



# Back analysis of the institutional and social responses to the eruption and the lahars of Mount Pinatubo Volcano from 1991 to 1998 (Central Luzon, Philippines)

Frédéric Leone, Jean-Christophe Gaillard

## ► To cite this version:

Frédéric Leone, Jean-Christophe Gaillard. Back analysis of the institutional and social responses to the eruption and the lahars of Mount Pinatubo Volcano from 1991 to 1998 (Central Luzon, Philippines). *GeoJournal*, 1999, 49 (2), pp.223-238. halshs-00119436

**HAL Id: halshs-00119436**

**<https://shs.hal.science/halshs-00119436>**

Submitted on 9 Dec 2006

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

## **Back analysis of the institutional and social responses to the eruption and the lahars of Mount Pinatubo volcano from 1991 to 1998 (Central Luzon, Philippines)**

*Analyse en retour des réponses institutionnelles et sociales liées à l'éruption et aux lahars du volcan Pinatubo de 1991 à 1998 (Central Luzon, Philippines)*

**Frédéric LEONE**

Department of Geography, University of French West Indies and Guyana, 97 275 Schoelcher, Martinique, France  
E-mail: Frederic.Leone@martinique.univ-ag.fr

**Jean-Christophe GAILLARD**

Department of Geography, University of Savoy, 73 376 Le Bourget du Lac Cedex, France  
E-mail: jean-christophe.gaillard@univ-savoie.fr

### **Abstract**

Mount Pinatubo volcano erupted in June 1991 in the main island of Luzon belonging to the Philippines archipelago. Huge economic losses and population exodus have followed. This major crisis has been relayed with other crisis due to lahars which have been supplied with eruption deposits. These lahars have occurred every year since 1991 during the rainy season. They will probably last until 2005. After a brief presentation of the Philippine official response system to disasters, this paper draws up a critical analysis of the different kinds of institutional and social responses deployed to manage the different crisis and post-crisis phases of this event. Based on three viewpoints: from population, media and other actors, this analysis attempts to point out the strengths and weaknesses of the official management system, especially by studying the efficiency and the range of the taken solutions. So, it appears that the management of the June 1991 main crisis (eruption) was a success. On the other hand, difficulties have occurred with lahars risk management. Indeed, these lahars have obliged the authorities to protect and reaccommodate thousands of people. In spite of persistent problems, the management system (monitoring/warning/evacuation) of lahar crises improves year after year. Failures appear especially about rehabilitation program (protection/rehousing). Many of direct (lack of means, of preparedness, of coordination, of dialog, etc.) and indirect (politico-administrative, socio-economic, cultural contexts) factors come to lock the wheels of the institutional response system. They defer the socio-economic start of this north Philippines vital area.

**Key words:** Philippines, Mount Pinatubo, Volcanic eruption, Lahars, Natural disaster, Crisis management, Institutional response, Social response.

### **Résumé**

L'éruption du volcan Pinatubo survenue en juin 1991 sur l'île principale de Luzon dans l'archipel des Philippines a entraîné des pertes économiques et des mouvements de population considérables. Cet événement a été relayée par d'autres crises plus localisées consécutives aux nombreux lahars alimentés par les matériaux déposés au moment de l'éruption. Ces lahars se manifestent chaque année depuis 1991 au moment de la saison des pluies et vont probablement perdurer jusqu'aux environs de 2005. Après une brève présentation du système officiel philippin de gestion des catastrophes, cet article mène une analyse critique des différents types de réponses institutionnelles mais aussi sociales apportées aux différentes phases de crise et de post-crise associées à cet événement. L'analyse s'est appuyée sur les points de vue des populations, des médias et de divers autres acteurs. Elle a pour but la mise en évidence des forces et faiblesses du système officiel de gestion et prévention, notamment à travers la portée et le niveau d'efficacité des solutions adoptées. Il en ressort que si la crise principale de juin 1991 a été bien gérée, les difficultés sont apparues surtout du fait de la persistance et de l'ampleur des lahars induits. Ces phénomènes ont en effet contraint les autorités à reloger et protéger plusieurs milliers de personnes. Malgré quelques faiblesses persistantes, le système de gestion (surveillance/alerte/évacuation) de ces crises répétées s'améliore d'année en année. Les dysfonctionnements apparaissent surtout au niveau du programme de réhabilitation (protection/relogement) qui est loin de faire l'unanimité, notamment au sein des populations. En effet de nombreux facteurs directs (manques de moyens, de planification, de coordination, de concertation, etc.) mais aussi indirects (contextes politico-administratifs, socio-économiques, culturels) viennent bloquer les rouages du système institutionnel de réponse à cette catastrophe et par voie de conséquence retarder le redémarrage socio-économique de cette région pourtant vitale du nord des Philippines.

