II. DAMAGE ASSESSMENT

1. Introduction

Estimates of the damage caused by the eruption were arrived at on the basis of incomplete information, since they were prepared when national and local authorities were still busy dealing with the most pressing aspects of the emergency phase. It was decided, however, that some degree of accuracy would have to be sacrificed in view of the urgent need to provide some kind of guideline for the rehabilitation and reconstruction effort and for any international cooperation that might be required.

The information which was made available by authorized national and local authorities and by reliable trade and professional associations sources was of a preliminary nature. This information was then verified, supplemented and adjusted on the basis of direct observations in the field made by members of the mission's group of experts.

These data were processed using a special methodology designed by ECLAC on the basis of its experience with many similar assignments.[9] Direct damage to capital stock and inventories was calculated using the replacement cost of assets that were completely destroyed and the costs of repairing those which were damaged. An assessment was also made of indirect damage (e.g., the reduced output of some farmland as a result of direct damage, the increased expenditure that will be necessary in order to return the affected zone to normal, and the lower income that will be earned for the provision of certain types of services).

The damage estimates were calculated in the local currency at April 1992 prices and then converted into dollars based on an exchange rate of 5 córdobas to the dollar. Damage to import and export products were calculated directly in dollars based on those products' international prices.

Despite the above-mentioned limitations, it is felt that the results of this assessment provide an indication of the order of magnitude of the damage and can be used to define the areas or sectors which will require priority attention and international cooperation for their rehabilitation and reconstruction.

2. Affected population groups

The type of natural phenomenon which caused this disaster, as well as the action taken to cope with the emergency, made it possible to lessen its impact on the population's living conditions. In fact, there were

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[9] See ECLAC, Manual para la estimación..., op. cit.

only two deaths and only 46 inhabitants of the affected zone sought medical attention for injuries of various sorts (another 100 people were injured in the course of clean-up work in urban areas, however).

On the other hand, a total of 12,000 people had to be evacuated to the emergency relief camps, and it is estimated that a total of around 150,000 people were affected to varying degrees by the eruption. The severity of the disaster's impact on these people differed according to their location within the disaster zone and their ability to recover their lost production and income levels.

Virtually all the people who had to be evacuated were from very low-income groups and/or living in extreme poverty, as mentioned in the preceding chapter. The remainder of the affected population, who sustained less severe losses, is made up of people with higher incomes who are engaged in intensive farming activities (staple grains, cotton, sugar cane) or in commercial activities in the zone's urban centres.

The hardest hit areas —where the layer of volcanic matter is greater than 10 centimetres in depth— are home to about 6,000 people, most of whom live in extreme poverty. These people are engaged in very low-productivity, subsistence-level farming, wood-cutting or stock-raising activities within an ecosystem damaged by the environmentally harmful practices which these people have found it necessary to employ in order to survive.

Most of these people have very low incomes and are engaged in the production of sorghum, sesame, yucca, sugar cane and fruit. Owing to the poor quality of the soil and the rudimentary farming techniques that they use, their output is far below the average productivity levels of the rest of the country and their harvests are not even large enough to fulfil their own food needs. Very few of these farmers manage to produce a surplus of staple grains for sale on the market, and consequently very few have access to the type of cash income obtained by owners of small plots of land in other parts of the country. Thus, in order to earn a cash income they find it necessary to hire themselves out to farms that produce export crops, such as cotton and sugar cane.

The drop in the international prices of Nicaragua's export products, in combination with a number of domestic factors, has led to a decrease in the amount of land devoted to cotton production, thereby reducing the employment opportunities for the inhabitants of this zone even further. This situation has prompted them to increase their wood-cutting and hunting activities in order to earn enough to buy food. The impact of these activities on the environment is very harmful and, even so, they do not provide these people with a way out of their extreme poverty.

The eruption of the Cerro Negro volcano has exacerbated the situation in this zone so much that a large number of its inhabitants will no longer be able to survive —even at their present subsistence level— unless they modify their traditional activities, since land use will have to be shifted over to a different type of production (primarily forestry). This subject will be discussed further in chapter III.

Hence, the livelihoods of most of the inhabitants of the affected zone have been at least temporarily impaired by the suspension or reduction of their production activities. During the emergency phase of the disaster, the already extremely low incomes of the zone's woodcutters (about 250 córdobas per month) fell to virtually nothing and, for those woodcutters who live in areas where the trees were covered with thick layers of volcanic ash, will remain very low for the rest of the year. In addition, the vast majority of these people lost the meagre food stocks they had been able to set aside from previous harvests before the disaster. Consequently, they are now obliged to subsist on the emergency aid provided

by the authorities and the scant food reserves that were not damaged by the eruption. There is thus no question whatsoever about the fact that these people's very lives are in serious jeopardy and that a means of resolving their situation will have to be found very soon.

