Paper 3

Assessing institutional and environmental parameters of agricultural water use in South Asia: Evidences from the Indo-Gangetic Basin

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Abstract

The Indo-Gangetic Basin encompasses most of the fertile landholdings in South Asia. However, low agricultural productivity is observed in the four riparian countries - India, Pakistan, Nepal and Bangladesh - by nailing down rural welfare. Accusations are directed at the inability of water supply sector to ensure high productivity rates and security of subsistence farmers. However, little is known about the demand side and farmers' perceptions towards the effects of water use on agricultural productivity. To this aim, we conduct an economic assessment through a stated preference approach on crucial institutional and environmental related parameters of agricultural water that could enhance productivity potential. Also, vital socio-demographic elements are examined as influential factors. The analysis is based on an extensive research survey accomplished in selected clusters along the Indo-Gangetic Basin.

Keywords: South Asia, Indo-Gangetic Basin, agricultural water, stated preference, economic assessment

1. Introduction

The Indo-Gangetic Basin (IGB) drains the southern Himalayan and Hindu Kush "water tower" of Asia and provides the economic base for agriculture, forestry, fisheries, livestock, and urban and industrial water requirements for about a billion people (Sharma et al, 2010). Rich alluvial soils and abundant surface and groundwater sources suggest a high agricultural potential in the four riparian countries of Pakistan, India, Nepal and Bangladesh. However, productivity in large parts of the IGB is relatively low while the rural poverty is distinctively high (Amarasinghe et al, 2007a).

Inefficient water management has been highlighted as a major cause of low yields and revenues in the IGB (Diao et al, 2003; Hellegers et al, 2006; Cai and Sharma, 2010). Supply-side technical and economic solutions such as the revitalization of existing projects, introduction of new large-scale irrigation dams and low recovery cost schemes try to reverse conditions of inefficient water use (Jain et al, 2007; Mukherji et al., 2009). However, a recent shift from supply-side solutions to demand-side management is underway. The rapid expansion of private groundwater pumping and informal water trading mainly in Indian regions portrays a new era to agricultural water in IGB area. Farmers justify the rapid growth of private initiatives on the inability of the state supply projects to efficiently cover the augmented water needs (Asian Development Bank, 2007).

The expansion of groundwater pumping in high permeable alluvium derived soils which are usually met in IGB area has induced water pollution from agrochemical residues and geogenic contamination with arsenic. Also, over-pumping practices have diminished groundwater reserves by provoking erosion effects (Rodell et al; 2009; CPWF, 2010). The close linkage between groundwater and surface water sources progressively induces an overall degradation of the water status in IGB. A quantitative and qualitative deterioration has mostly affected the ecological services associated with the water cycle. Water scarcity in the dry season, high soil salinity, and erosion in several downstream areas are the most indicative problems related with the disturbance of ecological services (Chakraborti et al.; 2004; Sharma and Cai, 2009). The significance of ecological services is acknowledged amongst scientific community but was unknown to the farming community in the IGB until recently. However, water deterioration has given profound insights to farmers about the vital role of ecological services by triggering the need for preservation initiatives (Ambastha et al, 2007).

The absence of an appropriate institutional setting for private water initiatives and the still unclear- for farmers- linkage of water with ecological services set forth new dimensions stemming from the demand side. Noteworthy attempts have been mainly focused on the assessment of water demand in the IGB through water pricing and agricultural growth proxies (Ranganathan and Palanisami, 2004; Kumar, 2005; Shah et al 2006, 2009; Singh, 2007; Kakumanu

and Bauer, 2008). The effects of economic instruments on water demand and the impact on agricultural productivity in the IGB is another approach that has been also explored (Hellegers et al, 2006; Narain, 2008). It is generally observed that high attention is given to the identification of the optimal water pricing which could best enhance agricultural growth. However, there are still poor evidences about users' preferences on institutional and environmental key attributes that significantly affect water status and agricultural growth in IGB area.

This paper attempts to elicit through a stated preference approach vital institutional and environmental related attributes of agricultural water. The research data is extracted from the survey analysis of selected clusters[1] of the four riparian countries of Pakistan, India, Nepal and Bangladesh. In Section 2, the methodological context of the study is explained while in Section 3, a brief description of the sampling areas is presented. In Section 4, the economic assessment of institutional and environmental related parameters is conducted while the relationship with key socio-demographic elements is exhibited. Section 5 discusses the research findings while the conclusions of the study are presented.

2. Methodological Context

The research initially attempts to infer economic implications in major institutional and environmental water related parameters through a demand side analysis. The environmental and institutional parameters to be assessed are identified by the relevant literature review and experts' opinion who participated in the research projects under which this study was conducted (Fan et al, 2000; Sabau and Haghiri, 2008; Sharma et al, 2010).

The major institutional services are discerned in the establishment of groundwater market, the revitalization/introduction of common tube well systems and the discontinuation of water provision from private tube wells. Accordingly, the environmental services are directly and indirectly identified. Directly, crucial supportive services such as microclimate stabilization, infiltration of groundwater reserves and erosion protection are underlined. Discontinuation of water-intensive crops/ varieties and the control of agricultural residuals are investigated as indirect environmental attributes.

The assessment of all the institutional and environmental parameters is realised through a stated preference approach. The stated together with the revealed preference approach constitute the core methodological tools for the elicitation of individuals' perceptions (Pearce, 1993; Hanley and Louviere, 2009). An initial

[1] Cluster is considered to be a compound of small settlements which may be formed as villages or sparse inhabitants' areas.

distinction between stated and revealed preferences would enlighten the differentiation between the two and the reasoning behind our selection.

