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Subjective Well Being and the Impact of Climate Change

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Subjective Well Being and the Impact of Climate Change

(Draft)

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Abstract

We analyze the relationship between subjective well-being as a non-income welfare measure and climate variables such as temperature, precipitation rates or wind and climate change related disaster data like droughts, storms or floods. Therewith, we estimate the effects from events related to climate change on subjective well-being and point out possible welfare losses and gains due to climate change.

Even though that there is a growing number of research on well-being in terms of income measures and climate change, there is only little research on the effect of climate change and non-income measures such as subjective well-being. Further those studies lack some comparison. Except Rehdanz and Maddison (2005) and Becchetti et al. (2007) all studies turn to national analyses when analyzing the influence of climate on subjective well-being. So far there are very few studies on middle- and none on low-income countries, but at the same time extreme weather events may especially affect people in poorer countries. Therefore, we test this relationship for low and middle-income countries in Latin America and put the results in comparison to earlier studies.

We apply survey data from the Latinobarómetero which cover the years 1985-2008. In linear probability model we analyze the effect of climate and climate change related disasters on subjective well-being in Latin America and control for gender, age, marital status and income as well as the macroeconomic environment.

Keywords: Subjective Well Being, Climate Change
JEL Classification: I30, Q54

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1 Introduction

Today, climate change related risks for growth and development are widely acknowledged. The likely consequences of rising sea levels, increasing mean temperatures, more extreme weather events or desertification have been investigated and attempts have been made to assess the economic costs of climate change. Early studies estimated substantial cost of 2% of global income by 2100 (e.g. Pearce et al. 1996) but largely ignored potential benefits of global warming and the mitigating effects of adaptation. Depending on the assumptions made, recent studies which explicitly consider the more complex interplay between climate change and economic responses vary a lot regarding the predicted costs. For example, the Stern Report (2006) on the economics of climate change forecasts large damages which are equivalent to 5% of global GDP per year. Other studies arrive at much lower costs of 0.2% of global income (Mendelsohn, Williams, 2004; Tol, 2002). Since there are many uncertainties regarding the magnitude of climate change effects and when they will fully materialize, the underlying assumptions need to be clearly spelled out when interpreting these estimates.

In terms of regional distribution of climate change effects, previous studies concluded that some countries and regions are more vulnerable than others. In particular, countries with a relatively large agricultural sector and regions located in low latitudes will be affected more severely. Since both facts apply to many developing countries, it is safe to reason that the poorest in Africa and Southeast Asia will have to face the bulk of damages from climate change, whereas estimates for advanced countries suggest zero or even positive net market impacts (Mendelsohn et al., 2006).

Evaluating the economic costs is a useful exercise to gauging the financial consequences of climate change and evaluating alternative mitigation strategies. However, to fully capture overall welfare impacts of climate change, a solely monetary approach is unlikely to suffice. Conceptual as well as empirical research has demonstrated that welfare is not necessarily an objective phenomenon that can be captured by monetary measures alone, but rather an encompassing concept and closely associated with the subjective assessment of the current state of being (Frey and Stutzer, 2002; Kapteyn, Kooreman and Willemse, 1987). Extensive empirical research on determinants of subjective wellbeing (SWB) verified the impact of individual, regional and national factors on personal welfare. It is now very well understood that besides financial resources, SWB is determined by personal characteristics like age, gender, education, health, attitudes and beliefs as well as the broader economic conditions like

inflation, unemployment rate, and the level of income inequality (Dolan, Peasgood and White, 2007).

Few studies have looked at the impact of environmental aspects like pollution and climatic conditions on SWB and results suggest that these factors are equally important (e.g. Ferrer-i-Carbonell, Gowdy, 2007; Frijters, van Praag, 1998). Two studies very close to our project is Rehdanz and Maddison (2005) and Becchetti et al. (2007). Using data on happiness provided by the World Database of Happiness (Veenhoven, 2001), they analyse the impact of climate variables for 67 countries over the period 1972-2000. Regarding variables on the climatic conditions, they apply various indices on temperature and precipitation as well as locational parameters like absolute latitude. Results obtained from a panel-corrected least squares approach demonstrate the strong influence of climate variables on self-reported levels of happiness. With the help of predicted changes in temperatures and precipitation levels by 2039 and 2069, they calculate the change in income required to keep happiness at a constant level. Their results support earlier findings that high-latitude countries will benefit from limited climate change, but low-latitude countries are likely to suffer most.

