*Environmental sanitation and water supply during floods in Ecuador (1982—1983)**

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INTRODUCTION

Natural disasters in the countries of the Third World cause more serious damages than in the industrialized countries. The loss of lives, economic losses, and events of this kind interfere significantly with the development process. Floods are the most frequent kind of disaster (40% of the total), followed by tropical hurricanes (20%), earthquakes (15%), and droughts (15%) (Burton *et al.*, 1978).

In Ecuador, the floods caused by the phenomenon of El Niño at the end of 1982 and during the first months of 1983 were very extensive. They caused great losses and are also the most frequent natural disaster to have occurred in the last forty years (Evaluation Technologies, 1983). Consequently, studies of this kind of disaster from different points of view are justified, since floods will probably recur for a long time to come.

In addition to establishing a frame of reference on natural disasters in the country, the characteristics of the phenomenon of El Niño, its consequence, and the damage produced, we are particularly concerned with analyzing the relation between the sanitation conditions observed and their possible effects on health.

Experiences in disaster sanitation administration in Ecuador should also be recorded, since they may serve as a basis for certain phases of preventive planning for dealing with disasters.

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THE DISASTERS IN ECUADOR AND THE FLOODS OF 1982—1983

Historical background on disasters

It is of great importance to review historical information on disasters in order to identify and evaluate the potential dangers in a given region. This is the first step in preparing a plan.

In order to facilitate planning for disasters and aid operations, OFDA/AID* prepared a country profile that contains a great deal of useful information and an outline of the greatest disasters for the period 1942—1983 (see Table 1). The data are not complete, especially those referring to losses, and opinions will differ on the criteria that prompted the inclusion of some disasters and the exclusion of others. A summary follows in Table 2 which indicates that of the twenty-four disasters, floods are the most frequent and have affected the greatest number of persons. The recent floods that created 950,000 victims and caused great losses are the most important disaster in the last forty years.

The floods of 1982—1983 and the phenomenon of El Niño

The Ecuadorian coast experiences floods every year during the winter period, which is usually November to June; there are also areas where rains are very limited: part of Manabí, the Santa Elena peninsula in Guayas, and the southern part of El Oro.

The rainfall and floods in Ecuador in 1982—1983 were directly related to the phenomenon of El Niño, which is an ocean-atmosphere interaction that has great impact on the climate and the marine ecosystem of the Western Pacific. It occurs at intervals of from three to six years,† and the occurrence in the period referred to was one of the most intense in the present century. Known at "El Niño-Southern Oscillation," its effects were manifested between October 1982 and July 1983 by modifications of the temperature and density of large masses of ocean water, which interfered seriously with fishing in Ecuador and Peru and produced heavy and prolonged rains that caused floods and landslides in extensive areas of Ecuador, Peru and Bolivia, and droughts in the Andean areas of Peru and Bolivia. Economic losses and damages in the social sectors were large (Jordán, 1985). Those that occurred in Ecuador are detailed below.

The influence of El Niño on the overall climatic system has been investigated since 1904. Its importance has prompted many studies. Currently a world project known as Tropical Ocean Global Atmosphere (TOGA) has been

*OFDA/AID: Office of U.S. Foreign Disaster Assistance/ Agency for International Development.

†The Niños of 1917, 1925, 1932, 1953, 1966, 1972 and 1982—1983 have had a severe impact on Ecuador.

Table 1. Disasters occurring in Ecuador (1942—1983)

Disasters	Location	Dates	Deaths	Affected	Losses $1,000
Earthquakes	Occidente Ambato,	1942	200	—	—
	Ambato, Pelileo	5th August 1949	6,000	100,000	20,000
	Provincia Loja	9th December 1970	29	60,000	4,000
	Prov. Esmeraldas	9th April 1976	10	—	4,000
	Prov. Cotopaxi	4th October 1976	0	20,000	—
	Guayaquil	18th August 1980	6	—	—
Volcanic eruptions	El Sangay	8th July 1975	0	—	—
	Cotopaxi	December 1976	1	20,000	—
Droughts	Generalized	1964	—	600,000	—
Floods	Valle Río Daule	April 1965	—	50,000	4,000
	Milagro	8th February 1967	—	20,000	100
	Prov. Manabí	8th April 1970	20	140,000	500
	Prov. Imbadura	November 1970	0	100	20
	Prov. Guayas	March 1971	0	10,000	—
	N.E. Río Putumayo	August 1971	0	2,400	50
	Prov. de Guayas, Los Ríos, Esmeraldas and Manabí	30th December 1982	30*	—*	—*
Landslides	Quito-Santo Domingo	May 1966	50	500	—
	Quito	9th March 1971	20	6	—
	Prov. Esmeraldas	11th February 1976	60	—	—
Epidemics	Guayaquil and surroundings, Playas and surroundings	August 1967	36	528	—
		May 1969	400	40,000	—
	Quito	January 1977	0	300	—
Fires	Colimes, Prov. Guayas	14th October 1966	0	800	134
Aviation accidents	Cuenca	11th July 1983	119	—	—
Total			6,981	1,064,634	32,804

