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Co-Location, Socioeconomic Status and Perceptions of Environmental Change in the Indian Sundarbans

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Abstract

Research on the determinants of collective action in the commons generally focuses on interest-group heterogeneity, implicitly assuming that groups perceive the same problems but have different priorities. This paper changes the focus to the role played by perceptions themselves. Within localities, collective action may be easier if elite and non-elite households have similar perceptions of environmental problems. Regionally, collective action may be aided by common perceptions among local elites who communicate across village lines. This paper uses regression analysis to explore variations in environmental perceptions across classes and localities, using new survey data from the Indian Sundarbans. The paper finds that perceptions vary significantly across localities. Within localities, perceptions among elite households vary significantly more than perceptions among non-elite households. The results therefore favor locally-oriented collective action in the region, along with local governance that promotes non-elite participation.

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1. Introduction

Collective actions in the commons are complex (for example, see Wade 1987a: Wade 1987b; Ostrom, Walker and Gardner 1992; Baland and Platteu 1993; Bardhan 1993; Ostrom et al. 1999; Ostrom 2003). The role of interest group homogeneity/ heterogeneity in determining successes and failures of collective actions in commons has been studied over a long period of time, as heterogeneity makes it harder for communities to reach an agreement about the sharing of benefits and costs of collective action (examples include Kanbur 1992; Baland and Platteu 1995. Alesina, Baqir and Easterly 1999; Poteete and Ostrom 2004). However, research on the determinants of collective action in the commons generally focuses on interest-group heterogeneity in endowments, wealth, economic interests, culture, political convictions, gender, etc., implicitly assuming that groups perceive the same problems but have different priorities (Baland and Platteu 1999; Bardhan and Dayton-Johnson 2000; Poteete and Ostrom 2004; Somanathan, Prabhakar and Mehta 2007; Ruttan 2008; Araral 2009; Marchiori 2014; Kölle 2015). This paper changes the focus to the role played by perceptions themselves. Within localities, collective action may be easier if elite and non-elite households have similar perceptions of relevant problems. Regionally, collective action may be aided by common perceptions among local elites who communicate across village lines. The case study on environmental perceptions in Indian Sundarbans presented in this paper is expected to shed light on patterns of perceptions differing with income, education and location of households, using new survey data.

The Sundarbans is home to some of the poorest and the most vulnerable communities of India. The region is currently threatened by several environmental factors related to climate change, including increased frequency and intensity of cyclonic storms (Bandyopadhyay et al. 2018), fluctuations in temperature and rainfall, and rising salinity as sea level rise continues

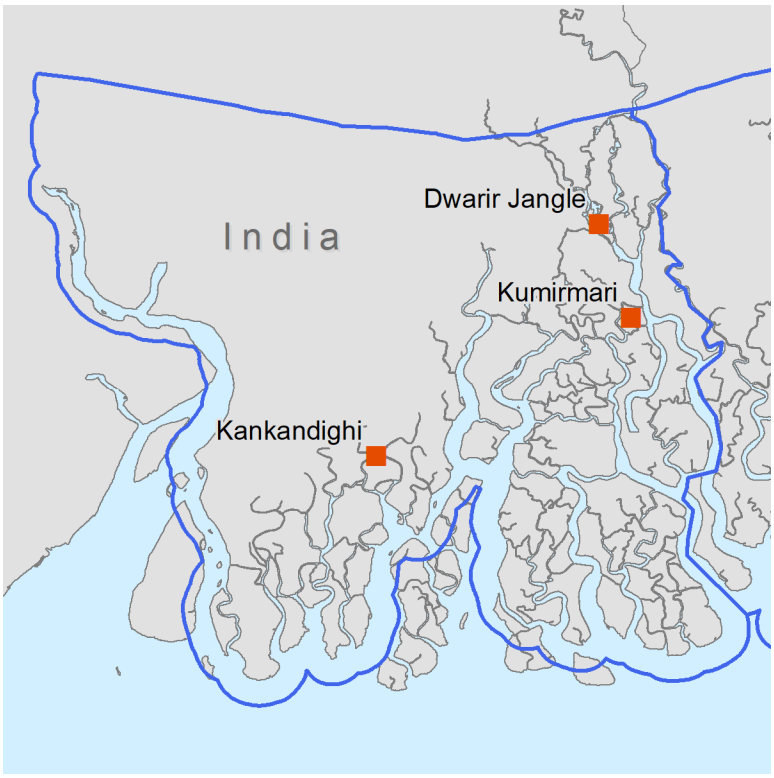
(Mukhopadhyay et al. 2018). These factors can produce stresses that directly affect household welfare, including reduced timber stocks, livestock, fisheries and soil fertility; crop damage from insect infestation and water pollution; reduced access to drinking water; and forced outmigration of family members (Dasgupta, Sobhan and Wheeler 2017; Dasgupta et al. 2017). For understanding patterns of environmental perceptions across households, we conducted a survey of 600 households in three dispersed localities in the Indian Sundarbans. For each household, the survey collected extensive information on socioeconomic status variables, livelihoods, migration behavior and perceived threats from climate-related factors. We assign households to the three localities and three socioeconomic status groups, from information about their asset ownership and the education of the household head. In the survey, households performed separate ranking exercises for perceived changes in general environmental conditions: rainfall, temperature and salinity; and livelihood-related conditions: timber stocks, livestock, fisheries and soil fertility, insect infestation of crops, water pollution, access to drinking water, and forced outmigration of family members. Using the ranks for each household, we compute its numerical scores for each factor within each change group: 5 for environmental conditions, 10 for livelihood-related conditions. For each change group, we compute correlation coefficients for all unique household pairs in the sample. Then we estimate regression models to test the effects of socio-economic status, ethnicity and location of households on inter-household correlations.

