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Disaster Risk and Poverty in Latin America: The Peruvian Case Study[♦]

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[♦] Document prepared for the ISDR/RBLAC Research Project on Disaster Risk and Poverty. This document is part of the Latin American contribution to the Global Assessment Report on Disaster Risk Reduction, and the Regional Report on Disaster Risk and Poverty in Latin America. The terms *natural disaster* and *climate-related events* will be used interchangeably, understanding that socioeconomic conditions play a role to explain the intensity and consequences of such phenomena. Thus, no event is strictly or exclusively natural.

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The Peruvian Case Study

Final Version

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1 Introduction

Natural hazards, an increasingly important phenomenon, have a direct impact on the welfare of regions and specific households. The growing incidence and persistence of natural events are strongly linked to increasing vulnerability of households and communities in developing countries. Previous socioeconomic vulnerabilities may exacerbate the impact of a specific event, making more difficult the process of recovery (Vatsa and Krimgold, 2000). Thus, the impact of such events could result in an immediate increase in poverty and deprivation, but they also have long-term, permanent effects (Carter et al, 2007).

Vulnerability to natural disasters is a complex issue, as it is determined by several conditions like economic structure, the stage of development, coping mechanisms available, risk assessment, and frequency as well as intensity of disasters. In this sense, the impact on the poor could be multidimensional.

Lindell and Prater (2003) outline the policy relevance of the issue. First, policy makers can better understand the kind of external assistance that is more effective; second, specific population groups can be identified as more vulnerable; and third, it may be also useful for planning fast response-assistance for natural disasters to avoid long term consequences on welfare. For example, De Janvry, et al. (2006) show that pre-existing conditional cash transfer schemes function as a safety net for those exposed to the disaster. Alpizar (2007) also finds that access to formal financial services mitigates the negatives effects from natural disaster shocks for farmers in El Salvador, as it leads to more efficient production.

Latin America is a region prone to natural disasters and the consequences are still to be understood. Auffret (2003) found that the impact of natural disasters in Latin America and the Caribbean is very significant, especially for the Caribbean, where the volatility of consumption is higher than the one observed in other regions of the world, mainly due to inadequate risk-management mechanisms. The geographical conditions of the continent make it prone to the occurrence of severe intensity events. Yet, part of the impact derives from the vulnerability implied by low levels of socioeconomic development and inadequate risk management (Charveriat, 2000). Such double-causality is extensively discussed in De la Fuente, et al. (2008). Thus, in addition to the fact that the region has been constantly hit by several natural disasters, as hurricanes, drought, floods and earthquakes,[1] the unfortunate fact that poverty and inequality are high and persistent make of this area an interesting field for the analysis of welfare related issues and their relation to disaster shocks.

The main objective of this study is to explore the relationship between natural hazards and poverty in the Peruvian context. Peru is well known to have a high incidence of natural hazards and disasters, apart from being one of the main ENSO centers in the region. Moreover, the lack of formal insurance mechanisms for natural disasters in many areas of the country, particularly in the poorest, as well as the tendency to establish new settlements in high-risk areas, increases the probability of households constantly falling into poverty traps.

This document is divided in the following sections. Section 2 presents the principal objectives and basic information on the data sources to be used. Section 3 uses the Peruvian official database on natural hazards from the National Institute of Civil Defense (INDECI) to give an overview of the temporal and geographical distribution of natural hazards in the country. In section 4 we explore the causal relationships between natural hazards and poverty indicators at the regional and household level. Section 5 is reserved for the conclusions derived from this study.

2 Objectives and Methodology

The principal objectives of this study are the following:

a. To present a general overview of the different natural disasters that affected the country in the past years, with a differentiation by type of disaster and regions affected.
b. To estimate the relation between natural disasters on social indicators at the local level (districts or provinces), establishing a causal link whenever it is possible.
c. To determine the impact of natural disasters on social indicators -income, consumption, assets- at the household level

The main source of information for natural disasters will be the country´s official database of INDECI, containing reports at the district level for different sorts of natural

[1] For example Charveriat (2000) reports an average of 32.4 disasters per year in Latin America and the Caribbean for the decade of nineties.

hazards since the year 2003. This database includes information on the occurrence of events as well as different types of damages caused by them, like number of deaths and affected population, houses destroyed and damaged, crops destroyed, and damages in other public infrastructure. However, all this information is not currently of public access and we were only able to obtain the complete data for the occurrence of events and houses damaged and destroyed.

It is important to mention here that obtaining reliable information on natural hazards at the local level has being one of the most difficult tasks to complete this report. Information from the DesInventar database, whit reports on natural hazards by districts since 1970, was found to be severely biased towards better-off districts because it relies only on the reports appearing in the more important newspapers of Lima. Even though this database can still provide important information on the development of disasters over time, it was difficult to use it for exploring the links with welfare indicators. This problem has being partially solved with the information on the INDECI database. The National System for the Prevention and Attention of Disasters (SINPAD), create since the year 2001, completely change the organization of data collection on natural disasters by decentralizing this responsibility to the lower level possible and creating a newer and user-friendly interface for the report of natural hazards. The Committees for Civil Defense in each district were now the ones trained to manage the new system and periodically upload the reports on the central database. Moreover, there is an increasing effort from INDECI to link the use of this system with the help that districts obtain when a disaster occurred. However, a new limitation appears when using this data as information is only available since the year 2003, which will pose certain restrictions for the analysis of the relationship between natural hazards and welfare indicators. Annexes 1 through 3 present a comparison and a detailed assessment of bias in both databases.

In order to complement the analysis at the local level, we also count with information from the national population census of 1993 and 2005 at the district level, and information on poverty rates (fgt0) and per-capita consumption at the provincial level derived from poverty maps elaborated by combining information from the 1993 and 2005 national population census with information from national household surveys.

For the analysis at the household level we can rely on the National Household Survey (ENAHO) of the National Institute of Statistics (INEI). With this survey it is possible to ensemble a five-wave panel database for the period 2002-2006 with information for more than two thousand households located in rural areas. As this survey is used to calculate and monitor poverty in the country, it allows calculating household' consumption levels as well as income, including also several information on durable and productive assets. What is more, the survey includes a question about the experience of a negative shock in the last 12 months (death of an income's provider, unemployment, natural hazard), and asks also about the consequences of that shock and the strategies undertaken (depletion of assets, borrow money, etc.)

3 Overview of Natural Hazards in Peru (SINPAD DATABASE)

Peru is globally considered among the countries where 'El Niño Southern Oscillation' (ENSO) strikes harder. The Peruvian ocean is the scenario of the encounter of warm waters from the Equator with the colder front coming from the extreme Southern Pacific (better known in Peru as the 'Humbold current'). The predominance of the colder waters from the south explains how, despite being a 'tropical' territory, we find a much more moderate temperature throughout the Peruvian coastal region, with very little precipitation and highly dependent on rainfall at the Western slopes of the Andean highlands.

At the peak years along the ENSO cycles, popularly known as 'El Niño years', the classic pattern of events is a combination of floods in the northern coast with extreme droughts in the southern Andean highlands. The most recent 'El Niño years' have been 1972, 1983, and 1997-98 although the ENSO cycle is a dynamic climatological process and in the recent years the media tend to grade every year having a more or less strong ENSO effect.

The following analysis provides an overview of natural hazards in Peru since 2003. The assessment is focused both upon the frequency as well as the magnitude (measured in terms of number of houses destroyed and number of houses affected) of the events. The bottom line of the assessment is to find a pattern of the most important hazards, their geographical location and their long term cycles. However, since the objective of the study is to assess the relationship between natural disasters and poverty, we are more interested not necessarily in the most catastrophic and isolated events, rather than the most regular and predictable. The latter are usually smaller events but their accumulation over time may cause huge material costs as well as deaths.

We classify the events using the same three categories presented in the INDECI database: External geodynamical, internal geodynamical, and meteorological – oceanographic events. This event typology is used to evaluate the frequency and the magnitude of natural disasters. The principal phenomena associated to these categories are summarized in the following table:

Table 1: Phenomena by event typology

Meteorological – Oceanographic	External geodynamical	Internal Geodynamical
Frost Flood Ocean rise (Maretazo) Precipitation – Hail Precipitation – Rain Precipitation – Snow fall River rise (Avenida) Drought Thunderstorms Strong winds Others meteorological	Alud Alluvium Avalanche Slides Huayco Derrumbe Others external geodynamical	Volcanic Activity Earthquake Others internal geodynamical

Source: INDECI – SINPAD (taken from its webpage: http://www.indeci.gob.pe)

3.1 Frequency and magnitude of all events: Geo-Ext, Geo-Int and Met-Oce

In this section we present the frequency distribution and general magnitude of all phenomena by type of events (geo-ext, geo-int y met-oce).

Table 2 shows a complete information set regarding the frequency distribution of all events happened during the period 2003 – 2008. It presents what percentage of total events corresponds to each category as well as the magnitude of the events, measured by the number of houses destroyed and affected. As it is well known, the total number of houses destroyed measures mainly the effect of the intensive events, while the total number of houses affected gives us information regarding material damage generated by events of lower intensity, that is, the extensive events like rainstorms, frosts, or droughts. These extensive events are more important in the long term assessment of poverty incidence, since vulnerable households that systematically face extensive events would not be able to move out of their socio economic situation.

As expected, the more frequent events during the period 2003-2008 are the meteorological – oceanographic events, representing 84.5% of the total number of events, followed by the external geodynamical events with 11.3% and the internal geodynamical events –including earthquakes- with 4.1%. Among the met – oce events, strong winds and rains account for 24.7% and 22.4% respectively, followed by frosts and floods (14.7% and 10.5% respectively).

In terms of magnitude of the events, as expected almost three fourths (73.8%) of the total number of houses destroyed are generated by geo-int events, mostly by earthquakes. The geo-ext events only account for 3.2% of the total number of houses destroyed in the period, while the met-oce events account for the other 23%. Among the latter, the most damaging events are rains and floods.

Finally, the met-oce events are the most important ones when we measure the magnitude of them by the total number of houses affected, accounting of 84.3% of these damages. Again rains and floods are the most damaging met-oce events. The geo-int events account only 13.6% of the houses affected –mostly by earthquakes-, while the geo-ext events are almost insignificant accounting only for 2% of the total number of houses affected in the period.

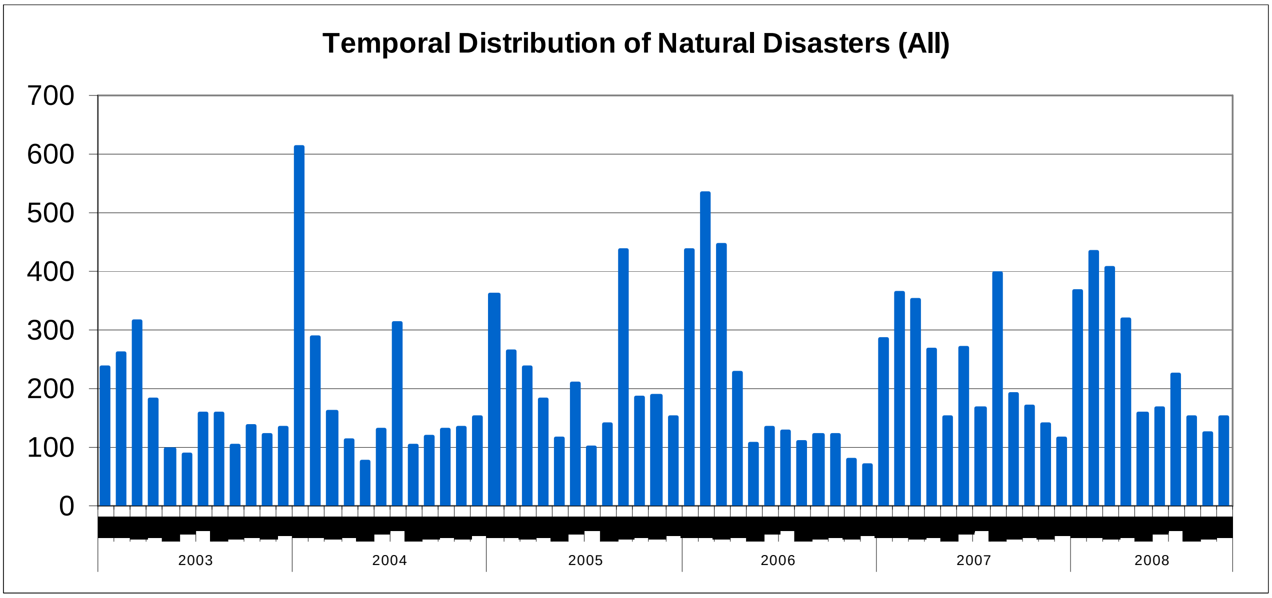
Table 2: Natural Disasters Peru 2003-2008: reported events, houses destroyed and houses affected, by event type

Event Type	Event	Reported events			Houses Destroyed			Houses Affected		
		Frequency	Event %	Event Type %	Frequency	Event %	Event Type %	Frequency	Event %	Event Type %
External Geodynamical	Slide	745	5.00	11.33	2,209	1.74	3.24	3,309	0.91	1.97
	Derrumbe	421	2.83		431	0.34		489	0.13	
	Huayco	340	2.28		926	0.73		1,953	0.54	
	Alluvium	34	0.23		110	0.09		412	0.11	
	Alud	5	0.03		0	0.00		6	0.00	
	Avalanche	4	0.03		1	0.00		0	0.00	
	Others (External Geodynamical)	138	0.93		443	0.35		1,033	0.28	
Internal Geodynamical	Earthquakes	569	3.82	4.14	93,765	73.74	73.83	49,716	13.62	13.74
	Volcanic activity	15	0.10		64	0.05		4	0.00	
	Others (Internal Geodynamical)	32	0.21		56	0.04		439	0.12	
Meteorological – Oceanographic	Strong Winds	3,681	24.72	84.53	3,833	3.01	22.93	24,100	6.60	84.28
	Precipitation – Rain	3,338	22.42		13,149	10.34		176,454	48.35	
	Frost	2,184	14.67		160	0.13		13,234	3.63	
	Flood	1,706	11.46		9,253	7.28		74,861	20.51	
	Drought	545	3.66		0	0.00		2,577	0.71	
	Precipitation - Hail	436	2.93		360	0.28		4,513	1.24	
	Precipitation – Snow Fall	299	2.01		97	0.08		7,524	2.06	
	River Rise	209	1.40		1,132	0.89		2,712	0.74	
	Thunderstorms	109	0.73		83	0.07		111	0.03	
	Ocean Rise (Maretazo)	24	0.16		10	0.01		367	0.10	
	Others (Meteorological – Oceanographic)	55	0.37		1,077	0.85		1,116	0.31	
	Total	**14,889**	**100.00**	**100.00**	**127,159**	**100.00**	**100.00**	**364,930**	**100.00**	**100.00**

3.1.1 Number of events reported

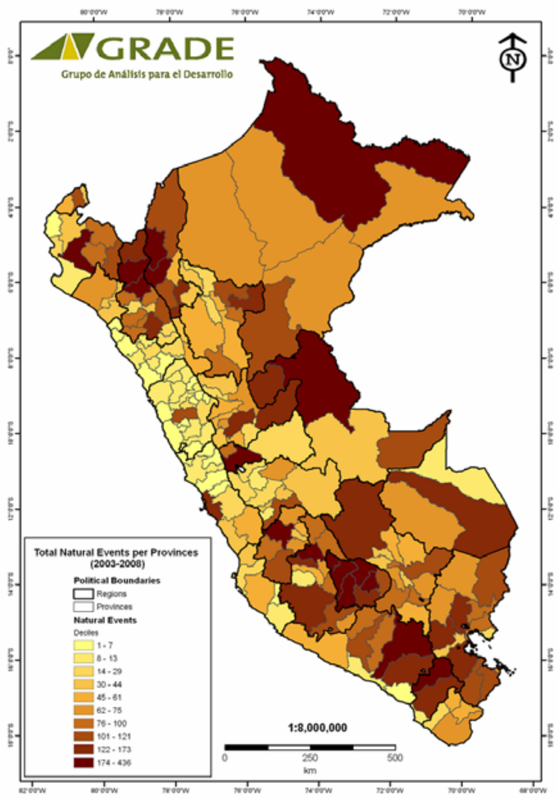
The temporal distribution of all natural disasters in the period 2003-08 is shown in Graph 1.

Graph 1: Temporal distribution of natural disasters (All)



There is a clear seasonality trend in the series, with a larger number of events during the first quarter of each year, most likely due to the rainy season in the highlands.

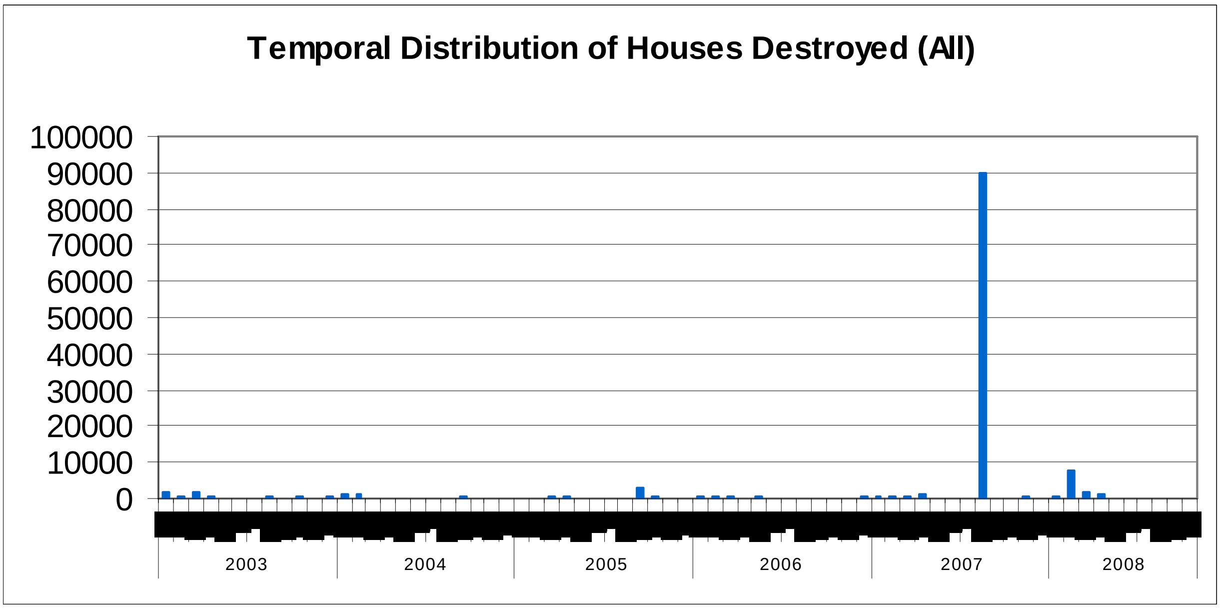
Map 1: Spatial distribution of natural disasters (All)



The spatial distribution of events is presented in Map 1, which reports all events in the period at the Provincial level, adding the total number of events at the district level. The Provinces which report a larger number of events in the period are Abancay, Humanga, Andahuaylas, and Huancavelica in the central – south sierra, Piura in the northern coast, and Bagua and Cutervo in the northern highlands and upper Amazon.