**Mots clés:** Philippines, Mont Pinatubo, Eruption volcanique, Lahars, Catastrophe naturelle, Gestion de crise, Réponse institutionnelle, Réponse sociale.

## **1. Introduction: a persistent threat**

After almost US\$ one billion in economic losses and 2.1 million persons affected, the eruption of Mt Pinatubo volcano in June 1991 in the Philippines was seen as an event of exceptional intensity (Leone, 1996) (**fig.1 and table 1**).

Because of the huge quantity of pyroclastic material deposited on the slopes of the volcano ( $5\text{--}7\text{ km}^3$ ) (Janda & al., 1997; Wolfe, 1992), numerous lahars occurred from the very first phases of the eruption when the typhoon Yunya passed over the 10 main waterways flowing down from the volcano. From this time, lahars appeared regularly with an annual frequency corresponding to the arrival of the monsoon and threaten a total area of  $770\text{ km}^2$ .

The volumes mobilized by these lahars for the year 1997 have been estimated at 160 million  $\text{m}^3$  concentrated mainly in the valleys of the Pasig-Potrero, Marella-Sto. Tomas, Bucao, O'Donnel and Sacobia rivers. The volumes which can still be mobilized up to the year 2005 for the first three of these channels are estimated respectively at 60-80, 70 and 200 million  $\text{m}^3$ . As for the Pasig-Potrero watershed, the towns of Sto. Tomas, Bacolor, Sta. Rita, Guagua Minalin, Porac and San Fernando, the capital of the Pampanga province, remain the most exposed agglomerations if we assume that the lahars will maintain the same routes as the last seasons (PHIVOLCS, 1997).

The need to control this disaster, its consequences and the risks associated with lahars, have, for the past six years, led the Philippine institutions to set up a certain number of structural and non-structural responses to which the populations have reacted more or less well. In fact, though the setting up of these structures has been simplified by a good national knowledge of natural disasters and strong international collaboration, they do not always have the expected scope or efficiency. An analysis of these responses gives a glimpse of a certain number of strong points, as well as some weaknesses in the Philippine system of natural disasters management.

## **2. The evolution of the institutional responses**

### **2.1. The official theoretic response system**

The first decree relative to the control of catastrophes in the Philippines dates back to 1978 (Republic of the Philippines, 1978). It led, in 1988, to the setting up of a system of prevention and control (*Calamities and Disaster Preparedness Plan*) at several administrative levels of action and decision (NDCC, 1988). It subordinates to the Coordinating Councils (*Disaster Coordinating Councils, DCC*) from the national (*National-DCC*) to the local scale (*Barangay-DCC*), going through intermediary levels with the *Regional, Provincial, Municipal Disaster Coordinating Councils* (**fig.2**). The National Coordinating Council, which orchestrates everything, is formed of the secretaries from almost all the Ministerial Cabinets, the Head of the Armed Forces, the General Secretary of the Red Cross, the Director of the *Philippine Information Agency*, and a secretary from the Executive Office of the President. Its Executive Director is the Administrator of the Office of Civil Defense (OCD) and his operational arm the *Civil Defense Operation Center*, which places him directly under the umbrella of the Department for National Defense, itself placed under the authority of the President of the Republic.