On the basis of the isolines shown in map 2, which indicate the depth of the layer of volcanic ash and sand, and information regarding the location of dwellings in the affected zone, it has been determined that a total of 270 households (or approximately 1,600 persons) will have to be relocated because they otherwise will not be able to produce the food they need, will exert excessive pressure on the area's scarce forestry resources, and will run the risk of falling victim to disease as a result of the unsanitary conditions prevailing in the area. There is also another group —of around 370 households, or approximately 2,200 people— who, although they could continue to live in the zone, will not be able to carry out production activities that would provide them with a livelihood.

3. Social sectors

a) Housing

Damage to housing and to the infrastructure of other social sectors resulted mainly from the additional weight placed on buildings by the accumulation of sand and ash on rooftops. Very few houses were completely destroyed, despite the fact that in some places they were covered with over 20 centimetres of volcanic material. Where complete destruction did occur, it was mainly attributable to the precariousness or deterioration of existing structures, both urban and rural. In other cases, damage took the form of material accumulated around houses, which hampered their normal use and created a risk of flooding in the event of rain.

In assessing the damage to rural housing, it was assumed that some 100 houses would be abandoned by families unable to return to their place of origin because of problems with the land, as will be seen subsequently; in such cases, the damage suffered was considered to correspond to the value of a house comparable to the one abandoned. It is also estimated that 550 additional houses suffered moderate damage, related mainly to the total or partial destruction of the roof and to the removal of material accumulated in and around the house.

In urban areas, most of the housing affected was located in the cities of León and Telica, though minimal damage was also reported in such cities as Quezalguaque and Corinto. A group of precariously built houses on the outskirts of León suffered similar damage. The structural damage to these houses was minimal, since the layer of sand and ash was not very thick. It is estimated that a total of 15 houses suffered some degree of damage, while a total of 21,735 houses required cleaning of their roofs and replacement of roofing material destroyed in this operation.

The assessment of the disaster's indirect effects on the housing sector is based on the assumption that 100 houses must be relocated because their rehabilitation in the same area would not ensure adequate living conditions and would leave them vulnerable to future volcanic eruptions. Thus, the cost of building 100 new houses, in a location yet to be determined, has been recorded as an indirect effect.

It has been estimated that the direct cost of cleaning the roofs of 21,735 urban and 2,000 rural houses and of repairing 15 urban and 550 rural houses amounts to some 9,092,500 córdobas. The indirect

cost of rebuilding the 100 units in the rural sector for families unable to return to their former homes is estimated at 3,300,000 córdobas. Therefore, the total amount of damage for the housing sector amounts to about 12,392,500 córdobas (see table 1).

b) Education

School infrastructure suffered damage as a result of accumulated sand and ash on rooftops. The roofs collapsed because they had not been designed to withstand the added weight or because building standards had not been met in their construction.

In the city of León, three old school buildings were affected because the structures supporting the roofs were in an advanced state of deterioration. In rural areas, nearly 29 classrooms in seven school buildings were damaged to some degree; almost all of them were located in an area covered by a deposit of over 15 centimetres of volcanic material.

In some schools, furnishings were damaged because there was no time to remove them. As in the case of houses, it was necessary to clean the roofs of school buildings.

Some damage occurred in school buildings that were used as temporary shelters for disaster victims; for this reason, classes were suspended for more than two weeks. Lastly, since part of the rural population will have to be relocated to areas outside the zone most severely affected, three new rural schools will have to be built.

Estimates indicate that the direct cost of repairing three urban schools and seven rural schools, replacing their furnishings and cleaning the roofs of other schools amounts to 1,232,700 córdobas. The indirect cost of relocating three schools to an area outside the most severely affected rural zone and of minor damage in schools used as shelters amounts to another 789,900 córdobas. Thus, the total cost for the education sector amounts to 2,022,600 córdobas (see table 1).

c) Health

Upon receiving news of the eruption, the Government proceeded to evacuate the inhabitants of areas near the volcano and to lodge them in temporary shelters in adjoining areas. The number of people evacuated to refugee camps varied over time, ranging from about 12,000 in the first few days to 8,950 around 20 April 1992.

The most common illnesses in refugee camps have been respiratory, diarrheal and skin diseases. Although most of the refugees have now returned to their original places of residence, the return of some refugee families to areas considered inappropriate for living urgently requires that technical and political decisions be taken on the uses to be made of the affected area and on the final destination of populations that will have to be resettled.

The sector's infrastructure suffered minor damage caused by the accumulation of volcanic material on rooftops; some of the medical equipment installed in such buildings was also affected. Specifically, seven medical stations and health centres and three hospitals were damaged.

