



Measuring slum severity in Mumbai and Kolkata: A household-based approach



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A B S T R A C T

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Slums pose a significant challenge for urban planning and policy as they provide shelter to a third of urban residents. UN-Habitat reports that, in 2001, approximately 924 million people lived in slums or informal settlements across the world (UN-Habitat, 2003). However, varying definitions of what constitutes a slum result in different slum population estimates. Most definitions treat a slum as a community of several households, rarely recognizing that housing conditions differ for each individual household within the area. Moreover, definitions of slums usually take a dichotomous approach whereby a place is either a slum or not. Little attempt is made to go beyond this slum/non-slum dichotomy. This paper moves beyond the traditional ways of defining a slum by proposing a new household level enumeration of slums and developing Slum Severity Index (SSI), which measures the level of deprivation on a continuous scale based on the UN-Habitat's slum definition. We apply this new approach of analyzing slums to a household survey dataset to estimate the total number of slum households in Mumbai and Kolkata, two megacities in India. To contrast our approach, we compare these estimates with the Census of India's. The comparison highlights stark differences in the two estimates and the slum/non-slum household classifications. The estimates by the Census are considerably smaller than those based on the UN-Habitat definition in both cities. By applying the SSI, we also demonstrate intra-urban variability in housing conditions within our study cities. The analysis highlights differences in slum profiles measured in terms of both housing deprivation levels and housing deprivation types in both cities. The main objective of this study is to demonstrate the usefulness of the household level analysis of slums in drawing implications for designing and implementing slum policies.

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Introduction

In 2001, UN-Habitat (2003) estimated that there were 155 million slum dwellers in India. The estimate, however, shows a stark difference from the domestic figure of 54 million reported by the Census of India (2001). This gap could mean significant misallocations of budgetary resources since urban planners and policy makers rely on these estimates to identify household beneficiaries and to budget for slum improvement programs such as the *Environmental Improvement of Urban Slums Program* and the *National Slum Development Program* (Planning Commission of India, 2008). It is well known that inadequate targeting is one of the main reasons

for failing to make the expected impacts of slum policies (Mathur, 2009).

The discrepancy in the two estimates stems from the different slum definitions used by the UN-Habitat (2002) and the Census of India (2001). The former identifies slums using household as the unit of analysis whereas the latter recognizes them at the neighborhood scale. The neighborhood level definition identifies slums as an aggregated representation of multiple households; see for example, the definitions of 21 cities from across the world in UN-Habitat (2003). The approach makes some slum neighborhoods more identifiable than others, either because of distinct physical conditions of the housing in those neighborhoods or because of a distinct set of socio-economic and demographic characteristics of their inhabitants such as concentrated poverty (Montgomery, 2009).

There are some benefits of implementing slum improvement programs and policies at the neighborhood level such as ease of

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monitoring the programs or the aggregate public health benefits arising from positive externalities (Mehta & Mehta, 2012). However, because of the heterogeneity of different living conditions and socio-economic and demographic characteristics of residents (Seeley, 1959; Stokes, 1962; Van Vliet, 1987; Sandhu, 1989), it becomes difficult to delineate slum areas using the neighborhood as the unit of analysis. Moreover, since living condition is an attribute of an individual household, there is a merit to determine slum status at the household level. Such an approach would also allow urban planners and policy makers to tailor and target slum improvement programs and policies based on the needs of individual households. This is particularly important since new slum policies are seeking better approaches to identify and target beneficiaries. *The Basic Services to Urban Poor Program* in India, for instance, mandates identification of beneficiaries even if they do not live in legally identified slums (MHUPA, 2009). Our approach does not prevent the implementation of neighborhood level programs if deprived households are spatially clustered.