This paper's principal objective is to determine the relationships linking co-location and socioeconomic status to perceived environmental changes, and the potential implications for local and regional environmental governance.

2. Data and Methods

In order to explore the patterns of perception of environmental factors related to climate change in the Indian Sundarbans, we conducted a survey of 600 households in three localities (mouzas) that are distributed across the Indian Sundarbans (Figure 1). One locality is in North 24-Parganas District (Dwarir Jangle, Sandeshkhali II Block), and two are in South 24-Parganas District (Kumirmari, Gosaba Block; Kankandighi, Mathurapur II Block). The survey employed maximum variation sampling to capture the range of household socioeconomic, demographic and geographic characteristics.[1] Two hundred households were sampled in each locality.[2] The survey was conducted during March 2016 - January 2017.

Figure 1: Survey localities in the West Bengal Sundarbans



[1] For a description and discussion of this sampling approach, see Palinkas et al. (2015).
[2] Sampling dimensions are tabulated in Appendix A.

For each household, the survey collected extensive information on socioeconomic status. For this exercise, we focus on survey-based measures of household wealth, education and ethnicity. We index wealth by counting total asset possession from a possible set of 29 assets.[3] We assign households to three wealth categories using breaks in the distribution at ownership at 2 and 4 assets. The survey reports the education level of the household head in 8 categories.[4] We classify education levels in 3 categories: primary, secondary, and post-secondary.

In the survey, households performed separate ranking exercises for perceived changes in general environmental conditions and livelihood-related conditions. In particular, surveyed household representatives were asked to rank perceived changes in 2 categories: (1) five general environmental conditions (less rain, more rain, more salinity, more frequent droughts, more heat); (2) ten environment-related threats to livelihood (tree loss, livestock loss, crop damage, fish loss, water pollution, soil fertility loss, water loss, pests and insects, animal diseases, forced out-migration of prime-age workers).

For understanding the variation in rank assignments, we first computed the numerical scores for each factor within each change group (5 for general environmental conditions, 10 for livelihood-related conditions) using the ranks for each household. For each change group, we then computed correlation coefficients for all unique household pairs in the sample. Finally, we estimated regression models to test the effect of four categorical variables on inter-household correlations: (1) common locality; (2) common status in the highest socioeconomic group; (3)

[3] Assets queried were Own car, Taxi, Auto rickshaw, Truck/small truck, Bicycle, Motor bike, Gas stove, Mixer, Refrigerator/Freezer, Washing machine, Iron, Geyser, Radio/Cassette recorder, Color television, Black and white television, DVD Player, Land telephone, Mobile, Sewing machine, Power generator (Kerosene), Power generator (Solar), Electric fan, Air conditioner, Personal computer, Motor boat, Row boat or sail boat, Animal drawn cart, Jewelry, Other building excluding dwelling.

