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Nexus between Water, Energy Poverty and Food safety, in urban areas of a developing country: Colombian case.

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Abstract

According to the Sustainable Development Goals (SDGs) put forth by the United Nations (UN), the main challenges facing humanity approaching to the year 2030 are as follows: no poverty; zero hunger; clean water and sanitation; affordable and clean energy; and climate action among others (United Nations, 2015). To achieve these goals is necessary to know the Nexus between Water, Energy and Food known in the literature as WEF Nexus. This paper attempts to establish relationships between Water (sanitation and potable water), Energy (modern cooking fuels), and Food (food scarcity). The results are based on The Quality of Life National Survey (QLNS) collected by the National Administrative Department of Statistics (DANE, 2017).

Keywords: WEF Nexus; Quality of Life National Survey; Sustainable Development Goals.

Introduction

According to the Sustainable Development Goals (SDGs) put forth by the United Nations (UN, 2015), the main challenges related to the development of humankind are: No poverty; Zero hunger; Clean water and Sanitation; and Affordable and Clean Energy. All these SGDs are interlinked (Hoff, 2011). The term WEF Nexus has gained importance since 2008 by the World Economic Forum (Blanke, 2008). The three-node Nexus has several approaches such as: (i) water-energy-food; (ii) water-energy-climate; (iii) land use-climate change-energy; and (iv) environment-water-climate (Al-Saidi and Elagib 2017; Dale et al., 2011; Groenfeldt, 2010).

Recent literature addresses topics like water-energy Nexus in urban areas, the objective is to minimize water and energy consumption and achieve maximum efficiency in end-use. In urban areas the relationship consist in urbanization, supply and demand, and population growth (Ahmad et al., 2020). The Water-Energy and Food consumption is also important node of study. The research question is: how water-energy in the food system is assessed. The use of water and energy in the urban food system in low GDP countries are related to processing and distribution: preparation and cooking (Islam et al., 2020). The COVID-19 pandemic brought disruptive consequences in WEF Nexus mainly in low and middle income countries, different aspects like: sanitation; drinking water; affordable and clean energy; and food sufficiency. These factors shows the crosslinking between COVID-19 and the WEF Nexus (Al-Saidi and Hussein, 2021). The WEF Nexus node can be focused into three categories: internal relationship analysis; external impact analysis; and evaluation of the coupled system (Zhang et al., 2018).

Table 1 presents socioeconomic indicators of Colombia related to: Gross Domestic Product (GDP); poverty and urban population, according to World Bank (WB, 2021). This paper tries to establish mutual relationships and identifying the driving factors between economic and social conditions in urban areas of Colombia with respect to WEF Nexus.

Table 1. Energy and socioeconomic indicators in Colombia, data from [10]

Variable	2010	2017
GDP (constant 2011 - USD) - Billion	286.5	372.7
GDP per capita, PPP (constant 2017 international USD)	11,823	14,219
Urban population (% of total population)	77.9	80.4
Poverty gap at 1.90 USD a day (2011 PPP) (%)	2.8	1.6
Access to rural electricity (% of total population, on interconnected areas)	96.7	98.5
Gini Index	54.6	49.7
Population living in slums (% of urban population)	14.3	----

Methods

The proposed methodology is presented in the Figure 1, related to WEF Urban Nexus. This approach seeks reponses between unilateral and mutual relationships. The mutual relationship includes: Water (potable water and sanitation); Energy Poverty (cooking fuels and electricity access); and Food Security (food scarcity). The unilateral relationships is focused between: water and income; energy poverty and income; and food security and income. The analysis applied in this paper are based on centered relationships in low income, middle income and high income on households.

