Economic and Social Effects of El Niño in Ecuador, 1997-1998

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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 resulting from inclement weather from general inadequacies in infrastructure and lack of economic development. This study proposes methodologies to identify different types of risks associated with natural disasters and to establish degrees of vulnerability to such risks by geographical areas and population groups. It finds that most economic costs in Ecuador relate to losses of agricultural production and damages to infrastructure. Increased health risks are also critical. Outcomes suggest that most of the agricultural income losses are 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. For some, El Niño was not a disaster but a boon. Wealthy shrimp producers, in particular, saw productivity increase by over 25%, while banana exporters can compensate for production losses through higher export quotas and prices. Health risks are greatest in areas with poor sanitary infrastructure and poor overall social conditions.

FOREWORD

As part of its mission, the Poverty and Inequality Advisory Unit encourages new research to assess the impact of adverse covariant shocks on poverty and design appropriate policies to protect the poor against these shocks.

Meteorological and seismic phenomena of extreme magnitude, which are frequent in Latin America and the Caribbean, can translate into a sharp increase of poverty and inequality when risks to productive, social and housing infrastructure are not properly addressed beforehand. In order to reduce the human, economic and social toll taken by natural events, a careful analysis of the geographical location, type of occupation and level of income of human settlements is an essential step in correctly assessing and reducing the vulnerability of a country to natural hazards.

This case study assesses the economic and social impact of El Niño by estimating the increase in rural poverty in affected areas. It also proposes a methodology to analyze risks posed by El Niño-related weather patterns and evaluate the degree and nature of the vulnerability of different population groups to such risks. Finally, the study gives useful recommendations for designing effective preventive and relief policies to reduce the economic and social negative impact of natural disasters.

Economic and Social Effects of El Niño in Ecuador, 1997-8 can provide a useful analytical foundation for future IDB projects aiming at reducing the risks and costs associated with natural hazards in Latin America and the Caribbean.

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Contents

I.
Introduction

The natural phenomenon of "El Niño" is a regularly occurring change in Pacific Ocean temperatures provoking temporal climatic change around the world.[1] Along the coast of South America, El Niño is felt in the form of extremely heavy rainfall causing floods and landslides, often with disastrous consequences. The poor are often the most affected by these events because they tend to live in more precarious dwellings and have limited access to protective infrastructure.

The 1997-98 El Niño in Ecuador cost the lives of at least 286 people and left some 30,000 persons homeless. A much larger share of the population was affected by income losses as agricultural land flooded or lost their jobs because of the resulting stagnation in economic activity. We estimate that about a quarter of the total was exposed to increased health risks in the form of infectious diseases such as malaria, diarrhea, and cholera, related to floods and damages to sanitary infrastructure.

In contrast to many other natural disasters, El Niño came pre-announced. Early in 1997 it was clear there was a large probability that the phenomenon would set in around November and cause extremely heavy rainfall (with all its related consequences). The experience of 1982-83 yielded some lessons, leading the government to prepare a Contingency Plan and declare a state of emergency in July 1997. The Ecuadorian authorities established a budget for emergency relief and reconstruction of US$318 million, of which US$231 million was in the form of loans from multilateral agencies and related counterpart funds.

The paradox of the situation was that while the authorities felt that this time around they were better prepared, preventive action and preparations for rehabilitation and reconstruction were unsatisfactory. In this study we argue that a better assessment of the different types of risks associated with the phenomenon, as well as the identification of the vulnerability of different population groups could have greatly improved the response. Government approaches to the risks on the part of the authorities remained too general and untargeted. The Contingency Plan identified a total of 6.5 million people at risk, that is 57% of the total population, but did not specify the responses needed for the different types of impacts such as destroyed dwellings, 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.[2] A second objective of the study is to show how the methodology used to differentiate between risks and vulnerability of different population groups may help to guide policies whose aim is preventive reconstruction of the affected areas and, at the same time, target the benefits to those most vulnerable.

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[1] The phenomenon El Niño should not be confused with the El Niño ocean current, which each year around Christmas brings warmer seawater to the coasts of Ecuador and Peru, to return 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 in Ecuador was in 1982-3. When referring to "El Niño" in this study we indistinguishably refer to "the phenomenon."

[2] We refer to "potential" impact because the effects of the disaster were not fully measurable at the time that this study was completed (February-June 1998). Moreover, effects of the phenomenon were still being felt at the time.

Section 2 of this report offers a conceptualization of the types of risk and vulnerability associated with El Niño and how to assess the costs of this type of natural disaster. Section 3 provides 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 agroecological zones. This analysis is subsequently used to estimate the potential impact on rural poverty and to identify the rural population that is likely to have suffered most from the natural disaster. A study of the vulnerability to health risks and preventive actions required to reduce it is presented in Section 4. Section 5 summarizes the emergency relief and preventive actions taken or programmed by the authorities and undertakes a general assessment of their effectiveness. Policy conclusions are drawn in Section 6. The discussion there centers around the question of whether disaster relief and income loss compensation programs should be emphasized, or if the disaster offers an opportunity to reconsider development plans and investment priorities in order to reduce future vulnerability to weather shocks in a more structured way. The conclusions favor of the latter solution.

II.
Economic and Social Costs of El Niño

Methodological Considerations

"It's because of El Niño." This often-heard expression is used in many parts of the world to explain abnormal climatic conditions experienced during 1997 and 1998. While it is a well-known natural phenomenon, it is not always clear to what extent heavy rainfalls and floods or prolonged periods of drought 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 and subsequent floods and landslides that affected most of the country's coastal region during 1997-8 were undoubtedly related to the El Niño phenomenon. Yet roads, bridges, and drinking water systems succumb to some degree of damage every year during the rainy season. In addition, it is normal for agricultural producers not to harvest a portion of their crops during periods when rural roads are impassable. There is no reliable record of what these 'normal' damages are, and hence it is difficult to measure how much of the destruction in 1997-8 was actually caused by El Niño. Further, some areas have been more heavily affected than others. This is not 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 than others. It also raises the issue of how to measure *costs*: should damages be valued at the cost of rehabilitation, that is, returning the assets to pre-El Niño condition, or should they be valued at reconstruction costs, that is, at what it would cost to upgrade them to provide better protection in the future?

