Evaluation of climate variability and temperature extremes in Colombia: Opportunities for the outlining of climate change and human health adaptive strategies.

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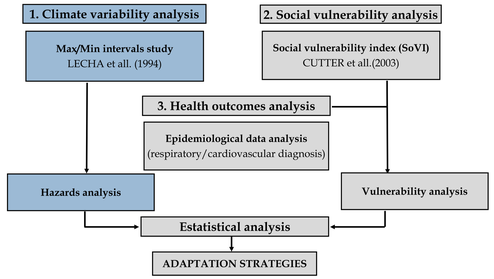
Introduction

Climate change acts as a multiplier of existing human health problems (MCMICHAEL & WILCOX, 2009). Therefore, the need arises to create measures to improve the population's adaptive capacity to deal with human health risk associated to extreme meteorological events. Colombia already has public policies aiming to develop climate change adaptation plans. However, these policies do not include the need to outline specific adaptive strategies for the public health sector.

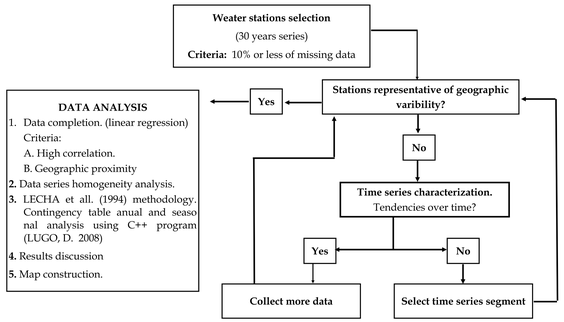
Here we show the application of an objective method that allows the creation of base-line knowledge of climate variability in Colombia. This definition of the thermal regime for the country will be contrasted with a social vulnerability analysis and epidemiological data to obtain a wide set of observations to contribute with the planning of climate change adaptation initiatives implemented by governmental institutions in the country at the municipal level.

Methodology

Overall the research plan contemplates 3 defined steps as follows.



Step 1 (Climate variability analysis) is the **subject of this presentation**



Results

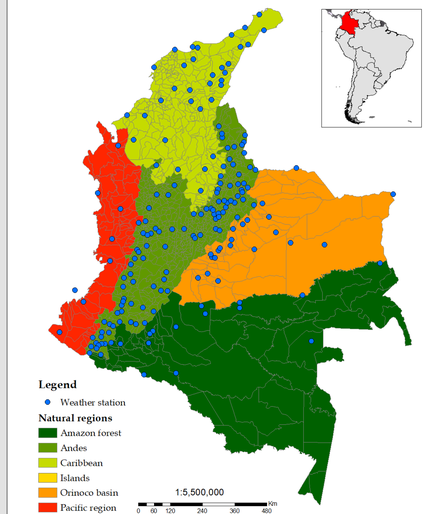


Figure 1. Weather stations selected for the daily temperatures variability analysis.

1. Weather station selection.

Filter #1 (See methodology)

- Forty three (43) weather station met the criteria for inclusion in the study. Few were located on the Caribbean region and the Orinoco basin and no station were selected for the Amazon region.
- Hystorically those regions have the smalest population density. However, the population living in those areas represents either very socially vulnerable comunities or ethnic minorities.

Filter #2

- Observation of multi-anual daily temperature showed little to no tendency overall.
- As seen in figure 1. A hundred and two (182) weather station were selected for the analysis of types and subtipes of the temperature regime in Colombia over the 2010-2015 period.

2. Characterization of climate variability

Lecha (1994) methodology consist on the analysis of relative frequencies using a contingency table to combine the simultaneous behavior of maximum and minimum temperatures of recorded data over a selected period of time.

The table is split in 5°C intervals that serve as subdivisions that generate climatic categories, types and subtypes. Here we presente the result for categories found in Colombia as read in the Table 1.

Mininum \ Maxims	<= 15	<= 20	<= 25	<= 30	<= 35	> 35
	1	2	3	4	5	6
> 25 A				Warm with small thermal oscillation	Very warm	
<= 25 B						
<= 20 C			Cold	Comfortable or fresh	Warm with marked thermal oscillation	
<= 15 D						
<= 10 E	Very cold					
<= 5 F						

Table 1. Contingency table showing the color codes for categories resulting from daily temperature analysis.

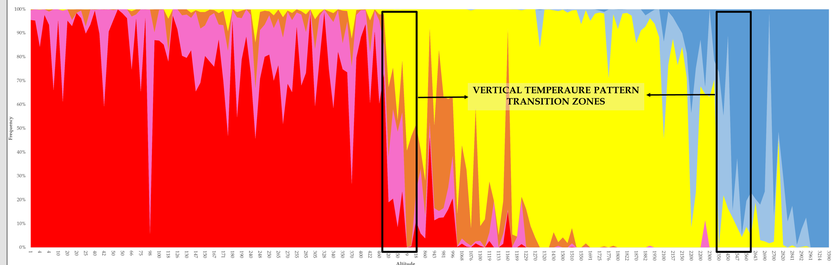


Figure 2. Relative frequency of climatic categories in Colombia along the vertical gradient** for the 2010-2015 period. ** Vertical gradient seen here as the variety of altitudes in which weather stations are present over the territory.

Vertical temperature patterns

As seen in figure 2., costal zones (Caribbean and Pacific regions) and the Orinoco plains (a.k.a "Los llanos") of Colombia are characterized by very warm days (A5,A6 and B5,B6 categories) with different types and subtypes depending on the local geographic factors.