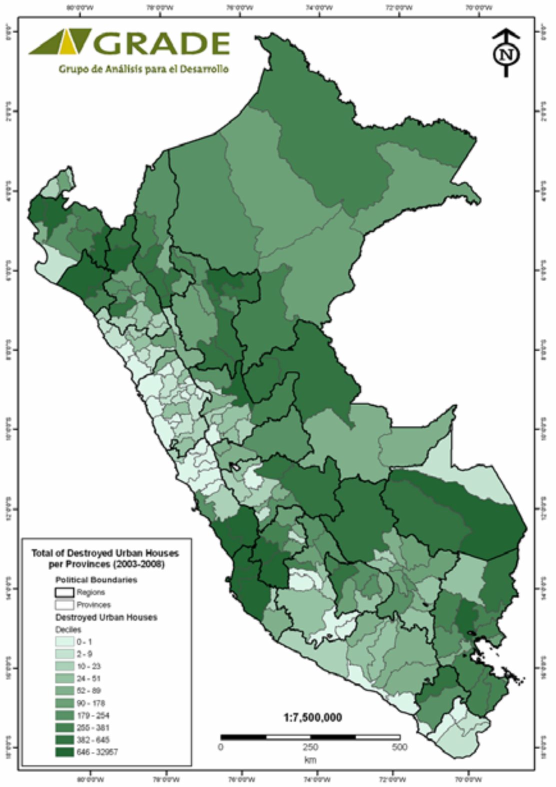
3.1.2 Number of houses destroyed caused by natural hazards

Graph 2: Temporal distribution of houses destroyed



Graph 2 clearly shows the strong impact of the August 2007 earthquake, which accounts for most of the material losses, specially the number of houses destroyed.

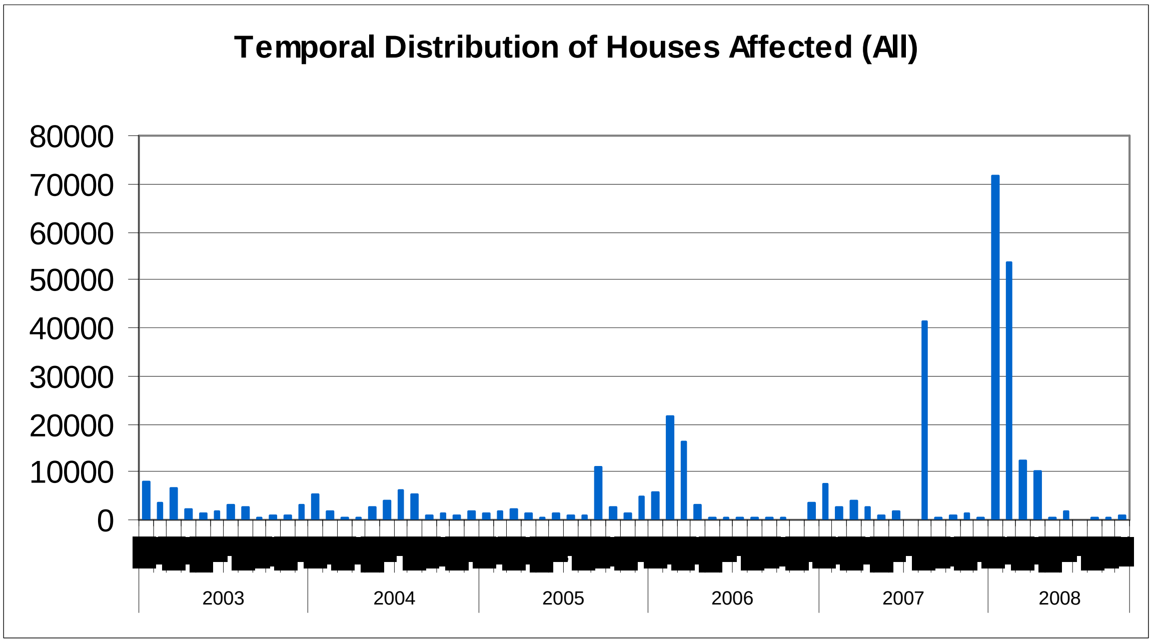
Map 2: Spatial distribution of houses destroyed (All)



The spatial concentration of the total number of houses destroyed is shown in Map 2. The Provinces with more material losses are highly concentrated in the central – southern coast region of Ica and Lima.

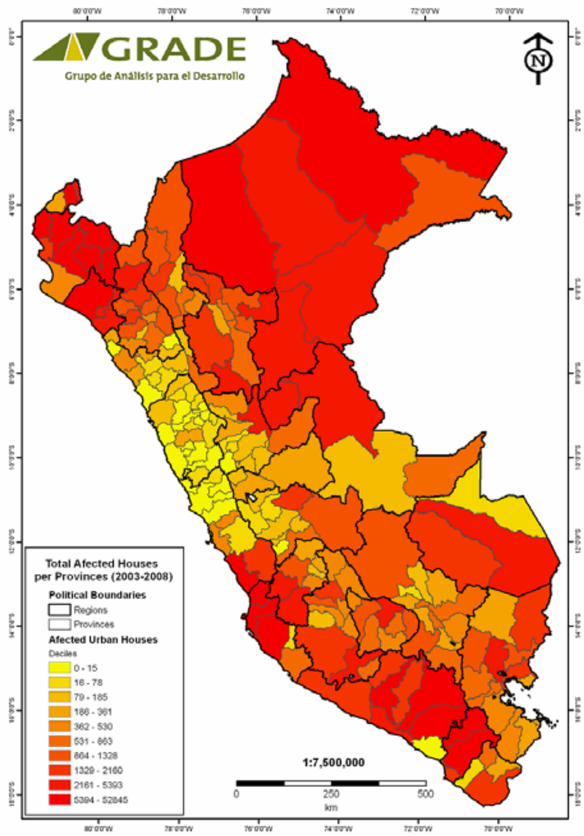
3.1.3 Number of houses affected caused by natural hazards

Graph 3: Temporal distribution of houses affected



Graph 3 shows the temporal distribution of affected houses in the period 2003-2008. It is clear that the August 2007 earthquake has much less relative importance when we use this indicator. Moreover, it is during the last summer season of 2008, with a high incidence of rains and floods, where we find more houses affected in the period.

Map 3: Spatial distribution of houses affected (All)



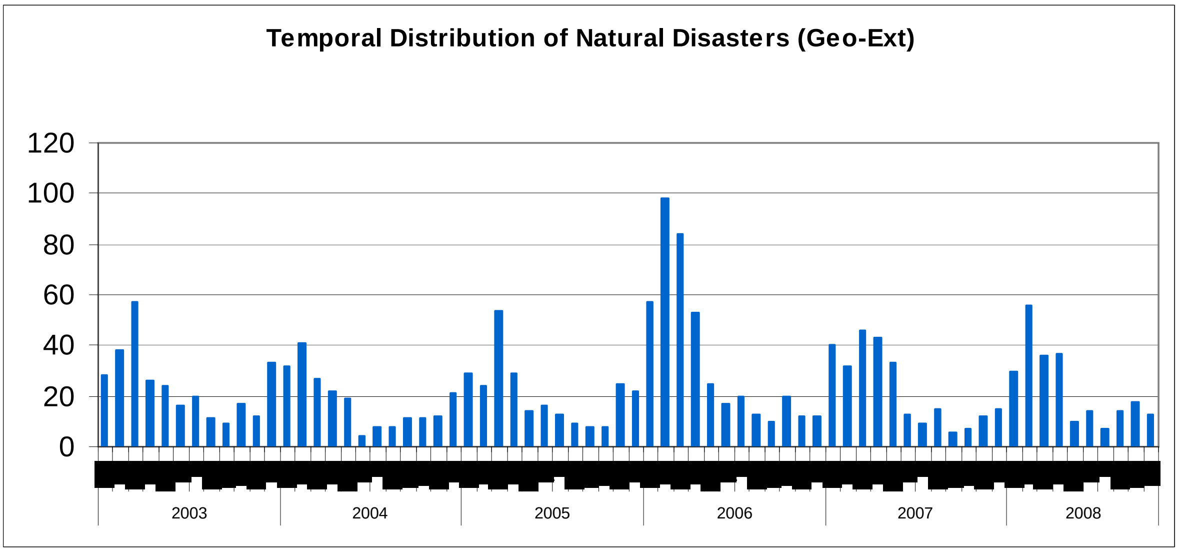
The spatial concentration of the houses affected is shown in Map 3. The Provinces with a larger number of houses affected are concentrated in the northern coast (Piura), where the incidence of rains and floods is traditionally is more important.

3.2 Geo-ext disasters

As we explained before, the geo-ext events account only 11.3% of the total number of events registered in the period. Given the characteristics of these events the magnitude of them are very weak but is equally necessary to present their temporal and spatial distribution.

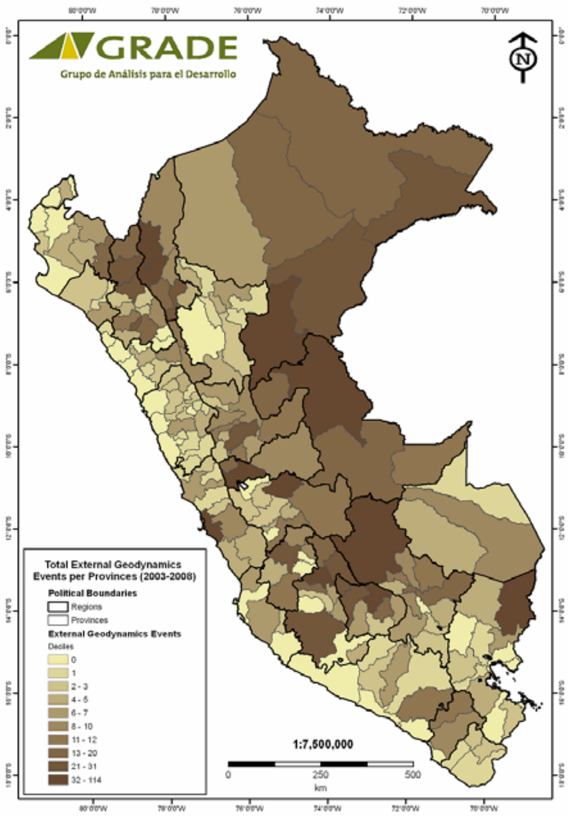
3.2.1 Number of Geo-ext events

Graph 4: Temporal distribution of geo-ext events



Graph 4 presents the temporal distribution of the geo-ext events. Once again, it is during the first quarter of the year where these events occur, increasing the total number of geo-ext events during the last years.

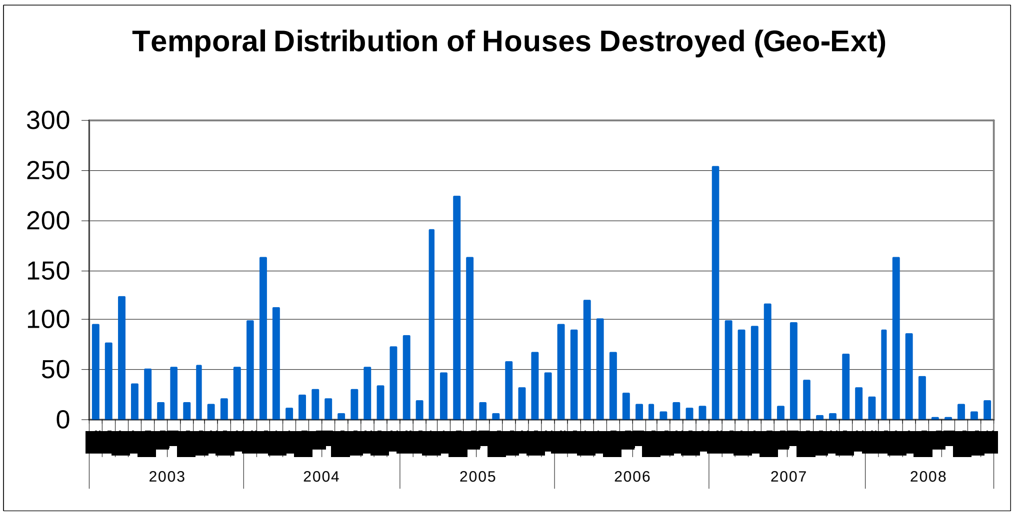
Map 4: Spatial distribution of geo-ext events



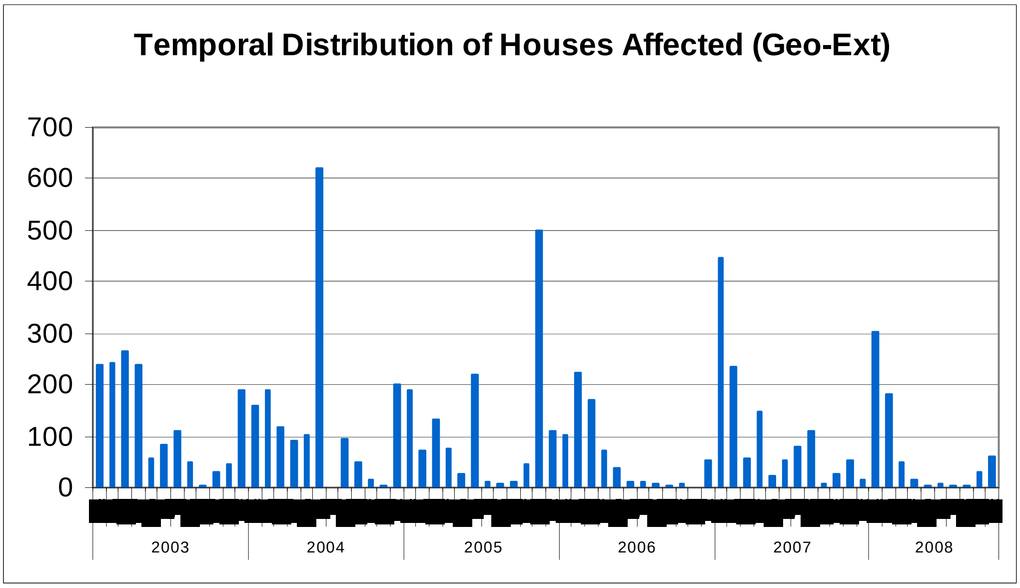
Map 4 shows the spatial concentration of geo-ext events. They are widely spread in the country, but the northern Amazon region of Loreto, Amazonas, and Ucayali, as well as the eastern slopes of the highlands in the central sierra, are the most important regions. Lima appears again with a relative importance frequency of geo-ext events.

3.2.2 Magnitude of the geo-ext events

Graph 5: Temporal distribution of houses destroyed by geo-ext events

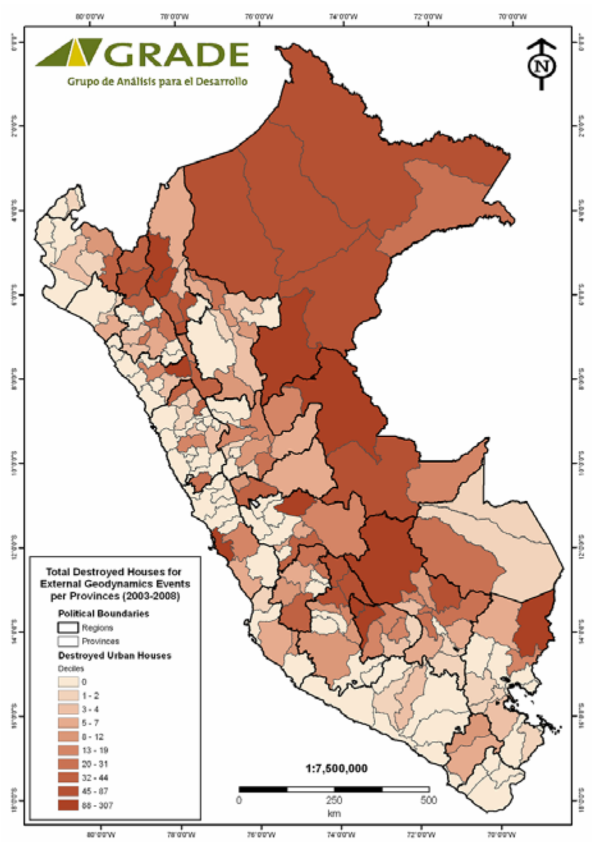


Graph 6: Temporal distribution of houses affected by geo-ext events



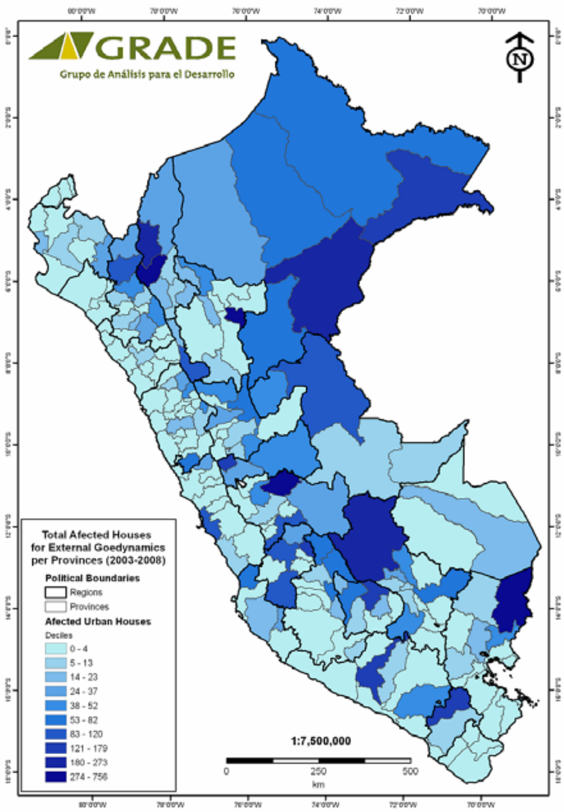
Both, Graph 5 and Graph 6 show the temporal distribution of houses destroyed and houses affected by geo-ext events. They are quite similar, with a striking peak in January 2007, most likely due to the incidence of huaycos, rains and floods.

Map 5: Spatial distribution of houses destroyed by geo-ext events



Map 5 shows the spatial concentration of houses destroyed by the geo-ext events. The regions more affected are located in the northern Amazon and in the central highlands.

