Climate Change Impacts on Poverty in Mexico

Extended abstract

Introductory background

Climate Change poses enormous challenges for population wellbeing. It is expected that developing countries will be disproportionately affected, both by their degree of exposure and by the resources available to them to cope. Previous research suggests that climate change can affect poverty levels, in the short and long term, by affecting economic growth of countries, but also the income, consumption and assets of households (Ahmed, Diffenbaugh and Hartel 2009; Hallegatte et al., 2014). On the one hand, climate change is expected to impact the availability and price of basic goods such as food and energy, affecting the levels of household consumption. On the other hand, it will also influence the household livelihoods, through their effects on productive activities and household assets.

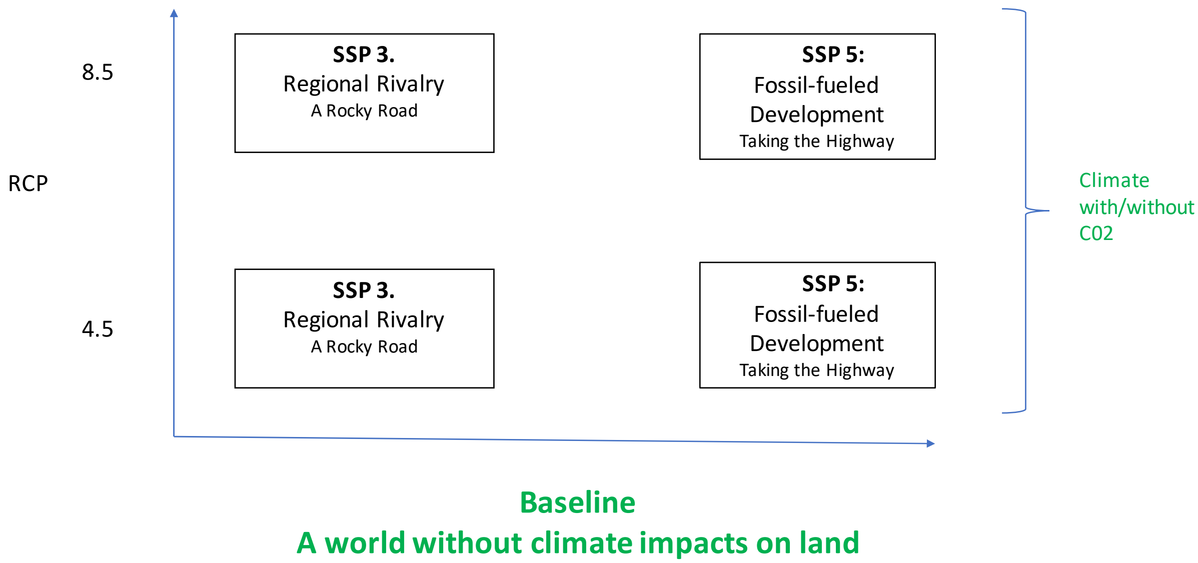
Despite the anticipated large impacts of climate change, there is still limited research on its impacts on poverty and inequality. Analytically, this could be explained because of the difficulties to count, first, with reliable assessments of climate changes impacts and, second, with a method to translate those into effects for households' well-being. In this paper, we seek to overcome those issues in order to estimate expected impacts of climate change on poverty changes in Mexico (2010-2050). We combine the results from climate change impact scenarios for Mexico with household survey data on income composition. Extending the method of Hertel et al (2011) we estimate how changes in prices and income under four distinct climate change scenarios would impact poverty levels in Mexico.

We consider two questions:

a) what is the impact of climate change on poverty changes in Mexico between 2010 and 2050?
b) Does mitigation lessen poverty impacts of climate change?

Data and methods

We employ the results from an IAM exercise where a physical-atmospheric model (CESM) was combined with a General Equilibrium Model(iPETS), to examine climate change impacts on crop productivity and land availability, as well as food prices and impacts on income, both globally and within Mexico. We estimate four types of scenarios, two representing different socioeconomic futures and two suggesting different Radiative Concentration Pathways (see Figure 1). By comparing different socioeconomic scenarios (SSP5 and SSP3) we consider changes in demographic and income distribution in Mexico to assess whether this might offset food price effects. By comparing the two climate scenarios (RCP 8.5 and RCP 4.5) we can explore the costs and benefits of mitigation for poverty in Mexico. For each scenario, the IAM exercise produces estimates on GDP impact, consumption and income changes, as well as changes in prices. On a second stage, we use those estimates to extent Hertel et al. (2011) method to estimate household poverty changes due to climate change impacts on agricultural productivity.



