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Child Poverty Estimation and Analysis Using Household Survey and Geospatial Data

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Abstract

Two practical applications combining household survey and geospatial data are presented. First, administrative level one data from household surveys are combined with geospatial data to project child poverty headcount rates at administrative level two and below. This analysis is carried out using the same indicators and thresholds across countries (to estimate child poverty nationally and at administrative level one). Small area estimates and machine learning models are used to generate the estimates at lower administrative levels. This first part of the paper includes a presentation of results and discussion of limitations of this methodology. Besides this discussion, the paper includes a second practical application combining georeferenced data and survey data. In this case, the child poverty subnational data used in the first part are combined with high-resolution geographical data about environmental risks. Combining these two sets allows to analyze the relationship between child poverty and environmental risks which provides an important tool for Disaster Risk Reduction plans.

Introduction and motivation

One of the motivations for this paper is the recognition that child poverty is different from adult poverty. This is the case whether we look at monetary poverty or multidimensional poverty. Child poverty tends to become invisible in poverty estimates carried out at the household level because children's needs are different from those of adults (for example, in terms of immunization or nutrition or school attendance). Also, it is often the case that even if households had sufficient income or consumption levels to surpass a poverty line it does not mean that children actually can avail themselves of the services or the goods that they would need to satisfy the right to health or nutrition or schooling. That is why child poverty (the actual deprivation suffered by individual children) is different from children in poor households. This difference applies whether it is monetary or multidimensional poverty that is being estimated.

This paper is organized in two parts. In the first part the description of estimating and projecting subnational child poverty levels is presented. In the second part, these estimates and projections are combined with information about environmental risks. A brief summary section concludes the paper.

Part1 Child Poverty Estimation and Projections at Sub-national Level

1.1 Measuring Child Poverty

As a first step, it is important to understand what child poverty is and to define child poverty conceptually. The human rights approach to poverty offered by the Office of the High Commissioner for Human Rights is a good framework to define child poverty. The main distinction in this framework is between rights that constitute poverty and other rights. Rights that constitute poverty are those rights that require

fundamentally and directly material resources to be realized. These material resources are goods or services which could be bought privately by the households or could we provided by the state.

An analysis of the Convention of the Rights of the Child, going article by article, allows the identification of nine dimensions or nine rights that constitute child poverty. These are: clothing, education, health, housing, information, nutrition, play, sanitation, and water. There are many other bad things that happen to children, many of which are gruesome child rights violations (from violations to the right of privacy through children engaged in labor, to children sent to prison with adults or being victims of violence). These other child rights violations do not constitute child poverty because the violation of the right is not the result of lacking access to good and services.

UNICEF has engaged for several years in estimating globally child poverty using the same dimension, the same indicators within each dimension, and the same thresholds to determine the deprivation in each of these dimensions. These estimates are done in order to provide comparability across countries and to be able to estimate regional or global aggregates of child poverty but they do not replace or compete or should be seen as a substitute for properly measuring child poverty at the country level with the indicators and the thresholds of deprivation which are relevant at each country context.