The assessment of predefined perceptions - expressed by the revealed preference approach - is conducted through surrogate or proxy markets (Pearce and Ozdemiroglu, 2002). For instance, we may assume the development of a large reservoir for irrigation purposes which is about to create a new artificial lake in IGB area. The funding organisation may desire to estimate the economic benefits from future fishing activities through a feasibility assessment. The revenues from fishing activities can be captured from already existent prices of similar goods in the nearby markets. Then, the relevant benefits could be accounted through some necessary adjustments for the enclosure of local peculiarities. However, such an assumption presupposes that the inhabitants will be willing to fish in the lake by setting aside their current professional activities. In other words, it is required that their preferences towards fishing instead of farming which mainly occurs in rural areas of IGB, are taken for granted. This means, that farmers' preferences are conceived as *predetermined* which should be revealed from the developers for the estimation of the relevant benefits.

In another case however, the developers may desire to know the preferences of local farmers before estimating the potential benefits from fishing. In other words, they desire to create a hypothetical case for a fishing market where the benefits will depend on farmer's preferences. This approach is known as *stated preference approach* where the assessment is conducted through a hypothetical or constructed market mainly based on survey analysis (Alpizar et al, 2001, DTLR, 2002). In our case, the difficulty to define surrogate markets for institutional and environmental related services in IGB obstructed the implementation of the revealed preference technique. Further, the biases emanating from stereotype presumptions about the inferiority of institutional water-related interventions and environmental services strengthened our inclination to stated preferences.

The implementation of stated preference for the economic assessment of water and environmental related parameters is conducted through the Willingness to Pay (WTP) and Willingness to Accept (WTA) techniques. Both techniques are based on hypothetical payment scenarios, which try capturing people's desirability to pay (WTP) or get compensated (WTA) for specific aspects or the entirety of goods and services (Carson et al, 1995). The application of WTP and WTA in our study is conducted through questionnaire forms and open-ended questions in representative clusters of Pakistan, India, Nepal and Bangladesh. The open-ended question is preferred towards a multiple choices setting due to the potential biases emerging from the adoption of predetermined bids. It is acknowledged that similar biases may occur in open-ending questions when unrealistically high or low bids appear (Cameron and Quiggin, 1994; NOOA, 1995). To this aim, an extensive introduction on the concept of economic assessment was offered to respondents by trained local researchers. Further, the

outliers were excluded from the sample as a potential distortion of the final outcome (Garrod and Willis, 1999).

The consultation of the relevant literature review, experts' opinion and the conducting of field visits in the examined areas contributed to the designing of the following WTP and WTA questions (Table 1):

Table 1. WTP and WTA assessment framework

Examined Parameters	Area	Approach	Inference
Establishment of groundwater market	India-Pakistan-Nepal	Stated Preference-Questionnaire Form	WTP
Preservation of environmental services			
Revitalization/introduction of common tube well systems	India-Nepal		
Discontinuation of private tube well use for the preservation of common sources			WTA
Replacing high water-consuming crops	Nepal-Pakistan		
Managing agricultural residues			
Pausing fishing activities for protective purposes	Bangladesh		
Discontinue water consumptive rice			

The respondents who refused to participate in the economic assessment were also explored for the identification of potential methodological inconsistencies. It is almost evident that the potential negation of respondents is followed with zero or extremely high bids (Bateman et al, 2002). However, it is unclear whether the negation pertains to the economic situation of the arguer or low confidence of the methodology *per se*. In case the method is encountered as inappropriate, the negations are perceived as protest bids. If the economic situation is the causal factor for arguers' response, then a negation is apprehended as zero bid with no actual impacts on the theoretical grounds of the method. To this end, the presence of protest bids is investigated in our study through a set of negation options (Table 2) as below:

Table 2. Protest and zero WTP/WTA bid options

Options	Technique	Inference
Opposed to such economic approaches	WTP/WTA	Protest bid
No trust in the payment authority	WTP/WTA	
It is not me who should pay for these services	WTP	Zero bid
Not enough money to pay	WTP	
No revitalisation of the common tube well effectively	WTP	
I do not believe they will compensate me effectively	WTA	
Do not know how much to ask for	WTA	
Prefer to use my own tube well	WTA	

In case of positive stance towards the economic assessment, the relevance of the responses with agricultural revenues[2] and basic socio-demographic elements are explored. We employ Univariate General Liner Model (UGLM) as a tool which can implement both regression and analysis of variance (ANOVA) approach. With UGLM the analyst may use simultaneously fixed factors, random factors and covariates as predictors. The dependents should be numeric while the independents may be categorical factors (including both numeric and string types) or quantitative covariates. The variance analysis uncovers the main and interaction effects of categorical independent variables (factors) on an interval dependent variable. Further, the inclusion of covariate as predictor allows the model to test main and interaction effects of the factors by controlling for the effects of selected other continuous variables which covary with the dependent. The data should be originated from a random sample for purposes of significance testing (Garson, 2010). In our case, the MGLM fitted to our objectives because we were allowed to explore the effects of socio-demographics as categorical fixed factors and the revenues as interval co-variable in the same model.

For the operational aspects of UGLM we consider $y_1, y_2, \ldots y_n$ to denote n independent observations on a response. We treat y_i, as a realization of a random variable Y_i. In the general linear model, we assume that Y_i has a normal distribution with mean μ_i and variance σ^2 as shown below:

$$Y_i \sim N(\mu_i, \sigma^2) \text{.....(1)}$$

We further assume that the expected value μ_i is a linear function of p predictors that take values $x'_i = (x_{i1}, x_{i2} \ldots, x_{ip})$ for the i-th case, so that $\mu_i = x'_i\beta$, where β is a vector of unknown parameters (Burridge and Sebastiani, 1992).

