Beyond the Lack of Data: How to Generate Spatial Data on Displaced Populations Using Global Positioning System (GPS) Loggers

The Example of Populations Displaced due to Ganges Riverbank Erosion in Malda, West Bengal, India

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Short Paper
Corresponding Author:
marion.borderon@univie.ac.at
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Marion Borderon[1] , Stefan Kienberger[2], Suresh Kumar[3], Sébastien Oliveau[4] and Tuhin K. Das[5]

[1]University of Vienna, Austria
[2]University of Salzburg, Austria
[3]Centre for Geoinformatics, New Delhi, India
[4]University of Aix-Marseille, France
[5]Jadavpur University, Kolkata

Abstract

This case study proposes an alternative spatial sampling design when there is no enumeration of the target population. Empirical studies and spatial quantitative assessments at a local scale, in the global South or in a sensitive context often face the limitations of baseline knowledge and secondary data, resulting in the challenge of choosing methods or models appropriate to the situation. Yet, to understand the vulnerability of population to disasters and improve their resilience require a clear picture of the situation. Various methods have already been proposed for sampling when data on a population are limited. While taking these methods and their limits into account, we present a new approach to design a population sample by using Global Positioning Systems (GPS) loggers. GPS systems are now widely available and easy to use and are useful when it comes to collect accurate and consistent data. A stratified survey, combined with 4,095 questionnaires, was carried out in 2015 in Malda (West Bengal). The survey allowed us to capture the spatial pattern of the erosion-affected population and to better understand their vulnerability. The method therefore shows promise for use in case studies in environments where detailed geographic and human census data have either limited availability or little relevance.

Keywords:

Global Positioning System, spatial survey sample, data-limited environment, vulnerability assessment

1 Introduction

The lower Ganges region in India, especially the district of West Bengal, is particularly vulnerable to climate change hazards, including slow-onset events such as riverbank erosion (IPCC, 2014; Das and al., 2014). Riverbank erosion results in loss of productive land and other natural resources for the riverine households, and threatens their livelihoods and food security. Indeed, riverbank erosion accounts for the largest losses in this region of the world (Penning-Rowsell et al. 2013; Makenro 2000). Damage from riverbank erosion occurs gradually and has long-term impacts that are irrecoverable naturally (Alam et al., 2017).

However, the lack of data, particularly geospatial information on the relocation pattern of displaced populations, presents a fundamental challenge in assessing the vulnerability of populations affected by riverbank erosion and in estimating their loss and damage.

At village level, few data are available. Each gram panchayat collects information such as the number of water points, schools or health centres, and proposes some estimate of the number of households, but no precise figure for the total population is available.[1]Detailed knowledge of the displaced population is even more limited and not well documented. This limited knowledge ofthe populations and their distribution makes it impossible to perform classical and representative random sampling of the particular populations of interest.

Indeed, the random probability sample is usually presented as the gold standard to obtain a representative sample (Levy and Lemeshow, 2008). When all eligible respondents and households are known in a specific target geography, they can be counted and then randomly selected to construct a sampling frame (Kondo and al., 2014). For resource-challenged areas or contexts of rapid change, such as our case study area, an alternative that uses a stratified GPS survey is proposed. GPS systems allow more accurate and consistent data collection than estimating locations or area using paper maps or a compass and distance measurement (Martinez, 2013; DHS, 2013).

This paper presents an original sampling method which makes it possible to carry out a spatial vulnerability assessment for a population in a resource-limited context.

2 Methods

Description of the area studied

In the district of Malda in West Bengal, the course of the Ganges upstream of the Farakka dam continues to change. Millions of rupees are spent every year on bank protection, but no rehabilitation programme for the erosion victims is in place. About 190km² of fertile land were eroded from the left bank of the river between 1931 and 1999 (Rudra, 2000).

[1]The *gram panchayat* is the cornerstone of local self-government organization in India at the village or small-town level (the *panchayati raj* system); each *gram panchayat* has a *sarpanch* as its elected head. In 2015, the authors managed to obtain some official data from the Gram Panchayat office of Panchanandapur I, Panchanandapur II and Bangitola.

According to the Human Development Report provided by the government of West Bengal (2007), nearly 10,000 families in Malda have lost their land. These families have mostly resettled at sites in the same district. For some people, displacement and resettlement have occurred more than once as they have not moved far from the river, even though the banks are being eroded. It is assumed that they take this risk because their occupations are linked to the river. Therefore, the rehabilitation policy for this displaced population needs further investigation, across the various resettlement locations. A spatial overview is currently lacking. The aim of the present study was to map precisely the spatial distribution of resettled people in order to facilitate appropriate recovery plans.[2]

We therefore decided to concentrate on the Malda region, and in particular on one of the most severely affected 'Blocks': Kaliachak II. Impacted by the left-bank erosion of the Ganges upstream of the Farakka dam, this rural community development block comprises a population of 210,105 (Chandramouli, 2011), a proportion of whom have been displaced due to the hazard. The block is divided into eight gram panchayats(GPs), comprises 41 gram sansads,[3] and around 16,000 households. The study has focused on the three most affected GPs of this district. The affected GPs in this Block have been listed and a complete listing of gram sansads has also been prepared, from the data of the gram panchayat offices of Panchanandapur I, Panchanandapur II and Bangitola.

