Assessing Vulnerability to Food Insecurity in Mountain Areas of Ecuador: the Composite Vulnerability Indicator (CVI)

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ABSTRACT

Mountain communities are particularly vulnerable to food insecurity, as they live in isolated areas and fragile ecosystems characterized by poor soil quality and high risk of natural disasters. According to a study by Huddleston et al. (FAO, 2003) almost 250 million people vulnerable to food insecurity were living in mountainous areas of developing countries. A new study, started in 2014 by the Mountain Partnership, aimed to update those results: the present article is part of that study. Household survey data are used to assess the vulnerability to food insecurity of mountain peoples from Ecuador, where mountains cover about the 40% of the national territory and host almost half of the total population.

Using data from the 2011-12 Household Income and Expenditure Survey of Ecuador (ENGHUR) and matching them with the geographic location and elevation of each interviewed household, a profile of mountain peoples of Ecuador is drawn. Vulnerability to food insecurity by elevation class is then analysed through the new "Composite Vulnerability Indicator" (CVI), which takes into account the food security dimensions relevant at the household level. The final figure of people vulnerable to food insecurity is obtained assuming that, if a household is vulnerable under one dimension of food insecurity, it is vulnerable to food insecurity as a whole. Different patterns between urban and rural areas are investigated, in order to distinguish the differential drivers of vulnerability in the two areas, and social safety nets are finally taken into account.

Keywords: Mountain, Vulnerability, Food Security, Sustainable Development Goals

PAPER

1. Vulnerability to Food Insecurity in the frame of the Sustainable Development Goals

Mountain communities are particularly vulnerable to food insecurity, as they live in isolated areas and fragile ecosystems characterized by poor soil quality – shallow soils, steep slopes, moisture and temperature constraints – and high risk of natural disasters such as avalanches, landslides, earthquakes and flash floods. In addition, migrations to major urban centres and lowlands caused over time the erosion of traditional livelihood systems and an increase in food insecurity among those who remained (FAO 2002). At the household level, vulnerability to food insecurity is related to the (in)ability to cope with external shocks that impact food and nutrition security, and to come back to the original conditions once the shock is over.

Vulnerability, on the other hand, can be reduced by building resilience of both people and communities (UNDP 2014) through safety nets that guarantee a minimum acceptable level of household food security over time. They are policy measures adopted to prevent vulnerable people from falling under certain minimum levels of livelihood because of a shock. In the framework of the Sustainable Development Goals[1], targets 1.5[2], target 2.1[3] and target 13.1[4] point to the direction of reducing vulnerability to food insecurity and building the resilience of vulnerable people. Building resilience is also implicitly acknowledged in several other targets (ODI, 2015).

[1] A complete list of the SDGs and their targets is available at: https://sustainabledevelopment.un.org

[2] Target 1.5: "Build the resilience of the poor and those in vulnerable situations, and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disasters".

[3] Target 2.1: "By 2030 end hunger and ensure access by all people, in particular the poor and people in vulnerable situations including infants, to safe, nutritious and sufficient food all year round".

[4] Target 13.1: "Strengthen resilience and adaptive capacity to climate-related hazards and natural disasters in all countries".

According to a study by Huddleston et al. (FAO 2003) almost 250 million people vulnerable to food insecurity were living in mountainous areas of developing countries. The present article is part of a new study started in 2014 by the Mountain Partnership - and presented at COP 21, Paris, in 2015 - aiming to update the results obtained by Huddleston et al. To show the possibilities offered by household surveys in the analysis of vulnerability to food insecurity, household survey data are used to assess the vulnerability to food insecurity of mountain peoples of Ecuador, a country where mountains cover about the 40% of the national territory and host almost half of total population.

In order to estimate the number of mountain people vulnerable to food insecurity in Ecuador, a new "Composite Vulnerability Indicator" (CVI) is derived, which encompasses three food security dimensions relevant at the household level: physical access, economic access, and utilization. The final figure of vulnerable people is then tabulated by elevation class and by urban and rural areas of the country, as well as by ethnic group. Social safety nets are finally taken into account, obtaining the number of vulnerable people not benefiting from any form of aid.

Next sections are as follows: section 2 explains the newly developed methodology of the Composite Vulnerability Indicator; Section 3 describes the main characteristics of Ecuador people by elevation class, based on ENIGHUR 2011/12 data; Section 4 introduces the results of the application of the CVI to the Ecuador case study; Section 5, finally, concludes.