[4] Education levels queried were Pre-Primary (below 1), Primary (1-4), Upper Primary (5-8), Secondary (9-10), Higher Secondary (11-12), Undergraduate (B.A/B.Sc/B.Com), Post-graduate (M.A/M.Sc/M.Com), Post-Masters (Phd/Voc/Doctor/Eng).

common status in the lowest socioeconomic group; and (4) common ethnicity. We specified our regression model at the micro-level to capture the full range of individual variation in the sample, and estimated the following regression equation:

(1) $\rho_{ij} = \beta_0 + \beta_1 L_{ij} + \beta_2 HS_{ij} + \beta_3 L_{ij} + \beta_3 E_{ij} + \varepsilon_{ij}$

where

ρ_{ij} = Correlation coefficient for individuals i and j
L_{ij} = 1 if individuals i and j have a common locality; 0 otherwise
HS_{ij} = 1 if individuals i and j both have High SES, as previously defined; 0 otherwise
LS_{ij} = 1 if individuals i and j both have Low SES, as previously defined; 0 otherwise
E_{ij} = 1 if individuals i and j have common ethnicity; 0 otherwise
ε_{ij} = Random error term

The analysis was conducted for all pairs of household heads whose responses are recorded for questions on changes in general environmental conditions, changes in livelihood-related conditions, asset ownership, education and ethnicity. For estimation, spatial econometric estimation is not needed in this case, since the paired household observations are drawn from all three locations. However, we believe that error variance may not be independent of the distance between household heads in each pair. Accordingly, we augment standard OLS and robust estimators with a GLS estimator that incorporates standard errors for 10 clusters identified by relative distance.

3. Results

As expected, households varied in the number of rank assignments of perceived changes in environmental conditions by category; some cited only one factor, while others ranked all factors. variables, livelihoods, migration behavior and perceived threats from climate-related factors. Tables 1 and 2 provide information on mean scores by locality and socioeconomic status (SES) group, and summary cross-correlations. For this tabulation, we divide the sample into three SES groups: Low, for households in wealth category 1 with a primary-educated head; High, for

households in wealth category 3 with a post-secondary-educated head; and Middle, for all other households.

Table 1a displays mean scores for the 10 environment-related threats to livelihood across the three localities and three SES groups. The intergroup correlation coefficients in Table 1b reveal substantial variation, both within and across localities, that is summarized in Table 1c. The distribution is roughly symmetric, with one negative correlation (-0.20), first, second and third quartile points at 0.37, 0.51 and 0.64, respectively, and a maximum at 0.97.

Table 1a: Livelihood-related change - Scores by locality and socioeconomic status
Locality codes: 1 - Dwarir Jangle; 2 - Kumirmari; 3 - Kankandighi

Locality	1			2			3		
SES	Low	Middle	High	Low	Middle	High	Low	Middle	High
Households	23	61	46	3	15	3	20	43	22
Change									
Tree Loss	7.2	7.4	7.7	6.0	5.2	5.0	7.8	7.2	7.4
Livestock Loss	4.1	5.4	5.9	7.7	7.8	9.0	8.2	7.3	8.1
Crop Damage	6.0	5.7	6.4	6.7	6.9	6.7	5.4	6.1	6.5
Fish Loss	2.1	5.2	6.9	5.3	5.3	7.3	3.8	5.2	4.5
Water pollution	8.4	6.7	6.9	6.3	4.9	5.0	4.7	4.1	3.5
Soil Fertility Loss	5.0	3.5	2.5	4.0	4.3	3.3	6.2	4.6	5.5
Water Loss	3.1	2.8	2.2	6.3	5.0	4.3	6.1	5.6	5.8
Pests and Insects	4.7	2.9	1.9	3.7	5.6	4.7	5.6	4.7	4.2
Animal Diseases	4.1	2.8	2.4	5.0	5.0	4.0	4.0	4.8	4.7
Out-Migration	1.3	2.1	1.6	4.0	4.3	5.7	3.3	5.2	4.7

Table 1b: Correlation coefficients - Livelihood-related change scores

Locality		1			2			3		
	SES	Low	Middle	High	Low	Middle	High	Low	Middle	High
1	Low	1.00								
	Middle	0.72	1.00							
	High	0.54	0.97	1.00						
2	Low	0.33	0.63	0.66	1.00					
	Middle	0.13	0.38	0.44	0.70	1.00				
	High	-0.20	0.38	0.53	0.60	0.79	1.00			
3	Low	0.41	0.44	0.32	0.50	0.52	0.20	1.00		
	Middle	0.04	0.45	0.46	0.61	0.64	0.58	0.72	1.00	
	High	0.09	0.35	0.33	0.60	0.64	0.45	0.82	0.94	1.00

Table 1c: Distribution of correlation coefficients

Min	P25	P50	P75	Max
-0.20	0.37	0.51	0.64	0.97

Tables 2a-2c provide the same information for five changes in general environmental conditions. Here typical correlations are higher, although substantial variation is also evident.