The gram sansads were divided into three categories, in which: (1) all the households are displaced people due to riverbank erosion; (2) the households are a mixture of displaced and non-displaced people; (3) all the households are non-displaced people. (In this context, non-displaced people means people not affected by the riverbank erosion.) This leads to different types of settlement (Figure 1).

For the GPs selected, it was decided to investigate exhaustively all the gram sansads. Carrying out the cross-sectional survey in all 41 gram sansads was justified by the fact that displacement is often a collective process. Several households from the same village moved simultaneously and resettled together in a new place. To investigate too few would risk a high clustering effect and a biased picture of the spatial situation.

[2]The question of displaced households and relocation can be a highly sensitive issue. The local staff who conducted the survey, the households investigated and the members of the project have been made aware that the data can only be used for scientific purposes: assessing the vulnerability of the displaced groups compared to the non-displaced groups. No other individuals or institutions may use these data for any purpose. Ethical clearance has been sought and obtained, and the data have been made anonymous.

[3]A *gram sansad* (an aggregation of villages) is a sub-unit of the *gram panchayat*.

Figure 1: Examples of three types of villages, Kaliachak II Block, Malda, West Bengal, India

Sampling Design

The objective was to provide the following missing data:

(i) type of village (with displaced households, non-displaced households, or with a mixture of both)
(ii) proportion of each group per village
(iii) size of each household
(iv) occupation of the head of the household

(v) presence of children (or not)
(vi) information on displacement (or not) and its consequences.

Taking into account the available budget and time limitations, we decided that the maximum number of households which could be investigated was around 4,000, that is around 25% of the total population studied. As we did not have the number of households in each village, or an exhaustive list of the addresses for each household, a specific sampling technique was used to choose randomly the households that we would investigate. Each team of enumerators would interview one in four households in each village. A starting point in the village was chosen at random, from which the investigators visited each street to identify one household then skip three, before starting again (see Figure 2). This method for selecting households was inspired by the 'random walk' method (Turner et al., 1996; Miligan et al., 2004). Each time a choice had to be made (for example to go right or left at the end of a street), a random procedure was repeated (similar to the game 'pitch and toss'). Thus, a random direction was selected each time a bifurcation was encountered. This sampling technique is referred to as stratified random sampling. The advantage is that it guarantees that specific groups are represented in the sample(s), even proportionally, by selecting households from the strata list (the village list). The disadvantage is that at the end of the investigation of a village, one, two or three houses can remain outside of the procedure (see Figure 2).The sampling procedure is also complex and requires greater effort than a simple random technique.

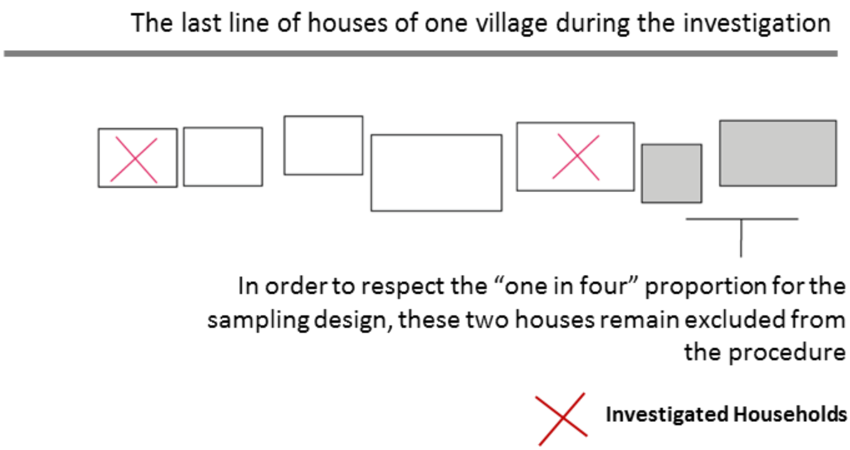

Figure 2: Potential bias for sampling procedure: the threshold of one householdin four

3 Preliminary Results

The survey was carried out in February–March 2015, by a team of 10 trained interviewers under the supervision of a GPS coordinator. The teams were trained in the use of GPS loggers before the official launch of the survey. Additionally, the questionnaire was tested during the pre-test phase and slightly adjusted.

4,095 questionnaires allowed us to overcome the difficulties of investigating hard-to-survey populations and to assess the spatial pattern of these displaced households in a data-limited context (Table 1).