Source: Evaluation Technologies (1983).
*According to UNDRO (1983): 300 deaths; CEPAL (1983) estimated 950,000 affected and U.S.$640.6.

Table 2. Disasters in Ecuador, 1942—1983

Disaster	Number	Deaths	Affected
Floods	7	320	1,172,500 (58%)
Droughts	1	—	600,000 (30%)
Earthquakes	6	6,445	180,000 (9%)
Others	10	686	62,134 (3%)
Total	24	7,451	2,014,634 (100%)

initiated that is cosponsored by Intergovernmental Oceanographic Commission (IOC) and World Meteorological Organization (WMO) with the objectives of learning more about ocean-tropical-atmosphere interactions and providing scientific bases for a forecasting system (Rasmusson, 1985).

The Study Commission for the Development of the River Guayas Basin (CEDEGE) has analyzed recent hydrometeorological phenomena in the area with the most affected population. It has also prepared a study of works for protection against floods in the lower part of the Basin. Table 3 contains a summary of data from six stations with the longest records, showing periods of return for monthly maximum values that range from 100 to 12,000 years. The greatest anomalies occurred from November to January and in May and June. The resulting floods covered 80% of the Lower Basin, which encompasses 161,000 ha. This corresponds to a return period of 12 years and serious repercussions on economic activities, especially in the agricultural and livestock sector and for the population at large. It is also related to the prolonged permanence of a layer of water that damaged permanent crops and in addition prevented harvesting and preparations for sowing short-cycle crops. The solution proposed envisages flood control and ensuring against risk in summer for a 25-year return period through drainage projects, coffer dams, and a dam in Baba (CEDEGE, 1984b).

Quantification of damage in affected area

The affected surface area is estimated at between 12 and 15% of the national territory (CEPAL, 1983), mainly in the provinces of Esmeraldas, Manabí, Guaras, Los Ríos and El Oro, which suffered intense rains, floods, landslides, and ground swells on the coast (Fig. 1). The damages were quantified with the collaboration of a mission from ECLA (CEPAL, 1983), and constitute 6.4% of the 1983 GDP. Its distribution is:

Sectors	Millions of dollars
Social	23.6
Transportation	209.3
Production	405.6
Others	2.1
Total	640.6

The economic report of IDB for 1984 (IDB, 1985) examines the situation of the countries of the region up to 1983. For Ecuador it notes that the GDP showed a reduction of 3.3% after 17 years of continuous growth. This value implies a GDP per capita of — 6.1%. The causes, according to the Bank, are several: external factors, debt service, the austerity program, and the disaster caused by El Niño, among others.

Rehabilitation and reconstruction of drinking water and sewerage systems, according to an initial IEOS estimate, amounts to 59.8 million dollars (IEOS, 1983).

ENVIRONMENTAL SANITATION AND HEALTH

Effect of the floods on health

The epidemiology of natural disasters may be considered a recent discipline, since the epidemiological method began

Table 3. Precipitation in selected stations in the Guayas Basin

Station	Maximum and minimum values for the period							
	Monthly average (mm)		Winter 1982—1983 (mm)		Percentage over average		Return (years)	
Santo Domingo	82	570	475	742	91	899	2	1,430
Pichilingue	14	454	409	891	142	2,878	3	100
Isabel María	2	400	303	862	129	15,150	5	670
Milagro	6	387	367	789	156	3,968	12	1,250
Guayaquil	3	294	177	830	192	5,519	12	200
Salinas	0.3	55	1.4	701	350	116,767	2	12,000

Source: CEDEGE (1984).

