ECONOMIC AND SOCIAL EFFECTS OF "EL NIÑO" IN ECUADOR, 1997-8[1]

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ABSTRACT.

Natural disasters, like the "El Niño" phenomenon often hit hardest on the poor. Yet it is often difficult to separate the effects on living conditions produced by the inclement weather conditions from general inadequacies in infrastructure and lack of economic development. Furthermore, there may be controversy as to how to value damages due to the natural disaster: just to repair and rehabilitate or to reconstruct to prevent and enhance development. This methodological problem related to the measurement of the costs also affects policy choices. How much should one focus on emergency relief and what can be done to obtain better prevention against recurring weather shocks such as the El Niño phenomenon? Ecuador's policy orientation appears to have been greatly oriented at reactive, relatively untargeted emergency relief, whereas this study recommends greater emphasis on pro-active and targeted developmental investment.

This study finds that economic and social costs of "El Niño" in Ecuador have been substantial. Most economic costs relate to losses of agricultural production and damages to infrastructure. Increased health risks are most critical in the social sectors. Close to 300 deaths directly linked to the floods are to be lamented and about a quarter of the Ecuadorian population has been exposed to increased risk of diseases and mortality.

Outcomes suggest that most of the agricultural income losses be borne by small farmers in the production of rice, corn, coffee and cocoa and to a lesser extent by agricultural workers in the sugar cane industry and banana plantations. The overall impact on the already high poverty incidence in the affected areas could be as large as 10 percentage points. The disaster has also been beneficial to some, in particular the wealthy shrimp producers who saw productivity go up by over 25%, while banana exporters could compensate production losses through higher export quota en export prices. Health risks are greatest in areas with poor sanitary infrastructure and overall social conditions. The affected areas largely coincide with areas hit in previous occurrences of El Niño, the previous being in 1982-3.

This study proposes methodologies to identify different types of risks associated with natural disasters such as El Niño and to establish degrees of vulnerability to such risks by geographical areas and population groups. This should help to set policy

priorities towards preventive investment and better protection of the most vulnerable population.

CONTENTS

1. INTRODUCTION

The natural phenomenon of "El Niño" is a regularly returning change in temperatures of the Pacific Ocean provoking temporal climatic change around the world.[2] Along the South American coast changes are felt in the form of extremely heavy rainfall causing floods, landslides and so on often with disastrous consequences. Because they live in poorer homes and tend to have less access to protective infrastructure such disasters often hit hardest on the poor.

The occurrence of El Niño in Ecuador in 1997-8 cost the lives of at least 286 people and some 30,000 persons were severely affected by loosing their homes and had to recur to families, friends or camps to survive. A much larger share of the population has been affected by income losses as they saw their agricultural lands flooded or went without employment due to stagnation in economic activity. We estimate that about a quarter of the total population has been severely exposed to increased health risks related to floods and damage to sanitary infrastructure and the consequent spread of infectious diseases such as malaria, diarrhea, cholera and other.

In contrast to many other natural disasters, El Niño came pre-announced. Early in 1997 it was clear that with a large probability the phenomenon would set in around the month of November and cause extremely heavy rainfall with all the related consequences. Lessons could be learned from the previous appearance in 1982-3. A contingency plan was ready in July 1997 and the state of emergency was declared at that same point in time, some four months before the first symptoms announced the actual arrival of "El Niño". The Ecuadorian authorities had established a budget for emergency relief and reconstruction of US$ 318 million, of which US$ 231 million in the form of loans from multilateral agencies and related counterpart funds.

The paradox of the situation has been that while the Ecuadorian authorities seem to have felt better prepared than ever (the event of 1982-3 took them by surprise), preventive action and the preparation for rehabilitation and reconstruction proved surprisingly little effective. In this study we conclude that authorities did not really learn from the previous experience and failed to

[2] The phenomenon El Niño should not be confused with the ocean current "El Niño" which each year around Christmas brings warmer seawater to the coasts of Ecuador and Peru, to retreat back to the coast of Mexico around April. This period marks the rainy season. The phenomenon of El Niño originates in waters near Indonesia. It returns with a regularity of about once every seven years, but with a maximum delay of 15 years. The previous occurrence with heavy impact of the phenomenon El Niño in Ecuador was in 1982/3. When referring to "El Niño" in this study we indistinguishably refer to "the phenomenon".

adequately distinguish between the different types of risks associated with the phenomenon and to identify degrees of vulnerability to such risks of different parts of the population. The approach to the risks remained remarkably general and untargeted. The Contingency Plan identified a total of 6.5 million people at risk, that is 57% of the total population, without an elaboration how to respond to different types of impacts of El Niño: on destroyed houses, loss of income and production, increased health risks and so on.

The first objective of this study is to analyze the (potential) impact of El Niño in terms of economic losses and increased health risks, with particular emphasis on the most vulnerable population groups. We indicate "potential" impact at the time of executing the study (February and June 1998), the consequences of the disaster were not fully measurable for a lack of output indicators after the event and due to the fact that the phenomenon had not fully stopped leaving traces of destruction.

A second objective of the study is to show how the methodology used to differentiate between risks and vulnerability of different population groups to such risks may help to guide policies aiming at preventive reconstruction of the affected areas and target the benefits towards the most vulnerable.

The study concentrates on the following aspects:

- A conceptualization of types of risk and vulnerability associated with El Niño and how to assess the costs of this type of natural disaster (Section 2).
- An estimation of the economic costs (and benefits!) in terms of foregone earnings to farmers and agricultural workers, based on an analysis of the vulnerability to weather shocks by crops and agro-ecological zones. This analysis is subsequently used to estimate the possible impact on rural poverty and to identify the rural population that probably has suffered most from the natural disaster (Section 3).
- Study of the vulnerability to health risks and required preventive action to reduce such vulnerability (Section 4).
- A summary of the emergency relief and preventive actions taken or programmed by the authorities and a general assessment of their effectiveness (Section 5).
- Policy conclusions are drawn in Section 6. The discussion there centers around the question whether one should emphasize disaster relief and income loss compensation programs or

rather use the natural disaster to reconsider development plans and investment priorities in order to reduce vulnerability to weather shocks in a more structural way. The conclusions go in favor the latter solution.

2. ECONOMIC AND SOCIAL EFFECTS OF "EL NIÑO": WHAT AND WHOSE COST?

2.1 Methodological considerations

'It's because of "El Niño"', is an often-heard explanation in many parts of the world for the occurrence of abnormal climatic conditions during 1997 and 1998. While a known natural phenomenon, it is not always clear to what extent heavy rainfalls and floods or prolonged periods of draught observed around the world can all be related to "El Niño". Also precise indications of the deviation from normal conditions are not always available.

In the case of Ecuador, the inclement weather conditions and subsequent floods and landslides that affected most of its coastal regions during 1997-8, undoubtedly are related to the "El Niño" phenomenon which returns with intervals of between 7 and 15 years. Yet roads, bridges and drinking water systems suffer annually from some degree of damages during the normal rainy season and also agricultural producers normally do not harvest a portion of their crops during periods rural roads are impassable. There is no good record of what these 'normal' damages are and hence difficult to measure how much of the destruction in 1997-8 is actually caused by "El Niño". Further, some areas have been more heavily affected than others have. Not always because rainfalls have been more heavy, but because of greater deficiencies in existing infrastructure. Similarly certain areas have been less affected by increased health risk because of better coverage of immunizations and sanitation systems. This raises the issue of **vulnerability**: some areas and population groups may be more at risk due to "El Niño" than others. It also raises an issue of how to measure **costs**: should damages be valued at cost of rehabilitation in the pre-El Niño condition or at reconstruction costs which give better preventive protection?

Studies of natural disasters are inherently complex and have to deal with important methodological problems. The first is the **uncertainty** regarding El Niño. Despite the general predictability of the El Niño phenomenon, there still remains a considerable degree of uncertainty regarding how, when and to what degree it will affect areas of potential risk. Based

on an evaluation of past experience this issue is approached in this study by identifying different types of risks attached to the phenomenon and the different degrees of **vulnerability** of geographical zones and population groups that are likely to be affected by the natural disaster. In particular, we deal with the vulnerability to agricultural income losses and increased health risks associated with the environmental damages caused by El Niño. Although the study was executed while the natural disaster had not fully finished leaving its traces of destruction, the first indications of the impact showed good consistency with the predictions of the vulnerability analysis. Hence, the approach should help to more easily identify types of emergency relief and preventive action to be undertaken, as well as to prioritize among areas and population groups requiring specific attention to cope with the losses and to target possible preventive interventions.

The second problem relates to the **assessment of costs**. Several problems are at stake here. One is the choice of an appropriate benchmark as suggested above. If one is only interested in the cost associated with the natural disaster one should be able to (a) distinguish between the damage caused by the disaster and (b) the "normal" depreciation of capital stock (infrastructure), production levels or health risk situation. In particular, what should be considered the "normal" situation in areas subject to other weather shocks or exogenous shocks. Comparison with the previous or an average year may not be adequate. Another consideration of importance is how to value damage to natural and physical capital stocks, output losses and foregone earnings. This is not just a technical issue, but one linked to policy objectives. For instance, damage to infrastructure could be valued at the cost of full reconstruction, leaving it in a better shape than before. This can make good sense from a developmental point of view. However, it may also be subject to political economy problems. If roads and bridges were in a bad shape to begin with, then the natural disaster would be blamed for poor investments in the past. Costs due to the natural disaster may thus be 'exaggerated' and this "political economy of natural disasters" (see e.g. Albala-Bertrand 1993; Noll 1996) may easily lead to misguiding disaster-relief policies and foreign assistance programs. However, if the main policy objective is to achieve developmental reconstruction of the affected areas such valuation of resource needs may well be justifiable, as long as it is clear these are distinct from the precise damages caused by the natural disaster.

Two more methodological problems associated with cost assessments should be considered. First, one has to distinguish between *direct* and *indirect* losers. Farmers may have lost a harvest as a direct consequence of El Niño, but consumers and agro-industries may be indirect losers as food prices may have increased and/or supply of inputs has stagnated. The analysis of identifying direct and indirect effects is further complicated by market responses to the natural disaster, e.g. farmers may find some compensation for output losses through higher food prices, transporters affected by damaged roads through higher freight fees. Second, one has to distinguish *losses* from *delays*. In agriculture, for instance, losses will be associated with labor that went unused and output of crops that could not be harvested. There would be delays if sowing and harvesting have been delayed in response to El Niño.

In this study, the costing problem is dealt with at two levels. First, an estimation of the direct cost of the damages (to the extent valuable in monetary terms) and second, in function of the type of vulnerability, some estimates are made of possible costs of reconstruction which would provide greater protection.

On **costs** (section 3), we restrict ourselves to estimate what we define as direct costs, that is the economic costs (in the form of foregone earnings and/or rehabilitation of damaged infrastructure to its functional state prior to El Niño). Hence we do not try to estimate indirect costs which may result through input-output links or through absolute and relative price effects by which production losses in one sector spill over to others. To do this properly a general equilibrium model would be required, an exercise clearly beyond the scope of this study.

Since no disaggregated data derived from direct observation are available, we need to identify areas and population groups by their vulnerability to the (potential) impact of El Niño. We focus in particular on two main types of vulnerability associated with "El Niño": that affecting agricultural production and incomes and that raising health risks.

2.2 Identifying the vulnerable population in Ecuador

The *official policy orientation* in Ecuador has focused on the **environmental risks** linked to the phenomenon itself, that is the risks associated with heavy rainfall, storms and spring-tides. These may provoke floods, landslides, rupture of dikes, and so on, which in turn will affect

roads, sanitation systems and other types of infrastructure as well as may put in danger the lives and health conditions of people.

The experience of the effects of El Niño in 1982-3 served as a basis to identify the areas of major potential risk by type of natural cause. The *Defensa Civil* (Civil Defense) was designated with organizing preventive action and by July 1997 it had identified 93 *cantones* (municipalities), of which 77 belonged to the provinces of the *Costa* (the tropical lowlands bordering the Pacific Ocean) (see Table 1). Later on, 12 more cantons were added to reach a total of 105 potentially affected municipalities with an aggregate population of 6.5 million, that is 57% of the country's population was considered to be at risk (see Table 2).

This official 'map' of vulnerable areas was meant to orient humanitarian emergency action for the affected population, preventive health actions, and the rehabilitation of infrastructure. Evacuating and assisting people in emergency situations and maintain flooded areas accessible was the main worry of the *Defensa Civil*, but other agencies, such as the Ministry of Health, the Ministry of Social Works and local authorities had to rely on the same information.

Table 1

'Official Map' of potentially affected areas due to environmental risks associated with the phenomenon of El Niño, 1997-8
(number of potentially affected cantones in provinces of the Costa)

TYPE OF ENVIRONMENTAL RISK	GUAYAS 27 cantons	LOS RIOS 11 cantons	EL ORO 14 cantons	MANABI 19 cantons	ESMERALDAS 6 cantons
Maximum risk of flooding	4	4	-		-
Very vulnerable to tamping of draining and sewerage systems	16	6	11	13	2
Only torrential rains	6	-	8	-	1
Spring-tides	6	-	3	7	4
Overflowing of rivers	2	2	8	9	7
AFFECTED HYDROGRAPHIC BASINS	Río Guayas and micro-basins	Basin (delta) of Río Guayas	Lower parts of river basins Jubones, Santa Rosa and Pagua.	Chone and Portoviejo	Santiago-Cayapas, Ostiones, Mata and lower part of Muisne

* Some cantons are affected by more than one type of risk at a time.
Source: Defensa Civil del Ecuador, (July 1997); and Secretaría Técnica del Frente Social (SIISE), *Cronología del fenómeno de El Niño en base al Periódico Hoy, 1982-1983 (febrero 1998).*

Table 2
Potentially affected municipalities (cantons) and population by phenomenon of El Niño, 1997-8

	No. of affected cantons	Total population (millions)
According to: Defensa Civil	105	6.5
According to: This Study		
Vulnerable to agricultural income losses	39	1.2
(of which: poor)[1]	39	0.9
Vulnerable to increased health risk	65	5.3
(of which: very vulnerable)[2]	52	2.5
Memo:		
Total population Ecuador (Nov. 1997)		11.2
Total population Costa provinces		5.6

Source: Defensa Civil (1997) and text.
Notes:
1. Population with consumption level below poverty line of US$ 61 per person, per month in 1997
2. Population of cantons with an index of social and sanitation conditions (ICSS) below the national average. See text.