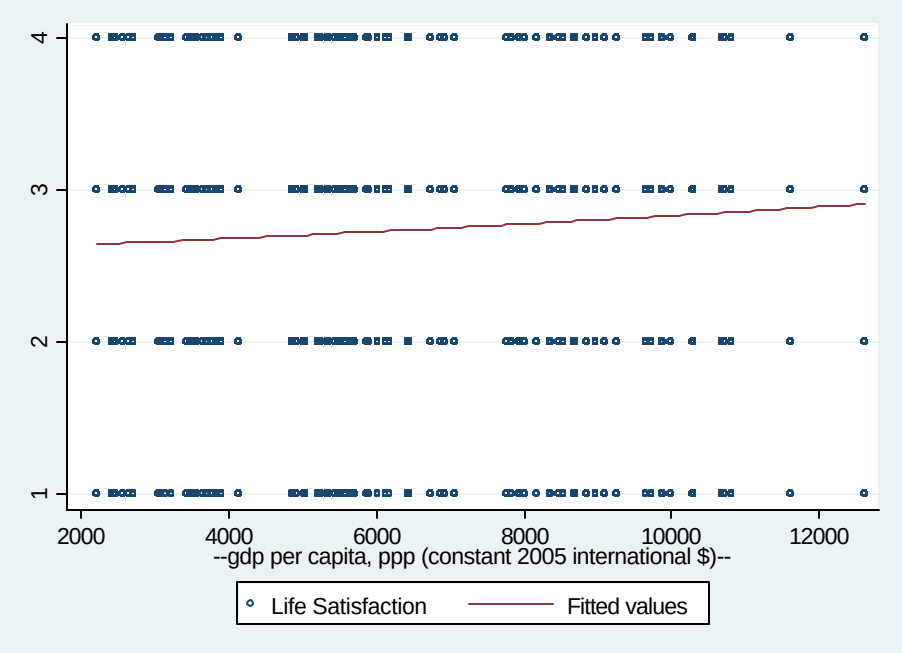
Although our research question is similar to Rehdanz and Maddison (2005), our study differs in a number of points. First, we will use an alternative indicator for measuring SWB and hence will be able to test the robustness of their results. Second, our study is regionally focussed on Latin America and the more homogeneous group of countries with similar historical background may facilitate a comparative analysis of life satisfaction. Third, we will rely on alternative climate data from the FAOClim-NET which will allow us to test the sensitivity of previous results.

2 Related Literature

2.1 Welfare Theory and Subjective Well-Being

Easterlin (1974) is among the first ones to conclude that human well-being does not depend exclusively on income. He therefore compares changes in income and in SWB across countries and over time. Within countries he finds a positive relationship between income and SWB, but when analyzing across countries this relationship diminishes. Therefore, within countries the wealthier individuals are on average the happier ones. Meanwhile, between countries the wealthiest are not necessarily the happiest, which is called the Easterlin Paradox.

Figure 1: Life Satisfaction and Income in Latin America



Source: Latinobarómetero 2009 and WDI 2009.

Easterlin (1974) points out that this could be due to the fact that individuals compare their own wealth with the wealth of their surroundings. So, if one individual gains in welfare than another one might feel relatively less well off. Frey and Stutzer (2002) analyze the relationship between SWB and income in a cross county setting. They find that income on average contributes to SWB but at diminishing rates. Hence, one may expect large gains SWB at lower levels of income. They also explain why this is the case. First, individuals' aspirations adjust and therefore they always want more. And second, these wants are insatiable. Frey and Stutzer (2000) point to the importance of good institutions as being

beneficial to SWB. Di Tella et al. (2003) and Di Tella and MacCulloch (2006) test the effect of a sound macro-economic environment on SWB. They find that recessions create strong psychic loses besides the decline in GDP and the rise in unemployment. Finally, Di Tella and MacCulloch (2008) bring together macro and micro variables and disproof the Easterlin Paradox. After controlling for macroeconomic stability, crime rates, environmental degradation, working hours and life expectancy they find increasing rates of SWB with income even across countries.