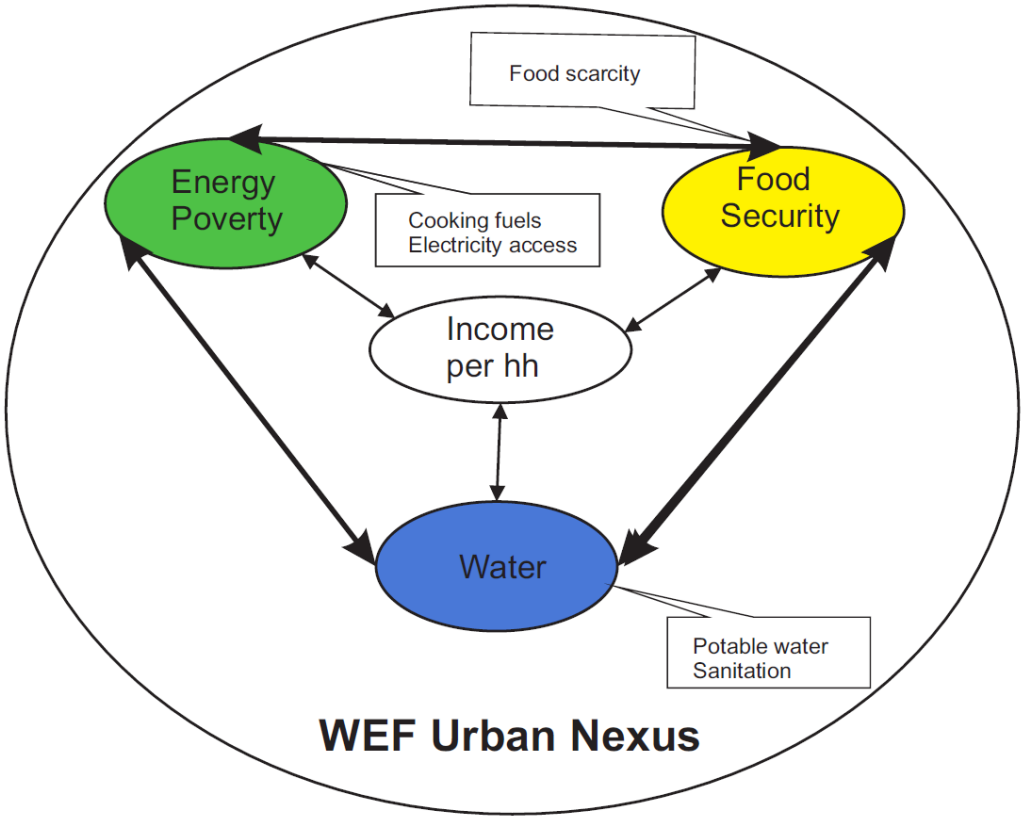

Figure 1. proposal methodology for WEF Urban Nexus in a developing country.

The DANE collected several surveys related to measure the living standards and characterized the population in urban, municipal townships, and rural areas of Colombia covering a national representative sample. These surveys was designed and executed following the methodology of living standards measurements study (Grosh and Glewwe, 1995) which was promoted by the World Bank and conducted by the DANE since the mid-1990s.

The data used in this study comprises solely urban areas of Colombia. In the database it was applied a preprocessing of data, transforming raw data into an understandable format without missing values or inconsistencies, including data cleaning, dimensionality reduction and handling of imbalanced data sets.

The data used in this study taken from the QLNS 2010 (DANE, 2010) corresponds to 8,974 households and the QLNS 2017 (DANE, 2017) corresponds to 8,612 households in Colombia. These database contains information related to: kind and features of the households; goods and services; consumption of goods; health; education level; workforce; energy en-user; food safety and others related data.

The specific information used in this paper for each household is described as follows:

(i). Water: Potable water (binary) and sanitation (binary).
(ii). Energy poverty: Type of fuel used for cooking (Categorical).
(iii). Food: safety: Food scarcity (Binary).
(iv). Another parameters: Income that corresponds to the income per household, expressed in constant dollars (USD) of 2018.

Results

The first analysis presents unilateral relationships between: potable water and sanitation; cooking fuels used in urban areas; and food scarcity; all this parameters with respect to the income of urban areas between 2010 and 2017 according to QLNSs. Figure 2 shows the quantity of population with potable water and sanitation was 89% in 2010, with respect to 2017 was 93% of households had potable water. Whereas with respect to sanitation in 2010 was 85% of households counted with regard to sanitation and was 86% in 2017 86%.

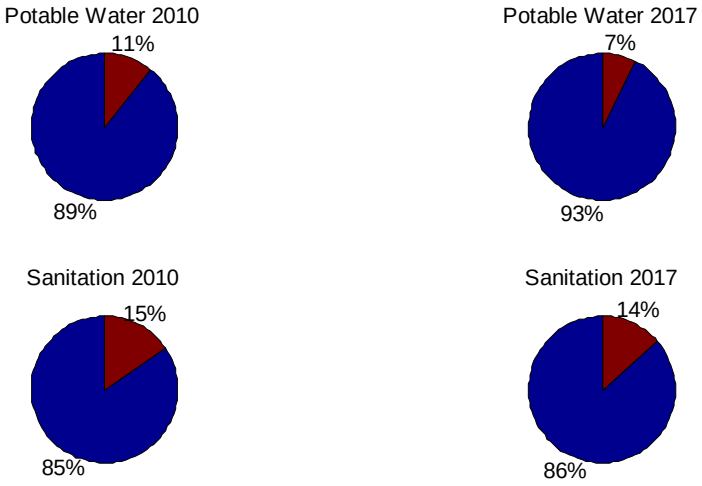

Figure 2. Potable water and sanitation (2010 – 2017).