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 phenomenon, there remains considerable uncertainty regarding how, when, and to what degree it will affect areas of potential risk. Based on an evaluation of past experience, we approach this issue 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. 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 this study was undertaken while the event was still occuring, first indications of its impact are consistent with the predictions of the vulnerability analysis. Hence, the approach should help to more easily identify the types of emergency relief and preventive action that should be undertaken. It should also be useful in establishing priorities among areas and population groups requiring specific attention to cope with losses and to target interventions that might prevent even larger losses.

The second problem relates to the *assessment of costs*. Several issues are at stake here. One is the choice of an appropriate benchmark as suggested above. To measure the cost associated only with the natural disaster, we must be able to distinguish between the damage caused by the disaster and the "normal" depreciation of the capital stock (infrastructure), changes in production levels or the health risk to the population that are independent of it. In particular, the "normal" situation in areas subject to other weather or exogenous shocks should be taken into account. 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, that is, making improvements in the structure as well as rebuilding it and leaving it in a better shape than before. Although this can make good sense from a developmental point of view, it may raise political economy problems. For instance, if roads and bridges were already deteriorated or in need of repair, then the natural disaster, rather than poor investments in the past, would be blamed. The result would be exaggerated natural disaster costs (see Albala-Bertrand 1993; Noll 1996) and may easily lead to misguided disaster relief policies and foreign assistance programs. However, if the main policy objective is developmental reconstruction of the affected areas, such valuation of resource needs may well be justifiable. However, these costs must be clearly distinguished from the damages caused solely by the natural disaster.

Two other methodological problems associated with cost assessments should be considered. They are distinguishing between *direct* and *indirect* losers, and seperating *losses* from *delay*. Farmers may have lost a harvest as a direct consequence of El Niño, but consumers and agro-industries may suffer indirect effects in the form of increased food prices and/or reduced or stagnant supply. The identification of direct and indirect effects is further complicated by market responses to the natural disaster, e.g. farmers may compensate for output losses by raising food prices and transporters affected by damaged roads may raise freight fees. Losses in agriculture may be associated with labor that went unused crops that could not be harvested. However, there could also be delays if sowing and harvesting have to be put off in response to El Niño.

This study deals with the cost problem at two levels: first, an estimation of the direct cost of the damages (in monetary terms); and second, estimates of possible costs of reconstruction and improvements that would afford greater protection from similar events in the future are made as a function of the type of vulnerability.

On *costs* (section 3), we restrict ourselves to estimates of 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: those affecting agricultural production and incomes, and those raising health risks.

Identifying the Vulnerable Population in Ecuador

Official policy 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 endanger the lives and health of the population.

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 given the responsibility of organizing preventive actions. By July 1997, it had identified 93 *cantones* (municipalities), of which 77 were in the provinces of the *Costa* (the tropical lowlands bordering the Pacific Ocean, see Table 1). Twelve more municipalities were later added, reaching a total of 105 municipalities that could be potentially affected. The aggregate population of the area in question is 6.5

million. In other words, 57% of the country's population was considered to be at risk (see Table 2).

This identification of vulnerable areas was meant to guide humanitarian emergency relief and rehabilitate the affected infrastructure. The main concern of the *Defensa Civil* was evacuating and assisting people in emergency situations and keeping flooded areas accessible. Other agencies, such as the Ministry of Health, the Ministry of Social Works, and local authorities also relied on the same information.

Table 1
Areas Potentially Affected by Environmental Risks as a result 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	Río Guayas Basin (delta)	Jubones, Santa Rosa and Pagua. Lower parts of river basins	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* (February 1998).

Table 2

Potentially Affected Municipalities (Cantons) and Population, 1997-8

	No. of affected cantons	Total population (millions)
Defensa Civil Estimates	105	6.5
Breakdown proposed by 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.
3. Note that one cannot simply add the subtotals of the two categories because there is substantial overlap.

By focusing primarily on the environmental risks, the authorities were unable to adequately categorize and distinguish between different 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 for the poor population *only*, and
- vulnerability to increased health risk for the very vulnerable population *only*.