2. A new Methodology: the Composite Vulnerability Indicator (CVI)

Drawing from a global GIS-based analysis of mountain environments and populations, the study of Huddleston et al. (FAO, 2003) estimated that about 40% of mountain people across the world was vulnerable to food insecurity[5].

The 2015 FAO model (FAO, 2015) builds on the 2003 model adding more information to better capture the factors contributing to ensure food security in the specific mountain context[6]. The final figures show that nearly 330 million people, corresponding to 39% of the 2012 mountain population, with higher shares in Africa and Asia compared to Latin America.

To the aims of the present article, a new methodology is proposed which makes use of household survey data in place of spatial data. The unit of analysis is the household, whose vulnerability to food insecurity is analyzed under the lens of three food security dimensions[7]:

1. Physical access to food markets. For isolated households, access to food markets is made difficult by the poor conditions, or even the absence, of transport infrastructure. Consequently, isolated households' food security is more affected by extreme climatic conditions and environmental shocks. Moreover, the opportunities to market their own products are scarce, reducing the potential to improve their livelihoods and their economic access to additional food. Physical access to food is therefore a crucial issue for mountain population that has to be taken into account into the building of a composite vulnerability indicator. The present study considers access to improved ways of transportation like paved or cobbled roads as an indicator for the physical access dimension.
2. Economic access to food. Inadequate purchasing power is generally viewed as the main cause of food insecurity at the household level. As per survey data, the most reported causes of reductions in food expenditure were related with lack of good job opportunities and of health/job assistance: this combination is therefore used to identify vulnerable households under the perspective of the economic access dimension, along with the national poverty line8. In rural areas, on the other hand, land ownership is used as an indicator of household resilience9. Additional details are provided in paragraph 4.
3. Utilization. Sufficient energy and nutrient intake is the result of good care and feeding practices, food preparation, dietary diversity and intra-household distribution of food. When combined with good biological utilization of food consumed, this determines the nutritional status of individuals.

5 People were considered vulnerable in rural areas characterized by: cereal production less than 200 kg per person; low to medium bovine density index; closed forests and protected areas. 15% of urban mountain people was also considered vulnerable.

6 Yields were taken into account not only for the main cereal crops, but also for beans, cassava and potatoes. FAO Global Land Cover map was used to identify cultivated areas, while the Spatial Production Allocation Model (SPAM) provided information on the yield of the selected crops. Yields were then converted to calories available per hectare using the nutrient values adopted by the FAO Nutrition Division. A threshold of 1,370 calories and of 14 g of protein per person per day was taken as a threshold for vulnerability. For proteins, the production of meat and other products from cattle, sheep, goats and chicken was taken into account, rather than considering just bovine density. In urban areas, the World Bank "Poverty headcount ratio at urban poverty line" was averaged across developing countries, and the resulting value (23.6%) was used as the share of vulnerable people in mountain urban areas. People living in protected areas and closed forests, instead, are not considered vulnerable in this update.

7 A fourth dimension – Availability – is not taken into account, as it is more relevant at the country level, rather than at the household level. In addition, data on food availability are only available at the national level. A detailed description of the food security dimensions can be found in FAO, 2013.

Poor hygienic conditions and the consumption of contaminated water, on the other hand, are in most cases the main determinants of health problems that may impact food utilization. In this study, access to improved water sources and presence of improved sanitation facilities are used as indicators of the utilization dimension of food insecurity.

Each dimension described above is associated to an indicator that can assume values of either 0 or 1, with 1 indicating a vulnerable household under a particular dimension and 0 indicating a non-vulnerable one. The final Composite Vulnerability Indicator (CVI) takes into account the three dimensions in order to come up with a final figure of people vulnerable to food insecurity under the assumption that, if a household is vulnerable according to one dimension, it is vulnerable to food insecurity as a whole. This means that each dimension is given the same importance and is not assigned any weight.

It is to be noted, however, that the concept of vulnerability to food insecurity should not be confused with food insecurity itself. A household "vulnerable" to food insecurity, indeed, may be or may be not actually food insecure, depending on exogenous conditions and the presence of safety nets.

3. Ecuador Mountains: Main Characteristics

Ecuador is the most densely populated country of Latin America and the Caribbean, and one of the most "biodiverse" countries in the world. With a 2014 GDP of about US$100 billion and a population of almost 16 million, the World Bank ranks it in the "upper middle income" group. At the time of the household survey, however, food insecurity was still an issue for nearly 13 percent of its population, according to the 2015 SOFI report (FAO, 2015). The Ecuadorian territory can be roughly divided into three geographic regions: the Pacific coast in the west, characterized by plains and coastal hills; the Amazon in the East, covered by rainforest; and the Andes in the Centre. Galapagos Islands are also part of the national territory.

