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Gender and Climate Change in Latin America: An analysis of vulnerability, adaptation and resilience based on household surveys[♦]

Lykke E. Andersen,^{*} Dorte Verner[⊗] and Manfred Wiebelt^{*}

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Abstract:

This paper analyzes gender differences in vulnerability and resilience to shocks, including climate change and climate variability, for Peru, Brazil and Mexico, which together account for more than half the population in Latin America.

Vulnerability and resilience indicators are measured by a combination of the level of household incomes per capita and the degree of diversification of these incomes. Thus, households which simultaneously have incomes which are below the national poverty line and which are poorly diversified (Diversification Index below 0.5) are classified as highly vulnerable, whereas households which have highly diversified incomes above the poverty line are classified as highly resilient.

The analysis shows that female headed households in all three countries tend to be less vulnerable and more resilient than male headed households, despite the fact that the former usually have lower education levels.

Keywords: Livelihood diversification, resilience, vulnerability, external shocks, Mexico, Brazil and Peru.

JEL classification codes: D13, I32, O54.

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1. Introduction

At a first glance, it would seem that climate change, and all its associated effects, like temperature increases, floods, droughts, sea level increase, glacier retreat, etc., would be about the most non-discriminating process imaginable on this planet. CO₂ emissions from anywhere in the World spread rapidly across the entire globe and everybody experiences the increasing CO₂ concentration at about the same time.

However, there are complex and dynamic links between gender relations and climate change, and they exist at all the levels from vulnerability to adaptation to mitigation (Terry, 2009). The literature suggest that rural women in developing countries are among the most vulnerable groups (Lambrou and Piana, 2006; IPCC, 2007) because they often are responsible for the most climate sensitive activities, such as agriculture, water collection and fuelwood collection (Byrne and Baden, 1995; Denton, 2009). Within these climate sensitive activities there are also often gendered differences in access to water, land and resources (Sachs, 1996; UN Women Watch, 2009). One of the reasons why women are left with the more climate sensitive activities is gendered differences in labor market access (Buechler, 2009) and mobility (UN Women Watch, 2009).

Manata and Papazu (2009) describe the issue in this way: "The hardships caused by new challenges posed (by climate change) hit the women of the developing world disproportionately hard and exacerbate the already existing inequalities between the sexes. This is due to the division of labour between the sexes, which places the primary burden of natural resource management on the women, making women more vulnerable than men to the consequences of climate change, as well as making great demands on women's adaptive capabilities."

Research on mobility and migration patterns suggests that in times of disaster and stress, such as those that might arise from climate change, men tend to migrate while leaving women and girls behind to cope. The resulting increased domestic and work burdens make it difficult for them to continue their existing income-generating activities, let alone take up additional opportunities (Denton, 2009).

The fact that women and girls are often responsible for most of the unpaid care tasks around the household also means their lives are directly affected by the changes brought about by climate change. They often have to walk further to find increasingly scarce food, fuel and water, as well as caring for family members who are susceptible to the health risks linked to climate change. For example, climate change is expected to cause more extreme precipitation patterns, with more droughts and more floods (IPCC, 2013), and in both cases it is typically women that have to work harder to obtain water during droughts, and dealing with the mess and increased disease

burden caused by floods (Denton, 2009). As a result, women and girls find themselves with less time for education, income-generating activities or participation in community decision-making processes, further entrenching unequal gender relations (Skinner, 2011).

There may also be gendered differences in spending patterns. Households that spend a larger share of their income on food may be particularly vulnerable to food price increases brought about by climate change (FAO, 2011).

However, gender roles and relations are highly context specific and therefore must be studied and addressed in local contexts (Verner, 2012).

In this paper we will analyze gender differences in vulnerability and impacts of climate change in several Latin American countries using information from household surveys regarding the composition of households, the sources of incomes, and the patterns of spending. We apply the methodology of Andersen & Cardona (2013) to estimate the level of vulnerability for different household types.

Due to the nature of the household data that we are analyzing, we cannot analyze intra-household inequalities in vulnerability to climate change. Instead we compare and contrast households that are female and male headed in order to analyze gender differences in vulnerability to climate change.

The rest of the paper is organized as follows. Section 2 explains the methodology for measuring vulnerability and resilience, which is adopted from Andersen & Cardona (2013). Sections 3 to 5 present three cases studies from Peru, Brazil, and Mexico, respectively. Section 6 provides conclusions and policy recommendations.

2. Methodology

2.1. *Defining household types*

In Latin America, the husband is usually the designated head of household by default, and only in special circumstances will that default rule be broken. One such case is obviously one-person households involving only a woman. Another case is single-carer households with kids or older dependents. And a final, much rarer, case is households which do include a husband, but he is so weak (physically disabled, mentally challenged, alcoholic, absent, etc.) that the default option is not considered reasonable and the woman has to take on the role as head of household.

Thus, the particular vulnerability of some female headed households does not necessarily stem from the fact that the head is a female per se, but rather from the sometimes very complicated situation that has lead the household to become female headed in the first place.

