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Where are the poor? A disaggregation approach of mapping urban poverty

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ABSTRACT

In this paper, we highlight an approach for mapping indicators of poverty. The main drive for developing such an approach is to address the neglected aspect of the spatial dimension of poverty since in most cases the indicators chosen for poverty rely on household data. Such data if spatially analyzed are usually aggregated to administrative units such as neighbourhoods or wards. Therefore the spatial heterogeneity within the administrative unit is hidden. For target interventions, detailed spatial information is needed on poverty as a multidimensional phenomenon at a disaggregated level.

The study shows an approach to address the neglected aspect of the spatial dimension of poverty, based on a case study of the city of Cebu in the Philippines. It is integrating locally available datasets on poverty relevant issues from several municipal departments with information extracted from a recent very-high resolution satellite image. The indicators identified and mapped are dwelling size, building density, lack of proper road network, poor structural quality of buildings and access to water and sanitation. Analysis is done at both disaggregated and aggregated levels (using data from the census) to demonstrate how data aggregation can hide spatial variation of poverty but also to examine the robustness of the selected spatial indicators.

The results at the disaggregated level clearly locate poverty areas and show that the nature of poverty varies among those areas. For some areas, the main issue is e.g. structural quality of buildings, while for others it is either access to proper sanitation and/or access to water supply. This approach has potential by using locally available datasets in combination with satellite image data to provide spatially detailed information usable for both planning and monitoring poverty intervention.

1 INTRODUCTION

To eradicate extreme poverty is one of the Millennium Development Goals (MDG's), the target is to halve the proportion of people whose income is less than one dollar a day, by 2015 (UN/DESA, 2006). Presently, more than a billion people in the developing world live on less than one dollar a day, with an increasing number and proportion of poor people living in urban areas. Even though efforts are made to localise urban poverty in many developing cities, the scarcity of relevant data, coupled with lack of both human and financial resource for data collection and analysis is a significant constraint to target interventions.

Traditionally approaches of measuring poverty have been focusing on income and consumption (monetary dimension of poverty), while recently poverty is understood as a multidimensional phenomenon focusing on multiple sources of deprivation in poverty areas (Martinez-Martin, 2005). Those areas are characterized by overcrowding, insufficient water supply, sanitation and infrastructure, problems of health and nutrition, limited access to education, as well as insecurity, exposure to hazard, deficient social relations, etc (Turkstra and Raithelhuber, 2004). As a multidimensional phenomenon urban poverty is also spatially heterogeneous since poor people tend to be clustered in specific places. Therefore it is important to capture the spatial heterogeneity and the substantial variation of poverty areas to know better where the poor are and how they are distributed throughout the city. Targeting of the poor depends significantly on how poverty is conceptualized, measured and analyzed within a specific local context. To be able to locate the urban poor and adequately profile them for target intervention requires defining, identifying and understanding areas of poverty not only on their commonalities but also on their diverse characteristics in terms of social, economic and physical conditions in a local context.

In principle, there are three main approaches of analysing poverty depending on the availability of data (Zeller et al., 2006), namely the construction of a poverty line, rapid appraisal and participatory appraisal methods or construction of a weighted poverty index (combining qualitative and quantitative indicators).

In most countries if spatial analysis of poverty is done it is at national, city or district level. This aggregation of data hides the stark contrast of income and living conditions between better-off urban citizens and the urban poor and overlooks pockets of poverty areas within the city (Hall et al., 2001). In recent years, poverty mapping, which is a powerful new information analysis and communication tool, has come into prominence and is bridging this gap in provision of the required spatial information. A variety of methods to spatially locate poverty has been developed e.g. small-area estimation (combining census and survey data for disaggregated geographic units such as municipalities), multivariate weighted basic-need index (disaggregating poverty using statistical techniques such as principal components), combination of qualitative information and secondary data (e.g. mapping poverty based on livelihood strategies), extrapolation of participatory approaches (incorporating local perception of poverty), direct measurement using household-survey data or census data (Davis, 2003).