2.2 Subjective Well-Being and the Environment

Frijters and van Praag (1998) are among the first ones to analyze the impact of climate variables on SWB. They analyze the impact of changes in temperature, humidity and precipitation with a panel of 3727 households in Russia to find that an increase in average temperature could lead to lower heating expenses. Nevertheless, they report problems of muliticoliniarity among the climate variables. Welsch (2002) was one of the first to analyze the relationship between SWB and environmental pollution. He analyzes the effect of various pollutants among 54 countries in 1995 and concludes that multicoliniarity among the pollutants is very strong. Welsch (2006) redoes his study with a panel of 10 European countries to find significant negative results which differ among the pollutants. Rehdanz and Maddison (2005) analyze SWB and climate change on a cross country level. They analyze a panel of 67 countries and conclude that those countries living in the north (high latitude) would generally benefit from slightly higher mean temperatures. Rehdanz and Maddison (2008) extend their study to a national analysis of the 15 German states and pollution of the air as well as disturbances by noise to conclude that the disturbances are not capitalized into property prices. Ferrer-i-Carbonell and Gowdy (2007) analyze the relationship between SWB and environmental awareness with a panel from the British Household Panel Survey. They find that environmental awareness is positively correlated with SWB meanwhile environmental concerns are negatively correlated. Smyth et al. (2008) analyze SWB and pollution levels in urban China. Brereton et al. (2008) analyze again the relationship between SWB and climate variables but point the attention to spatial variables like proximity to the coast and find that climate has a significant impact on well-being.

2.3 Shortcomings of Subjective Well-Being Measures

Besides the advantage that with the SWB approach individual welfare is measured and differences in income as well as other dimensions of life are controlled for, there are still some concerns about this approach. First of all, there are two common measures of SWB. One which focuses on life satisfaction and one which aims to measure happiness are currently applied in the literature. Stevenson and Wolfers (2008) point out that those measures should not be treated equally since they tend to measure different things. The former takes account on the individual's perception of how his or her life has been so far, meanwhile the later aims on the current situation when the individual is asked: "How happy are you with your life?" This difference in the perception of the question might explain the low correlation between the two variables.

Another mayor issue is the inconsistency of the data. Krueger and Schkade (2008) tested the correlation between test and the re-test results and concluded that there is either a strong unobserved bias when answering the questions or the people are very inconsistent in their perception of SWB. As a matter of climate and therewith cold or rain, we control for those influences but nevertheless the data should be treated with care. Rojas (2008) compares real income and SWB measures in Mexico and finds that 12% of the observed households consider themselves to be poor meanwhile they are not income poor and vice versa. The reason for this non-compliance could be based on the fact that the evaluation of SWB is very sensitive to comparisons. Even a relatively rich individual feels poor in a neighborhood of extremely rich ones and a moderately well off individual feels rich in a poor neighborhood. Last but not least Ferrer-i-Carbonell and Frijters (2004) address methodological issues and point out that the assumption of cardinal or ordinal scales makes little difference but allowing for fixed effects changes the results.

3 Empirical Approach

3.1 Data

The data we apply is from the Latinobarómetero, which covers 18 Latin American countries over the period from 1995 until 2008.[2] The survey contains about 1000-1200 households per wave and country. The SWB variable life satisfaction is coded on a scale of 1 to 4. The question is:

"In general, would you say you are satisfied with your life? Would you say you are:

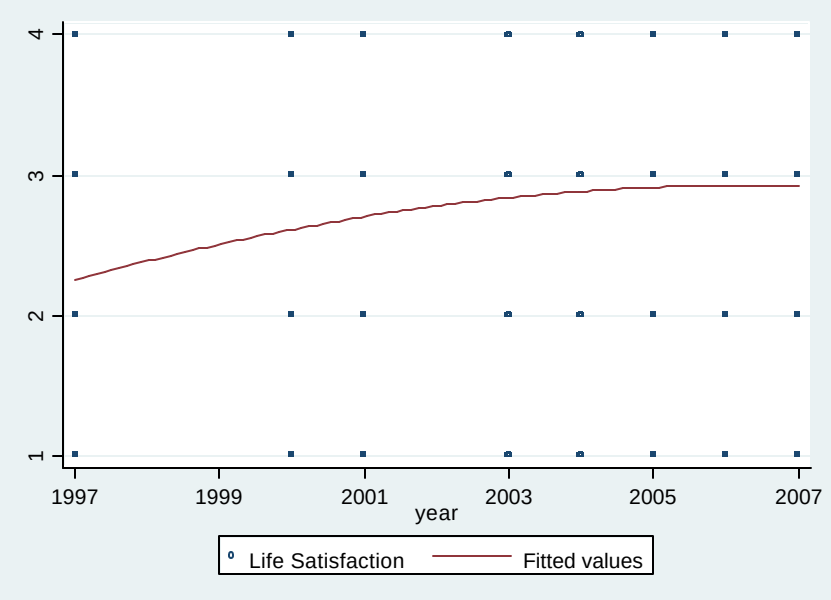
1 Very satisfied,

2 Fairly satisfied,

3 Not very satisfied,

4 Not satisfied at all".[3]

Figure 2 Life Satisfaction over Time in Latin America



Source: Latinobarómetero 2009.

Figure 2 describes the development of life satisfaction over time in the 18 Latin American countries. There is evidence for a strong rise in average life satisfaction by about 0.75 points

[2] The countries are Argentina, Bolivia, Brazil, Chile, Colombia, Costa Rica, Dominican Republic, Ecuador, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Uruguay and Venezuela. As concerning the waves 1999 is missing.

[3] We reversed the coding for matter of the interpretation oft he results.

on our 1 to 4 points scale between 1997 until 2007. The data on the individual's income such as subjective income, subjective economic situation and the objective wellbeing which is the pollster's perception of the economic situation of the household are all categorical variables on scale of either 1 to 4 or 5. Being married, unemployed, religious or male are dummy variables and education accounts for the number of years of education.

The weather data is from the FAOClim-NET database and includes: average annual temperature and the temperature of the annual hottest and coldest month (max and min) in degrees Celsius, annual precipitation rates and annual average wind speed 2m above ground. The macroeconomic variables like GDP per capita are from the World Development Indicators 2009 data CD and the climatological disasters are from the EM-DAT international disaster database and account for damage costs in thousand US$. [4]

Table 1 Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
life_satis	83190	2.76	0.95	1	4
married	83641	0.66	0.47	0	1
unemploy	83641	0.06	0.23	0	1
edu	82745	9.00	4.68	1	17
religious	83641	0.98	0.13	0	1
ob_wellbeing	83607	3.27	0.92	1	5
sub_eco_sit	72130	2.90	0.82	1	5
sub_income	82223	2.30	0.85	1	4
male	83641	0.49	0.50	0	1
age	83641	45.49	13.78	21	85
lngdp_pc	72440	8.69	0.43	7.70	9.44
pop_dnst	72440	56.05	76.35	7.21	326.37
tmp_ann	83641	21.68	4.49	12.97	28.15
tmp_ann_max	83641	30.30	3.87	19.40	36.70
tmp_ann_min	83641	23.12	5.43	13.20	32.00
pre_ann	83641	618.78	519.24	0.00	1638.60
wind_ann	83641	3.40	1.36	0.80	6.18
latitude	83641	-7.18	19.02	-34.83	18.43
elevation	83641	493.02	714.10	6.00	2548.00
drought	82338	36200.68	227560.80	0	1650000
flood	82338	37999.38	149602.00	0	1028210
storm	82338	17640.87	100171.40	0	988300

Source: Latinobarómetero, WDI 2009 and FAOClim-NET

[4] We chose the damage costs instead of the number of disasters to account fort he size oft he disaster.