Map 6: Spatial distribution of houses affected by geo-ext events



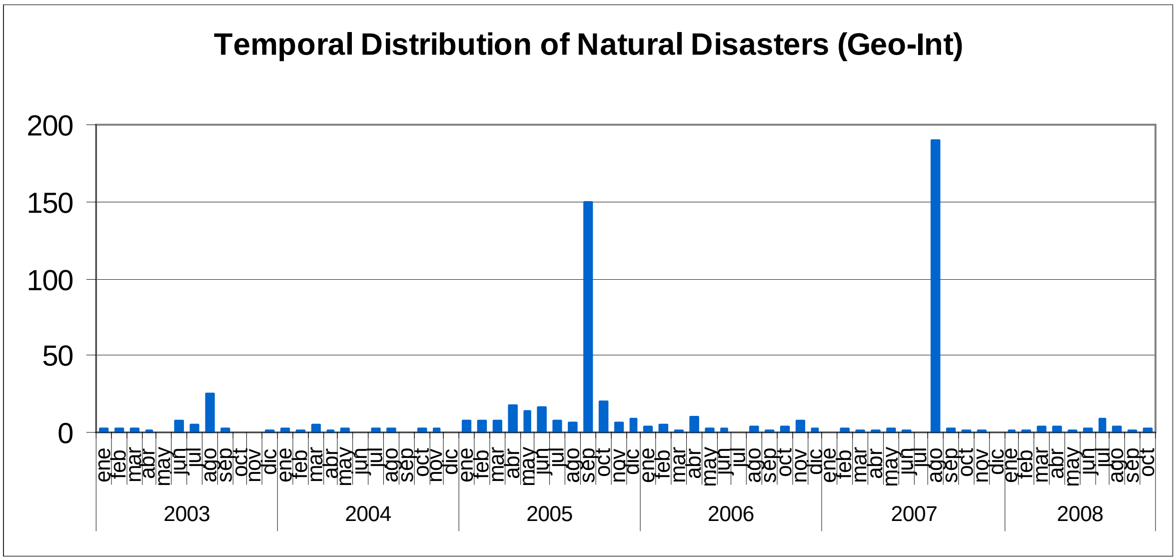
Map 6 shows the spatial concentration of the houses affected by the geo-ext events. As in the previous indicator, they are more concentrated in the northern Amazon and central highlands regions.

3.3 Geo-int Disasters

The geo-int events are basically earthquakes. These are not frequent but with large impacts in terms of deaths and houses destroyed. Let us present a similar assessment of the temporal and spatial frequency and impact of the geo-int events in the period 2003-2008.

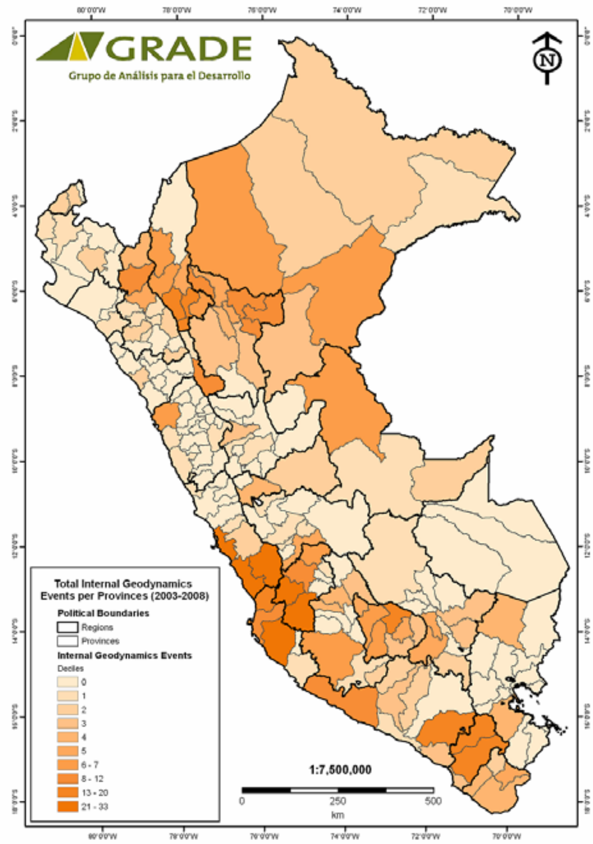
3.3.1 Number of Geo-int events

Graph 7: Temporal distribution of geo-int events



Graph 7 shows us the temporal distribution of geo-int events during the period 2003-2008. Two earthquakes, one of September 2005 (in the northern upper Amazon region), and the latter in August 2007 (in the central coast), explain most of the events. They were the strongest seismic events with a larger number of replicas.

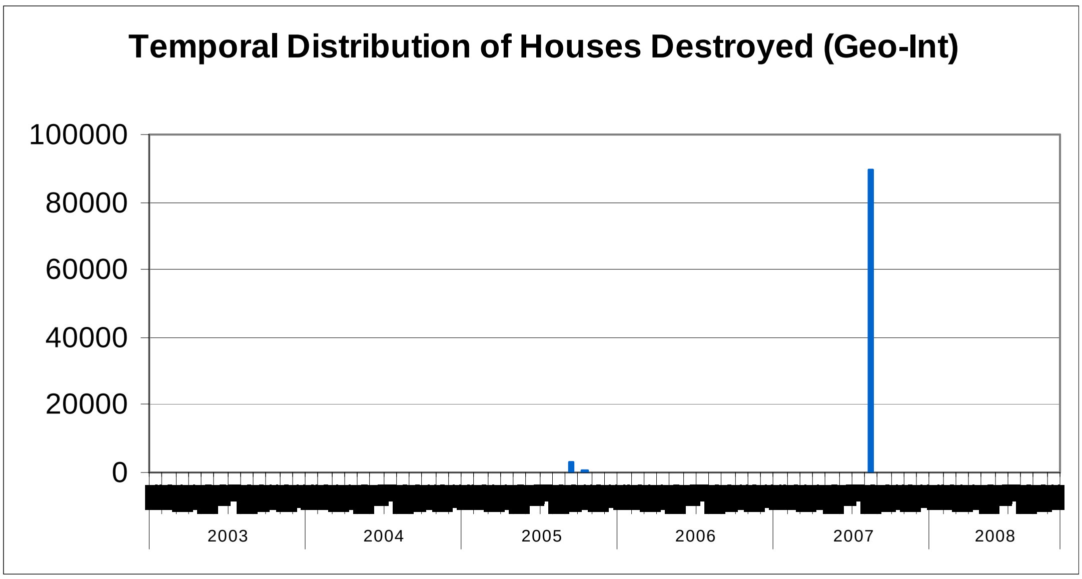
Map 7: Spatial distribution of geo-int events

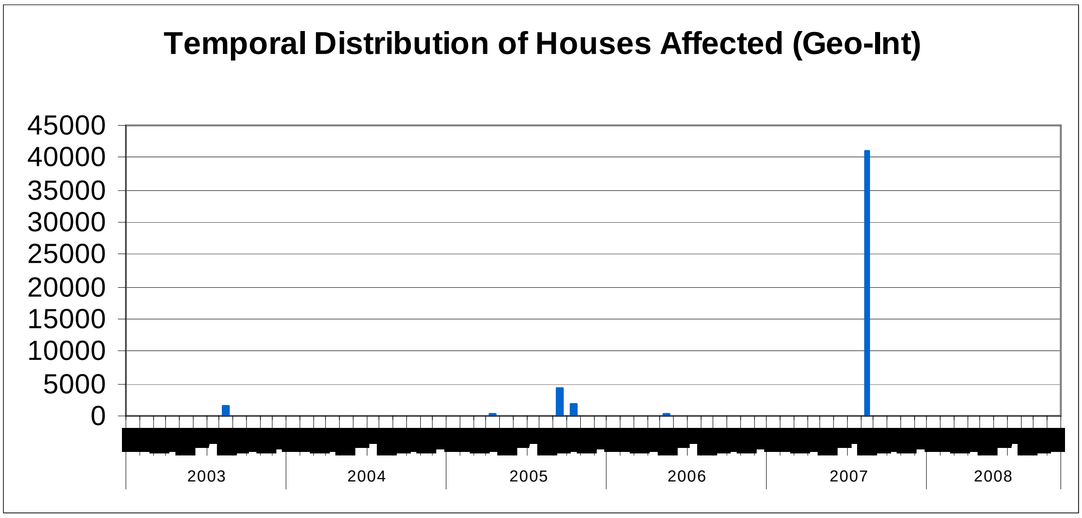


Map 7 shows the spatial concentration of geo-int events in the period. The regions of Ica, Lima, Arequipa and Huancavelica are the most important in this short period.

3.3.2 Magnitude of the geo-int events

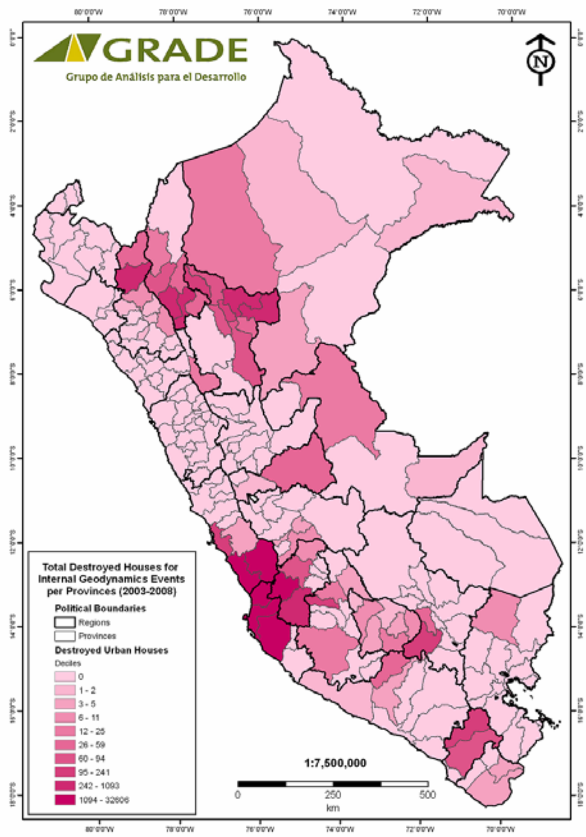
Graph 8: Temporal distribution of houses destroyed by geo-int events





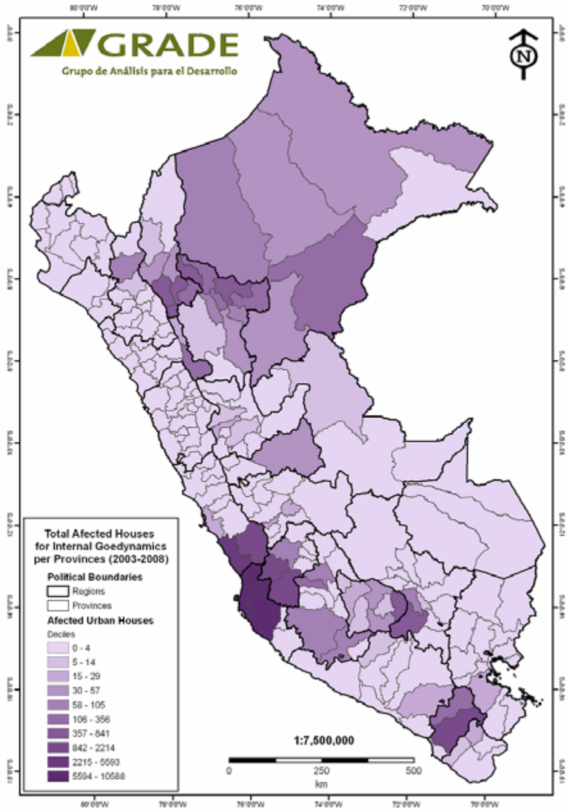
Regarding the magnitude of this geo-int, both Graph 8 and Graph 9 show us that the August 2007 earthquake is the one with hardest damage.

Map 8: Spatial distribution of houses destroyed by geo-int events



Map 8 again shows us the spatial concentration of the number of houses destroyed due, in this case, to the geo-int events. As expected, the regions of Ica and Lima are the most affected, , followed by the Northern Upper Amazon region.

Map 9: Spatial distribution of houses affected by geo-int events



Map 9 shows the spatial concentration of houses affected by geo-int events in the period. As expected, the regions of Ica and Lima concentrate most of the damage.

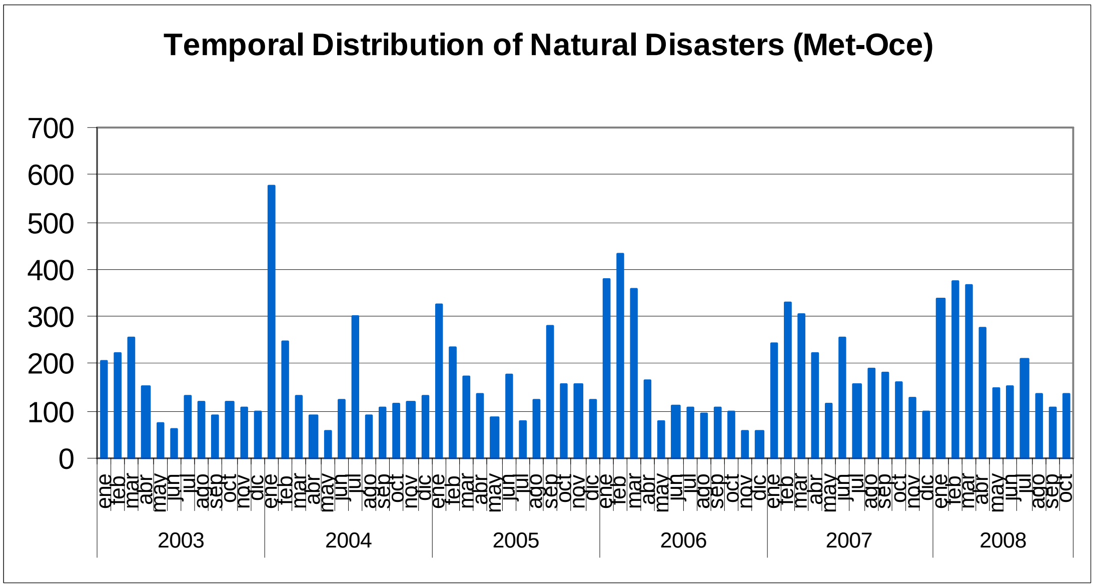
3.4 Met-oce Disasters

As presented in section 3.1, meteorological – oceanographic events account for more than 80% of the total number of events happened during the period 2003-2008. However, this type of events, like rains, floods, strong winds, frosts, or snowfall, do not generate material damage as hardly as other types of events, like the geo – int for example. Hence, these met-oce events only account for 23% of the material damage measured by the total number of houses destroyed in the country for the period 2003-2008.

But the met-oce events are much more important from another material damage perspective: houses affected or damaged. More than 84% of the total number of houses affected by natural disasters in the period 2003-2008 in Peru, were generated by these met-oce events. Hence the accumulated economic losses for most vulnerable households could be of great importance.

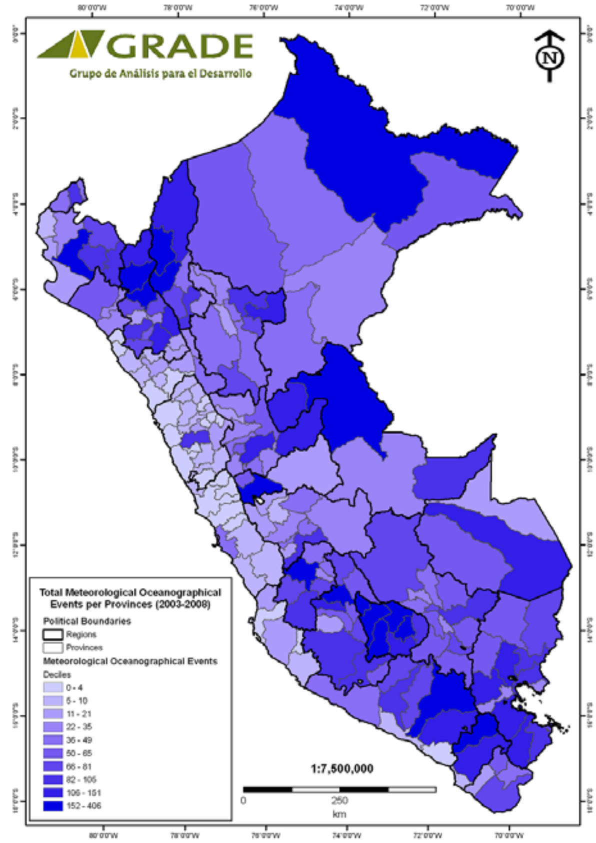
3.4.1 Number of met-oce events

Graph 10: Temporal distribution of met-oce events



The temporal distribution of these met-oce events is shown in Graph 10. Again we can observe a seasonal pattern with relative peaks during the first quarter of the year.