One recent study presented by Baud et al. (2006), shows the relevance of a mapping urban poverty on sub-city level in Delhi (India), comparing the different wards by conceptualizing poverty by an index of multiple deprivation. The potential of recent very-high resolution satellite images (providing spatial resolutions of less than one meter) to disaggregate poverty further than to administrative levels of neighbourhood or wards has been explored by Lemma et al. (2006). Very-high-resolution satellite images supported by local knowledge, field observations and available local data can provide information on the location of poverty areas. The integration of these datasets in a GIS can generate a wealth of information on urban poverty. The advantage of such an approach is that it is locally generated, and thus easier for institutional embedding. Further, the use of very-high resolution images as backdrop images for 'putting the poor on the map', is an important aspect for gaining political support and communicating results to non-technical audiences at the local level (Turkstra and Raithelhuber, 2004).

2 BACKGROUND

Cebu City is located on the central eastern part of Cebu Province, an island at the centre of the Visayas in Southern Philippines and is the capital of the province as well as of the Central Visayas region. Based on the last population census conducted in 2000, the city had a total population of approximately 700,000. As Figure 1 shows, Cebu City is subdivided into 80 barangays (smallest administrative unit, similar to wards), 49 urban barangays where the majority of the population lives and 31 rural barangays (the later study focuses on 12 centrally located urban barangays).

High development pressure as a consequence of economic growth during the last decade has dislocated the urban poor into overcrowded and hazardous areas. It is pertinent to note that the concept of poverty in Cebu is viewed differently by the urban poor and the policy and decision makers. According to the study conducted by Etemadi (2001), the urban poor view poverty as deficiency in income, living conditions, access to basic services and resources, and working conditions. While policy and decision makers view the urban poor as the 'homeless and landless' even if they have earnings. As a consequence the main thrust of the policy and decision makers, is providing services and assistance whenever there is an incidence of demolition (Etemadi, 2001).

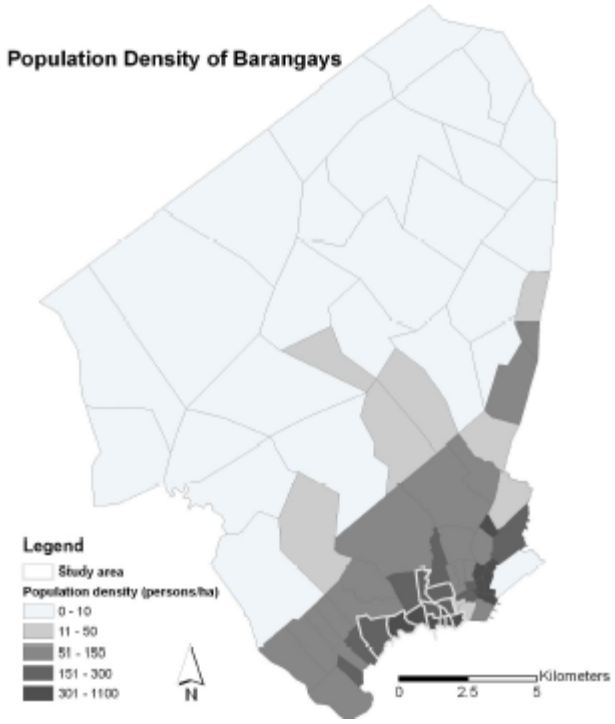

Figure 1: Population Density in Cebu

The Division for the Welfare for the Urban Poor (DWUP) has the mandate to provide adequate housing facilities, such as the socialized housing facility to the urban poor and ultimately relocate them from hazard zones of the cities. The poor however are required to organize themselves into cooperatives associations known as the Homeowners Associations (HOA). There are about 600 of these Homeowners Associations in Cebu City. The DWUP usually stimulates the formation of these associations in order to provide them with assistance in the form of:

- Assisting the HOA in case of eviction actions taken by landowners.
- Buying land for the HOA, for onsite settlement or land resettlement (mostly into fringe areas). In these cases the households are required to pay for the land in installments.
- Playing a leading role in providing basic services to the sites acquired.

Most of the poverty areas in Cebu are located on low-lying pieces of land squeezed between subdivisions and factories in highly polluted industrial areas. In some cases the areas are so crowded that some dwellings have been extended unto the water surface along the coastline. In most of the areas basic services like potable water supply, sanitary facilities and proper road network are almost non–existent. The structural quality of most dwelling units is poor and can be deemed shanties.