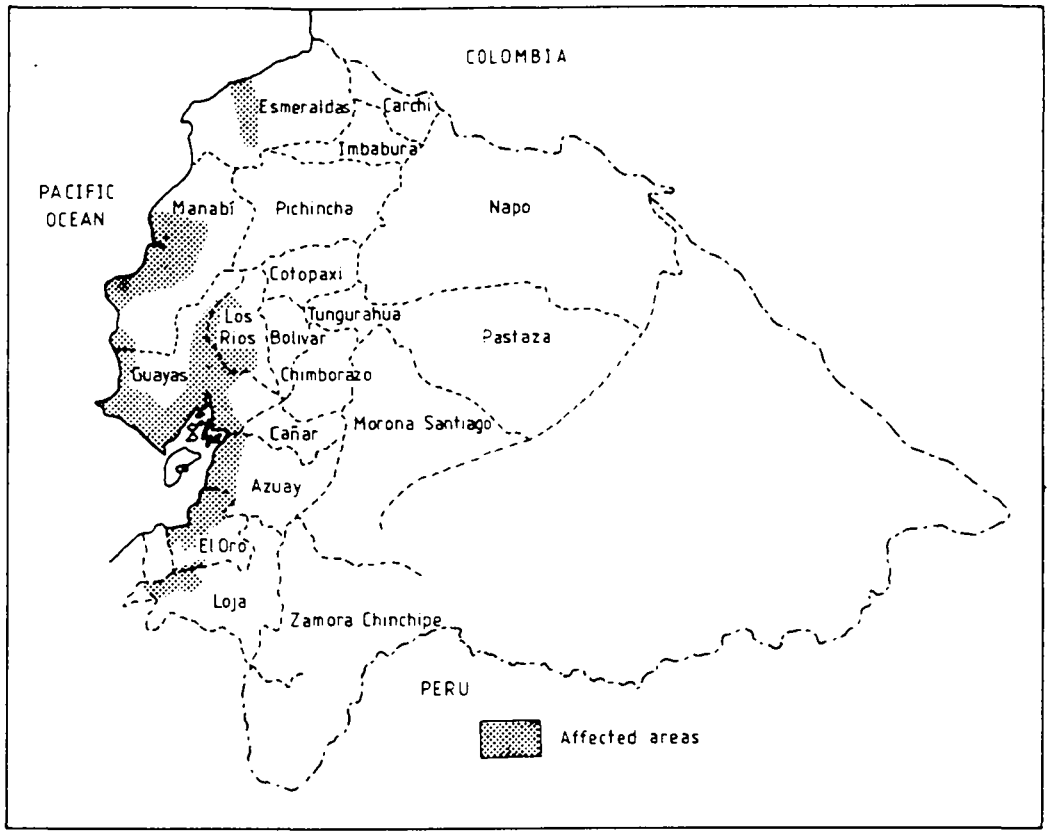

Fig. 1. Ecuador: Areas affected by the floods.

to be applied in the 1970s (Western, 1972; de Ville de Goyet, 1979). Only in 1984 was a text published that organized and brought together the studies and experiences of various specialists (Seaman, 1984). One of the important tasks undertaken by Western (1981, 1982), Lechat (1980), de Ville de Goyet (1979), Seaman (1984), and others has been the establishment of scientific bases for analyzing post-disaster health considerations and designing surveillance systems that make it possible to guide the adoption of control measures, thereby avoiding the expensive improvizations of the past that have been described as a "secondary disaster" (de Ville de Goyet, 1979).

The literature on floods that generate communicable disease problems, especially gastrointestinal diseases associated with bad sanitation conditions, is quite limited; however, the numerous studies on large-scale floods occurring mainly in the developed countries have made it possible to affirm that the outbreaks observed have occurred occasionally and in places of shelter, with the exception of an epidemic of malaria in Haiti and outbreaks of leptospirosis in Lisbon and in Recife (de Ville de Goyet, 1979).

However, other specialists have begun to document cases that appear to show a correlation between poor sanitation and a significant increase in gastrointestinal diseases after floods. Mention may be made of Beinin (1979), with reference to the USSR, and Weniger *et al.* (1983), who report on an outbreak associated with melting of snows and floods; and Standard, Lechat *et al.* (1983), on the effects of Hurricane David in Dominica. Bissell (1983) discusses the consequences of Hurricanes David and Frederick in the Dominican Republic; and Lye (1984) studies factors that influence diarrhoeal disease in the rural area of Malaysia.

In the particular case of the floods of 1982—1983 produced by El Niño: Gueri (1984) advanced some evidence on their effects on health in the north of Peru; and Cavalié (1985) studied their relation to malaria in Ecuador. In this paper we will describe the apparent relation between sanitation deficiencies produced by the floods and certain enteric diseases.