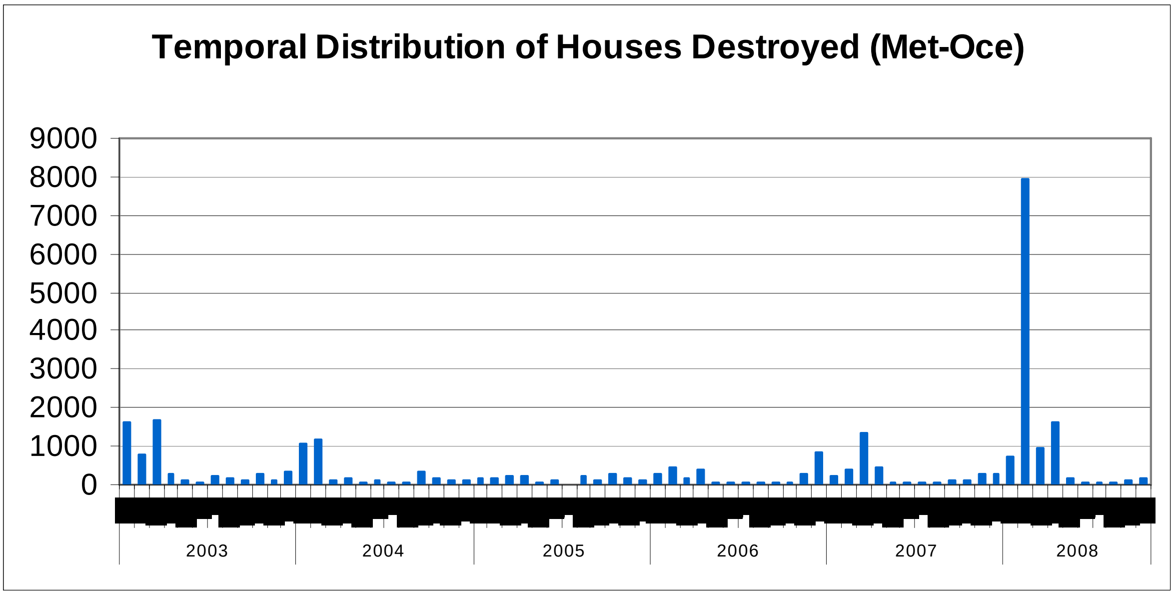
Map 10: Spatial distribution of met-oce events



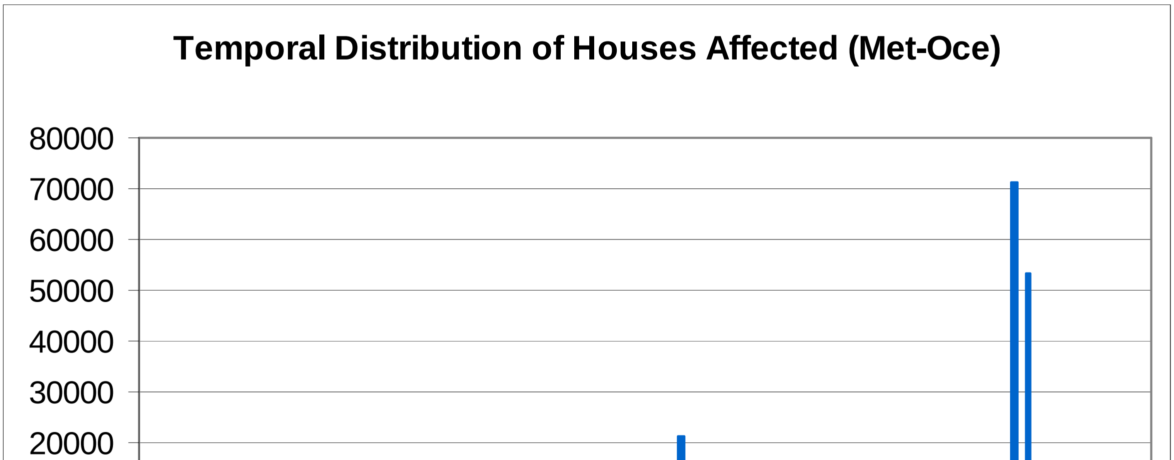
Map 10 shows the spatial distribution of met-oce events happened in the period 2003-2008. Several sub regions in the Peruvian Amazon (Ucayali and Loreto), as well as the central Andes (Huancavelica, Apurimac) and the northern coast (Piura) are the most affected regions.

3.4.2 Magnitude of the met-oce events

Graph 11: Temporal distribution of houses destroyed by met-oce events

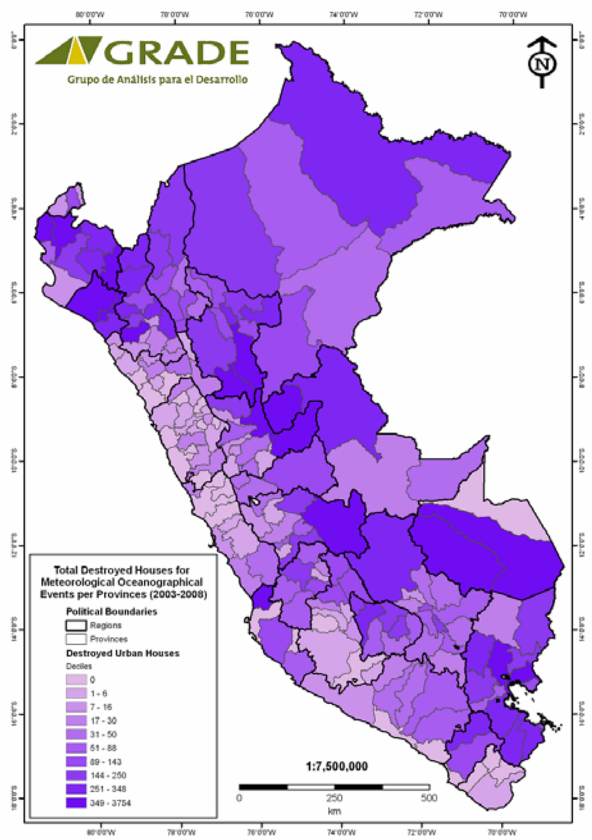


Graph 12: Temporal distribution of houses affected by met-oce events



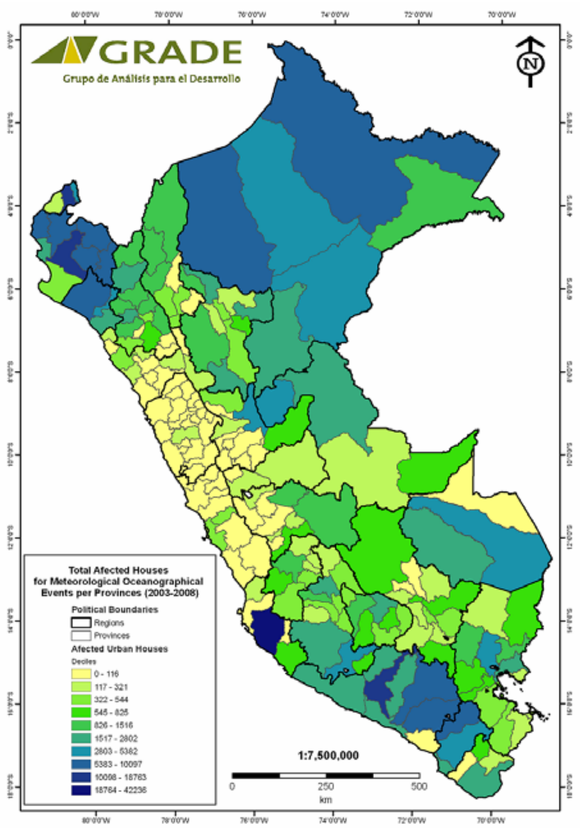
Graph 11 and Graph 12 show the temporal distribution of the material damages associated with houses destroyed by met-oce events happened during the period 2003-2008. There is a clear peak during the last summer of 2008 due to a larger number of rains and floods.

Map 11: Spatial distribution of houses destroyed by met-oce events



The Map 11 shows the spatial distributions of number of houses destroyed by the met-oce events. The classic ‘ENSO signatures’ of the northern coast region of Piura and the central coast region of Ica are clearly an important feature of the map, followed by some sub regions in the Amazon.

Map 12: Spatial distribution of houses affected by met-oce events



Map 12 presents the spatial distributions of the Lumber of houses affected by the met-oce events during the period of 2003-2008. Again the regions of Ica and Piura, along with some regions the northern Amazon are among the most affected.

4 The impact of Natural Hazards on Poverty indicators

4.1 Analysis at the District level

In this section we will try to use the SINPAD database to explore the link between disasters and poverty at the local level. Even though the information in SINPAD appears to be more reliable, the short period of time for which this information is available poses new restrictions for this type of analysis. Poverty indicators at the local level are usually based on Population Census information which, in the case of Peru, is only available for the years 1993 and 2005. In particular, we count with information from Poverty Maps constructed by Escobal and Ponce (2008) using a combination of Population Census information and National Household's surveys. This information is available at the Province level (195) and consists on poverty rates (FGT0) calculated at 1993 and 2005.

Given that SINPAD information is only available for the years 2003-2007, we constructed a variable for the average number of disasters by year for the period 2003-2005. Using this information and other province's characteristics we will explore the effect of disasters on poverty rates at 2005, and then try to expand our analysis to the change on poverty rates between 2005 and 1993. Province' characteristics are presented in Appendix 4.

Table 3 divides all provinces in quintiles using poverty rates at 2005 and shows the average of different variables for each quintile. While provinces in the richest quintile have an average of 6.2 events by year in the period 2003-2005, provinces in the poorest quintile receive an average of 11.2 of the same type of events[2]. This initial evidence of a positive relationship between poverty rates and occurrence of disasters can also be observed in Graph 13 (correlation coefficient=0.19)

Table 3: Characteristics of Provinces per quintiles of poverty rate (2005)

Mean variables	Poverty Quintiles (2005) 1	2	3	4	5
Poverty rate 2005	30.02	52.45	63.16	72.51	83.77
Characteristics of the dwellings					
% with electricity 1993	62.93	36.77	29.05	16.52	12.87
% with water 1993	63.94	41.91	32.02	26.94	21.24
% with sewerage 1993	65.15	40.74	46.43	19.55	20.60
Difference in % with electricity 2005-03	14.17	19.74	20.92	19.55	25.28
Difference in % with water 2005-03	9.83	21.75	28.31	28.72	25.97
Difference in % with sewerage 2005-03	10.58	18.86	19.86	23.47	20.31
Population indicators					
Total population 1993	287,287.62	88,748.33	85,193.59	51,954.49	52,113.44
Difference in population 2005-03	63,689.44	13,887.79	13,815.23	4,720.08	7,805.23
% of rural population 1993	23.02	47.14	58.50	69.54	73.99
Welfare indicator					
Poverty rate 1993	48.38	67.71	66.45	72.74	75.56
Natural disasters indicator					
Average number of natural disasters 2003-05	6.24	6.56	8.98	9.45	11.23
Others variables					
Number of schools 1993	445.95	228.59	250.05	215.64	177.03
Difference in number of schools 2005-1993	460.13	115.87	105.21	55.08	63.59
Kilometers of paved road per province	144,879.80	95,882.51	97,157.59	55,573.84	60,305.05
Mean Altitude	852.74	1,797.97	2,048.56	2,785.62	3,060.30

Graph 13: Scatter of mean of number of disasters 2003-05 and poverty rate at 2005

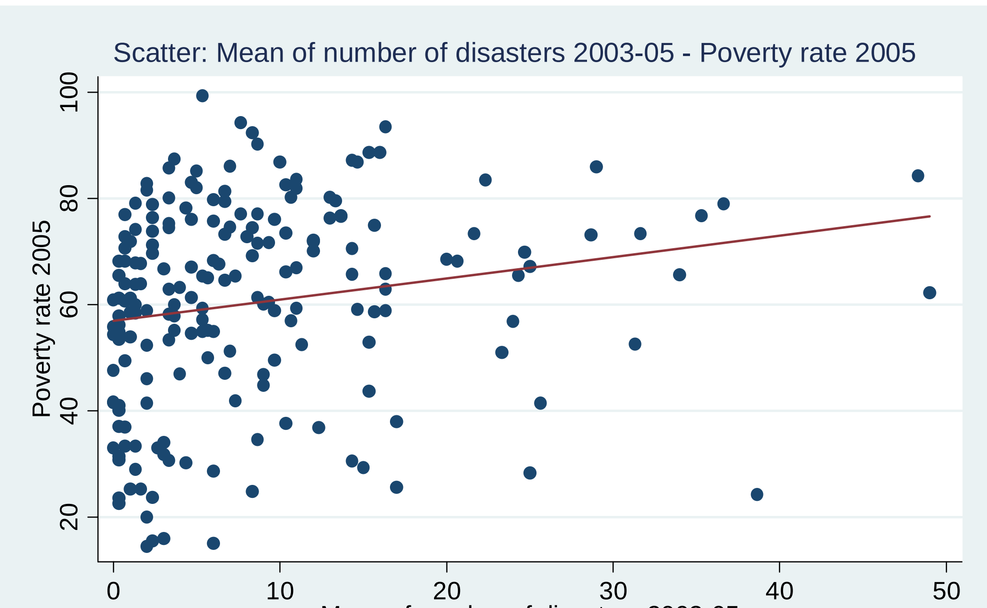


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Table 4 presents the OLS estimation results of different models to explain poverty rates at 2005. For all of them we use the average number of natural disasters by year for the period 2003-2005 excluding strong winds. Model 1 presents the results when using only this variable in the right hand side. Model 2 includes a group of provinces characteristics at 1993, like percentage of population with access to different services, number of schools, percentage of rural population, and kilometers of paved road, as well as a time invariant variable for the mean altitude of districts in the province. As some of these variables are strongly correlated with others (see Correlation table in the Annex), Model 3 tries to correct this issue by eliminating some of them. Model 4 to Model 6 replicate the previous models but adding to the explanatory variables the poverty rate at district level in 1993.

VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Mean of number of natural disasters 2003-05	0.400***	0.179**	0.226**	0.197*	0.159*	0.163*
	(0.149)	(0.0869)	(0.0883)	(0.119)	(0.0898)	(0.0905)
Porc with electricity 1993		-0.277***			-0.239***	
		(0.0907)			(0.0916)	
Porc with water 1993		-0.255**	-0.460***		-0.217*	-0.401***
		(0.115)	(0.0471)		(0.124)	(0.0545)
Porc with sewerage 1993		-0.0748			-0.0374	
		(0.0623)			(0.0718)	
Number of education centers 1993		0.00191	0.0013		0.00201	0.00178
		(0.00153)	(0.00138)		(0.00156)	(0.00153)
Number of kilometers of road per province		-2.56e-05*	-2.85e-05**		-2.52e-05*	-2.62e-05*
		(1.37e-05)	(1.36e-05)		(1.36e-05)	(1.35e-05)
Altitude		0.00422***	0.00566***		0.00439***	0.00566***
		(0.000947)	(0.000705)		(0.00100)	(0.000695)
Porc of rural population 1993		-0.0679			-0.00716	
		(0.0912)			(0.112)	
Poverty rate 1993				0.487***	0.0766	0.150***
				(0.0682)	(0.0661)	(0.0566)
Constant	56.99***	76.60***	65.90***	26.22***	63.84***	53.97***
	(1.859)	(8.819)	(2.938)	(4.829)	(15.13)	(5.691)
Observations	195	194	194	188	188	188
R-squared	0.036	0.663	0.633	0.261	0.667	0.65

Robust standard errors in parenthesis
*** p<0.01, ** p<0.05, * p<0.1

Table 4: OLS Estimates, Dependent variable: Poverty rate 2005

The coefficient for the disasters variable is positive and significant for all models presented. As this variable is measured only for the period 2003-2005, and provinces characteristics relate to 1993, there is less scope for an indirect effect of disasters via changes in other variables like the ones on access to services. The inclusion of the variable for poverty rate at 1993 does not change substantially the regressions results. Based on the results of Model 3 and Model 6 we can state that the effect of disasters on poverty rates ranges between 0.16 and 0.23. This means that one extra event a year will increase poverty rates at the provincial level by these amounts. As the sample standard deviation of the disaster variable is around 9, this would imply that an increase in the average number of disasters by one standard deviation from the mean will race poverty rates by at least one percentage point.

A similar regression analysis is applied to explain changes in poverty rates between 2005 and 1993 at the provincial level. Results for different specifications are presented in the following table.

Table 5: Regression, Dependent variable: Difference in poverty rate 2005-1993

VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Mean of number of natural disasters 2003-05	-0.0343	-0.187	-0.244*	-0.0745	-0.205	0.187**	0.161*
	(0.126)	(0.137)	(0.135)	(0.140)	(0.136)	(0.0882)	(0.0889)
Porc with electricity 1993			0.326***		0.239**		
			(0.118)		(0.115)		
Porc with water 1993			-0.0711		-0.109		
			(0.121)		(0.118)		
Porc with sewerage 1993			0.277***		0.340***		
			(0.0775)		(0.0790)		
Total population 1993			-3.79e-05*		3.04E-05		
			(2.02e-05)		(3.73e-05)		
Number of education centers 1993			0.0302**		0.0203		
			(0.0147)		(0.0153)		
Number of kilometers of road per province		4.55E-06	-1.08E-05		-1.08E-05	-2.48e-05*	-2.78e-05**
		(1.73e-05)	(1.42e-05)		(1.42e-05)	(1.33e-05)	(1.30e-05)
Altitude		0.00453***	0.00745***		0.00892***	0.00409***	0.00432***
		(0.00110)	(0.00131)		(0.00123)	(0.000791)	(0.000819)
Porc of rural population 1993		0.104	0.398***		0.413***	0.341***	0.438***
		(0.0657)	(0.124)		(0.114)	(0.0441)	(0.0503)
Difference in population 2005-03					2.35E-05		8.57E-06
				(8.26e-05)	(9.85e-05)		(6.05e-06)
Difference in porc with electricity 2005-03				-0.0547	-0.209**		0.0227
				(0.116)	(0.0960)		(0.0762)
Difference in porc with water 2005-03				0.0971	-0.190**		-0.233***
				(0.101)	(0.0923)		(0.0565)
Difference in porc with sewerage 2005-03				0.124	0.05		0.0722
				(0.156)	(0.156)		(0.0994)
Difference in number of education centers 2005-03				0.00337	-0.0363**		
				(0.0110)	(0.0142)		

Poverty rate 1993						-0.804***	-0.822***
						(0.0537)	(0.0592)
Constant	-5.623***	-19.89***	-62.41***	-8.771**	-57.13***	20.73***	19.95***
	(1.826)	(3.754)	(10.15)	(3.639)	(10.28)	(3.962)	(4.342)
Observations	188	188	188	188	188	188	188
R-squared	0	0.152	0.268	0.017	0.323	0.63	0.661

Robust standard errors in parenthesis
*** p<0.01, ** p<0.05, * p<0.1

Models 1 and 2 present the results of the OLS regression when using the disasters variable alone and with a few provincial characteristics. The coefficient for the disasters variable is not significant in any case. Model 3 adds to the regression other variables at 1993, related to different access to services, while Model 4 adds only the change of those variables between 2005 and 1993. According to these models there is no significantly positive effect of disasters on the change in poverty rates. The same result is obtained when including all previous variables together (Model 5). However, if we include in the right hand side the initial level of poverty in 1993 (Model 6 and 7), we obtain again a positive and significant effect of the disasters variable. In this case, the occurrence of one extra event will increase the change in the poverty rate between 2005 and 1993 by a minimum of 0.16 percentage points.

4.2 Analysis at the Household level

4.2.1 Data and Descriptive Statistics

The quantitative analysis is based on the national household survey ENAHO, conducted by the National Institute of Statistics (INEI). It has been possible to ensemble a five-wave unbalanced panel database for the period 2002-2006 with information for 2,091 households at rural level. However, most of these households do not have information for all the five periods of the survey. Some households were not encountered again, while others were not included in one year, but appear again in another wave. Due to these problems, the balance panel database just includes 831 households.

ENAHO is used to calculate and monitor poverty in the country, consequently it allows calculating household' consumption levels as well as income. Furthermore, it includes valuable information regarding durable and productive assets and access to public services. The survey also includes a question about the experience of a negative shock in the last 12 months (death of an income's provider, unemployment, natural hazard), and asks also about the consequences of that shock and the strategies undertaken (depletion of assets, borrow money, etc.)