The NDCC plans the guiding activities in the field of communication, warning signals, emergency transportation, evacuation, rescue, engineering, health, rehabilitation, public education and auxiliary services (fire fighting and Police).

Outside the crisis periods during which it activates the control process, the NDCC formulates a certain number of rules and recommendations (*Memorandum Order*) aimed at improving the system of response to disasters. The inferior councils coordinate, above all, the operational control of the crises occurring at their level of activity. They bring together officials, regional, provincial and municipal representatives of the various national agencies who are all gathered in different *Task Units*. They are also involved in prevention measures and manage their interior organization according to the recommendations issued by the upper echelons. The officials of the BDCC are also taken from local population.

Since 1990, the *Philippine Institute of Volcanology and Seismology* (PHIVOLCS) has been a member of the NDCC in the capacity of seismic and volcanic alert Official. It is in this capacity that it played a major role in the control of the 1991 Mt Pinatubo eruption. We should note that its counterpart in typhoon and floods alert is the *Philippine Atmospheric Geophysical and Astronomical Services Administration* (PAGASA), and that they are both attached to the *Department of Science and Technology* (DOST).

### **2.2. The warning and evacuation system surrounding the 1991 eruption**

The Philippine authorities demonstrated indisputable efficiency to manage the first phases of Mt Pinatubo crisis, when the population was put in a state of alert. Indeed, the volcano's awakening has been diagnosed sufficiently early, the risks were properly defined and the prediction of the zones at risk was based on the examination and interpretation of the volcano's previous historic and geological events. The authorities were able to predict the paroxysmal phase of the eruption, the warning was given on time, and the population was able to be evacuated. The number of recorded victims, mostly due to roof collapses and epidemic aftermath (Ewert & Newhall, 1998; Orejas, 1998a), is quite small considering the intensity of this eruption, thought to be one of the most awesome of this century (Punongbayan & Newhall, 1995)

The first signs of unrest (rumblings, fissures, landslides) were reported to PHIVOLCS in August 1990 by a nun working with the Aetas tribal community living on the north-west side of the volcano. At that time, no direct connection could have been established between these surface manifestations and an awakening of the volcano. However, on April 3, 1991, the nun returned to PHIVOLCS following that seismic tremors, explosions and abnormal steam jets occurred. After a seismic auscultation of the zone, PHIVOLCS was able to conclude that the volcano was reawakening and then, it was decided to evacuate the Aetas villages lying within a radius of 10 km around the summit.

When American volcanologists of the *US Geological Survey* (USGS) confirmed the threat of an imminent eruption, a 5-levels warning and evacuation system was established on May 13, 1991. This system included a concentric danger zone around the volcano, fixing progressively four radii of evacuation from 10 to 40 km between June 7 and June 18, depending on the evolution of the threat. Evacuation orders to 446 centers (June 26, 1991) were conveyed to the relevant Coordination Councils (DCC) or local authorities. These evacuation orders were passed on and received relatively well by the population, and this because of a previous intense work on awareness (notably the projection of films) and on field information, carried out by PHIVOLCS and USGS. The high credibility of the scientific authorities among the population was notably embodied by the director of PHIVOLCS, whose personality came over well in the media and undoubtedly played an important role in this success.

In July 1992, when the Pinatubo activity resumed, the system was reactivated up to alert number 5. It was then revised and adapted (December 1992) according to the new, less intense and decreasing activity of the volcano (Punongbayan & al., 1997).

From that time, as a precaution, the entire zone located within the 10 km radius around the crater has been decreed as permanent high risk sector by PHIVOLCS. All human occupation of this zone remains prohibited (Tayag & al., 1994).

### ***2.3. The complementary warning and evacuation system for lahars and floods (1991 - 1998)***

The above-mentioned system has been supplemented since 1991 by a monitoring, warning (long and short term), and evacuation system in case of lahars and floods. This has been progressively improved.