There is potentially a big difference in vulnerability between a young single woman who has chosen to remain single, and a single mother who has ended up as a single-carer because the husband died or disappeared. Thus, a careful analysis should distinguish between different types of female headed households.

According to this argument, we will analyze five different types of male headed households as well as five different types of female headed households. Table 1 shows the approximate distribution of all households among these household categories, in total and by rural and urban location. The table uses the 2008 Peruvian national household survey as an example. The most common household type is the classic nuclear family, headed by a male with a spouse and one or more children. About half of all households fall in this category. Less than a fifth of all households in Peru are female headed.

The most common type of female headed households is other female headed households in urban areas. These are non-traditional households headed by a female, without a spouse or partner, but with other income earning adults and possibly some dependents. It can, for example, be a grandmother with grown children and grandchildren living in the house. Or it can be a couple of adult sisters living together.

As we can see in Table 1, single-carer households are about 3 times more likely to be headed by a woman than by a man, while dual-carer households are about 30 times more likely to be headed by a man. Since it is likely more complicated to be a single care-giver than to share the burden between two adults, this asymmetry alone is enough to suspect that female headed households may be more vulnerable than male headed households.

Table 1: Distribution of households by type (% of all households)

Type of household	Peru, 2008		
	Rural	Urban	Total
Male headed	40.2	40.7	80.9
- Single male	1.4	1.0	2.5
- Male headed couple without dependents	9.8	8.2	18.0
- Male headed couple with dependents	24.7	25.2	49.9
- Male headed single-carer household	1.2	1.3	2.5
- Other male headed household	3.1	5.0	8.0
Female headed	6.8	12.3	19.1
- Single female	1.3	1.1	2.4
- Female headed couple without dependents	0.1	0.2	0.4
- Female headed couple with dependents	0.5	1.3	1.8
- Female headed single-carer household	2.8	3.8	6.6
- Other female headed household	2.0	5.8	7.9
Total	47.0	53.0	100.0

Source: Authors' elaboration based on national household survey data.

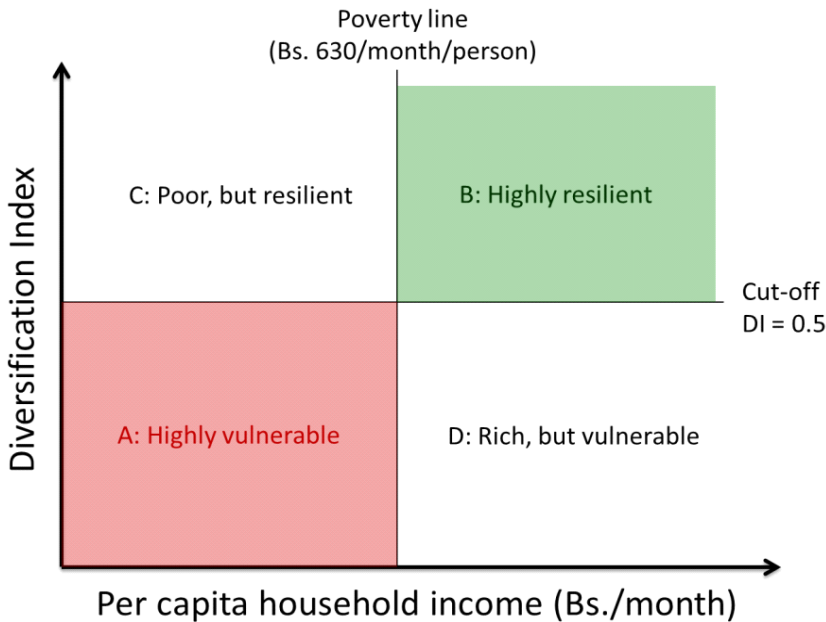
2.2 Measuring vulnerability

In order to explore which of these types of households can be considered particularly vulnerable, we will apply the vulnerability indicators of Andersen and Cardona (2013).

Andersen and Cardona (2013) argue that although vulnerability is a very complex concept, it can usefully be quantified and analyzed at the household level using just two main indicators: i) per capita household income and ii) household income diversification. The groups that are most vulnerable would be those who simultaneously have low levels of income and low levels of diversification.

Andersen and Cardona (2013) develop a simple typology of vulnerability based on these two indicators. Households that have per capita incomes below the national poverty line and have a Diversification Index below 0.5 are classified as highly vulnerable, while households that have per capita incomes above the poverty line and a Diversification Index above 0.5 are classified as highly resilient (see Figure 1).

Figure 1: The four main vulnerability types in Andersen and Cardona (2013)



Source: Andersen and Cardona (2013).

Diversification is the opposite of income concentration, so a simple and logical way of constructing a Diversification Index, DI , is simply one minus the widely used Herfindahl–Hirschman Index of Concentration:

$$DI = 1 - \sum_{i=1}^N p_i^2 \quad (1)$$

where N is the total number of income sources and p_i represents the income proportion of the i -th income source. The value of the Index is zero when there is complete specialization (100% of

total household income comes from one source only) and approaches one as the number of independent income sources increases and no single source dominates household incomes.