1. Table 6 shows the average of the most important variables use in our analysis for the year 2002. Those are the "initial conditions" that characterized the households of our sample (see Appendix 6 and
2.
3.

Appendix 7 for a full report of the descriptive variables for the unbalance and balance panel, respectively). There are statistically significant differences between the households that report having experienced a natural disaster in 2002 and the ones that did not. The human capital variables show more positive results for the households that experienced a shock. By contrast, those households had less access to piped water, electricity and fixed telephone. A lower percentage of those households received income from renting private properties, in comparison with the households that did not experience a shock. Furthermore, households that experienced a shock in 2002 were less integrated to the market, since a lower percentage of their total income came from monetary sources. This is consistent with the fact they had a higher percentage of income that came from agricultural activities. These results could be signaling some bias in the report of natural disasters by households more involve in traditional agriculture and with less access to market and services. Notice that, those households were poorer in 2002, but the result is not statistically different from the poor rate of the households that did not experience a shock. The analysis of the impact of natural disaster will take into account this feature of the sample.

Table 6: Profile of households, if whether they suffered a natural disaster (2002)

Variable	Natural disaster (NO)	Natural disaster (YES)	Difference (p-value)
PERCENTEGES			
Human capital			
Gender of the hh (woman)	14.13	7.01	**
HH is literate	54.52	82.68	***
At least one children don't go to school	4.27	0.00	***
Characteristics of the dwellings			
Low quality of dwelling's materials	22.38	19.68	

Owner of house	84.39	92.59	
Water: access to public network	42.21	18.08	***
Sewerage connected to public network	57.07	47.49	
Electricity as lightning source	37.07	20.56	*
Telephone (fixed)	0.36	0.00	*
Welfare indicator			
Poor [consumption]	63.97	75.44	
Poor [assets]	40.69	28.56	
Risk management and coping indicators			
Receive income from renting private properties	9.86	2.58	**
Remittances			
Receive local remittances	27.58	18.38	
Receive international remittances	0.62	1.31	
Remittances (from at least one source)	28.14	19.69	
Food assistance (at least one member)			
Glass of milk	42.20	58.37	
Popular dinning room	7.22	1.53	**
Scholar breakfast	20.39	52.74	***
Other program	7.00	19.95	
Proportion of beneficiaries (as a proportion of total members)	24.97	40.43	***
Welfare indicators			
Monetary expenses (as % of total expenses)	59.10	57.38	
Monetary income (as % of total income)	59.39	48.70	***
Participation in agricultural activities			
Percentage of members that have as main activity agriculture	42.78	48.94	
Percentage of members that have as secondary activity agriculture	8.31	12.09	
Percentage of income from agricultural activities	34.89	42.15	*
AVERAGES			
Human capital			
Age of the hh	48.11	46.30	
Average years of education of the members of the household	4.32	4.41	
Total years of education of the members of the household	20.00	21.24	
Average years of education of the hh	4.46	5.04	
Welfare indicators			
Number of members per worker	2.95	3.19	
Assets			
Livestock (on sheep equivalences)	18.30	30.23	**
Vector of assets	769.51	511.30	
Risk management and coping indicators			
Local Remittances (Yearly amount)	223.96	358.07	
International Remittances (Yearly amount)	8.56	9.67	

*** 1% significance ** 5% significance *10% significance
Source: ENAHO 2002-2006. Balance Panel

4.2.2 Poverty matrix

Table 7: Poverty matrix (percentages)

Year	**2006**		
2002	Poor	Non-Poor	Overall
Poor	46,14	18,05	64,19
Non-Poor	9,38	26,43	35,81
Overall	55,51	44,49	100,00

Source: ENAHO 2002-2006. Unbalance Panel

Probability that a non-poor household in 2002 becomes poor in 2006: 0.26

- (Non Poor(2002) and Poor(2006))/Total Non Poor in 2002

Probability that a poor household in 2002 becomes non poor in 2006: 0.28

- (Poor(2002) and Non-Poor(2006))/Total Poor(2002)

We obtain four categories from analyzing poverty transitions from 2002 to 2006. A household is classified as “Never Poor” if it has never fallen under the poverty line in the five periods of the survey. Conversely, it is classified as “Always Poor” if it has been poor in every wave of the survey. Households are can be also classified as “Several episodes” if it has been poor more than two times but less than five times, between 2002 and 2006. Finally, a household that has fallen under the poverty line just once is classified in the category “One episode”.

The four categories obtain from the construction of the poverty matrix are used in Table 8 to draw a new profile of the households in the sample. In addition, a mean analysis has been included to show if the differences between the households classified as “Never poor” and “Always poor” are statistically different. As expected, the households that never experienced an episode of poverty were better endowed than the households classified as “Always poor” in terms of human capital, assets and access to services. The former are also more integrated to the market, which is reflected in their higher percentage of monetary income and expenses. Notice that there seems to be a positive correlation between the proportion of income generated from agricultural activities and the number of poverty episodes experienced by a household in the rural area. This reflects the presence of a more traditional agriculture in this area. Since chronically poor households heavily rely in agricultural income -that in turns is heavily affected by natural hazard- a higher impact of natural disasters is expected for them.

Table 8: Profile of households, according to poverty status (Consumption, 2002-2006) (2002)

Variable	Never poor (1)	One episode (2)	Several episodes (3)	Always poor (4)	Diff 1/ (p-value) (1) vs (4)
PERCENTEGES					
Human capital					
Gender of the hh (woman)	13.36	22.02	15.01	9.57	**
HH is literate	64.70	56.26	56.16	53.22	
At least one children don't go to school	0.00	1.00	4.15	6.64	***
Characteristics of the dwellings					
Low quality of dwelling's materials	15.48	21.52	26.37	19.88	
Owner of house	82.38	86.80	82.79	86.76	***
Water: access to public network	58.48	55.28	34.73	34.16	**
Sewerage connected to public network	66.23	58.87	61.28	44.81	**
Electricity as lightning source	68.83	61.58	30.21	18.19	***
Telephone (fixed)	0.60	0.00	0.31	0.36	*
Welfare indicator					
Poor [assets]	26.24	33.70	38.36	51.29	***
Risk management and coping indicators					
Receive income from renting private properties	18.05	11.81	10.11	3.40	**
Remittances					
Receive local remittances	23.65	27.11	31.87	24.55	
Receive international remittances	0.34	0.00	1.46	0.00	
Remittances (from at least one source)	23.65	27.11	33.33	24.55	
Food assistance (at least one member)	0.00	0.00	0.00	0.00	
Glass of milk	20.38	30.18	43.69	58.58	***
Popular dinning room	4.40	7.98	6.34	9.89	
Schoolar breakfast	6.18	16.05	20.14	34.67	***
Other programm	4.14	2.76	7.65	13.09	***
Proportion of beneficiaries (as a proportion of total members)	14.49	21.30	26.30	33.68	***

Welfare indicators					
Monetary expenses (as % of total expenses)	70.85	64.17	56.94	53.86	***
Monetary income (as % of total income)	74.36	66.72	56.39	51.56	***
Participation in agricultural activities					
Percentage of members that have as main activity agriculture	40.97	41.96	45.06	41.34	
Percentage of members that have as secondary activity agriculture	5.97	8.07	9.87	8.65	
Percentage of income from agricultural activities	25.15	26.54	36.09	41.06	***

*** 1% significance ** 5% significance *10% significance
Source: ENAHO 2002-2006. Balance Panel
1/ Mean differences are calculated by comparing column (1) with column (4)

In the ENAHO interview, households are asked to report if the have experienced any of the shocks included in 8 different categories (see Table 9). Most of the households do not report having experienced any negative episode, and these results are similar for the four categories of the poverty transitions. Nonetheless, having suffered a robbery or an assault and a natural disaster is significantly different for households classified as "Never Poor" in comparison with households classified as "Always poor". The latter tend to recall more being hit by a natural disaster. This is consistent with the fact that these households obtain a higher proportion of their income from agricultural activities.

Table 9: Shocks experienced by household in 2002

Variable	Never poor	One episode	Several episodes	Always poor	Diff (p-value)
Shock: Loss of job	1.55	0.69	0.86	0.00	
Shock: Bankruptcy of family business	0.60	2.40	0.49	0.28	
Shock: Death of an income perceiver	0.00	0.00	0.96	0.96	
Shock: Sickness or accident of a household member	4.20	3.48	3.42	1.85	
Shock: Abandonment of the head of the household	0.00	0.00	0.29	0.00	
Shock: Fire housing/business	0.00	0.00	0.29	0.00	
Shock: Robbery, assault	5.50	3.03	7.23	4.20	**
Shock: Natural disaster	5.54	2.66	2.60	11.41	*
Shock: Other	0.00	1.73	0.52	0.69	
Shock: None	84.17	87.40	83.57	80.61	

*** 1% significance ** 5% significance *10% significance
Source: ENAHO 2002-2006. Balance Panel
1/ Mean differences are calculated by comparing column (1) with column (4)

4.2.3 Poverty transitions, multivariate household regressions

A first approach to estimate the impact of hazard over poverty is to use the categories obtained from the analysis poverty transitions as dependent variable. One can model probabilities of entering; exiting, remaining or staying out of poverty based on status regression and then establish whether a hazard may have a differentiated impact depending on the poverty transition in turn. All the multinomial regressions estimate in this section use as poverty base status the category "Never poor".

For this specification we have estimated poverty transitions using two different measures. First, we rely on the official estimates of poverty, following the INEI methodology that compares the real monthly per capita consumption of each household with a predetermined poverty line that is calculated valuating a basket of goods. Second, we measure a vector of assets by adding the different number of durable goods (e.g. radio, TV, car, trunk) that households possess. We use the median of the reported price of each item –in 2006- as a weight to be able to sum these different items. In addition, a factor of depreciation is included to account for the age of the objects, information that is also reported in the survey. A household is considered poor by assets if the value of this vector is below the median value for all the rural households included in the ENAHO in 2006 (not just the panel observations).

A. Poverty, measured as monthly per capita consumption

Use as a dependent variable a set of categories that does not change over time (e.g. Poverty transitions) imposes some restrictions for the estimation of a multinomial regression using a panel database. One option is not take into account the time dimension of the data and pool it. Under this specification, a household classified as "Never poor" is considered as five different observations (one for each year) with the same value of the dependent variable. To circumvent this restriction, we reshape the data in order to estimate a multinomial regression that considered the information for each household in each year. Then, we control the four categories of poverty transitions by having experienced a shock in different years and some additional controls that capture the initial conditions of our sample. Notice that we exclude the year 2002 for the estimation of the poverty transitions in order to use the information of that year as the initial conditions.

Table 10 shows the odd ratios of the multinomial regression for three different models that include different controls. All models include controls for demographic composition (not reported). These odd ratios –also know as risk ratio- are the ratio between the probability to belong to each category and the probability to belong to the base category, given a unit increase in the corresponding explanatory variable.

Table 10: Multinomial regression. Dependent variable: Poverty transitions, consumption (2003-2006)

	One episode			Several episodes			Always Poor		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Average of shocks	0.0731*	0.0645	0.0558	1.993	17.66	142.1*	21.70***	91.07*	923.8**
	(0.113)	(0.133)	(0.196)	(3.222)	(58.05)	(427.2)	(11.46)	(220.8)	(2601.7)
Total years of education (2002)	1.002	1.005	1.006	0.976**	0.982*	0.980*	0.949***	0.961***	0.959***
	(0.00876)	(0.00857)	(0.00968)	(0.0103)	(0.00975)	(0.0112)	(0.0132)	(0.00988)	(0.0133)
Female head of household (2002)	0.976	0.826	0.859	0.623	0.500	0.512	0.281**	0.202***	0.199**
	(0.635)	(0.584)	(0.636)	(0.337)	(0.312)	(0.317)	(0.169)	(0.125)	(0.130)
Agriculture as main activity (2002)	2.267	1.465	1.396	2.635	1.318	1.243	5.128***	1.839	1.686
	(1.165)	(0.911)	(0.812)	(1.576)	(0.907)	(0.843)	(2.824)	(1.262)	(1.039)
Agriculture as secondary activity	3.028	1.975	1.756	6.255	3.561	3.284	4.419	1.865	1.846
	(2.696)	(1.999)	(1.670)	(8.690)	(4.732)	(4.271)	(4.679)	(1.421)	(1.200)
Proportion of agricultural	2.345***	1.879	1.877	2.013	1.832	1.820	2.185	1.832	2.036
	(0.687)	(1.128)	(1.153)	(1.493)	(1.538)	(1.601)	(1.248)	(1.742)	(1.899)
Low quality dwelling (2002)		0.823	0.743		0.766	0.675		0.588	0.513
		(0.396)	(0.422)		(0.438)	(0.420)		(0.227)	(0.217)
Quantity of animals (2002)		1.000	1.000		1.002	1.000		0.995	0.993
		(0.00989)	(0.00789)		(0.00967)	(0.00912)		(0.0113)	(0.00967)
Access to piped water (2002)		0.540*	0.499*		0.506***	0.457***		0.373***	0.362***
		(0.186)	(0.179)		(0.131)	(0.130)		(0.0410)	(0.0603)
Access to electricity (2002)		0.383***	0.411***		0.302***	0.312***		0.170***	0.173***
		(0.101)	(0.119)		(0.0898)	(0.0800)		(0.0444)	(0.0462)
Vector of assets (2002)		1.000	1.000		1.000**	1.000**		1.000	1.000
		(0.0000)	(0.0000)		(0.0000)	(0.0000)		(0.000)	(0.000)
Shock(mean)*Quantity of		0.987	0.985		0.974	0.970		0.985	0.984
		(0.0273)	(0.0272)		(0.0196)	(0.0252)		(0.0246)	(0.0295)
Shock(mean)*Low housing(2002)		2004.8***	3836.6**		95.25*	123.0		107.7	148.9
		(5469.0)	(12871.1)		(258.2)	(430.7)		(331.3)	(538.1)
Shock(mean)*Proportion of		0.209	0.450		0.0443	0.0573		0.145	0.141
		(0.885)	(1.885)		(0.155)	(0.181)		(0.424)	(0.335)

Coping strategy: savings (average)			0.393			0.00727**			0.00261***
			(0.848)			(0.0153)			(0.00284)
Coping strategy: assets(average)			7.174			740.8			23.90
			(41.25)			(3223.3)			(110.9)
Coping strategy: credit (average)			0.0236**			0.330			0.114
			(0.0394)			(0.537)			(0.155)
Coping strategy: workload(average)			4.653			0.213			0.0843*
			(12.93)			(0.369)			(0.118)
Coping strategy: external support			0.000375			0.00101			0.000661
(average)			(0.00278)			(0.00605)			(0.00336)
Coping strategy: food (average)			0.442			0.0697			0.159
			(0.429)			(0.293)			(0.534)
Demographic fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographic variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	830	830	830	830	830	830	830	830	830

Exponentiated coefficients; Standard errors of the original coefficients in parentheses.
ENAHO 2002-2006: Balanced panel
* p<0.10 ** p<0.05 *** p<0.01

According to model 1, the probability of being “Always Poor” is 21 times the probability of being “Never poor”, given that the household experienced a natural disaster. Similarly, the probability of being “Always Poor” is 5 times the probability of being “Never poor”, given a unit increase in the proportion of member of the household that have as agriculture as main activity. However, this last result vanishes when we add variables that capture the access to services. Then the probability of being “Never Poor” is higher than the probability of being “Always Poor” of having experienced “Several episodes” of poverty (see model 2). In contrast, the variables that capture participation in agricultural activities are not statistically significant. In addition, the probability being “Never Poor” is 13 times the probability of having fallen below the poverty line in just one period given that the household experienced a natural disaster (see column 1, Table 10). Notice that the interaction variables do not have a statistically significant effect. The same thing occurs when we add the coping strategies report by the families (see model 3). In this case, the coefficient of the variable shock jumps which can be indicating a high level of correlation between those variables. These results are consistent if we restrict the sample to agrarian households (households that received income from agricultural activities) (see Appendix 8).

One main disadvantage of the information collected in the ENAHO, is that it does not allow us to differentiate between different Natural Disaster that took place during that period. For instance, the impact of a drought on households’ income and poverty is expected to be higher than a landslide. At this point, our variable of shock is a measure of the aggregate information for five periods, that combines all natural disaster suffered and reported by the households, regardless their magnitude and impact. To circumvent this potential problem and test the robustness of our results, we analyzed the specifications show above for each pair of years. In that way, we can identify if there is a differentiated effect for each year. That is to say, this can be signaling that there were particularly damaging shocks in some years. In this exercise the categories of the poverty transitions take into account the poverty exist and entries year by year and are renamed as follow: Poor to Non Poor, Non-Poor to Poor, Remain Poor, Never Poor. We use the specification of model to 2 to estimate this exercise. In this case, we do not use the average of shocks suffered in the two-year period, but rather a variables of shock for each of them.

Table 11 shows the coefficient of the shock suffered in both periods that are being compared (the complete regression in shown in Appendix 9). It is very clear that the results shown in Table 10 are picking up the effects of a shock produced in 2004. The probability of "Remain poor" is 14 times higher than the probability of being "Never poor", given that the household reported a shock in 2004. This probability decreases the next period, but it is still statistitically significant. Notice that the probability of moving from Poor to Non Poor is also higher than the probability of being Never Poor. This could sound strange, but it is actually capturing the fact that given that the household reported a shock in 2004, its odds of remaining non poor decrease.

Table 11: Multinomial regression. Dependent variable: Poverty transitions, consumption

	Poor-Non Poor	Non Poor-Poor	Remain poor
Poverty transitions: consumption (2002-2003)			
Shock: Natural Disaster (t)	2.441	5.827	1.518
	(1.502)	(7.709)	(1.194)
Shock: Natural Disaster (t+1)	0.656	0.284	0.93
	(0.575)	(0.42)	(1.086)
Poverty transitions: consumption (2003-2004)			
Shock: Natural Disaster (t)	1.057	2.252	2.803
	(1.079)	(1.611)	(2.628)
Shock: Natural Disaster (t+1)	13.40**	4.096	14.04***
	(14.13)	(4.893)	(8.665)
Poverty transitions: consumption (2004-2005)			
Shock: Natural Disaster (t)	6.061***	1.068	4.673***
	(3.812)	(1.033)	(2.375)
Shock: Natural Disaster (t+1)	2.426	0.805	0.516
	(2.347)	(1.410)	(0.886)
Poverty transitions: consumption (2005-2006)			
Shock: Natural Disaster (t)	0.303	0.595	0.418
	(0.462)	(0.267)	(0.474)
Shock: Natural Disaster (t+1)	1.246	0.898	3.130
	(1.433)	(1.630)	(4.699)

Exponentiated coefficients; Standard errors of the original coefficients in parentheses.
ENAHO 2002-2006: Balanced panel
* p<0.10 ** p<0.05 *** p<0.01

B. Poverty, measured as possession of assets

As a second approach, we estimate the same specification report in section A, but using the possession of assets as a measure of poverty. Similarly to the prior models, all specifications include controls for demographic composition (not reported). In both specifications the variable of natural disaster does not have a statistically significant effect over any of the categories of the poverty transitions (see Table 12).