The main purpose of this paper is to apply the individual household level definition of slum developed by the UN-Habitat to identify and enumerate slum households in the two case study cities in India, Mumbai and Kolkata. The household level information extracted from the National Family and Health Survey (NFHS) data is used to operationalize the definition and to develop the Slum Severity Index (SSI), a novel household level measure for housing deprivation. The UN-Habitat (2003) reports the total number of slum households in India. It, however, does not provide the city level information and the level of housing deprivation for households. This study is the first attempt to apply the UN-Habitat definition to investigate Indian slums. The remainder of this paper first discusses the UN-Habitat (2002) and the Census of India (2001) definitions of slums (Slum definitions section) before introducing the data used to estimate the slum populations in Mumbai and Kolkata (Data: National Family and Health Survey section). Methodology section discusses the methods used to identify slum households and outlines our approach to construct a unique Slum Severity Index (SSI). Analysis results section presents the results highlighting the differences in the slum population estimates based on different definitions. Policy implications and concluding remarks section provides implications of our findings on designing and targeting slum improvement programs and policies and concludes with the ways to move forward.

Slum definitions

In 2001, the Census of India, for the first time in its history, carried out a slum census for the entire country. As a part of this exercise, enumeration blocks were delineated as slum or non-slum areas based on the following definition (Census of India, 2001):

“For the purpose of Census of India, 2001, the slum areas broadly constitute of: (i) All specified areas in a town or city notified as ‘Slum’ by State/Local Government and Union Territories (UT) Administration under any Act including a ‘Slum Act’; (ii) All areas recognized as ‘Slum’ by State/Local Government and UT Administration, Housing and Slum Boards, which may have not been formally notified as slum under any act; and (iii) A compact area of at least 300 population or about 60–70 households of poorly built congested tenements, in unhygienic environment usually with inadequate infrastructure and lacking in proper sanitary and drinking water facilities.”

From the above definition, it is evident that the first two criteria are based on the official recognition of an area as a slum by the respective local or state governments. Such a definition is inevitably arbitral because local and state governments differ

significantly on what they constitute as a slum (MHUPA, 2010). This is because, in the federal structure of India, the matters pertaining to housing and urban development have been assigned to the state governments by the constitution. The 74th Constitutional Amendment Act of 1992 further delegated many of these functions to the urban local bodies (Government of India, 1992). The third criterion in the above definition allows the Census of India to identify areas as slums even when they are not recognized as slums by the local or state governments. This criterion also makes the Census of India’s definition somewhat objective, in the sense that it is mainly based on measurable attributes such as compactness and availability of infrastructure services (e.g. water and sanitation). Nonetheless, this criterion does not provide a precise measure of these attributes (Risbud, 2010), i.e. what is considered “compact” or “poorly built” for instance is not clearly defined within this definition.

Furthermore, the definition only identifies an area as a slum if it has minimum 300 people or 60–70 households living in a geographically contiguous area, thereby failing to recognize slum households who do not live in a large cluster. Such a definition would ignore newly formed slums where the population has not yet reached the population threshold of 300 people. A second limitation of using the neighborhood level approach is that the definition fails to recognize households with poor housing conditions if a large majority of their neighbors have adequate housing and access to infrastructure services. The reverse may also be true; it is possible that there may be households with acceptable living conditions who would be unnecessarily categorized as slum dwellers because a large proportion of their neighbors lack appropriate housing and access to infrastructure. In the context of the United Kingdom (UK), area-based policy initiatives have received this criticism: a deprived area may contain people who may not be deprived and less deprived areas may contain people who are deprived (Smith, 1999). Another limitation of the neighborhood-based definition is that households with different levels of housing deprivation within the same neighborhood are not differentiated from each other, even when such variation actually exists (Sandhu, 1989).

The definition suggested by UN-Habitat (2002) adopts a household level deprivation approach:

“A household is a slum-dweller if it lacks one or more of the following five elements: 1) access to adequate drinking water 2) access to adequate sanitation 3) housing with adequate space 4) housing with adequate structure to protect against climatic conditions and 5) secured tenure.”

The UN-Habitat (2002) definition overcomes the limitations of defining a slum at the neighborhood level and allows us to differentiate households within a slum area. The UN-Habitat definition also provides measurable criteria for classifying a household as a slum dweller. This is a step forward from the widespread practice of identifying slums on the basis of local reputation or official recognition as is the case for the Census of India’s (2001) definition. The household-based approach may be new for defining slums but it is frequently used in the developed countries, most notably in the UK, to identify household level deprivation e.g. indices of multiple deprivation developed by the Census of the UK (Census Dissemination Unit, 2012).