Table 2a: General environmental changes - Scores by locality and socioeconomic status
Locality codes: 1 - Dwarir Jangle; 2 - Kumirmari; 3 - Kankandighi

Locality	1			2			3		
SES	Low	Middle	High	Low	Middle	High	Low	Middle	High
Households	23	72	70	29	124	42	29	65	31
Change									
Less Rain	8.2	6.5	5.3	0.0	0.6	1.0	0.3	0.6	2.3
More Saline	7.0	5.2	3.9	5.9	4.0	5.7	5.9	6.3	4.8
More Rain	2.7	5.5	7.4	0.7	0.3	0.0	0.3	0.9	1.8
More Frequent Drought	1.7	2.6	3.0	0.0	0.0	0.0	1.0	1.4	1.2
More Heat	8.4	7.8	7.8	8.1	8.8	8.9	8.9	8.3	7.9

Table 2b: Correlation coefficients - Livelihood-related change scores- General environmental change scores

Locality		1			2			3		
	SES	Low	Middle	High	Low	Middle	High	Low	Middle	High
1	Low	1.00								
	Middle	0.82	1.00							
	High	0.29	0.78	1.00						
2	Low	0.60	0.57	0.33	1.00					
	Middle	0.65	0.67	0.45	0.96	1.00				
	High	0.69	0.64	0.33	0.99	0.98	1.00			
3	Low	0.59	0.53	0.28	0.99	0.98	0.99	1.00		
	Middle	0.57	0.50	0.24	0.99	0.96	0.98	1.00	1.00	
	High	0.71	0.71	0.45	0.97	1.00	0.99	0.97	0.96	1.00

Table 2c: Distribution of correlation coefficients

Min	P25	P50	P75	Max
0.24	0.56	0.71	0.98	1.00

Table 3 presents the distributions of correlation coefficients for the two change groups. Both sets are distributed in the range [-1,1], with thousands of positive and negative values. Above the median, percentile points are substantially higher for the general environmental change factors. This is consistent with the cross-correlation patterns displayed for mean scores in Tables 1c and 2c.

Table 3: Distributions of interpersonal correlation coefficients

Environmental Change Factors	N	Min	P10	P25	P50	P75	P90	Max
Livelihood-Related	23,871	-0.94	-0.30	-0.07	0.15	0.37	0.62	1.00
General	109,278	-1.00	-0.40	-0.01	0.49	0.67	1.00	1.00

Our regression results of estimated effects of four categorical variables: common locality; common status in the highest socioeconomic group; common status in the lowest socioeconomic group; and common ethnicity on inter-household correlations are presented in Table 4. Estimates indicate common locality has a highly-significant positive impact on the interpersonal correlation of scores for both general environmental conditions and environment-related threats to livelihood. Conversely, high SES has a consistently negative impact on the correlation -- marginally for threats to livelihood and with high significance for general environmental conditions. Low SES has a consistently positive impact that is marginally significant for threats to livelihood and highly significant for general environmental conditions. While common ethnicity has a positive impact, it is both small in size and statistically insignificant in all cases.

Table 4: Regression results - Determinants of common environmental perceptions

Dependent variable: Inter-individual correlation coefficient

	Environmental Threats to Livelihood			General Environmental Conditions		
Individuals Have Common:	OLS	Robust	GLS	OLS	Robust	GLS
Locality	0.136 (29.76)**	0.136 (28.32)**	0.137 (5.49)**	0.089 (27.25)**	0.089 (26.99)**	0.094 (4.21)**
High SES	-0.002 (0.10)	-0.002 (0.09)	-0.018 (0.54)	-0.080 (3.95)**	-0.080 (4.22)**	-0.074 (2.59)*
Low SES	0.029 (1.96)	0.029 (2.08)*	0.027 (1.41)	0.040 (3.22)**	0.040 (3.33)**	0.031 (2.15)*
Ethnicity	0.005 (0.94)	0.005 (0.91)	0.004 (0.23)	0.006 (1.88)	0.006 (1.88)	0.004 (0.13)
Constant	0.095 (28.86)**	0.095 (33.29)**	0.093 (7.84)**	0.277 (123.40)**	0.277 (123.36)**	0.285 (9.84)**
Obs	23,871	23,871	20,503	109,278	109,278	96,141
R-squared	0.04	0.04	0.04	0.01	0.01	0.01

Absolute value of t statistics in parentheses
* significant at 5%; ** significant at 1%

Tables 5 and 6 display predicted correlations from the GLS regressions by locality of residence and SES.[5] Middle SES is assigned to paired status for individuals who are neither High SES nor Low SES. Both tables display the highest correlations for paired individuals with Low SES in a common locality. Conversely, paired individuals with High SES in different localities have the lowest correlations. Typical correlations are higher for general environmental changes than for livelihood-related changes, but livelihood-related changes have greater relative effects. From highest to lowest case, the correlation falls by 69% for livelihood-related changes and 49% for changes in general environmental conditions.