The long-term alert system was first based on the forecasts established by the *Pinatubo Lahars Hazards Taskforce* (PLHT), an emergency unit regrouping geologists from PHIVOLCS, from the *Philippines Mines and Geoscience Bureau* (MGB) and the *National Institute of Geological Sciences* from the University of the Philippines (UP-NIGS), spontaneously gathered on the initiative of a Philippino-American researcher from the University of Illinois (Chicago, USA) on June 16, 1991. This unit was replaced in 1992 by the *Zambales Lahar Scientific Monitoring Group* (ZLSMG), more autonomous and independent than PHIVOLCS, which is still involved in the evaluation of the threats (Rodolfo, 1995).

The cartography of the high-risk zones was also led in collaboration with foreign experts, notably from Indonesia, Switzerland (*Swiss Disaster Relief*), Japan (*Japan International Cooperation Agency*, JICA) and the United States (*US Agency for International Development*, USAID). The risk charts produced have, since 1993, been integrated in a Geographical Information System (GIS) developed in collaboration with the *Australian International Development Assistance Bureau* (AIDAB) and governed by the *National Development Authority* (NEDA) of Region III (Central Luzon).

From 1991, the follow-up of the lahars was improved thanks to the installation of a telemetrised instrumental monitoring network which was progressively widened. It complements a seismic network to monitor the volcano activity. These are both governed by PHIVOLCS and USGS and presently centralized at the *Pinatubo Volcano Observatory* (PVO) which was created in 1991 on the former U.S. Clark Air Base (Mabalacat, Pampanga).

The short-term system of this network was then developed by combining it with human surveillance (about ten observers from the National Police and the Army), meteorological forecasts from PAGASA, and pluviometric information from a second network governed by the Office of Civil Defense in collaboration with the Japanese (JICA). This all led to a three-levels alert and general evacuation system orchestrated by the Regional Coordination Council (RDCC) of Central Luzon (**fig. 3**) (RDCC III, 1997).

Once warning is given, it is spread at the local level, notably through the various relevant Coordination Councils, using various communication means. The evacuation is the responsibility of both the National Police, which mobilizes a variable number of units (three levels of intervention) depending on the size of the zone concerned, and of the various organizations present on the field (NGO's, local voluntary associations). Different complementary shifts allow for the validation and confirmation of the warning, or the involvement of other crisis control participants, such as media and various government agencies. The population is, then, directed temporarily to the evacuation centers. The majority of these centers (226 at the end of 1993, about 100 in June 1996) are schools or other public buildings (churches, Town Halls, etc.) to which tent camps must sometimes be added in periods of major evacuation. These evacuation centers are managed by both the RDCC and the NGO's. The relief goods are mostly provided by the *Department of Social Welfare and Development* (DSWD) and the NGO's whose role on the field proves fundamental.

This general warning and evacuation system is combined with different measures of information and education depending on the period of the considered alert:

- measures aimed at encouraging the population to accept the need to permanently leave the areas which are risky or likely to become long-term risk zones (months or years);
- preparation measures aimed at improving short-term evacuation alerts (a few days or hours before).

These awareness programs are aimed at three groups of people directly concerned by the lahars: the population directly or indirectly threatened (the evacuees, for example) (RDCC III, nd), the officials and other decision-makers, the journalists and the Police and Army staff assigned to survey the lahars. They are based essentially on the diffusion of posters, risk charts, brochures, booklets, videos and on public and individual interviews (Janda & al., 1997).

As of now, this lahar risk controlling system continues to evolve. Efforts are concentrated mainly on the short-term warning system: equipment, registration methods, the communication system network, public education, organization of future evacuations (RDCC III, 1996). As for the long-term system, it is based on a henceforth dependable cartography of the whole risk zones.

#### **2.4. Victim assistance and rehabilitation program**

Resettlement proved inevitable for the Aetas and the other communities living in the nearby zone devastated by the pyroclastic flows, as well as for the numerous populations directly threatened by lahars as these flowed downstream.