To describe the effect of climate on life satisfaction we find that a rise in temperature is positively correlated with life satisfaction and precipitation rates and wind are negatively correlated.[5] This goes in line with the data of Rehdanz and Maddison (2005) and Frijters and Van Praag (1998), they also find a positive correlation between their measures of SWB and higher temperatures. Nevertheless, in a country which already faces a very hot climate one might expect an inverted u-shape with initially rising SWB with higher temperatures but after passing a certain temperature threshold there might be lower levels of SWB. Therefore, a more in debt analyzes is needed.

3.2 Methodology

To analyze the effect from climate on SWB we follow the approach from Rehdanz and Maddison (2005) and set up the following reduced form regression approach:

$$\begin{aligned} SWB_{j,t} = \alpha &+ \beta_1 Indivdual\ Controls_{j,t} + \beta_2 lnGDPpc_{i,t} + \beta_3 PopDensity + \beta_4 Drought_{i,t} \\ &+ \beta_5 Flood_{i,t} + \beta_6 Storm_{i,t} + \beta_7 Latitude_{i,t} + \beta_8 Elevation \\ &+ \beta_9 Temperature + \beta_{10} Precipitation_{i,t} + \beta_{11} Wind_{i,t} + \beta_{12} Year_t \\ &+ \beta_{13} Country_i + \mu \end{aligned}$$

The SWB variable is life satisfaction on individual level *j*, which is to be explained by the dependent variables. We introduce GDP per capita in logs at the country level *i* to control macroeconomic shocks. Socio economic variables such as age, dummies for being married, unemployed, religious or male and the number years in school are introduced to control for socio economic impacts. Further the subjective economic situation, the subjective income and the objective wellbeing which is the pollster's perception of the economic situation of the household control for the individual's income.

The damage costs from climatological disasters such as floods, storms or droughts account for climatological disasters which are related to climate change. Finally, the climate variables temperature, precipitation rates and wind account for the impact of climate on life satisfaction.

We do not follow the approach of Rehdanz and Maddison (2005) who average the categorical SWB data over countries and therewith neglect the inner country variance of the SWB data.[6] We follow the approach of Becchetti et al. (2007) but instead of a multinomial probit we

[5] See appendix 2.

[6] With inner country variance of the SWB data we refer to individual improvements or deteriorations of SWB which would be leveled off when looking at country averages.

apply a linear probability model with heteroscedasticity robust standard errors to allow for an easier interpretation of the results. This comes at the cost that we cannot apply panel techniques but we take the inner country variance of the SWB data into account.