Table 1

NICARAGUA: DAMAGE AND LOSSES IN THE SOCIAL SECTORS

(Thousands of córdobas)

Sector and subsector	Estimated damage and losses			
	Total	Direct	Indirect	Imported component
Total	16,255.4	10,924.5	5,330.9	1,281.6
Housing sector	12,392.5	9,092.5	3,300.0	879.1
Urban areas:				
-roof cleaning	2,173.5	2,173.5	-	
-house repair	450.0	450.0	-	
Rural areas:				
-roof cleaning	969.0	969.0	-	
-house repair	5,500.0	5,500.0	-	
-house rebuilding	3,300.0	-	3,300.0	
Education sector	2,022.6	1,232.7	789.9	30.0
Urban areas:				
-school repair	390.0	390.0	-	
-furniture replacement	19.5	19.5	-	
-roof cleaning	178.9	178.9	-	
-other damage	170.9	-	170.9	
Rural areas:				
-school repair	592.6	592.6	-	
-furniture replacement	29.6	29.6	-	
-school relocation	600.0	-	600.0	
-roof cleaning	22.1	22.1	-	
-other damage	19.0	-	19.0	
Health sector	1,840.3	599.3	1,241.0	372.5
Urban areas:				
-infrastructure repair	491.3	491.3	-	
Rural areas:				
-infrastructure repair	108.0	108.0	-	
-new health centre	150.0	-	150.0	
Emergency care	1,091.0	-	1,091.0	

Source: ECLAC, on the basis of official information and in-house estimates.

Moreover, a number of additional expenses were incurred to treat illnesses caused by the disaster and to provide first aid to populations located in refugee camps. The sector also launched immunization programmes and educational programmes on training and sanitation for refugees.[10]

In addition, it will be necessary to build and equip a medical station to care for the families to be settled in new areas.

It is estimated that the direct cost of repairing the sector's infrastructure and equipment will amount to 599,300 córdobas. In addition, the indirect cost of building and equipping a new medical station and of providing medical care during the emergency will amount to some 1,241,000 córdobas. Thus, total damage to the health sector will amount to about 1,840,300 córdobas (see table 1).

4. Productive sectors

a) Agriculture and livestock

Undoubtedly, the damage to the agricultural sector caused by the eruption was of greatest significance, in that it not only adversely affected the land that sustained agricultural and livestock production, but also destroyed some crops which had not been harvested and damaged some permanent plantations.

Although there were varying degrees of damage depending on geographical location and proximity to the volcano, the traditional utilization of soils will have to change significantly over a relatively large area. In any event, the main effect of this has been to diminish the income and prospects of the zone's inhabitants.

In this regard, it should be stressed that producers using land in the lower parts of the zone apply higher-output technologies and earn considerable incomes. However, those in the upland areas are unable to meet their most basic needs.

i) Soils affected. Field studies carried out after the eruption have shown that a total of about 23,800 hectares (34,000 manzanas) were covered by layers of sand and ash of varying thickness. The distribution of these areas in relation to the thickness of the layer of material deposited by the eruption is as follows:

Thickness of material deposited (cm)	Area covered (hectares)	Percentage of total %
Less than 10	16,200	68
10 to 19	4,500	19
20 to 44	2,400	10
Over 45	700	3
	23,800	100

[10] See the report of the Pan American Health Organization entitled Sector Salud, Managua, 25 April 1992.

In reality, it cannot be said that any soils have been lost as a direct or indirect result of the eruption. What has actually happened is that, on the one hand, the soils that were covered by a layer of sand and ash less than 10 centimetres thick will require prompt motorized, deep ploughing to effectively incorporate the ash before the next farming season, which may even result in the production of slightly higher unit outputs in the relatively near future. On the other hand, although the soils that were covered by a thicker layer of volcanic material (an area of nearly 2,100 hectares) have not been rendered totally useless, the inhabitants of the zone will have to use them in a manner different from that applied before the disaster.

The direct cost or damage resulting from the need to use machinery to rehabilitate the soils covered by less than 10 centimetres of sand and ash, over an area of 13,500 hectares,[11] has been estimated at 2,350,000 córdobas, 1,330,000 of which represents foreign currency needed to finance the cost of fuel and lubricants and depreciation of machinery.

Indirect damage to land covered by 15 or more centimetres of sand and ash, which are now to be used for extensive forest production that would not allow the inhabitants of the area to maintain a level of income with which they could remain above the level of extreme poverty for a relatively long period, has been calculated as the cost of providing such persons with land in safe areas outside the zone so that they can plant basic grains and other commodities.

In this regard, it should be borne in mind that it has been found necessary to provide land suitable for intensive agricultural purposes (annual crops) for a total of 640 families.

Of these, 270 will have to relocate to other areas because of their vulnerability to the impact of future eruptions and their inability to plant basic grains in the future. Some 100 of these are now located on land with a layer of sand and ash over 45 centimetres thick, and 170 on land with a layer between 15 and 45 centimetres thick.