The problem with this approach is that by mainly focusing on the environmental risks the authorities were unable to properly distinguish between types of vulnerability: that is which areas and population groups would be more affected by losses in agricultural production, infrastructure and increased prevalence of diseases and mortality.

In this paper we focus on two types of vulnerability which are the most relevant in relation to the consequences of El Niño:

- vulnerability to income losses, in particular due to damages to agricultural production and infrastructure
- vulnerability to increased health risk

As shown by Table 2, this still implies that a large part of the Ecuadorian population has been exposed to severe income losses and enhanced health risks. We estimate the population most at risk to be 0.9 million people with strongly worsened economic conditions and 2.5 million people exposed to greater health risks. The population vulnerable to income losses and those with enhanced health risk due to El Niño overlap to a great extent.

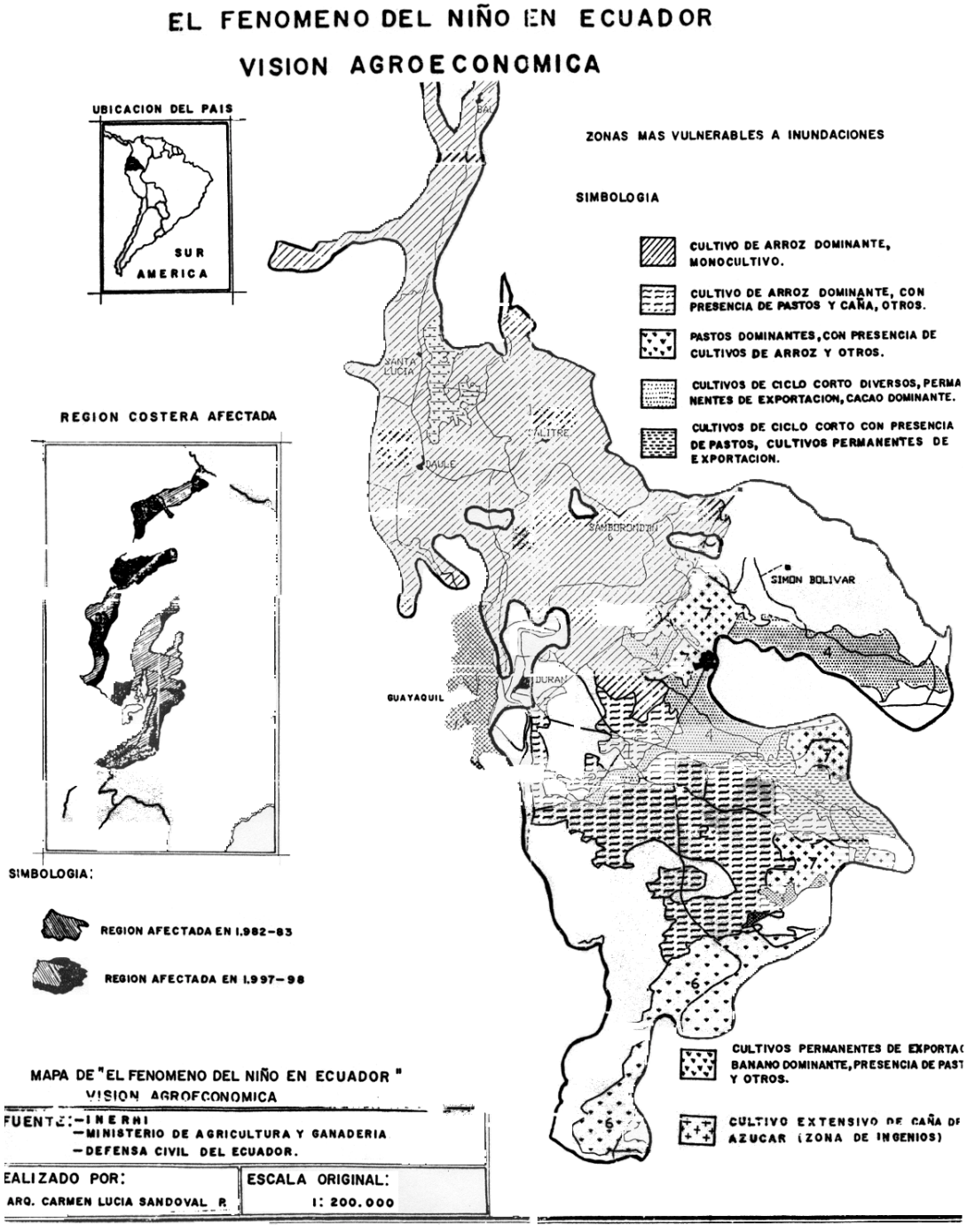
By focusing on risk factors this analysis of vulnerability is particularly useful for guiding preventive action. At the same time, mid-way 1998 when this study was completed no adequate information is available to evaluate the precise impact of El Niño on living standards of the population in the affected areas. Hence we use the vulnerability analysis also to project the likely impact of El Niño on rural poverty and to locate priority areas for repair and reconstruction of sanitary infrastructure and health services.

To identify ***agricultural vulnerability*** we combine the following types of information on arable land: (i) the risk of floods; (ii) the location of rivers and river basins and the vulnerability to overflowing due to heavy rainfall; (iii) actual and potential land use by crops; and (iv) distribution of land by size of land holdings.

Map No. 1 gives a global sketch of the most vulnerable areas, in particular of the cultivated areas of the basin of the river Guayas. The inserts locate the area and indicate the affected areas during the 1982-3 episode of El Niño and that of 1997-8. Map No. 1 is not sufficiently detailed for the agricultural vulnerability analysis. The identified zones are heterogeneous in terms of altitude, water control systems and land use. For a proper analysis geographic maps which can identify land use and altitude levels at intervals of 5 meters (at least

for the low lands). Such maps have not been elaborated for the risk zones in Ecuador, even though this would be technically feasible using available aerial photography. This would also be the appropriate technique to monitor the affected areas due to El Niño, but unfortunately the relevant authorities have not made use of it. Due to limited time and the high costs involved, we only used the source for a small area. For mapping out the total vulnerable area we used available cartography and data on land use from various sources and fieldwork reports. The vulnerable areas were subdivided into large agro-ecological zones (Vos, Velasco and De Labastida 1998): (a) terraces and alluvial levels (vulnerable to overflowing of rivers); (b) the Guayas river basin (very sensitive to flooding); (c) the lower slopes of the Western cordillera (sensitive to torrential rains and overflowing river levels); and (d) coastal border (sensitive to sea water erosion and spring tides).

Map No. 1: Agricultural vulnerability to El Niño (Guayas River Basin)



For each of these the most vulnerable areas were defined (using also altitude levels) and combined with information on agricultural production and land use at the (administrative) level of cantons. Although the political-administrative delimitation of provinces and cantons does not precisely coincide with the four agro-ecological zones defined above, it does allow to combine the information on land use and vulnerability to flooding with other socio-economic information at the local level. Using the poverty map for Ecuador (Larrea and others 1996), we add information on poverty incidence in the (potentially) affected agricultural zones to identify the most vulnerable population to agricultural income losses at the level of cantons. This way we obtain a total rural population vulnerable to agricultural losses for 39 cantons of 1.2 million (Table 2). Of these, 73% are estimated to have per capita consumption levels below a poverty line of US$ 61 per person, per month (at 1997 prices).[3]

Also in ***health*** we look for structural risk factors. Based on an analysis of the observable deterioration in health conditions following El Niño in 1982-3, we construct a composite index defining the social and sanitary conditions (ICSS) surrounding the population in the potentially affected areas. Using a principal components analysis we find four determinants strongly associated with the likelihood of suffering increased health risk due to El Niño (Velasco and others 1998): (1) access to drinking water; (2) access to adequate sewerage systems; (3) overcrowdedness of housing and (4) adult functional illiteracy. The resulting index has a range of 0 to 100. The lower the ICSS the greater the expected health risks. Applying the ICSS to the 105 potentially cantons we identify the size of the population with high vulnerability to health risks at 2.5 million (Table 2). Subsequently, as explained in Section 4, we combine this information with available data on actual damages to social infrastructure, increase in infectious diseases, deaths and so on due to El Niño as well as with data on available health services to identify priority actions, both preventive action and reconstruction.

[3] The indicated poverty line is taken from the World Bank poverty study of Ecuador (World Bank 1996).

3. ESTIMATION OF ECONOMIC AND SOCIAL COSTS OF DAMAGES IN THE RURAL SECTOR CAUSED BY THE PHENOMENON OF EL NIÑO IN 1997-8

3.1 Total foregone earnings in agriculture

Agriculture has been, next to roads and transportation, the main economic sector having suffered damages due to the El Niño event (Table 3). Even though by June 1998 not all effects were visible, total expected net losses, valued in terms of foregone earnings (see below), are estimated at US$ 112.3 million (or 4.7% of agricultural GDP and 0.6% of total GDP). While substantial, these losses are considerably lower than those of a CEPAL study (CEPAL 1998) conducted around the same time as the present study. CEPAL estimates damages in agriculture as high as US$ 966 million which would be the equivalent of 37.6% of agricultural GDP and 4.8% of total GDP. Differences in the identification of the actually flooded areas and differences in valuation methodology explain the large discrepancy. Our lower estimate is in part due to a greater precision in identifying the actually flooded areas at an adequate level of topographic detail as proposed in Section 2. Foregone earnings in this study have been valued in terms of *value added*, rather than total production costs as in the CEPAL study. In effect in the case of most annual crops production (and harvesting) was delayed thus not incurring much of the intermediate input costs. Further, we used 'pre-El Niño' off-farm and market prices differentiated by the 'normal' market orientation of the produce (domestic or external), whereas in the CEPAL study mostly export prices were used. These methodological differences are detailed further in an extended version of this study (Vos, Velasco and De Labastida 1998: Annex 1).

As indicated by Table 3, besides costs, El Niño has brought also some important benefits to agriculture and fishing. Rainfall in normally dry areas has yielded productivity increases for some agricultural crops. The most noticeable gains can be observed, however, in (on land) **shrimp farming**, where damages to the fishing pools have been limited, while the warmer waters have allowed for substantial productivity gains due to increased natural larva production. Shrimp production and exports have been up by 26% during November 1997 and June 1998 as compared to the same period in 1996-7 (see Vos, Velasco and De Labastida 1998: Table 8). The gains in shrimp production partly offset losses in agriculture, however these gains accrue to the

wealthy large-scale shrimp farmers and exporters, while the agricultural losses have fallen mainly on the poorer farmers and agricultural laborers.

Table 3
Estimation of the overall direct costs of the damages caused by the phenomenon of "El Niño",1997-8
(values in millions of US dollars)

	1997-8 (until June 1998)		
	Costs	Benefits	Net Costs
Agriculture	182.3	15.3	167.0
Farmers-owners	*50.8*	*6.7*	*44.1*
Agricultural workers	*73.9*		*73.9*
Domestic traders	*57.6*	*8.6*	*49.0*
Livestock	7.7		7.7
Livestock farmers-owners	*2.4*		*2.4*
Wage-earners in livestock	*2.7*		*2.7*
Shrimp farming	7.5	75.5	-68.1
Fishing	12.4	6.7	5.7
Traditional fishing	*12.4*		*12.4*
Industrial fishing boats		*6.7*	*-6.7*
Total Agriculture, Livestock and Fishing	***209.9***	***97.5***	***112.3***
(% of agricultural GDP)	*8.8%*	*4.1%*	*4.7%*
(% of total GDP)	*1.1%*	*0.5%*	*0.6%*

Sources: Vos, Velasco and De Labastida (1998).

Although our estimates of the costs are much modest than those produced by the Ecuadorian authorities and by CEPAL, agricultural income losses nevertheless have been substantial to groups of farmers. The most heavily affected crops are rice, corn, and sugar cane which are mainly produced for the domestic market and the export crops bananas and coffee (see Table 4). About 14% of the total area under cultivation in the affected provinces suffered from damages and production losses. Rice, corn and coffee are mainly grown by small-scale producers at family-owned farms and make relatively intensive use of family and hired labor. Self-employed farmers and workers in those sectors had to cope with important income losses impacting on the poverty rates in the affected regions, as we shall see in more detail below.

Banana and sugar cane are mostly produced on large plantations in Ecuador's lowlands. While relatively extensive in labor use some 12,000 workers have temporarily lost their jobs in

those sectors due to El Niño of 1997-8. Owners of banana plantations have incurred production losses due to the natural disaster. However, at the same time, they saw an increase in the export value thanks to an increase in export prices and an increase in export quota to the European Union. Sugar cane has been heavily affected. Production on some 53% of the cultivated area could not be harvested. About 90% of all sugarcane are produced at three large industrial estates (*ingenios*) which operate with seasonal workers. Workers have been put out of work, but the estate owners obtained some compensation as the government gave them exclusive permit to commercialize and distribute imported sugar.

Agricultural income losses due to El Niño thus seem to be severe. The impact on living conditions has been compounded by damages to the transport infrastructure, housing and sanitation systems and overall macroeconomic effects.

