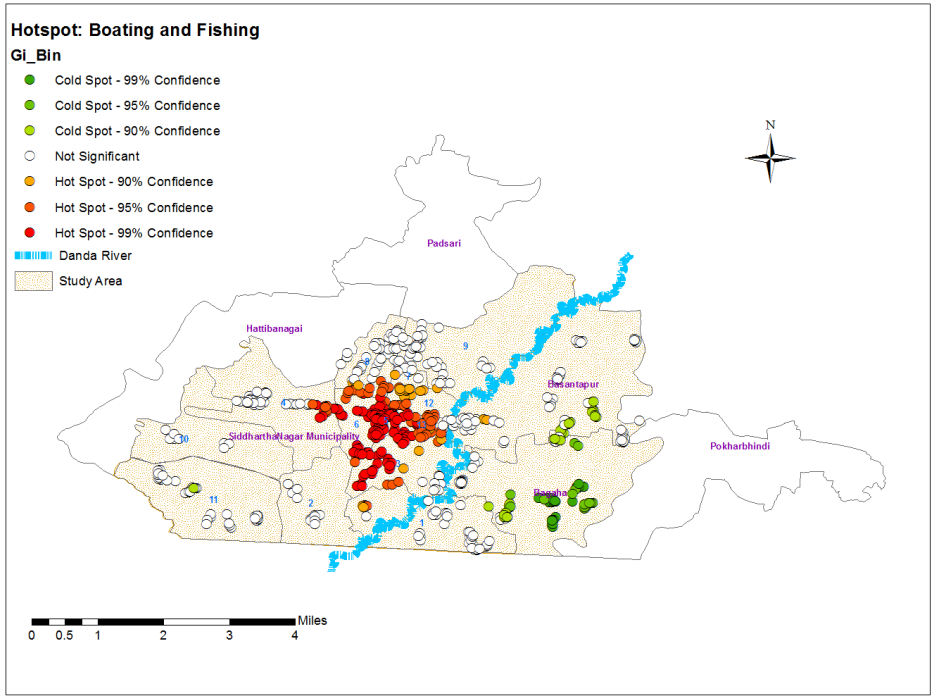
Note: The figure compares the marginal WTP estimates and the 95% confidence interval for the two GMNL models: GMNL with preference uncertainty and GMNL without preference uncertainty. The darker shades are the marginal WTP estimates for the GMNL model that incorporates preference uncertainty while the lighter shades are the GMNL model without uncertainty. The GMNL model with preference uncertainty has narrower confidence interval bands, however, the mean marginal WTP estimates does not vary too much between the two models.

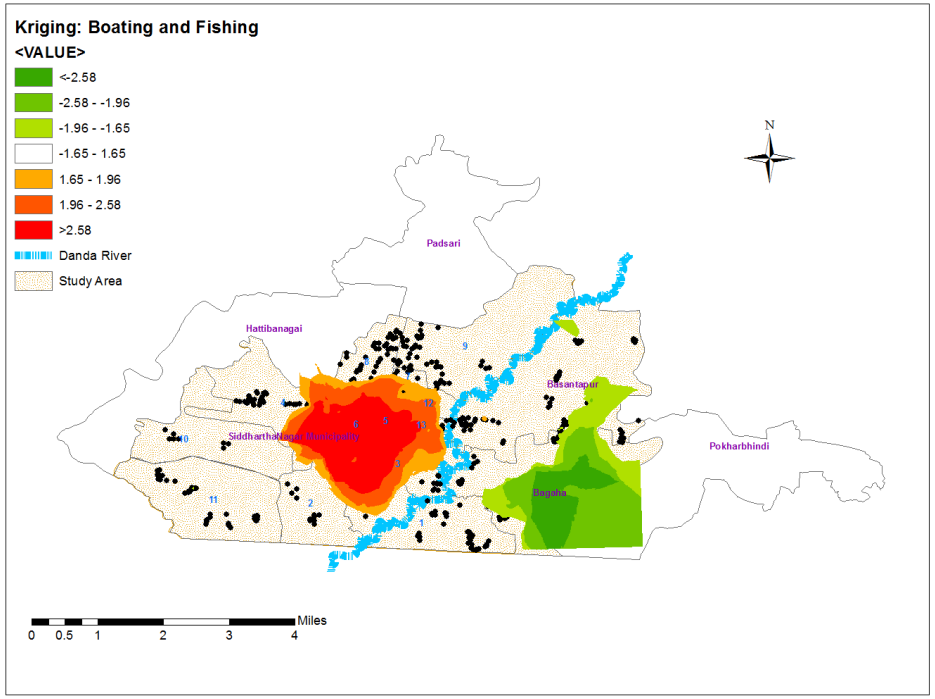
Spatial Analysis: (Boating, Fishing & Irrigation)



