

# **SAMPLING DESIGN FOR THE BANGLADESH POVERTY AND GROUNDWATER SALINITY SURVEY 2016**

The main objective of the Bangladesh Poverty and Groundwater Salinity Survey (BPGSS) 2016 is to understand the linkages between groundwater salinity and poverty in coastal areas in Bangladesh. It is also to assess the extent to which high water salinity might be associated with poor health outcomes among women and children, and identify potential coping and adaptation mechanisms, which households might be using to address high water salinity in these areas.

The Bangladesh Poverty and Groundwater Salinity Survey 2016 collected data from a total of 1,500 households in three sub-districts or upazilas in Bangladesh – 500 households in each upazila distributed across 50 primary sampling units (PSUs).<sup>1</sup> The three upazilas selected for this study are the following: (i) Taltoli upazila in the Barguna district of the Barisal division; (ii) Morrelganj upazila in the Bagerhat district of the Khulna division; and (iii) Shyamnagar upazila in the Satkhira district in the Khulna division. Each upazila was allocated an equal size of households in order to get poverty estimates of similar precision.<sup>2</sup> The sampling frame consists of a list of all rural villages developed by the Bangladesh Bureau of Statistics (BBS) based on the Census Enumeration Areas (CEAs) constructed for the 2011 Census of Population and Housing. PSUs are constructed by dividing rural villages into listing blocks or Enumeration Areas (EAs) of around 50 households each and then randomly selecting one block for listing.

The three upazilas included in this study were selected based on discussion with a water salinity expert in Bangladesh and practical considerations using a two-stage procedure. In the first stage, we combined upazila level poverty data from the official 2010 Bangladesh Poverty Maps with upazila level information on groundwater salinity collected by the Bangladesh Water Development Board (BWDB) with support from the Institute of Water Modelling (IWM).<sup>3</sup> Using these combined dataset, we classified all 146 upazilas in coastal areas in four groups: (i) high water salinity and high poverty rate; (ii) high water salinity and low poverty rates; (iii) low water salinity and high poverty rate; (iv) low water salinity and low poverty rates.<sup>4</sup> Figure 1 shows the spatial distribution of coastal area upazilas based on these four categories. In the second stage, we selected one upazila from each of the first three categories as focal areas for this study after discussion with a groundwater expert on availability of other water-supply options (e.g. managed aquifer recharge) and practical considerations. This categorization of upazilas also serve as our three

---

<sup>1</sup> The definition of household used in the Bangladesh Poverty and Groundwater Salinity Survey 2016 follows the definition used in the Household Income and Expenditure Survey 2016/17 which defined a household as a dwelling unit where one or more persons live and eat together with common cooking arrangements.

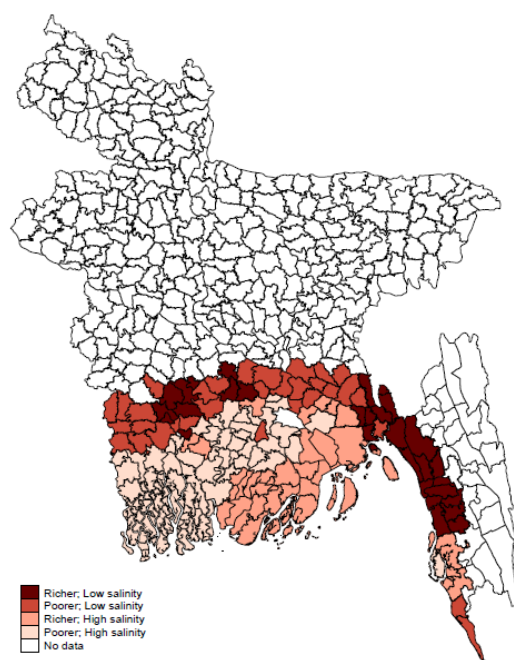
<sup>2</sup> The Amtali upazila was split after the 2011 Census of Population and Housing into two upazilas – “new” Amtali and Taltoli. Our data collection is focused on the Taltoli upazila as this is closer to the Bengal Bay where high water salinity issues are more pervasive.

<sup>3</sup> Data on ground water salinity was published as part of Bangladesh Water Development Board (2013). Hydrogeological study and mathematical modelling to identify sites for installation of observation well nest. Final Report “Establishment of monitoring network and mathematical model study to assess salinity intrusion in groundwater in coastal area of Bangladesh due to climate change,” vol. 5 (Water Quality). Bangladesh Water Development Board (BWDB) and Institute of Water Modelling (IWM), Dhaka. The variable used to assess water quality was the one reporting electrical conductivity (EC) interpolations estimated at the upazila using the zonal statistics function in ArcGIS, and based on data collected from soil salinity monitoring stations.

<sup>4</sup> The cut-offs defined for the classification of upazilas into these four groups were determined based on the median values of the poverty rates and water salinity distributions across the sample (37 percent and 3,941 microSiemens per cm, respectively).

sampling strata – high water salinity and high poverty rate, high water salinity and low poverty rates, and low water salinity and high poverty rate.

**Figure 1. Classification of upazilas by water salinity and poverty rates**



As it was mentioned before, PSUs in the Bangladesh Poverty and Groundwater Salinity Survey 2016 are equally allocated across strata. Using equal allocation results in an allocation of PSUs which resembles quite closely the distribution of households across strata that one would obtained using probability proportional to size (PPS) with the population size used as the measure of size and rounded to the pre-determined cluster size of 10 households per PSU. Table 1 shows the number of rural villages and households in the 2011 Census of Population and Housing and the Bangladesh Poverty and Groundwater Salinity Survey 2016 by stratum.

During the listing of households in selected listing blocks, five variables are collected from each household – (i) household size, (ii) number of rooms in dwelling, (iii) household owns a refrigerator, (iv) household owns at least one bicycle, and (v) household owns at least a fan.<sup>5</sup> Using these five variables, household per capita expenditure and poverty status is predicted for each household.<sup>6</sup> Households within each PSU were then divided by poverty status and sorted from richer to poorest based on the predicted household per capita expenditure. Then, 5 households are randomly selected from the poor and non-poor sub-groups using systematic equal probability sampling. The poverty rates in the three upazilas selected for this study are below the 50 percent, which implies that the poor are being explicitly being oversampled under this sampling design.

<sup>5</sup> These five variables were selected based on a per capita consumption regression model constructed ex-ante using data from the HIES (2010), which allowed to predict at least a quarter of the observed variation in per capita household expenditure.

<sup>6</sup> Poverty lines in Bangladesh are measured at the division level and separately for urban and rural areas.

**Table 1. Number of Rural Villages and Households  
in the 2011 Census of Housing and Population and the Bangladesh WASH-SWIFT sample**

Stratum			2011 Census of Population and Housing				Bangladesh WASH-SWIFT sample		
ID	Description	Upazila	Rural villages		Individuals		Number		
			Number	Share	Number	Share	PSUs	Households*	Cluster size
1	High salinity, high poverty rate	Morrelganj	180	38.3%	125,072	40.6%	50	500	10
2	High salinity, low poverty rate	Taltoli	82	17.4%	60,907	19.8%	50	500	10
3	Low salinity, high poverty rate	Shyamnagar	208	44.3%	122,137	39.6%	50	500	10
Total:			470	100.0%	308,116	100.0%	150	1500	-

\* Numbers reported correspond to rounded PPS selection based on the number of slums households.