Table 4
Agricultural losses by main crops, 1997-98
(values of costs in thousands of US$)

CROP	*TOTAL CULTIVATED AREA*	*AFFECTED AREA*		*VALUE ADDED OF LOST PRODUCE (factor prices)*			*TOTAL VALUE OF PRODUCTION OF LOST PRODUCE $ x 10^3*		
	Sep. 97	*Niño 97-98*		*TOTAL*	*Wages*	*Surplus*	*At producer*	*Trade*	*At market*
	Ha	*Ha*	*%*	*$ x 10^3*	*$ x 10^3*	*$ x 10^3*	*Prices*	*margin.*	*prices*
Rice	337,500	105,336	31.2%	35,577	28,413	7,164	39,527	10,410	49,937
Banana	186,880	25,380	13.6%	19,171	3,562	15,609	82,485	25,322	107,807
Corn	293,800	130,676	44.5%	19,285	13,148	6,137	36,318	8,017	44,336
Cocoa	260,230	49,290	18.9%	8,961	7,366	1,595	16,736	1,753	18,489
Coffee	249,130	74,640	30.0%	12,543	7,511	5,031	30,070	5,792	35,862
Sugar cane	51,800	27,540	53.2%	13,907	5,370	8,537	32,965	1,977	34,942
Pasture	2,335,000	82,487	3.5%	5,074	2,678	2,396	17,995	0	17,995
Other	93,000	45,340	48.8%	10,223	5,891	4,332	17,740	4,317	22,058
TOTAL	3,807,340	540,689	14.2%	124,741	73,939	50,802	273,837	57,588	331,425

Source: Vos, Velasco y De Labastida (1998), based on: MAG (DINAREN, DISPLASEDE, Direcciones Provinciales); Banco Central; INEC (SEAN); CLIRSEN; FAO; Cámaras de Agricultura; own fieldwork

Note: Includes damages in 5 provinces of the coastal area (Costa) plus tropical zones of provinces Cañar and Bolívar, which for their main part belong to the highlands (Sierra).

El Niño has left the coastal road **infrastructure** in a poor condition. However, it should be indicated that much of the road system was in a pretty bad shape to begin with (see also CEPAL 1998). Most transportation connection over land consist of unpaved secondary and tertiary roads (some 9,000 km) which even during the normal rainy season are locked out for weeks or months. The main road system (some 2,500 km) has suffered severe damages and only on specific spots. Our own assessment of the damages lead us to assume that only some 60 kilometers require complete reconstruction, while some 400 km are in need of partial repair. Ten bridges have fully collapsed and the cost of rebuilding these constitutes about half of the estimated damages to the transport infrastructure valued at US$ 204 million (see Vos, Velasco and De Labastida 1998). CEPAL (1998) also reports substantial income losses for transporters due to higher operation costs and losses of cargo by transport operators. Our own fieldwork and interviews with transporters suggest that vehicles indeed have operated at higher variable costs and some shipments have had to be foregone. Yet in all (main) roads have remained accessible during the period of the disaster and prices have been raised to make up for the increase in operational costs. Overall it is not clear how much income losses have been actually incurred by the transport sector and for the analysis of the poverty impact in rural areas we were thus unable to consider these costs.

Costs to other economic sectors seem to have been relatively small compared to agriculture and transport. The estimated damages to social infrastructure mainly relate to the cost of destroyed or affected resident dwellings, water supply and sanitation systems, hospitals and health centers and schools (Vos, Velasco and De Labastida 1998: section 4.4). All these costs were estimated at unit prices of rehabilitation to the state prior to El Niño. Some 14,000 homes were fully or partially destroyed mainly those of the poorest population and the cost of rehabilitation is estimated at about US$ 35 million. Probably more important than the damages to health-related infrastructure as such are the increased health risks associated with poor sanitary conditions and ill-functioning health services. Such increased health risks not just occur because of damaged social infrastructure, but in many regions because of a structural lack of it. We deal with the consequences of the losses in social infrastructure in the section on health (section 4).

Direct economic costs of El Niño in agriculture and transportation infrastructure thus appear to be substantial enough to affect macroeconomic indicators. Clearly, the natural disaster

has come at a bad moment. The most serious attempts to date towards macroeconomic stabilization of the Ecuadorian economy in the mid-1990s (see Jácome, Larrea and Vos 1998) were already heavily tested by the strong drop in oil prices in 1997. Oil is the country's main export product and oil revenues have a strong direct impact on the fiscal balance and the overall growth rate. Estimates for economic growth suggest a drop in GDP of the first two quarters of 1998 to 0.6%, down from 2% growth achieved in the first half of 1997. Overall growth for 1998 was 2.2%, somewhat below the average rate of the 1990s (2.7%). Overall inflation reached 34% per annum in July 1998, up from 30% for 1997.[4]

It is difficult to trace the precise impact of El Niño on these macroeconomic indicators due to the presence of other external shocks. The fiscal deficit has increased in the first half of 1998 due to a further drop in oil prices and a loosening of spending controls in face of the presidential and congressional elections held in May. This may have caused the additional inflationary pressure as much as the drop in the supply of agricultural products. Central Bank data indicate a fall in agricultural GDP by 1.3% in the first two quarters of 1998 compared to the first half of 1997. Output also has fallen in the oil and construction sectors, but in contrast other sectors like transport (!) and electricity showed an increase in their rate of growth despite of the presence of El Niño, while the growth impact on other urban sectors seems to have been minor.

A major consequence of El Niño in 1982-3 was a steep rise in food prices. This has not occurred in 1997-8. Food prices have risen from 35% at the end of 1997 to 43% in July 1998 (annual rates), but far from the dramatic increase observed in the previous decade. It may also be a confirmation that the agricultural damages are not as big as suggested by the estimates of the Ecuadorian authorities and CEPAL. One should add though that timely increases in imports of basic food crops such as rice and sugar have weakened the upward pressure on food prices. Further there has been no apparent major impact on the urban economy. The urban population has suffered from a rise in food

prices, but this rise has been far from dramatic. Fully comparable data on urban employment were not available by June 1998. Yet two different labor force surveys held in November 1997

[4] Estimates of Banco Central del Ecuador, *Boletín de Coyuntura*, http://www.bce.fin.ec, August 1998

and April 1998, respectively, indicate that *urban* unemployment has not increased in that period and may even have slightly dropped.[5]

In all, the El Niño phenomenon has brought substantial economic damages. The exact macroeconomic impact is difficult to estimate due to the presence of other external shocks, but seems to have been by and large limited to the agricultural sector. The analysis also suggests that the costs (and benefits!) of El Niño appear unequally distributed. To the extent there have been benefits, such as in the production and exports of shrimp, these almost entirely accrue to the rich owners of the large-scale shrimp farms. Plantation owners in banana and sugar cane production have suffered significant production losses, however these saw compensation in the form of a rise in export prices and quota in the case of banana and of an exclusive right to commercialize imported sugar in case of the sugar estates.

The main losers in the process appear to be the self-employed farmers and agricultural workers in rice, corn, banana, coffee, sugar cane and other small crops for the domestic market. In the remainder of this section we will try to identify the location of the most affected farmers and estimate the likely impact of the income losses on rural poverty.

3.2 The impact of El Niño on rural employment and poverty

A close relationship has been observed between land distribution and rural poverty (Vos 1985; Barreiros and others 1987; World Bank 1996). Less access to land is
associated with less access to credits and modern agricultural inputs and so with lower agricultural incomes.

Table 4 showed that, in absolute terms, the major agricultural income losses due to El Niño can be observed in the production of rice (US$ 36 million), followed at some distance by corn (*maíz duro*) (US$ 19 million), export bananas (US$ 19 million), sugarcane (US$ 13 million) and coffee (US$ 12 million). Most sugarcane and banana production for exports is produced at

[5] Both the regular urban employment survey of INEC (November 1997) and a new urban labor force survey conducted by the Universidad Católica of Quito (April 1998) report an open unemployment rate in the major cities of around 9%. The CEPAL study (CEPAL 1998) and official reports (e.g. COPEFEN 1998) also cite these surveys and report a steep increase in urban unemployment (to around 17%). This outcome was based, however, on the provisional, unpublished data from the April 1998 survey, where the error was made to classify housewives not actively seeking work as unemployed. After correction of this error, he open employment rate in the major cities is about 9% in April 1998, somewhat below the rate observed in November 1997.

large scale plantations of over 100 hectares. The other crops (rice, coffee and cocoa) are mainly produced at small- or medium-scale family farms, while corn is predominantly small-scale production at plots of less than 5 hectares. Also in livestock production the poorer farmers are the most affected as these lack the resources to move cattle to areas safe of floods.

There are no direct survey data to obtain a direct measure of lost employment in agriculture and the rural sector at large. However, it is possible to estimate the likely loss in full-time equivalent employment from microeconomic information on labor use per hectare by crop and by technology level and apply the derived parameters to the affected cultivated areas. Results are shown in Table 5. Clearly the data refer to direct employment losses in agriculture due to the reduced area that has been cultivated and/or harvested during November 1997 and May 1998. Demand for agricultural labor likely has fallen by some 56,000 man-years, probably affecting about 112,000 agricultural workers or about 11% of the economically active population in rural areas in the *Costa*. About half of the affected workers are wage earners (most contract workers in sugar cane and banana plantations), one-third temporary hired workers (mostly in rice production) and the remainder paid family workers. Applying mean daily wage rates by area and crop, we estimate that the total foregone earnings of the affected workers is in the order of US$ 73,9 million which amounts to about US$ 650 per worker.

Table 5 gives the estimate of likely losses in wage income of agricultural workers, based on our method to estimate of production losses using the identification of areas vulnerable to flooding (section 2) and parameters regarding labor use by crop and land size. Rural surveys are scarce in Ecuador and information systems on land use and agricultural production are incomplete or have been abandoned for a lack of resources in recent years (such as the SEAN). Hence it may be difficult to confirm the estimates of Table 5 through direct observation and one has to rely on indirect measurement methods as the one used here.

Table 5
Employment losses and related foregone earnings[1] in agriculture

CROP	AFFECTED AREA Has	LOSS OF DIRECT EMPLOYMENT		FOREGONE WAGE EARNINGS[1] US$ million
		Affected workers	Increase in unemployment (man-years)	
Pasture	82,487	4,126	2,063	2.7
Rice	105,336	43,716	21,858	28.4
Corn (maíz duro)	130,676	20,228	10,114	13.1
Banana	25,380	3,427	1,714	3.6
Sugar cane	27,540	8,262	4,131	5.4
Coffee	74,640	11,556	5,778	7.5
Cocoa	49,290	11,332	5,666	7.4
Other	45,340	9,071	4,536	5.9
TOTAL	540,689	111,718	55,859	73.9

Source: Table 4; Ministry of Agriculture (MAG); MAG-ORSTOM; and Vos, Velasco and De Labastida (1998).

Note: 1. Refers to foregone earnings in terms of wages only. See Table 3 for total agricultural income losses.

Measurement of the (possible) impact on rural poverty has to rely, for the same reasons, on indirect methods. To obtain an idea of the potential impact on rural poverty the following sources and procedures were used:

- Income and consumption data from the 1995 *Encuesta de Condiciones de Vida* (LSMS) were used as well as the projection of per capita consumption and poverty data at the level of cantons as produced for the Poverty Map for Ecuador (see Larrea and others, 1996).[6]
- Poverty indices are derived using consumption levels and a poverty line of US$ 61 per person per month as established by the poverty study of the World Bank (1996).
- Consumption data for 1995 were updated for the affected cantons to projected values at November 1997 prices, using the overall consumer price index and the average growth rate of agricultural value added between 1995 and 1997.

[6] The methodology applied in Larrea et al. (1996) is similar to that applied in other countries of the region. It uses an econometric analysis to identify determinants of urban and rural consumption levels and poverty rates using the LSMS survey data at the national and regional level (Costa, Sierra, Oriente). The results are then used to project consumption and poverty at the municipal level substituting data on the determinants such as education and other socio-economic characteristics as derived from the population census into the estimated regression functions.

- It is assumed that the poverty-growth elasticity for the rural population is –1 (see Jácome, Larrea and Vos 1998, for a justification of this elasticity).
- Losses of value added accruing to owners (surplus) and traders (trade margins) are also included in the estimate of the impact on poverty, except in the cases of banana and sugarcane where large scale (non-poor) ownership dominates and where also trading is mostly controlled by the same large landowners or by wealthy trading firms. Moreover, most of the landowners in export banana and sugar cane production typically do not reside in rural areas.

Before the natural disaster, poverty already affected a major share of the rural population in the areas hit by El Niño. The rural poverty incidence in those areas was about 73% (Table 6). We estimate that, under the given assumptions, the agricultural income losses due to El Niño may have led to a rise in the poverty incidence by about 11 percentage points. This implies that the living standard of an additional 120 thousand inhabitants has fallen below the subsistence level.

El Niño has hit hardest on the rural population in the province Los Ríos where many farmers are engaged in the production of rice and corn. Foregone agricultural incomes amount to 25% of mean consumption of rural households in this province and we estimate a rise in the rural poverty incidence by 18.6% points, increasing the number of poor by 53,000.

Another severely affected area is the countryside in the Guayas province where the rural population is expected to have lost about 14% of its resources to satisfy basic human needs. The number of people below the poverty line likely increased by 10% (21,500 persons). In Guayas, self-employed and workers in the production of rice as well as wage earners in sugar cane are seen to be most affected. The third most affected province is Manabí where rural poverty is expected to have increased by 35,000 people (8%). There the most affected are small producers of coffee and corn.