[2] It should be mentioned that the revenues derived from agricultural activities are to be identified with the agricultural income since the sampling were exclusively farming communities

Due to the high right skewing in most of the WTP and WTA bids a normalisation of the values has occurred into natural logarithms. However, the very small bids would result in negative numbers along the logarithmic conversion. For that reason, a constant was added for the conversion in positive values as below (Osborne, 2002):

$$X : X' = Ln(X + C) \text{.....(2)}$$

The right skewing of agricultural revenues which is used as a predictor in our model was also treated through the transformation in logarithmic values. The conversion in logarithmic scale (base 10) instead of natural logarithm is justified by the theoretical assumptions of the stated preferences assessment (Bateman et al, 2002). In effect, the income which is identified with agricultural revenues in our case, acts as a predictor for the estimation of WTA/WTP bids to be offered for the examined services. The WTA and WTP bids in turn should reflect the utility derived by the assessment of these examined services. The utility can be directly identified through a bids function model or alternatively through the insertion of proxies and normalisation processes (Hanemann, 1994; Fisher, 1996). In our case, the bids function model was chosen due to the relative straightforward assumptions. However, the higher the income, the less the utility to be derived from bids due to the marginal declining utility levels (Bateman et al, 2002). For that reason, a logarithmic transformation of income should better reflect the assessment process as presented below:

$$B_{WTP,\,WTA} = a + bLogY_{ij} \text{.....(3)}$$

where:

$B_{WTP,\,WTA}$ = Bid for WTA and WTP in the related questions

Y_{ij} = Income (revenues) for i-th cases and j-th respondents

a = constant

b = marginal impact on income (revenues)

The socio-demographics to be inserted in UGLM analysis should be converted into ordinal and nominal factors as dictated by the model. Namely, the household, the age and education socio-demographic components were transformed to dummy categorical variable (Table 3) as below:

Table 3. Socio-demographic characteristics of the respondents

Classification	Age (year)	Household Size (no.)	Education level
1	>25	>4	Postgraduate
2	25-34	4-6	Graduate
3	35-44	7-10	Secondary School
4	45-54	11-14	Primary School
5	55+	15+	Madrasah (only for Pakistan)
6	--------	---------	Not Schooled

The significance of the socio-demographic factors and the revenues covariate towards the economic assessment are then examined on a national scale. However, a comparative cross-national analysis between the offered (WTP) and accepted (WTA) bids is also conducted for the identification of well established models. Further, a more detailed analysis on the significance of each category of the factors is undertaken for the understanding of its contribution to the model.

The study does not consider the occurrence of unpredicted external conditions (i.e., natural disasters, price squeezing because of rapid trade liberalisation, etc.) as being influential to the findings. Although external factors are indirectly considered through the error term in the analysis, however, there is not an explicit reference to the erratic and unpredicted effects of such conditions.

3. Case Study Analysis

The IGB area is featured with a set of contradictory natural and socio-economic elements. The high soil fertility provoked by the abundance of surface water and groundwater delineates the highest crop productivity potential for the countries sharing the basin (Cai and Sharma, 2010). However, the IGB is currently discerned as a hotbed of rural poverty in South Asia (Amarasinghe et al, 2007b). Poverty estimations point out that almost over 40% of the IGB belongs to the Below Poverty Line (BPL) group with people living on less than US$2 per day (Khandker and Haughton, 2010; World Bank Indicators, 2010). The following figure depicts the IBG basin while the main streams and political boundaries of the riparian are mentioned:

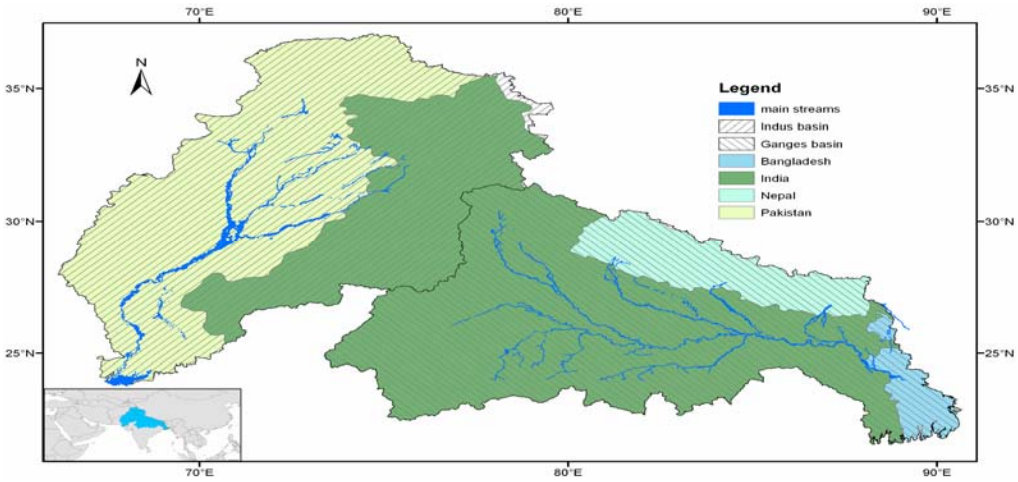

Figure 1. The Indo-Gangetic basin area

The clusters selected from India were situated in the state of Bihar, along the eastern regions of the Ganges Basin. Bihar is enriched with fertile alluvial plains and abundant water resources. However, the region is confronted with low agricultural productivity, extreme poverty and regional disparities (World Bank, 2005; Sharma et al, 2010). With 43% of the population below the poverty

line, Bihar presents some of the lowest income rates in South Asia. For the needs of the survey, seven disadvantaged villages from four districts were chosen.