In general there is tremendous lack of public

spaces. Poverty areas have very high population and building densities. The density is usually greater than 60 households per hectare. Plot and dwelling size is usually below the minimum requirement of 36 and 25 square meters respectively. Detached buildings do not comply with the legal set back requirements of 1.5m set back side distance and 3m set back front distance. However, recognizing that urban poverty is a major problem facing the city, the Cebu city government has become one of the most active local government units in the Philippines dealing with this phenomenon.

Characteristics of poverty areas (pockets of poverty) in Cebu:

- Located on low-lying land (unto water surface) and near industrial areas.
- Overcrowded areas with high densities with lack of public space.
- Plot and dwelling size below the minimum requirement.
- Insufficient basic services - potable water supply, sanitary facilities, roads.
- Shanties makeshift structures (‘barong-barong’) with non compliance to building regulations.

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Figure 2: Characteristics of poverty areas in Cebu

3 METHODOLOGY

Acquiring comprehensive information on the spatial location of pockets of poverty, reflecting their heterogeneity requires the integration of multiple data sources. We employed group discussions with local experts and stakeholders to develop a list of indicators of locating pockets of poverty, as well as obtaining a good overview of locally available data to support their implementation. The group discussions were held with the Chief Planning Officer and other senior personnel of the Planning Department, the coordinator of Division of Welfare for the Urban Poor, a senior official of the National Statistical Office and the community leader of the Basak San Nicholas Sitio Pandayen Homeowner Association. Based on the group discussions the following list of indicators for identifying pockets of poverty has been developed (see table 1).

Role	Domain	Indicator	Measure	Data Source
Identifying pockets of poverty	Urban morphology	• Lack of proper road network	• Irregular patterns/ absence of accessible roads to vehicle traffic (e.g. 5m access roads)	Visible image interpretation (QuickBird 2005)[1]
		• Building densities	• Crowding of buildings – more than 90% of roof coverage	
		• Small dwelling size	• Roof area of building (less than 25m^2)[2]	
		• Poor structural quality of buildings	• Building material of roof (mostly corrugated iron sheets)	
	Location	• Natural hazard zones	• Location of flood prone areas • Location of dry hydrants	Records of HOA[3] (2003), dry hydrants and past flooding events (2005)
		• Location in poverty area	• Location of Homeowner Association (HOA)	
Analysing diversity	Living Conditions	• Access to water & sanitation	• Water point connections • Availability and type of toilet facility	Watsan Dataset (last update 1998)

Table 1: Disaggregated indicators of poverty pockets

The first group of indicators is the basis for identifying pockets of poverty and the second group (living conditions) is reflecting the diverse characteristics poverty. Optimally more indicators could have been developed for reflecting the diversity of poverty (using e.g. social dimension) but the employed indicators are understood as examples to combine spatial disaggregation with an analysis of poverty as a multidimensional phenomenon. For identifying the visible-morphological characteristics the main data sources was a very-high resolution satellite image (QuickBird 2005). However, since not all the characteristics of these areas are visible from space, data have been collected from other sources, namely flood records, location of HOA and dry hydrants. Field observation was also an important source since it could validate the data collected from the other sources. Data used for analysing differences in living conditions of the identified pockets of poverty was a dataset containing information regarding water connection and the availability of toilet facility of households (Watsan[4]).

The indicators were compared and analyzed with two indicators (namely dwelling size and structural quality of dwellings) derived from the census database (2000) on aggregated data at barangay level to determine whether there is any correlation. The statistical data were used to determine whether the barangays with a larger coverage of poverty pockets (at disaggregated level) have also a higher number of small buildings (below the minimum requirement) or higher number poor structural quality of buildings.

[1] Pan-sharped multispectral image of 0.7m spatial resolution.

[2] The 25m^2 threshold was defined based on information from the Planning Department regarding the non-compliance of most dwellings in poverty areas satisfying the minimum standard of 25m^2.

[3] Database of the Division for the Welfare for the Urban Poor of registered members of HOA. Dataset is so far not used to analyse poverty within the City. During the group discussion the potential of utilizing this dataset was identified as the majority of urban poor are organised into HOA. Besides the location of these areas, the dataset give information on socio-economic characteristics.