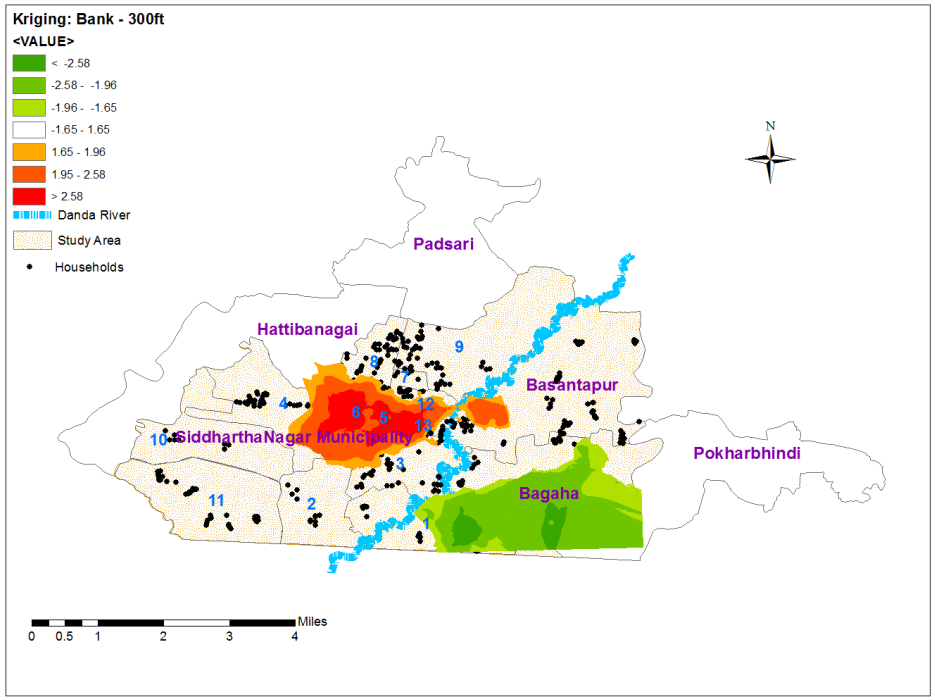


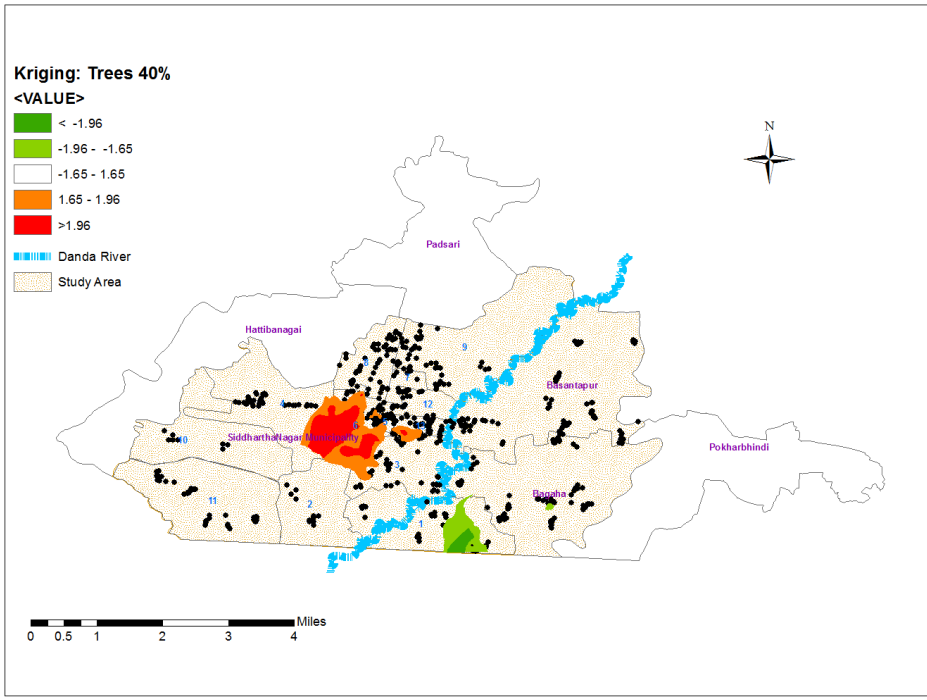
Hot Spot Analysis: Attribute (Boating & Fishing)