Variables such as the participation of the members in agricultural activities and access to public services have the same direction found in the specifications that use consumption to measure poverty. One can argue that natural disaster affect these households through its negative effect over the agriculture activity, affecting the level and variability of their income, but not their possessions of durable goods.

Table 12: Multinomial regression, Dependent variable: Poverty transitions: assets (2003-2006)

	One episode			Several episodes			Always Poor		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Average of shocks	1.021	1.402	6.993	1.006	0.817	2.127	0.369	11.40	26.85
	(0.639)	(2.226)	(8.713)	(0.588)	(0.680)	(1.815)	(0.331)	(17.95)	(68.12)
Total years of education (2002)	0.982**	0.987*	0.989	0.965**	0.968*	0.969*	0.917***	0.925***	0.928***
	(0.00863)	(0.00706)	(0.00677)	(0.0171)	(0.0161)	(0.0162)	(0.0135)	(0.0131)	(0.0124)
Female head of household (2002)	1.445	1.583	1.635	1.925*	2.017*	2.142	3.485**	3.470***	3.534**
	(0.632)	(0.669)	(0.734)	(0.748)	(0.856)	(1.002)	(1.879)	(1.620)	(1.847)
Agriculture as main activity (2002)	2.738	1.821	1.616	7.671***	5.225**	5.158**	8.606**	5.747**	6.501**
	(2.640)	(1.674)	(1.688)	(5.278)	(3.594)	(4.063)	(7.930)	(4.375)	(5.921)
Agriculture as secondary activity (2002)	2.221	1.005	1.123	1.931	0.918	0.957	1.137	0.467	0.497
	(1.885)	(0.713)	(0.837)	(1.391)	(0.616)	(0.693)	(1.168)	(0.450)	(0.524)
Proportion of agricultural income(2002)	2.490**	2.174	2.611*	0.782	0.685	0.671	0.930	0.898	1.019
	(0.955)	(1.115)	(1.333)	(0.167)	(0.171)	(0.189)	(0.213)	(0.623)	(0.698)
Low quality dwelling (2002)		1.174	1.119		0.832	0.773		2.169	2.003
		(0.608)	(0.615)		(0.480)	(0.402)		(1.056)	(0.947)
Quantity of animals (2002)		0.999	0.997		0.997	0.995		1.001	1.000
		(0.00571)	(0.00613)		(0.00384)	(0.00338)		(0.00714)	(0.00738)
Access to piped water (2002)		0.817	0.790		0.421***	0.382***		1.126	1.123
		(0.310)	(0.332)		(0.120)	(0.126)		(0.492)	(0.470)
Access to electricity (2002)		0.270***	0.257***		0.414***	0.408***		0.0991***	0.101***
		(0.0595)	(0.0503)		(0.0472)	(0.0450)		(0.0394)	(0.0382)
Shock(mean)*Quantity of animals(2002)		0.983	0.983*		1.000	1.001		0.855***	0.845**
		(0.0115)	(0.0102)		(0.00842)	(0.00755)		(0.0513)	(0.0616)
Shock(mean)*Low housing(2002)		2.270	1.737		3.541	3.111		0.000720***	0.000***
		(3.027)	(2.570)		(5.088)	(4.165)		(0.00188)	(0.001)
Shock(mean)*Proportion of agricultural income(2002)		0.725	0.340		0.475	0.338		0.808	0.621
		(2.136)	(0.924)		(0.410)	(0.325)		(3.245)	(2.966)

Coping strategy: savings (average)			0.104			0.167*			0.00136
			(0.260)			(0.165)			(0.00625)
Coping strategy: assets(average)			2.502			181.2**			1.444
			(12.12)			(367.0)			(4.613)
Coping strategy: credit (average)			0.0101			0.328			0.0441**
			(0.0378)			(0.943)			(0.0607)
Coping strategy: workload(average)			0.304			0.998			0.555
			(0.282)			(0.761)			(0.530)
Coping strategy: external support			0.000***			0.0235			0.000**
(average)			(0.000)			(0.0581)			(0.000)
Coping strategy: food (average)			0.176			0.113*			3.100
			(0.311)			(0.132)			(6.929)
Demographic fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Demographic variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	830	830	830	830	830	830	830	830	830

Exponentiated coefficients; Standard errors of the original coefficients in parentheses.
ENAHO 2002-2006: Balanced panel
* p<0.10   ** p<0.05   *** p<0.01

As we have already explained above, the aggregate measure of shock could be hidden some year specific effect. In this case, the probability of moving from being Non poor to being Poor is 4 times the probability of being Never Poor in assets' possession, given that the household suffered and reported a shock in 2004. However, the specific effect found we found in Table 11 is not so clear in this exercise. Here, we found that a shock suffered in 2005 increases the probability Remain Poor. In this case, the probability of being Never Poor is higher than the probability of exiting a poverty status. That is to say, this shock decreased the probability of holding a level of durables good that is higher than the median for rural households.

Comparing the results of Table 11 and Table 13, we can argue that the shock suffered in 2004 first damaged the household income. These shocks probably force the households to deplete their assets in order to smooth consumption and overcome the negative effects of the shocks. Then, suffer a shock in 2005; made those households more vulnerable since it increased their odds to remain poor in assets possessions. We can also speculate that shocks suffered in 2004 and 2005 affected different assets. One affected income more directly (e.g. frost) while other affected more durable goods (e.g. landslide).

Table 13: Multinomial regression. Dependent variable: Poverty transitions, assets

	Poor-Non Poor	Non Poor-Poor	Remain poor
Poverty transitions: consumption (2002-2003)			
Shock: Natural Disaster (t)	0.319	0.811	0.192
	(0.610)	(0.853)	(0.297)
Shock: Natural Disaster (t+1)	1.004	1.227	1.243
	(0.589)	(1.114)	(0.264)
Poverty transitions: consumption (2003-2004)			
Shock: Natural Disaster (t)	1.821	0.338	0.901
	(1.149)	(0.257)	(0.544)
Shock: Natural Disaster (t+1)	1.982	0.521	1.249
	(1.748)	(0.770)	(0.852)
Poverty transitions: consumption (2004-2005)			
Shock: Natural Disaster (t)	1.754	4.704***	0.988

	(1.004)	(2.032)	(0.759)
Shock: Natural Disaster (t+1)	0.242***	0.473	1.944**
	(0.111)	(0.340)	(0.609)
Poverty transitions: consumption (2005-2006)			
Shock: Natural Disaster (t)	0.865	0.422	1.645
	(0.745)	(0.361)	(1.089)
Shock: Natural Disaster (t+1)	1.217	1.672	0.395
	(0.797)	(0.549)	(0.268)

Exponentiated coefficients; Standard errors of the original coefficients in parentheses.
ENAHO 2002-2006: Balanced panel
* p<0.10 ** p<0.05 *** p<0.01

4.2.4 Change in per capita consumption

The exercises shown above put special emphasis on households exist and entries to poverty. To keep on digging on the effects of natural disasters on household income we conducted an additional exercise. Our main objective is to take advantage of the panel data set and follow the evolution of income, given shock suffered in different years of the period analyzed. We estimate the following equation:

$$\Delta \ln pccons_{it} = \alpha_o + \alpha_1 \ln pccons_{it-1} + \alpha_2 X_{it} + \varepsilon_{it} \,,$$

where *pccons* is the monthly per capita consumption and X is a set of characteristics of the household. Since the lag of the dependent variable is used as a regressor, OLS and Within Group estimators provide biased estimators. This is mostly because of the existence of unobserved individual (household) fixed effects. To circumvent this bias, a system GMM estimator has been used to estimate this equation.

Special attention has been placed on testing the validity of the instruments chosen. The system GMM estimator -with three lags of the dependent variable as instruments- has been chosen as the preferred specification to model the accumulation function for the entire data. According to the Arellano/Bond test there is no second-order serial autocorrelation in Model 1. Additionally, Hansen statistics shows that the null of exogeneity cannot be rejected. Both conditions are not satisfied by Model 2 and Model 3 that includes an interaction effect and some coping strategies reported by the households. The coefficient lag of the dependent variable is -0.67 (see Table 14). This means that an increase in 1% of the capital in time t explains 33% of the increase in capital in the next period. In addition, the coefficient of the lag of the dependent variable is lower than the coefficient obtained in an OLS specification (-0.39) and higher than the coefficient obtained in a Fixed Effects model (-1.07). In the preferred specification (Model 1) the variable that captures natural disasters have a negative impact over the growth of monthly per capita consumption. The access to services such as electricity and piped water increase the growth rate of monthly per capita consumption.

Table 14: System GMM. Dependent variable: Growth of monthly per capita consumption

	Model 1	Model 2	Model 3
(log) Monthly per capita consumption	-0.669**	-0.483***	-0.474***
	(0.239)	(0.114)	(0.127)
Shocks: Natural disaster	-0.076*	-0.078*	-0.065
	(0.033)	(0.037)	(0.041)
Quantity of animals	0.002	0.003***	0.003***
	(0.001)	(0.001)	(0.001)
Vector of assets	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
Access to piped water	0.092**	0.083***	0.084**
	(0.033)	(0.024)	(0.026)
Telephone (land line)	0.125	0.081	0.074
	(0.107)	(0.089)	(0.093)
Access to electricity	0.146*	0.105**	0.102**
	(0.063)	(0.035)	(0.038)
Shocks*Poverty(Assets)		0.000	-0.000
		(0.000)	(0.000)
Coping strategy: assets			-0.156
			(0.562)
Coping strategy: savings			-0.125
			(0.267)
Constant	3.313**	2.393***	2.350***
	(1.168)	(0.549)	(0.610)
Arellano-Bond Test	0.100	0.000	0.001
Hansen Test	0.655	0.772	0.706
Demographic fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
N	3320	3262	3262

Standard errors in parentheses
ENAHO 2002-2006: Balanced panel
* p<0.10 ** p<0.05 *** p<0.01

In order to check the robustness of our results, we repeated this exercises for several sub-samples. Specifically, we test the results for four different groups: agrarian households (households that perceived income from agricultural activities), and households living in the three Peruvian geographical domains (Coast, Andes, Rainforest) (see Table 15 and Table 16). The results for the agrarian households are consistent with the results shown in the prior Table. In this case, the variable shock is negative and statistically significant in Model 2. In this specification the quantity of animals have a positive effect on the growth rate of monthly per capita consumption. However, the model suffers from serial correlation of second order (see Arellano Bond Test), which can lead to biased coefficients.

Table 15: System GMM. Dependent variable: Growth of monthly per capita consumption. Sub sample: Agrarian households

Variables	Model 1	Model 2	Model 3
(log) Monthly per capita consumption	-0.446*	-0.481***	-0.504***
	(0.222)	(0.118)	(0.135)
Shocks: Natural disaster	-0.068	-0.077*	-0.073
	(0.037)	(0.037)	(0.040)
Quantity of animals	0.003**	0.003***	0.003***
	(0.001)	(0.001)	(0.001)
Vector of assets	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
Access to piped water	0.058*	0.065**	0.068**
	(0.025)	(0.023)	(0.026)
Telephone (land line)	-0.015	0.010	0.006
	(0.073)	(0.072)	(0.076)
Access to electricity	0.106	0.109**	0.115**
	(0.063)	(0.038)	(0.041)
Shocks*Vector of assets		0.000	0.000
		(0.000)	(0.000)
Coping strategy: assets			0.011
			(0.517)
Coping strategy: savings			-0.080
			(0.258)
Constant	2.188*	2.351***	2.458***
	(1.067)	(0.556)	(0.635)
Arellano-Bond Test	0.013	0.002	0.004
Hansen Test	0.433	0.623	0.718
N	2723	2679	2679

The results found for the sub-samples of each geographical domain are consistent with the results find for the whole sample. Notice that the coefficient of the variables shock has a positive effect. These results have to be taken with cautious since the low number of observations that belong to these sub-sample (250) and the low percentage households that report shocks in that area (7% in average)

Table 16: System GMM. Dependent variable: Growth of monthly per capita consumption. Sub sample: Geographical domains

	Coast			Andes			Rainforest		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
(log) Monthly per capita consumption	-0.804***	-0.569***	-0.589***	-0.904***	-0.885***	-0.751***	-0.752***	-0.583***	-0.740***
	(0.231)	(0.154)	(0.132)	(0.241)	(0.127)	(0.144)	(0.220)	(0.158)	(0.151)
Shocks: Natural disaster	-0.154***	-0.137**	-0.187**	-0.115*	-0.106*	-0.098	0.118*	0.092	0.121
	(0.045)	(0.049)	(0.068)	(0.048)	(0.048)	(0.057)	(0.054)	(0.092)	(0.099)
Quantity of animals	0.001	0.002	0.000	0.004	0.005***	0.005***	0.001	0.001	-0.000
	(0.001)	(0.001)	(0.001)	(0.003)	(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
Vector of assets	0.000	0.000	0.000	0.000*	0.000***	0.000***	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Access to piped water	0.168**	0.118**	0.117**	0.093	0.123*	0.106*	0.016	0.035	0.004
	(0.057)	(0.038)	(0.040)	(0.056)	(0.054)	(0.049)	(0.044)	(0.039)	(0.045)
Telephone (land line)	0.132	0.114	0.152*						
	(0.118)	(0.084)	(0.077)						
Access to electricity	0.068	0.044	0.041	0.254**	0.252***	0.198**	0.243***	0.193***	0.248***
	(0.051)	(0.037)	(0.036)	(0.095)	(0.066)	(0.069)	(0.068)	(0.051)	(0.060)
Shocks*Vector of assets		-0.000	0.000		-0.000	-0.000		0.000	-0.000
		(0.000)	(0.000)		(0.000)	(0.000)		(0.000)	(0.000)
Coping strategy: assets			0.312			1.210			-0.250
			(0.297)			(2.142)			(0.384)
Coping strategy: savings			0.309			-0.121			0.943
			(0.293)			(0.333)			(0.685)
Constant	4.018***	2.863***	2.986***	4.220***	4.095***	3.501***	3.705***	2.907***	3.685***
	(1.144)	(0.767)	(0.654)	(1.150)	(0.580)	(0.656)	(1.082)	(0.779)	(0.747)
Arellano-Bond Test	0.115	0.006	0.032	0.714	0.407	0.165	0.054	0.010	0.049
Hansen Test	0.238	0.196	0.211	0.547	0.321	0.682	0.345	0.525	0.491
N	1096	1071	1071	1224	1206	1206	1000	985	985

Source: ENAHO 2002-2006. Balance Panel
* p<0.05 ** p<0.01 *** p<0.001

4.2.5 Analysis at the bottom of the distribution

As we have mentioned lines above, it is possible that the report of natural disasters is biased to households that are poorly endowed and less integrated to the market. To circumvent this problem and to analyze the impact of natural disaster at the bottom of the income distribution, we have estimated a Quantile regression. We use as dependent variable the (log) monthly per capita consumption in 2006. We add dummies for the shock reported in each year as well as some additional controls of the prior period. This model also use controls for demographic composition (not reported). In addition, we have included the variable "plots" that captures the number of plots worked by a household. This variable was included to the ENAHO questionnaire just in 2004.

The reported coefficients show the median of each variable in the corresponding percentile. That is why the column that shows the results for the whole sample is equal to the column shows the results for the 50th percentile. The constant term captures the median of the dependent variable if all control variables are set to 0. This constant term is use to compare the coefficients corresponding to each the explanatory variable. For instance, the variable "Shock: Natural disaster" in 2002 decrease the median monthly per capita consumption in 0.28 logarithm points. In other word, having experienced a shock in 2002 reduces the monthly per capita consumption of the bottom 25th of the distribution in 3.85%3. It also reduces the monthly per capita consumption of the 50h of the distribution, but in a lower percentage (2.68%) (see Table 17). Further exercises are reported in Appendix 10 and Appendix 11, however the correct interpretation of the coefficient of interaction variables is a pending task in this report.

[3] This result is obtained after exponentiating the value in logs.

Table 17: Quantile regression, Dependent variable: (log) Monthly per capita consumption (2006)

Controls: 2005

Variables	**Total**	**25th Percentile**	**50th Percentile**	**75th Percentile**
Constant	**3.853*** **	**3.538*** **	**3.853*** **	**4.126*** **
	(0.170)	**(0.165)**	**(0.170)**	**(0.188)**
Shock: Natural disaster (yes=1) [2002]	-0.236***	-0.283***	-0.236***	-0.291***
	(0.072)	(0.077)	(0.072)	(0.077)
Shock: Natural disaster (yes=1) [2003]	0.134**	0.041	0.134**	0.058
	(0.053)	(0.056)	(0.053)	(0.064)
Shock: Natural disaster (yes=1) [2004]	-0.108**	-0.048	-0.108**	-0.119**
	(0.046)	(0.048)	(0.046)	(0.054)
Shock: Natural disaster (yes=1) [2005]	-0.091*	-0.191***	-0.091*	-0.138**
	(0.048)	(0.047)	(0.048)	(0.054)
Shock: Natural disaster (yes=1) [2006]	-0.226***	-0.091*	-0.226***	-0.177***
	(0.051)	(0.049)	(0.051)	(0.057)
Total years of education (all members) [2005]	0.006***	0.008***	0.006***	0.003***
	(0.001)	(0.001)	(0.001)	(0.001)
Gender of the hh (woman=1) [2005]	0.264***	0.103*	0.264***	0.363***
	(0.059)	(0.057)	(0.059)	(0.063)
Number of plots [2005]	-0.024**	-0.031***	-0.024**	-0.030***
	(0.010)	(0.009)	(0.010)	(0.011)
Main activity: agriculture [2005] 1/	-0.169**	-0.216***	-0.169**	-0.144*
	(0.067)	(0.071)	(0.067)	(0.076)
Secondary activity agriculture [2005] 1/	-0.280***	-0.185*	-0.280***	-0.186*
	(0.086)	(0.099)	(0.086)	(0.099)
Agricultural income (proportion of total income) [2005]	-0.205***	-0.14*	-0.205***	-0.008
	(0.069)	(0.072)	(0.069)	(0.087)
Livestock (on sheep equivalences) [2005]	0.002***	0.002***	0.002***	0.003***
	(0.001)		(0.001)	(0.001)
Vector of assets [2005]	0.000***	0.000**	0.000***	0.000***
Water: access to public network (yes=1) [2005]	0.079**	0.013	0.079**	0.129***
	(0.034)	(0.034)	(0.034)	(0.038)
Telephone (fixed) (yes=1) [2005]	0.872***	0.437***	0.872***	0.584***
	(0.179)	(0.138)	(0.179)	(0.136)
Electricity as lightning source (yes==1) [2005]	0.138***	0.187***	0.138***	0.155***
	(0.034)	(0.036)	(0.034)	(0.039)
N	771	187	381	582

Standard errors in parenthesis
Source: ENAHO 2002-2006: Balanced panel
* p<0.10, ** p<0.05, *** p<0.01
1/ Number of individuals as a proportion of total members

5 Conclusions

We begun our research with the main objective to explore the relationship between natural hazards and poverty in the Peruvian context. One of the main ENSO centers in the region, Peru is well known to have a high incidence of natural hazards and disasters, and the probability of households constantly falling into poverty traps due to the lack of formal insurance mechanisms for natural disasters in many areas of the country, particularly in the poorest, as well as the tendency to establish new settlements in high-risk areas. The study faced some methodological constraints due to the lack of sound and reliable data at the micro level. Despite the fact that available data bases (both Desinventar and INDECI) are providing new insights on the importance of natural hazards in Peruvian long term development, there is clearly ample space for improvement in the construction and maintaining of a national information system on natural hazards.