The Andes are the longest mountain range in the world and the highest range outside Asia; they are made up of parallel ranges interspersed with high plateaus crossing the country from north to south, and covering about 40 percent of the national territory. More than one third of the mountainous territory is characterized by an elevation of 2,500 meters or more; however, due to their proximity to the Equator and hence to the lack of harsh climatic conditions, elevated plateaus have been chosen throughout history as locations for major urban settlements: nearly half of the total population of Ecuador live in mountain areas. In particular, twelve out of the 38 cities with 50,000 or more inhabitants are located in elevation class three, which is also the class with the highest value of population density (table 1). The capital Quito, located at an elevation of 2 850 m (Elevation Class 3[10]), is an urban area with infrastructure and subsidiary activities uncommon to most of the mountain areas around the world.

Table 1 - Population density and number of major cities per elevation class

Elevation class (Kapos et al., 2000)	Population density (people/km^2)	Number of cities with 50,000+ inhabitants
Class 1 (> 4,500 m)	.	.
Class 2 (3,500 – 4,500 m)	1.8	0
Class 3 (2,500 – 3,500 m)	**163.9**	12
Class 4 (1,500 – 2,500 m)	45.6	2
Class 5 (1,000 – 1,500 m)	15.7	0
Class 6 (300 – 1,000 m)	30.8	2
Class 0 (0 – 300 m)	44.9	22

Credits: Author's elaborations on data from Population Census 2010; INEC data on elevations.

Household Income and Expenditure Surveys (HIES) are a rich source of information on household livelihood. Matching survey data with the location of each household and its elevation[11] allows us to derive household statistics by elevation class and to identify patterns of living conditions and exposure to food insecurity along the different elevation classes.

[8] The National Statistical Office of Ecuador (INEC) provides estimates of the national poverty line every 3 months by comparing per capita income with the consumption poverty line (línea de pobreza por consumo). All the individuals whose income is below poverty line are considered poor. As of December 2011, poverty line was set at $72.87 per month, corresponding to $2.43 per day. Using data of ENIGHUR 2011/12, per capita income of each interviewee was derived and deflated with base December 2011. Hence, while the original study used a urban poverty line averaged over the developing countries, here a national poverty line, specific for the country under analysis, is adopted.

[9] See for instance: Skerrat, 2013.

[10] To the aims of this article the UNEP-WCMC classification is used, described in Kapos et al. (2000).

[11] No data were available on the slope of each household location, which is an important element to determine the elevation classes 4, 5 and 6; the results shown here may therefore slightly differ from those that would be obtained in presence of that piece of information. 12 Encuesta Nacional de Ingresos y Gastos de Hogares Urbanos y Rurales. Since the survey was not designed to be representative at the level of the mountain versus non mountain areas, the expansion factors have been recomputed to derive statistics representative of the population of the different elevation classes, based on the 2010 Census data.

Data presented in this case study were gathered by the Ecuadorian National Statistics Institute (INEC) in 2011–12 through a Household Income and Expenditure Survey (ENIGHUR[12]) that involved almost 40 000 households and about 150 000 people. Matching survey data with the location and the corresponding elevation of each surveyed household allowed the study to derive household statistics by elevation class and to identify patterns in the change of living conditions and vulnerability to food insecurity in the different classes. Food security statistics were derived using the ADePT-FSM tool[13], jointly developed by FAO and the World Bank.

A main feature of Ecuador mountain areas is that, while elevation Classes 2 and 5 have a strong rural character, with low population density and low number of cities, Classes 3 and 4 show the opposite characteristics. Classes 2 and 5 have the lowest percentages of dwellings with improved water sources and sanitation facilities, a high dependency ratio and the highest percentage of women among the elevation classes, suggesting that many adult men leave their families in search of better employment and economic conditions. This preliminary conclusion is supported by the results of the survey's "self-evaluation of living standards" module, which included questions on the causes of household poverty. In answering those questions, "unemployment" and "lack of good jobs" were the causes most frequently reported by respondents of those elevation classes.

The more urbanized elevation classes 3 and 4, on the contrary, are characterized by higher per capita income and a lower percentage of people working in the primary sector. Class 3 has the highest percentage of people holding a University degree and the highest standards of water and sanitation facilities among the elevation classes, but is also characterized by higher income inequality and higher food prices.

The main agricultural products by elevation class are reported in table 2. In the highest elevation class, roots, tubers and pulses compensate for the lower availability of cereals. In particular, potato is the most frequent crop in class 2, preceded by maize in the immediately lower class and also by beans in class 4. At lower altitudes, cash crops are more frequently cultivated.