The inhabitants of areas with over 45 centimetres of volcanic material will only be able to live by hunting or cutting firewood, which would cause further environmental degradation and would not provide income for them to acquire food. Job possibilities for these people are minimal because of insufficient demand for labour in the area. The inhabitants of areas with deposits between 15 and 45 centimetres thick will have to work in the forestry sector (by cutting firewood) and, to a limited degree, in the agricultural sector by growing such products as cassava, sugar cane and fodder. In any event, they will not be able to earn sufficient income to escape from their current situation of extreme poverty, which will, rather, become more acute because of their inability to produce the basic grains they need in view of the current condition of the land.[12]

The cost of such indirect damage has been estimated as the cost of providing land suitable for production of annual crops, near the area affected by the disaster, for the aforementioned 640 families.

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[11] Note that this figure refers exclusively to agricultural land, and does not include land used for other purposes.

[12] The foregoing assertions are based on the fact that the loose sand and ash have little water-retention capacity or fertility, and a high degree of heat emission. In addition, they do not provide a favourable environment for the germination of seeds, either because the roots cannot reach the underlying soil or because the plant cannot sprout above the surface.

This includes the provision of housing and basic infrastructure for only 270 families, since the rest will continue to reside in their place of origin. The cost is expected to amount to some 10,000,000 córdobas[13] (see table 2).

ii) Agricultural production. With the above-mentioned exceptions (sugar cane and bananas), most annual or seasonal crops in the affected area had already been collected before the eruption, as had most of the production of permanent plantations. Therefore, production losses in the area have been minimal from a national perspective; however, as noted previously, some small-scale producers in the area lost not only their current crop but also their sole means of subsistence for the short- and medium-term future.

To illustrate the type of production carried out in the affected zone, the land area used for each crop in the 1991-1992 growing season which was heavily covered with various thicknesses of sand and ash is indicated below:

Crop	Land area (in hectares)
Cotton	385
Sesame	709
Sugar cane	291
Corn	140
Beans	2
Sorghum	207
Cassava	723
Fruits	180
Fodder	1,243

The rest of the above-mentioned total land area was either used for brushwood and forests or was not used for agricultural purposes.

Recorded as a direct loss was the total value of the fruits and fodder that were to be harvested in the coming months and of nearly 35% of the sugar-cane crop. In both cases, the deposit of sand and ash either totally destroyed or reduced the crops that were ready for harvesting, valued at 1,490,000 córdobas.

In the zones least affected by sand and ash, production losses in banana and sugar cane crops amounted to an estimated 22 million córdobas. In the case of bananas, losses were estimated at 20 million córdobas, since the sand perforated the bags that protected the tree roots and damaged the fruit embryos. The cane sugar covered with sand could not be processed because it would have damaged the mills, so that some 50,000 quintals of sugar cane, valued at 2 million córdobas, remained unprocessed.

In total, direct damage amounted to 23.5 million córdobas.

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[13] The total cost of the resettlement programme will rise with the addition of the cost of housing and other infrastructure and basic services, in an overall development plan for this population group. However, this paragraph only considers the cost of the land.

Table 2

NICARAGUA: DAMAGE AND LOSSES IN THE AGRICULTURAL SECTOR

(Thousands of córdobas)

Sector and subsector	Damage			
	Total	Direct	Indirect	Imported component
Total	44,985	29,455	15,530	
Soils	12,350	2,350	10,000	1,326
With less than 20 cm of sand and ash	2,350	2,350	-	1,326
With 20 to 45 cm of sand and ash	6,000	-	6,000	
With over 45 cm of sand and ash	4,000	-	4,000	
Production	28,885	23,485	5,400	2,089
Cotton	2,493	-	2,493	996[a]
Sesame	2,187	-	2,187	1,093[a]
Bananas	20,000	20,000		
Sugar cane	2,278	2,278	-	
Maize	300	-	300	
Sorghum	420	-	420	
Fruit	648	648	-	
Fodder	559	559	-	
Other areas	3,750	3,620	130	
Livestock	120	120	-	
Firewood	130	-	130	
Cleaning of drainage ditches	2,500	2,500	-	
Feeding of disaster victims	1,000	1,000	-	

Source: ECLAC, based on official figures provided by the Ministry of Agriculture and the Nicaraguan Institute of Natural Resources and the Environment (IRENA), and on in-house estimates.

[a] Products that will no longer be exported.

Recorded as indirect damage was the value of other crops which can no longer be produced because the soils affected by the rain of sand and ash must be used for other purposes; this value amounts to 5,400,000 córdobas.

Thus, total damage to agricultural production amounts to 29.5 million córdobas (see table 2).

iii) Other damage related to the sector. Other damage occurred in areas linked to the agricultural and rural sector. These include direct losses of cattle and hogs and of some smaller domestic animals; sand deposits in the channels of natural drainage systems; and the cost of feeding the population evacuated during the emergency. This value —as direct damage— has been estimated at about 3,620,000 córdobas.