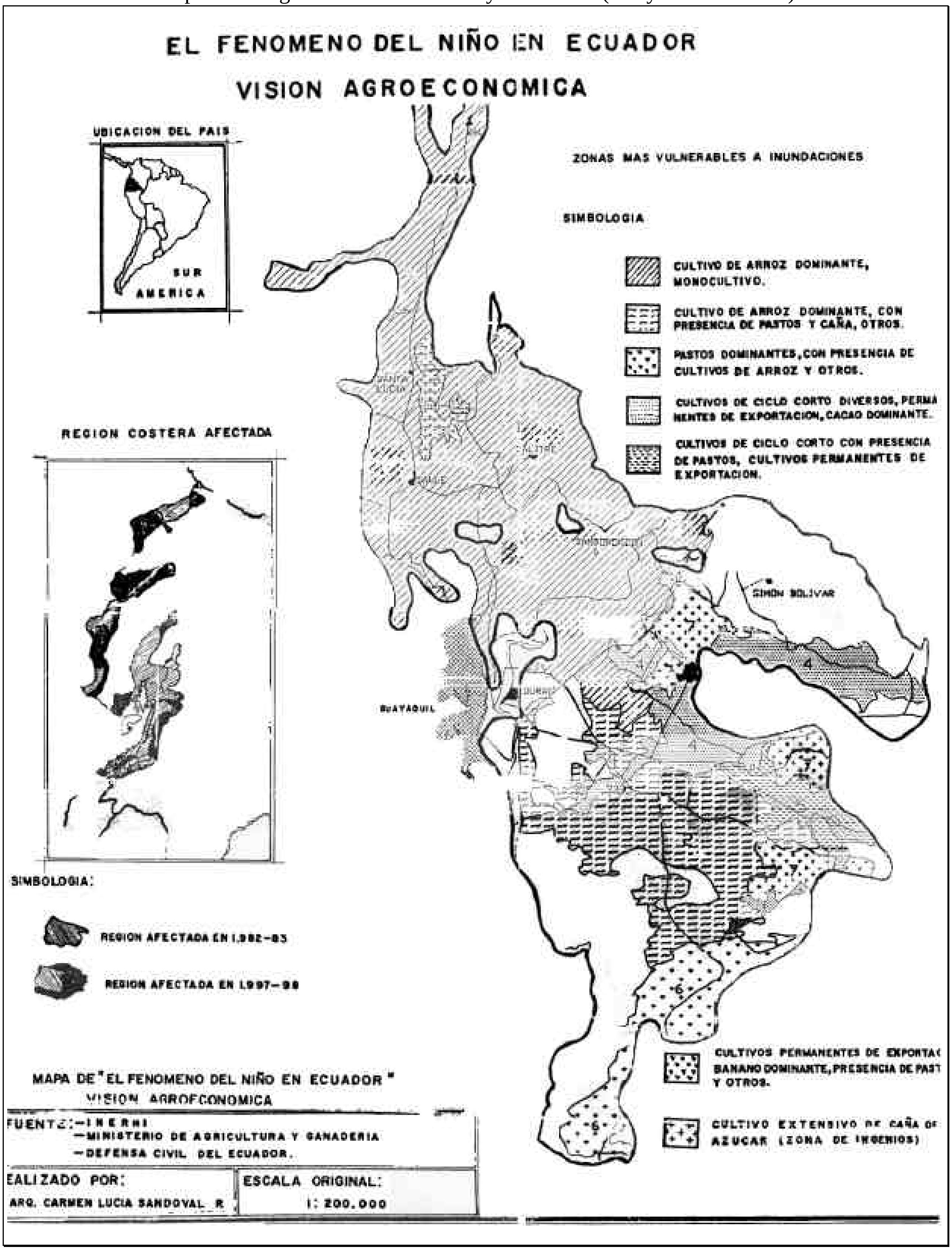
As shown on Table 2, this more restricted focus on the risks for the poor and very vulnerable still implies that a large part of the Ecuadorian population has been exposed to severe income losses and increased health risks. We estimate that among the poor and very vulnerable, the population most at risk of experiencing income losses totals 900,000, while 2.5 million people are exposed to greater health risks. These two groups 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 through 1998 when this study was completed, no adequate information was available to evaluate the precise impact of El Niño on the living standards of the population in the affected areas. Hence we also use the vulnerability analysis 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 crop; and (iv) distribution of land by size of land holdings.

Map No. 1 provides an overview of the most vulnerable areas, in particular of the cultivated areas of the Guayas River basin. The inserts locate the area and indicate those affected during the 1982-3 and 1997-8 episodes of El Niño. However, the map 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 lowlands) are required. Such maps have not been devised for Ecuador's risk zones, even though this would be technically feasible using available aerial photography. The development of these maps would be an appropriate technique to monitor the areas affected by El Niño. Due to the limited time and the costs involved, we only used the source for a small area. Available cartography and data on land use from various sources and fieldwork reports were used to map the total vulnerable area. The vulnerable areas were subdivided into large agroecological zones (Vos, Velasco and De Labastida 1998) as follows: (i) terraces and alluvial levels (vulnerable to overflowing of rivers); (ii) the Guayas river basin (very sensitive to flooding); (iii) the lower slopes of the Western cordillera (sensitive to torrential rains and overflowing rivers); and (iv) coastal areas (sensitive to sea water erosion and spring tides).

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



The most vulnerable areas for each of these zones were established (also using altitude levels) and the information was combined with data on agricultural production and land use at the (administrative) canto level. Although the political-administrative boundaries of provinces and cantons does not precisely coincide with the four agroecological zones defined above, it does allow the combination of information on land use and vulnerability to flooding with other socioeconomic data at the local level. For example, 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. In 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 the poverty line (US$61 per person per month at 1997 prices).[3]

Structural risk factors are analyzed to ascertain the impact on health. Based on an analysis of the observable deterioration in health conditions following El Niño in 1982-3, a composite index is constructed which defines the social and sanitary conditions (ICSS) of the population in the potentially affected areas. Using a principal components analysis, four determinants are found to be strongly associated with the likelihood of increased health risk due to El Niño (Velasco and others 1998): (i) access to drinking water; (ii) access to adequate sewerage systems; (iii) overcrowding of housing; and (iv) 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 affected cantons we find that 2.5 million people are highly vulnerable to increased health risks (Table 2). Subsequently, as explained in Section 4, we combine this information with available data on actual damages to social infrastructure and increases in infectious diseases and deaths due to El Niño, as well as with data on available health services, to identify priority actions, both preventive and reconstructive.

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

III.
Estimates of Economic and Social Costs in the Rural Sector Caused by El Niño in 1997-8

Total Foregone Earnings in Agriculture

Agriculture, roads and transportation experienced most of the damages caused by El Niño (Table 3). Even though not all effects were evident by June 1998, total expected net losses, valued in terms of foregone earnings are estimated at US$112.3 million (or 4.7% of agricultural GDP and 0.6% of total GDP).[4]

As indicated in Table 3, El Niño also has brought 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 in (on land) *shrimp farming*, where damage to the fishing pools was limited, while the warmer waters allowed for substantial productivity gains due to increased natural larva production. Shrimp production and exports rose by 26% between 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 wealthy large-scale shrimp farmers and exporters, while agricultural losses have fallen mainly on the poorer farmers and agricultural laborers.