Climate Change Impacts on agriculture

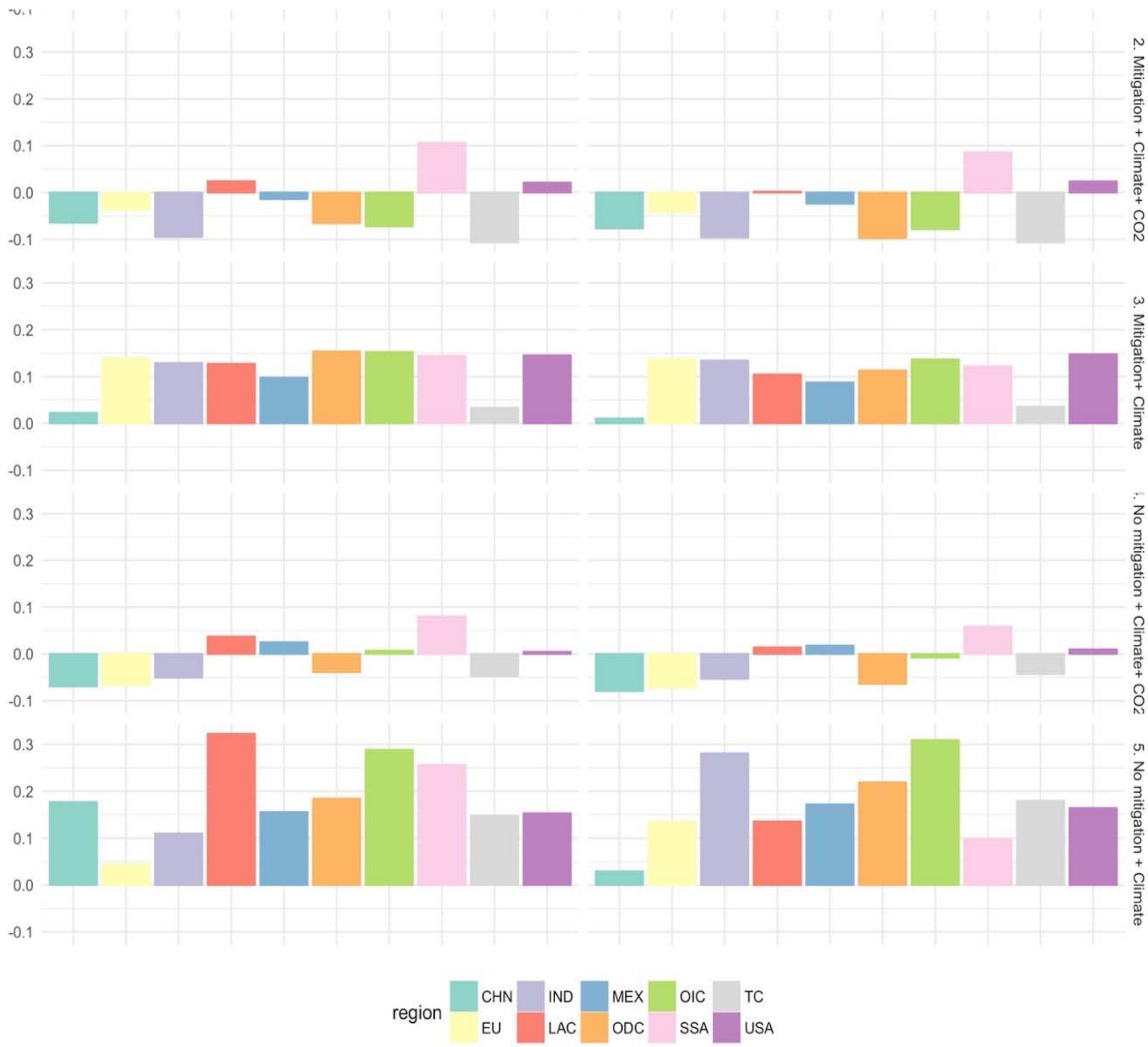
We employed results from a coupled, integrated assessment model, between the CESM and the iPETS models. CESM is a leading global earth system model based at NCAR and developed in collaboration with the wider research community. CESM integrates models of the atmosphere, oceans, and land surface to simulate the evolution of the climate system historically and into the future. It is especially well suited to this impact analysis given its incorporation of crop growth as part of its land surface model. iPETS is an inter-temporal computable general equilibrium (CGE) model that has been used to examine the implications of demographic and socioeconomic change for global and national C02 emissions and energy use. iPETS accounts for household heterogeneity in relation to educational level, age, sex, urban/rural residence, and it is currently including income categories. It distinguishes 6 consumption goods, including energy and food. Accounting for such heterogeneity is central for impact assessment because capturing the implications of socio-economic trends for climate impacts requires the ability to distinguish among household types of differing vulnerability. As a result of a recent project, Mexico was single out from the rest of Latin America and, therefore, we were able to estimate national results within a global model – which includes nine other regions. Those, CESM estimate land productivity changes due to climate change (agricultural land and crop yields). Those results are integrated into the iPETS model to estimate their impacts on food prices, as well as household income.