However, even in the UK, the approach has been limited to use aggregated indices at the neighborhood level, which has its limitations in reaching the deprived population (Noble, Wright, Smith, & Dibben, 2006). There is an ongoing debate in developed countries (see Noble et al., 2006) on the effectiveness of implementing area-wide initiatives to solve wider deprivation (Kleinman, 1999) and lack of cost-effectiveness of such approach compared to citywide sector or domain based interventions (PIU, 2000). The large-scale

empirical evidence on effectiveness of area-based policies is limited (Atkinson & Kintrea, 2001), but small studies suggest that preference for area-based initiatives are largely driven by political motives and with a belief that the concentration of deprived people have a compounding effect on deprivation (Andersson & Musterd, 2005). Andersson and Musterd (2005) suggest that such policies are less cost-effective compared to sectoral or domain initiatives (e.g. city-wide program to improve sanitation). However, Smith (1999) argues that area-based initiatives are effective in targeting deprived population primarily because geographically targeted interventions can provide more resources rather than spreading them evenly, small area initiatives can solve local problems as they tend to be more “bottom-up” and allow more community participation. Although this debate requires concrete and large-scale evidence, this is often not available even in developed countries (Atkinson & Kintrea, 2001). Empirical evidence on the effectiveness of area-based targeting vis-à-vis domain or sector based targeting is even less available in developing countries especially in relation to slums.

There have been a limited number of attempts to construct deprivation measures for slums in developing countries. For example, Gulyani and Bassett (2010) developed a “living conditions diamond” that measured housing deprivation in slums of Nairobi and Dakar along four dimensions including infrastructure, housing unit and neighborhood or location. However, their analysis only presented an aggregated percentage for each city along these four dimensions and thus lacked an intra-city comparison between slums and non-slums. In a similar way, Martínez-Martin, Mboup, Sliuzas, and Stein (2008) compared slums in 188 developing world cities along five different dimensions. Weeks, Hill, Stow, Getis, and Fugate (2007) developed a slum index for Accra at the neighborhood level. This study aggregated data for each enumeration area in Accra and demonstrated the intra-city variability in what they referred to as “slumness”. Baud, Pfeffer, Sridharan, and Nainan (2009) and Mundu and Bhagat (2008) developed similar multiple deprivation indices aggregated at the ward level for Delhi and Mumbai respectively.

However, any neighborhood level definition inevitably relies on the assumption that slums are identifiable because of a distinct set of socio-economic and demographic characteristics of its inhabitants that are homogenous within an area (Montgomery, 2009). Preliminary research has shown that the spatial concentration of poverty is not as prevalent as often thought. Both slums and non-slum areas have degree of heterogeneity in terms of their residents’ socio-economic conditions (Montgomery & Hewett, 2005; Montgomery, Stren, Cohen, & Reed, 2003). For example, Pryor (2003) found that slum dwellers in Dhaka ranged from relatively wealthy with stable jobs to the very poor with informal jobs. Similarly, in Accra, Jankowska, Weeks, and Engstrom (2011) demonstrated that there were variety of people living in slums including lawyers, doctors and government workers. It is important to recognize the socio-economic variability of individual households within a spatial unit since it is often mirrored in the physical aspects of the housing which defines a slum (Jankowska et al., 2011). The UN-Habitat (2002) definition recognizes such variability by identifying the type of housing deprivation for each household. This study operationalized the UN-Habitat (2002) definition of slums to construct the SSI using the household level survey data described in the next section. The importance of such an effort is noted by the UN-Habitat’s recent report on state of the world’s cities 2008–09 that emphasized the need to group households based on severity rather than purely on place (UN-Habitat, 2009).

Data: National Family and Health Survey

The data used for our analysis is from the Demographic and Health Surveys (DHS) which is routinely conducted in over 90