In addition, owing to the relatively long period of inactivity on the part of the zone's inhabitants during the emergency, the cutting of firewood from forests in the affected area came to a halt. An initial estimate values this indirect loss at about 130,000 córdobas.

Thus, the total amount of such damage comes to about 3,750,000 córdobas (see table 2).

Total losses in the agricultural sector have been estimated at 22,890,000 córdobas, of which 7,460,000 córdobas represent direct damage and 15,530,000 represent indirect damage. Moreover, this damage will have a bearing on the balance of payments owing to the need to import machinery and equipment for land rehabilitation, for an estimated amount of 1,326,000 córdobas, and to the loss of cotton and sesame exports in the amount of 2,090,000 córdobas (see table 2).

b) Trade and industry

The commercial sector suffered damage because, despite the high degree of self-sufficiency of producers in the agricultural and forestry sector in the affected area, a considerable proportion of their products are marketed in the city of León. Apart from this, commercial activity in León, an important trading centre at the regional and national levels, was reduced for a number of days because of the need to devote considerable efforts to the clean-up of volcanic material in houses and streets.

It was found that some commercial establishments suffered damage to their infrastructure and inventories, which represents direct damage estimated at 500,000 córdobas. Moreover, a 10% reduction in commercial activity for an estimated period of 30 days resulted in a loss of sales (indirect damage) in the amount of 8,000,000 córdobas. Total damage to the sector therefore amounts to 8,500,000 córdobas.

The zone's industrial sector was affected in that the buildings of seven industrial plants of various types suffered superficial damage, especially to their roofs. Production was therefore reduced for a period of 15 days while repairs were being made. These losses have been estimated at about 6,400,000 córdobas; this figure includes 150,000 in direct damage to infrastructure and 6,250,000 in indirect damage to production.

5. Infrastructure

a) Transport and communications

Damage in this sector includes various effects on the subsectors of urban transport and road systems, interurban and rural transport and road systems, railway transport, air transport, telecommunications and postal services, and others.

i) Urban transport and road systems. In the cities of León and Telica and, to a lesser degree, in the port of Corinto, deposits of sand and ash on streets and on the roofs and yards of houses necessitated the clean-up of roadways and the temporary suspension of State bus service in León for about 12 days.

Two to five centimetres of sand and ash, with variations depending on each area's exposure to the wind and distance from the Cerro Negro volcano, fell on the roofs of buildings and on urban roads in these cities. The cost of cleaning the road system, loading the sand from roofs and streets onto trucks and transporting it to a location approximately five kilometres from the city is estimated at 7,420,000 córdobas.

Owing in part to the deposits of sand and ash in León and to the need to transport disaster victims to temporary shelters, users of State buses were obliged to travel by other (usually more expensive) means, or on foot. The use of these less appropriate alternatives resulted in an additional cost of about 10,000 córdobas.

Thus, direct damage to this subsector amounted to 7,420,000 córdobas, while indirect damage amounted to only 10,000. Total damage therefore amounted to 7,430,000 córdobas (see table 3).

ii) Inter-urban and rural transport and road systems. The Ministry of Building and Transport estimates that some 188 kilometres of public interurban and rural roadways were covered by significant amounts of sand and ash.

The vast majority of these roads are rural dirt or gravel roads; however, some paved roads were also affected, notably Route 12 (between León and Telica). On paved roads, the layer of sand was only a few centimetres thick and dispersed quickly without causing major traffic problems; however, it is obstructing drains and blocking gutters and, if these are not cleaned before the rains begin, flooding could result on either side of the road, along with the destruction of the pavement, base or sub-base of the road itself. Because of the amount of work to be done and the fact that a significant portion of the Ministry's resources are already committed to clean-up work in the city of León, it is uncertain whether this task can be completed in time.

On unpaved roads as well, small amounts of sand did not cause significant traffic problems. However, in areas where the layer of sand was over 10 centimetres thick, even vehicles with four-wheel drive have difficulty travelling over the mounds of sand. Low-intensity precipitation could compress the sand and form a smooth surface over which light vehicles could travel; however, more intense rainfall, which is likely to occur, would have a negative effect, in addition to worsening the blockage of drainage channels and culverts. Nevertheless, owing to problems of access as well as of insufficient resources, it is unlikely that these roads will receive any attention before the rains begin; one of the effects of this would be to increase the cost of operating vehicles using such roads.