The average number of cattle per household is much lower at higher elevations than at lower altitudes, while the opposite is true for sheep. Consequently, the average value of animals per person is lower (table 2).

Table 2 - Main agricultural products (based on the frequency of positive answers by respondents) and average value of sold and own consumed animals by elevation class.

	Class 2 (3500-4500)	Class 3 (2500-3500)	Class 4 (1500-2500)	Class 5 (1000-1500)	Class 6 (300-1000)	Class 0 (0-300)
Main agricultural products (ranking)	1. Potato 2. Onion 3. Broad bean 4. Barley	1. Maize 2. Potato 3. Beans 4. Broad bean 5. Alfalfa	1. Maize 2. Beans 3. Potato 4. Yucca 5. Banana	1. Maize 2. Yucca 3. Plantain 4. Beans 5. Coffee	1. Plantain 2. Yucca 3. Maize 4. Cacao 5. Potato	1. Maize 2. Plantain 3. Cacao 4. Rice 5. Yucca
Average total value of sold/own-consumed animals per hh ($)	**138**	170	223	**400**	361	283

Source: author's elaborations on ENIGHUR 2011-12 data; INEC data on elevations.

The food group "cereals and products" contribute the most to the dietary energy and protein consumption in all elevation classes, with white rice being the biggest energy contributor among the single food items. However, the share of energy derived from cereals on total dietary energy is lower in mountains than in the country as a whole, while the share of roots, tubers and pulses is higher. In quantitative terms, milk is the most consumed food item in Classes 1 through 5, while in Class 6 and in lowlands white rice is followed by green plantains. Meat and meat products contribution in total dietary energy, finally, are substantially lower in rural classes 2 and 5 if compared to more urbanized classes 3 and 4.

Households in the rural Classes 2 and 5 spend the highest income portion on food and are characterized by the lowest dietary diversity, measured in terms of total number of food items reported during the interview. The share of dietary energy obtained from own-produced food on total dietary energy in rural Class 5 is higher than in all other classes. The mostly urban Class 3, on the other hand, obtained its highest share of calories from purchased food.

12 Encuesta Nacional de Ingresos y Gastos de Hogares Urbanos y Rurales. Since the survey was not designed to be representative at the level of the mountain versus non mountain areas, the expansion factors have been recomputed to derive statistics representative of the population of the different elevation classes, based on the 2010 Census data.

13 Available at: http://www.fao.org/economic/ess/ess-fs/fs-methods/adept-fsn/en/

As to the food consumed away from home, an important component is represented by food received free by children at school. School feeding programs are aimed at addressing the issue of food insecurity in the more vulnerable areas; the higher shares of children receiving food at school are observed in rural elevation classes 2 and 5, although in absolute terms the greatest number of children receiving food is found in the urbanized class 3.

4. Vulnerability to food insecurity in Ecuador

The first question of the ENIGHUR 2011-12 questionnaire asks about the "main access" to the dwelling. This piece of information was used to derive an indicator reflecting the "physical access" dimension of food security. For values of the variable "main access to dwelling" ranging from 1 to 3[14] the household was categorized as non-vulnerable under the physical access dimension, while it was considered vulnerable for values of the variable ranging from 4 to 6[15]. The "Physical Access" Vulnerability indicator can therefore assume two values: 1 for vulnerable households and 0 for non-vulnerable households. Main results are shown in table 3; household weights[16] were used to expand the results to the entire population. About 650,000 mountain people, corresponding to 9% of mountain population, have poor or no access to improved roads and hence difficulties in accessing markets, against a share of 6% in lowlands. The percentage of household with poor or no access to roads is higher in elevation classes 2 and 5 although, in absolute terms, the highest number of people with poor access to markets is found in class 3. Clearly, isolation is a typical rural problem: while in urban areas the share of "isolated" mountain people ranges between 1 and 3 percent, in rural areas twenty to thirty percent of the population can be considered isolated (table 3).