Across all scenarios, climate change diminishes land productivity and increase food prices in Mexico between 2010 and 2050. However, negative impacts of climate change on agricultural land are larger under no mitigation and if we do not consider the impacts of C02 fertilization. Similarly, climate change impacts are larger under a scenario of rapid fossil-fuel growth (SSP5). Decreasing agricultural productivity drives to higher food prices, those, these are expected to be larger on no-mitigation scenarios.

Agricultural Land

Land Cover|Cropland (million Ha/yr)(against baseline)
2. Mitigation + Climate+ CO2
3. Mitigation+ Climate
No mitigation + Climate+ CO2
5. No mitigation + Climate
region
CHN
EU
IND
LAC
MEX
ODC
OIC
SSA
TC
USA

Food Price



Impacts on poverty

From the previous scenarios, we obtained changes on prices and income for at the national level and for rural and urban households. We use those estimates to extent Hertel et al. (2011) method to examine household poverty changes due to climate change impacts on agricultural productivity. Basically, the method estimates poverty impacts as a function of changes on income and price of living.

$$\mathrm{H} = -\sum_s Bs * \varepsilon_s * \sum_j \alpha_{sj}^{p}(W_j - C_r^{p})$$

Bs: share of a given stratum of the national poverty

ε_s : the stratum specific elasticity with respect to real income

p_{sj}: share of income obtained from factor in a particular stratum, for households in the neighborhood of poverty