Using the more detailed information at the level of cantons and combining the information on the expected poverty impact and the most vulnerable cultivated areas to flooding (see section 2), one may obtain a ranking of most affected areas by agricultural income losses. These areas are not only identifiable by degree of poverty, but also by main type of agricultural production and zone of agricultural vulnerability. A provisional ranking of cantons can be found

in Table A.1.[7] Clearly, the cantons with the higher poverty incidence predominantly depend on the production of the most affected crops by El Niño, i.e. rice and corn, and to a somewhat lesser degree those that are dependent on coffee and cocoa production. In all most vulnerable regions the family-based farming on small plots is the most common mode of production. Poverty rates tend to be lower in areas where banana and sugarcane production is most important and where agricultural wage earners are the most affected socio-economic group. Using this ranking we may identify the most vulnerable population groups by cantons as follows (see Table A.2):

- **Self-employed farmers and families** (rice, corn, coffee, cocoa, livestock, other crops): cantons of Bolívar, Chone, Santa Ana, Jipijapa, Tosagua, Sucre and Rocafuerte in the province of ***Manabí***; Esmeraldas and Quinindé in the province of ***Esmeraldas***; Vinces, Palenque, Quevedo, Ventanas, Baba and Babahoyo in ***Los Ríos***; La Trocal in ***Cañar***; and Palestina, Samborondon and Urbina Jado in ***Guayas***.
- **Agricultural workers (wage earners)** (sugarcane and banana): cantons Quinindé (***Esmeraldas***); Baba and Babahoyo (***Los Ríos***); La Troncal (***Cañar/Guayas***); El Triunfo and Naranjito (***Guayas***); El Guabo, Pasaje and Santa Rosa (***El Oro***).

The government's Contingency Plan containing the guidelines as to how to respond to the impact of the disaster defined a much larger number of potentially affected cantons. However, the Plan failed to differentiate the affected zones by the degree of agricultural vulnerability to the consequences of El Niño. The above analysis allows to do so, thereby providing a tool for targeting possible intervention to compensate for income losses and/or for targeting preventive action to reduce vulnerability to future weather shocks like El Niño. We turn to the policy implications in Section 5.

[7] This is a provisional ranking for two reasons. First, some cantons could not be included in the analysis as these are newly created (i.e. after 1990) and for which no information is available about land use and the ructure of agricultural production. Secondly, for the design of policy interventions one may wish to add other criteria than those applied here.

Table 6

Impact of El Niño on Rural Poverty in the affected Municipalities (cantons) in the provinces of the Costa (values are per capita and in US$ of 1997)

	Before El Niño			**Economic impact of El Niño in affected areas (US$ of 1997 *per capita)***					**Impact El Niño on Rural Poverty**				
	Rural population of affected cantons	Poverty incidence (rural)	Incidence of extreme poverty (rural)	Annual consumption per capita	Total agricultural income losses (per capita)	Forgone wage earnings (per capita)	Forgone self-employed income per capita	Foregone trade margins (per capita)	Impact on consumption (%)	Poverty incidence after El Niño	Increase in poverty incidence (% points)	Extreme poverty incidence after El Niño	Increase extreme poverty (% points)
El Oro	78,992	57.4%	10.7%	962	41	26	6	8	4.3%	59.1%	+1.7%	11.1%	+0.5%
Esmeraldas	172,809	76.4%	28.5%	615	9	7	1	1	1.4%	76.9%	+0.5%	28.9%	+0.4%
Guayas	215,739	68.4%	17.5%	666	91	58	14	20	13.7%	78.2%	+9.8%	19.9%	+2.4%
Los Ríos	285,898	75.4%	22.9%	608	153	87	29	37	25.2%	94.0%	+18.6%	28.7%	+5.8%
Manabí	431,090	75.5%	25.9%	593	55	28	13	14	9.3%	83.6%	+8.1%	28.3%	+2.4%
Total affected areas	1,184,528	73.1%	***25.5%***	***599***	***77***	***44***	***15***	***18***	***12.9%***	***84.3%***	***+11.2%***	***28.8%***	***+3.3%***
Memo													
Total provinces of Costa	1,793,384	72.7%	22.3%	647									
Total country	4,667,116	74.9%	24.6%	591									

Source: Tables 4 and 5; INEC, Encuesta de Condiciones de Vida 1995; STFS, Poverty Map (Larrea and others 1996); Vos, Velasco and De Labastida (1998).
Note: See text for estimation methodology.

4. IMPACT OF EL NIÑO ON HEALTH RISKS: NATURAL DISASTER OR DISASTER OF HEALTH POLICIES?

El Niño is also a source of increased health risks in the form of increased disease prevalence and infant mortality rates. Floods and standing water are sources of malaria among other infectious diseases. Damages to drinking water and sanitation systems increase the risk of diarrhea, dengue fever and cholera. The agricultural income losses leading to increased rural poverty, in turn are a cause of increased malnutrition, which is an important cause of high infant mortality rates.

The experience with the El Niño phenomenon in 1982-3 confirmed the association of the indicated factors. This reality is compounded by the fact that important parts of the affected areas suffer from great deficiencies in sanitary infrastructure to start with, as well as from inadequate coverage of immunizations, reduced access to health services and low educational levels.

There is no timely and adequate statistical information available (by June 1998) to study the changes in the epidemiological profile and infant mortality rates after El Niño of 1997-8. Instead, we apply the methodology of identifying areas of vulnerability to health risks as suggested in Section 2. Ex-post testing of this methodology to the changes in health conditions due to El Niño of 1982-3, showed a high degree of consistency between health vulnerability areas and observed deterioration of health conditions and prevalence of diseases (Velasco and others 1998; Vos, Velasco and De Labastida 1998). This suggests that preventive health interventions to counteract the effects of El Niño in 1997-8 could well have benefited from this approach. We will also argue that interventions of rehabilitation and preventive action for new occurrences may well be served by this methodology.

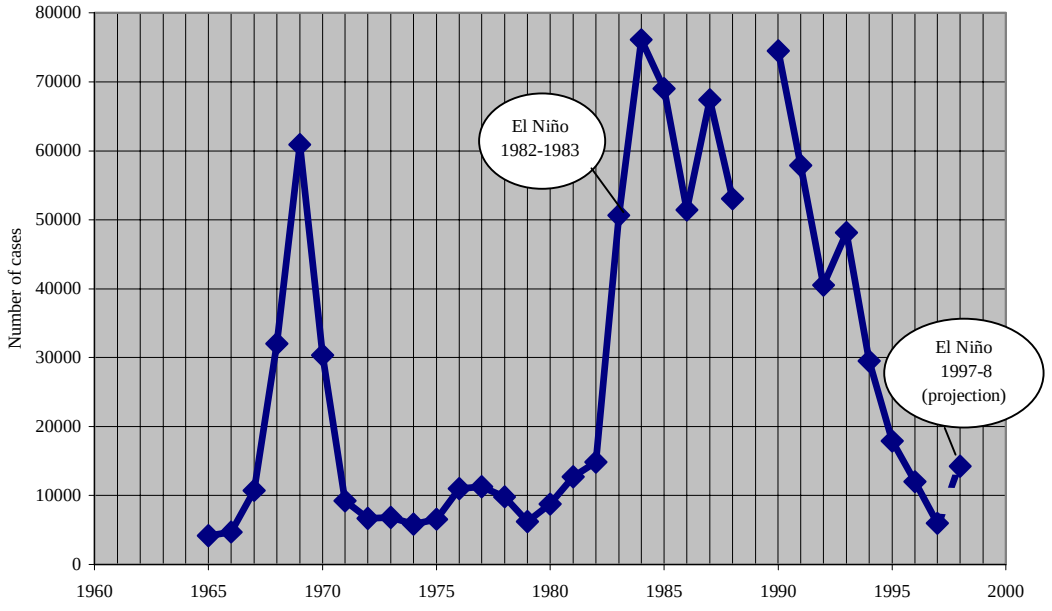
Past experience and existing evidence indicates that:

- The El Niño event tends to enhance the incidence of malaria and other infectious diseases, which are strongly related to poor sanitary conditions. In 1982-3 the number of cases of malaria increased steeply and it took more than a decade to bring the prevalence of the disease back to levels of the early 1980s (see Figure 1). In 1997 some 17,000 cases were reported and in the first five month of 1998 5,935 cases, a

significant increase from levels in the preceding year. Also 'new' diseases[8] have spread such as leptospirosis, cholera and dengue. The highest concentration of these diseases has been found in areas where sanitation systems broke down due to El Niño, in particular in the poorer neighborhoods of the cities of Guayaquil, Bahía, Chone and Machala.

- In 1982-3 infant mortality increased substantially in the regions hit by El Niño. The infant mortality rate increased from 52 to 65 per thousand live births in the affected provinces before and after the disaster (Vos, Velasco and De Labastida 1998). A drop in the coverage of immunizations in 1983 exacerbated the rise in child mortality. Vaccination campaigns in subsequent years have helped to reduce infant mortality.

Figure 1: Trends in malaria prevalence, 1965-98 (number of cases)



Source: Aguilar (1994); Ministry of Health, SNEM.

- In November 1997 the Ministry of Public Health ordered a number of measures of preventive action. These included an intensification of the vaccination program in the

[8] That is diseases that were virtually eradicated before 1990.

potentially affected areas and the application of insecticides to combat malaria. Probably this has helped to mitigate some of the potential impact of El Niño. It remains yet to be seen to what extent infant mortality has been contained by these measures. Nevertheless, the general impression is that preventive action has fallen short, as resources have been limited and no instruments to target actions to the more vulnerable population groups were in place (Velasco and others 1998). Furthermore, over time too little was done to improve other critical conditions preventing spread of infectious diseases and premature child deaths including adequate sanitary conditions, poverty reduction and reducing malnutrition.

To identify the more vulnerable population to increased health risk, we construct a composite *Index of Social and Sanitary Conditions* (ICSS). The ICSS has been constructed applying a *principal component analysis* to a range of determinants found to be strongly associated with the prevalence of infectious diseases and infant mortality.[9] On the basis of this analysis the ICSS has been composed of four variables: access to safe drinking water, access to sewerage systems, functional illiteracy among the adult population and the degree of overcrowdedness of housing. The index has a range of 0 to 100. The higher the index, the better the social and sanitary conditions to withstand the health risks associated with El Niño.

The ICSS was applied to data from the 1982 population census and was found to predict with fairly great accuracy which cantons suffered from an increase in infant

[9] Principal component analysis is a method to provide a metric to different components of a variable (if of different dimensions) by giving weights to the different components according to their contribution to the "principal component". In order to get there one has to choose a set of indicators which are considered to be determinants of – in this case – health conditions, but whose problem is their interdependence (and hence not usable in OLS regression). The first component represents the dimension of maximal variability in the data. This is the "unobservable index" that we want to construct of welfare (or in this case: health vulnerability). The principal components are new variables created as linear combinations (weighted sums) of the original variables. The weights are generated as linear combinations of the co-variance structure of the variables and have a finite variance (for each set of weights the sum of the squares is constrained to be one). Redundancy or interdependence of the indicators is not considered to be a problem in this method. Rather, it is seen as an advantage: the optimization process links the data sub-sets and increases the number of constraints on the algorithm to converge to a "true composite measure". Limitations of this approach are of course in the assumptions. The method assumes that the main source of variability in the data is indeed related to differences in welfare dimensions (i.e. the chosen health factors) and not, for instance by different preferences and factors other than those taken into account. Further, outcomes are sensitive to the initial choice and grouping of the data. We do not see this as a major problem in this case as we depart from a sub-set of indicators of which we think a priori that they determine health conditions simultaneously.

mortality and in the prevalence of infectious diseases during El Niño of 1982-3 (see Velasco and others 1998). Hence we applied the instrument also to the 1990 population census data, the most recent data set to repeat the analysis at the level of cantons, to obtain the closest possible identification of health vulnerability to El Niño of 1997-8. Table A.2 gives the results. It shows that the ten cantons with the highest vulnerability include Eloy Alfaro, Muisne and San Lorenzo in the province of Esmeraldas, Palenque and Baba in Los Ríos, Colimes, Pedro Carbo, Palestina and Urbina Jado in Guayas and Flavio Alfaro and Paján in Manabí.

The ICSS helps to provide a first indication of vulnerability and the (geographical) targeting of health interventions may start with a ranking of municipalities by their score on the index. Clearly to decide on priority policy actions a more complete health sector analysis would be required on the causes of mortality and morbidity and the cost-effectiveness of both preventive and curative health interventions. Such diagnoses are hard to come by in Ecuador. Nevertheless, to take the analysis one step further, we apply a ***factor analysis*** to identify the factors that seem most associated with improving (or compensating for) the social and sanitary conditions of the population (through the ICSS) including overall economic conditions (proxied by the poverty index), education and availability of health services. The factor analysis further considers a number of known facts about the consequences of El Niño of 1997-8, including:[10]

- Direct effects on the population, distinguishing: (i) increase in disease prevalence (cholera, dengue fever and malaria); (ii) number of deaths, wounded, and evacuated population; (iii) children that could not assist school due to damages to education infrastructure; (iv) damage to houses; and (v) damage to sanitation systems.
- Impact on health services (hospitals and health centers): (vi) number of health units that suffered damages and (vii) health units requiring additional investment in equipment, medication and personnel.
- Damages to road infrastructure: (viii) damages to main roads (in kilometers) and (ix) number of bridges that have collapsed due to El Niño.

[10] We apply a fixed-effects design factor analysis. The factor analysis examines the effect of several independent variables (the mentioned indicators of the impact of El Niño) on a dependent variable (the ICSS index, i.e. the vulnerability to health risks).

We use this method to come to a *typology* of required policy interventions at the provincial and the level of cantons. Table 7 lists some of the indicators measuring the impact of El Niño by provinces. Table A.2 gives additional data by municipalities (cantons).

Table 7
Situation variables that form part of typology by provinces

PROVINCIAS	EL ORO	ESMERALDAS	GUAYAS	MANABI	LOS RIOS
Affected health centers	7	6	17	8	6
Damaged and destroyed houses	2,305	1,125	1,623	4,337	805
Cases of malaria	298	1,578	2,077	160	95
Cases of cholera	44	170	1	26	0
Cases of dengue fever	205	713	77	1,049	110
Affected sanitation systems	3	2	3	3	1
Damaged roads and bridges	5	16	19	14	7

Source: Vos, Velasco and De Labastida (1998), based on: SIISE (STFS 1998) and Ministry of Public Works (May 1998).