[4] Main drawback of this data is the temporal difference as well as it is not covering the entire study area (2 barangays are not covered).

3.1 Identifying pockets of poverty

Interpretation of indicators based on scale

Scale	Interpret. element	Indicator	Nature of indicator
1:8,000	colour	Appearance of roof materials	Very visible
	texture	Extreme clustering of buildings	Very visible
	size	Small dwelling size	Not clearly visible
1:1,200	pattern	Irregular layout	Very visible
	size	Small dwelling size	Visible but most areas are heterogeneous

Table 2: Image interpretation elements

Pockets of poverty can be located on a QuickBird image by describing typical characteristics based on colour, texture, size and pattern (Lemma et al. 2006). Based on these interpretation elements the characteristics of the poverty pockets visible on the image, are:

- Irregular layout pattern – inability to observe formal road network within settlements and non – visibility of access roads or footpaths,
- Extreme clustering and continuous roof coverage of buildings (texture), greater than 90% roof coverage,
- Small size of buildings – of less than
- the stipulated required 25 m²,
- Tabl e 2: Image interpretation elements
- Bluish-grey appearance of roof materials of the clustered buildings (colour).

These visible characteristics were used as criteria in identifying the poverty pockets. They are easily observable on a satellite image depending on the display scale. At different scales, the indicators have their strengths and weaknesses. For instance, the characteristics of colour and texture – the bluish-grey appearance of roof materials and the extreme clustering of buildings are good indicators at a scale of 1:8,000. On the other hand, the characteristic of pattern – irregular layout and non–visibility of access roads or footpaths are better indicators at a large scale such as 1:1,200.

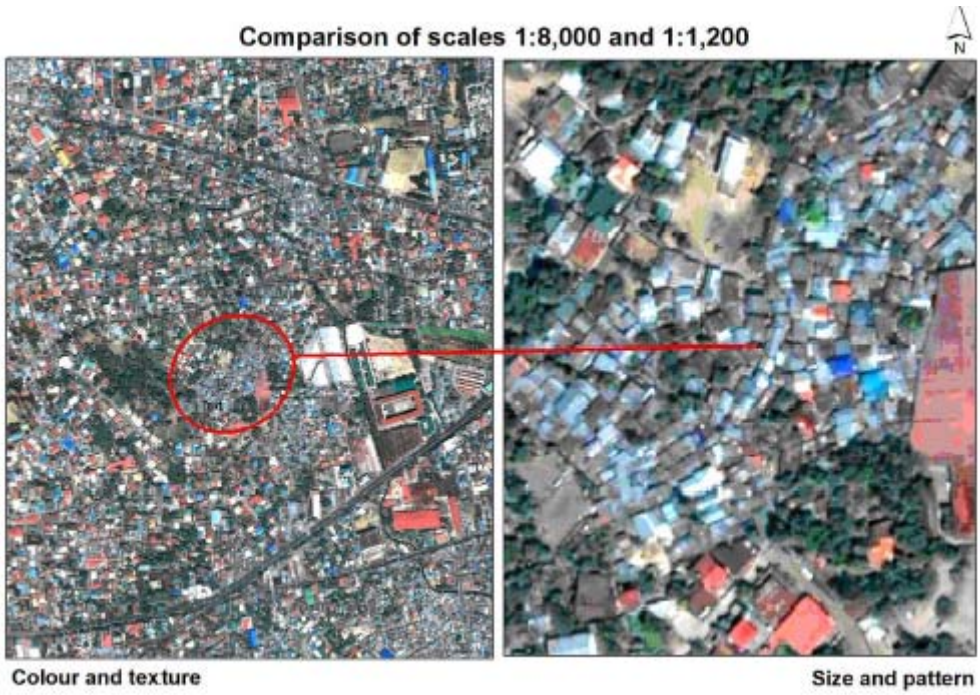

Figure 3: Comparison of indicators at different scales for a poverty pockets in Cebu (QuickBird 2005)

The small size of buildings tends to be a fuzzy indicator at both scales. At the smaller scale small buildings are not clearly visible on the satellite image. At the larger scale it is somewhat difficult to clearly distinguish pockets of poverty pockets based on small size of buildings since no areas can be classified as totally homogeneous. Any particular block or area within the city contains buildings with different sizes. Considering these strengths and weaknesses, visual interpretation was therefore be done at two levels of visibility, one at a scale of 1:8,000 and then at a larger scale of 1:1,200.