Materials and methods

Field studies were carried out between 4th January and 22nd June 1983 by professional personnel of the Ecuadorian Sanitary Works Institute (IEOS), with the participation of the author of this paper. Part of the supplementary and evaluation activities — reports, projects, laboratory work, preparation of educational material, etc. — was carried out in Quito and Guayaquil.

In addition to inspections of sanitation systems, special importance was attached to sampling and testing to verify the bacteriological quality of the water. For this purpose the standard methods of the American Public Health Association (1980) were used. Except for the water companies in the important cities and some systems controlled by the IEOS, it may be said that bacteriological control of the water for human consumption does not exist

in Ecuador in accordance with the guidelines prescribed by WHO (OMS, 1985) or the standards that other countries have adopted. This situation made it necessary to carry out special sampling of water supply systems in order to illustrate diagnosis of the situation more objectively.

During the first months of 1985 the morbidity rates of communicable diseases and other health indicators usually analyzed after natural disasters were compiled and examined:

- Influenza — representing the respiratory diseases
- Typhoid and hepatitis — representing the enteric diseases
- Malaria and dog bites — representing ecological changes

It is necessary to point out that the epidemiological surveillance system of the Ministry of Public Health is seeking to improve notification and unify the criteria for diagnosis, since frequently it is based only on clinical examinations because laboratory resources are limited. For the purposes of comparing data in the period of study (1981—1984), it may be said that the notification system has improved, but it is not possible to establish a percentage quantification of this improvement. Information was not received for some diseases of interest for study, such as diarrhoea, skin diseases and snakebites.

At the request of the government, multilateral agencies and friendly governments granted financial assistance and technical co-operation in different categories. Collaboration was also received for the environmental sanitation subsector, which was co-ordinated in part by the IEOS.

Results

Basic sanitation. It is important to point out the levels of coverage of water supply and sanitation in the coastal provinces, since it is the systems of this population group that were evaluated (see Table 4).

The percentages of urban population that do not have access to water services are of the order of 30%, and 37% are not provided with excreta disposal services. For the rural environment the percentages of the population without such services are 75 and 80%, respectively.

Various field work reports (Hederra, 1983a—c; IEOS, 1983a—d) and evaluations of these reports and of activities carried out (Hederra, 1983d; Cabrera and Roura, 1984), are summarized in Table 5, below.

Although there are lacunae in this information, it undoubtedly provides a general picture of the situation. Damage to drinking water systems includes catchments, wells and elevating plants; pipelines and impulsions; interruption of service and water polluted in distribution and in tankers (see also Tables 6 and 7). Damage to sanitary sewerage systems includes elevating plants and pipelines or impulsions, sewer networks, and obstructions with reflux of sewage. Damage to storm water sewerage systems includes obstruction of pipes and catch basins; sediments in the streets; flood or reflux of surface waters.

With reference to the water quality of distribution networks in the systems, Table 6 shows the localities sampled; the results are shown in Table 8.

Pollution of water distributed in tank trucks was also verified (see Table 7). Although the number of samples is small, the proportion of polluted samples is of the same order as that found in the distribution networks. This is logical, since the water is of the same origin; but we should remember that tank trucks in normal times supplied a third of the urban coastal population, and this proportion probably rose during the floods when the service was interrupted.

The city of Babahoyo was severely affected by the floods and for a long time a layer of water covered most of the city. One of the consequences was partial discharge of wastewater into this floodwater through the inspection wells of the sewerage system, since the three sewers at their points

Table 4. Percentages of coverage with drinking water services, sewerage systems, and latrines — urban population (1983), (provisional information)

Province	Drinking water, sewerage, and latrine services					
	Household connections	Public sources	Total	Sewer connections	Latrines	Total
Esmeraldas	60.3	13.2	73.5	40.2	18.8	59.0
Manabí	68.0	10.4	78.4	36.3	21.7	58.0
Los Ríos	76.7	7.1	83.8	40.0	23.6	63.6
Guayas	62.6	3.3	65.9	46.5	18.0	64.5
El Oro	69.9	3.5	73.4	50.8	16.4	67.2
Total coast	65.0	5.2	70.2	44.6	18.8	63.4

Sources: Calculations of the IEOS based on 1974 and 1982 censuses and its own data (Toro, 1983; Direccion Naciónal, 1984).