In the case of Pakistan, the examined area is divided through Upper Rechna, Middle Rechna and Lower Rechna catchment area in the Indus Basin. The four districts enclosed in the Rechna subbasin, namely Hafizabad, Sheikhupura, Faisalabad and Toba Tek Singh, were chosen. Two sample villages were adopted on the basis of best geographical dispersion in each district. The farmers were grouped according to their landholding size in eight classes. The number of farmers selected in each class was determined proportionately.

In Nepal, the area of Biratnagar was chosen due to its location in the wider basin of the Ganges River. Biratnagar is positioned in the Koshi subbasin on the southern lowland belt of Nepal, near the south-eastern border with India. Four disadvantaged villages in the two districts of Morang and Munsari were adopted as case studies. Emphasis was given to the difficulties faced in drought conditions by also contemplating the rarity of canal irrigation and pumping devices.

In Bangladesh, the study area was positioned in the Eastern Ganges Basin (EGB) as a sub-sector of the broader IGB where a maximization of water allocations is appraised. The area chosen was based on a rough division between the upper, middle and lower stream of the sub-basin. A sample of three districts and 27 representative clusters was adopted for the collection of water productivity values and drivers on different capture and culture fishery systems. Overall, 1,950 farmers were surveyed from 13 districts and 50 clusters in the entire IGB area.

A random sample of about 30% of the total households was collected from each cluster while all interviews were conducted on-site through qualified local researchers. To achieve high heterogeneity of the sample, a set of environmental, technical and socioeconomic criteria were introduced for the selection. The heterogeneity aspired to attribute a representative geophysical and socioeconomic overview of the surrounding clusters in the IGB area. Emphasis was given to the least developed regions where dependence on agriculture and water supply is more evident. Due to the particular characteristics of each area, the environmental and institutional issues considered in the selection process vary accordingly. The differentiation is distinctive in the case of Bangladesh due to the large dependence on aquaculture and capture fisheries activities. However, the findings inferred from the entire sampling in the four countries attribute a concrete insight into the major water-related issues affecting farming activities.

The selected clusters should overall cover a set of diversified criteria as shown in Table 4.

Table 4. Criteria for the selection of a representative cluster in the IGB area

Criteria for the cases of India, Nepal and Pakistan				
Agro-ecological subregion (according to international indices)	**Soil type (according to international indices)**	**Agricultural water patterns**	**Cultivation seasons**	**Environmental characteristics**
		Tube well	Kharif (rainy)	Near to river
		Bore well	Rabi (winter)	Near to spring
		Rain-fed	Summer	Near to forest
		Canal		Water congested area
		Pond/tank		

Criteria for the case of Bangladesh			
Capture fisheries	**Culture fisheries**	**Other fishery systems**	**Environmental characteristics**
River and *Beel*	Cultured	Rice-fish culture	High fish diversity
Beel and Khal	Culturable	Golda culture	Moderate fish diversity
Beel	Derelict	Bagda culture	Low fish diversity
Baor			High vegetation diversity
River			Moderate vegetation diversity
Khal			Low vegetation diversity
Floodplains and/or river/*khal*			

Notes: ***Kharif season****: May to October;* ***Rabi season****: November to April****; Beel****: Low-lying depression in the floodplain (small lakes);* ***Khal:*** *Connecting canals that feed the beels with water in some instances;* ***Cultured Pond****: Pond where culture of fish is practiced under definite production plan;* ***Culturable Pond****: Pond usually not under planned aquaculture practice;* ***Derelict Pond****: Pond or ditches where aquaculture is difficult without possible major renovations;* ***Bagda culture****: Marine shrimp (Penaeus monodon);* ***Golda culture****: Freshwater shrimp (Macrobrachium rorenbergii);*

4. Results

4.1. Economic assessments trough WTP and WTA

The stance of respondents towards their agreeability or reluctance to participate in the assessment process is initially delineated. As presented in Figure 2, the highest negation is perceived from Pakistanis to all the relevant cases, with large divergence from the other respondents. On an average, about two-thirds of the Pakistani farmers are reluctant to offer (WTP) or accept (WTA) any payment. The negation is drastically decreased for Indian respondents related to WTP bids whereas it gets minimized when Indians are asked to get reimbursed (WTA) for the discontinuation of private tube wells.

The Nepalese stance seems to be highly differentiated between WTP questions, where the negation is rather low, and WTA ones, where the refusal to participate becomes threefold higher. The Bangladesh respondents generally show the lowest negation levels for the WTA cases in which they are assessed.

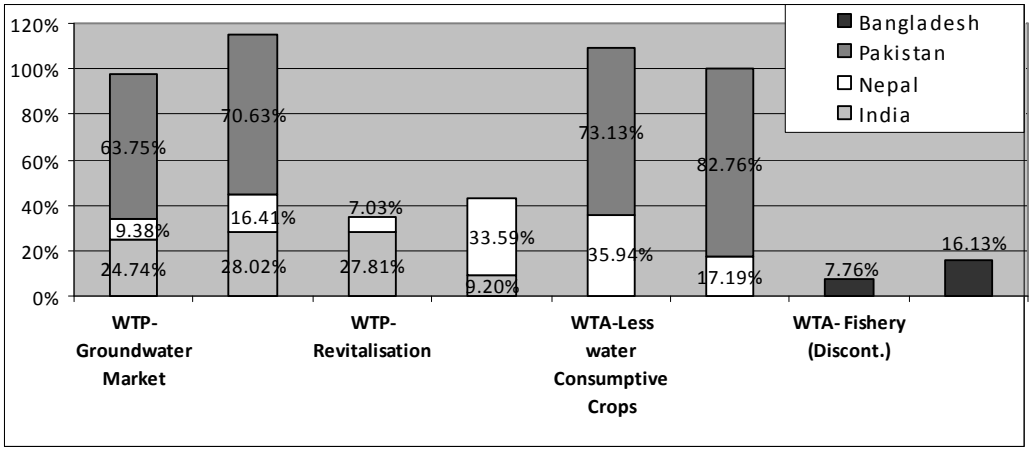

Figure 2. Negative responses in WTP/WTA inferences

In turn, we unravel the negation reasoning through a set of predefined replies for the identification of protest and zero bids (Figure 3). The payment affordability ("Not enough money to pay") comprises the major reason for WTP bids. Accordingly, for WTA bids an equally high amount of respondents is uncertain about the amount to request for compensation (''Do not know how much to ask for''). The stance of all respondents clarifies their unfamiliarity to economic assessments. However, these responses are not classified as protest bids and do not set in doubt the elicitation approach.