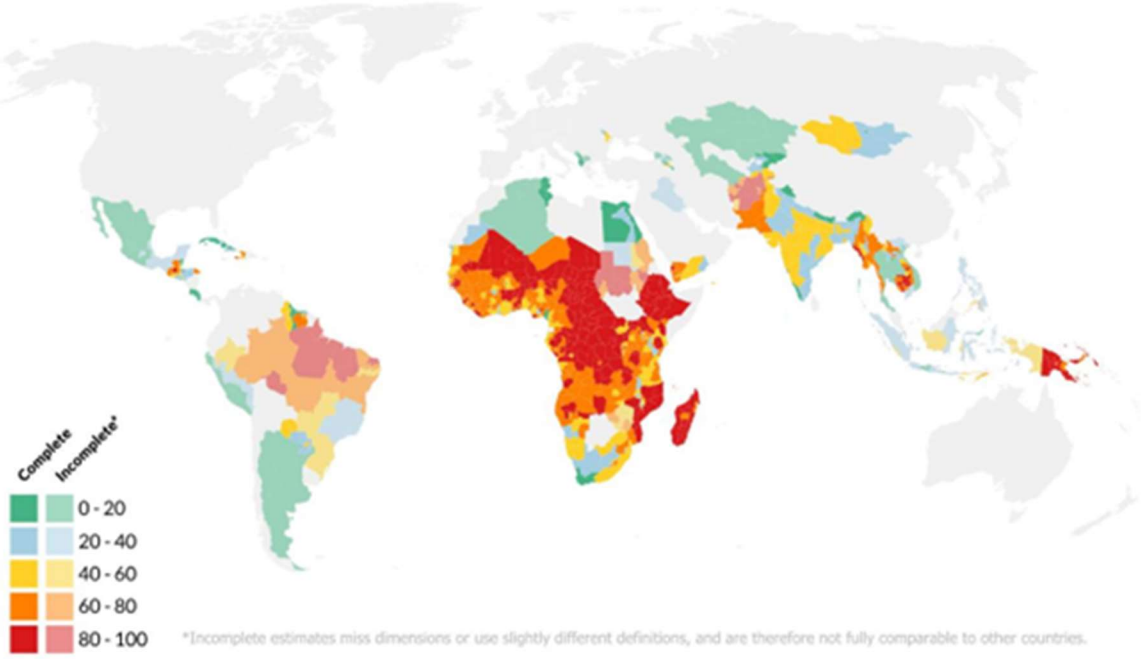
In particular, in order to be able to cover a wide range of countries, very specific indicators were selected and not all the nine dimensions were covered. Obviously, countries are encouraged to estimate child poverty using the nine dimensions. Moreover, countries, when measuring child poverty, should take special care in including specific needs of particular groups of children. It is important to highlight these are not additional rights or additional dimensions. It is simply the recognition that when establishing deprivation in some dimensions may entail some groups of children might requiring different or additional elements (goods or services). For example, there may be some children who were exposed to violence and they need some specific mental health support that should be included in the measure of deprivation in the health dimension. If there are children suffering from physical impairment who need but do not have elements to allow them to surmount these physical impairment (and be able to go to school with other children), the lack of these implements should also be counted as deprivation in the education dimension. If children need special education materials like books in their own native language which may be different from the dominant language in the country and they do not have access to them, the situation should also be counted as deprivation in the education dimension.

1.2 Sub-national estimates, administrative level 1

Using household surveys like the UNICEF Multiple Indicator Cluster Survey (MICS) or the Demographic Health Surveys (DHS), it is possible to estimate the proportion of children in poverty at the national level but also at the administrative level 1. This is the case because these surveys are representative at this first level of geopolitical administrative units. These subnational child poverty rates have been estimated using the same dimensions, the same indicators, and the same thresholds of deprivations (See Annex I) for close to 80 countries covering about 2/3 of the child population in developing countries. Not only has the proportion of children in poverty been measured but we also the depth of child poverty (measured as the number of deprivation suffered per child) and the severity of child poverty (measured as the proportion of children suffering four or more simultaneous deprivations) been estimated. These estimates have also been complemented with estimates of child poverty in a few countries where the surveys did not include exactly the same indicators or dimensions as in the 80 countries either because some indicators were not

included in the surveys or because those countries have not engaged in a MICS or a DHS and another household survey had to be used. These data are presented in Figure 1.

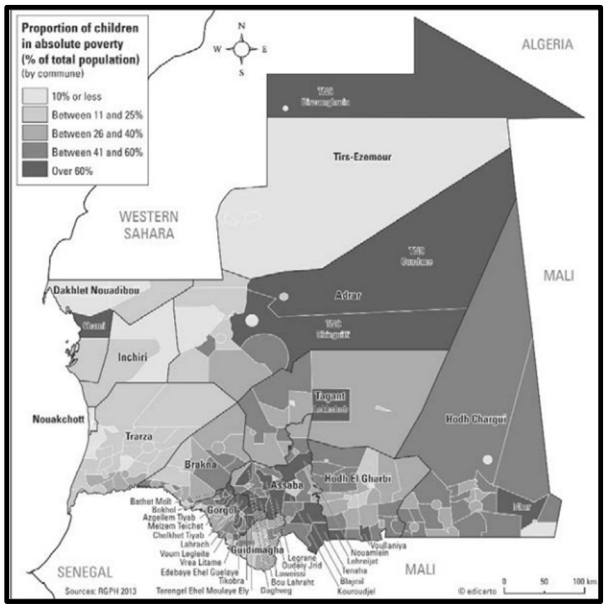
Figure 1 Child poverty at administrative level 1 (developing countries).