Fig. 5. Damage and effects on coastal sanitation systems caused by rainfall and floods, 1983

Breakdown of damage and effects on systems	Coastal provinces declared emergency areas				
	Esmeraldas	Manabí	Guayas	Los Ríos	El Oro
A. Drinking water systems					
- Damage or flooding of catchments or wells	V		V	X	X
- Damage or flooding to elevating or treatment plants	X	X			X
- Damage to conduits or impulsions	VX	VX	X		X
- Damage to tanks		X			
- Damage to networks		X		X	
- Interruption of service (partial or total)	X	X	X	X	X
- Water polluted in networks	X	X	X	X	X
- Water polluted in cisterns or tanks		X	X		X
- Water polluted in tankers	X	X		X	
B. Sanitary sewerage systems					
- Damage to elevating or treatment plants		X			
- Damage to conduits or impulsions		X			
- Damage to sewer networks		X	X		X
- Obstruction of sewerage system		X	X	X	
- Reflux of sewage		X	X	X	
C. Storm water sewerage systems					
- Damage to conduits or structures					
- Obstructions of piping and sumps		X	X		
- Abundance of sediments in streets		X	X	X	
- Flooding or reflux of surface waters	X	X	X	X	X
D. Solid waste systems					
- Interruption of service				X	
- Presence of foci or flies bad odors, etc.		X		X	
E. Temporary shelters					
- Destruction of dwellings		X	X		
- Location of families in educational establishments and public places	X	X	X	X	
- Poor sanitary conditions of sheltered persons		X			

Source: Hederra (1983d); Cabrera and Roura (1984).

Table 6. Bacteriological control in drinking water system networks, January and February 1983

Province	Locality	Number of samples	Samples polluted		Low residual chlorine (less than 0.20 mg/l.)
			Coliform	Fecal coli	
Esmeraldas	Esmeraldas	3	2	2	0
	Tachina	1	1	1	1
	Atacames	1	1	1	1
Subtotal: 3		5.	4 (80%)	4	2 (40%)
Manabí	Portoviejo	14	6	0	11
	Honorato Vásquez, Santa Ana	7	4	0	1
	Chone	2	0	0	0
	Charapotó	1	1	1	1
	Sequita	1	1	1	1
	Higuerón	1	1	1	1
	Pichincha	1	1	0	1
	Manta	9	4	0	1
	Montecristi	1	1	0	1
	Paján	5	5	0	0
	Bahía de Caráquez	6	3	0	3
Subtotal: 11		48	27 (56%)	3	21 (44%)
Los Ríos	Babahoyo	27	18	18	7
	Vinces	1	1	0	0
	Ricaurte	1	1	1	1
	Baba	1	1	0	0
	Ventanas	1	1	1	1
	Quevedo	3	3	3	3
Subtotal: 6		34	25 (74%)	23	12 (35%)
Guayas	Las Guayas	1	1	0	No information
	Balzar	2	1	0	No information
Subtotal: 2		3	2 (67%)	0	—
El Oro	Machala y Pto. Bolívar	4	4	4	3
	Arenillas	2	1	1	2
	Huaquillas	2	0	0	0
	Santa Rosa	4	4	3	0
	Puerto Jelí	1	1	1	0
	Pasaje	3	3	3	2
	Guabo	1	1	1	1
Subtotal: 8		17	14 (82%)	13	8 (47%)
Total: 30		107	72 (61%)	43	43 (40%)

Table 7. Bacteriological control of tank trucks for distribution of water — January and February 1983

Locality	No. of samples	Polluted samples		Low residual chlorine (less than 20 mg/l.)
		Coliforms	Fecal coli	
Esmeraldas	1	0	0	0
Portoviejo	1	0	0	1
Jipijapa	2	2	0	2
Babahoyo	1	1	0	0
Total	5	3 (60%)	0	3 (60%)

Source: IEOS.

Table 8. Bacteriological pollution of water supply systems

	Localities sampled*	Bacteriological pollution in the network
Esmeraldas	3	3
Manabí	13	12
Los Ríos	6	6
Guayas †	2	2
El Oro	8	7
Total	32	30 (94%)

*Carried out by the IEOS in January and February, 1983.
†Does not include the systems of the Municipal Drinking Water Company of Guayaquil.

of discharge into the river had a head equal to that of the rest of the system. This critically polluted the floodwaters of the center of the city, producing the following average values from three samples taken on 6th January 1983:

Coliforms: 11×10^6

Fecal coli: 3×10^6

Upon comparison with the values mentioned by Castagnino (1980), we may conclude that this degree of pollution corresponds to raw wastewater. Although in the other flooded localities the situation was not equal to that of Babahoyo, in many cases the presence of wastewater was observed in the inhabited area (see Table 5).