After the evacuations, the victims are usually taken in charge by the NDCC which is responsible for controlling the evacuation centers. After 45 days, another government structure takes over, the *Mount Pinatubo Commission* (MPC) responsible for the planning of more long-term resettlement and reconstruction.

Indeed, immediately after the eruption of Mt Pinatubo on June 26, 1991, the Philippine government developed a structure - *the Presidential Task Force Pinatubo* - capable of planning, guiding and coordinating the efforts at rehabilitating the stricken zones. But in October 1992, this initial structure was dissolved to make way for the MPC, which was placed under the authority of the President of the Republic and empowered to assist the victims of the eruption, lahars and floods. It is composed of eleven members taken from different institutions. It allows for the coordination of about twenty different government agencies. Its activities which were planned to last up to 1997 have finally been extended until December 31, 2000. They are based on a program of rehabilitation and integrated development working toward 4 major goals:

- to provide additional funds for immediate relief of the victims;
- to establish resettlement centers, homesites and townsites;
- to provide livelihoods and employment opportunities;
- to repair, reconstruct or replace government infrastructure damaged or destroyed by Mt Pinatubo (MPC, nd).

It works closely with the various foreign partners above mentioned, and numerous other partners coming from the Private Sector or from non-government organizations. International assistance focuses mainly on reconstruction.

To be resettled, the affected families staying in evacuation centers have to apply for a housing unit to the MPC which generally transfers them into its bunkhouses. The evacuees can remain there several months or even years, prior to be

definitively reaccommodated in a resettlement center. This trip is often difficult owing to the length of the waiting stage and the living conditions in the evacuation centers and the bunkhouses (congestion, lack of supplies...).

After five years of operation, (June 1992 to December 1997), 42,396 families have been reaccommodated in 23 resettlement centers (10 upland and 13 lowland) in a radius of 35 km around the volcano. This program required more than 6,000 hectares of lands and, to accompany this, 366 km of road, 317 km of electrical network and 267 schools have been constructed, within a US\$ 250 millions global fund (MPC, 1998a&b).

Beside, a few other resettlement centers are managed by other national or local government agencies, by provincial governments and by certain NGO's.

In order to provide evacuees with new jobs, the MPC and the Technology and Livelihood Resource Center (TLRC) have set up the Productivity Center lease program aimed at attracting factories around the resettlement areas. Actually, 10 productive centers accommodate 40 factories which employ 4,872 workers from the resettlement sites. These factories (garment, toys...) profit by all-equipped building rented at subsidized rates. They just have to engage at least 70% of their workforce among Mt Pinatubo victims. Near the Madapdap resettlement site (7,257 families), the MPC has also established the regional "Furniture City" which accommodates 14 factories employing 467 craftsmen from the nearby center. To accompany these projects, the MPC has worked out an adapted training program for the rural displaced populations (Siason, 1996; Unite, 1996; Cervantes & al., 1997; MPC, 1998a&b; TLRC, nd&1998).

In 1998, the MPC planned to resettle 9,000 lahar-displaced families still remaining in bunkhouses or evacuation centers. This, notably through the opening of a 24<sup>th</sup> resettlement site and the extension of other ones (MPC, 1998a & b). On the other hand, the MPC and the TLRC begin to introduce the ASAHAN program whose mission is "*to provide the poor with the means to work and earn a living (...) and to enhance the capability of the ASAHAN Partner-Network in providing enterprise development services needed by the poor*" (MPC-TLRC, 1997; MPC, 1998a).

Parallel to these different relief and reconstruction activities, an important protection program for the zones prone to lahars and floods has been in operation since 1992. It uses a certain number of technical solutions (barriers, dams, dikes, drainage gutters, spillways) aimed at limiting and controlling the flow of sediments from their source to the sea along the main active lahar channels. This vast engineering program, quite controversial and quite costly, has already resulted in the dredging of tens of million cubic meters of material, the construction of 85 km of dikes, and the building of numerous bridges. It goes on presently with increasingly huge projects leading to sacrifice numerous downstream sectors converted into reception basins for lahars.