Table 3

NICARAGUA: DAMAGE AND LOSSES IN THE TRANSPORT AND COMMUNICATIONS SECTOR

(Thousands of córdobas)

Sector and subsector	Estimated damage and losses			
	Total	Direct	Indirect	Imported component
Total for the sector	10,050.0	9,410.0	640.0	1,970.0
Urban transport and road systems	7,430.0	7,420.0	10.0	
Inter-urban and rural transport and road systems	495.0	445.0	50.0	
Railway transport	760.0	570.0	190.0	
Telecommunications and postal services	170.0	-	170.0	
Air transport	1,090.0	870.0	220.0	
Transport of disaster victims	105.0	105.0	-	

Source: ECLAC, on the basis of official figures from the Ministry of Building and Transport, TELCOR, the Municipality of León and other sources, as well as in-house estimates.

The clean-up of culverts would cost about 350,000 córdobas. The clean-up of gutters along some 50 kilometres of main roads would cost another 40,000 córdobas. Removing the sand deposited on the surface of another 50 kilometres of secondary roads would cost 55,000 córdobas. Thus, total direct damage to the subsector would amount to 445,000 córdobas.

With the onset of the rains, the costs of operating the few tractors, trucks and oxcarts that use less important secondary roads will rise in any event. The presence of a thick layer of sand on the surface would exacerbate traffic problems. The amount of the increase in costs of operation would be limited by the decrease in traffic as a result of the reduction in agricultural activity caused by the eruption itself; however, these indirect costs are estimated at some 50,000 córdobas.

Total damage to the subsector therefore amounts to about 495,000 córdobas (see table 3).

iii) Railway transport. The Ferrocarril de Nicaragua railway system, which normally plays a fairly minor role in the national economy, also suffered some damage because of the eruption.

Direct damage affected a locomotive when sand and ash entered its engine, and repairs were needed for rolling stock because of derailments caused by excessive deposits of sand; indirect damage consisted of higher costs of operation.

Direct damage is estimated at 570,000 córdobas and indirect damage at 190,000 córdobas. Thus, total damage to the railway subsector amounts to some 760,000 córdobas (see table 3).

iv) Telecommunications and postal services. In shelters for disaster victims, the agency in charge of the subsector (TELCOR) established temporary facilities to provide the refugee population with telecommunications and postal services. This indirect cost amounts to a relatively modest 170,000 córdobas.

v) Air transport. The eruption of the Cerro Negro volcano affected this sector by necessitating detours of commercial aircraft using routes that overfly the area affected by the eruption; by depositing significant amounts of sand and ash on landing strips used by small airplanes engaged in insecticide spraying and other agricultural operations; and by resulting in a temporary halt to such flights.

The direct cost of eliminating the layer of sand and ash obstructing landing strips to ensure the safety of small airplanes has been estimated at about 870,000 córdobas. In addition, it is estimated that the indirect cost of detouring regular commercial flights has amounted to about 100,000 córdobas. The indirect cost of the reduction in flights for agricultural purposes while landing strips are being repaired is estimated at about 120,000 córdobas.

Thus, direct damage amounts to 870,000 córdobas and indirect damage is estimated at another 220,000 córdobas, for total losses in the subsector of about 1,090,000 córdobas (see table 3).

vi) Other costs. As a result of the disaster, it was necessary to incur transport expenses to evacuate and return disaster victims and their belongings, using various means of transport. The total cost of this operation has been estimated at some 105,000 córdobas (see table 3).

Total damage to the transport and telecommunications sector is estimated at 10,050,000 córdobas. Of this amount, 9,410,000 córdobas represent direct damage and 640,000 represent indirect damage (see table 3).

b) Energy

The system of electricity generation, transmission and distribution, which is operated by the Nicaraguan Energy Institute (INE), suffered very little damage as a result of the eruption.

Some INE facilities suffered direct damage. Although electrical power plants were not damaged because they are not located in the areas affected, some minor INE equipment and furniture were damaged following the collapse of workshop and warehouse roofs. Moreover, two transformers fused and a number of distribution poles and lines were destroyed. The cost of replacing or repairing these items has been estimated at some 150,000 córdobas which includes some US$8,000 for the replacement of imported equipment and materials.

This natural disaster also had indirect effects during the emergency, and immediate rehabilitation work had to be carried out. Specifically, emergency electric power lines were hooked up to serve refugee camps in six localities; transformers and transmission and distribution lines, will require continued maintenance and cleaning, as a result of short circuits which will be caused by rain falling on the volcanic ash covering such equipment; the utility's operating costs have been increased over a period which is estimated to last for 30 days; and it has been decided to clean INE-owned buildings and switchyard. Apparently, INE did not lose much income owing to the fact that the area most affected by the eruption was not electrified, although it has noticed that users are late in paying their bills most probably because they are apprehensive about the future. The indirect damage is estimated at some 3,750,000 córdobas including about US$40,000 for fuel, equipment and materials that are not produced locally.

The disaster has not had any direct effects on the hydrocarbons sector, which is also run by INE; indirect effects, however, include the use of more fuel —mainly diesel— to support the most pressing emergency and rehabilitation work at the national level.