The delineation of the poverty pockets was done by on-screen digitizing. To facilitate digitizing, specific interpretation guidelines were employed. Firstly, the minimum size of a poverty pockets had to be established. In exploring the Homeowner Association (HOA) records, it was found that they have none less than 7 structures for one specific location. Using this as reference in combination with the average dwelling size of 14 m², a minimum of approximately 100 m² was established as minimum mapping area. Secondly, in order to assist with the interpretation, available data layers of the major roads, rivers and barangay boundary were overlaid on the satellite image.

Not all spatial indicators are visible on the image, thus further supporting indicators have been used on e.g. the location of hazards zones. For the indicators not visible from the satellite image, data on these indicators is extracted from the following datasets:

- Flood prone areas: Point locations of previous flooding events, such areas are mostly occupied by the poor, since they tend to occupy land that is prone to environmental hazards such as floods.
- Dry hydrants: all records of outlet points. These outlets are located in very high density areas inaccessible to emergency vehicles such as the fire engines. Such areas are mostly areas with poor living conditions.
- Location of HOA: The HOA capture the poor that organised them in Homeowner Association.

3.2 Analysing diversity of poverty pockets based on living conditions

In order to analyse differences between the identified pockets of poverty two measures that indicate differences in living conditions were selected, namely access to water and sanitation. The data were retrieved from the Watsan dataset. The records enable to identify households with no toilet facility and records with water source far from house, e.g. open wells whereby households must get water by container, this type of water source has also possible contamination. They are classified as households without piped water. Notwithstanding the possible geometric inaccuracy5 of the point data selected, the clustering of the points at

previously defined pocket of poverty (on the QuickBird image) give evidence of two aspect of the diversity of living conditions between the pocket of poverty.

3.3 Census data to indicate poverty levels on aggregated units

In order to analyse the robustness of the selected indicators for identifying pockets of poverty, there was need to compare the results with available data from the census that provide information on poverty. Since dwelling size and structural quality of buildings were selected previously as indicators, data on these indicators were accordingly extracted from the census. The census data is aggregated at the level of the barangays. The data on dwelling size was available in interval range and not by absolute numbers. Therefore all records of dwelling size were selected for the barangays under study within the interval ranges of 0-9 m² and 10-19 m². Records of dwelling size within the interval range of 20-29 m² were not selected since these will include dwellings above the minimum requirement of 25 m², which is not defined as a characteristic of poverty pockets.

When overlaying the data on the QuickBird image the points did not accurately overlap with the buildings visible on the image.

4 DISCUSSION OF RESULTS

For implementing the set of indicators, 12 centrally located urban barangays were selected (see figure 1). Based on the interpretation guidelines suspected areas of poverty were delineated. But, visual image interpretation could not determine ultimately whether these areas are occupied by poor households. Further evidence was needed to verify this classification, using locally available data sources. The location points of HOA, dry hydrants, flood prone areas greatly facilitated data extraction of the pocket of poverty. Figure 4 illustrates the clustering of the locations of the Homeowners Associations, the dry hydrants and the flood prone areas and locations identified from the image interpretation using the morphological indicators.