Table 3 - Vulnerable people by elevation class and area - Physical Access dimension

	Isolated people (National, %)	Isolated people (National, 000)	Isolated people (By area, %)	Isolated people (By area, 000)
Elev. Class 2 (3500-4500)	32	9	Urban: -	Urban: -
			Rural: 32	Rural: 9
Elev. Class 3 (2500-3500)	7	333	Urban: 1	Urban: 39
			Rural: 18	Rural: 294
Elev. Class 4 (1500-2500)	13	144	Urban: 3	Urban: 20
			Rural: 24	Rural: 125
Elev. Class 5 (1000-1500)	22	55	Urban: 2	Urban: 1
			Rural: 27	Rural: 55
Elev. Class 6 (300-1000)	11	106	Urban: 2	Urban: 9
			Rural: 21	Rural: 97
Mountain areas	**9**	**648**	**Urban: 2**	**Urban: 69**
			Rural: 21	**Rural: 579**
Elev. Class 0 (0-300)	6	425	Urban: 1	Urban: 46
			Rural: 19	Rural: 379
Ecuador	**7**	**1,072**	**Urban: 1**	**Urban:114**
			Rural: 20	**Rural: 958**

Source: author's elaborations on ENIGHUR 2011-12 data; INEC data on elevation and population.

Reducing food expenditures is one of the possible coping strategies adopted by vulnerable households in a period of food/market crisis or after being hit by an external shock. The share of households adopting such strategy can therefore be used as a benchmark of vulnerability at the household level. The adoption of such coping strategy was surveyed by ENIGHUR over a period of one year preceding the interview. About 1.6 million mountain people[17] reduced their food expenditures, corresponding to about 23% of total mountain population[18]. About 1 million of these vulnerable people are located in elevation class 3, although the highest share of population that reduced food expenditures is located in elevation class 2 (about 40%).

The main causes behind the food expenditure reductions, as reported by the interviewees, were:

1. Lack of more rewarding job positions for the household head;
2. Death/illness of a household member;
3. Job loss (in urban areas) and failure of family business (in rural areas).

Based on the answers of respondents on the causes of reduced food consumption over the previous year, households are identified as „vulnerable" under the Economic Access dimension if the following situations occurs (see table 4):

[14] Corresponding to (respectively): 1: Highway/paved road; 2: Cobbled Road; 3: Road (not paved).
[15] Corresponding to (respectively): 4: Path; 5: River/sea/lake; 6: Other.
[16] See note 13.
[17] Without considering people of the highest income quintile. As explained in note 13, all the figures on population are referred to the 2010 Census of Population.
[18] In mountain urban areas 20% of people reduced food expenditures, while in rural areas the share was 26%. At national level, around 4 million people - 28% of national population - reduced food expenditures in the previous year.

a) In rural areas: per capita income below national poverty line, and the household does not own land nor it benefits of any health/job insurance scheme[19].

b) In urban areas: per capita income below poverty line or, for the lowest two income quintiles, households not covered by any kind of health or job insurance.

Results are displayed in table 4 below.

As to the Utilization dimension, finally, the following water sources have been considered „unimproved": truck delivery; well; river, ditch; other sources; on the other hand, "public aqueduct"; "public tank, fountain"; and "pipeline – untreated water" were considered as improved water sources. For the sanitation facilities, all the different types of "toilet" were considered „improved", while "latrine" and "no sanitation facility" were considered as indicators of vulnerability.

Main results are shown in tables 5 and 6. Eight percent of mountain population, corresponding to about 0.5 million people, lack of improved water sources (table 5): this result reflects a better condition of mountain versus lowland populations in Ecuador, as lack of access to improved water sources mainly regards rural areas. As to sanitation, about 0.6 million of mountain people (8%) lack of improved sanitation facilities, against a national average of 10% (table 5).

Thus, also for sanitation facilities the situation in highlands is better than in lowlands, although in the rural elevation classes 2 and 5 about one quarter of the population do not have access to improved sanitation facilities. Similarly to the previous indicator, indeed, the lowest standards are observed in rural areas, where 19% of the population is vulnerable under this dimension, while only 1% of urban mountain population lack of improved sanitation facilities.

Table 4 - Vulnerable people by elevation class and area - Economic Access dimension

	Poverty/no insurance (% population)	Poverty/no insurance (000 people)	Poverty/no insurance (% population)	Poverty/no insurance (000 people)
Elev. Class 2 (3500-4500)	51	14	Urban: -	Urban: -
			Rural: 51	Rural: 14
Elev. Class 3 (2500-3500)	17	775	Urban: 17	Urban: 506
			Rural: 17	Rural: 269
Elev. Class 4 (1500-2500)	18	199	Urban: 23	Urban: 134
			Rural: 12	Rural: 64
Elev. Class 5 (1000-1500)	24	59	Urban: 36	Urban: 18
			Rural: 20	Rural: 41
Elev. Class 6 (300-1000)	28	272	Urban: 32	Urban: 163
			Rural: 24	Rural: 109
Mountain areas	**19**	**1,319**	**Urban: 20**	**Urban: 821**
			Rural: 18	**Rural: 498**
Elev. Class 0 (0-300)	24	1,801	Urban: 27	Urban: 1,530
			Rural: 14	Rural: 271
Ecuador	**22**	**3,121**	**Urban: 24**	**Urban:2,352**
			Rural: 16	**Rural: 769**

Source: author's elaborations on ENIGHUR 2011-12 data; INEC data on elevation and population.