INE reckons that it has had to allocate 555,000 gallons of diesel for that purpose to various central and local government bodies at an estimated cost of 280,000 córdobas, 90% of which is in foreign currency since Nicaragua does not produce diesel. However, the Governments of Mexico and Venezuela donated 11,000 barrels to Nicaragua for that purpose and all INE had to do was to take fuel from its own reserves and then cover the cost of transporting the diesel from its places of origin to Nicaragua.

In a nutshell, total direct damage to the energy sector amounted to 430,000 córdobas, while indirect damage totalled 3,780,000 córdobas, of which 975,000 will be needed in foreign currency to import fuel, equipment and materials that are not available locally (see table 4).

Table 4

NICARAGUA: ENERGY SECTOR: DAMAGE AND LOSSES

(Thousands of córdobas)

Sector and subsector	Estimates of damage and losses			
	Total	Direct	Indirect	Imported components/ inputs
Sector total	4,210.0	430.0	3,780.0	975.0
Electricity subsector	3,930.0	150.0	3,780.0	723.0
Buildings	150.0	50.0	100.0	8.0
Equipment and materials	30.0	30.0	-	30.0
Transmission lines	100.0	70.0	30.0	20.0
Emergency installations in camps	350.0	-	350.0	75.0
Increase in operating costs	300.0	-	300.0	90.0
Increase in maintenance costs	3,000.0	-	3,000.0	500.0
Hydrocarbons subsector	280.0	280.0	-	252.0
Fuels	280.0	280.0	-	252.0

Source: ECLAC estimates, on the basis of INE data.

c) Water and sanitation

Generally speaking, drinking water supply and sanitation systems in the area affected suffered moderate damage, partly due to the fact that the water supply systems are based on deep wells and are therefore less vulnerable to disasters than are the systems based on the harnessing and treatment of surface water. The heaviest damage in absolute terms occurred in the urban areas, which have the most equipment, especially the city of León.

The direct damage suffered by drinking water facilities in the urban areas was mainly caused by the deposits of volcanic sand and ash into the mechanical and electrical equipment of the pumping stations. Damage was also caused by the accumulation of sand and ash in the water storage tanks.

The water supplied to rural areas comes from open-air wells which are sometimes over 200 metres deep. In such cases, animal traction is used to pump the water. Almost all the wells observed do not meet the minimum sanitation conditions, for lack of casing heads and covers. The reason that few wells were damaged was that their owners managed to cover most of them with wood, plastic and other material. However, many of them will probably have to be disinfected, since small animals fleeing from the volcanic eruption fell into them.

The sewerage system of the city of León was slightly damaged as a result of the accumulation of volcanic matter in the stabilization ponds —which had previously had operational problems— and the deposits of sand and ash into the sewerage network. Although it was not designed to do so, the León sewerage system operates partly as a mixed system in that it evacuates sewage and rain water simultaneously. Thus, any matter that is not removed from the system before the rainy season might be dragged into the networks and block them.

In the rural areas, excreta are eliminated through sanitary latrines. None of the latrines observed in the evaluation meets minimum standards of hygiene since, apart from being poorly designed, they are very precarious structures without any protection from insects. In general, all the latrines would have to be rebuilt and the rural folk would have to be trained in how to operate and maintain them.

The indirect effects on the rural drinking water supply systems include the installation of disinfection equipment to strengthen existing systems and prevent water pollution; using trucks to distribute water in the rural areas affected; the installation of storage tanks in the refugee camps and some rural areas; and the expansion of drinking water supply networks to meet the needs of the refugee population. Other indirect effects are expected to arise from the fall in INAA income owing to the heavy use of water to control dust in León which cannot be charged to users. In the rural areas, additional costs have been envisaged for the rehabilitation of wells, and the estimated cost of supplying drinking water to the affected population that might have to be resettled outside the area has also been budgeted for.

The cost of latrines built in the rural areas to cater for the emergency has also been counted as an indirect effect. The direct damage suffered by the drinking water and sanitation systems has been estimated at 1,298,600 córdobas, while the indirect costs have been estimated at 2,055,900. Hence, overall damage under this item amounts to 3,354,500 córdobas (see table 5).

Table 5

NICARAGUA: DAMAGE TO AND LOSSES IN DRINKING WATER AND SANITATION SYSTEMS

(Thousands of córdobas)

Sector and subsector	Estimates of damage and losses			
	Total	Direct	Indirect	Imported components
Sector total	3,354.5	1,298.6	2,055.9	1,017.1
Urban areas:	2,021.5	458.6	1,562.9	852.1
- Repairs of drinking water system	111.4	111.4	-	
- Repairs of sewerage system	347.2	347.2	-	
- Supply of emergency water	1,562.9	-	1,562.9	
Rural areas:	1,333.0	840.0	493.0	165.0
- Repairs of wells	840.0	840.0	-	
- Installation of latrines	393.0	-	393.0	
- Drinking water system for resettlement area	100.0	-	100.0	

Source: ECLAC, on the basis of official data supplied by INAA, the Ministry of Health and its own estimates.

d) Costs of the emergency

Although the costs incurred during the emergency phase —whose duration will probably depend on when the rainy season starts— have been added up and included in each of the sectors and items already described in this report, specific figures are given below for information purposes.