[5] Ethnicity has no meaningful effect on these results; the table entries are calculated for paired individuals who do not have common ethnicity.

Table 5: Livelihood-related changes: Predicted interpersonal correlations by co-location and SES

Common Locality	Common SES		
	Low	Intermediate	High
Yes	0.26	0.23	0.21
No	0.12	0.09	0.08

Table 6: General environmental changes: Predicted interpersonal correlations by co-location and SES

Common Locality	Common SES		
	Low	Intermediate	High
Yes	0.41	0.38	0.31
No	0.32	0.29	0.21

4. Discussion

Cost-effective adaptation to climate-related changes will require increased public investment, but it will also depend on local support for appropriate collective action. An extensive literature has studied the determinants of effective collective action at the village level, with a major focus on the problem of interest-group heterogeneity (Vedeld 2000; Kurian and Dietz 2013). Relevant factors include differences in wealth, education and patterns of resource tenure and ownership (Beck and Nesmith 2001; Gaspart 2003). While such studies generally find that greater homogeneity is a positive factor, they have also explored important differences that are attributable to outside intervention modes, the presence of intermediating institutions, and the role of "policy entrepreneurs" in forging and sustaining collective agreements among heterogeneous actors (Myers 1997; Kurian and Dietz 2007). More generally, the policy literature on commons problems explores the implications of heterogeneity in income, education and ethnicity for support for environmental regulation (Jones and Dunlop 1992; Wang et al. 2018; Chen 2017; Janmaimool

2017; Chakraborty et al. 2017; Liu and Mu 2017). The principal focus is transactional, on the implicit assumption that agents have common perceptions of the problems but different priorities for addressing them.

This paper attempts to contribute by addressing another aspect of heterogeneity that has received less attention in the literature: the role played by differences in perception. Within localities, collective action may be easier if elite and non-elite households have similar perceptions of critical environmental problems. At the same time, extensive research indicates that regional governance is dominated by economic and educational elites who communicate across village lines (Khan 2008; Ghertner 2011; Oyono 2004; Lucas 2016; Piabuo et al. 2018). By implication, regional environmental governance is likely to be more effective if elites in different localities have common perceptions of the critical problems. Several other possibilities emerge from this line of inquiry, depending on comparative conditions at the village and regional levels. In the weakest scenario, environmental governance is hindered by perceptual heterogeneity within and across villages. Local governance may be strengthened if village elite and non-elite households share common perceptions, while regional governance may dominate if village-level perceptions differ but elites share perceptions across villages.

We conducted a survey of 600 households in the Indian Sundarbans, which is threatened by several environmental factors related to climate change, and explored the impacts of location and socioeconomic status on patterns of perceptions of environmental change. Our findings have three noteworthy features. First, for the broad Middle group, we find a positive, highly-significant correlation of perceptions across all localities.[6] Common locality adds a highly-significant

[6] These are the constant terms in the regressions.

increment to the correlation. Another increment is added for low SES households. In contrast, high SES subtracts a significant increment.

Given the complexity of collective actions in the commons, it is widely acknowledged that systems of governance need to be flexible to allow adaptation of management regimes to local conditions (Adhikari and Lovett 2006). In the literature on the environmental commons, attention focuses primarily on class-related interests that affect the prospects for local or regional action. Our results suggest that socioeconomic status may also operate through perceptions of environmental change that become more varied as socioeconomic status increases. While our results suggest that the strongest perceptual foundations for action in the commons are local, they also indicate that disagreement about priorities may undermine the leadership potential of local elites. By implication, village-level governance based on widespread participation in decision-making seems likely to promote the most effective environmental measures in the Indian Sundarbans. This is a key message for development partners, policy makers and practitioners working on management of environmental resources in the Indian Sundarbans.

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Appendix Table A1: Survey dimensions for household selection

Household Characteristic	Dimensions
Address	Panchayat
	Village
	Within village
Location	Close to the river
	Intermediate location
	Interior village
Ethnicity	Scheduled caste
	Scheduled tribe
	OBC[7]
	General
Religion	Hindu
	Muslim
	Christian
Education	Highest level
Occupation	Agriculture
	Fishing
	Forestry
	Service
Income and Employment	Permanent
	Seasonal
Migration	Permanent Seasonal
Housing Details	Housing type
	Distance from amenities
	Household assets

[7] OBC abbreviates Other Backward Caste, a term utilized by the Government of India.