1.3 Sub-national estimations and projections, administrative level 2

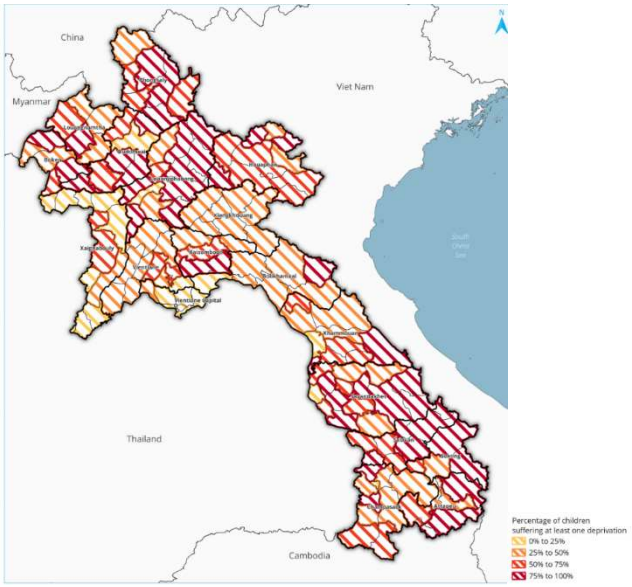
Besides these national estimates at the first level of geopolitical administrative units we have two possibilities for also estimating and projecting child poverty at admin level two. One option is the case in which we have data from a representative household survey which allows us to estimate the different components or dimensions of child poverty. If they have sufficient sample size, then valid and representative estimates of the proportion of children in poverty can be established. For example, this is the case of Mauritania which can be seen in Figure 2

Figure 2 Child poverty rates at admin level 2 in Mauritania



However, in most cases we do not have the luxury of household surveys which provide this type of information at admin level two. In these cases, we can use additional sources of information (for example a census) and project child poverty using small area estimates. Basically, this process entails interpolating information from the household survey which is representative and valid at admin level 1 with information from a census. However, a census does not usually have all the information for the dimensions and the indicators that are needed to estimate child poverty. Thus, we need to combine the information in the household survey which does cover all the dimensions and indicators but is not representative at admin level 2, with partial or limited information at the most minor administrative level from the census. This combination allows to project the values of child poverty at admin level 2. For example, in figure three this is done for Laos.