developing countries to collect, analyze, and disseminate data on population, health, HIV and nutrition (<http://www.measuredhs.com>) with the help of USAID. In India, the DHS is known as the National Family and Health Surveys (NFHS). The main objective of NFHS is to provide the national and state level estimates of health indicators. The latest round of NFHS-3 (2005–06) also collected data on slums and non-slums in 8 selected cities within India. Out of these 8 cities, the information required to operationalize all 5 criteria in the UN-Habitat definition were collected only in Kolkata and Mumbai, which limits the scope of this study to cover only these 2 cities. The 2 cities are however India’s megacities: Mumbai is the largest city of India with a population of 11.8 million people and is located on the western coast of the country while Kolkata is the third largest city of India with a population of 4.4 million people and is located on the eastern coast of the country. NFHS employed a three stage sampling strategy to collect the relevant data. In the first stage, the subunits of the cities called wards were selected as the Primary Sampling Units (PSUs), with a probability proportional to the population size (PPS). In the second stage, Census Enumeration Blocks (CEB) were selected from each sampled PSU. Both slum and non-slum CEBs were selected separately at this stage. In the final stage, households were randomly selected within each selected CEB. In Mumbai, 2187 households were surveyed (0.08% of total 2.8 million households) whereas in Kolkata, 2291 households were surveyed (0.25% of total 0.9 million households). The specific areas covered under the NFHS were the areas within administrative boundaries of Greater Mumbai Municipal Corporation and Kolkata Municipal Corporation respectively. NFHS used three types of questionnaires of which the household questionnaire provided information on housing conditions at the household level. For further documentation on data and survey methods, readers are referred to IIPS and Macro International (2007).

Methodology

We used the NFHS survey data to: i) identify slums at the individual household level; ii) estimate slum populations in the two cities; and iii) develop a continuum scale for determining the severity of each slum household based on the UN-Habitat definition of slums. The following sections describe the weights assigned to subsample the households for the analysis, the approach to operationalize the UN-Habitat definition of slums, and the method for developing the SSI.

Weight assignment

The questionnaire recorded whether the selected household was from the census-defined slum or not i.e. from a slum CEB or a non-slum CEB. In Mumbai, 1104 households out of 2187 households (50.5%) surveyed were from the census-defined slums. However, 1.33 million households out of 2.52 million households (52.9%) lived in slums according to the Census, which suggests under-sampling of slum households in the survey. Similarly, in Kolkata, 1104 households out of 2291 households (48.2%) surveyed were from the census-defined slums. However, 0.27 million households out of 0.92 million households (30%) lived in slums according to the Census, which suggests over-sampling of slum households in the survey. To avoid the sampling bias, appropriate sampling weights for both cities were calculated from the known proportion of census-defined slum households in the population as shown in Table 1. The formula to calculate the weights are given by Equations (1) (for non-slum sample) and (2) (for slum sample) below.

Table 1
Sampling bias due to departure from slum proportions in Mumbai and Kolkata.

City	Households in population				Households in sample				Weights	
	Slum	Non-slum	Total	% Slum	Slum	Non-slum	Total	% Slum	Slum	Non-slum
Mumbai	1,331,984	1,183,605	2,515,589	52.9%	1104	1083	2187	50.5%	1.049	0.950
Kolkata	278,868	650,718	929,586	30.0%	1104	1187	2291	48.2%	0.623	1.351

$$w_{NS} = \frac{S_{NS} + S_S}{S_{NS} + \alpha/\beta(S_S)} \quad (1)$$

$$w_S = \alpha/\beta \times \frac{S_{NS} + S_S}{S_{NS} + \alpha/\beta(S_S)} \quad (2)$$

where α and β are, respectively, the ratio of slum households to non-slum households in the census and that in the sample, and n_{NS} and n_S are the sample sizes of non-slum and slum households respectively.

Measurements to operationalize the UN-Habitat definition

UN-Habitat defines slum households as those who lack one or more of the following five housing elements: i) access to drinking water; ii) access to sanitation; iii) housing with adequate space; iv) housing with adequate structure; and v) secure tenure. The UN-Habitat definition, however, does not explicitly state what constitutes lack of access to water and sanitation. The security of tenure, adequate structure and adequate living space are equally ambiguous criteria. The following assumptions were made to operationalize each criterion:

- i) *Lack of Access to Drinking Water*: WHO and UNICEF developed a guideline on water and sanitation for household surveys in 2006. The guideline was followed in the NFHS survey. For access to drinking water, WHO and UNICEF (2006) classifies water sources into improved and unimproved where improved sources includes piped water to the dwelling unit, piped water to the yard, public tap/standpipe, and tube well or borehole. Unimproved access includes tanker truck and bottled water. We took access to improved sources as equivalent to having an access to water whereas access to unimproved sources were considered as equivalent to lacking access to water, as suggested by the UN-Habitat (2006b).
- ii) *Lack of Access to Sanitation*: Similarly, WHO and UNICEF (2006) classified sanitation facilities into improved and unimproved facilities. Improved facilities include flush to piped sewer system, flush to septic tank, flush to pit latrine, flush to somewhere else, flush to unknown outlets, and pit latrine with slab, while unimproved facilities are comprised of pit latrine without slab/open pit and no facility/uses bush/field. We assumed improved sanitation as equivalent to having access to sanitation and unimproved sanitation as equivalent to lack thereof.
- iii) *Lack of Adequate Space*: We used the UN-Habitat (2006a) guideline that suggests a threshold of three people per room to determine overcrowding. The questionnaire had two separate questions: one on the number of rooms in the house and another on the number of people living in the house. These questions allowed us to calculate the number of people per room for each household.
- iv) *Lack of Adequate Structure*: The Census of India (2001) and the National Sample Survey Organization (2010) classifies housing structures into three categories: *kachcha*, which means houses made with temporary materials, *semi-pucca*, which means houses made with semi-permanent materials

and *pucca*, which means houses made with permanent materials. NFHS used the same approach to classify housing structures. We took a conservative approach to assume that *kachcha* houses lack permanent structure.

- v) *Secured Tenure*: There were two types of questions in the NFHS questionnaire that captures the security of tenure. The first type of questions pertains to the legal occupation of the house and the second type of questions pertains to the occupant's perceived security of tenure. Legal documentation or lack thereof is considered inadequate measure for secured tenure in informal settings (Mahadevia, 2010). We thus relied on the perceived security of the residents themselves. The approach is deemed appropriate especially in the Indian context where the property rights regime with respect to land is fragile (Mahadevia, 2010).

Slum status and Slum Severity Index

The measurements discussed above provide the basis to operationalize the five criteria of the UN-Habitat (2002) definition of slums. In our analysis, each household was assigned a binary score for each criterion, 1 if the household is deprived on that criterion and 0 otherwise. The decomposed score on each of these five elements allowed us to group households by type of deprivation e.g. water deprived slums, sanitation deprived slums, overcrowded slums, etc. This is in contrast to the traditional approach that groups slum households by area (e.g. Dharavi) even when the type of deprivation varies greatly within the area defined as a slum.

A deprivation score named the Slum Severity Index (SSI) was developed by aggregating the binary scores. The SSI ranges between 0 and 5 where 0 indicates the non-slum status whereas the score of 5 lacks all the five basic elements of housing, suggesting the poorest living conditions. The SSI advances the traditional slum/non-slum dichotomy to the slum spectrum, allowing us to differentiate households by degree of housing deprivation.

Analysis results

Using the approach described in Methodology section, we estimated the number of slum households in Mumbai and Kolkata to be compared with the estimates by the Census of India. Fig. 1 shows the gap in the two estimates. In Mumbai, there are more than 730,000 households that are not identified as slum households by the Census definition even when they are classified as slums according to the UN-Habitat definition i.e. lack at least one of the five housing elements. Similarly, Kolkata has as many as 320,000 households that are not identified as slum households by the Census of India definition.

Table 2 shows the cross-tabulation of the slum/non-slum household percentages estimated for each city based on the two different definitions. The percentage of slum households reported by the Census is about 30% lower than the estimate based on UN-Habitat (2002) definition in both cities. Our estimate of percentage of slum households in Mumbai is 81.7% using the UN-Habitat (2002) definition whereas the Census (2001) reported only 52.5% slum households. Similarly, Kolkata has 64.1% of slum households based on the UN-Habitat (2002) definition compared to only 29.0%