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4 While substantial, these losses are considerably lower than those estimated in an ECLAC study (1998) conducted around the same time as this one. ECLAC 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 areas actually flooded and in the valuation methodology explain the large discrepancy. Our lower estimate is in part due to greater precision in identifying the areas actually flooded 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 by total production costs as was done in the ECLAC study. 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 the ECLAC study used mostly export prices. These methodological differences are detailed further in an extended version of this study (Vos, Velasco and De Labastida 1998: Annex 1).

Table 3
Estimation of the Overall Direct Cost of the Damages Caused by El Niño, 1997-8
(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).

As the data shows, some groups of farmers have suffered substantial agricultural income losses. The most heavily affected crops are rice, corn and sugarcane (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 experienced damages and production losses. Rice, corn and coffee are grown mainly in family-owned farms by small-scale producers 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. As will be shown in more detail below, this had an important impact on poverty rates in the affected regions.

Banana and sugarcane are mostly produced on large plantations in Ecuador's lowlands. The 1997-98 El Niño left some 12,000 workers temporarily out of work in these labor-intensive industries. Although the owners of banana plantations incurred production losses as a result, their losses were partly offset as export prices rose and the European Union raised its import quotas. Sugarcane growers and laborers were similarly affected. About 90% of all sugarcane is produced at three large industrial estates (*ingenios*) which operate with seasonal workers. As a result of El Niño, 53% of the cultivated area could not be harvested leading to job losses for workers. Estate owners did not fare as badly, however. The government gave them exclusive licenses to market and distribute imported sugar.

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

Table 4
Agricultural Losses by Main Crops, 1997-98
(values of costs in thousands of US$)

CROP	TOTAL CULTIVATED AREA Sep. 97 Ha	AFFECTED AREA Niño 97-98 Ha	%	VALUE ADDED OF LOST PRODUCE (factor prices) TOTAL $ x 10^3	Wages $ x 10^3	Surplus $ x 10^3	TOTAL VALUE OF LOST PRODUCTION $ x 10^3 At producer prices	Trade margin.	At market 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
Sugarcane	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 and De Labastida (1998), based on: MAG (DINAREN, DISPLASEDE, Direcciones Provinciales); Banco Central; INEC (SEAN); CLIRSEN; FAO; Cámaras de Agricultura; own field-work

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

El Niño has left the coastal road *infrastructure* in poor condition. However, it should be indicated that much of the road system was in 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 unusable for weeks or months. The main road system (some 2,500 km) has suffered severe damage only in specific areas. Our own assessment of the damages leads us to assume that only about 60 kilometers require complete rebuilding, while about 400 km are in need of partial repair. Ten bridges have fully collapsed and the cost of rebuilding them is over US$100 million. Fieldwork and interviews with transporters suggest that vehicles operated at higher variable costs and some shipments have had to be foregone. Yet, all (main) roads have remained accessible during the period of the disaster and prices were raised to make up for the increase in operating costs. Overall, the size of income losses actually incurred by the transport sector is not clear. As a result, the analysis of the poverty impact in rural areas does not consider these costs.

Costs borne by 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 residential dwellings, water supply and sanitation systems, hospitals and health centers, and schools (Vos, Velasco and De Labastida 1998: section 4.4). These costs were estimated at unit prices of rehabilitation to the State prior to El Niño. Some 14,000 homes, mostly those of the poorest, were fully or partially destroyed. The cost of rehabilitating these homes is estimated at about US$35 million. Probably more important than the damages to the health infrastructure are the increased health risks associated with poor sanitary conditions and ill-functioning health services. These increased health risks occur not just because of damaged social infrastructure, but in many regions because they are lacking. 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 the economy as a whole. Clearly, the natural disaster has come at a bad moment. The most serious attempts to date to stabilize Ecuador's economy in the mid-1990s (see Jácome, Larrea and Vos 1998) were already strained by the 1997 drop in oil prices, the country's main export product. Estimates for economic growth in 1998 show a drop during the first two quarters to 0.6% from 2% in the first half of 1997. Overall growth for 1998 was 2.2%, somewhat below the average of the 1990s (2.7%). Inflation reached an annual rate of 34% in July 1998, up from 30% for 1997.[5]

It is difficult to trace the impact of El Niño on real economic growth due to the presence of other external shocks. For instance, the fiscal deficit increased in the first half of 1998 due to a further drop in oil prices and a loosening of spending controls in the face of presidential and congressional elections held in May. This, rather than the drop in the supply of agricultural products, may well have caused the additional inflationary pressure. Central Bank data show that agricultural GDP fell by 1.3% in the first two quarters of 1998 compared to the first half of 1997. Output also fell in the oil and construction sectors. In contrast, growth in other sectors, such as transport and electricity, increased despite the El Niño, while the impact on other sectors seems to have been minor.

A major consequence of the 1982-3 El Niño was a steep rise in food prices. This did not occur in 1997-8. Food price inflation went up from 35% at the end of 1997 to 43% in July 1998 (annual rates); far from the dramatic increase observed in the previous decade when food prices nearly doubled. One should add though that timely increases in imports of basic food crops such as rice and sugar weakened the upward pressure on food prices. Further, there was no apparent major impact on the urban economy. Fully comparable data on urban employment were not available by June 1998. Yet two different labor force surveys undertaken in November 1997 and April 1998 indicate that *urban* unemployment did not increase in that period and may even have dropped slightly.[6]

In sum, the El Niño phenomenon caused substantial economic damages. The exact macro-economic impact seems to have been limited, by and large, to the agricultural sector. The analysis also suggests that the costs (and benefits) of El Niño appear unequally distributed. To the extent that there have been benefits, they mostly accrued to the more well off owners of large-scale shrimp farms and banana and sugarcane plantations. 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 crops for the domestic market. In the remainder of this section we will try to identify the location of the most affected farmers and

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

[6] 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 ECLAC study (ECLAC 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, in which housewives not actively seeking work were erroneously classified as unemployed. After correction of this error, the open employment rate in the major cities is about 9% in April 1998, somewhat below the rate observed in November 1997.

estimate the likely impact of the income losses on rural poverty.