In the following paragraphs we present a brief summary of the main sections of the study, namely, the overview of natural disasters in Peru during the period 2003 – 2008, and the assessment of the relationship between natural hazards and welfare indicators.

Overview of natural hazards in Peru: the INDECI national database 2003 - 2008

The more frequent events during the period 2003-2008 are the meteorological – oceanographic events, representing 84.5% of the total number of events, followed by the external geodynamical events with 11.3% and the internal geodynamical events –including earthquakes- with 4.1%. Among the met – oce events, strong winds and rains account for 24.7% and 22.4% respectively, followed by frosts and floods (14.7% and 10.5% respectively).

In terms of magnitude of the events, as expected almost three fourths (73.8%) of the total number of houses destroyed are generated by geo-int events, mostly by earthquakes. The geo-ext events only account for 3.2% of the total number of houses destroyed in the period, while the met-oce events account for the other 23%. Among the latter, the most damaging events are rains and floods.

Finally, the met-oce events are the most important ones when we measure the magnitude of them by the total number of houses affected, accounting of 84.3% of these damages. Again rains and floods are the most damaging met-oce events. The geo-int events account only 13.6% of the houses affected –mostly by earthquakes-, while the geo-ext events are almost insignificant accounting only for 2% of the total number of houses affected in the period.

Meteorological – oceanographic events account for more than 80% of the total number of events happened during the period 2003-2008. However, this type of events, like rains, floods, strong winds, frosts, or snowfall, do not generate material damage as hardly as other types of events, like the geo – int for example. Hence, these met-oce events only account for 23% of the material damage measured by the total number of houses destroyed in the country for the period 2003-2008.

But the met-oce events are much more important from another material damage perspective: houses affected or damaged. More than 84% of the total number of houses affected by natural disasters in the period 2003-2008 in Peru, were generated by these met-oce events. Hence the accumulated economic losses for most vulnerable households could be of great importance.

Relationship between natural hazards and welfare indicators

Initial evidence of a positive relationship between natural hazards and poverty was presented in section 4.1 of this document, where we observed that provinces in the richest quintile have an average of 6.2 events by year in the period 2003-2005 while provinces in the poorest quintile present an average of 11.2 of the same type of events. Based on the results of the OLS regression to explain poverty rates at the year 2005, we can state that the effect of disasters on poverty rates ranges between 0.16 and 0.23. This means that one extra event a year will increase poverty rates at the provincial level by these amounts. As the standard deviation of the disaster variable in our sample is around 9, this would imply that an increase in the average number of disasters by one standard deviation from the mean will race poverty rates by at least one percentage point. Finally, even though the short period of time for which data on natural hazards is available makes it difficult to estimate its impact on long-term changes in poverty rates (2005-1993), we presented the results of different OLS regression specifications in order to explore possible effects of natural hazards on this variable. Our findings indicate that after controlling for initial poverty levels (1993) there seems to be a positive and significant effect of disasters on the change in poverty for this period.

The analysis at the household level presented in section 4.2 showed that there is a higher report of natural disasters from households that have less access to public services, that there are less integrated to the market, and that have a higher proportion of agricultural income.

The multinomial regressions show that households are between 21 and 91 times more likely to be "Always Poor" than to be "Never Poor" given that they have experienced a natural disaster on the period under analysis (2002 – 2006). These results only hold if consumption, rather than assets, is used to measure poverty. An increase in the participation in agricultural activities leads to a higher probability to be Always poor rather that Never Poor. However, this effect losses statistical significance when the variables that capture the access to services are included.

We found that there is a "year effect" that is not captured under this initial specification. To circumvent this problem and test the robustness of our results, we estimated the multinomial regressions for each two-year periods. In the case of consumption, it is very clear that the results shown in the prior specification are picking up the effects of a shock produced in 2004. As shown in Graphs 1 and 10 of section 3 (overview of natural hazards in Peru), this year shows the highest report of number of meteorological and oceanographic events, and, moreover, the largest number of total events during the summer season.

In the case of possession of durable goods, the aggregate specification is hidden the effect of a shock occurred reported in 2005. Taking into account both results, we can speculate that a shock suffered in 2004 affected more income than assets. However, to surpass the negative effect of the shock, the household probably depleted their assets. This situation made the household more vulnerable to a future shock and more likely to remain poor by assets in the next period.

Natural disasters negatively affect the growth rate of monthly per capita consumption, while the access to services such as electricity and piped water positively affect it. These results are consistent when we repeat the exercise for four different sub-samples. When the full sample is disaggregated into three geographic regions it becomes evident that stronger effects appear in the Coastal and Andean regions.

In order to analyze the impact of natural disaster at the bottom of the income distribution, we have estimated a Quantile regression. We found that an increase in the average shocks experienced during the whole period reduces the median of the monthly per capita consumption of the bottom 25th of the distribution 3.85%[4]. It also reduces the monthly per capita consumption of the 50th of the distribution but in a lower percentage (2.68%).

[4] This result is obtained after exponentiating the value in logs.

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Appendix 1: Comparison of SINPAD and DesInventar databases

# of events reported	2003		2004		2005		2006	
Type of event	SINPAD	DesInv	SINPAD	DesInv	SINPAD	DesInv	SINPAD	SINPAD
Strong Rains	388	15	426	17	391	7	738	27
Floods	470	83	234	49	134	8	348	41
Earthquackes	35	12	11	1	261	14	32	15
Freeze	73	42	438	28	296	2	177	12
Landslides	138	46	100	29	99	11	158	14
Droughts	5	3	215	39	224	5	74	0

Appendix 2: Analysis of Bias in the Natural Hazards Reports of the DesInventar database

The information on natural hazards in the DesInventar database relies on reports that appear in newspapers of the national capital of Peru, Lima. Therefore, it was expected that natural hazards events which occurred in somehow more “important” districts would have a higher probability of being reported in these newspapers than other events happening in more “marginal” districts of Peru. The objective of this section is to analyze the extent of this potential bias in the DesInventar database.

For that matter, we will use different measures of district´s importance and relate them to the number of reported events in the database. Our main comparison will be between districts that are capital of a province and the rest of the districts in the same province. A similar analysis will be done with provinces that are capital of a department and the rest of the provinces in the same department.

A. Missing districts in the DesInventar Database

First of all, it is important to notice that the number of districts for which the complete DesInventar database (1970-2006) contains positive reports on natural hazards (Extensive and Intensive events of both, Hydro-meteorological and Geological type) is only an 80% (1,477) of the total number of districts in Peru. In the following table we compare some characteristics of the districts with a positive number of reports in the DesInventar database with the districts that do not present any information.

Table 18: Characteristics of Missing Districts in DesInventar

Variables (at 1993)	With reports	Without reports	T-Test (p-value)
Population Variables			
Total population	14,284.94	3,378.82	0.00
Urban population	10,343.75	901.09	0.00
Rural population	3,941.19	2,477.73	0.00
Access to public services			
Percentage with electricity	29.41	12.12	0.00
Percentage with cces	36.77	27.41	0.00
Percentage with sewerage	33.88	26.09	0.00
Other variables			
Altitude	2,161.02	2,559.59	0.00
Index of ccessibility (less is more accessive)	4.12	5.30	0.00
Surface	266.26	190.93	0.00
Population pressure	499.19	41.00	0.00
Districts capital of province (1 yes, 0 no)	0.13	0.01	0.00

District´s without any natural hazard reported in the database are less populated and more rural than the ones with reports. Moreover, districts excluded from the DesInventar database present on average worse living conditions than the ones with at least one report. Variables related to district´s isolation, like mean altitude and accessibility (index derived from type of principal road), confirm the idea that more marginal districts have being excluded from the database.

The last variable included in the table, reveals that almost all districts that are capital of a province present at least one report in the database. As we mentioned before, one feature that could better capture the district´s importance is the condition of being a province´ capital. In the following section we will use this classification to explore the difference in the number of reports between these districts and the rest.

B. Comparison of Reports by district´s geo-political condition (Desinventar)

We compare the difference between the number of reports registered in each district capital of province with the mean number of reports registered for the rest of the districts of that same province. For that matter we use two different categories of events: all events reported, and extensive events excluding fire.

Table 19: Events reported by districts geo-political classification (Desinventar)

T-TEST		
Geo-political classification	Mean events reported	
	All events	Events Extensive no-Fire
Provincial capital	20.5	17.3
Other districts	4.2	3.9
P-value	0.0	0.0

At a 99.9% significance level, the number of reports in capital districts are higher than the average number of reports in other districts.

Continuing with this idea, now we scale up the previous comparison to the provincial level. We proceed by calculating the difference between the number of reports in the districts capital of provinces and the mean number of reports for the rest of the districts in the same province. Then, we identify the provinces that area capital of a department, and compare the difference found before, between these provinces and the rest of the provinces in the same department. We expect that the difference in number of reports between districts that are capital of a province and the rest of the districts in the same province, is higher for provinces that are capitals of a department than for provinces that are not.

Table 20: Events reported by province geo-political classification (Desinventar)

T-TEST		
	Mean difference between # of reports in districts that are provincial capitals and the mean # of reports in districts that are not provincial capitals	
	All Events	Events Extensive No-fire
Provinces that are departmental capitals	64.5	49.3
Other provinces	8.1	7.4
P-value	0.0	0.0

The results of this table confirm our hypothesis. The bias on the number of reports is even stronger for districts capitals of a province that is in turn the capital of a department.

Finally, when we look at the relationship between the number of reports by district and different measures of district´s isolation, we find a significant coefficient for most of them.

Table 21: Number of reported events and districts isolation variables (OLS) [Desinventar]

Variables	Number of reports		
	event_all	event_extnofire	event_inten
Altitude	-0.00127***	-0.000872***	-0.0000118***
	(-5.21)	(-4.12)	(-3.57)
Surface	0.00378**	0.00435***	0.000000188
	(-2.84)	(-3.75)	(-0.01)
Accesibility Index	-1.147***	-1.033***	-0.00435*
	(-8.04)	(-8.34)	(-2.25)
Distance to the Provincial Capital	-0.0158**	-0.0140**	-0.000113
	(-3.05)	(-3.10)	(-1.60)
Constant	13.60***	11.45***	0.0787***
	(-15.62)	(-15.15)	(-6.66)
N	1541	1541	1541
adj. R-sq	0.094	0.092	0.017

t statistics in parentheses

* p<0.05, ** p<0.01, *** p<0.001

In conclusion, there seems to be a strong bias in the information on natural hazards in the DesInventar database. First, more isolated districts do not count with any report on natural hazards in the past 36 years. Second, districts of higher rank or importance in terms of geo-political classification systematically present a higher number of reported events than the rest, even when compared to their neighbor districts. Given that the main scope of this study is to assess the relationship between natural hazards and welfare indicators, the fact that districts with better socio-economic conditions (like provincial capitals) tend to have a higher number of reported events in the DesInventar database due to its method for data collection, will seriously limit the possibility of using this information in our analysis.

Appendix 3: Analysis of Bias in the Natural Hazards Reports of the SINPAD database

A. Missing districts in the SINPAD Database

In the other hand, it is important to notice that the number of districts for which the complete SINPAD database (2003-2008) contains positive reports on natural hazards is an 85% (1,554) of the total number of districts in Peru. In the following table we compare some characteristics of the districts with a positive number of reports in the SINPAD database with the districts that do not present any information.

Table 22: Characteristics of Missing Districts in SINPAD

Variables (at 2005)	With reports	Without reports	T-Test (p-value)
Population Variables			
Total population	15,308.7	8,449.0	0.01
Urban population	11,279.5	6,726.3	0.09
Rural population	4,029.1	1,722.7	0.00
Access to public services			
Percentage with electricity	47.6	58.0	0.00
Percentage with water	57.7	66.9	0.00
Percentage with sewerage	52.0	49.5	0.16
Other variables			
Altitude	2,245.6	2,193.2	0.56
Index of accessibility (less is more accessive)	4.42	3.95	0.00
Surface	74,015.2	32,138.3	0.00
Km to the capital of province	54.80	51.22	0.44
Districts capital of province (1 yes, 0 no)	0.12	0.02	0.00

District´s without any natural hazard reported in the database are less populated than the ones with reports. Moreover, districts excluded from the SINPAD database DO NOT present on average worse living conditions than the ones with at least one report. In fact, districts excluded present on average better living conditions with respect to the variables access to electricity and to water. Variables related to district´s isolation, like mean altitude and distance of the district to the capital, do not present robust different in the groups of districts. This information tell us that the idea that more marginal districts have being excluded from the database do not holds in the case of SINPAD database.

The last variable included in the table, reveals that almost all districts that are capital of a province present at least one report in the database. As we mentioned before, one feature that could better capture the district´s importance is the condition of being a province´ capital. In the following section we will use this classification to explore the difference in the number of reports between these districts and the rest. But in the case of the variable district capital the result could be explain through of the variable population.

B. Comparison of Reports by district´s geo-political condition

We compare the difference between the total number of reports registered in each district capital of province with the mean number of reports registered for the rest of the districts of that same province. For that matter we use two different categories of events: all events reported, and all events reported excluding strong wind.

Table 23: Events reported by districts geo-political classification (SINPAD)

T-TEST		
Geo-political classification	Mean events reported	
	All events	All Events (without strong wind)
Provincial capital	20.78	15.26
Other districts	7.16	5.25
P-value	0.0	0.0

At a 99.9% significance level, the number of reports in capital districts are higher than the average number of reports in other districts.

Continuing with this idea, now we scale up the previous comparison to the provincial level. We proceed by calculating the difference between the number of reports in the districts capital of provinces and the mean number of reports for the rest of the districts in the same province. Then, we identify the provinces that area capital of a department, and compare the difference found before, between these provinces and the rest of the provinces in the same department. We expect that the difference in number of reports between districts that are capital of a province and the rest of the districts in the same province, is higher for provinces that are capitals of a department than for provinces that are not.

Table 24: Events reported by province geo-political classification (SINPAD)

T-TEST		
	Mean difference between # of reports in districts that are provincial capitals and the mean # of reports in districts that are not provincial capitals	
	All Events	All Events (without strong wind)
Provinces that are departmental capitals	30.17	26.08
Other provinces	10.46	7.27
P-value	0.0	0.0

The bias on the number of reports is even stronger for districts capitals of a province that is in turn the capital of a department.

Finally, when we look at the relationship between the number of reports by district and different measures of district´s isolation, we find a significant coefficient for most of them.

Table 25: Number of reported events and districts isolation variables (OLS) [SINPAD]

Variables	Number of reports	
	ev_tot	ev_tot_sven
Altitude	0.000590* (-2.38)	0.000849*** (-4.97)
Surface	0.0000144*** (-8.89)	0.0000100*** (-9.00)

Accessibility	-0.243 (-1.63)	-0.181 (-1.75)
Distance to the Provincial Capital	-0.0167*** (-3.32)	-0.0101** (-2.93)
Constant	7.873*** (-9.43)	4.927*** (-8.57)
N	1736	1736
adj.R-sq	0.044	0.047

t statistics in parentheses

* p<0.05, ** p<0.01, *** p<0.001

Appendix 4: Characteristics of Provinces (SINPAD Database)

Variables	**Mean**	**Std. Dev.**	**Min**	**Max**
Characteristics of the dwellings				
% with electricity 1993	31.63	23.74	0.42	88.56
% with water 1993	37.21	21.94	0.26	89.62
% with sewerage 1993	38.49	23.52	1.57	88.43
Difference in % with electricity 2005-03	19.93	12.38	-13.09	63.05
Difference in % with water 2005-03	22.92	18.12	-53.30	71.97
Difference in % with sewerage 2005-03	18.61	10.22	-15.85	46.36
Population indicators				
Total population 1993	113,059.5	416,721.1	2,532.0	5,706,127.0
Difference in population 2005-03	20,783.6	92,926.5	-15,846.0	1,248,390.0
Porc of rural population 1993	54.44	25.39	0.08	90.99
Welfare indicator				
Poverty rate 1993	66.00	18.98	7.31	96.89
Poverty rate 2005	60.38	19.07	14.55	99.3
Change in Poverty rate 2005-1993	-5.92	19.03	-58.89	57.72
Natural disasters indicator				
Average number of natural disasters 2003-05	8.49	9.09	0.00	49.00
Others variables				
Number of schools in 1993	263.45	577.45	0.00	7,887.00
Difference in number of schools 2005-1993	159.97	689.43	0.00	9,386.00
Kilometers of paved road per province	90,759.8	89,373.4	0.0	441,194.2
Mean Altitude	2,104.13	1,351.30	12.33	4,167.25

Appendix 5: Correlation of variables of interest (SINPAD Database)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Poverty rate 2005 (1)	1								
Mean of number of natural disasters 2003-05 (2)	0.1923	1							
% with electricity 1993 (3)	-0.74	-0.149	1						
% with water 1993 (4)	-0.6563	-0.0839	0.8485	1					
% with sewerage 1993 (5)	-0.6703	-0.1114	0.7043	0.5961	1				
Number of education centers 1993 (6)	-0.1496	0.202	0.2388	0.2216	0.2466	1			
Kilometers of paved road per province (7)	-0.3276	0.2582	0.2795	0.2596	0.2993	0.2134	1		
Altitude (8)	0.5672	0.1656	-0.4326	-0.2333	-0.6329	-0.1632	-0.2324	1	
Porc of rural population 1993 (9)	0.7029	0.111	-0.8886	-0.878	-0.6644	-0.2147	-0.3044	0.4505	1