The advantage of using the Diversification Index, instead of just the number of different livelihood sources, is that it that the Index is not very sensitive to the grouping of small income sources together with bigger ones. For example, if a household had three sources, contributing 90%, 9% and 1%, respectively, the Diversification Index would be 0.1818. If we lump together the last two sources, the index changes only marginally to 0.1800. This is a reduction of less than 1% in the Index, whereas the reduction in number of livelihood sources would be 33%. This property of robustness to alternative classifications is important as we will necessarily have to make some assumptions about how to classify and group different income sources together (Andersen and Cardona, 2013).

In principle, one should define “sources” in such a way that there is very low correlation across states of nature. Thus, if both the husband and the wife is engaged in subsistence agriculture, that would count as only one income source, because adverse climatic or market conditions would affect both in a very similar way. If they also had some cattle; that would count as an additional income source, as cattle and agricultural productivity are not strongly correlated. Indeed, cattle are often used as a self-insurance mechanism in Latin America. In practice, the exact classification of sources will depend on the amount of detail available in the household surveys of each country. Thus, while the Index can be compared across groups within the same country, it is more difficult to compare across countries.

2.3. Measuring adaptation and resilience

Adaptation can be defined as “the process of taking deliberate actions to become more resilient (or less vulnerable) in the face of adverse shocks or stresses” (Andersen et al., 2014). These “deliberate actions” can be carried out either by households and individuals themselves or they can be implemented as policies and initiatives by institutions and governments. In the typology of Figure 1, that would mean efforts to move households in the direction of the upper-right corner of high incomes and high levels of diversification, and thus high levels of resilience.

The effectiveness of adaptive measures can thus be measured as changes in the levels of income and the levels of income diversification of each household or household type. This has, for example, been done in Andersen et al. (2014). In the present study, however, we will only analyze household surveys at one point in time. Thus, rather than adaptation, we will measure the result of adaptation, which is resilience. As the indicator of resilience we will use the share of households that are located in the upper right corner of Figure 1, that is, households which have per capita incomes above the national poverty line and an income Diversification Index above 0.5.

2.4. Limitations of analyzing gender issues at the household level

It is important to bear in mind that this household level analysis ignores intra-household gender differences in vulnerability. While we can compare the situation of female headed and male headed households, we cannot evaluate the situation of women within male headed households. Thus, many of the arguments mentioned in the introduction about gender and climate change cannot be evaluated using the methodology outlined in this section because they refer to the distribution of responsibilities and power within households.

3. Case study: Gender and climate change in Peru

When the Mega-El Niño of 1997-1998 occurred, cities along the Peruvian coast experienced temperature increases of 6°C in just a few months, while the impact in most other places in the Americas was limited to a couple of degrees or less. The El Niño event also dramatically altered precipitation patterns in Peru, causing extensive damage. Flooding affected 120,000 homes and destroyed 50 bridges, hundreds of kilometers of paved roads, and 50,000 hectares of crops. The unusually warm water off the coast caused fish to migrate to colder, more nutritious waters, causing sharp reductions (about 74%) in the Peruvian fish harvest, which in turn adversely affected the manufacturing chain dependent on fish as a raw material. An excess number of cases of diarrhea were registered as were outbreaks of malaria, cholera, and dengue fever. Due to the breakdown of infrastructure, prices in some places rose by 20-100% due to lack of supply of basic goods. Exports were also adversely affected. Total losses were estimated at close to a billion dollars (Andersen, Suxo and Verner (2009).

While the relationship between global processes of climate change and specific climate events like the 1997-8 El Niño remains unclear, one of the predicted outcomes of climate change is that extreme climate events will occur with greater frequency and severity (Rivero Reyes, 2002). As argued in the beginning of this paper, there are likely to be gendered differences in the impacts of such extreme events, and Rivero Reyes (2002) provides an interesting case study of the gendered differences in responses to El Niño in the Piura region of Peru. During the most critical period of El Niño, when many rural communities were flooded or cut-off, food supplies were extremely scarce, and prices increased to levels beyond the incomes of the poorest households (Rivero Reyes, 2002).

Discrimination against women means that women in rural Piura typically have low access to education, specialist technical assistance, healthcare or control over the family's productive resources. These widespread and profound inequalities put poor women (and their children) in a situation of particular vulnerability to food insecurity during El Niño. Gender inequalities in food distribution and consumption within households were common. Widespread malnutrition also exposed women and children disproportionately to epidemics (acute respiratory and diarrheal infections, malaria, dengue and cholera), which increased significantly during El Niño. Pregnant women were at particular risk from malaria, which causes serious complications during pregnancy (Rivero Reyes, 2002).

Increased migration of men out of the Piura area and into the coastal valleys and cities in search of employment increased the number of temporarily female headed households. The increased burden of household and agricultural work placed on woman in the absence of men posed an acute limitation to their ability to seek paid employment (Rivero Reyes, 2002).

3.1. Gender and vulnerability in Peru

About 19.1% of all households in Peru are female headed, but the percentage is significantly lower in rural areas (14.4%) than in urban areas (23.2%). Table 1 show that about 6.8% of all households are female headed rural households, suspected to be among the most vulnerable to climate change.