Other environmental health problems. Municipal solid waste services, which normally cover from 30 to 60% of the dwellings in medium-sized cities, faced serious difficulties in functioning due to the presence of water and sediments in the streets. This was an additional factor in sanitary deficiency.

Animal deaths were estimated at some 1,000 head of cattle at the end of the month of January (FAO, 1983); consequently, it is probable that the total for the period was greater. Other animals, such as pigs and fowl, also died because of the floods. However, there were no reports of sanitary problems or of inconveniences from the presence of corpses, possibly because they were very scattered and adequate measures were taken.

Dwellings destroyed or damaged numbered some 5,700 in the urban area and around 8,000 in the rural areas (CEPAL, 1983). This forced many families to seek shelter in schools and other public establishments. The sanitary conditions of some of these places, such as the Bay of Caráquez were deficient. Despite this, no outbreaks of disease were reported, perhaps because both the number of refugees and their permanence were limited.

Ecological conditions in the flooded area and the suspension of spraying of dwellings with insecticides permitted multiplication of mosquitoes transmitting the causative agents of malaria, which caused a great increase in cases of this disease (Cavalié, 1985). From the second half of 1980 up to the end of the first half of 1982, spraying was irregular and was suspended in the middle of that year for lack of insecticides. It was resumed only in 1983 when donations of insecticides were received because of the floods. Labor conflicts also took place in that period.

The health authorities received reports of a high number of persons bitten by snakes, which was verified by a herpetologist (Touzet, personal communication); information on the number of cases and their severity was not complete.

Something similar occurred with dog bites; a rabies campaign diminished the problem and reduced the number of cases of human rabies (Gutierrez, personal communication) (see Table 9).

Measurement of the effect on health. Figure 2 contains information on morbidity rates of some reportable diseases in the five coastal provinces: Esmeraldas, Manabí, Los Ríos, Guayas and El Oro. The corresponding rates have been noted in Table 9.

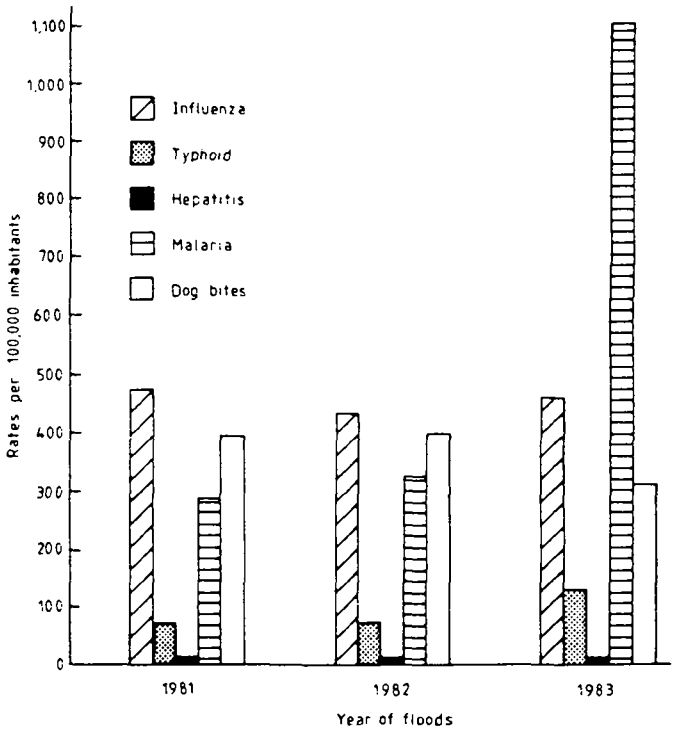

Fig. 2. Morbidity from some diseases in coastal provinces 1981—1983.

Malaria and typhoid are the diseases that show a notable rise in 1983, coinciding with the period of floods. The first of these diseases has already been studied (Cavalié, 1985), and because of its close relation to sanitation we have included Fig. 3, showing the monthly cases of typhoid and other salmonellosis in order to visualize the period 1982—1984 in greater detail and the probable effect of the rains and floods.