Wj : percentage change in income from factor endowment j

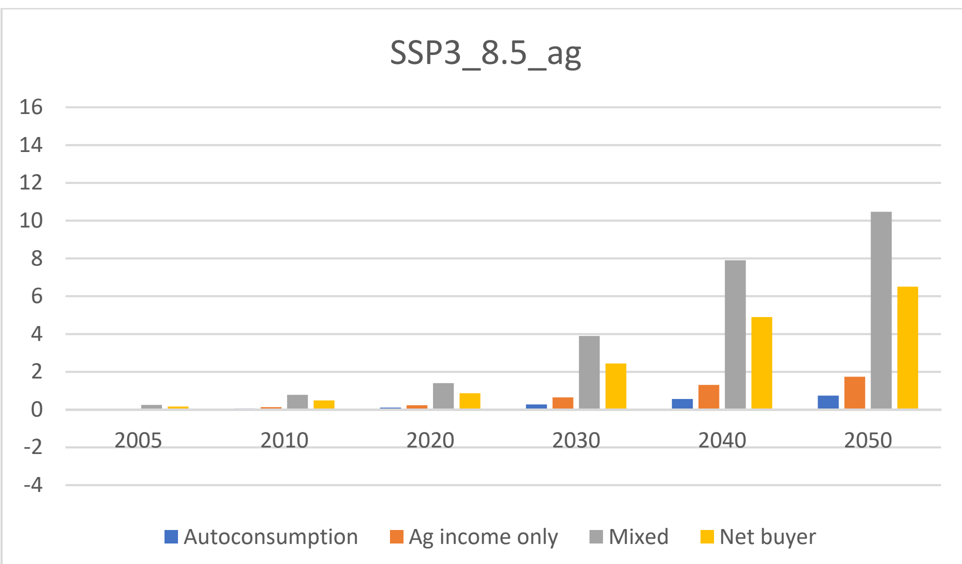
C^{P_r}: the changing cost of living

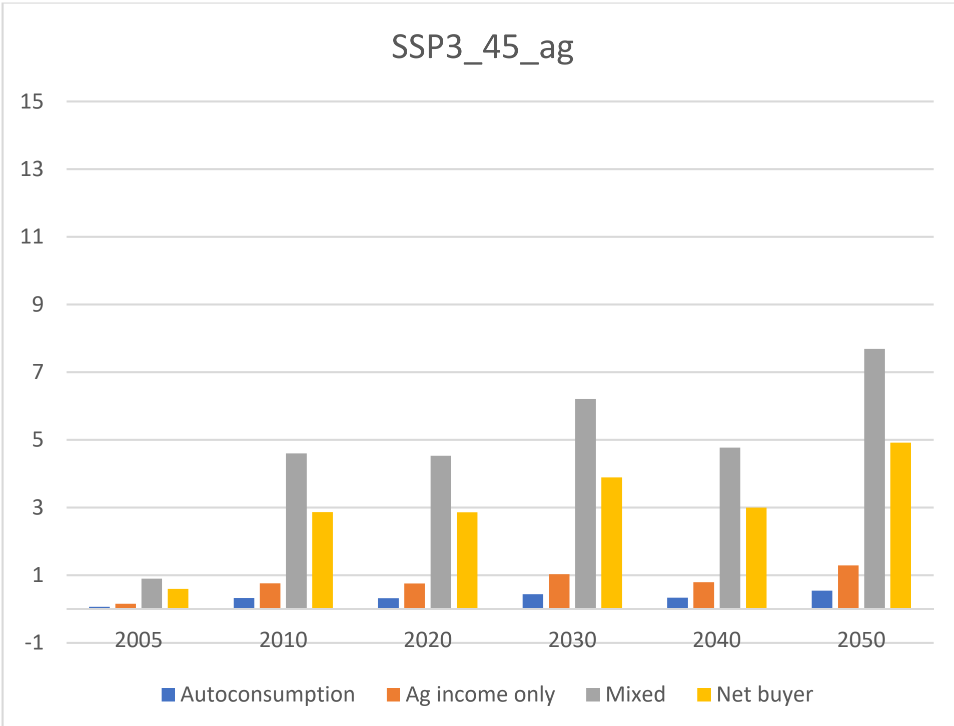
For that, we used data from the Income and Expenditure National Survey 2004, to estimate household income composition for different types of households: a) net-buyers of food; b) mix-income household; and c) producers. Thus, we can estimate poverty changes for each type of household since have an estimated changed on their differences income sources (labor, capital and other). We calculate those changes under different scenarios (from IAM) and we can estimate poverty proportion and "sensibilities" to poverty from survey data. Estimations on future income trends and living costs (food prices) were obtain from the iPETs results. For simplicity, we presented here only the results for non-C02 fertilization for rural households.

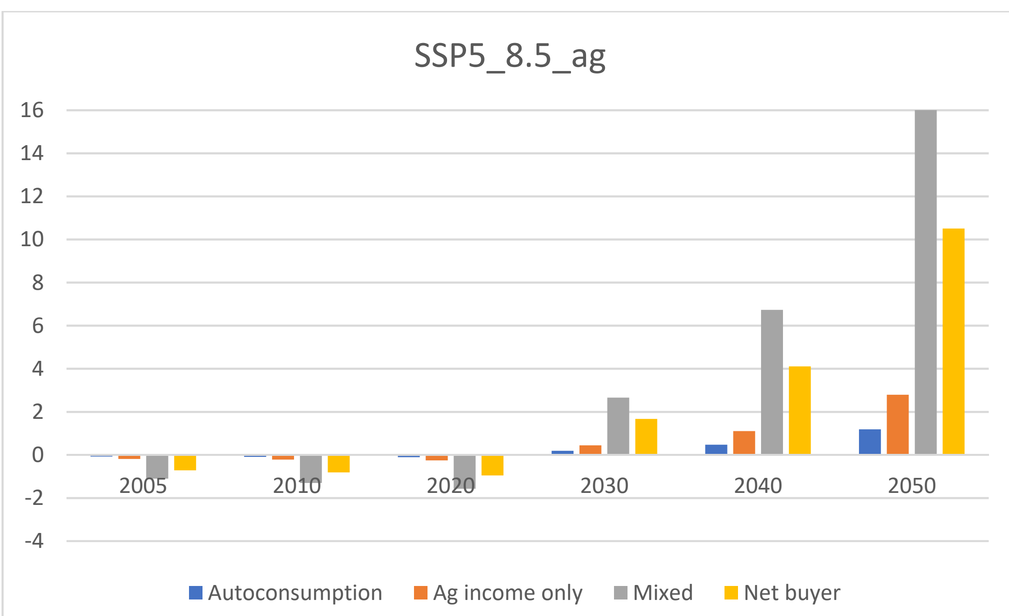
Rural Households				
	% of households	% extrem poor	Contribution to national poverty	Elasticity to poverty
Autoconsumption	9.61	11.80%	7.71%	0.435
Ag income only	13.81	9.37%	18.79%	0.424
Mixed	17.21	8.40%	34.21%	1.396
Net buyer	59.37	10.56%	39.29%	0.770
Income composition				
	Labor	Capital	Other	
Autoconsupmtion	47.579%	2.319%	50.102%	
Ag income only	51.221%	2.227%	46.552%	
Mixed	44.923%	0.775%	54.303%	
Net buyer	59.262%	3.825%	36.912%	
Source: Authorscalculations. ENIGH 2004				