Kriging Analysis: Other Attributes





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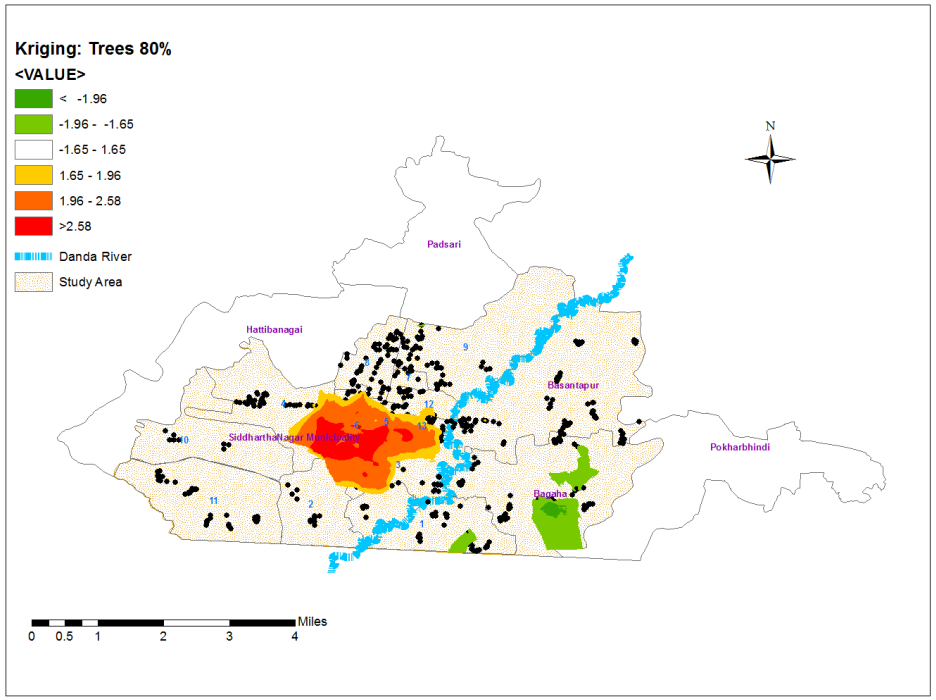

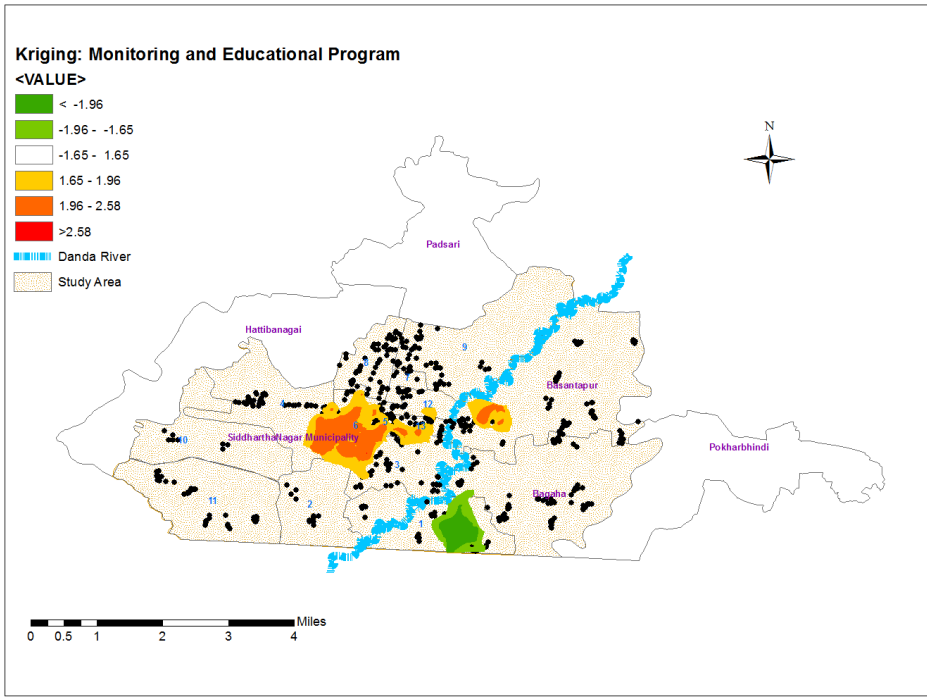

Conclusion

- Investigated people's preferences for ecosystem services in the Danda River basin, Nepal.
  - People are willing to support a new management program for Danda improvement & wish to move awa from the status quo levels.
  - People in developing countries have a deep seated mistrust in the government. Might be effective to decentralize management of the resource to the community to enhance conservation.
- The inclusion of preference uncertainty in model estimation lowered the variance and increased precision of WTP estimates.

Conclusion

- We found evidence of significant hot and cold spot areas for ecosystem services.
  - Provides a signal regarding the magnitude and spatial distribution of the value of Danda ecosystem.
  - Policymakers can set different targets for specific areas and design programs that are consistent with public preferences.
- The results from this study used as a basis to implement a pilot project called *Danda Ecological Monitoring Program* (DEMP).
  - Systematic collection of Danda River quality data. *Citizen Science* Program
- The *National Planning Commission* has granted funds to conduct a feasibility study on Danda ecosystem.
  - *"Valle de Oro National Wildlife Refuge"*