3.3 Results

Table 2 Results from the Linear Probability Model

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	LPM yc wt	LPM yc wt	LPM yc wt	LPM yc wt	LPM yc wt	LPM yc wt	LPM yc wt
VARIABLES	life_satis	life_satis	life_satis	life_satis	life_satis	life_satis	life_satis
married	0.0574***	0.0590***	0.0596***	0.0585***	0.0596***	0.0592***	0.0599***
unemploy	-0.0836***	-0.0806***	-0.0798***	-0.0788***	-0.0795***	-0.0784***	-0.0781***
edu	-0.000628	-0.000607	-0.000253	-0.000337	-0.000507	-0.000448	-0.000294
religious	0.0869***	0.0815***	0.0803***	0.0865***	0.0855***	0.0873***	0.0860***
ob_wellbeing	0.0427***	0.0474***	0.0459***	0.0466***	0.0471***	0.0460***	0.0453***
sub_eco_sit	0.239***	0.240***	0.239***	0.240***	0.240***	0.239***	0.240***
sub_income	0.133***	0.132***	0.134***	0.133***	0.133***	0.133***	0.134***
sex	-0.00260	-0.00238	-0.00295	-0.00276	-0.00267	-0.00291	-0.00316
age	-0.00408**	-0.00440**	-0.00423**	-0.00448**	-0.00436**	-0.00432**	-0.00437**
agesq	4.97e-05***	5.26e-05***	5.15e-05***	5.37e-05***	5.25e-05***	5.20e-05***	5.29e-05***
lngdp_pc		-0.229**	-0.121	-0.235**	-0.198**	0.192*	0.232**
pop_dnst		-0.00138	-0.00182*	-0.00106	-0.00232**	-0.00255**	-0.00241**
drought		-6.12e-08***	-7.60e-08***	-5.43e-08***	-7.56e-09	-2.19e-08	-4.46e-08***
flood		-1.93e-07***	-1.80e-07***	-1.88e-07***	-1.90e-07***	-1.79e-07***	-1.72e-07***
storm		-5.76e-08	-6.46e-08*	-4.21e-08	-6.18e-08*	-2.43e-09	-4.54e-08
latitude		0.0129***	0.00879***	0.0117***	0.00954***	0.0151***	0.0144***
elevation		-0.000127**	-0.000239***	-9.89e-05***	-7.59e-05***	0.000181***	-1.21e-05
tmp_ann		1.189***					
tmp_sq		-0.0627***					
tmp_cu		0.00105***					
tmp_ann_max			0.797***				0.555***
tmp_max_sq			-0.0328***				-0.0227***
tmp_max_cu			0.000422***				0.000287***
tmp_ann_min				0.0779			
tmp_min_sq				-0.00679*			
tmp_min_cu				0.000138***			
pre_ann					0.000434***		7.84e-05*
pre_sq					-5.10e-07***		-2.07e-09
pre_cu					1.99e-10***		0
wind_ann						-0.787***	-0.674***
wind_sq						0.180***	0.171***
wind_cu						-0.0122***	-0.0129***
Constant	0.974***	-2.774	-2.353	4.368***	3.073***	1.067	-4.257**
Time/Country Dummies	yes	yes	yes	yes	yes	yes	yes
Observations	69,692	68,414	68,414	68,414	68,414	68,414	68,414
R-squared	0.248	0.250	0.250	0.250	0.251	0.251	0.252

Source: Authors Estimations. Note: *, ** and ***denote significance at 10%, 5% and 1% level, respectively. Note: The dependent SWB variable life satisfaction is coded on a scale of 4 to 1 coded: 4 Very satisfied, 3 Fairly satisfied, 2 Not very satisfied, 1 Not satisfied at all".

In table 2 column 1 we present a standard SWB regression with the socio-economic control variables. In line with the literature we find that being married, religious affect SWB positively and being unemployed negatively. Also having a higher level of objective wellbeing, which is the pollster's perception of the economic situation of the household and having a higher subjective income as well as facing a better subjective economic situation, which is a subjective judgment of the economic situation yields on average higher levels of SWB. Different from the literature are the non significant results on the number of years of education and the gender dummy, which turns one if the individual is male. Again in line with the literature are the results on age and age squared which imply that SWB declines during life but after passing through a minimum, individuals face higher levels of SWB as they get older.

In column 2 to 7 we introduce the macroeconomic control variables such as GDP per capita and add the disaster damage costs which are not too strongly correlated with the climate data. The variable latitude accounts for the distance to the equator. The countries closer to the equator are on average poorer which might explain the positive coefficient of the variable. Following Rehdanz and Maddison (2005) and Becchetti et al. (2007) and for reasons of multicollinearity among the climate variables we introduce the climate variables separately into the model in table 2 column 2 to 6. Except for the variable wind we find an n-shape relationship. Therefore, a rise in temperature or precipitation rates does lead to higher levels of SWB to a certain point. After reaching this threshold higher temperatures or precipitation rates lead to declining levels of SWB. For the variable wind the relationship could be described as an inverse n-shape. Higher levels of wind lead to a decline in SWB but after passing again a threshold level they might lead to a slight rise in SWB. In table 2 column 7 we introduce the annual hottest month, annual precipitation rates and annual average wind speed simultaneously and receive similar results.

Surprisingly our results are closer to the results of Rehdanz and Maddison (2005) than to Becchetti et al. (2007) even though, our model and its specification is closer to the later one. Nevertheless, none of the two studies introduced climatological related disasters in the analysis.