Appendix 6: Descriptive statistics (Unbalance panel)

Variable	Obs	Mean	Sd	Min	Max
Human capital					
Age of the hh	8411	49.58	16.25	14	96
Education of the hh: equal or lower than complete primary (yes=1)	8400	0.28	0.45	0	1
Average years of education of the members of the household	8410	4.45	3.13	0	17
Total years of education of the members of the household	8411	19.31	15.63	0	131
Average years of education of the hh	8411	4.52	4.65	0	18
Gender of the hh (woman=1)	8411	0.16	0.36	0	1
HH is literate (yes=1)	4105	0.57	0.49	0	1
At least one children don't go to school (yes-=1)	8411	0.11	0.31	0	1
Characteristics of the dwellings					
Low qualitity of dwelling's materials (yes=1)	8369	0.15	0.36	0	1
Owner of house (yes=1)	8410	0.85	0.35	0	1
Number of rooms use to sleep	4373	1.60	1.13	0	7
Water: access to public network (yes=1)	8411	0.41	0.49	0	1
Sewerage connected to public network (yes=1)	8411	0.59	0.49	0	1
Electricity as lightning source (yes=1)	8411	0.37	0.48	0	1
Telephone (fixed) (yes=1)	8411	0.01	0.09	0	1
Welfare indicators					
Number of members per worker	8382	2.87	1.84	1	13
Poor [consumption] (yes=1)	8411	0.60	0.49	0	1
Poor [assets] (yes=1)	8411	0.43	0.49	0	1
Monetary expenses (as proportion of total expenses)	8411	0.56	0.23	0	1
Monetary income (as proportion of total income)	8411	0.55	0.26	0	1
Risk management and coping indicators					
Received credit from any source (year 2004-2006) (yes=1)	4375	0.39	0.49	0	1
Receive income from renting private properties	8411	0.10	0.30	0	1
Remittances					
International Remittances (yes=1)	8411	0.25	0.43	0	1
Local Remittances (yes=1)	8411	0.01	0.08	0	1
Remittances (at least one source)	8411	0.00	0.03	0	1
International Remittances (Yearly amount)	8411	602.16	2115.52	0	43176
Local Remittances (Yearly amount)	8411	43.18	828.00	0	33660
Food assistance (at least one member, yes=1))					
Glass of milk	8411	0.37	0.48	0	1
Popular dinning room	8411	0.07	0.25	0	1
Schoolar breakfast	8411	0.19	0.39	0	1
Other programm	8411	0.10	0.30	0	1
Proportion of beneficiaries (as a proportion of total members)	8411	0.26	0.29	0	1
Assets					
Livestock (on sheep equivalences)	7916	17.77	29.03	0	530
Vector of assets	8411	863.57	2813.15	0	57795.7
Number of plots (2004-2006)	8411	1.04	2.02	0	20

Appendix 7: Descriptive statistics (Balance panel)

Variable	Obs	Mean	Sd	Min	Max
Human capital					
Age of the hh	4150	48.99	15.47	15	94
Education of the hh: equal or lower than complete primary (yes=1)	4147	0.29	0.46	0	1
Average years of education of the members of the household	4150	4.57	3.06	0	17
Total years of education of the members of the household	4150	20.72	16.14	0	131
Average years of education of the hh	4150	4.65	4.65	0	18
Gender of the hh (woman=1)	4150	0.13	0.34	0	1
HH is literate (yes=1)	2025	0.58	0.49	0	1
At least one children don't go to school (yes-=1)	4150	0.03	0.17	0	1
Characteristics of the dwellings					
Low qualitity of dwelling's materials (yes=1)	4150	0.18	0.39	0	1
Owner of house (yes=1)	4150	0.87	0.34	0	1
Number of rooms use to sleep	2265	1.67	1.07	0	7
Water: access to public network (yes=1)	4150	0.39	0.49	0	1
Sewerage connected to public network (yes=1)	4150	0.59	0.49	0	1
Electricity as lightning source (yes=1)	4150	0.40	0.49	0	1
Telephone (fixed) (yes=1)	4150	0.00	0.07	0	1
Welfare indicators					
Number of members per worker	4144	2.86	1.78	1	13
Poor [consumption] (yes=1)	4150	0.61	0.49	0	1
Poor [assets] (yes=1)	4150	0.39	0.49	0	1
Monetary expenses (as proportion of total expenses)	4150	0.57	0.22	0	1
Monetary income (as proportion of total income)	4150	0.57	0.25	0	1
Risk management and coping indicators					
Received credit from any source (year 2004-2006) (yes=1)	4375	0.39	0.49	0	1
Receive income from renting private properties	4375	0.10	0.30	0	1
Remittances					
International Remittances (yes=1)	4375	0.25	0.43	0	1
Local Remittances (yes=1)	4375	0.00	0.07	0	1
Remittances (both sources)	4375	0.25	0.44	0	1
International Remittances (Yearly amount)	4375	609.97	2190.52	0	43176
Local Remittances (Yearly amount)	4375	20.05	491.70	0	33660
Food assistance (at least one member, yes=1))					
Glass of milk	4375	0.43	0.50	0	1
Popular dinning room	4375	0.08	0.27	0	1
Schoolar breakfast	4375	0.22	0.42	0	1
Other programm	4375	0.12	0.32	0	1
Proportion of beneficiaries (as a proportion of total members)	4375	0.28	0.29	0	1
Assets					
Livestock (on sheep equivalences)	4375	18.59	30.89	0	366
Vector of assets	4375	943.48	2740.07	0	39777.7
Number of plots (2004-2006)	4375	1.01	1.74	0	20

Appendix 8: Multinomial regressions. Dependent variable: Poverty transitions, consumption

Model 2	One episode	Several	Always Poor
Subsample: Agrarian households			
Average of shocks	0.0690	13.98	36.44*
	(0.195)	(46.36)	(77.12)
Shock(mean)*Quantity of animals(2002)	0.993	0.978	0.991
	(0.0274)	(0.0182)	(0.0238)
Shock(mean)*Low housing(2002)	16666.7**	664.1	1409.4
	(69930.3)	(2957.0)	(6428.7)
Shock(mean)*Proportion of agricultural income(2002)	0.0701	0.0341	0.234
	(0.405)	(0.134)	(0.698)
N	678		
	One episode	Several	Always Poor
Subsample: Coast			
Average of shocks	2702.4	421400.3	13336215.8**
	(13802.0)	(3925802.9)	(104785085.9)
Shock(mean)*Quantity of animals(2002)	1.027	0.974	0.938
	(0.0541)	(0.0517)	(0.0574)
Shock(mean)*Low housing(2002)	135.8***	8.732	5.526
	(18.75)	(34.54)	(11.30)
Shock(mean)*Proportion of agricultural income(2002)	0.000139***	0.106	0.00471***
	(0.000111)	(0.349)	(0.00786)
N	274		

Appendix 9: Multinomial regression. Dependent variable: Poverty Transitions, consumption

	Poverty transitions: consumption (2002-2003)			Poverty transitions: consumption (2003-2004)			Poverty transitions: consumption (2004-2005)			Poverty transitions: consumption (2005-2006)		
	Poor-Non Poor	Non Poor-Poor	Remain poor	Poor-Non Poor	Non Poor-Poor	Remain poor	Poor-Non Poor	Non Poor-Poor	Remain poor	Poor-Non Poor	Non Poor-Poor	Remain poor
Shock: Natural Disaster	2.441	5.827	1.518	1.057	2.252	2.803	6.061***	1.068	4.673***	0.303	0.595	0.418
(t)	(1.502)	(7.709)	(1.194)	(1.079)	(1.611)	(2.628)	(3.812)	(1.033)	(2.375)	(0.462)	(0.267)	(0.474)
Shock: Natural Disaster	0.656	0.284	0.93	13.40**	4.096	14.04***	2.426	0.805	0.516	1.246	0.898	3.130
(t+1)	(0.575)	(0.42)	(1.086)	(14.13)	(4.893)	(8.665)	(2.347)	(1.410)	(0.886)	(1.433)	(1.630)	(4.699)
Total years of	0.991	1.00	0.976**	1.000	0.975**	0.979**	1.002	1.001	0.993	1.021*	1.001	0.983***
education (t)	(0.0146)	(0.0111)	(0.00975)	(0.0113)	(0.0121)	(0.0105)	(0.0128)	(0.00512)	(0.009)	(0.0119)	(0.0164)	(0.00499)
Female head of	1.008	0.333*	0.472	0.492	0.705	0.274**	0.812	0.566	0.296***	1.032	0.327	0.218***
household (t)	(0.631)	(0.212)	(0.283)	(0.295)	(0.358)	(0.148)	(0.340)	(0.442)	(0.136)	(0.616)	(0.245)	(0.119)
Agriculture as main	0.990*	0.996	0.994	1.519	0.589	1.547	1.003	1.006	0.997	0.998	0.996	0.987***
activity (t)	(0.001)	(0.00701)	(0.00595)	(0.815)	(0.655)	(0.674)	(0.0158)	(0.0127)	(0.0140)	(0.004)	(0.00418)	(0.00466)
Agriculture as secondary	0.885	1.002	1.064	2.406	2.435	6.464***	0.278***	0.581**	0.319***	0.584	0.807	0.294***
activity (t)	(0.35)	(0.395)	(0.258)	(1.565)	(2.337)	(2.980)	(0.0701)	(0.147)	(0.0770)	(0.205)	(0.270)	(0.140)
Proportion of agricultural	0.624	0.347***	0.266***	0.387	0.586	2.935	0.384*	0.500**	0.260***	0.382***	0.391***	0.293***
income(t)	(0.205)	(0.114)	(0.0957)	(0.326)	(0.329)	(2.209)	(0.207)	(0.173)	(0.0948)	(0.0871)	(0.110)	(0.0748)
Low quality of	1.000	1.000	1.000**	1.464	0.284***	0.813	1.000*	1.000	1.000***	1.000***	1.000*	1.000
dwelling (t)	(0.000)	(0.000)	(0.000)	(0.693)	(0.0645)	(0.148)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Quantity of animals (t)	0.958	1.03	0.998	0.995	0.998	0.995	0.991	0.997	0.995	0.958*	1.026***	1.001
	(0.031)	(0.019)	(0.0246)	(0.006	(0.004)	(0.004)	(0.0120)	(0.00968)	(0.0114)	(0.0221)	(0.0102)	(0.0103)
Access to piped water (t)	3.287	0.000***	4.358	1.055	0.481*	0.640	1.352	0.306	0.262	0.387	0.000***	3.906
	(2.678)	(0.000)	-4.442	(0.386)	(0.206)	(0.255)	(1.858)	(0.973)	(0.318)	(0.409)	(4.15e-15)	(3.291)
Access to electricity (t)	0.348	0.000***	0.361	0.511**	0.735	0.281***	0.112***	0.476	0.408	2314.2**	0.646	331.7
	(0.717)	(0.000)	-0.745	(0.137)	(0.158)	(0.0748)	(0.0830)	(1.281)	(0.432)	(9037.2)	(2.190)	(1216.7)
Vector of assets (t)	1.004	0.981	0.996	1.000	1.000**	1.000***	0.983*	0.938**	0.975***	0.990	0.978	0.999
	(0.006)	(0.031)	-0.0202	(0.000)	(0.000)	(0.000)	(0.00894)	(0.0281)	(0.008)	(0.0161)	(0.0275)	(0.0133)
Shock*Quantity of	0.756	3.254	1.349	0.975	0.996	0.987	0.295	3.079	4.124	0.797	0.000***	0.500
animals (t)	(0.536)	(2.916)	-1.624	(0.0158)	(0.00655)	(0.0162)	(0.401)	(5.154)	(3.625)	(0.756)	(6.88e-15)	(0.432)
Shock*Low housing (t)	3.074	3.345	4.092	4.538***	10.95	2.786**	1.488	18319.3***	1647.6	0.647	3.050	0.463

	(5.518)	(5.237)	-7.323	(2.657)	(16.56)	(1.397)	(2.952)	(61583.7)	(8046.4)	(1.127)	(7.352)	(0.906)
Shock*Proportion of	2.441	5.827	1.518	1.025	0.0101*	0.108	6.061***	1.068	4.673***	0.303	0.595	0.418
agricultural income (t)	(1.502)	(7.709)	-1.194	(2.214)	(0.0241)	(0.222)	(3.812)	(1.033)	(2.375)	(0.462)	(0.267)	(0.474)
Shock*Quantity of	0.656	0.284	0.93	0.985	1.000	0.978***	2.426	0.805	0.516	1.246	0.898	3.130
animals (t+1)	(0.575)	(0.42)	-1.086	(0.001)	(0.004)	(0.005)	(2.347)	(1.410)	(0.886)	(1.433)	(1.630)	(4.699)
Shock*Low housing (t+1)	0.991	1.00	0.976**	4.359*	14.40***	3.734	1.002	1.001	0.993	1.021*	1.001	0.983***
	(0.015)	(0.011)	-0.00975	(3.832)	(12.87)	(5.672)	(0.0128)	(0.00512)	(0.009)	(0.0119)	(0.0164)	(0.00499)
Shock*Proportion of	1.008	0.333*	0.472	0.230	1.794	1.419	0.812	0.566	0.296***	1.032	0.327	0.218***
agricultural income (t+1)	(0.631)	(0.212)	-0.283	(0.488)	(3.413)	(1.886)	(0.340)	(0.442)	(0.136)	(0.616)	(0.245)	(0.119)

Appendix 10: Quantile regression, Dependent variable: (log) Monthly per capita consumption (2006)

	Quantile 0.25	Quantile 0.50	Quantile 0.75
Constant	4.492***	4.784***	5.103***
	(0.0662)	(0.0825)	(0.0433)
Average of shocks	-0.691***	-0.947***	-1.506***
	(0.182)	(0.243)	(0.120)
Total years of education (2002)	0.00711***	0.00717***	0.00654***
	(0.00122)	(0.00161)	(0.000747)
Female head of household (2002)	0.0687	0.136**	0.0533*
	(0.0536)	(0.0628)	(0.0303)
Quantity of animals (2002)	0.00312***	0.000893	-0.000144
	(0.000766)	(0.000947)	(0.000525)
Vector of assets (2002)	0.0000240***	0.0000296***	0.0000174***
	(0.00000730)	(0.00000829)	(0.00000341)
Low quality dwelling (2002)	0.0511	0.0371	0.0259
	(0.0570)	(0.0654)	(0.0320)
Access to piped water (2002)	0.102**	0.102**	0.0963***
	(0.0425)	(0.0504)	(0.0266)
Telephone (land line) (2002)	-0.554***	-0.659**	-0.865***
	(0.143)	(0.273)	(0.145)
Access to electricity (2002)	0.263***	0.225***	0.211***
	(0.0448)	(0.0543)	(0.0273)
Agriculture as main activity (2002)	0.428***	0.299***	0.439***
	(0.0707)	(0.0847)	(0.0463)
Agriculture as secondary activity (2002)	-0.00751	-0.187	0.0343
	(0.0987)	(0.140)	(0.0833)
Proportion of agricultural income(2002)	-0.145*	-0.0880	-0.278***
	(0.0838)	(0.0995)	(0.0539)
Shock(mean)*Quantity of animals(2002)	0.000217	0.00559**	0.00909***
	(0.00177)	(0.00246)	(0.00115)
Shock(mean)*Low housing(2002)	-0.117	0.309	0.398***
	(0.232)	(0.282)	(0.121)
Shock(mean)*Proportion of agricultural income(2002)	0.0996	0.143	0.860***
	(0.323)	(0.410)	(0.190)

Source: ENAHO 2002-2006. Balance Panel
* p<0.05 ** p<0.01 *** p<0.001

Appendix 11: Quantile regression, Dependent variable: (log) Monthly per capita consumption (2006). Including coping strategies.

	Quantile 0.25	Quantile 0.50	Quantile 0.75
Average of shocks	-0.550***	-1.072***	-1.887***
	(0.0809)	(0.125)	(0.100)
Total years of education (2002)	0.00651***	0.00719***	0.00582***
	(0.000484)	(0.000757)	(0.000910)
Female head of household (2002)	0.0376*	0.0939***	0.00367
	(0.0204)	(0.0290)	(0.0258)
Quantity of animals (2002)	0.00129***	0.000582	-0.0000552
	(0.000304)	(0.000435)	(0.000456)
Vector of assets (2002)	0.0000200***	0.0000288***	0.0000205***
	(0.00000291)	(0.00000341)	(0.00000302)
Low quality dwelling (2002)	0.0646***	0.0641**	0.00574
	(0.0225)	(0.0295)	(0.0276)
Access to piped water (2002)	0.0578***	0.111***	0.0717***
	(0.0171)	(0.0231)	(0.0217)
Telephone (land line) (2002)	-0.458***	-0.558***	-0.783***
	(0.0568)	(0.125)	(0.130)
Access to electricity (2002)	0.229***	0.168***	0.215***
	(0.0176)	(0.0247)	(0.0235)
Agriculture as main activity (2002)	0.375***	0.246***	0.425***
	(0.0267)	(0.0387)	(0.0388)
Agriculture as secondary activity (2002)	0.0110	-0.224***	-0.142**
	(0.0394)	(0.0625)	(0.0721)
Proportion of agricultural income(2002)	-0.110***	-0.179***	-0.311***
	(0.0340)	(0.0445)	(0.0441)
Shock(mean)*Quantity of animals(2002)	0.0000405	0.00470***	0.00830***
	(0.000674)	(0.00113)	(0.00104)
Shock(mean)*Low housing(2002)	-0.189**	0.132	0.463***
	(0.0908)	(0.119)	(0.103)
Shock(mean)*Proportion of agricultural income(2002)	-0.0214	0.605***	1.179***
	(0.121)	(0.180)	(0.162)
Coping strategy: savings (average)	1.193***	0.703***	0.872***
	(0.0904)	(0.149)	(0.152)
Coping strategy: assets(average)	0.987***	0.668***	0.198
	(0.119)	(0.232)	(0.181)
Coping strategy: credit (average)	0.513***	0.708***	0.763***
	(0.126)	(0.179)	(0.165)
Coping strategy: workload(average)	0.296***	0.168*	0.183*
	(0.0660)	(0.100)	(0.0965)
Coping strategy: external support (average)	0.491**	0.243	1.775***
	(0.203)	(0.343)	(0.330)
Coping strategy: food (average)	-0.936***	-0.503***	-0.115
	(0.0860)	(0.131)	(0.126)

Constant	4.518***	4.807***	5.153***
	(0.0268)	(0.0375)	(0.0389)

Source: ENAHO 2002-2006. Balance Panel
* p<0.05 ** p<0.01 *** p<0.001