The level of per capita household income is practically the same for female and male headed households, despite the fact that female headed households earn less income than male headed households in both rural and urban areas (see Table 2). The average becomes the same because the proportion of female headed households in urban areas is larger, and the incomes of urban households are at least double those of rural households. The sub-group with the lowest incomes is female headed single-carer households in rural areas (2.8% of all households). The next lowest income group is the standard male headed couples with dependents in rural areas (24.7% of all households).

Table 2: Per capita household income, by household type (Soles per month per person)

Type of household	Peru, 2008		
	Rural	Urban	Total
Male headed	330	820	567
- Single male	743	989	846
- Male headed couple without dependents	293	862	548
- Male headed couple with dependents	243	740	491
- Male headed single-carer household	262	597	434
- Other male headed household	487	985	790
Female headed	285	764	568
- Single female	325	879	584
- Female headed couple without dependents	339	1030	783
- Female headed couple with dependents	289	627	527
- Female headed single-carer household	185	571	403
- Other female headed household	374	858	726
Total	322	805	568

Source: Authors' elaboration based on national household survey data.

Female headed households, especially in urban areas, tend to have a slightly more diversified income base than male headed households. The most diversified sub-group is "Other female headed household in urban areas" while the least diversified sub-group is "Single male in urban areas" (see Table 3).

Table 3: Household Income Diversification Index, by household type

Type of household	Peru, 2008		
	Rural	Urban	Total
Male headed	0.462	0.418	0.441
- Single male	0.310	0.256	0.287
- Male headed couple without dependents	0.434	0.345	0.394
- Male headed couple with dependents	0.516	0.475	0.496
- Male headed single-carer household	0.467	0.418	0.442
- Other male headed household	0.497	0.509	0.504
Female headed	0.459	0.477	0.470
- Single female	0.397	0.401	0.399
- Female headed couple without dependents	0.403	0.367	0.380
- Female headed couple with dependents	0.488	0.510	0.504
- Female headed single-carer household	0.513	0.461	0.483
- Other female headed household	0.489	0.544	0.529
Total	0.461	0.433	0.447

Source: Authors' elaboration based on national household survey data.

Combining the information in Tables 2 and 3, we can calculate the probability of being highly vulnerable (simultaneously having a per capita income below the national poverty line and having a Diversification Index below 0.5).

As can be seen in Table 4, the most vulnerable group is female headed households in rural areas; 26.24% of these are classified as highly vulnerable, with the single females in rural areas being the most vulnerable sub-group (37.18% of which are highly vulnerable).

In contrast, female headed households in urban areas constitute the least vulnerable group with only 8.64% classified as highly vulnerable. In total, since there are many more female headed households in urban areas, female headed households on average turn out less vulnerable than male headed households (see Table 4).

Table 4: Probability of being highly vulnerable, by household type (%)

Type of household	Peru, 2008		
	Rural	Urban	Total
Male headed	25.48	11.82	18.86
- Single male	35.48	24.39	30.82
- Male headed couple without dependents	31.17	17.32	24.95
- Male headed couple with dependents	20.97	7.74	14.38
- Male headed single-carer household	33.11	17.53	25.12
- Other male headed household	4.19	1.92	2.81
Female headed	26.24	8.64	15.82
- Single female	37.18	14.37	26.54
- Female headed couple without dependents	27.27	11.39	17.07
- Female headed couple with dependents	12.20	4.64	6.88
- Female headed single-carer household	26.78	13.39	19.23
- Other female headed household	6.04	1.28	2.58
Total	25.62	11.00	18.18

Source: Authors' elaboration based on national household survey data.

3.2 Gender, adaptation and resilience in Peru

Table 5 shows the probabilities of being highly resilient (simultaneously having a per capita income above the national poverty line and having a Diversification Index above 0.5). This probability is considerably higher for female headed than male headed households, especially in urban areas.

Table 5: Probability of being highly resilient, by household type (%)

Type of household	Peru, 2008		
	Rural	Urban	Total
Male headed	26.69	41.79	34.01
- Single male	14.13	16.56	15.15
- Male headed couple without dependents	21.91	29.08	25.13
- Male headed couple with dependents	31.38	51.09	41.20
- Male headed single-carer household	17.75	41.23	29.78
- Other male headed household	46.60	58.06	53.56
Female headed	27.52	50.60	41.18
- Single female	20.47	34.52	27.02
- Female headed couple without dependents	13.64	31.65	25.20
- Female headed couple with dependents	39.02	57.73	52.17
- Female headed single-carer household	24.85	47.71	37.74
- Other female headed household	45.67	63.91	58.92
Total	26.85	44.08	35.61

Source: Authors' elaboration based on national household survey data.

One of the reasons why female headed households tend to be more resilient, is that the female heads are in general several years older (see Table 6), and as shown by Andersen and Cardona (2013), the age of the head of household is one of the main determinants of vulnerability and resilience. Young households are much more likely to be vulnerable, because they have not had time to accumulate human, physical and social capital that can form the basis for a large and diversified income base. They generally also have several young children whom do not contribute to household incomes, but do increase the denominator of the income per capita indicator, and do limit the mother's income earning possibilities.