The Impact of El Niño on Rural Employment and Poverty

Various analysts have documented a close relationship 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 credit and modern agricultural inputs, and also with lower agricultural income. Table 4 showed that, in absolute terms, the major agricultural income losses due to El Niño occurred in the production of rice (US$36 million), followed at some distance by corn (*maíz duro*) (US$19 million), bananas for export (US$19 million), sugarcane (US$13 million) and coffee (US$12 million). Most sugarcane and banana production for exports takes place at 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 in plots of less than 5 hectares. In livestock production, the poorer farmers are also the most affected as they lack the resources to move cattle to areas safe from floods.

There are no direct survey data to measure employment losses 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 then apply the derived parameters to the affected cultivated areas. The results are shown in Table 5. Clearly, the data refer to direct employment losses in agriculture due to the reduced area that was 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 the rural areas of the Costa. About half of the affected workers are wage earners (mostly contract workers in sugarcane and banana plantations), one-third are temporary workers (mostly in rice production) and the remainder are paid family workers. Applying mean daily wage rates by area and crop, we estimate that the total foregone earnings of 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 for 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 lack of resources in recent years (such as the SEAN). It may be difficult to confirm the estimates of Table 5 through direct observation, and therefore one has to rely on indirect measurement methods as the one used here.

Table 5
Employment Losses and Related Foregone Earnings in Agriculture

CROP	AFFECTED AREA Has	LOSS OF DIRECT EMPLOYMENT		FOREGONE WAGE EARNINGS[1] US$ million
		Affected workers	Increase in un-employment (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
Sugarcane	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: The 1995 *Encuesta de Condiciones de Vida* (LSMS) as well as projection of per capita consumption and poverty data at the level of cantons produced for the Poverty Map for Ecuador (see Larrea and others, 1996).[7]

- *Poverty* indices: Derived using consumption levels and a poverty line of US$61 per person, per month as established by the World Bank poverty study (1996).

- *Consumption* data for 1995: 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.

- *Poverty-growth* elasticity for the rural population: Assumed to be –1 (see Jácome, Larrea and Vos 1998, for a justification).

- *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 trading is mostly controlled by the same large landowners or by wealthy trading firms. Moreover, most of the landowners in export banana and sugarcane production typically do not reside in rural areas.

[7] 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 socioeconomic characteristics, as derived from the population census into the estimated regression functions.

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, agricultural income losses due to El Niño may have led to a rise in the incidence of poverty of about 11 percentage points. This implies that the living standard of an additional 120,000 residents fell below the subsistence level.

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

Another severely affected area is the countryside in the Guayas province where it is estimated that the rural population lost about 14% of the resources available to satisfy basic human needs. The number of people living below the poverty line likely increased by 10% (21,500 persons). In Guayas, self-employed farmers and workers in the production of rice, as well as wage earners in sugarcane were the most affected. The third most affected province was Manabí where rural poverty is estimated to have increased by 35,000 people (8%). In Manabí, the most affected group was small producers of coffee and corn.

Using more detailed information at the canton level and combining it with the information on the expected poverty impact and the cultivated areas most vulnerable 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.[8] Clearly, the cantons with the higher incidence of poverty depend on the production of the most affected crops i.e. rice and corn, and to a somewhat lesser degree, coffee and cocoa production. In all of the most vulnerable regions, the family-based farm 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 socioeconomic 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 did not differentiate their affected zones by the degree of agricultural vulnerability. The above analysis allows one to do so, thereby providing a tool for targeting possible interventions to compensate for income losses and/or for targeting preventive action to reduce vulnerability to future weather shocks. We turn to the policy implications in Section 5.

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

Table 8
Typology of Affected Provinces in the Costa

TYPES / PROVINCES	1 Priority action: affected persons and sanitation infrastructure	2 Priority action: preventive health care	3 Priority action: 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.

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

IV.
Impact of El Niño on Health Risks: Natural Disaster or Failed 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 as well as other infectious diseases. Damages to drinking water and sanitation systems increase the risk of contracting diarrhea, dengue fever and cholera. The agricultural income losses leading to increased rural poverty, in turn, result in increased malnutrition, which is an important cause of high infant mortality rates.

The experience with the 1982-3 El Niño confirmed the association of these factors. This is compounded by the fact that important parts of the affected areas suffer from great deficiencies in sanitary infrastructure 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 (as of June 1998) to study the changes in the epidemiological profile and infant mortality rates resulting from the 1997-8 El Niño. Instead, the methodology applied is that 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 areas vulnerable to health risks and the 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 involving rehabilitation and preventive action for new occurrences may well be served by this methodology.

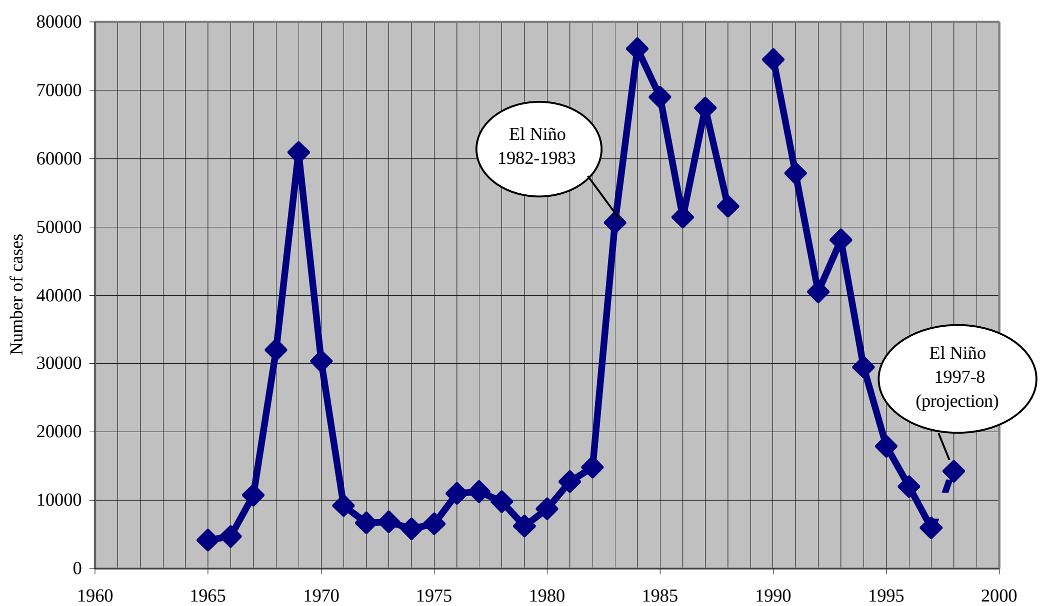
Past experience and existing evidence indicates that:

- 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 the 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 were reported, representing a significant increase in the preceding year. Also 'new' diseases[9] such as leptospirosis, cholera and dengue have spread. The highest concentration of these diseases was 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 births in the affected provinces increased from 52 per thousand live before the disaster to 65 per thousand afterward (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 helped reduce infant mortality.

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

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 the implementation of a number of preventive measures. These included an intensification of the vaccination program in the potentially affected areas and the application of insecticides to combat malaria. It is probable that these measures helped to mitigate some of the potential impact of El Niño. It remains yet to be seen to what extent infant mortality has been affected by these measures. Nevertheless, the general impression is that preventive action fell short because resources were limited and no instruments to target actions to the more vulnerable population groups were in place (Velasco et al. 1998). Furthermore, over time too little was done to improve other critical conditions to prevent the spread of infectious diseases and premature child deaths, including adequate sanitary conditions, poverty reduction and reducing malnutrition.

To identify the population most vulnerable to increased health risks, we construct a composite *Index of Social and Sanitary Conditions* (ICSS). The ICSS was 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.[10]

[10] Principal component analysis is a method to measure different components of a variable (if they are of different dimensions) by giving weights to the different components according to their contribution to the "principal component." In order to do this, the analyst has to choose a set of indicators which are considered to be determinants of – in this case – health conditions, but which because of their interdependence are not suitable for OLS regression. The first component represents the dimension of maximum 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

On the basis of this analysis, the ICSS was composed of four variables: access to safe drinking water; access to sewerage systems; functional illiteracy among the adult population; and the degree of overcrowding in housing. The index has a range of 0 to 100. The higher the index, the better the social and sanitary conditions are 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 mortality and the prevalence of infectious diseases during the 1982-83 El Niño (see Velasco et al. 1998). We then applied the instrument to the 1990 population census data, the most recent data set to repeat the analysis at the level of cantons, in order to obtain the closest possible identification of health vulnerability to El Niño of 1997-8. Table A.2 provides 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 provide a first indication of vulnerability. The (geographical) targeting of health interventions may start with a ranking of municipalities by their score on the index. To decide on priority policy actions clearly would require a more complete health sector analysis of 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 the availability of health services. The factor analysis also considers a number of known facts about the consequences of El Niño of 1997-8, including:[11]

- Direct effects on the population, distinguishing: (i) the increase in disease prevalence (cholera, dengue fever and malaria); (ii) the number of deaths, as well as the wounded and evacuated population; (iii) the children that could not attend 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): (i) number of health units that suffered damages and (ii) health units requiring additional investment in equipment, medication and personnel.

- Damages to road infrastructure: (i) damages to main roads (in kilometers) and (ii) number of bridges that have collapsed due to El Niño.

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

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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 subsets 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 because we begin from a subset of indicators that we believe a priori determine health conditions simultaneously.

[11] 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).

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 provincial level we arrive at 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 sanitation infrastructure (health centers, sewerage and drinking water systems) and roads and bridges.

- *Type 2*: *Impact on Persons.* Priority action is to mitigate the risk of infectious diseases via vaccination programs and other preventive health care.

- *Type 3: Impact on Infrastructure.* Areas that require priority action to rehabilitate sanitary infrastructure and roads.

To target 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. This methodology leads to four types of cantons (see Tables 9 and A.3):

- *Type A: Low Vulnerability and Low Impact.* These cantons show relatively good socioeconomic conditions and access to health services. Moreover, the measured impact of El Niño has been small, requiring low priority in policy action. Example: Marcelino Maridueña in the province of Guayas.

- *Type B*: *Moderate Vulnerability, but Relatively Strong Impact from El Niño* (in terms of damaged housing, size of evacuated population, and increased prevalence of infectious diseases). Temporary support to reestablish homes, etc. in these cantons may be a relatively high priority, but investments in sanitary infrastructure may be a lower priority. 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 socioeconomic conditions in general. Example: Chone in Manabí.

- *Type D*: *High Vulnerability and Strong Impact from El Niño.* These are the poorest areas that also suffered the heaviest impact from 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.

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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.

Table 9
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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).

Priority action are interpreted in two ways: First, short run emergency assistance to mitigate El Niño's impact through health assistance and repairs to infrastructure; and second, medium run actions should have improved the coverage and quality of preventive and curative health infrastructure to help reduce the vulnerability of health risks and provide better protection against El Niño in the future and improve health conditions in general. Analysis leads us to conclude that:

- Esmeraldas and Manabí are the most affected provinces. Measures are needed to improve the sanitation infrastructure, repair health centers, and rehabilitate 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 evacuees. While emergency assistance and 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 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 Type 1 interventions should be emphasized there.

- Social and sanitary conditions in El Oro are relatively better, but there was some increase in malaria, dengue, and cholera in 1998. In this case, priority should be given to preventive health care (Type 2). However, in some cantons a broader range of interventions (Type 1) is needed (such as in Guabo; see Table A.2).