The highest voting for protest bids are distinctively lower than zero ones as indicatively occurs with the suspicion towards the reliability on the compensating authorities or the sufficient compensating amount. Generally, the opposition towards the elicitation approach stands among the lowest ranked options which enhance the credibility of the entire undertaking.

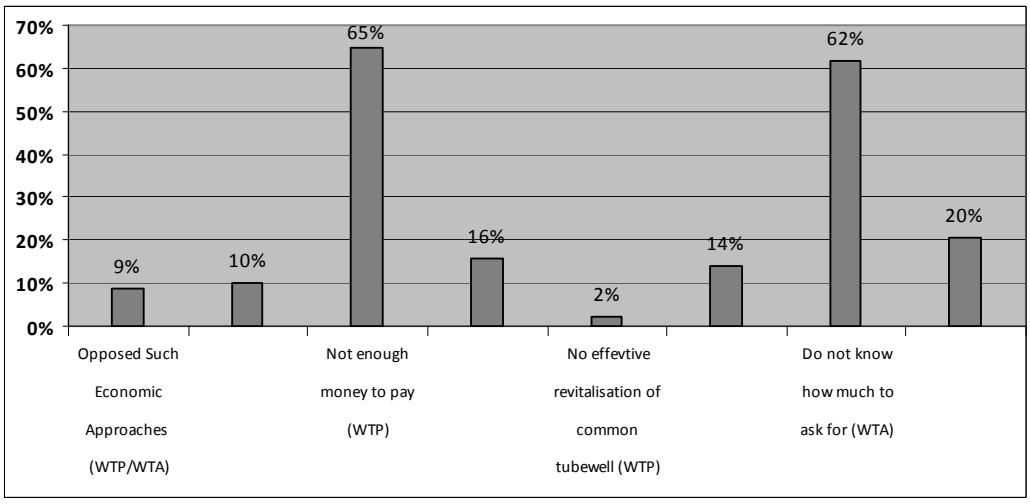

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Figure 3. Reasoning of the negation in WTP/WTA inferences

The assessment of WTP bids for the establishment of a groundwater market and the preservation of environmental services ascribes the highest amount to Pakistani respondents (Table 5). Interesting though is the fact that the majority of Pakistani participants had already expressed the highest opposition towards these two water related parameters. Nevertheless, the remaining respondents are willing to offer a threefold to fourfold higher amount as compared to Indian farmers and distinctively higher from the Nepalese ones.

For the case of WTP in the revitalisation of common tube wells, Nepalese appear distinctively more positive than the Indians by comparatively offering a six-fold amount. This eagerness could be in part justified due to the fact that the sample area in Nepal is largely dependent on shallow common wells except for a few canal irrigated lands. Observations on the central tendency indicators (mean and median) display an almost normal distributed sample. The only exception appears to be on the Nepalese stance towards a groundwater market where some higher bids provoke a right skewing of the distribution.

Table 5. WTP for institutional and environmental related services in the IGB area ($/yr)

Parameter	Groundwater Market			Environmental Services			Revitalization of common well	
	India	Nepal	Pakistan	India	Nepal	Pakistan	India	Nepal
Valid	328	58	50	312	50	48	320	60
Missing	161	69	270	177	77	270	169	67
Mean	7.25	22.21	27.26	6.32	15.97	28.69	6.082	29.05
Median	5.18	16.38	27.33	5.18	16.38	30.22	5.18	29.77
Std. Dev.	1.90	1.58	2.66	1.83	1.46	2.27	1.97	1.6

In case of WTA queries as presented in Table 6, the highest WTA amounts is requested by Bangladesh farmers for the discontinuation of fishing activities and the replacement of water consumptive rice. This is extensively justified due to their absolute dependence on fishing and secondarily rice for self-consumption and market purposes. A discontinuation of these farming practices would result in deprivation of their basic nutritional intake and almost complete loss of their income. An also distinctively high amount is requested by Indian farmers for discontinuing pumping from private tube wells. This is again justified by the large dependency of Indian respondents to groundwater sources and pumping practices in the examined districts.

Much lower WTA amounts are requested by Pakistani clusters. However, in the case of Pakistan, the WTA bids do not question the pausing of the current cultivation and hence their future employment status per se, as is the case in India and Bangladesh. Instead, they are related to the adoption of more environmentally friendly options in cultivation patterns.

Table 6. WTA for Institutional and Environmental related services in IGB area ($/yr)

Parameter	Stop private use		Change high water consumptive crops		Manage agricultural residuals		Reduced/ no fishing	Change rice cultivation
	India	Nepal	Pakistan	Nepal	Pakistan	Nepal	Bangladesh	Bangladesh
Valid	31	27	48	24	35	48	236	154
Missing	458	100	272	103	285	79	1050	1132
Mean	69.37	18.49	22.97	18.83	37.46	17.74	178.97	165.04
Median	112	16.39	27.33	16.39	9.08	16.39	158.98	148.13
Std. Dev.	1.75	1.34	1.98	1.4	6.5	1.28	1.93	2.36

The central indicators reveal a concrete stance of Indian respondents to get reimbursed for the discontinuation of private water sources. The inverse situation occurs in Pakistani clusters for the management of agricultural residues where some high bids steeply raise the mean indicator. Few high bids appear to also give a slight advance to the mean indicator in Bangladesh while the Nepalese sample is almost identically distributed.