At the level of provinces we get to the following typology (Table 8):

- ***Type 1: impact on persons and infrastructure***. Areas (provinces) that require priority action to mitigate health impact (prevention of spread of malaria, cholera, dengue and leptospirosis) and restore and construct both sanitation infrastructure (health centers, sewerage and drinking water systems) as well as roads and bridges.
- ***Type 2***: ***impact on persons***. Priority action is to mitigate risk of infectious diseases via vaccination programs and other preventive health care.
- ***Type 3***: ***impact on infrastructure***. Areas that require priority action in rehabilitating sanitary infrastructure as well as roads.

Table 8
Typology of Affected Provinces in the Costa

TYPES / **PROVINCES**	1 Priority action towards affected persons and sanitation infrastructure	2 Priority action towards preventive health care	3 Priority action towards sanitary and road infrastructure
El Oro		X	
Esmeraldas	X		
Manabí	X		
Guayas[1]	(X)		X
Los Ríos[1]	(X)		X

Source: Vos, Velasco and De Labastida (1998), based on: SIISE (STFS 1998) and Ministry of Public Works (May 1998).

Note: 1. Priorities at provincial level biased by situation in main cities. Areas outside main cities fall under Type 1. See text.

For the targeting of interventions at the municipal level we combine the factors determining the degree of vulnerability to health risks and the degree of damages to health infrastructure by El Niño. This leads to four types of cantons (see Tables 9 and A.3):

- ***Type A: low vulnerability and low impact***. These cantons show relatively good socio-economic conditions and access to health services. Moreover the measured impact of El Niño has been small, hence requiring low priority in policy action. Example: Marcelino Maridueña in the province of Guayas.
- ***Type B***: ***moderate vulnerability, but relatively strong impact of El Niño*** (in terms of damaged housing, size of evacuated population and increased prevalence of infectious diseases). These may require relatively high priority of temporary support to reestablish homes, etc., but a lower priority in investments in sanitary infrastructure. Example: Santa Rosa in El Oro.
- ***Type C***: ***high vulnerability, but moderate impact of El Niño.*** Emphasis in these cases should be on medium run investment in sanitary infrastructure and improvement in socio-economic conditions in general. Example: Chone in Manabí.
- ***Type D***: ***high vulnerability and strong impact of El Niño***. These are the poorest areas that also suffered the heaviest impact of El Niño, requiring both short-term emergency assistance and substantial investment in preventive and curative health to reduce vulnerability to health risks. Example: Baba in Los Ríos.

Table 9
Typology of cantons (municipalities) affected by El Niño. Case studies.

TYPE Canton (Province)	A Marcelino Maridueña (Guayas)	B Santa Rosa (El Oro)	C Chone (Manabí)	D Baba (Los Ríos)
Poverty incidence (%)	23%	41%	60%	75%
Functional illiteracy (% of population > 15 years)	15%	18%	35%	46%
Medical personnel (x 10.000 inhabitants)	64	21.6	17	9.5
Deaths due to El Niño	1	25	7	3
Wounded due to El Niño	0	38	-	0
Damaged and destroyed houses	16 (1%)	1,838 (18%)	292 (1%)	60 (1%)
Total dwellings in canton	1,633	10,096	20,634	5,682
Pupils unable to assist school due to El Niño	0	7,836	436	1,840
Severely affected population	0	1,106 (2%)	112 (0.1%)	269 (0.8%)
Evacuated population	0	2,194 (4%)	87 (0.6%)	206 (0.6%)
Total population	9,557	60,060	136,564	34,725

Sources:Tables A.2 and A.3, based on Vos, Velasco and De Labastida (1998) and SIISE (STFS 1998) and Defensa Civil (May 1998).

We interpret priority action at two instances. First, emergency assistance needed in the short run to mitigate the impact of El Niño through health assistance and repair of damages to infrastructure. Second, over the medium run, actions should have dealt with improvement in the coverage and quality of the preventive and curative health infrastructure, such that it helps to reduce the vulnerability of health risks and hence provide better protection against future appearances of El Niño and to improve health conditions in general. The analysis of the existing situation leads us to conclude that:

- Esmeraldas and Manabí are the most affected provinces. The population in these areas needs almost universal action to improve sanitation infrastructure, repair of health centers and rehabilitation of roads and bridges. Most cantons in these provinces show high vulnerability and high impact of El Niño (type D). On average Esmeraldas shows the highest vulnerability to health risks (poorest social and sanitary conditions), but Manabí suffered a much larger impact of El Niño as measured by the prevalence of infectious diseases, deaths and evacuated population. While emergency assistance and improvement of sanitation infrastructure are required in both provinces, Manabí would initially require more emphasis on the former and Esmeraldas on the latter.

- Los Ríos and Guayas have suffered heavy damages to sanitary and road infrastructure. Hence the policy priority is Type 3 (see Table 8). However, this outcome is biased due to the situation in the larger cities (Guayaquil, Durán, Salinas, Milagro, Babahoyo, and Quevedo). Most other municipalities in these two provinces show high vulnerability to health risks and have been substantially affected by El Niño (Type D; Table A.3), hence where Type 1 interventions should be emphasized.
- El Oro has a relatively better social and sanitary conditions, but did show some increase in cases of malaria, dengue and cholera during 1998 as compared to 1997, hence policy should give priority to preventive health care (Type 2). However, in some cantons a broader range of interventions (Type 1) needs to be targeted (such as in Guabo; see Table A.2).

Preventive health policies prior and during El Niño of 1998 lacked a guide of this sort. The Ministry of Public Health did establish a contingency action plan, though, ahead of the occurrence of El Niño and mobilized a budget from unused project funds (to a total of US$ 8 million) to finance activities. Most of this budget could be executed (88% by May 1998) on the repair of damaged health centers and sanitation systems, purchase and distribution of medicines in the affected areas, health education campaigns and actions to combat the outbreak of malaria. Prior to the contingency plan the Ministry had already, as indicated, launched a campaign of immunizations of children under five years of age and also provided health centers with additional supplies of medicines to cure infectious diseases (MSP 1997). Resources to prevent the outbreak and combat malaria proved insufficient though (Velasco and others 1998). By the end of El Niño (May/June 1998), the Ministry had shifted emphasis to the rehabilitation of damaged drinking water systems as preventive action to contain parasitic diseases.

Despite these efforts, actions in public health have been largely reactive to the threat of El Niño. Few lessons were drawn from the experience with El Niño of 1982-3. Preventive measures, such as investment in flood-resistant sanitation systems and permanent vaccination campaigns in the vulnerable areas, were not implemented beyond some isolated cases. One such exception is Babahoyo in Los Ríos where – with external funding – improved sanitation system and related infrastructure was built after El Niño of 1982-3. The project took seven years to complete and cost US$ 300 per beneficiary. The

outcome though was that there were no more problems of flooding, neither during the normal rainy seasons nor during the El Niño event of 1997-8, and there was a strong reduction in the prevalence of infectious diseases. Not many other positive examples of this sort can be built on. During the most recent episode of El Niño the Ministry of Public Health has not worked with a systematic methodology of vulnerability to health risks which could both serve as a tool for an early warning system and to set priorities in preventive and curative action. At the ending of the climatic effects of El Niño 1997-8, the Ministry is essentially responding to demands it receives from provincial health departments without having tools to prioritize allocation of resources and actions in function of needs and deficiencies in health services.

5. ACTION FOR EMERGENCY RELIEF AND RECONSTRUCTION: HOW MUCH HAS HAPPENED?

The phenomenon of El Niño of 1997-8 was a pre-announced disaster. The Ecuadorian authorities declared a state of emergency on July 2, 1997 and formulated a contingency plan prior to the disaster. In November 1997, when El Niño had given its first signs of presence, a total budget of US$ 333 million had been put together for emergency relief, preventive action and humanitarian aid (Table 10). The World Bank, IDB and CAF provided most of the funding (US$ 208 million) in the form of loans. The contingency plan proved useful in preparing the population for the event. In October 1997 a special coordination unit (COPEFEN) was created to implement the contingency plan and coordinate actions towards prevention, emergency relief and repair of damages to be undertaken by a wide range of public entities.

Table 10
Available Financing for Emergency Aid and Rehabilitation of Damages caused by El Niño, 1997-8
(August 1998)
(millions of US$)

	Total amount
Government Resources	***67.2***
Funds reserved by central government (569 rehabilitation projects)	41.0
Emergency assistance of military	5.2
Counterpart Funds for Foreign Loans received for El Niño	21.0
International Humanitarian Aid	***35.8***
Humanitarian aid of governments and government agencies	23.4
Humanitarian aid of NGO's and private donations	9.5
Cooperation of international organizations	0.8
Transport costs for international humanitarian aid	2.1
Foreign Loans for El Niño	***215.0***
World Bank (reallocation of existing social sector loans)	20.0
World Bank (new loans)	60.0
Inter-American Development Bank (reallocation of existing social sector loans)	34.2
Inter-American Development Bank (new loans)	70.8
Corporación Andina de Fomento (CAF)	25.0
United States (PL 480 for reactivation of agriculture)	5.0
Total	**318.0**

Source: CEPAL (1998: p. 14); COPEFEN (1998).

Despite these preparations, a main conclusion of this study is that the authorities were poorly prepared to counteract the main effects of the disaster and, in particular, protect the more vulnerable groups of the population. This is apparent from the following:

- The *Defensa Civil* had prepared itself to provide emergency humanitarian aid, but did not manage to establish effective coordination with local governments and communities. In effect, in the course of events the army had to be called in to overcome problems of transportation and logistics.
- The COPEFEN proved little effective and its director was accused of fraud in February 1998 and was replaced. Over 90% of the government budget for emergency aid (US$ 41 million) was transferred to provincial authorities, but only 55% could be justified with proper accounts (COPEFEN 1998: 3).
- It took until April 1998 before COPEFEN managed to improve its operative capacity and was placed under political responsibility of the Vice-President of the Republic. World Bank and IDB condition their funding to the establishment of a Technical Committee with representatives of provincial authorities and a committee with

broader participation of civil society. In August COPEFEN reports that the inputs of the Provincial Technical Committee have been little useful to plan activities and allocate resources, while the civil society committee could never be formed (COPEFEN 1998: 8).

- The Contingency Plan identified 105 potentially affected cantons with a total population of 6.5 million, more than half of the Ecuadorian population (see Table 2). These cantons were classified by climatic risk (Table 1), but this classification proved little useful to target actions of prevention and rehabilitation. The authorities lacked methodologies as proposed here to distinguish between types of risk and vulnerability of different areas and population groups, which could guide targeted action towards preventive action and post-disaster support in health, improvement of sanitary infrastructure and coverage of risk of agricultural production losses.

As a consequence, the authorities lacked a clear and systematic idea of how to allocate available resources for emergency relief and reconstruction to the affected and needed areas. By January 1998 only 15% of IDB resources and 10% of World Bank funds were disbursed for specified actions. No earlier than July 1998 more substantial progress was made to find a destination for the available resources. By August 1998 73% of the international support was allocated to projects of rehabilitation and reconstruction. However, by then only 19% of the resources had effectively been disbursed for concrete action (see Table 11).

The allocation of resources by COPEFEN is guided by (i) the estimation of damages by sector as estimated by CEPAL (1998) and (ii) advise from the Provincial Technical Committee (COPEFEN 1998). One may have doubts about the effectiveness of the process. The CEPAL report seems to overestimate the economic damages, but more importantly only specifies costs by sector but does not provide a basis to differentiate risks and needs by population groups. Hence it may prove to be a poor guide for the targeting of actions to vulnerable population groups and areas. Further, COPEFEN itself is doubtful about the functioning of the Provincial Technical Committee (COPEFEN 1998).

Table 11
Execution status of foreign assistance for rehabilitation projects
El Niño, 1997-8 (until August 1998)
(values in millions of dollars)

	External Finance			Committed and disbursed by COPEFEN			
	1	2	(2)/(1)	3	(3)/(1)	4	(4)/(1)
	Loan commitments	**Disbursements**	**%**	**Committed**	**%**	**Disbursed by COPEFEN**	**%**
IDB	105.0	45.4	43%	82.1	78%		
World Bank	80.0	9.9	12%	56.7	71%		
CAF	25.0	22.8	91%	25.0	100%		
Counterpart funds	21.0	..	..	4.0	19%		
Total	231.0	78.1	34%	167.8	73%	45.0	19%
Source: COPEFEN (1998)							

6. CONCLUSIONS AND POLICY RECOMMENDATIONS

El Niño of 1997-8 has caused substantial damages in Ecuador and has cost the lives of at least 286 human beings. This study estimates the (direct) economic costs of the damages at US$ 534 million or 2.7% of GDP. The most affected population groups have been the poorer self-employed farmers and agricultural workers who suffered production and employment losses. We estimate poverty in the affected rural areas may have increased by as much as ten percentage points in 1998. In the social area, increased health risks form the most important danger presented by El Niño. There has been a spread of contagious diseases such as malaria, cholera and dengue. During 1998 no information was available to measure the direct health impact, but based on risk factors we estimate that some 2.5 million Ecuadorians in the coastal regions are most vulnerable to diseases and worsening of health conditions caused by El Niño.

The more vulnerable population to the effects of El Niño typically has lower initial incomes, lower educational levels, and less access to economic and social infrastructure. The vulnerability is enhanced by poor quality of available infrastructure. In this sense, the consequences of El Niño are in the first place a problem *of* development than an obstacle *to* development.

How to respond to natural disasters like El Niño? What objectives would precisely be pursued in disaster relief actions? During and immediately after the disaster there is the need for emergency action to save lives, evacuate people from flooded areas and provide them with shelter and food, health interventions to prevent outbreak of

epidemics, and so on. After the event, what can and should be done to compensate those that suffered most and what by way of preventive action in case of future occurrences? In the case of El Niño we know it is a recurring event, even though there will always remain uncertainty as how, when and where exactly it will leave a trace of disaster.