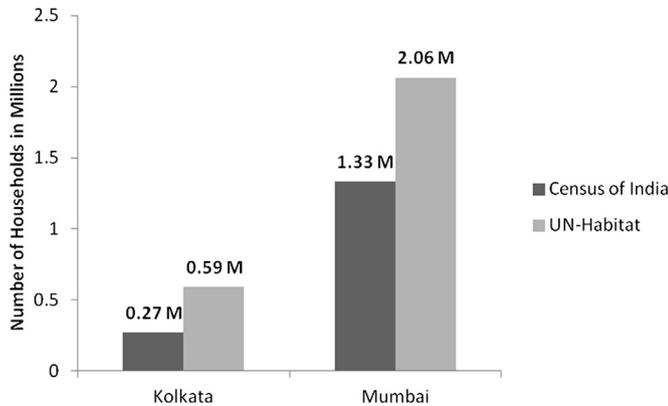


Fig. 1. Estimated number of slum households in Mumbai and Kolkata by census and UN-Habitat definitions.

according to the Census (2001). The cross-tabulation further indicates that, in Mumbai, 35.5% of the UN-Habitat defined slum households is considered non-slum by the Census. This percentage is even larger (39.9%) for Kolkata. The percentage of households classified as slum by the Census but not by the UN-Habitat definition remained relatively small for both cities, recording about 5%. The table clearly indicates that the Census of India underestimates slum households compared to UN-Habitat, which is in line with the underestimation at the country level as discussed in Introduction section.

The 'Total' columns in Table 3 for each city show the percentages of households classified as slums when the five criteria specified in the UN-Habitat definition were applied individually. The numbers exhibit that there are almost no households that are classified as slums based on the first criterion, i.e. lack of access to water, while the majority of households are defined as slums in both cities when lack of access to sanitation was used for classification. The gap in the percentages in the two cities was the largest when lack of adequate space was used to define slum households, indicating that the problem of overcrowding is much less prevalent in Kolkata.

Our analysis revealed that housing deprivation is equally prevalent in non-slum households. In Mumbai, housing deprivation is more prevalent in slums, while the reverse is true in Kolkata. Overall, however, a relatively high percentage of non-slum households are deprived of durable structure, adequate space, sanitation and secured tenure in both Mumbai and Kolkata. For instance, in Kolkata, there are more households deprived of sanitation in non-slums than in slums based on the Census classification, indicating that Census categories may not prove very useful for urban planning and policymaking.

There are four possible reasons why the Census slum categories do not capture housing deprivation. First, it is well established that not all poor live in slums and those who live in slums are not necessarily the poorest (Chandrasekhar & Mukhopadhyay, 2008; Sengupta, 1999). It is possible that poor people in non-slum areas are deprived of housing since poverty and physical housing

Table 2
Cross-tabulation by UN-Habitat and census of India definitions.

		UN-Habitat definition					
		Mumbai			Kolkata		
		Slum	Non-slum	Total	Slum	Non-slum	Total
Census of India definition	Slum	46.3%	6.2%	52.5%	24.3%	4.8%	29.0%
	Non-slum	35.5%	12.0%	47.5%	39.9%	31.1%	61.0%
	Total	81.7%	18.3%	100.00%	64.1%	35.9%	100.0%

Table 3
Housing deprivation in census of India defined slums and non-slums.

Housing characteristics	Mumbai			Kolkata		
	Slums	Non-slum	Total	Slum	Non-slum	Total
Lack of access to water	0.0%	0.0%	0.0%	1.1%	0.1%	1.2%
Lack of access to sanitation	41.7%	25.5%	67.0%	22.8%	29.1%	51.9%
Lack of adequate space	29.5%	23.6%	53.1%	14.7%	16.4%	31.1%
Lack of durable house structure	1.3%	0.9%	2.2%	2.2%	2.8%	5.0%
Lack of secured tenure	11.9%	8.3%	20.2%	9.0%	13.4%	22.4%

conditions are often correlated. Second, some slum households could feel more secure than those living in non-slums because slums, especially "registered¹" ones, tend to be "safe havens" against eviction and demolition drives. There is also a self-selection bias since those who did not have a secure tenure may have been evicted already. This is particularly the case in Mumbai where a large-scale eviction (90,000 families) took place between 2004 and 2005 (IPTEHR, 2005). Third, registration of slums is routinely conducted in India but once they are registered as slums, they are never de-registered even if housing quality improves (Gupta, Arnold, & Lungdim, 2009). Hence, the Census slums may not necessarily have a high percentage of households with housing deprivation. Fourth, the administrative boundary of the Municipal Corporation of Greater Mumbai includes outgrowth and hence households sampled for the survey include new peripheral slums that tend to have a higher prevalence of housing deprivation. In contrast, the administrative boundary of the Kolkata's Municipal Corporation does not include outgrowth and hence surveyed households include only those in the core area of the city. This could have led to overrepresentation of older slums that are more than 150 years old and hence could have secured higher service levels over time.