4.2. UGLM analysis with explanatory factors

Initially, the case of WTP for the establishment of groundwater market is exhibited. As presented in Table 7 the Indian sample offers a moderate explanation (R^2= 0.205) of the model with household size and revenues to justify this condition. Contradictorily, the bids are poorly explained in the case of Nepalese farmers (R^2= 0.159). In Pakistan, although the model is explained satisfactorily (R^2= 0.345), it is only the educational factor to weakly ascribe this relation.

Table 7. WTP for establishment of groundwater market (India-Nepal- Pakistan)

Source	India				Nepal				Pakistan			
	T. III	df	F	Sig.	T. III.	df	F	Sig.	T. III	df	F	Sig.
Cor.M.	25.92[a]	14	4.960	.000	1.45[a]	10	.641	.769	13.581[a]	11	1.531	.169
Inter.	4.018	1	10.763	.001	7.194	1	31.79	.000	6.328	1	7.847	.009
Educ.	.437	5	.234	.947	.311	3	.457	.714	7.507	3	3.103	.040
Age	3.032	4	2.031	.090	.285	3	.420	.740	3.990	3	1.649	.198
Hsd	12.603	4	8.440	.000	.830	3	1.223	.316	2.521	4	.781	.546
Reven.	6.599	1	17.677	.000	.011	1	.051	.823	1.372	1	.000	.997

Note: Cor. M. = Corrected Model, Inter. = Intercept, Educ= Education, Hsd= Household size, Reven=Revenues, T. III= Type III Sum of Squares (The abbreviations also apply for the tables, 8, 9, 10, 11, 12, 13)

Table 7. About here

The cross-national analysis for the WTP in environmental services is quite alike with groundwater market potential in terms of significance conditions (Table 8). The household and revenues components seem to adequately explain the comparatively lower significance of Indian model (R^2= 0.103) towards to Nepalese (R^2=0.298) and Pakistani (R^2= 0.446) ones. However, again the Nepalese sample acts insignificantly for all variables while the marginal significance attributed by Pakistanis is slightly explained by household factor.

Table 8. WTP for Environmental Services (India-Nepal- Pakistan)

Source	India				Nepal				Pakistan			
	T. III	df	F	Sig.	T. III.	df	F	Sig.	T. III	df	F	Sig.
Cor.M.	10.91[a]	14	2.109	.012	1.609[a]	10	1.103	.396	11.10[a]	11	2.196	.043
Inter.	6.049	1	16.366	.000	6.179	1	42.335	.000	2.250	1	4.893	.035
Educ.	2.028	5	1.098	.362	.345	3	.788	.511	3.272	3	2.371	.090
Age	1.348	4	.912	.457	.551	3	1.259	.309	1.713	3	1.242	.312
Hsd	4.650	4	3.146	.015	.745	3	1.702	.191	4.945	4	2.688	.050
Reven.	2.018	1	5.460	.020	.158	1	1.083	.308	.448	1	.975	.331

In the case of WTP for the revitalization of common wells the responses of both Indian (R^2= 0.076) and Nepalese (R^2= 0.16) farmers seems to be unrelated with the revenues and the socio-demographic elements (Table 9).

Table 9. WTP for the revitalization of common wells

Source	India				Nepal			
	T. III	df	F	Sig.	T. III.	df	F	Sig.
Cor.M.	10.62[a]	14	1.57	.086	1.47[a]	10	.66	.746
Inter.	6.92	1	14.37	.000	9.74	1	44.28	.000
Educ.	3.76	5	1.56	.170	.37	3	.57	.636
Age	2.91	4	1.51	.198	.3	3	.54	.657
Hsd	2.53	4	1.31	.264	.71	3	1.07	.372
Reven.	1.50	1	3.12	.078	.00	1	.01	.918

However, the situation radically changes for the WTA towards the discontinuation of private tube wells where the Indian model appears rather satisfactory (R^2= 0.686). This change seems to be mainly attributed to the educational factor. On the other hand, the model for the Nepalese farmers is exhibited as rather insignificant (R^2= 0.173) and with high irrelevance towards any of the factors (Table 9).

Table 10. WTA for the discontinuation of private tube wells (India-Nepal)

Source	India				Nepal			
	T. III	df	F	Sig.	T. III.	df	F	Sig.
Cor.M.	63.42[a]	11	3.76	.006	.24[a]	9	.302	.961
Inter.	8.04	1	5.25	.033	4.13	1	45.92	.000
Educ.	14.83	3	3.23	.046	.06	3	.228	.875
Age	2.13	3	.46	.710	.10	3	.402	.754
Hsd	9.05	4	1.47	.248	.07	2	.419	.666
Reven.	.02	1	.01	.896	.00	1	.004	.951

The findings of the other examined WTA paired questions are exhibited in Table 11. As presented for the WTA about the replacement of water consumptive crops, there is a moderate relation for the Pakistani sample (R^2=0.353) while the relation becomes highly satisfactory for the Nepalese (R^2=0.908) case. However, when looking through the variables it is well perceived that only the revenues covariate influences the relationship of the model. In the case of WTA for the management of agricultural residuals, a moderate relationship is observed for both the Nepalese (R^2= 0.234) and Pakistani (R^2= 0.451) which is however very poorly explained by all variables. Finally, the WTA bids of Bangladeshi for stopping fishing activities seems irrelevant towards all variables with a very weak relationship status (R^2= 0.039). The situation is moderately altered in the case of rice replacement (R^2= 0.152) where the revenues comprise the only highly influential factor.