The Ministry of Public Health established a contingency action plan in anticipation of the 1997-98 El Niño and authorized a budget for it from unused project funds (to a total of US$8 million). However, preventive health policies prior and during El Niño of 1998 were not targeted as described above. Most of the budget could be used (88% by May 1998) on the repair of damaged health centers and sanitation systems, as well as for the purchase and distribution of medicines in the affected areas, for health education campaigns, and to combat the outbreak of malaria. As indicated, prior to the contingency plan the Ministry had already launched an immunization campaign for 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 to combat malaria proved insufficient, however (Velasco et al. 1998). By the end of El Niño, the Ministry had shifted emphasis to the rehabilitation of damaged drinking water systems as a preventive measure to contain parasitic diseases.

Despite these efforts, they were generally in reaction to the threats posed by El Niño and might have been more effective if more had been learned from the experience of 1982-3. Preventive measures, such as investment in flood-resistant sanitation systems and ongoing vaccination campaigns in the vulnerable areas were not implemented beyond some isolated cases. One such exception is Babahoyo in Los Ríos where an improved sanitation system and related infrastructure were built with external funding following the El Niño of 1982-83. The project took seven years to complete and cost US$300 per beneficiary. The result was no more flooding during the normal rainy seasons, nor during the El Niño event of 1997-8. The prevalence of infectious diseases also declined markedly. However, there few other positive examples of this sort to build on. In preparing for future episodes of El Niño, the Ministry of Public Health could greatly improve its response if it uses a systematic methodology of vulnerability to health risks which could serve as a tool for an early warning system, and also as a way to set priorities for preventive and curative action.

V.
Action for Emergency Relief and Reconstruction

The 1997-8 El Niño disaster did not take the authorities by surprise. The Ecuadorian authorities declared a state of emergency on July 2, 1997 and formulated a contingency plan prior to the event. In November 1997, when El Niño first began to be felt, a total budget of US$333 million had been put together for emergency relief, preventive action, and humanitarian aid (Table 10). The World Bank, the IDB, and the 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 unit (COPEFEN) was created to implement the contingency plan and coordinate prevention, emergency relief, and repairs to be undertaken by a wide range of public entities.

Despite these preparations, a main conclusion of this study is that the authorities could have taken specific preventative steps to mitigate the impact of the disaster, especially for the more vulnerable groups of the population. This is apparent from the following:

- The *Defensa Civil* was prepared to provide emergency humanitarian aid, but was unable 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 was initially not as effective

Table 10
Available Financing for Emergency Aid and Rehabilitation
(August 1998)
(Millions of US$)

	Total amount
Government Resources	***67.2***
Funds reserved by central government (569 rehabilitation projects)	41.0
Emergency military assistance	5.2
Counterpart funds for foreign loans	21.0
International Humanitarian Aid	***35.8***
Humanitarian aid of governments and government agencies	23.4
Humanitarian aid of NGOs 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	34.2
loans)	70.8
Inter-American Development Bank (new loans)	25.0
Corporación Andina de Fomento (CAF)	5.0
United States (PL 480 for reactivation of agriculture)	
Total	**318.0**

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

as it should have been. 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 accounting (COPEFEN 1998: 3).

- It was not until April 1998 that COPEFEN managed to improve its operative capacity and was placed under the political responsibility of the Vice-President of the Republic. The World Bank and the IDB conditioned their funding on the establishment of a Technical Committee with representatives of provincial authorities and a committee with broader participation from civil society. In August 1998, COPEFEN reported that the inputs of the Provincial Technical Committee have been of little to plan activities and allocate resources, while the civil society committee was never formed (COPEFEN 1998: 8).

- The Contingency Plan identified 105 contons that would be potentially affected with a total population of 6.5 million, which represents more than half of the Ecuadorian population (see Table 2). These cantons were classified by climatic risk (Table 1), but this classification was not appropriate for targeting prevention and rehabilitation measures. The authorities did not have the methodologies as proposed here to distinguish between types of risk and vulnerability of different areas and population groups that could target action to prevention and post-disaster support in health, improvement of sanitary infrastructure, and coverage of agricultural production losses.

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

VI.

Conclusions and Policy Recommendations

El Niño of 1997-98 has caused substantial damage in Ecuador and took the lives of at least 286 persons. The most affected population groups were the poorer self-employed farmers and agricultural workers who suffered production and employment losses. We estimate that 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 are the most important danger presented by El Niño. Contagious diseases such as malaria, cholera, and dengue increased. No information was available to measure direct health impacts in 1998, but based on risk factors we estimate that some 2.5 million Ecuadorians in the coastal regions are most vulnerable to diseases and worsening health conditions caused by El Niño.

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

How can one respond to natural disasters like El Niño? What objectives should 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, as well as health interventions to prevent outbreaks of epidemics. After the event, what can and should be done to compensate those who suffered most and what type of preventive action should be taken? Despite the uncertainty surrounding when and where El Niño will strike and how much damage it will cause, it remains a recurring event.

How can one compensate for losses and what type of preventive action can be used? These policy questions refer 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 to be achieved. Finally, given the recurring nature of El Niño, the question of insurance schemes to protect families and workers in the future is also relevant.

Insurance and financial markets in Ecuador are underdeveloped and imperfect. Only a fraction of the population has auto or home insurance policies, while income risk insurance is nonexistent. In addition, the risks of natural disasters are difficult to insure as experience with insurance for damages resulting from hurricanes in the Caribbean and U.S. states like Florida proves. Moreover, the U.S. experience shows that even when some kind of insurance exists, the pressure on governments to declare a state of emergency is heavy and insurance companies are able pass costs on to taxpayers. In sum, it is difficult to visualize a private insurance scheme which would provide protection to the rural poor in Ecuador's vulnerable coastal areas.