Table 6: Average age of the head of household (years), by household type, Peru 2008

Type of household	Peru, 2008		
	Rural	Urban	Total
Male headed	48	48	48
- Single male	51	45	49
- Male headed couple without dependents	44	40	42
- Male headed couple with dependents	50	52	51
- Male headed single-carer household	56	49	53
- Other male headed household	52	53	53
Female headed	56	51	53
- Single female	59	47	54
- Female headed couple without dependents	44	42	43
- Female headed couple with dependents	46	47	47
- Female headed single-carer household	55	51	53
- Other female headed household	56	55	55
Total	50	49	49

Source: Authors' elaboration based on national household survey data.

Female headed households are also more resilient despite the fact that they are much less likely to have completed secondary school than male heads. Table 7 shows that only 32% of female heads have completed secondary education, while this is the case for 43% of male heads. The difference is largest in rural areas where only 14% of female heads have completed secondary school.

The sub-group with the lowest level of education, by far, is other female headed households in rural areas. These are likely widowers living with one or more grown children and grandchildren. These are quite resilient, despite the very low levels of education, both due to relatively high per capita incomes (by the standards of rural Peru) and due to these incomes being highly diversified.

Table 7: Percentage of household heads with completed secondary or higher education (%)

Type of household	Peru, 2008		
	Rural	Urban	Total
Male headed	24	63	43
- Single male	35	62	46
- Male headed couple without dependents	34	72	48
- Male headed couple with dependents	20	59	39
- Male headed single-carer household	19	64	42
- Other male headed household	20	54	41
Female headed	14	45	32
- Single female	15	52	32
- Female headed couple without dependents	28	51	45
- Female headed couple with dependents	20	46	38
- Female headed single-carer household	13	48	33
- Other female headed household	9	37	29
Total	22	58	41

Source: Authors' elaboration based on national household survey data.

In summary, according to the classification developed in this study, there were about 5.5 million highly vulnerable households in Peru in 2008. About 84% of these were male headed. Thus, it would be a mistake to focus mainly on female headed households when designing policies to reduce vulnerability, as this would disregard the vast majority of vulnerable households. Instead, it would be important to improve incomes and income diversification among male headed rural households, which concentrate the bulk of the vulnerable population. The most obvious way to do this is to encourage the wives to engage in economic activities that are uncorrelated to the activities of the husbands (typically non-agricultural jobs, such as teaching, health care, commerce, public administration, etc.).

4. Case study: Gender and climate change in Brazil

With more than a third of all households being female headed, Brazil has an unusually large female headship rate compared to other countries in Latin America. This is particularly pronounced in the urban areas of Brazil, where this share reaches 38%, whereas in rural areas it is only 18% (see Table 8). Combined with Brazil's very high urbanization rate of 85%, this means that only 2.6% of all households consist of female headed households in rural areas, the group that is often of concern when discussing gender and climate change (e.g. Rivero Reyes 2002; Lambrou and Piana 2006; and Denton 2009).

Table 8: Distribution of households by type (% of all households)

Type of household	Brazil, 2008		
	Rural	Urban	Total
Male headed	12.0%	53.2%	65.2%
- Single male	1.2%	5.1%	6.3%
- Male headed couple without dependents	2.0%	9.2%	11.2%
- Male headed couple with dependents	7.9%	31.8%	39.7%
- Male headed single-carer household	0.3%	1.3%	1.6%
- Other male headed household	0.7%	5.9%	6.6%
Female headed	2.6%	32.1%	34.8%
- Single female	0.5%	5.6%	6.1%
- Female headed couple without dependents	0.1%	1.8%	1.9%
- Female headed couple with dependents	0.5%	7.0%	7.5%
- Female headed single-carer household	0.8%	7.9%	8.7%
- Other female headed household	0.6%	10.0%	10.6%
Total	14.7%	85.3%	100.0%

Source: Authors' elaboration based on national household survey data.

4.1. Gender and vulnerability in Brazil

There is little difference in per capita incomes between female and male headed households in Brazil. In rural areas, female headed households earn slightly more than male headed households, whereas in urban areas the opposite is the case. Male headed couples with dependents in rural areas is the sub-group with the lowest levels of incomes of all groups (see Table 9).

Table 9: Per capita household income, by household type (Reales per month per person)

Type of household	Brazil, 2008		
	Rural	Urban	Total
Male headed	378	883	790
- Single male	707	1623	1446
- Male headed couple without dependents	615	1227	1118
- Male headed couple with dependents	253	630	555
- Male headed single-carer household	360	751	678
- Other male headed household	555	1105	1048
Female headed	409	812	782
- Single female	769	1464	1407
- Female headed couple without dependents	568	1197	1152
- Female headed couple with dependents	265	592	569
- Female headed single-carer household	263	523	498
- Other female headed household	407	763	742
Total	384	856	787

Source: Authors' elaboration based on national household survey data.

As in the case of Peru, female headed households are significantly more diversified than male headed households. Urban households are also generally more diversified than rural households (see Table 10).