### **3. The response of the population**

#### **3.1. During the warnings and evacuations**

During the volcano's eruptive phase in June 1991, most of the population reacted quite well to the evacuation orders, and this owing to the previous awareness, preparation and coordination efforts from the authorities on the field. However, some evacuated Aetas changed their minds and returned on the mountain to seek refuge and comfort from their God in caves. Others refused to leave, convinced that the eruption would not be violent enough to reach them, and, above all, scared at the thought of abandoning their belongings and their crops (Alcayde, 1991 in Tayag & al., 1997).

At the second warning in July 1992, the population reacted even better for they were more prepared and aware by the previous events. In spite of the repeated pleas from PHIVOLCS, 300 Aetas families however refused to evacuate (Crisostomo, 1992).

As for lahar warning, the quality of the population response remains irregular and reflects some difficulties on the part of the authorities to properly manage the system set up, notably during the first few years, which ended on several occasions in tens of victims.

Apart from those problems relative to the evacuations for which it was sometimes necessary to use force (Montano, 1994), there are, in the population, numerous psychological trauma demonstrated notably by the graffiti on the walls of the abandoned houses: the people seem to be noticeably traumatized by these evacuations. During the first ones, some believed it was the end of the world, or that death was immanent. Numerous symptoms (fits of hysteria, stress) persist in the refuges after the evacuations, in particular for children (Jimenez, 1993 in Banzon-Bautista, 1997). Stress also touches those still living near the lahar channels which are active during rainy season periods, and among those anxiously awaiting the warning signals.

However some positive responses have been developed among these people. Indeed, in some villages, the inhabitants develop their own surveillance and warning system with their own observation teams. Others, even more organized, proceed to the mobilization of available vehicles to make up for the shortage of official means needed for the evacuations.

But the main source of difficulties and danger stems from the fact that one part of the population, at least those most threatened, insist on remaining in their native villages, or on returning there systematically until the coming of the lahars. We will see that this behavior, which attests to a certain dose of fatalism, is especially linked to the unattractive and ill-adapted character of the resettlement or evacuation centers. These ones offer, indeed, only a few socio-economic alternatives and impose a "social adaptation" to those who settle there permanently. The very strong attachment of these people, for one part rural, to their origins, does nothing but reinforces their behavior.

According to a study carried out during the first months of 1998 in the Pasig-Potrero River basin (Gaillard & al., 1998; Gaillard 1999), 12% of the inhabitants of the most threatened zone have already lived in resettlement centers (60% at Bacolor Town Proper). They explain their come back by the lack of job (31%), the remoteness of this one (21%) and the attachment to their native villages (18%).

### ***3.2. After the catastrophe***

Considering the difficult living conditions in these centers, as well as the waiting period before settling there, the population still remaining in the lahar channels gradually adapts more or less passively to their new living conditions in the risk zones. Thus, some people raise their homes above concrete posts. Those who have lost their houses can only dig to exhume a few recoverable objects of value before leaving to settle some meters away in fortune shelters. Others protect their belongings with sandbags. Unfortunately, all these protection measures do not have the same efficiency facing lahars. Indeed, while the houses raised above broad and strong concrete posts have already withstood to several lahar seasons and, thus, seem to be one the best protection means, sandbagging, almost systematic in certain areas, does not seem very efficient facing lahars (Rodolfo, 1995). Otherwise, every month of June, at the onset of the rainy season, many people choose to leave their home as a preventive measure. For instance, 17% of the Pasig-Potrero watershed population rent a house or relocate to the dwelling of other family members in Angeles City or Metro Manila, such as in the resettlement centers (Gaillard & al., 1998; Gaillard, 1999). Indeed, some important flows of population appear, at this time, between the resettlement sites and the threatened villages; the men trying to protect at least their wives and their children while they watch the household belongings (Cola, 1997; Gaillard, 1999). Some subsistence activities have also been created: small business, cultivation, smuggling... During the first years following the eruption, some people have tried to adapt the agricultural production to the periodical threat. There were quick growing crops (tomatoes, peanuts, sweet potatoes) instead of the traditional annual yielding produce such as rice or sugar cane. In those zones still at risk, there are efforts to ward off nature's bad luck by organizing religious processions and prayer sessions. Protests against the policy of channeling the lahars and of creating vast spreading zones are often vehement. According to the above mentioned study (Gaillard, 1999), almost 50% of the inhabitants of Bacolor have an unfavorable point of view on the authorities, feeling their town sacrificed to protect San Fernando and Guagua. The criticisms are sometimes aimed at the local authorities and can even become sources of conflict between neighboring communities, suspecting each other of willingly damaging dikes (Banzon-Bautista, 1997).