How to compensate for losses and what preventive action? These policy questions refer back to the methodological issues raised in Section 2 regarding how to assess the costs of a natural disaster and will have to be framed with a clear view of the objectives that are to be achieved. Finally, given the recurring nature of El Niño, the question could be raised whether insurance schemes could be implemented to protect families and workers from the costs they may suffer in future events.

On insurance schemes we may be brief in the case of Ecuador. Firstly, Ecuador's insurance and financial markets are highly underdeveloped and imperfect. Only a fraction of the population has car or home insurance policies, while income risk insurance is non-existent. Second, also in contexts with more developed insurance markets, the risks of natural disasters prove difficult to insure (cf. the risk of hurricanes in the Caribbean and U.S. states like Florida). Moreover, the U.S. experience shows that even when there is some kind of insurance, the pressure on governments to declare a state of emergency is heavy and insurance companies are able to off load costs on tax payers. In all, it is difficult to visualize a private insurance scheme, which would provide protection to the rural poor in Ecuador's coastal areas who we have identified as the most vulnerable to the effects of El Niño.

The more pressing strategic policy question would be whether to concentrate on disaster relief (beyond emergency assistance) or development investment. How much should one spend on repair and rehabilitation (of roads, houses and agricultural lands) to bring disaster areas back into their state prior to the disaster, or should one focus on reconstructive investment oriented at reducing vulnerability and enhancing development in general? In the latter case, relocation of population out of vulnerable areas and reorientation of economic activities are options to be considered. Time and cost dimensions will be important here: development investment takes time and resources may be limited to meet structural needs in all affected areas.

Here we will suggest a policy approach that considers both: compensatory relief and developmental investment, but emphasizes the latter.

The policy recommendations that can be derived from this study are the following:[11]

Targeting and monitoring instruments:

- Policy actions should be targeted towards the more vulnerable and most affected population groups. Comparison of the 1982-3 and 1997-8 experience shows that El Niño, with a few exceptions, tends to affect the same geographical areas and that besides damages to infrastructure, agricultural income losses and increased health risks affect living conditions most. For the targeting, the methodologies applied in this study to identify vulnerable agricultural zones and classify the population by social and sanitary risks to health may provide useful starting points, both to elaborate more effective contingencies plans for future events and to target investments in response to the 1997-8 event.

Possible measures towards agriculture and rural development in the affected areas:

- A pure income transfer program to compensate poor farmers and agricultural workers for production and employment losses does not seem to be the best policy. What should be the size of the transfer? If compensated for the foregone earnings as estimated in this study, a perfectly targeted transfer scheme would require a total fund of US$ 130 million. However, as we have seen, a great majority (over 70%) of the population in the affected areas was poor prior to the El Niño and would remain poor after the indicated transfer. During the event it would have made sense to target food aid or direct income transfers to the most vulnerable population using the methodology proposed in Section 3 as a means of immediate assistance. This would be a recommendation to consider for a future event rather than as a meaningful action long after El Niño,[12] but also in that case such a scheme should typically be of a

[11] See Vos, Velasco and De Labastida (1998) for a further elaboration of these recommendations.
[12] The Ecuadorian government did proceed with allowing for greater imports of basic food items such as rice and sugar. This helped to contain food inflation and limited the spillover effects of El Niño on incomes of the urban population, but was untargeted and hence did little to compensate the affected rural poor.

short-term nature and last until agricultural production and rural employment have returned to 'normal' levels.

- After the event it seems to make sense to focus in the *short run* on a reactivation of agricultural production. We believe this makes sense for the following reasons. First, most agricultural production in the vulnerable areas is viable, albeit in need of productivity improvements and improvements in rural infrastructure. Second, relocation of some farmers to less vulnerable areas seems needed in a few specific areas (in particular, the shores in the delta of the Guayas River), but not viable for the larger affected population as the land frontier in Ecuador has been reached. Third, much of the lost employment will be regained as soon as agricultural production is rehabilitated. In the present context possible funds for an income transfer scheme might be best used to provide affected small-scale farmers with affordable credits to rehabilitate their land and prepare for a new harvest. The credit may contain a subsidy to compensate for the income losses (foregone savings) in the period of lost harvest due to El Niño. Fourth, employment is likely to increase in the short run if simultaneously a start is made with the repair of rural infrastructure (rural roads, bridges, irrigation systems).
- *Medium-term* measures should equally focus on improved credit schemes for small-scale farmers and improving rural infrastructure. As to the latter, this would involve continuing and finalizing investment projects towards improved water control and irrigation in the areas permanently vulnerable to flooding, in particular the area surrounding the delta of the river Guayas. Many such projects started in the early 1980s but were halted. The network of tertiary roads should be improved in the affected areas and made accessible for year-round transportation. Other medium-term, preventive action in rural areas should equally relate to improving agricultural productivity and employment opportunities, including technical assistance promoting greater diversification of production to crops with a short cycle and higher profitability (such as soya, mango and other) and improvement of distribution networks, storage systems, and packaging of products. All these measures should be expected to contribute to reducing the vulnerability to production losses due to

disasters such as El Niño, but also to those normally incurred during the regular rainy season.

- Rural poverty is closely associated with the unequal land distribution (World Bank 1996 and Jácome, Larrea and Vos 1998). Thus if the policy objective is to simultaneously achieve reduction in vulnerability to weather shocks and raise overall living conditions in the rural areas of the Ecuador's Costa region, then land reform policies should be considered as a part of the medium-term measures.

Health policies:

- In the health sector immediate action is required to eradicate malaria, cholera and dengue fever.[13] Critical for preventive action to reduce health vulnerability is the improvement of sanitary infrastructure resistant to the types of problems posed during the regular rainy season and exacerbated during episodes of El Niño. The ICSS may serve as a guide to target the investments in sanitary infrastructure. With reference to a successful project in Babahoyo, the unit costs of such a durable solution could be in the order of magnitude of US$ 300 per beneficiary. The back-of-the-envelop calculation for the severely vulnerable population in the provinces of the Costa would imply a total required budget of US$ 750 million, that is 0.5% of GDP if spread out over a period of seven years. Further cost-effectiveness analysis of this option may be needed before projecting it on the entire population, but the indications are that this could be in the range of a set of feasible policy solutions. Such investment in sanitary infrastructure should be supplemented by a permanent campaign of immunizations aiming at coverage of 100% (rather than that this should be developed as emergency action in the wake of the weather shock).

The findings and, hence, policy recommendations of this study depend to a considerable extent depend on an analysis of the probability of being affected by El Niño through the study of risk factors and identification of vulnerable areas and population

[13] The Ministry of Health did start a promising novel anti-malaria campaign in the post-El Niño period. Once reemerged, the prevalence of malaria can stay high for years after. The new campaign involves secondary school students who are trained to act as health agents to detect, prevent and monitor malaria cases.

groups. Ecuador lacks adequate and timely monitoring systems to capture the actual impact on incomes and health status during and shortly after the main symptoms of the disaster have disappeared. Hence a complete evaluation of the full impact of the disaster yet has to be made. It is important this is done. The main study produced on the effects of El Niño of 1982-3 was a report by CEPAL (1983), which was produced in February 1983 when the natural phenomenon was still in full effect. No serious ex-post evaluation was produced and the country probably will again be ill prepared for the next return of El Niño if this again is omitted for the 1997-8 event.

Such a study could also test the adequacy of vulnerability analysis applied in the present study as a tool for preventive action in face of expected new natural disasters. More importantly, it may guide the required priority setting and targeting in overall development policies in agriculture, health and infrastructure in Ecuador's vulnerable coastal region.

REFERENCES

Aguilar, Marcelo (1994) *La malaria es más que una picadura*, Quito: Fundación Juan César Garcia

Alballa-Bertrand, J.-M. (1993) *Political Economy of Large Natural Disasters: with special reference to developing countries*, Oxford, New York: Oxford University Press.

Barreiros, Lidia; Arend Kouwenaar, Rudolf Teekens and Rob Vos (1987) *Ecuador: Teoría y diseño de políticas para la satisfacción de necesidades básicas*, Santiago: PREALC and Institute of Social Studies.

CEPAL (1983) 'Ecuador: evaluación de los efectos de las inundaciones de 1982-1983 sobre el desarrollo económico y social', E/CEPAL/G.1240, Santiago: CEPAL (9 May).

CEPAL (1998) 'Ecuador: Evaluación de los efectos socio-económicos del fenómeno de El Niño en 1997-8', Santiago: Comisión Económica para América Latina y el Caribe (22 June).

COPEFEN (1998) ‘Séptimo Informe del Programa de Emergencia para Afrontar el Fenómeno de El Niño’, Quito: Unidad Coordinadora del Programa de Emergencia para Afrontar el Fenómeno El Niño (August).

Defensa Civil (1997) ‘Plan de Contingencia para enfrentar el Fenómeno de El Niño’, Quito, julio (mimeo).

FAO (1983) ‘Documento sobre las inundaciones del litoral ecuatoriano: octubre 1982 – junio 1983’, Quito: Banco Nacional de Fomento and Food and Agricultural Organization (UN) (mimeo).

Gobierno del Ecuador (1983) ‘Requerimientos de asistencia internacional para atender las necesidades de plazo inmediato como resultado de las inundaciones en el Ecuador’, Quito (mimeo).

Gómez Dantés, Héctor (1991) ‘El dengue en las Américas: un problema de salud regional’, *Revista de Salud Pública de México*, vol. 33 no. 4 (July-August).

Instituto Nacional de Pesca (1997) ‘Informe sobre el evento “El Niño 1997-1998” y su relación con la pesca y acuacultura’, Guayaquil (mimeo).

Jácome, Luis, Carlos Larrea and Rob Vos (1998) ‘Políticas macroeconómicas, distribución y pobreza en el Ecuador’, CORDES Documento de Trabajo No. 7, Quito: Cordes.

Larrea, Carlos and others (1996) *La geografía de la pobreza en el Ecuador*, Quito: Secretaría Técnica del Frente Social and UNDP.

Ministerio de Salud Pública (1997) ‘Informe de las actividades realizadas a propósito del Fenómeno de El Niño’, Dirección General de Salud, Quito, November (mimeo).

Ministerio de Salud Pública (varios años). ‘Tasas de dengue clásico, malaria, fiebre amarilla’, various years (1990 to 1997), Dirección de Epidemiología, Quito.

Noll, Roger (1996) “The complex politics of catastrophe economics”, *Journal of Risk and Uncertainty*, 12 (2-3): 141-146.

Secretaría Técnica del Frente Social (1997) *Pobreza y Capital Humano en el Ecuador*, SIISE, Quito: STFS.

Secretaría Técnica del Frente Social (1998) ‘Cronología del fenómeno de El Niño en base al Periódico Hoy, 1982-1983’, SIISE, Quito (February 1998).

Secretaría Técnica del Frente Social. (1998) *Sistema Integrado de Indicadores Sociales, SIISE*. Quito. Electronic data base.

Velasco, Margarita. (1998) "El fenómeno de El Niño y sus efectos en la Salud". *Síntesis Social* (Quito. SIISE-STFS). No. 2, Quito (February).

Velasco, Margarita, and others (1998) 'El fenómeno de El Niño. Una visión desde la Salud', Quito: Sistema Integrado de Indicadores Sociales, STFS (mimeo).

Vos, Rob (1985) 'El modelo de desarrollo y el sector agrícola en Ecuador, 1965-82', *El Trimestre Económico*, LII(208):1097-1140.

Vos, Rob, Margarita Velasco and Edgar de Labastida (1998) 'Efectos económicos y sociales del fenómeno de "El Niño" in Ecuador, 1997-8', Document prepared for the Inter-American Development Bank (SOC/POV), Washington D.C.: IDB (mimeo).

World Bank (1996) *Ecuador Poverty Report*, Washington D.C.: The World Bank.

Table A.1:
Affected cantons (municipalities) most vulnerable to agricultural income losses
(ranking by level of poverty incidence)