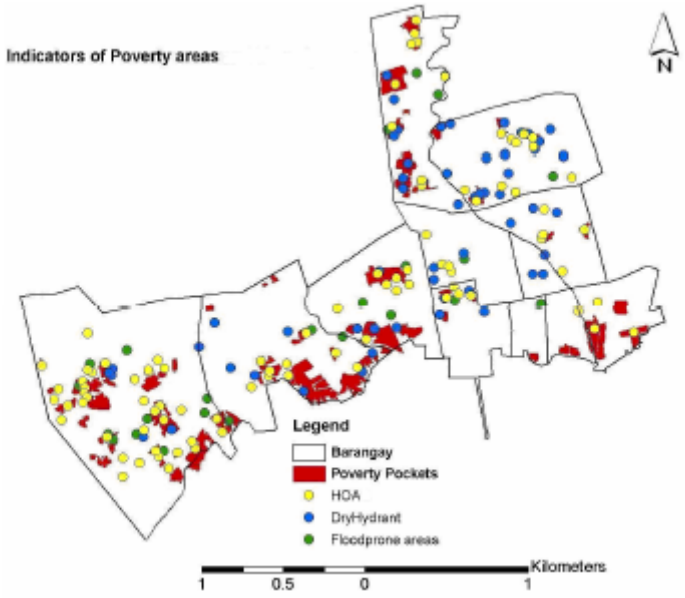

Figure 4: Pockets of poverty combining results of the visual interpretation with locally available data sources

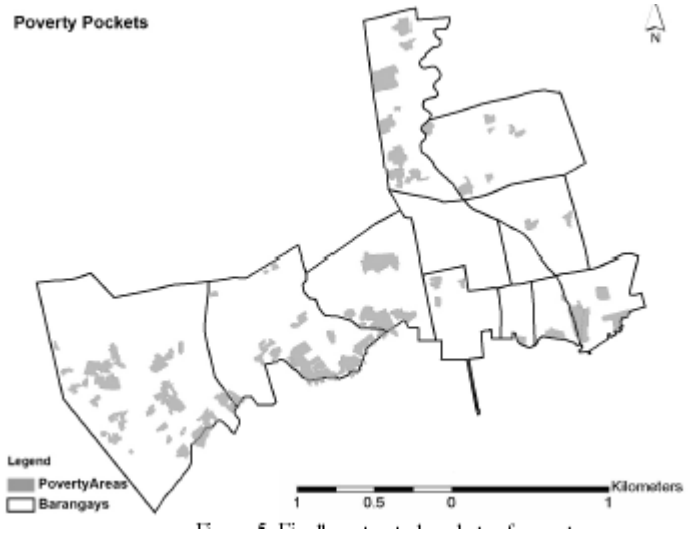

Figure 5: Finally extracted pockets of poverty

The selected data (figure 4) represent characteristics of the poverty pockets in terms of their location, density and vulnerability to environmental hazard. The data was then filtered to select only those areas equal or greater than 100m². As a consequence some areas on the map (see figure 5) where there are no poverty pockets, but there are some clustering of data, are those polygons of less than 100m². The total number of poverty pockets is 84 and accounted for 52.5 ha (12%) of the total land area of the barangays under focus. The smallest area is 0.01 ha while the largest is 3.3 ha.

For further analysis at a disaggregated level, the data were integrated with the Watsan data since this data is at the level of households and is able to provide both spatial and aspatial information on households' characteristics. The major limitation of using the Watsan data was the time difference and incompleteness of the dataset (two barangays were not covered by the dataset). In analysing the issue of water and sanitation the Watsan data was extracted according to households:

- Households (HH) without piped water.
- Households (HH) without toilet.

This distinction had to be made to give a better overview of the living conditions in the identified poverty pockets, using the important aspect of water and sanitation. Analysing the first category, the percentage of households without piped water located within the poverty pockets is 16%. The poverty pockets with the most households without piped water were found in the barangays of Basak San Nicholas and Mambaling with 88% and 38% respectively (see table 2).

Pocket ID	Barangay	Area in ha	% HH without piped water	% HH without toilet	% HH without water & toilet	Remarks
38	Basak San Nicholas	0.38	87.5	25.0	42.9	Most HH without piped water
62	Pasil	0.28	2.3	74.4	0.0	Most HH without toilet
63	Pasil	0.29	1.6	66.4	0.0	Most HH without toilet
72	Mambaling	0.35	19.8	98.0	39.6	Most HH without toilet
77	Mambaling	1.44	38.0	30.5	42.4	Most HH without piped water

Table 3: Poverty pockets with most problematic living standard

Figure 6: a) Households without piped water b) Households without toilets in poverty pockets

In analysing the second category which is based on proper sanitation, the percentage of households without toilet located within the poverty pockets is 25%. Comparing with the results of the first category the problem of sanitation is more widespread. The poverty pockets in Mambaling and Pasil have the highest percentages with 98%, 74% and 66% respectively (see table 2).