In the resettlement centers, in spite of the shortage of facilities, the lack of income sources and the difficulties in adapting to congestion or to estrangement from the native village, we can see various initiatives developing among the least resigned. Shopkeepers and craftsmen reopen their shops, local transportations (wheelers, tricycles...) have been developed, while some farmers return to cultivate their plots of land if these are not buried or too far away. Solidarity helps a lot, but the mood is often morose. They comfort themselves by awaiting their return to their native places, maybe in a few years.

### ***4. The weaknesses in the institutional response system***

As we could see through the brief analysis of recent crises linked to the eruption of Mt Pinatubo, the Philippine system of prevention and management of natural disasters shows a certain number of strength points. The main result has been the low number of casualties since 1991 and this, in spite of the presence of these particularly intense and recurrent phenomena which are lahars. Moreover, the noticeable improvement of the system from year to year, favored no doubt by an important international contribution, attests to the willingness of the authorities to undertake their responsibilities. However, the analysis of the responses and the reactions of the populations, as well as those of the other official or non-official participants involved in crises management, media included, still shows a number of deficiencies and dysfunctions at the root of the authorities difficulties to best control this post-catastrophic situation.

#### ***4.1. An over-technocratic approach to reconstruction***

The main reproach that can be made of the rehabilitation policy set up around Mt Pinatubo is the very technocratic planning of the resettlement which does not live up to the expectations of the evacuees. Indeed, the authorities hope to spare on the equipment in basic public services (schools, markets, hospitals) by creating huge centers much larger than those of the evacuated villages. This logic of development is in keeping with a more global plan aimed at converting Central Luzon Region into an area of economic transition, providing a large human and industrial reservoir located between Metro Manila and the rich northern provinces. It is planned to maintain only a few agricultural activities though this region's economy was formerly based on agriculture (Banzon-Bautista, 1997).

This technocratic notion of development is reflected in uniform resettlement centers recognizable by their checked urban-type architecture with modern public buildings placed around central squares, production centers (huge buildings planned to accommodate industries), and identically reproduced houses. During Philippine summer (April and May), the resettlement areas remain very hot, especially inside the houses roofed with iron sheet. The population seems not really inclined to adapt to these, especially considering that they are partly farmers in origin, and that the foreign and national investors are a bit hesitant to use this labor supply and its production tools. Another problem exists about the amortization fee asked by the MPC as usufruct, to each household. Indeed, the resettlement centers inhabitants, sometimes gathered in association, do not agree to pay roughly 250 Philippine pesos (about US\$4) monthly (P50 of which goes toward the maintenance of the centers). This tax aimed at legitimizing the cost of development, recovery and maintenance of the resettlement sites, has always been a root of conflict because the usufruct agreement has never been clear. For instance, before the last presidential election, some politicians promised free housing to Mt Pinatubo victims. Up to now, resettlement sites dwellers have not paid this fee yet (Orejas, 1998b).