Province	Canton	Poverty before El Niño	Total rural population	Poor rural population	No. of Agricultural zone	Main crops (by share of cultivated area)	Main affected socio-economic group
MANABI	Bolívar	80.4%	29,445	23,685	24	Cocoa (32%), Coffee (14%)	Farmer-owner
LOS RIOS	Vinces	80.3%	42,472	34,125	32	Rice (17%), Corn (5%)	Farmer-owner
ESMERALDAS	Quinindé	79.6%	65,793	52,362	28	Corn (43,2%), Banana (14,5%)	Farmer-owner, Agricultural worker
LOS RIOS	Palenque	79.4%	21,099	16,751	32	Rice, Corn (22%)	Farmer-owner
MANABI	Chone	78.4%	85,830	67,311	7,27	Rice (46%), Cotton (43%)	Farmer-owner
MANABI	Santa Ana	78.2%	49,838	38,972	20	Corn (62%), Cotton (19%)	Farmer-owner
ESMERALDAS	Esmeraldas	77.7%	51,585	40,095	25	Corn (52%)	Farmer-owner
MANABI	Jipijapa	77.6%	41,709	32,378	21	Corn (60%), Peanuts (15%)	Farmer-owner
CAÑAR	La Trocal	77.0%	11,346	8,733	1	Rice (49%), Livestock (20%)	Farmer-owner
GUAYAS	Palestina	76.6%	6,804	5,213	6	Rice (65%), Livestock (22%)	Farmer-owner
LOS RIOS	Quevedo	76.6%	64,932	49,736	29	Coffee, Cocoa (35%), Corn, Soya, Rice	Farmer-owner
MANABI	Tosagua	76.2%	28,182	21,469	23	Livestock (30%), Corn (17%)	Farmer-owner
MANABI	Sucre	76.2%	43,631	33,227	7	Rice (46%), Cotton (43%)	Farmer-owner
MANABI	Rocafuerte	76.0%	19,867	15,100	18	Rice (31%), Corn (22%)	Farmer-owner
GUAYAS	Samboron-dón	75.8%	19,077	14,451	8	Rice (16%), Other (84%)	Farmer-owner
GUAYAS	Urbina Jado	75.6%	42,338	32,008	9	Rice (44%), Other (56%)	Farmer-owner
MANABI	24 de Mayo	75.5%	39,354	29,732	21	Corn (60%), Peanuts (15%)	Farmer-owner
LOS RIOS	Ventanas	74.8%	40,801	30,530	30	Cocoa (25%), Coffee (18%)	Farmer-owner
LOS RIOS	Baba	74.7%	34,011	25,403	33	Rice, Corn (70%), Sugar cane (10%)	Farmer-owner, Agricultural worker
LOS RIOS	Babahoyo	74.7%	56,372	42,104	33	Rice, Corn (70%), Sugar cane (10%)	Farmer-owner, Agricultural worker
MANABI	Junín	72.7%	20,809	15,131	7	Rice (46%), Cotton (43%)	Farmer-owner
ESMERALDAS	Eloy Alfaro	72.3%	29,365	21,239	26	Cocoa (18%), Livestock (10%)	Farmer-owner, Agricultural worker
GUAYAS	Alfredo Baquerizo	72.2%	11,883	8,576	33	Rice, Corn (70%), Sugar cane (10%)	Farmer-owner, Agricultural worker
ESMERALDAS	Muisne	70.0%	26,066	18,258	27	Banana (14,5%), Coffee (14,9%)	Agricultural worker, Farmer-owner
GUAYAS	Naranjito	69.0%	7,558	5,217	3/4	Sugar cane (85%)	Agricultural worker
EL ORO	Arenillas	68.1%	7,782	5,296	14	Livestock (60%)	Agricultural worker
MANABI	Portoviejo	67.0%	72,425	48,556	7	Rice (46%), Cotton (43%)	Farmer-owner
GUAYAS	Durán	66.5%	3,281	2,183	1 y 5	Rice, Banana	Farmer-owner, Agricultural worker
GUAYAS	Santa Lucía	66.3%	24,071	15,966	6	Rice (65%), Livestock (22%)	Farmer-owner, Agricultural worker
GUAYAS	El Triunfo	65.0%	9,222	5,995	3/4	Sugar cane (85%)	Agricultural worker
LOS RIOS	Puebloviejo	65.0%	26,211	17,024	32	Rice, Corn	Farmer-owner
GUAYAS	Yaguachi	64.3%	26,692	17,165	10	Rice	Farmer-owner

Province	Canton	Poverty before El Niño	Total rural population	Poor rural population	No. of Agricultural zone	Main crops (by share of cultivated area)	Main affected socio-economic group
GUAYAS	Naranjal	61.6%	27,143	16,724	1 y 5	Rice, Banana	Farmer-owner, Agricultural worker
EL ORO	El Guabo	61.5%	19,610	12,063	11/12/13	Banana (60%), Coffee, Cocoa (20%)	Agricultural worker, Farmer-owner
EL ORO	Pasaje	58.9%	19,150	11,289	11/12/13	Banana (60%), Coffee, Cocoa (20%)	Agricultural worker, Farmer-owner
GUAYAS	Milagro	58.1%	26,324	15,284	2	Sugar cane (27%), Banana (15%)	Agricultural worker
EL ORO	Santa Rosa	53.2%	16,739	8,907	14	Livestock (60%)	Agricultural worker
EL ORO	Machala	49.6%	15,510	7,687	11/12/13	Banana (60%), Coffee, Cocoa (20%)	Agricultural worker, Farmer-owner
EL ORO	Huaquillas	29.8%	201	60	16	Livestock (60%)	Agricultural worker
Total (listed) affected cantons		73.1%	1,184,526	866,006			

Source: SIISE; Ministry of Agriculture (MAG); own fieldwork.

Table A.2
Vulnerability to Health Risks of Affected Cantons in the Costa[1]

Province	Canton	Ranking by ICSS	ICSS	Functional illiteracy rate (%)	Population with access to drinking water (%)	Population with access to sewerage (%)	Population not affected by overcrowded housing (%)	Prevalence of chronic malnutrition (%)	Population1990	Population 1997
ESMERALDAS	Eloy Alfaro	1	19.3	53.0%	6.5%	2.2%	68.7%	45.2	2,736	29,365
GUAYAS	Colimes	2	25.2	49.0%	8.9%	2.3%	66.4%	44.0	13,475	22,244
LOS RIOS	Palenque	3	25.5	52.6%	6.3%	4.0%	69.4%	43.5	13,117	21,099
ESMERALDAS	Muisne	4	25.6	51.2%	12.3%	10.0%	67.8%	45.5	3,086	26,066
LOS RIOS	Baba	5	26.5	46.2%	7.1%	4.3%	72.8%	42.9	8,761	34,011
GUAYAS	Pedro Carbo	6	27.8	45.5%	0.7%	0.4%	59.5%	44.8	16,075	36,581
GUAYAS	Palestina	7	29.7	47.1%	14.0%	5.7%	64.8%	43.9	5,610	12,943
GUAYAS	Urbina Jado	8	29.9	38.2%	7.0%	0.9%	64.9%	42.5	13,166	50,673
MANABI	Flavio Alfaro	9	30.7	44.4%	10.3%	1.6%	86.5%	42.9	17,509	27,311
ESMERALDAS	San Lorenzo	10	32.3	44.7%	16.8%	15.6%	69.3%	44.0	6,136	26,083
MANABI	Paján	11	32.4	50.4%	9.8%	7.5%	65.1%	43.8	7,815	49,093
EL ORO	Las Ladies	12	32.6	29.9%	8.1%	5.5%	73.4%	43.0	1,106	5,628
EL ORO	Chill	13	33.2	40.3%	12.2%	12.0%	84.7%	42.9	1,420	3,200
ESMERALDAS	Quinindé	14	33.5	43.0%	13.8%	14.3%	72.0%	42.6	15,026	87,360
GUAYAS	Santa Lucía	15	34.0	44.6%	11.4%	2.8%	61.4%	43.3	18,853	31,624
LOS RIOS	Montalvo	16	37.0	34.1%	4.1%	0.7%	83.0%	40.2	10,113	22,002
MANABI	Pichincha	17	38.3	50.5%	7.9%	3.0%	75.7%	44.1	8,861	33,341
GUAYAS	Santa Elena	18	38.4	27.0%	5.5%	1.8%	68.0%	41.4	15,799	97,165
GUAYAS	Daule	19	39.8	37.0%	20.3%	8.9%	67.3%	41.8	13,915	82,231
LOS RIOS	Vinces	20	40.3	36.9%	18.8%	17.0%	71.8%	40.3	18,616	62,727
GUAYAS	Balao	21	40.5	35.4%	22.3%	5.0%	73.7%	43.3	6,460	14,474
GUAYAS	El Triunfo	22	42.3	30.0%	1.7%	2.1%	75.8%	41.5	13,759	29,243
GUAYAS	Balzar	23	44.0	42.6%	23.4%	22.8%	67.9%	42.2	22,572	52,145
GUAYAS	El Empalme	24	44.1	37.7%	17.6%	7.1%	77.4%	42.0	19,759	46,226
GUAYAS	Playas	25	44.3	25.6%	3.0%	1.9%	78.5%	41.0	13,925	24,855
MANABI	Junín	26	45.2	38.5%	13.9%	11.2%	89.0%	40.4	11,917	20,809
GUAYAS	Samborondón	27	45.6	32.3%	30.9%	18.9%	74.7%	39.8	15,623	39,284
MANABI	Sucre	28	45.7	41.2%	16.9%	10.7%	79.5%	41.9	11,404	87,162
LOS RIOS	Puebloviejo	29	46.6	39.0%	21.7%	9.4%	72.1%	41.4	6,693	26,211
GUAYAS	Salinas	30	46.7	21.0%	2.1%	1.6%	75.5%	40.1	38,389	37,513
GUAYAS	Alfredo Baquerizo	31	46.7	38.1%	19.3%	7.7%	75.4%	40.8	9,469	18,798
MANABI	Montecristi	32	47.4	41.9%	19.6%	7.5%	73.2%	42.8	14,793	43,557
MANABI	Jipijapa	33	48.5	39.6%	22.3%	17.5%	68.9%	41.3	16,811	80,010
MANABI	Santa Ana	34	48.9	48.7%	9.3%	1.5%	82.0%	43.1	9,612	57,203

Province	Canton	Ranking by ICSS	ICSS	Functional illiteracy rate (%)	Population with access to drinking water (%)	Population with access to sewerage (%)	Population not affected by overcrowded housing (%)	Prevalence of chronic malnutrition (%)	Population1990	Population 1997
MANABI	Tosagua	35	49.2	38.4%	17.1%	2.3%	77.3%	40.7	10,752	36,754
MANABI	24 de Mayo	36	49.8	49.4%	8.2%	1.8%	81.0%	43.4	9,605	39,354
LOS RIOS	Babahoyo	37	49.9	28.3%	23.4%	23.9%	76.9%	37.0	29,887	121,987
MANABI	El Carmen	38	50.0	36.0%	22.1%	6.6%	83.8%	41.0	22,469	62,537
MANABI	Rocafuerte	39	50.5	32.5%	14.6%	5.0%	80.1%	38.5	15,826	30,096
LOS RIOS	Urdaneta	40	50.5	37.6%	24.4%	22.3%	78.7%	40.9	13,493	27,132
LOS RIOS	Ventanas	41	52.1	33.2%	21.5%	17.7%	75.4%	41.1	17,326	67,654
GUAYAS	Naranjal	42	52.8	32.3%	30.0%	22.2%	75.7%	41.2	8,680	45,646
GUAYAS	Yaguachi	43	52.9	29.2%	29.0%	19.2%	80.0%	40.0	9,878	45,481
LOS RIOS	Quevedo	44	54.1	30.7%	25.6%	17.8%	79.5%	39.4	53,809	195,809
MANABI	Chone	45	54.8	36.1%	31.4%	22.4%	84.6%	38.7	22,643	133,755
ESMERALDAS	Esmeraldas	46	54.9	26.9%	28.5%	32.0%	75.9%	38.0	58,801	200,634
EL ORO	El Guabo	47	55.8	23.7%	27.5%	16.6%	76.6%	40.6	7,433	32,452
EL ORO	Zaruma	48	56.2	28.0%	37.9%	35.9%	85.0%	38.1	4,154	27,410
GUAYAS	Naranjito	49	57.7	31.1%	29.8%	20.8%	81.8%	40.8	13,393	27,360
MANABI	Bolívar	50	57.8	38.4%	22.9%	20.1%	84.7%	40.2	13,194	43,465
EL ORO	Arenillas	51	59.8	20.6%	34.1%	35.4%	78.9%	38.0	7,687	21,182
EL ORO	Piñas	52	61.1	22.6%	42.6%	40.1%	90.4%	35.5	5,856	25,263
EL ORO	Marcabelí	53	62.1	24.5%	43.2%	32.2%	83.7%	39.9	2,191	5,655
EL ORO	Atahualpa	54	63.6	21.0%	37.1%	27.0%	94.8%	38.4	1,142	7,095
EL ORO	Portovelo	55	63.9	21.1%	39.4%	48.9%	85.5%	37.1	3,751	11,863
EL ORO	Balsas	56	65.1	18.7%	43.6%	40.1%	83.6%	37.4	2,040	4,703
EL ORO	Huaquillas	57	69.5	18.9%	41.0%	7.8%	78.7%	39.1	26,944	32,160
GUAYAS	Durán	58	71.0	14.6%	34.1%	41.8%	84.0%	32.3	79,711	98,537
EL ORO	Santa Rosa	59	71.4	18.3%	46.4%	53.0%	80.8%	36.1	22,463	58,824
GUAYAS	Milagro	60	72.2	20.7%	47.7%	27.7%	83.5%	35.8	72,807	134,624
MANABI	Portoviejo	61	73.0	25.1%	49.4%	45.1%	84.2%	34.2	91,715	233,761
EL ORO	Pasaje	62	73.3	19.4%	50.2%	46.0%	82.5%	36.0	22,256	59,456
EL ORO	Machala	63	75.2	12.8%	38.8%	50.8%	82.4%	33.8	132,474	182,287
MANABI	Manta	64	76.0	25.4%	55.7%	49.4%	83.6%	36.1	118,802	153,614
GUAYAS	Guayaquil	65	79.4	11.9%	46.4%	53.3%	81.3%	2.2	1,449,306	1,816,307

Source: Vos, Velasco and De Labastida (1998) based on Secretaría Técnica del Frente Social, SIISE (1998); INEC, Population Census 1982, 1990.
Note: 1. Only includes cantons established in1990 or earlier. New cantons created after 1990 are excluded for lack of complete data.