Cooking fuels are classified into three groups: modern, transitions and solid fuels
(Karimu, 2015; Schlag et al., 2008; Van der Kroon et al., 2013). According to Figure 3 presents the cooking fuels that are most used in Colombia based on NQSLs 2010 and 2017. With respect to modern fuels in the urban sample of 2010, 48.6% of the respondents used Natural Gas (NG) and 4.9% used electricity. The

transition fuels, 43.4% used Liquefied Petroleum Gas (LPG) and 3.1% includes the rest of fuels. In the urban sample of 2017 related to modern fuels, 63.1% used NG; and 2% used electricity. The transitions fuels as LPG corresponds to 33.4% and the rest of fuels are 1.5%.

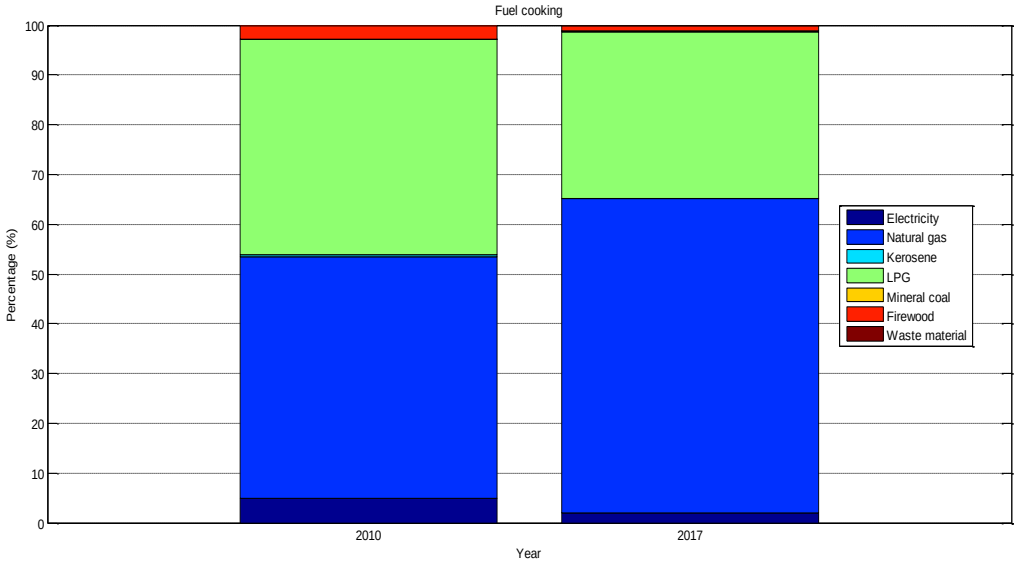

Figure 3. Evolution main source for cooking (2010-2017)

In terms of food safety, the result present that there was a lack of food of 13.4% in the sample of 2017. Figure 4 presents a monthly boxplot related to the income distribution in urban Colombia between the years 2010 and 2017. The box plot contains five type of information: minimum, first quartile, median, third quartile, and maximum. Between the first and third quartile we have the median value. For 2010 the first quartile corresponds to 153 USD, the median corresponds to 273 USD and the third quartile is 1057 USD. For 2017 the first quartile corresponds to 260 USD, the median corresponds to 472 USD and the third quartile is 850 USD.

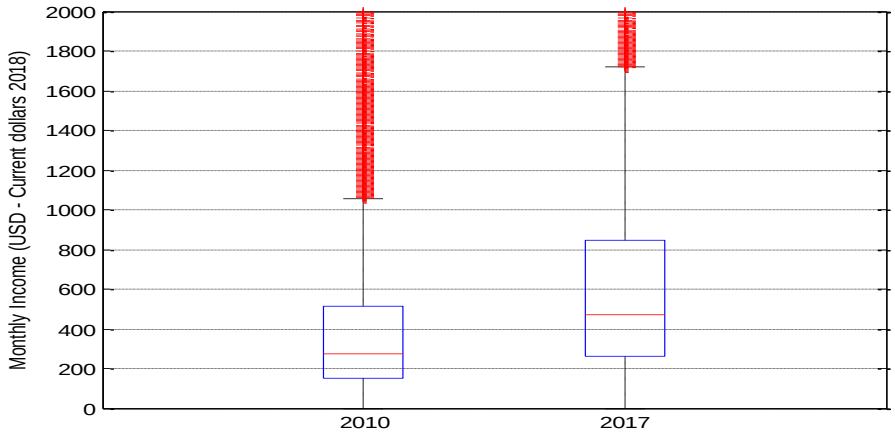

Figure 4. Distribution of income in the NQSLs 2010 and 2017.

Detailed results are presented in the Figure 5 analizing different socioeconomic status of urban population of Colombia. The socioeconomic status are divided into: low status (1,2); middle status (3,4); and high status (5,6) and slum nighborhoods that are no officially classified. The income is monthly in constant 2018 dollars. And these results shows the percentage of: Water (sanitation and potable water); Energy (use of modern cooking fuels); and Food (food scarcity). The relationships between the different socioeconomic status allow to visualize their differences into WEF Urban Nexus.