Table 10: Household Income Diversification Index, by household type

Type of household	Brazil, 2008		
	Rural	Urban	Total
Male headed	0.406	0.455	0.446
- Single male	0.217	0.226	0.224
- Male headed couple without dependents	0.338	0.407	0.395
- Male headed couple with dependents	0.438	0.477	0.469
- Male headed single-carer household	0.355	0.354	0.354
- Other male headed household	0.601	0.632	0.629
Female headed	0.461	0.479	0.478
- Single female	0.343	0.322	0.324
- Female headed couple without dependents	0.388	0.430	0.427
- Female headed couple with dependents	0.469	0.507	0.505
- Female headed single-carer household	0.410	0.391	0.392
- Other female headed household	0.625	0.625	0.625
Total	0.416	0.464	0.457

Source: Authors' elaboration based on national household survey data.

When combining information on levels of income and income diversification in order to calculate the probability of falling into the highly vulnerable corner of Figure 1, we obtain the results in Table 11. Rural households are more vulnerable than urban households, but within the rural area of Brazil, male headed households are more vulnerable than female headed households.

Table 11: Probability of being highly vulnerable, by household type (%)

Type of household	Brazil, 2008		
	Rural	Urban	Total
Male headed	22.63	8.47	11.08
- Single male	11.21	5.56	6.65
- Male headed couple without dependents	8.16	3.12	4.02
- Male headed couple with dependents	29.87	11.74	15.33
- Male headed single-carer household	22.86	11.97	14.02
- Other male headed household	1.60	0.79	0.88
Female headed	17.61	9.50	10.11
- Single female	6.53	3.80	4.02
- Female headed couple without dependents	6.88	3.58	3.82
- Female headed couple with dependents	27.66	11.87	12.97
- Female headed single-carer household	29.78	21.63	22.40
- Other female headed household	4.59	2.46	2.59

Total	21.73	8.85	10.74
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Source: Authors' elaboration based on national household survey data.

Thus, not only are there quite few female headed, rural households in Brazil (2.6% of all households in Brazil), but they are also significantly less vulnerable than their male headed counterparts (see Table 11). This suggests that there is little reason to worry particularly about female headed, rural households in Brazil.

4.2. Gender, adaptation and resilience in Brazil

The conclusion above is further strengthened by the analysis of resilience, which shows that female headed households are significantly more resilient than male headed households, with the difference being particularly large in rural areas (see Table 12).

Table 12: Probability of being highly resilient, by household type (%)

Type of household	Brazil, 2008		
	Rural	Urban	Total
Male headed	25.68	43.80	40.46
- Single male	10.09	7.99	8.39
- Male headed couple without dependents	25.89	34.55	33.00
- Male headed couple with dependents	23.72	45.73	41.37
- Male headed single-carer household	26.86	26.19	26.32
- Other male headed household	74.48	82.53	81.69
Female headed	38.87	46.65	46.07
- Single female	30.41	19.64	20.52
- Female headed couple without dependents	35.63	40.47	40.13
- Female headed couple with dependents	29.79	50.43	49.00
- Female headed single-carer household	24.90	26.19	26.06
- Other female headed household	71.30	76.37	76.06
Total	28.04	44.88	42.41

Source: Authors' elaboration based on national household survey data.

As in the case of Peru, one of the reasons that female headed households in Brazil are more resilient than their male headed counterparts is that the female heads are typically several years older (see Table 13).

Table 13: Household head age

Type of household	Brazil, 2008		
	Rural	Urban	Total
Male headed	47	46	46
- Single male	50	46	47
- Male headed couple without dependents	52	49	50
- Male headed couple with dependents	44	43	43
- Male headed single-carer household	53	47	48
- Other male headed household	57	54	54
Female headed	53	49	49
- Single female	65	58	58
- Female headed couple without dependents	48	45	45
- Female headed couple with dependents	39	40	40
- Female headed single-carer household	51	46	46
- Other female headed household	58	54	54
Total	48	47	47

Source: Authors' elaboration based on national household survey data.

Unlike Peru, however, female heads of households actually tend to be slightly better educated than their male counterparts, especially in rural areas (see Table 14). This helps explain why female headed households in rural areas have higher incomes than male headed households.

Table 14: Household head education (% who has conclude high school or more)

Type of household	Brazil, 2008		
	Rural	Urban	Total
Male headed	8.34	37.30	31.95
- Single male	7.64	38.67	32.68
- Male headed couple without dependents	9.35	39.00	33.72
- Male headed couple with dependents	8.58	37.56	31.82
- Male headed single-carer household	6.57	37.04	34.42
- Other male headed household	4.69	32.03	29.16
Female headed	11.23	36.31	34.42
- Single female	9.62	36.82	34.61
- Female headed couple without dependents	16.88	49.32	46.99
- Female headed couple with dependents	19.15	41.61	40.05
- Female headed single-carer household	9.04	37.10	31.31
- Other female headed household	7.73	29.43	28.12
Total	8.86	36.92	32.81

Source: Authors' elaboration based on national household survey data.

5. Case study: Gender and climate change in Mexico

If we classify all households in communities with more than 15,000 inhabitants as urban, about 60% of all households in Mexico can be considered urban. About a quarter of all households are female headed, and this holds for both rural and urban areas (see Table 15). As in the other countries analyzed, the most common household type is the typical nuclear family where the father is designated head of household. This group accounts for slightly more than half of all households. The second most common household type is “Other female headed household” which covers a variety of non-traditional constellations. This group accounts for 10% of all households.