Table 11. WTA related paired questions

WTA for the replacement of water consumptive crops (India-Nepal)								
Source	**Nepal**				**Pakistan**			
	T. III	df	F	Sig.	T. III.	df	F	Sig.
Cor.M.	.660[a]	10	4.955	.046	6.368[a]	11	1.539	.168
Inter.	3.928	1	294.75	.000	1.149	1	3.054	.090
Educ.	.063	3	1.588	.303	2.235	3	1.981	.137
Age	.172	3	4.309	.075	.995	3	.882	.461
Hsd	.077	3	1.930	.243	1.966	4	1.307	.289
Reven.	.403	1	30.239	.003	1.701	1	4.522	.042
WTA for the management of agricultural residuals (Nepal- Pakistan)								
Source	**Nepal**				**Pakistan**			
	T. III	df	F	Sig.	T. III.	df	F	Sig.
Cor.M.	.540[a]	9	.950	.500	45.896[a]	12	1.096	.423
Inter.	6.660	1	105.35	.000	4.349	1	1.246	.281
Educ.	.250	3	1.316	.289	9.509	4	.681	.615
Age	.321	3	1.690	.192	13.588	3	1.298	.309
Hsd	.062	2	.494	.615	14.079	4	1.009	.432

Reven.	.015	1	.239	.629	1.276	1	.366	.554
WTA for pausing fishing and replacing water consumptive rice (Bangladesh)								
Source	**Bangladesh-Fish**				**Bangladesh-Rice**			
	Typ.III S.Sq.	df	F	Sig.	Typ.III S. Sq.	df	F	Sig.
Cor.M.	3.960[a]	12	.750	.701	17.207[a]	12	2.110	.020
Inter.	65.325	1	148.47	.000	5.032	1	7.404	.007
Educ.	.369	3	.280	.840	5.137	3	2.519	.061
Age	2.467	4	1.402	.234	.887	4	.326	.860
Hsd	1.184	4	.673	.611	3.144	4	1.156	.333
Reven.	.587	1	1.334	.249	7.221	1	10.624	.001

Overall, the model for Indian respondents seems to act distinctively better than the others by explaining the three out of four WTP and WTA bids. Also, the revenues, the household size and the educational factor constitute the major influential parameters. The Bangladeshi sample then follows with an explanation in one out of two cases while the revenues constitute the only influential factor in the relations. It should be mentioned however, that the few cases assessed in Bangladesh cannot offer a clear insight about the significance of the selected variables in other potential cases. The Nepalese are getting behind with an explanation of two out of six models while alike to Bangladeshi, revenues is the only explanatory factor. The last ranking is rendered to Pakistani sample with one out of four satisfactory relations and the educational factor to consist of a moderate factor.

Also, there are not noticeable differentiations in the significance relations of the models among WTA and WTP responses. It is equally five insignificant against three significant relations for both WTP and WTA bids. This condition indicates the indifferent almost role of socio-demographic components and revenues between WTA and WTP bids for the institutional and environmental related parameters.

Further, a more detailed analysis on the categories of each socio-demographic factor is conducted according to the classification presented in Table 3. A concise description of the results is delineated here, while the detailed findings are displayed in Appendixes 1 and 2. A significance of prevalently very small (<4) and secondarily small (4-6) and medium (7-10) households is revealed while also the mature age groups (45-54) are influential for the Indian cases. Accordingly, the young (25-34) and medium aged (35-44) farmers affect in some cases the Nepalese sample. For the case of Pakistani and Bangladeshi samples there is hardly any category to act significantly in the examined models.

4. Discussion and Concluding Remarks

The economic assessment of institutional and environmental related parameters which affect the water demand side and agricultural productivity in the IGB area followed the main assumptions of the stated preference approach. It is acknowledged, however, that for the analysis of WTA and WTP bids, logarithmic related models and logistic regressions are usually applied. Indicatively, linear, logit and probit models predict the expected WTP and WTA frequencies, address the relative importance of economic coefficients and test the validity through a goodness of fit test (the likelihood ratio) (Garson, 2010). The case of logistic regression follows a similar conceptual pattern although the impact is usually explained in terms of odds ratios. These techniques could better explain dichotomous and payment-ladder queries which are often introduced for the elicitation of bids (Bateman et al, 2002; Bennet and Birol, 2010).

In our study however, an open-ending query was applied instead which cannot be explained through probabilistic analysis as is the case in the aforementioned techniques (Fisher 1996, Bateman et al, 2002). The study attempted to figure out the behavioral stance of farmers in the IGB towards a wide range of environmental and institutional parameters coupled with revenues and socio-demographic elements.

If looking through the application area, the study covered a very extensive territory demarcated by the IGB. It is inevitable that a plethora of other water source types, cropping and fishing patterns could be identified elsewhere in each country and between them. To this end, the introduction of diversified criteria as presented in Table 4, aimed at the selection of representative samples from agriculturally dependent regions with low economic welfare. It is acknowledged though that the capturing of all the water use and agricultural types in the IGB area could not be attained within this study.

The findings denote the positive stance of respondents in the assessment of crucial water-related services that could possibly enhance agricultural productivity. The negative responses seem to be related to high poverty levels and the unawareness of the respondents towards economic assessments. However, the approval of the stated preference approach with WTP and WTA inferences is indicated through the low attendance given to protest bids.

The explanatory analysis of the proposed bids through the UGLM technique revealed some substantial hints in country-wise and parameter-oriented contexts. It also appears that the differentiation between WTA and WTP query types does not remarkably affect the models' fit. Instead, it seems to be the

country origin that better determines models' significance and cohesion between the predictors and dependent variables.