Internal co-operation. The two sanitary engineers of PAHO and AID, who normally provide technical co-operation to the IEOS, devoted most of their time to disaster sanitation activities during the first months of 1983. The collaboration of PAHO in this field may be summarized as follows:

- Assistance in organizing working groups and co-ordination with international bodies.
- Participation in trips to the disaster area in order to make a preliminary diagnosis (IEOS, 1983a), to provide emergency sanitation measures, to distribute technical material (OPS, 1982; Assar, 1971), and to determine needs for international support (IEOS, 1983f).
- Contribution to formulate a program of rehabilitation based on inspections of the systems (IEOS, 1983g,h).
- Promotion and organization of training activities (Hederra and Hernandez, 1983; Hederra *et al.*, 1984).
- Preparation of an evaluative report on the effects of the floods on the sanitation systems and the measures adopted (Hederra, 1983d).

AID also carried out collaborative activities in diagnosis and other fields in disaster sanitation. Its most interesting contributions during the period of emergency were the transfer and implementation of three water treatment plants for Babahoyo and Baba (OFDA, 1984; Reiff, 1983a,b) and the execution of drainage works in Los Guasmos in Guayaquil (OFDA, 1984).

Part of the efforts of the sanitary engineers and other professionals engaged in preparing studies and projects was turned towards the acquisition of external financing, whose approximate amount is shown in Table 10. AID contributed most of the donations and granted the loan for rehabilitation; other donors were UNDRO*/UNDP, UNICEF and France (Pont a Mousson).

*Several European countries channeled funds through UNDRO.

Table 9. Compulsory notification of disease and incident rates in coastal provinces, 1981—1984 (Gutierrez, 1985; Izurieta, 1985; Division Nacional de Estadisticas, 1985)

Disease or incident	Morbidity (rate x 100,000 inhab.)			
	1981	1982	1983	1984
Influenza	478	436	459	207
Typhoid and other salmonellosis	73	75	127	80
Viral hepatitis	10	14	11	17
Malaria	288	323	1,108	760
Persons bitten by dogs	396	398	311	378

Deaths from human rabies were: twenty-one in 1981; nineteen in 1982; sixteen in 1983; thirteen in 1984.

Source: Ministry of Public Health.

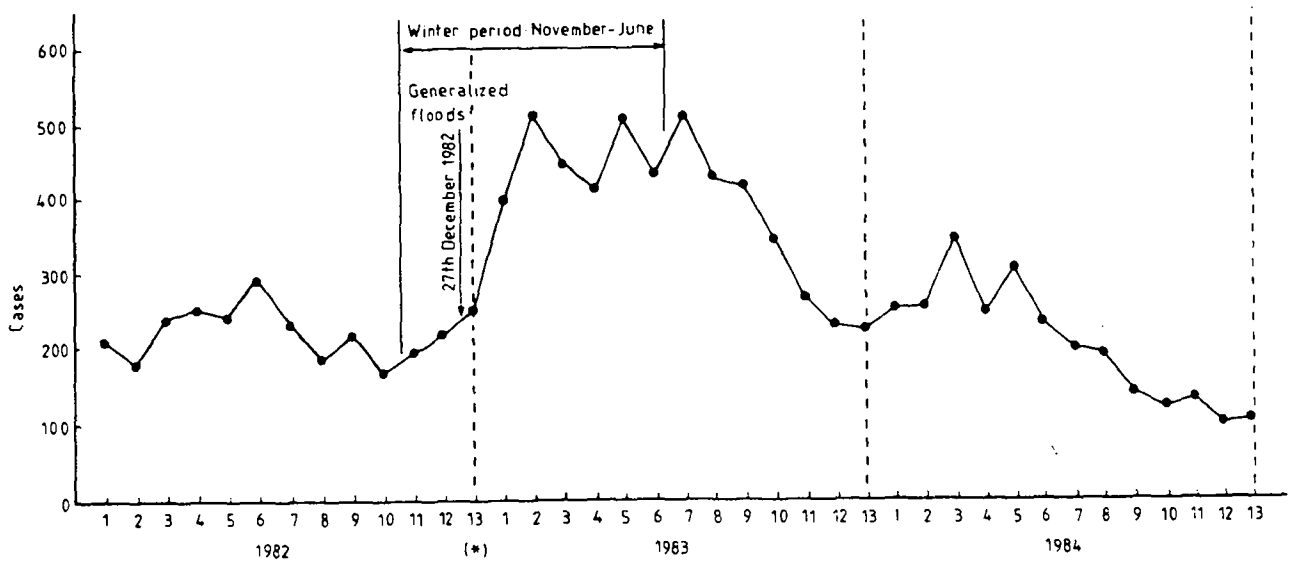

Fig. 3. Cases of typhoid and other salmonellosis in the coastal provinces, 1981—1984. Note: The data on the fifty-two weeks of epidemiological reporting were grouped into thirteen four-week periods.