Table 15: Distribution of households by type (% of all households)

Type of household	Mexico, 2008		
	Rural	Urban	Total
Male headed	29.0%	45.4%	74.5%
- Single male	2.1%	2.9%	4.9%
- Male headed couple without dependents	3.0%	4.8%	7.8%
- Male headed couple with dependents	20.6%	32.6%	53.2%
- Male headed single-carer household	0.8%	1.5%	2.3%
- Other male headed household	2.6%	3.7%	6.3%
Female headed	10.5%	15.0%	25.5%
- Single female	1.9%	2.7%	4.6%
- Female headed couple without dependents	0.2%	0.3%	0.5%
- Female headed couple with dependents	1.2%	1.6%	2.8%
- Female headed single-carer household	3.0%	4.7%	7.7%
- Other female headed household	4.3%	5.8%	10.1%
Total	39.5%	60.5%	100.0%

Source: Authors' elaboration based on national household survey data.

4.1. Gender and vulnerability in Mexico

In rural areas, income levels are less than half those in urban areas. In most categories, female headed households have lower incomes than male headed households, with the difference being particularly large in single person households (see Table 16). The gender difference observed for single persons is not just due to gender discrimination in the labor market, but also has to do with differences in age and activities. From Figure 2 below we can see that while single men are mostly in their 30s and 40s, single women are mostly in their 60s and 70s. Single women are almost twice as likely as single men to receive a pension (31% versus 17%) but they are much less likely to receive a labor income (50% versus 74%). Single women are also twice as likely to

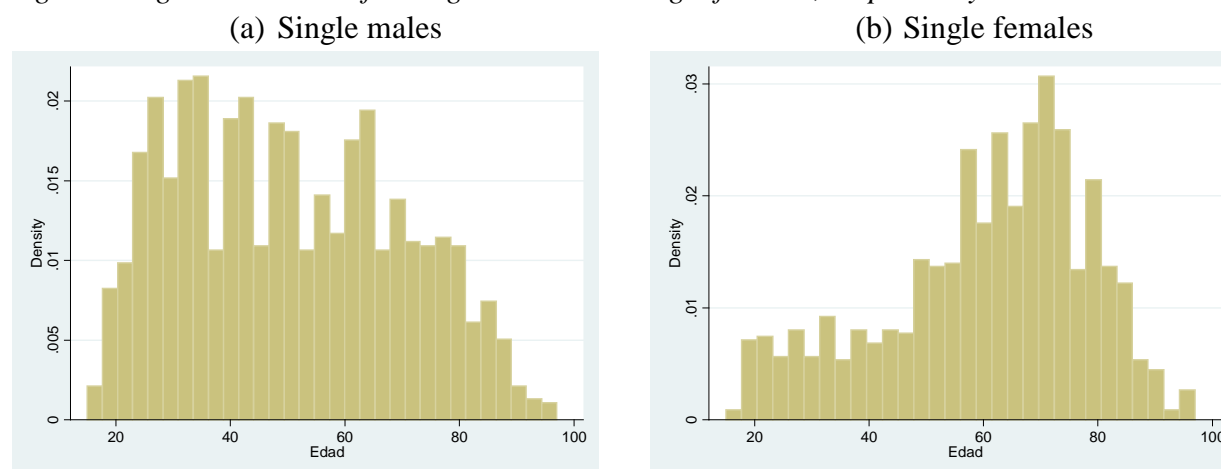
be analphabets as the single males (18% versus 9%), so this is a group to look out for in the vulnerability analysis.

Table 16: Per capita household income, by household type (Pesos per month per person)

Type of household	Mexico, 2008		
	Rural	Urban	Total
Male headed	1973	4246	3411
- Single male	4130	9304	7814
- Male headed couple without dependents	2897	5943	4774
- Male headed couple with dependents	1624	3335	2695
- Male headed single-carer household	1613	4641	3128
- Other male headed household	2943	5370	4662
Female headed	1839	4172	3455
- Single female	2277	6701	5400
- Female headed couple without dependents	2718	6052	5065
- Female headed couple with dependents	1870	3217	2848
- Female headed single-carer household	1438	3051	2441
- Other female headed household	2026	4008	3481
Total	1944	4227	3422

Source: Authors' elaboration based on national household survey data.

Figure 2: Age distributions for single males and single females, respectively



Source: Authors' elaboration based on national household survey data.

The level of income diversification is quite similar between male and female headed households, except among the singles, where the women are substantially more diversified (see Table 17).

Table 17: Household Income Diversification Index, by household type

Type of household	Mexico, 2008		
	Rural	Urban	Total
Male headed	0.488	0.406	0.436
- Single male	0.338	0.193	0.235
- Male headed couple without dependents	0.474	0.392	0.423
- Male headed couple with dependents	0.488	0.409	0.438
- Male headed single-carer household	0.533	0.306	0.419
- Other male headed household	0.606	0.591	0.596
Female headed	0.479	0.433	0.447
- Single female	0.438	0.301	0.341
- Female headed couple without dependents	0.406	0.403	0.404
- Female headed couple with dependents	0.450	0.464	0.460
- Female headed single-carer household	0.424	0.330	0.366
- Other female headed household	0.574	0.554	0.560
Total	0.486	0.413	0.439

Source: Authors' elaboration based on national household survey data.