The more pressing strategic policy question is whether to concentrate on disaster relief (beyond emergency assistance) or development investment. How much should be spent on repair and rehabilitation (of roads, houses and agricultural lands) to restore disaster areas to their state prior to the disaster? Should the focus be on reconstruction investment to reduce the vulnerability to natural disasters and enhance development in general? In the latter case, relocation of residents out of vulnerable areas and shifts in economic activities to less vulnerable options should be considered. Time and cost enter into consideration in this case because development investment takes time and resources may be limited to meet structural needs in all affected areas.

The policy approach suggested here considers compensatory relief and developmental investment, but emphasizes the latter. The policy recommendations fall in three main areas: targeting and monitoring instruments, agriculture and rural development, and health.[12]

Targeting and Monitoring Instuments

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

Agriculture and Rural Development in the Affected Areas

A possible first option is the implementation of an income transfer program to compensate poor farmers and agricultural workers for production and employment losses. However, this raises two questions: What should be the size of the transfer? And, is this still an optimal policy *after* the event? To start with the first question, if compensated for the foregone earnings as estimated in this study, a perfectly targeted transfer scheme would require total funding of US$130 million. However, as shown, over 70% of the population in the affected areas was poor prior to the El Niño and would remain poor after the transfer. *During* the event, as a means of immediate assistance, it could have made sense to target food aid or direct income transfers to the most vulnerable population using the methodology proposed in Section 3. This could be considered for a future event and is not a meaningful choice long after El Niño.[13] If, however, this option is implemented, it should typically be of a short-term nature and last until agricultural production and rural employment have returned to normal levels. In the current situation, available resources might be better used for targeted interventions to assist the affected rural population through increased income earning opportunities and improved infrastructure. One option could be a self-targeted employment program.

After the event it seems to make sense to focus in the *short run* on the reactivation of agricultural production for the following four reasons. First, most agricultural production in the vulnerable areas is viable, albeit in need of improvements in productivity and rural infrastructure. Second, the relocation of some farmers to less vulnerable areas seems necessary in a few specific areas (in particular, in the delta of the Guayas River), but is not a viable option 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 restore 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 as repair work on damaged rural infrastructure (rural roads, bridges, irrigation systems) gets underway.

Medium-term measures should also focus on improving rural infrastructure and credit for small-scale farmers. Improvements to rural infrastructure would involve continuing and finalizing investment projects to improve water control and irrigation in the areas vulnerable to flooding, in particular the delta of the Guayas River. Many such projects were begun in the early 1980s, but

[12] See Vos, Velasco and De Labastida (1998) for additional details.

[13] The Ecuadorian government permitted increases in 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 the incomes of the urban population, but was untargeted and hence did little to assist the affected rural poor.

were subsequently 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 aim at improving agricultural productivity and employment opportunities, and include technical assistance to promote a greater diversification of production to crops with a short cycle and higher profitability (such as soya, mango and others). Improvements are also needed to distribution networks, storage systems and packaging. All these measures can 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 distribution of land (World Bank 1996 and Jácome, Larrea and Vos 1998). Thus, if the policy objective is to simultaneously reduce the vulnerability to weather shocks and raise overall living conditions in the rural areas of 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.[14] 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 investments in sanitary infrastructure. With reference to a successful project in Babahoyo, the unit cost of such a durable solution could be in the order of a magnitude of US$300 per beneficiary. A rough estimate 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 to the entire population, but the indications are that this could be in the range of feasible policy solutions. These investments in sanitary infrastructure should be supplemented by a permanent campaign of immunizations aiming at 100% coverage.

The findings and policy recommendations in this study depend, to a considerable extent, on an analysis of the probability of an El Niño impact through the study of risk factors and the identification of vulnerable areas and population groups. Ecuador needs more adequate and timely monitoring systems to capture the actual impact on incomes and health status during and shortly after the main effects of the disaster have disappeared. A complete evaluation of the full impact of the disaster has yet to be made. It is important that this evaluation be done. The main study of the effects of the 1982-83 El Niño of 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 undertaken and the country probably will again be ill-prepared for the next El Niño if this study is not taken this time around.

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

[14] The Ministry of Health did start a promising and novel anti-malaria campaign in the post-El Niño period. Once re-emerged, 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.

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 Agri-cultural zones	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, Agri-cultural 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	Samborondón	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, Agri-cultural worker
LOS RIOS	Babahoyo	74.7%	56,372	42,104	33	Rice, Corn (70%), Sugar cane (10%)	Farmer-owner, Agri-cultural 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, Agri-cultural worker
GUAYAS	Alfredo Baquerizo	72.2%	11,883	8,576	33	Rice, Corn (70%), Sugar cane (10%)	Farmer-owner, Agri-cultural 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, Agri-cultural worker
GUAYAS	Santa Lucía	66.3%	24,071	15,966	6	Rice (65%), Livestock (22%)	Farmer-owner, Agri-cultural 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
GUAYAS	Naranjal	61.6%	27,143	16,724	1 y 5	Rice, Banana	Farmer-owner, Agri-cultural 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

Province	Canton	Poverty before El Niño	Total rural population	Poor rural population	No. of Agri-cultural zones	Main crops (by share of cultivated area)	Main affected socio-economic group
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 - 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 over-crowded housing (%)	Prevalence of chronic malnu-trition (%)	Popula-tion1990	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
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

Province	Canton	Ranking by ICSS	ICSS	Functional illiteracy rate (%)	Population with access to drinking water (%)	Population with access to sewerage (%)	Population not affected by over-crowded housing (%)	Prevalence of chronic malnu-trition (%)	Popula-tion1990	Population 1997
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
	Santa Elena	99,206	63.1%	26.7%	16.6	1	0	0.2%	864	1620	0.2%	6.0%	513	B

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 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
	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

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)
	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
	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	10,000	78.1%	25.9%	69.0	0	0	0.9%	0	0	0.0%	0.0%	0	B

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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.

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