At an aggregated level of the barangay comparison with the census data for some indicators used at disaggregated level is possible. The poverty polygons were summarized according to barangays and the % coverage of poverty pockets was then calculated for each barangay to determine which barangay has the highest coverage of poverty pockets.

Barangay Name	Census Data		Disaggregated Analysis
	% of small buildings	% of makeshift materials	% poverty pocket
Pahina San Nicholas	33.7	3.6	0
San Nicholas Proper	7.1	1.5	0
Pahina Central	33.0	0.2	2.8
Suba Pasil	36.9	1.4	2.9
Sawang Calero	36.9	2.4	3.7
Sambag I	16.3	0.8	3.8
Basak San Nicholas	29.5	1.2	12
Calamba	24.8	3.6	17.2
Mambaling	47.3	0.7	18.7
Duljo	27.0	1.5	19.2
Pasil	35.7	0.1	19.7
Ermita	52.8	15.2	27.3

Table 4: Comparing aggregated with disaggregated data

The comparison of poverty levels in table 3 based on the census data and the located pockets of poverty show a moderate correlation of 0.5 in both cases ('% of small buildings' and '% of makeshift materials' compared with the '% of poverty pockets'). The moderate correlation of the data can be explained by several reasons, from the census data only dwelling of less than 20m² were derived while using for the visual interpretation 25 m². Another reason can be attributed to the time difference of 5 years (between the census and the satellite image). For the barangays of San Nicholas Proper and Pahina San Nicholas no poverty pockets have been delineated, while the indicators derived from the census point to poverty which is not spatially clustered. Poverty is most pronounced in Ermita, having 27% of the area delineated as pockets of poverty as well 53% of substandard housing size and 15% substandard housing quality.

The census data provide a general indication which barangays are on average more effected by poverty relevant issues, while spatial variation within them is hidden. Using the employed set of indicators pockets of poverty could be detected leaving out poverty which is not spatially clustered.

5 CONCLUSIONS

The main thrust of this study was to develop an approach for mapping spatial indicators of poverty at a disaggregated level to make spatial heterogeneity within administrative unit visible. To support such an analysis, detailed spatial information is needed on poverty. A set of indicators was developed with the assistance of local experts and stakeholders reflecting poverty aspects of morphology, location and living conditions. Indicators related to morphology and location were used to find pockets of poverty while indicators on living conditions gave insights into the diversity of these areas.

The analysis of morphology was operationalised by indicators on size of dwellings, density characterised by the extreme clustering of roof coverage, lack of proper road network characterised by irregular layout of settlements and non-visibility of access roads, poor structural quality of buildings regarding roof material. These indicators were analysed using a very-high resolution satellite image. The criteria used on the image were based on the interpretation elements of colour, texture, pattern, shape and size. The other relevant datasets to assist in the identification were the point locations of the Homeowners Associations, dry hydrants and flood prone areas. The integrated datasets could provide detailed spatial data for identifying poverty pockets.

The results of data analysis at such a disaggregated level have shown where the critical poverty areas are located and identified critical issues of sanitation and access to water supply affecting these areas. The critical issues identified showed clearly that poverty is multidimensional in nature. The analysis could indicate the barangays with the highest percentage of poverty pockets (e.g. Ermita with 27% of poverty pockets) but also localise specific pockets of poverty with very critical living conditions. Such critical living condition could be e.g. localised in two areas within Basak San Nicholas and Mambaling which had the highest percentages of 43% and 42% respectively for households without water and toilet, were the main issue is water supply and to a lesser extent sanitation.

Analysis based on the data integration and correlation of the results at the disaggregated and aggregated levels gave credence to the fact that spatial variation can be hidden when data is aggregated. The results of the data analysis at the aggregated level have proven the robustness of the selected indicators in analysing poverty at the disaggregated level when comparing the percentages at the two levels. However, from the analysis it was apparent how aggregation can mask variation of poverty within the barangays since, poverty can be not localised and is averaged within one barangay. The specific areas (pockets of poverty) and their spatial extent were clearly visible at the disaggregated level. The combination of both, analysing poverty relevant indicators on administrative sub-city units in combination with localising the specific pockets of poverty has good potential to assist in better targeting interventions.

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