The Andes are characterized by comfortable and fresh days (C3, C4 and D3, D4 categories) in middle altitudes and cold (C2, D1, D2 categories) and very cold (all of E and F categories) days in high altitudes (<2300 m.a.m.s.l)

Categories seasonality

As shown in table 2 the categories of the vertical temperature pattern are recurrent during the yearly seasons. That is, although there is variability in the frequency of the different intervals from one month to another in the same climatic station, this variability happens over the same category.

Month \ Elevation	2	4	50	53	126	128	171	244	280	423	400	439	250	285	1090	1128	1151	1189	1342	1400	860	1493	1610	1320	1500	1667	1725	1816	1850	1810	1670	1882	2438	2547	2470	2700	3120	2961	2560	2650	2900	3214
J	B5	B5	B5,B6	B6	B5	B5	B5	B5	B5	B5	B5	B5	B6	C6	C5	C4	C4	C4	C4	C4	C4	C4	C4	C4	D4	D4	D4	D4	D3	D3	D3	D3	D3	E3	E3	E3	E2	E2	E2	E2	F3	F3	F2	F1
F	B5	B5	B6	B4	B5	B5	B5	B5	B5	B5	B5	B5	B5	B5	C5	C4	C4	C4	C4	C4	C4	C3	C4	C4	C3	D4	D4	D3	D3	D3	D3	C3	D3	E3	E2	E3	E2	E2	E2	E3	E2	E2	F2
M	A5	A5	A6	B5	B5	B6	B5	B5	B5	B5	B5	B5	B5	B5	C5	C4	C4	C4	C4	C4	C4	C4	C4	C4	D4	D4	D3	D3	D3	D3	C3	D3	D3	D2	E3	E2	E2	E2	E2	E3	E2	E2	E1
A	A5	A5	B5	B5	B5	B5	B5	B5	B5	B5	B5	B5	B5	B5	C5	C4	C4	C4	C4	C4	C4	C4	C4	C4	C4	D4	D3	D3	D3	D3	C3	C3	D3	D2	D2	E3	E2	E2	E2	E3	E2	E2	E1
M	A5	A5	B5	B5	B5	B5	B5	B5	B5	B5	B5	B5	B5	B5	C5	C4	C4	C4	C4	C4	C4	C4	C4	C4	D4	D3	D3	D3	C3	C3	D3	D3	D2	D2	D2	E3	E2	E2	E2	E3	E2	E2	E1
J	A5	A5	B5	B5	B5	B5	B4	C4	B4	B5	B5	B5	B5	B5	C5	C4	C4	C4	C4	C4	C4	C4	C3	D4	D4	D4	D4	D3	D3	C3	C3	D3	D2	E2	E3	E2	E2	E2	E2	E2	E2	E1	E1
J	A5	A5	B5	B5	B5	B5	B4	C4	B4	B4	B5	B5	B5	B5	C5	C4	C4	C4	C4	C4	C4	C3	D4	D4	D4	D3	D4	D3	D3	C3	C3	D3	D2	E2	E3	E2	E2	E2	E1	E2	E2	E1	E1
A	A5	B5	B5	B5	B5	B5	B5	B5	B5	B5	B6	B5	B5	B5	C5	C4	C4	C4	C4	C4	C4	C4	C3	D4	D4	D3	D4	D4	D3	C3	C3	D3	D2	E2	E3	E2	E2	E2	E1	E2	E2	E1	E1
S	A5	B5	B5	B5	B5	B5	B4	B5	B5	B5	B6	B6	B5	B5	C5	C4	C4	C4	C4	C4	C4	C4	D4	D4	D4	D3	D4	D4	D4	D3	C3	D3	D2	E2	E3	E2	E2	E2	F2	E2	E2	E1	E1
O	A5	B5	B5	B5	B5	B5	B5	B5	B5	B5	B5	B5	B5	B5	C5,C4	C4	C4	C4	C4	C4	C4	C4	C4	D4	D4	D4	D3	D3	D3	D3	D3	D3	D3	E3	E2	E3	E2	E2	E2	E3	E2	E2	E1
N	A5	B5	B5	B6	B5	B5	B5	B5	B5	B5	B5	B5	B5	B5	C4	C4	C4	C4	C4	C4	C4	C4,C3	C4	C4	D4	D3	D3	D3	D3	D3	D3	D3	D3	E2	E3	E2	E2	E2	E3	E2	E2	E1	E1
D	A5	B5	B5	B4	B5	B5	B5	B5	B5	B5	B5	B5	B5	B5	C5	C4	C4	C4	C4	C4	C4	C3	C3	C4	C4	D4	D3	D3	D3	D3	D3	D3	E3	E2	E3	E2	E2	E2	E3	E2	E2	F1	F1

Table 2.. Seasonality of climatic categories found in the climate variability analysis along the vertical gradient.

Conclusions

The method gives a detailed characterization of the variability of temperatures over the territory. Given the flexibility of the tool, it's possible to make a better analysis for the regions of specific interest.

The general analysis shows a pattern of temperature varibility that follows the expected variation of a vertical temperature gradiente. However, the results show the areas over the territory where the transition ocurres.

The Andes region, where more than 60% of the population is located, presentes the biggest frequency of confortable or fresh days. However, the biggest city in the country (Bogotá) is located at 2600 m.a.m.s.l, region of transition between confortability and cold or too cold days.

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Acknowledgements

I would like to thank Dr. Luis Lecha for his invaluable help on analysing the time series of temperature data and also Dr. Adelaide Cassia Nardocci for the support and guidance during all the process.

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