The average SSI was calculated for each city to compare the relative housing conditions in these cities. In order to compare the slum household estimates based on the UN-Habitat definition and the Census of India's, we enumerated slum households by counting the households whose SSI is equal or greater than 1. Table 4 presents the percentages of households for each SSI score by slum/non-slum classification of the Census. The table shows that none of the households in Mumbai has an SSI of 5 since all of them at least have access to water. However, in Kolkata, there are 0.2% of households who suffer from extreme housing deprivation, i.e. lacking all of the five basic elements of housing. It is of note, however, that there is a high prevalence of multiple deprivations (49% and 33% of the households in Mumbai and Kolkata respectively) in both cities. Average SSI can be a useful as a yardstick measure to compare slum situation within and across cities. For example, Kolkata has a mean SSI of 1.22 (with a standard deviation of 0.02), whereas Mumbai has a mean SSI of 1.41 (with a standard deviation of 0.02) which indicates a higher housing deprivation in Mumbai compared to Kolkata.

Policy implications and concluding remarks

This paper applied the UN-Habitat (2002) definition to estimate the numbers of slum households in Mumbai and Kolkata. The UN-Habitat approach of defining slums is considered more appropriate because it allows planners and policy makers to: i) accurately estimate housing problems in a city; ii) tailor housing programs based on housing needs of households; and iii) prioritize the beneficiaries

¹ "Registered" slums are the areas notified as slums by local or state governments in accordance with the Slum Clearance Act of 1956.

Table 4
Slum severity in census of India defined slums and non-slums.

Slum Severity Index	Mumbai			Kolkata		
	Slums	Non-slum	Total	Slum	Non-slum	Total
0	6.2%	12.0%	18.3%	4.8%	31.1%	35.9%
1	16.8%	15.8%	32.5%	8.1%	23.2%	31.3%
2	22.3%	16.3%	38.6%	10.7%	12.9%	23.00%
3	7.0%	3.3%	10.3%	4.5%	4.00%	8.4%
4	0.2%	0.1%	0.3%	0.8%	0.4%	1.2%
5	0.0%	0.0%	0.00%	0.2%	0.0%	0.2%

of policy interventions based on the degree of housing deprivation. However, it is worthwhile to note that even the UN-Habitat (2002) definition is considered conservative in the sense that it underestimates the deprivation of slum households. This is primarily because the definition is restricted to the physical and legal characteristics of slums but eschews the social dimensions that are often difficult to be measured (Davis, 2006). Nonetheless, we can expect that the underestimation is partially corrected as physical deprivation is highly correlated to social and economic marginalization (Arimah, 2001; Begum & Moinuddin, 2010).

Our analysis revealed that, if slums were identified in accordance with the UN-Habitat's definition as opposed to the Census of India definition, policy makers would face much larger problems than they currently do. Since the policy makers currently rely on the Census estimates, they fail to recognize the full extent of housing problems in cities, which could lead to insufficient budgetary allocations of governmental resources to housing programs. Accurately recognizing the full extent of housing problems is considered important for planning and policymaking purposes (Sen, Hobson, & Joshi, 2003).

The Census of India recognizes a slum at the neighborhood level while the UN-Habitat defines slums at the household level. Measuring deprivations at the household level could allow policy makers to design interventions that are tailored to individual household's needs rather than at the aggregate neighborhood level. For example, interventions for solving overcrowding would be much different from solving sanitation problems. As shown by Nandi and Gamkhar (2013), policy responses differ based on the type of deprivation in the case of India. Often, household level data is aggregated to the neighborhood level, resulting into a loss of heterogeneity among households. While such aggregations are useful for community level interventions and city level comparisons, they are less useful for household level interventions. Our household level approach in identifying slums allows planners and policy makers to design more targeted slum policies.