The outcome of our research indicates the high willingness of farmers to factually enhance agricultural productivity through the set up of water-related institutional and environmental services. To this end, an enclosure of the examined parameters and socio-demographic features in a reoriented irrigation policy could possibly improve water use and agricultural produce of agrarian regions in IGB area.

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Appendix 1. Detailed analysis of components in socio-demographic factors for WTP related questions

Cases	WTP Groundwater Market						WTP Environmental Services						WTP Revitalize common wells			
Countries	India		Nepal		Pakistan		India		Nepal		Pakistan		India		Nepal	
Parametr.	t	Sig.	t	Sig.	t	Sig.	t	Sig.	t	Sig.	t	Sig.	t	Sig.	t	Sig.
Intercept	4.717	.000	4.080	.000	2.171	.037	4.717	.000	4.080	.000	2.171	.037	4.701	.000	4.675	.000
[Educ=.0]	-.345	.731		.996			-.345	.731		.996			-.389	.698		
[Educ=1.0]	.512	.609		.279			.512	.609		.279			1.520	.130		
[Educ=2.0]	-.583	.560	-.004	.418			-.583	.560	-.004	.418			-.333	.740	.069	.945
[Educ=3.0]	.415	.678	-1.10	.	-2.01	.052	.415	.678	-1.10	.	-2.01	.052	-.215	.830	-1.15	.258
[Educ=4.0]	.299	.766	-.820		-1.31	.197	.299	.766	-.820		-1.31	.197	1.863	.064	-.145	.886
[Educ=5.0]	.	.	.		-.449	.656	.	.	.		-.449	.656	.	.	.	.
[Educ=6.0]						.						.	-.489	.625		
[Age=1]	-.327	.744					-.327	.744					1.470	.143		
[Age=2]	1.422	.156	.866	.392	1.962	.058	1.422	.156	.866	.392	1.962	.058	-.011	.992	.494	.625
[Age=3]	.043	.966	.219	.828	.995	.327	.043	.966	.219	.828	.995	.327	1.980	.049	.690	.495
[Age=4]	2.498	.013	-.043	.966	.152	.880	2.498	.013	-.043	.966	.152	.880	.	.	-.283	.779
[Age=5]	.	.	.	.	.	.	.	.	.	.	.	.	-1.576	.116	.	.
[Hsd=1]	-3.605	.000	-.170	.866	1.151	.258	-3.605	.000	-.170	.866	1.151	.258	-2.176	.030	.267	.791

[Hsd=2]	-4.943	.000	1.429	.162	1.650	.109	-4.943	.000	1.429	.162	1.650	.109	-1.799	.073	1.588	.121
[Hsd=3]	-3.887	.000	1.112	.274	.974	.337	-3.887	.000	1.112	.274	.974	.337	-1.381	.168	1.313	.198
[Hsd=4]	-.913	.362	.	.	.844	.405	-.913	.362	.	.	.844	.405	.	.		.
[Hsd5]	.	.			.	.	.	.			.	.	1.768	.078		

Appendix 2. Detailed analysis of components in socio-demographic factors for WTA related questions

Cases	**WTA No private Wells**				**WTA Consumptive Crops**				**WTA Agricultural Residuals**				**WTA Fishing**		**WTA Rice**	
Countries	**India**		**Nepal**		Nepal		Pakistan		Nepal		Pakistan		Bangladesh		Bangladesh	
Parametr.	t	Sig.	t	Sig.	t	Sig.	t	Sig.	t	Sig.	t	Sig.	t	Sig.	t	Sig.
Intercept	2.645	.016	6.441	.000	13.202	.000	1.145	.261	10.345	.000	.656	.521	10.999	.000	2.837	.005
[Educ=.0]	1.046	.309														
[Educ=1.0]																
[Educ=2.0]			-.341	.739	-1.463	.203			.080	.937	.288	.777	.340	.734	-.037	.970
[Educ=3.0]	1.162	.260	.294	.774	-1.560	.180	-1.375	.179	-1.857	.074	-1.31	.207	.886	.376	1.027	.306
[Educ=4.0]	-1.28	.224	-.505	.622	-1.843	.125	-1.223	.231	-.595	.557	-.646	.528	.540	.590	2.724	.007
[Educ=5.0]	.	.	.	.	.	.	-.101	.920	.	.	-.674	.510	.	.	.	.
[Educ=6.0]							.	.			.	.				

[Age=1]													1.785	.076	-.671	.697
[Age=2]	-.771	.450	-.160	.876	2.828	.037	1.301	.203	.685	.499	1.028	.319	1.727	.086	-.305	.611
[Age=3]	-.071	.944	.087	.932	3.200	.024	.705	.486	-.194	.848	1.795	.091	.904	.367	-.326	.469
[Age=4]	.356	.726	-.707	.492	.629	.557	-.249	.805	-1.383	.178	1.486	.157	.311	.756	-.483	.339
[Age=5]	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
[Hsd=1]	-1.617	.122	.120	.906	-2.115	.088	1.616	.116	-.866	.394	.327	.748	-.919	.359	-1.562	.146
[Hsd=2]	-1.71	.102	.853	.409	-1.858	.122	1.978	.057	.211	.834	.710	.488	-1.176	.241	-1.094	.247
[Hsd=3]	-.043	.966	.	.	-1.096	.323	1.218	.233	.	.	1.039	.314	-.428	.669	-1.216	.059
[Hsd=4]	-1.13	.271			.	.	.740	.465			-.678	.507	.066	.947	-1.053	.351
[Hsd5]	.	.					.	.			.	.	.	.	.	.