Figure 3 Child poverty rates at admin level 2 in Laos



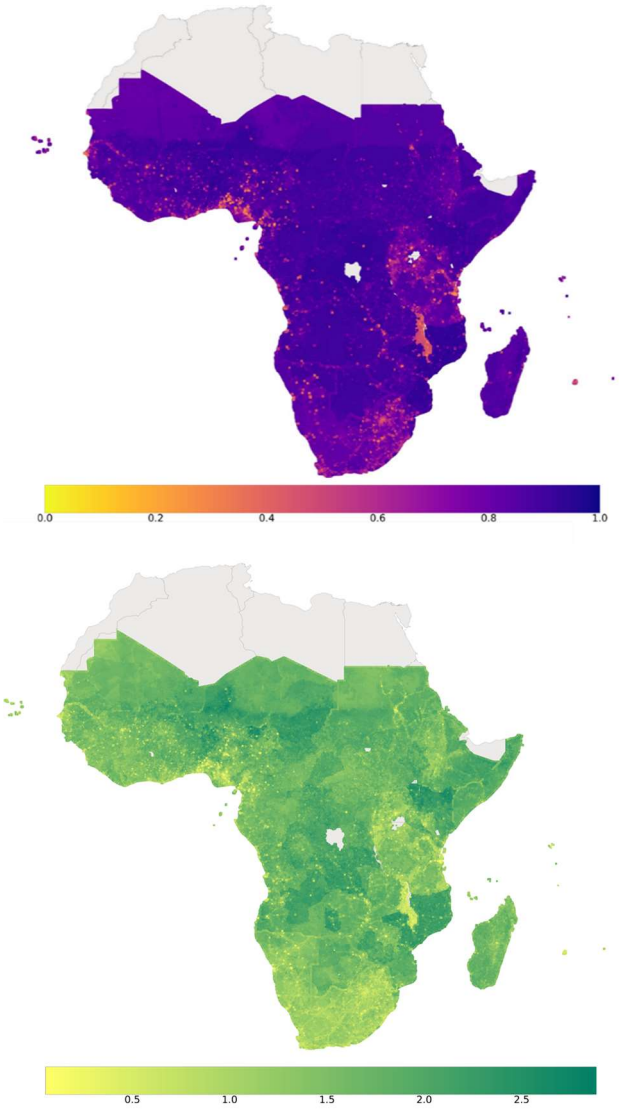
1.4 Sub-National "finely grained" projections

Besides estimating and projecting child poverty at admin levels 1 and 2 (directly or using small area estimates), it is possible to project child poverty at ever lower levels. The admin level 1 estimates, used in conjunction with additional sources of data and machine learning models, can provide child poverty values at very small geographic units.

In Figure 4, finely-grained maps of prevalence and depth of child poverty are presented. The predictions are on a hexagonal grid where each hexagon has an average area of just over 5 km^2. A machine learning model was applied using georeferenced DHS surveys. The machine learning model includes data such as nightlight intensity, elevation, vegetation, road density, and mobile cell towers from sources like Google Earth Engine, Uppsala Conflict Data Program, Open Street Map, etc.

The projections are based on a two-steps process. First, multidimensional child poverty is calculated only in the 25 countries that have a recent, comparable, georeferenced household survey. Taking into account the location displacement of households (for confidentiality) and a threshold of 30 children per hexagon, for each country deprivation in each dimension is calculated for the hexagons with data. The values are then aggregating across the dimensions to establish child poverty and calibrated so they "add up" to the ground truth established by the estimates at admin level 1 (from the household surveys). In the second step, a model that generalizes the projections to the rest of the countries that do not have survey information is used. Countries for which ground truth data are available are split and used iteratively to arrive at child poverty projections for the hexagons in neighboring countries.

Figure 4 Finely grained child poverty projections, Sub-Saharan Africa



1.5 Limitations

However, these results need to be interpreted very carefully. First of all the confidence intervals of the projections at the hexagon level are relatively large. Secondly the interpretation of the difference between contiguous hexagons maybe really problematic given the large confidence intervals. This means that to neighboring hexagons may be projected as having different levels of child poverty while actually they could be the same.

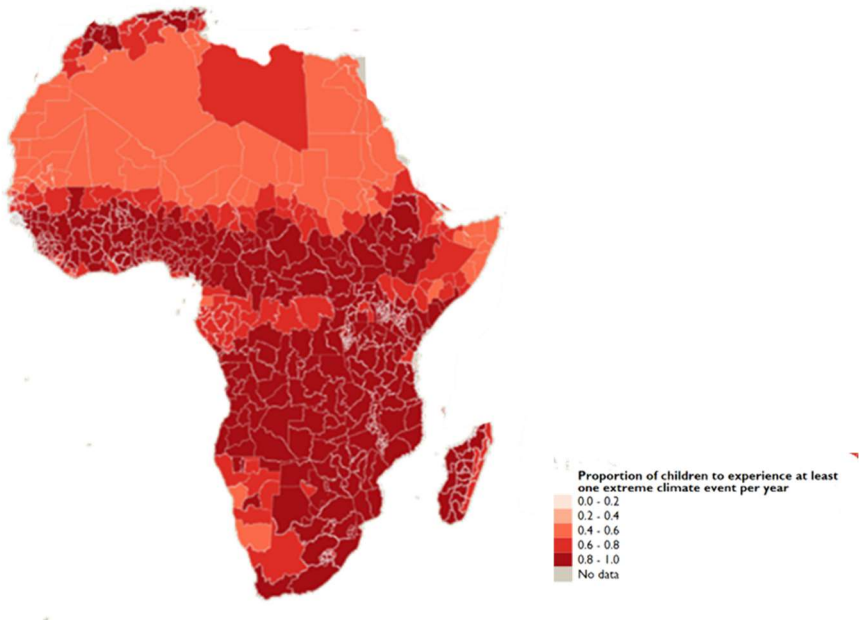
Part 2 Combining Child Poverty and Environmental Risks