Table A.3
Typology of 105 (potentially) affected cantons classified by priority type of intervention

Province	Canton	1997 population (projection)	Poverty incidence	Illiteracy rate	Medical personnel (x 10,000)	Deaths due to El Niño	Wounded due to El Niño	Damaged houses (% of total)	No. of affected families	No. of affected persons	Evacuated population (% of total)	Severely affected population (% total)	Pupils not assisting schools due to El Niño	Type (policy priority)
EL ORO	Machala	186,115	29.9%	12.8%	51.3	0	0	0.1%	116	531	0.1%	0.0%	4625	B
	Arenillas	21,627	50.9%	20.4%	19.4	0	0	1.6%	58	326	1.6%	0.0%	2252	A
	Atahualpa	7,244	42.8%	21.0%	12.4	1	0	0.0%	0	0	0.0%	0.0%	0	A
	El Guabo	33,133	53.7%	23.5%	7.8	0	0	1.8%	87	440	0.5%	0.1%	0	D
	Huaquillas	32,836	38.9%	18.8%	5.8	2	0	5.0%	260	1160	5.8%	0.1%	7965	B
	Pasaje	60,704	38.3%	19.2%	14.8	1	0	0.0%	1	5	0.3%	0.0%	610	A
	Portovelo	12,112	37.3%	20.6%	16.5	0	0	0.1%	0	0	0.0%	0.0%	0	A
	Santa Rosa	60,060	40.9%	18.0%	21.6	3	0	18.2%	914	3069	4.4%	1.8%	7836	B
ESMERALDAS	Esmeraldas	185,908	46.3%	24.9%	24.5	25	38	2.6%	629	1095	1.2%	1.1%	8565	A
	Eloy Alfaro	29,981	72.3%	52.7%	19.0	0	0	0.0%	0	0	0.0%	0.0%	0	D
	Muisne	26,614	70.0%	51.2%	12.4	2	0	2.8%	101	510	0.0%	0.3%	0	D
	Quinindé	89,194	72.1%	40.8%	10.0	0	0	1.5%	10	60	0.3%	0.4%	2041	D
	San Lorenzo	26,631	64.6%	44.2%	23.7	0	2	0.1%	0	0	0.0%	0.1%	0	D
	Atacames	18,939	69.5%	37.5%	7.9	0	0	0.0%	1	6	0.0%	0.0%	0	D
GUAYAS	Guayaquil	1,854,450	51.6%	11.8%	45.8	18	5	0.2%	712	2704	0.1%	0.1%	2621	A
	Alfredo Baquerizo Moreno	19,193	62.9%	37.7%	3.1	0	0	1.6%	21	106	0.0%	0.0%	0	A
	Colimes	22,711	72.1%	48.7%	1.3	1	0	0.3%	315	50	0.0%	0.0%	0	D
	Daule	83,958	59.0%	36.2%	10.5	3	0	0.0%	2	10	0.0%	0.0%	0	D
	Durán	100,606	24.4%	14.6%	13.0	2	3	0.1%	307	38	0.0%	0.1%	0	A
	El Empalme	47,196	58.1%	35.0%	12.5	0	0	1.1%	50	190	0.1%	0.0%	0	D
	El Triunfo	29,857	54.4%	30.0%	9.0	2	0	3.3%	208	646	0.5%	0.1%	0	D
	Milagro	137,451	34.5%	20.3%	22.5	3	0	0.4%	243	1075	0.1%	0.5%	492	A
	Naranjal	46,605	54.2%	32.2%	13.5	0	0	1.0%	557	2007	0.1%	7.3%	250	B
	Naranjito	27,935	50.5%	31.2%	11.5	0	0	0.0%	0	0	0.1%	0.0%	65	D
	Palestina	13,215	66.6%	46.8%	1.5	1	0	3.1%	335	467	4.8%	0.6%	727	C
	Pedro Carbo	37,349	69.7%	44.7%	6.4	0	0	0.0%	0	0	0.0%	0.0%	0	D
	Salinas	38,301	51.2%	22.5%	20.1	0	0	0.0%	140	0	0.0%	0.0%	0	A
	Samborondón	40,109	57.8%	32.2%	4.5	2	0	1.2%	44	207	0.5%	0.0%	1696	D

Province	Canton	1997 population (projection)	Poverty incidence	Illiteracy rate	Medical personnel (x 10,000)	Deaths due to El Niño	Wounded due to El Niño	Damaged houses (% of total)	No. of affected families	No. of affected persons	Evacuated population (% of total)	Severely affected population (% total)	Pupils not assisting schools due to El Niño	Type (policy priority)
	Santa Elena	99,206	63.1%	26.7%	16.6	1	0	0.2%	864	1620	0.2%	6.0%	513	B
	Santa Lucía	32,288	63.2%	44.4%	3.7	0	0	0.3%	282	50	0.2%	0.0%	1283	D
	Urbina Jado	51,737	71.6%	38.2%	3.7	1	0	3.9%	549	94	2.1%	0.0%	301	C
	Yaguachi	46,436	56.5%	29.0%	10.6	0	0	0.1%	16	118	0.3%	0.0%	38	D
	Playas	25,377	48.7%	25.6%	9.1	0	0	0.0%	15	251	0.1%	0.0%	1019	A
	Coronel Marcelino Maridueña	9,557	23.2%	15.2%	63.8	1	0	1.0%	16	20	0.0%	0.0%	0	A
	Lomas de Sargentillo	12,568	67.3%	44.1%	6.4	0	0	0.0%	0	0	0.0%	0.1%	0	D
	Nobol	11,973	56.9%	34.4%	5.0	0	0	0.3%	167	0	0.0%	0.0%	0	D
	La Libertad	62,714	45.2%	20.0%	14.7	1	0	0.0%	0	0	0.1%	0.0%	0	A
LOS RIOS	Babahoyo	124,549	52.9%	27.8%	29.8	7	2	1.0%	184	821	0.9%	0.1%	4351	A
	Baba	34,725	74.7%	46.2%	9.5	3	0	1.1%	53	269	0.6%	0.1%	1840	D
	Montalvo	22,464	64.8%	33.9%	6.7	1	0	1.5%	36	114	0.1%	0.2%	723	D
	Puebloviejo	26,761	65.0%	38.7%	3.7	1	0	0.2%	8	39	0.1%	0.0%	282	D
	Quevedo	199,921	54.0%	29.3%	11.5	3	2	0.5%	144	648	0.1%	0.0%	974	B
	Urdaneta	27,702	61.0%	37.4%	14.1	0	0	0.2%	0	0	0.0%	0.1%	0	D
	Ventanas	69,074	64.1%	33.1%	7.1	1	0	0.2%	14	79	0.1%	0.0%	2368	D
	Vinces	64,044	66.6%	36.5%	9.5	1	0	2.3%	230	1179	0.5%	0.0%	4648	D
	Palenque	21,542	79.4%	52.3%	0.9	0	1	1.3%	69	244	0.0%	0.3%	0	D
	Buena Fé	20,387	79.7%	42.7%	7.4	0	0	0.1%	2	9	0.0%	0.0%	0	D
MANABI	Portoviejo	238,670	40.2%	24.7%	27.6	17	8	4.8%	1061	6842	0.6%	1.3%	10027	B
	Bolívar	44,377	66.3%	37.6%	13.1	2	0	1.6%	96	480	0.2%	0.1%	0	D
	Chone	136,564	60.1%	35.3%	17.0	7	0	1.3%	244	1060	0.1%	0.1%	436	C
	El Carmen	63,850	65.6%	35.8%	8.3	1	0	0.2%	10	50	0.0%	0.0%	0	D
	Flavio Alfaro	27,884	75.9%	43.8%	4.7	3	0	0.2%	4	29	0.0%	0.0%	0	D
	Jipijapa	81,690	60.3%	37.7%	15.1	1	1	0.7%	67	437	0.1%	0.2%	200	C
	Junín	21,246	72.7%	38.1%	8.9	1	0	5.9%	91	461	1.2%	1.9%	122	D
	Manta	156,840	33.8%	25.1%	37.9	2	5	0.7%	122	603	0.0%	0.2%	133	A
	Montecristi	44,472	59.2%	41.6%	8.3	5	8	1.7%	94	387	0.4%	0.2%	1565	D
	Paján	50,124	73.8%	50.3%	8.8	5	0	0.9%	31	188	0.3%	0.4%	689	D

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	Pichincha	34,041	78.3%	50.2%	4.1	0	0	0.8%	25	125	0.0%	0.2%	0	D
	Rocafuerte	30,728	64.3%	32.0%	13.0	0	0	2.1%	56	258	0.4%	0.7%	902	D
	Santa Ana	58,404	72.4%	46.4%	8.0	24	16	2.4%	163	852	0.5%	0.4%	1115	D
	Sucre	88,992	59.4%	36.3%	27.4	22	32	5.3%	429	2247	7.5%	1.5%	2895	C
	Tosagua	37,526	67.9%	37.9%	2.9	0	0	0.6%	22	144	0.2%	0.1%	182	D
	24 de Mayo	40,181	75.5%	48.6%	6.7	1	0	1.2%	26	132	0.0%	0.7%	0	D
	Pedernales	35,240	77.5%	52.4%	3.7	6	0	0.4%	4	21	0.0%	0.3%	0	D
	Olmedo	11,658	77.4%	55.5%	10.3	0	0	12.9%	214	50	0.0%	1.3%	0	D
	Puerto López	16,095	67.7%	45.7%	5.0	3	0	2.4%	34	168	0.1%	0.7%	286	D
AZUAY	Cuenca	390,904	36.6%	22.9%	53.2	6	3	0.2%	83	418	0.0%	0.0%	84	A
	Santa Isabel	20,264	76.8%	35.9%	18.8	0	0	0.6%	53	285	1.4%	0.1%	0	D
BOLIVAR	Guaranda	78,223	69.1%	47.5%	30.7	12	0	0.0%	7	35	0.0%	0.0%	0	D
	Chillanes	24,181	82.1%	43.9%	15.7	1	0	0.0%	0	0	0.0%	0.0%	0	D
	Echeandía	11,597	65.9%	34.8%	13.8	0	0	2.0%	0	0	0.0%	0.0%	0	D
	San Miguel	33,117	70.2%	35.1%	16.9	0	0	0.1%	3	12	0.0%	0.0%	0	D
	Caluma	11,606	63.1%	31.7%	12.9	0	0	0.2%	5	25	0.0%	0.0%	0	D
CAÑAR	La Trocal	38,426	65.0%	30.2%	13.3	2	0	0.4%	8	147	0.3%	0.5%	403	D
COTOPAXI	La Maná	24,483	75.5%	33.5%	9.8	5	0	2.1%	65	268	0.5%	0.4%	549	D
	Pujilí	52,364	78.4%	51.2%	15.5	0	0	0.0%	3	8	0.0%	0.0%	0	D
CHIMBORAZO	Riobamba	193,403	48.0%	28.2%	28.2	3	2	0.0%	11	60	0.0%	0.0%	0	A
	Alausí	47,378	82.4%	59.4%	12.0	2	1	0.5%	64	309	0.0%	0.2%	0	D
	Chunchi	15,930	75.6%	48.6%	19.5	7	4	1.0%	10	43	0.0%	0.5%	0	D
	Pallatanga	11,197	83.9%	50.5%	7.1	0	0	0.3%	4	18	0.0%	0.0%	0	D
	Cumandá	10,081	78.1%	38.0%	8.9	0	0	4.9%	74	440	0.0%	1.3%	0	C
IMBABURA	Ibarra	141,107	47.2%	23.0%	28.2	0	0	0.0%	4	20	0.0%	0.0%	0	A
TUNGURAHUA	Ambato	268,993	42.2%	24.2%	29.2	0	0	0.0%	0	0	0.0%	0.0%	0	B
LOJA	Calvas	34,716	77.2%	26.9%	13.3	3	1	0.0%	0	0	0.0%	0.0%	0	D
	Celica	16,921	75.0%	29.9%	11.8	4	0	0.4%	0	0	0.0%	0.0%	0	D
	Espíndola	21,481	92.2%	44.3%	14.4	9	11	0.3%	3	15	0.0%	0.1%	0	D
	Gonzanamá	20,401	83.6%	35.2%	8.3	1	0	0.0%	0	0	0.0%	0.0%	0	D
	Macará	21,588	68.7%	21.9%	17.6	3	0	0.0%	0	0	0.0%	0.0%	0	D

Province	Canton	1997 population (projection)	Poverty incidence	Illiteracy rate	Medical personnel (x 10,000)	Deaths due to El Niño	Wounded due to El Niño	Damaged houses (% of total)	No. of affected families	No. of affected persons	Evacuated population (% of total)	Severely affected population (% total)	Pupils not assisting schools due to El Niño	Type (policy priority)
	Paltas	39,856	83.8%	33.6%	10.8	1	0	0.0%	0	0	0.0%	0.0%	0	D
	Puyango	19,844	78.8%	34.3%	17.6	2	0	2.6%	85	425	1.0%	0.0%	50	D
	Zapotillo	12,085	86.1%	41.1%	13.2	3	0	3.1%	61	305	0.0%	0.2%	0	D
MORONA SANTIAGO	Santiago	10,000	78.1%	25.9%	69.0	0	0	0.9%	0	0	0.0%	0.0%	0	B
NAPO	Tena	42,213	80.3%	28.5%	29.1	1	0	0.1%	0	0	0.0%	0.2%	0	D
	La Joya de los Sachas	19,122	93.1%	35.9%	6.8	0	0	0.6%	0	0	0.0%	0.7%	0	D
	Orellana	23,233	78.3%	24.0%	22.4	1	0	0.9%	5	36	0.0%	4.5%	0	D
	Loreto	9,533	98.2%	39.8%	12.6	1	2	1.0%	10	8	0.0%	0.1%	0	D
PASTAZA	Pastaza	39,411	63.5%	29.9%	44.4	0	1	2.2%	12	58	0.0%	0.8%	0	C
	Mera	7,023	47.2%	16.1%	61.2	2	2	0.2%	0	0	0.0%	0.2%	0	A
ZAMORA CHINCHIPE	Zamora	27,404	65.0%	22.0%	32.1	10	0	0.7%	0	0	0.0%	0.2%	0	
	Chinchipe	14,665	89.1%	27.1%	29.3	0	0	0.1%	0	0	0.0%	0.1%	0	C
	Nangaritza	5,097	84.7%	24.3%	13.7	0	0	0.1%	0	0	0.0%	0.1%	0	D
	Yantzaza	14,468	78.2%	26.8%	25.6	0	0	1.1%	85	196	0.0%	0.8%	0	C
	El Pangui	6,681	87.6%	36.8%	16.5	0	1	3.7%	23	137	0.0%	3.0%	0	D
	El Cóndor	5,749	84.8%	31.4%	0.0	0	0	1.0%	9	54	0.0%	0.0%	0	
GALAPAGOS	San Cristóbal	4,255	23.9%	8.7%	0.0	0	0	0.8%	4	30	0.0%	0.3%	0	

Source: Vos, Velasco and De Labastida (1998); SIISE.