Table 10. External resources obtained for basic sanitation systems affected by the floods

Phase	Amount of U.S.$	Observation
Emergency	444,000	Donation
Rehabilitation	834,000	Donation
Rehabilitation	2,070,000	Soft loan
Total	3,348,000	

DISCUSSION

Sanitation and health in floods

It is indisputable that the quality of the information is not good, that there are gaps, and that basic studies are lacking to compare the sanitation situation before the floods with what occurred during these phenomena. However, the indicators compiled provide a sufficiently clear picture of generalized unhealthy conditions and pollution by excreta, associated with a clear rise in the number of cases of typhoid in the coastal region. Once the climate becomes normal again and the floods disappear, typhoid declines to a "normal" endemic level.

In addition, many of the conditions that the disaster epidemiologists establish for the transmission of infectious diseases were present during the floods of 1982—1983 — in this case enteric diseases associated with deficiencies in environmental sanitation. According to Seaman (1984) and what has been set forth in preceding paragraphs:

Existence of the disease in the population. Typhoid and other salmonellosis are present in the country and, of course, also on the coast. The epidemic potential was demonstrated by the number of cases that increased significantly in a short time.

Ecological changes. The principal ecological change was the spread of excreta into the waters that covered the cities, their passage into water supply systems, and probably their incorporation into the sludge that remained for an additional period of time in the urban settlements. Undisposed of solid wastes probably contributed to the multiplication of flies and the increase in transmission of enteric diseases.

Malaria increased as a result of these ecological changes, but it was not clearly demonstrated if there was increase in dog or snake bites.

Population movements. The destruction of dwellings was not very extensive and the relatively limited information on temporary shelters leads us to deduce that large-scale displacements of population and prolonged permanence of families in shelters did not take place, nor was it possible to detect reports of outbreaks of diseases among sheltered persons despite the unhealthy conditions of some of these sites.

Damage to public services. This damage was relatively extensive and is described in detail in the reference to basic sanitation (see above). There was damage to structures, suspension of services, and bad water quality (pollution by coliforms).

Health services. There was only occasional discontinuity in these services, although certain health establishments had to be transferred to other sites or patients had to be referred elsewhere.

Alteration of individual resistance to disease. We do not know of any study regarding this particular aspect during the recent floods. However, the problem of lack of food was of concern to government authorities and a fair quantity of dietary rations was distributed in the affected area. Consequently, malnutrition associated with greater susceptibility to infectious diseases cannot be disregarded.

In summary, there are probably more factors favoring the transmission of diseases than those impeding transmission; therefore, the hypothesis of the association of an increase in cases of typhoid and poor sanitation during the floods on the Ecuadorian coast appears likely.

Experiences in disaster sanitation administration

The approaches to disaster administration applied to the coastal floods made it possible to assess the situation and adopt emergency measures.

During the inspection visits deficiencies were detected in the operation, maintenance, and administration of water supply and sewerage services. This is not the first time this has been observed during disasters: 39% of the rural water supply systems of northeastern Guatemala had deficiencies or were not functioning for reasons external to the earthquake of 1976 (Garcia *et al.*, 1977).

It was possible to obtain outside resources thanks to a strategy for the formulation of projects. Perhaps these resources would have been channeled to other sectors if the specialists in sanitation had lacked diagnoses and concrete proposals at the opportune time.

Disaster planning for drinking water and sewerage services and companies does not exist and co-ordination was weak (Hederra, 1983). It will be necessary to continue making efforts in order to disseminate concepts and methodologies in this field.

CONCLUSIONS

1. Floods and earthquakes should be considered in planning to deal with disasters as the most frequent events in the country.
2. The damages caused by the floods of 1982—1983 were extensive and affected the economic and social development of the country.
3. Sanitation systems suffered considerable damage. There were interruptions of services and microbiological pollution of fecal origin in the water.
4. It is highly probable that the microbiological pollution of the water supply systems and other serious sanitation deficiencies in the coastal provinces have had an effect on health, since the cases of typhoid and other salmonellosis were much higher than in previous and later years.
5. There was a great proliferation of malaria-transmitting mosquitoes, and cases of this disease increased significantly.
6. Disaster sanitation administration activities were carried out by the national body and the companies and services of the affected cities. This made it possible to adopt emergency measures and to obtain external resources.
7. The sanitation bodies had no planning for dealing with disasters, and it is advisable for plans of this nature to be formulated.

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