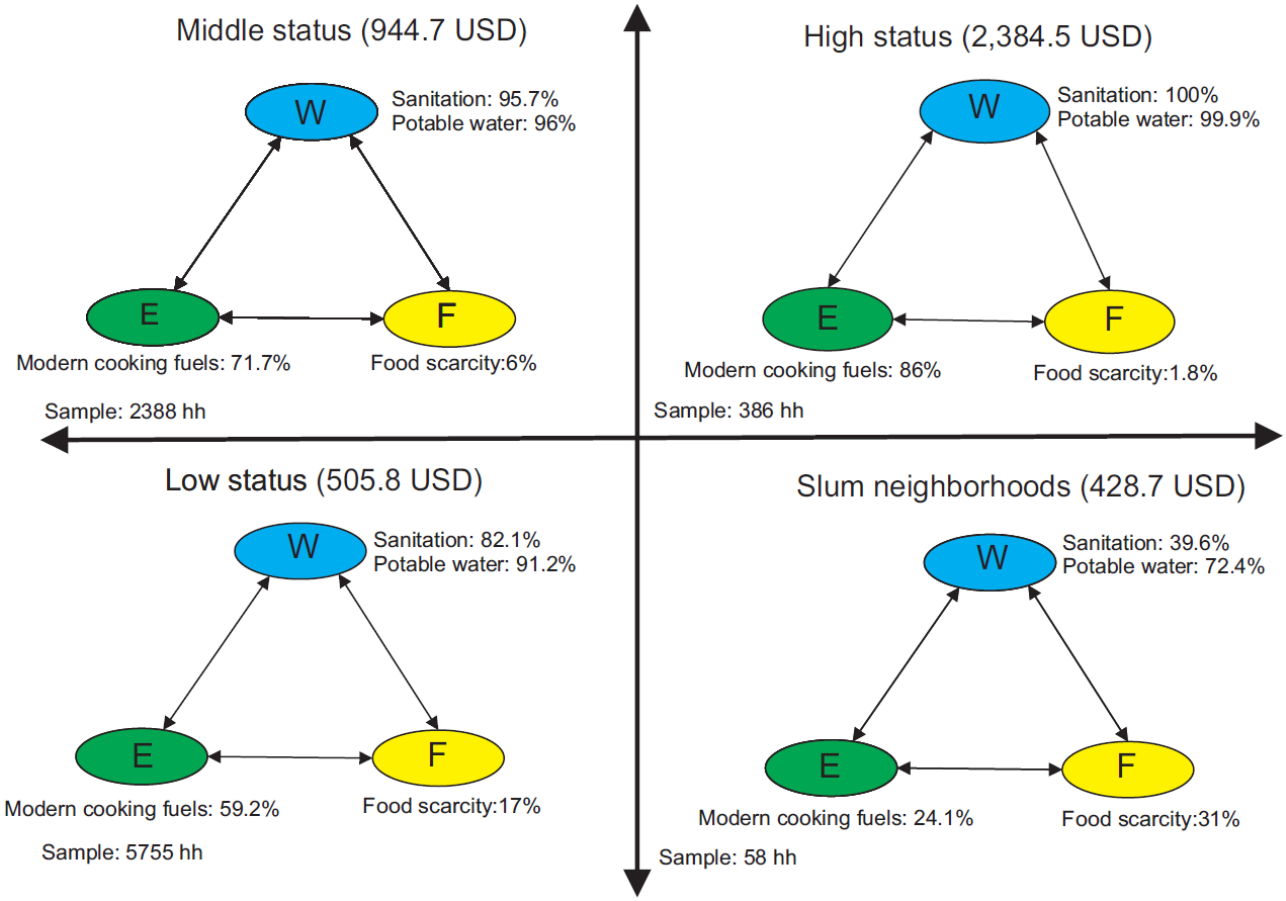

Figure 5. Results of WEF Urban Nexus in Colombia in households (NQSL 2017).

Conclusions

The literature in the Nexus between Water, Energy and Food is relatively recent. To understand these relationships allow to stablish best programs, for compliance of SDGs in developing countries. This work provides a first step in relationship the Nexus Water, Energy Poverty and Food safety, in urban areas of a developing country applied to urban areas of Colombia. These analyzes also allow to determine and to quantify the fraction of the population with restrictions in Water, Energy and Food. We are trying to explain these interlinks using unilateral and mutual relations. The analysis was focused on Water (potable water and sanitation); Energy Poverty (cooking fuels and electricity access); and Food Security (food scarcity) with a center on household income.

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