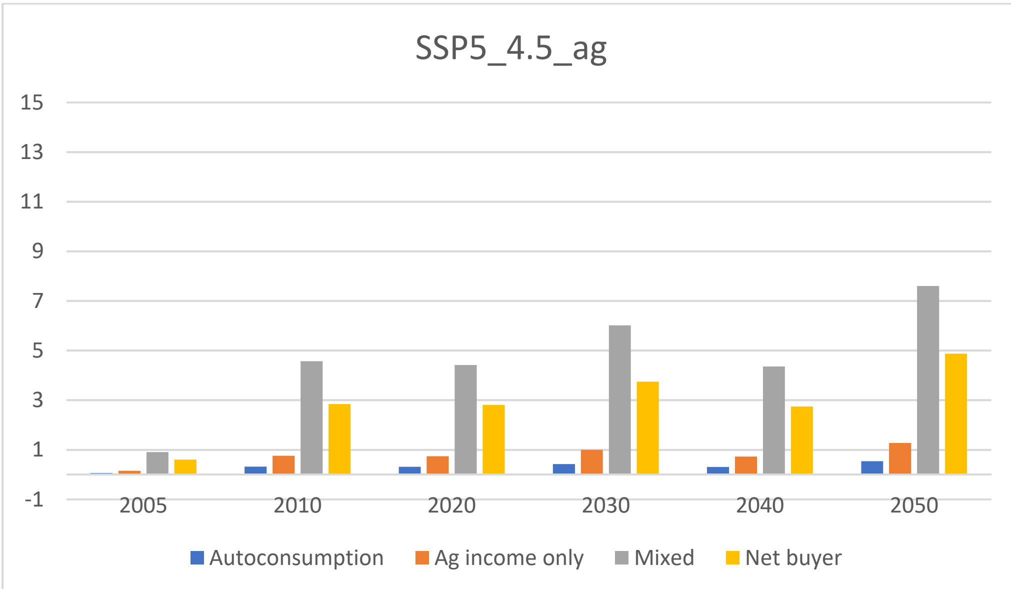
Hertel et al (2011) method makes future poverty change a function of current poverty level and income composition, as well as expected changes in income sources and prices. We can appreciate in the last table that the four groups of rural households differ importantly in their poverty rates, as well as their income sources. Poverty is higher among those who produce for autoconsumption, but propensity to poverty is higher among those with an income base and net buyers. In addition, those mixed-income households depend more on other sources of income (public and private transfers, non-market transactions).

The following graphs show that, compare to the base line, poverty increases for all rural households across all scenarios by the year of 2050, with mixed-income households and net buyers contributing the most. If we compare between SSP is noticeable that during the first decades of rapid fossil-based growth (SSP5), poverty diminished but it later increased rapidly to even higher levels than in SSP3. That would suggest that early gains in per-capita income are not sustainable in an intensive-energy future. On the other hand, mitigation of emissions goes hand by hand with lower poverty levels in both socioeconomic scenarios.




SSP3_45_ag
15
13
11
9
7
5
3
1
-1
2005
2010
2020
2030
2040
2050
Autoconsumption
Ag income only
Mixed
Net buyer


SSP5_8.5_ag
16
14
12
10
8
6
4
2
0
-2
-4
2005
2010
2020
2030
2040
2050
Autoconsumption
Ag income only
Mixed
Net buyer


SSP5_4.5_ag
15
13
11
9
7
5
3
1
-1
2005
2010
2020
2030
2040
2050
Autoconsumption
Ag income only
Mixed
Net buyer