While our approach does not focus explicitly on the neighborhood level, it does not prevent planners from formulating policies at more aggregated levels. Some policy interventions need to be implemented at the aggregate level. For instance, providing a subsidy to build a toilet is a household level intervention but connecting them with the city's sewer network is a neighborhood level policy. Spatial discontinuity could provide additional challenges for implementing and monitoring infrastructure services. Similarly, some interventions are cost-effective when implemented at the neighborhood level and hence require identification of a contiguous area for intervention e.g. a community standpipe to provide water to multiple households.

To capture the variability in their housing conditions, we created a novel SSI that measures slum severity level on a continuous scale instead of the traditional dichotomous classification used elsewhere. The SSI developed in this study can be used to identify the households who suffer from varying level of housing deprivation. For instance, there are several households in Mumbai and Kolkata

that suffer from the most severe level of deprivation, $SSI \geq 4$. Policy makers could set priorities for these households in implementing interventions which is important especially when financial resources are limited (Choguill, 1995).

Similarly, the interventions could be prioritized based on the prevalence of the type of deprivation within a city. For example, our analysis indicated that none of the households in Mumbai lack access to water and hence policy makers need to focus on other services such as increasing access to sanitation. However, it should be noted that 100% coverage of water is debated widely in the literature. Satterthwaite (2003), for example, argued that several indicators reported by national governments and international development agencies are "nonsense statistics". The author cites the case of Mumbai (Satterthwaite, 2003: p. 186) where the Asian Development Bank (McIntosh & Yniguez 1997) reported 100% water coverage despite that another study by Bapat and Agarwal (2003) reported that there were great difficulties in getting water within the Mumbai Slums. Satterthwaite (2003) argues that such statistics could be a result of definitions and assumptions being used. For example, when a slum dweller says "yes" to a water availability question, it may not accurately capture access to water since the question does not focus on quantity or quality of water, time spent in getting the water, etc. However, the NFHS collected detailed information on access to different types of water sources as opposed to the simplistic "yes" or "no" type of question for water availability. Hence our estimate on water availability in Mumbai seems plausible.

Furthermore, the decomposed SSI could be used to measure improvements in slum conditions more accurately. The traditional binary definition of slums fails to reflect the improvement brought by reducing one type of deprivation (e.g. sanitation) as slum dwellers typically face other types of deprivations simultaneously and they would still be classified as slum. The decomposed SSI, on the other hand, could provide evidence of positive change. This is particularly important since Indian cities are embarking upon an ambitious program called Rajiv Awas Yojana (RAY) to make India slum-free within five years (MHUPA, 2011). One of the cornerstones of this program is to monitor the slum-free city plans using a Management Information System (MIS). However, in the absence of objectively measurable indicators, such as the five criteria in the UN-Habitat (2002) definition, it is difficult for cities to monitor their own progress. At the national level, policy makers could use the average SSI as a yardstick to compare the progress of the cities and to allocate resources accordingly.

Finally, slum improvement policies in India have traditionally targeted households based on their demographic or socio-economic characteristics of residents. For example, the Government of Delhi recently proposed 100 percent housing subsidy to slum households who were below the poverty line (Kumar, 2011). Identification of beneficiaries should also include households with a severe housing deprivation because it is the housing conditions that define a slum (UN-Habitat, 2003) rather than the residents' socio-economic characteristics alone. Our approach could provide a housing deprivation measure that could assist planners with identification of the beneficiaries of slum improvement programs in a more complete fashion.

Although this study covered only two cities in India, our approach is applicable to other cities in India and in other developing countries since the DHS has been conducted in more than ninety developing countries around the world (USAID, 2012). While it is clear that a survey-based study cannot support citywide program implementation, our approach provides a framework that could be applied to citywide data once they are collected. In fact, it is increasingly becoming common to ask questions on housing conditions within censuses in many developing countries. The

most recent *Census of India* (2011), for instance, collected the information on all five elements of housing deprivation used to operationalize the UN-Habitat (2002) definition of slums in this study. As Noble et al. (2006) writes, an index should be neither driven by data availability nor by statistical techniques. It is important to first develop a clear model. Data on deprivation could be sought and statistical techniques could be applied only after a clear model is established. It is our hope that this study contributes to the development of such a model in the context of slum measurements, which could precede data collection on deprivation at the household level.

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