2.1 Mapping environmental risks

The information for child poverty at the sub national level (at admin level one, at admin level two, and even in very small hexagons) can be combined with information about environmental risks. Two data sources for environmental risks are used. One of them is the one used to construct the UNICEF-developed Children's Climate Risk Index (CCRI). The second one made of data provided by the BCLIMATE group at the Vrije Universiteit Brussels. They estimated the risk of different extreme weather events across the globe. Their analysis uses a 0.5 x 0.5-degree resolution (which represents about 50x50km on the equator) to describe extreme climate events such as wildfires, crop failures, droughts, river floods, heatwaves, and tropical cyclones.

Both sources provide information about several different types of environmental risks such as drought, floods, cyclones, pollution, etc. According to these sources of data, almost every child in the world is exposed to major climate environmental hazards. In addition, children in low- and middle-income countries are often those bearing the brunt of worsening climate change and its impacts, despite contributing least to it. Globally, 4 out of 5 children face at least one extreme climate event per year. In Figure 5 the proportion of African children experiencing least one extreme climate event per year is portrayed.

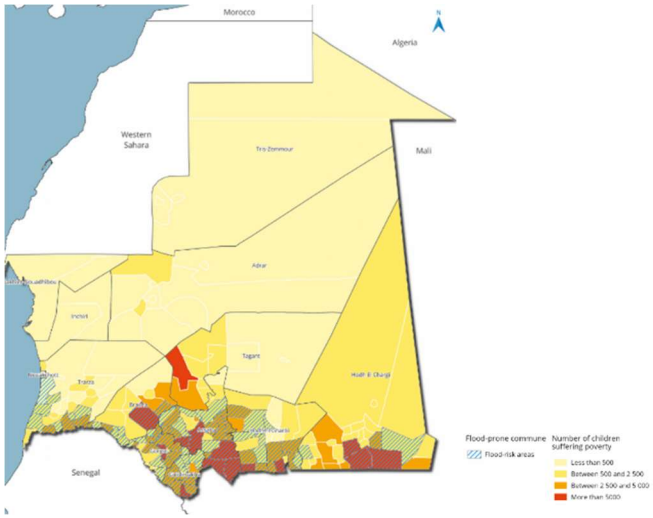
Figure 5 Children affected by extreme climate events, Africa



2.2 Environmental Risks and Child Poverty

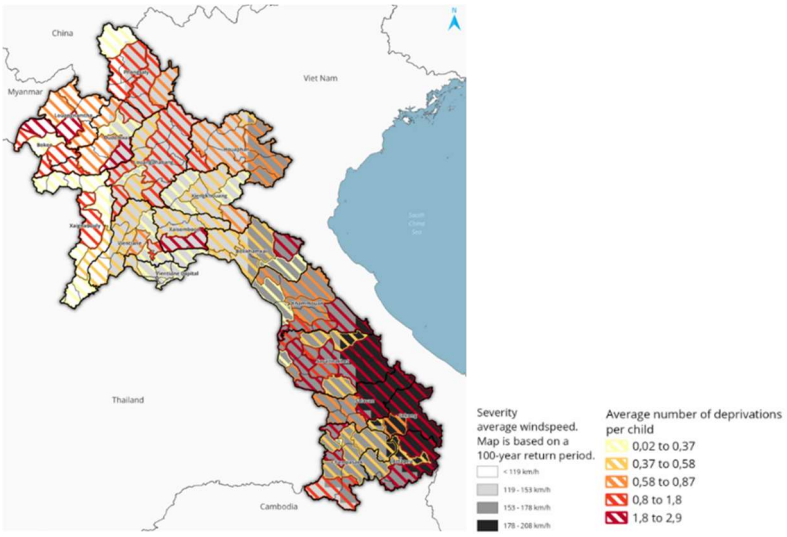
The information on environmental risk can be combined with the maps that were presented earlier for child poverty and various administrative and geopolitical levels. For example, in figure 6 the environmental risk of floods is combined with the information at admin level 2 that was obtained directly from a proper household survey in Mauritania. As it was discussed in Section 1, in most cases we do not have this type of representative data at admin level 2. Consequently, other options to combine maps of environmental risk and child poverty are explored.