Table 5 - Vulnerable people by elevation class and area according to the Utilization dimension (1)

	Unimproved water sources (% population)	Unimproved water sources (000 people)	Unimproved water sources (% population)	Unimproved water sources (000 people)
Elev. Class 2 (3500-4500)	16	5	Urban: -	Urban: -
			Rural: 16	Rural: 5
Elev. Class 3 (2500-3500)	3	153	Urban: 1	Urban: 38
			Rural: 7	Rural: 115
Elev. Class 4 (1500-2500)	4	48	Urban: 1	Urban: 4
			Rural: 8	Rural: 44
Elev. Class 5 (1000-1500)	11	28	Urban: 1	Urban: 1
			Rural: 13	Rural: 27
Elev. Class 6 (300-1000)	33	314	Urban: 25	Urban: 126
			Rural: 42	Rural: 188
Mountain areas	**8**	**547**	**Urban: 4**	**Urban: 169**
			Rural: 13	**Rural: 379**
Elev. Class 0 (0-300)	28	2,155	Urban: 16	Urban: 878
			Rural: 65	Rural: 1,277
Ecuador	**19**	**2,702**	**Urban: 11**	**Urban: 1,046**
			Rural: 35	**Rural: 1,656**

Source: author's elaborations on ENIGHUR 2011-12 data; INEC data on elevation and population.

[19] The security schemes taken into account are: IESS Seguro General; IESS Seguro Voluntario; IESS Seguro Campesino; seguro del ISSFA o ISSPOL; Seguro de Salud privado (con o sin hospitalización); Seguros Municipales de Consejos Provinsiales; Seguro M.S.P.

Table 6 - Vulnerable people by elevation class and area according to the Utilization dimension (2)

	Unimproved sanitation (% population)	Unimproved sanitation (000 people)	Unimproved sanitation (% population)	Unimproved sanitation (000 people)
Elev. Class 2 (3500-4500)	27	7	Urban: - Rural: 27	Urban: - Rural: 7
Elev. Class 3 (2500-3500)	6	260	Urban: 1 Rural: 15	Urban: 21 Rural: 239
Elev. Class 4 (1500-2500)	9	102	Urban: 1 Rural: 18	Urban: 7 Rural: 95
Elev. Class 5 (1000-1500)	26	64	Urban: 2 Rural: 31	Urban: 1 Rural: 63
Elev. Class 6 (300-1000)	14	135	Urban: 2 Rural: 28	Urban: 8 Rural: 127
Mountain areas	**8**	**569**	**Urban: 1** **Rural: 19**	**Urban: 37** **Rural: 532**
Elev. Class 0 (0-300)	11	844	Urban: 5 Rural: 29	Urban: 277 Rural: 567
Ecuador	**10**	**1,413**	**Urban: 3** **Rural: 23**	**Urban: 314** **Rural: 1,100**

Source: author's elaborations on ENIGHUR 2011-12 data; INEC data on elevation and population.

Once created the indicators of the single dimensions, CVI is derived as follows:

$CVI = \max (PA, EA, U_W, U_S)$

Where: PA is the indicator of the Physical Access dimension;

EA is the indicator of the Economic Access dimension;

U_W is the indicator of the Utilization dimension related with access to safe sources of drinking water;

U_S is the indicator of the Utilization dimension related with access to improved sanitation facilities.

As previously discussed, each of the above mentioned indicators can assume values of 0 and 1. Accordingly, the CVI is equal to zero when all the indicators are equal to zero, indicating a situation where a given household is not vulnerable to food insecurity, and is equal to 1 when at least one of the indicators is equal to 1, i.e. when a household is vulnerable under one of the food security dimensions.

According to this **Composite Vulnerability Indicator (CVI)**, about 5.8 million people in Ecuador are vulnerable to food insecurity, representing the 40% of national population[20] (table 7).

In mountain areas, the number of vulnerable people is 2.1 million, corresponding to 31% of mountain population. Hence, vulnerability to food insecurity is more severe in Ecuadorian lowlands than in mountain areas. As explained in previous sections, this is mainly due to climatic conditions that favor the presence of mountain urban areas served by many infrastructures, which does not represent a common situation in mountain areas all over the world.