It has been estimated that total costs amounted to 17.9 million córdobas (or the equivalent of US$3.6 million), which can be broken down approximately as follows:

Item	Thousands of córdobas
- Clean-up of dwellings and schools	2,568
- Clean-up and removal of ashes from urban areas and roads	8,735
- Clean-up of drainage channels and culverts	2,500
- Expenditure on refugee camps (temporary installations)	670
- Expenditure on food	1,000
- Expenditure on preventive and curative medicine	1,723
- Spending on the supply of water and construction of emergency latrines	372
- Other expenditure including transport	380
Total	17,948

These costs —which make allowance for depreciation of equipment and machinery— will be covered by the budget of the central government and the municipality of León (about 9.5 million), contributions of individuals to the repair of their houses (3.5 million) and donations made by the international community (approximately 5 million).[14]

e) Summary of the damage

Notwithstanding the provisional nature of the estimates described above owing to the lack of sufficient, wholly reliable data as a result of the brief period of time elapsed since the eruption, a figure can be put forward on the order of magnitude of the damage caused by the eruption, and the most severely affected sectors, which will have to receive priority attention in the rehabilitation and reconstruction work, can also be identified. Any fresh information compiled later will be used to refine the figures and conclusions presented here.

Total losses are estimated at around 94 million córdobas or the equivalent of US$18.8 million (see table 6).

[14] According to information provided by the Ministry of External Cooperation, this is the total amount of donations received by the Nicaraguan Government until the end of April 1992.

Table 6

NICARAGUA: SUMMARY OF DAMAGE AND LOSSES

(Thousands of dollars)

Sector and subsector	Damage			
	Total	Direct	Indirect	Imported component[a]
Total	18,745	10,467	8,278	
Social sectors	3,251	2,185	1,066	
Housing	2,479	1,819	660	175.8
Education	405	246	158	6.0
Health	481	112	370	74.5
Production sectors	11,977	6,021	5,956	
Agriculture and livestock	8,997	5,891	3,106	564.6 (417.8)[b]
Commerce and industry	2,980	130	2,850	36.0
Infrastructure	3,517	2,261	1,256	
Transport and communications	2,010	1,882	128	394.0
Energy	842	86	756	195.0
Drinking water and sanitation	665	293	372	33.0

Source: ECLAC, on the basis of official figures and in-house estimates.

[a] Future imports required.
[b] Exports which will have to be cancelled.

Sixty-four per cent of such damage was in the production sectors —agriculture, commerce and industry; 17% in social infrastructure —housing, education and health; and 11% in transport and communications infrastructure. The remaining 8% of damage occurred in the energy, water and sanitation sectors (see table 6).

The following is the breakdown of damage by types of losses:

	%
Total	100
- Production losses	46
- Damage to or destruction of capital stock	19
- Expenditure during the emergency phase	18
- Cost of land rehabilitation and resettlement	17

It should be noted that the total costs of damage is relatively low especially when compared with other natural disasters that occurred previously in the country; this was partly because the eruption affected a small area.

On the other hand, the breakdown of categories of damage is unusual in that expenditure during the emergency phase is a very large component; this is due to the fact that the removal of volcanic matter called for urgent work which involved the intensive use of machinery. What is typical, however, is that the most severely affected people were those who already earned very low incomes; they have now lost virtually all their limited stock of capital and social infrastructure and do not have any income-earning prospects.

It should also be noted that land resources have been so badly affected that the lowland areas will have to be ploughed deeply by machine, while the soils of the highlands will have to be used very extensively, even though such use could only mean much lower income for its inhabitants in future. Therefore, some of the inhabitants of the uplands will have to be resettled in neighbouring areas which are not only less vulnerable to similar disasters in future but whose soils also ensure them adequate income.

It can be deduced from the above damage analysis that priority attention will have to be focused in the short and medium term on the following major problems in order to find solutions to them:

i) rehabilitation of soils and resettlement including:

- changing the use to which upland and soils are put,
- deep ploughing of lowlands, and
- provision of land suitable for intensive farming.

ii) removal of sand and ashes;

iii) rehabilitation and reconstruction of social infrastructure, including housing, education and health; and

iv) making the people less vulnerable to disasters and improving their income and living conditions in general.

In the following chapters, a strategy based on a unified and consistent approach to rehabilitation and development will be outlined to deal with such problems; it will be expected to achieve environmentally sustainable changes in the production patterns in the area, coupled with greater equity in the distribution of the benefits of development among its inhabitants.