Table 1: Estimate of the proportion of households (HH) displaced due to riverbank erosion (RBE) and non-displaced in the 83 localities (of the 41 gram sansads)

Village profiles in the 3GPs	Number of villages	Number of investigated HH	Displaced HH due to RBE	Estimation of total HH*	Estimation of displaced HH due to RBE*
With non-displaced people	5	67	0	268	0
Mixed	41	2319	1511	9276	6044
Withdisplaced people	37	1709	1709	6836	6836
Total	**83**	**4095**	**3220**	**16380**	**12880**

* 25% of the households in each village in the 3 GPs studied were investigated, chosen according to the spatially random procedure described above. The total number of households and the proportion of displaced households were estimated according to this proportion.

The use of GPS tracking provides a better understanding of the relocation patterns around the Ganges River and allows us to obtain a representative survey sample where quantitative and spatial data were not previously available. An accuracy assessment cannot, however, be carried out as there is no reference dataset. Nevertheless, when the collected data are aggregated, they show consistency and fit with the current census data. The proportion and the location of the displaced and non-displaced people per village can be estimated. In Figure 3, the clustered aspects of the groups (non-affected (=not displaced), affected once so far (=one displacement), or affected several times (= several displacements)) is evidence for the clustered aspects of the relocation patterns.

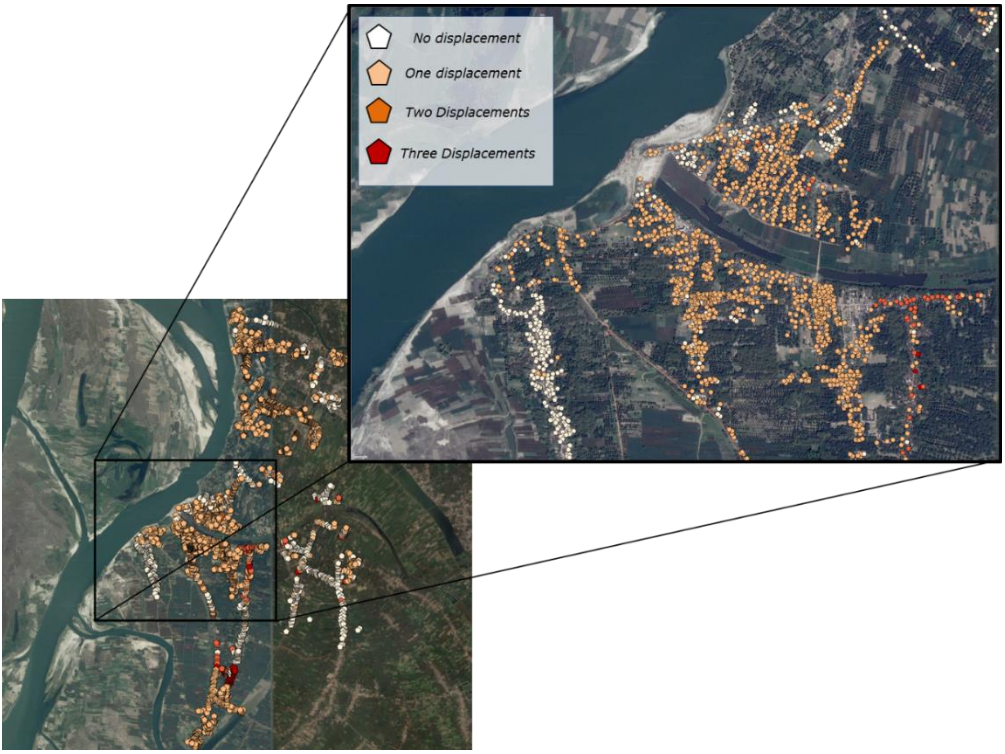

Figure 3: Overview of the location of the displaced and non-displaced households investigated

The households should be seen less as individual entities and more as belonging to a social community. (In this rural area, the community is linked to working activities; many work as day labourers, smallholders, fishermen, or in service-related activities, for example). The dates of the displacements are often the same between households, and they tend to resettle together. When they do not resettle in an existing village, they sometimes occupy land and use the name of their former village to designate their new location. Further analyses of our data have also pointed out the link between the vulnerability of households to erosion and their occupation. When the livelihoods of the community are linked to river activities, their vulnerability to riverbank erosion is maximal.

4 Conclusion and outlook

A stratified random spatial sampling method was used to design a cross-sectional survey and thus to map precisely the pattern of disaster-affected and non-affected populations in a region where maps, and household or address lists are not available. In the district of Malda, West Bengal, this has significantly increased knowledge about the relocation of populations affected by riverbank erosion.

This sampling strategy was designed to generate a representative sample of the studied population while reducing the potential for bias, and took into consideration the specific challenges of the study area. This strategy, or variations on it, is adaptable and should be considered and tested in other sensitive settings. The methodology is promising for use in developing nations with resource-challenged environments where detailed geographic and demographic data are less readily available, or when dealing with dynamic environmental and population changes.

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