The elevation classes with the higher prevalence of vulnerability are the mostly rural classes 2 and 5, although more than half of the mountain vulnerable people are located in the urbanized class 3. About 19 percent of mountain people have insufficient economic access to food (table 4), making of **economic access** the food security dimension that contributes the most to the final figure of vulnerable people in Ecuadorean mountain areas.

Table 7 - Vulnerable people by elevation class in Ecuador estimated with the Composite Vulnerability Indicator (CVI)

Elevation	Vulnerable People, National (%)	Vulnerable People, National (000)	Vulnerable People, by area (%)	Vulnerable People, by area (000)
Elev. Class 2 (3500-4500)	73	20	Rural: 73	Rural: 20
Elev. Class 3 (2500-3500)	26	1,162	Urban: 19 Rural: 38	Urban: 552 Rural: 610
Elev. Class 4 (1500-2500)	30	334	Urban: 24 Rural: 36	Urban: 145 Rural: 189
Elev. Class 5 (1000-1500)	48	121	Urban: 38 Rural: 51	Urban: 19 Rural: 102
Elev. Class 6 (300-1000)	53	509	Urban: 46 Rural: 61	Urban: 232 Rural: 277
Mountain areas	**31**	**2,147**	Urban: **23** Rural: **43**	Urban: **949** Rural: **1,198**
Elev. Class 0 (0-300)	48	3,627	Urban: 39 Rural: 74	Urban: 2,171 Rural: 1,457
Ecuador	**40**	**5,774**	Urban: 32 Rural: 55	Urban: **3,119** Rural: **2,655**

Source: author's elaborations on ENIGHUR 2011-12 data; INEC data on elevation and population.

[20] See notes 13 and 18: population figures refer to the 2010 Population census data.

In mountain urban areas, the share of people vulnerable to food insecurity is 23%, mainly due to high income inequality, higher prices of food, and lack of job or health assistance: a percentage substantially higher than the value estimated by Huddleston et al. for urban areas, but in line with the World Bank indicator used for the study update. In mountain rural areas, on the other hand, vulnerability to food insecurity affects 43% of the population. Indeed, as discussed in the previous sections, isolation, poor quality of water and sanitation facilities, and lack of good job opportunities mainly impact rural mountain areas. Migration in rapidly expanding mountain urban areas, on the other hand, has determined poverty conditions for a substantial number of urban people.

Table 8 below compares the results obtained with the new CVI approach against the results obtained with: the spatial approach of the 2015 update; the FAO indicator "Prevalence of undernourishment" (PoU); and the share of people declaring to have reduced food consumption in the year prior to the survey (ENIGHUR 2011/12 data). At the national level, while 13% of people are estimated to have a caloric consumption below the minimum level for a healthy life, 28% of total population had to reduce food consumption in the year prior to the survey, and 40% are considered vulnerable according to the CVI approach. These results confirm that being vulnerable to food insecurity does not necessarily mean that a particular household is actually food insecure: only about one third of the vulnerable people is below the threshold of minimum dietary energy consumption, and only two thirds of the vulnerable people actually had to reduce food consumption in some way. As to mountain areas, CVI results are in line with those obtained through the spatial approach considering the LAC region, and are slightly higher than the results obtained for the South America sub-region.

Table 8 - Comparison of food security indicators in Ecuador

	National	Mountain areas
Prevalence of undernourishment[21] (PoU, 2010-12)	13%	.
Reduced food consumption (benchmark; ENIGHUR 2011/12)	28%	23%
Vulnerability to Food Insecurity (Spatial approach)	.	31% (LAC[1]) 27% (S.A.[2])
Vulnerability to Food Insecurity (CVI approach)	40%	31%

1: Latin America and Caribbean (Including: Caribbean, Central America and South America).
2: South America

Based on self-declared ethnicity, the two groups with the lowest share of vulnerable people (about 35 percent) are *Mestizo* and *Blanco*, which account for about 75 percent of the total population.

Among indigenous people, which account for about 7% of total population, vulnerability to food insecurity is about 60 percent, and among other minorities[22], the prevalence is higher than the national average as well. Indigenous people - almost 1 million - are mostly located in mountain areas, where they account for about 13 percent of the mountain population, and in rural areas. Vulnerability therefore shows differential patterns among different ethnic communities.