Figure 6 Flood risks and child poverty at admin level 2 in Mauritania



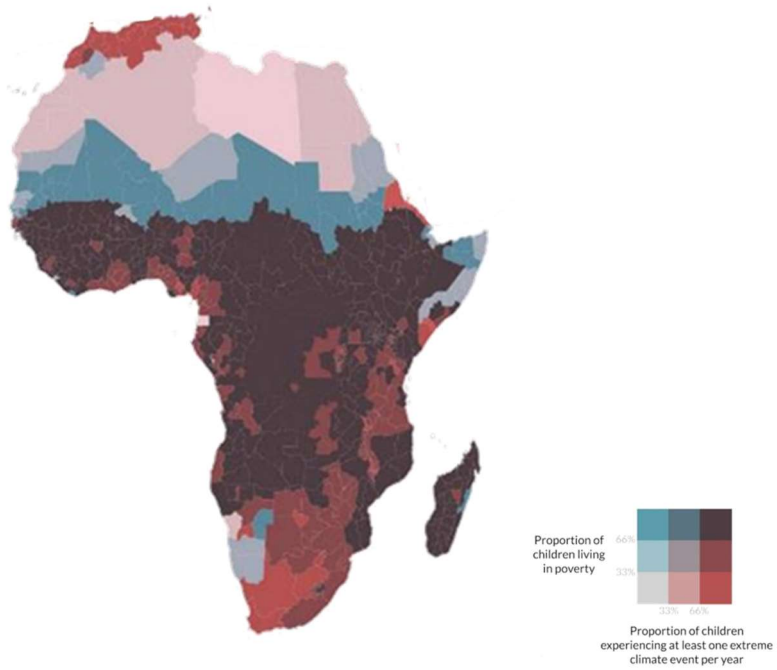
For the cases of Laos that was discussed in Section 1, information about environmental risk coming from the CCRI database was combined with projections using small area estimates of child poverty at admin level 2 (Figure 7). However, what is shown in the map is not the proportion of children in poverty but the average number of deprivation suffered by children (the depth of child poverty). This information is shown combined with the risk the risk of cyclones.

Figure 7 Risk if cyclones and depth of poverty at admin level 2 in Laos



The final example is the combination of the very finely detailed projections of child poverty for Africa (estimates for countries in Northern Africa Have also been included) which were seen earlier with the information on environmental risk coming from the BCLIMATE model. In this case, the larger the risk of the environment is shown in darker red shades. Darker shades of blue are used for higher and higher levels of child poverty (Figure 8).

Figure 8 Child poverty and climate risks in Africa



Concluding Remarks

In this brief article we have attempted to do three things first we have shown that it is possible do you use to obtain subnational estimates of child poverty using various methods. When household surveys already provide information at admin level one or admin level 2 this is very easy. However, as in most cases when this type of information is not available, we can use small area estimates when we have a census.

Secondly we have shown that we can go further than this level of geographic disaggregation to estimate and provide more granular projections. This can be done using machine learning methods which can use other types of data like night lights or roads or other geospatial data.

The third element in the article is the combination of these subnational maps of child poverty with environmental risks. These maps could be done not only for the proportion of children in poverty but also for measures of the depth and severity of child poverty, providing very valuable information for Disaster Risk Reduction planning.