When combining information on levels of income and income diversification in order to calculate the probability of falling into the highly vulnerable corner of Figure 1, we obtain the results in Table 18. The most vulnerable type of households is female headed single-carer households, especially those in rural areas. On average, female headed households are more vulnerable than male headed households in rural areas, but less vulnerable in urban areas, making female headed households slightly less vulnerable at the national level.

Table 18: Probability of being highly vulnerable, by household type (%)

Type of household	Mexico, 2008		
	Rural	Urban	Total
Male headed	28.07	20.61	23.35
- Single male	25.06	10.72	14.85
- Male headed couple without dependents	21.86	12.56	16.13
- Male headed couple with dependents	31.03	24.33	26.84
- Male headed single-carer household	25.88	30.15	28.02
- Other male headed household	8.95	5.58	6.56
Female headed	32.42	17.96	22.41
- Single female	31.81	12.20	17.96
- Female headed couple without dependents	28.57	14.86	18.92
- Female headed couple with dependents	32.93	19.63	23.26
- Female headed single-carer household	44.40	32.55	37.03
- Other female headed household	18.92	10.13	12.47
Total	29.01	19.90	23.11

Source: Authors' elaboration based on national household survey data.

4.2. Gender, adaptation and resilience in Mexico

Female headed households are slightly more likely to be classified as highly resilient than male households (see Table 19). This is mainly because female headed households are more likely to have unusual household compositions (40% of all female headed households fall in the “Other female headed household” category), which are extraordinarily resilient compared to all other household types. “The other male headed household” category is even more resilient, but only 8% of all male headed households fall in this category, so it does not contribute much to the average for male headed households.

Table 19: Probability of being highly resilient, by household type (%)

Type of household	Mexico, 2008		
	Rural	Urban	Total
Male headed	19.02	31.89	27.16
- Single male	15.98	7.78	10.14
- Male headed couple without dependents	22.30	25.67	24.38
- Male headed couple with dependents	16.91	31.23	25.87
- Male headed single-carer household	10.11	15.28	12.70
- Other male headed household	46.06	67.91	61.54
Female headed	19.27	34.43	29.77
- Single female	21.21	18.70	19.44
- Female headed couple without dependents	7.98	30.18	23.61
- Female headed couple with dependents	21.22	37.04	32.72
- Female headed single-carer household	7.65	16.70	13.28
- Other female headed household	31.75	53.06	47.39
Total	19.08	32.56	27.81

Source: Authors' elaboration based on national household survey data.

6. Conclusions and recommendations

This paper has analyzed gender differences in vulnerability and resilience to shocks, including climate change and climate variability, for Peru, Brazil and Mexico, which together account for more than half the population in Latin America.

Vulnerability and resilience are measured by a combination of the level of household incomes per capita and the degree of diversification of these incomes. Thus, households which simultaneously have incomes which are below the national poverty line and which are poorly diversified (Diversification Index below 0.5) are classified as highly vulnerable, whereas households which have highly diversified incomes above the poverty line are classified as highly resilient.

The analysis shows that female headed households in all three countries tend to be slightly less vulnerable and more resilient than male headed households. When looking at sub-groups, some exceptions can be found, though. Female headed households in rural Peru are slightly more vulnerable than their male counterparts, and female headed households in urban Brazil are more vulnerable than male headed households in urban Brazil. The latter is due mainly to a relatively large and highly vulnerable group of female headed single-carer households in urban Brazil.

In virtually every comparison do female headed households come out as more resilient than male headed households, and this is despite the fact that the former usually have lower education levels (except rural Brazil, where female headed households are better educated than male headed households).

These findings seem to contradict conventional wisdom as well as the arguments found in the literature review in the introductory section of this paper. However, it should be remembered that this analysis ignores intra-household differences in vulnerability. Almost all arguments mentioned in the introduction refer to differences between men and women within the same household, rather than differences between male and female headed households, as was analyzed in this study.

Indeed, this study suggests that female headed households are doing fine compared to male headed households in Latin America. If there would be any disadvantage for women, it would be for women within male headed households, or women recently abandoned by the male head.

Thus, while climate change policy of course should seek to integrate women's concerns, as well as men's, it should do so without making it a special basket case and insulating such issues from the wider discourses about the overall environmental constraints faced by everyone (Denton, 2009).

It would be a mistake to look at women as vulnerable and therefore unable to offer solutions to the problem. Goetz (1991) argues that 'separate women's projects have provided planners with alibis to prove their commitment to the basic needs of women without having to deal with the implications of treating women as equal agents in development.'

Greater attention to gender analysis in climate change should supplement, not supplant, other dimensions, such as class, ethnicity and regional affiliations, which also determine the climate-related implications for men and women (Denton, 2009).

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