Vulnerability can be reduced by building resilience of both people and communities (UNDP 2014). Social safety nets are an important tool in order to guarantee a minimum acceptable level of household food security over time. They are policy measures adopted to prevent vulnerable people from falling under certain minimum levels of livelihood as a consequence of a shock, allowing households to stay food secure over time. To the aims of this study, a household is benefiting of social safety nets if it benefits of at least one of the following:

- Free breakfast at school (for children aged 5-14);

- Free lunch at school (for children aged 5-14);

- Received "Mi papilla"[23] (for children aged less than 5);

- Received food bags and/or fortified food and/or food education;

- Have been visited by a health care team.

Out of the 2.1 million vulnerable people living in Ecuadorian mountain areas, about 1 million belong to households benefiting from some form of social safety nets. This leaves out about 1.1 million mountain people who are vulnerable to food insecurity and do not benefit from any social safety nets, corresponding to 16 percent of total mountain population.

21 The methodology to estimate the prevalence of undernourishment can be found in SOFI 2015 (FAO, 2015).
22 *Negro, Mulato and Montubio.*
23 Complementary food with high nutrient density.

Again, in mountain areas the share of vulnerable people not benefiting of safety nets is lower than in lowland, with the higher shares observed in classes 2 and 6, and the higher share of people benefiting of safety nets living in class 5 (table 9).

Table 9 - Social safety nets and vulnerable people by elevation class

	Number of vulnerable people (000)	Vulnerable people benefiting of social safety nets (000)	Vulnerable people benefiting of social safety nets (%)	Vulnerable people not benefiting of social safety nets (000)	Vulnerable people not benefiting of social safety nets (% on TOTAL population of the class)
Elev. Class 2 (3500-4500)	20	13	64	7	26
Elev. Class 3 (2500-3500)	1,162	511	44	651	14
Elev. Class 4 (1500-2500)	334	170	51	164	15
Elev. Class 5 (1000-1500)	121	78	65	42	17
Elev. Class 6 (300-1000)	509	254	50	255	27
Mountain areas	**2,147**	**1,027**	**48**	**1,119**	**16**
Elev. Class 0 (0-300)	3,627	1,692	47	1,936	26
Ecuador	**5,774**	**2,719**	**47**	**3,055**	**21**

Source: author's elaborations using ENIGHUR 2011-12 data, and INEC data on elevations.

5. Conclusions

The present study introduces the use of household survey data in the analysis of vulnerability to food insecurity in mountain areas and a new composite indicator called Composite Vulnerability Indicator (CVI). While the spatial approach is mainly based on the presence of given crops and farm animals, and hence on the availability dimension of food security, the new approach takes into account the dimensions of physical and economic access to food, and utilization, which may affect stability of a household"s food security over time.

Based on indicators reflecting the dimensions of food security more relevant at the household level and using ENIGHUR 2011/12 survey data, around 31% of Ecuadorian mountain people - corresponding to 2.1 million people - are estimated to be vulnerable to food insecurity. Two different patterns of vulnerability to food insecurity can be identified in mountain areas of Ecuador: one of the rural areas and one of the urban areas. While in rural contexts vulnerability is often linked to isolation, poor water and sanitation infrastructures, and lack of good job and education opportunities - which in turn causes outmigration to urban areas - in urban settings vulnerability to food insecurity is driven by high income inequality and higher prices of food. In addition to that, the lack of any job or health assistance causes the inability of a household to cope with food related or economic shocks. The majority of vulnerable mountain people live in rural areas, although vulnerability to food insecurity also interests the 23% of the urban mountain population, corresponding to almost 1 million people. This is the reason why in Ecuador, as opposed to many other developing countries, mountain areas are better-off compared to lowlands, because they host densely populated urban areas served by infrastructure generally not available in mountain areas of other developing countries. Almost half of mountain vulnerable people belong to household benefiting from school feeding or other nutrition and health care programs. This means that about 16% of total mountain people, besides being vulnerable to food insecurity, do not benefit from any social safety net, and is therefore at a greater risk in case of a food or market-related shock. This new approach has the advantage of allowing for a precise characterization of vulnerable areas, describing where each of the different vulnerability factors play a major role not only at regional and sub-regional level, but also at national and sub-national level. It also allows to understand who the most vulnerable people are, and for a precise localization of vulnerability hotspots. This, in turn, has a huge potential to help target and facilitate policy interventions.

The results obtained with the new CVI methodology are consistent with those obtained with existing FAO and World Bank methodologies, encouraging to apply this new methodology to other country of different regions and income level[24], provided survey data and geographic location of the interviewed households are available for the analysis.

[24] Another case study, of Malawi, has already been published in the same FAO 2015 publication, although other countries should be analysed to test the robustness of the CVI methodology.

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