4 Conclusion

In the first chapter we pointed out that there is a need to apply not only monetary measures to estimate potential gains and losses from climate change. Climate is a strong determinant of human well-being. Slow and minor changes might be adapted easily but abrupt and bigger changes such as disasters are difficult to adapt to and affect well-being negatively. We introduced the concept and the measures of SWB as a non-income based welfare measure and pointed to the advantages and shortcomings in terms of reliability of this measure.

Our empirical analysis applies life satisfaction as a measure of SWB. We control for the socio-economic and macroeconomic environment and find a significant positive effect from temperature and precipitation rates on life satisfaction up to a certain threshold, higher levels of temperature and precipitation rates may lead to a loss of life satisfaction. A rise in wind speed leads to a decline in life satisfaction.

For the first time we introduced climatological associated disasters in the analysis and found that the occurrence and the size of disasters such as floods, droughts and storms are negatively related to the level of life satisfaction. Since climate change is associated with a rather small rise in average global temperature but we already observe a strong rise in climatological related disasters we may not underestimate the effect of climate and climatological related disasters on life satisfaction and should analyze disaster data more deeply

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Appendix

Appendix 1 Cross Correlations

	life_satis	married	unemploy	edu	religious	ob_wellbeing	sub_eco_sit	sub_income	sex	age	lngdp_pc	pop_dnst	life_exp
life_satis	1.00												
married	0.02	1.00											
unemploy	-0.04	-0.05	1.00										
edu	-0.03	0.00	0.01	1.00									
religious	0.06	0.01	0.00	-0.05	1.00								
ob_wellbeing	0.14	0.03	-0.05	0.34	-0.01	1.00							
sub_eco_sit	0.29	0.03	-0.07	0.14	0.02	0.25	1.00						
sub_income	0.18	0.03	-0.09	0.25	-0.01	0.34	0.39	1.00					
sex	0.01	0.12	0.04	0.04	-0.05	0.01	0.01	0.05	1.00				
age	0.05	-0.01	-0.06	-0.33	0.05	-0.01	-0.07	-0.07	0.01	1.00			
lngdp_pc	0.13	-0.03	0.03	0.05	0.01	0.10	0.08	-0.01	-0.03	0.14	1.00		
pop_dnst	0.07	-0.01	-0.02	-0.15	0.00	-0.05	-0.07	-0.03	0.02	-0.02	-0.18	1.00	
life_exp	0.22	-0.02	0.03	-0.04	0.01	0.08	0.04	-0.05	-0.02	0.17	0.73	-0.07	1.00

Source: Latinobarómetero and WDI 2009

Appendix 2 Cross Correlations

	life_satis	tmp_ann	tmp_ann_max	tmp_ann_min	pre_ann	wind_ann	vap_ann	drought	flood	mass_movem~t	storm	latitude	elevation
life_satis	1.00												
tmp_ann	0.04	1.00											
tmp_ann_max	0.00	0.78	1.00										
tmp_ann_min	0.08	0.90	0.61	1.00									
pre_ann	-0.04	-0.21	0.10	-0.32	1.00								
wind_ann	-0.08	-0.07	-0.03	-0.28	0.37	1.00							
vap_ann	0.05	0.98	0.74	0.91	-0.22	-0.11	1.00						
drought	-0.02	-0.08	-0.06	-0.06	-0.08	0.00	-0.11	1.00					
flood	-0.01	-0.11	0.00	-0.23	0.22	0.20	-0.12	0.00	1.00				
mass_movem~t	-0.02	-0.02	-0.01	-0.01	0.17	-0.06	-0.03	-0.02	-0.02	1.00			
storm	0.03	0.12	0.15	0.13	-0.03	-0.12	0.11	0.22	-0.04	-0.02	1.00		
latitude	0.14	0.53	0.09	0.76	-0.50	-0.40	0.56	-0.14	-0.28	-0.08	0.15	1.00	
elevation	0.09	-0.47	-0.71	-0.15	-0.09	-0.09	-0.40	0.05	-0.10	0.04	-0.04	0.31	1.00

Source: Latinobarómetero, FAOClim-NET and EM -DAT