A certain lack of flexibility is felt, then, in the planning and the physical and socio-economic rehabilitation of Central Luzon. It would seem propitious to adapt the programs in accordance with the cultural, ethnic and socio-professional specificities of the different communities there (Anderson, 1993). With respect to the resettlement phase, this adaptation should rather take into account the expectations of the affected people which are the most concerned.

#### ***4.2. A lack of consultation of the population***

The population, indeed, seems little involved in the choice of reconstruction (Banzon-Bautista, 1997). This lack of participation which also concerns the local authorities is due to a centralization of the powers and decisions quite unfavorable to dialog. The government's first target seems to be to reconstruct the infrastructures as quickly as possible without really bothering about the expectations and the needs of the affected communities. This results in a low motivation to recreate a social organization and to the development of a culture of dependence on the part of the evacuees on local voluntary associations and on various government organizations which undertake the management of the centers. Nevertheless, in some sites managed by NGO's, the inhabitants themselves gradually assume the administration, but the number of candidates likely to undertake such functions soon proved limited, likewise in the official centers, where only 22% of the evacuees are involved in the ongoing community life of the resettlement site (Gaillard, 1999).

Certain officials are agree to point out the need to create complementary social and economic structures notably at the local level, to better consider the needs of the population and, above all, to respond to them.

A few other centers, financed by the private sector and not really recognized, if at all, by the Mount Pinatubo Commission, seem to be abandoned by the government. These communities are forced to manage alone, as they do not benefit particularly from the basic commodities and infrastructures (JICA, 1995). Outside of the centers this feeling of being abandoned persists also in certain villages converted in reception basins for lahars, in Bacolor for instance (Vizcarra, 1995).

#### ***4.3. Ill-adapted and poorly distributed solutions***

The technocratic ambitions are reflected also in the technical and financial choices adopted concerning the protection of the zones threatened by lahars. Indeed, the institutions have embarked since 1991 on a vast lahar diking program



privileging once more, technical solutions to the detriment of socio-economic problems. This certainly gives an impression of visible actions, but that are not satisfying from the view of the numerous evacuees awaiting employment or transportation means to go to work. Moreover, some hastily constructed dikes have not always proved completely satisfying, which just increased the feeling of false security induced by the works. The haste and the lack of planning have sometimes led to useless sacrifices of zones with high agricultural potential during the creation of spreading basins. It seems also that a certain number of centers have been established in threatened zones (Tayag & al., 1994; Gaillard & al., 1998; Gaillard, 1999). It was even suggested to dump waste water in lahar areas such as Porac or Bacolor (Today, 1997; The Philippine Journal, 1998). It should have enriched the soils and induced the growth of plant life.

An intense debate highly supported by the Philippine media, always oppose those in favour of technical solutions of the problems (dike construction) to those who reproach the government for not investing sufficiently in the socio-economic development, notably in resettlement centers to hold residents (Rodolfo, 1995; Manila Bulletin, 1995) (fig. 4).

It seems necessary, however, to find a happy medium between the short term structural measures and the long term non-structural measures. Indeed, at the beginning of 1998, there remained 9,227 families to be protected from lahars (MPC, 1998a).

#### *4.4. The problems of coordination and communication*

The difficulty for the authorities to best control rehabilitation is accentuated by some problems of internal and external coordination (De Leon & Laigo, 1993; Gastardo-Conaco & al., 1993). Indeed, the different government agencies involved tend not to work together, which is incompatible with the initial objectives, one of consensual, integrated and especially decentralized reconstruction management. These difficulties are also found between local and regional governments, and through the relationships with the NGO's or private investors. The government must, for example, play a fundamental role of coordination from the very first stages of the resettlement process by negotiating the purchase of lands with the private owners (Banzon-Bautista, 1993). We notice also that the institutional plan for coordination, organized by the Committees (DCC), is not always adhered to and that certain intermediate steps are bypassed because of hierarchical short-circuiting.

These coordination and communication problems improves the role of the NGO's which, thus, often tend to fill the deficiencies of official response system, especially at the local level. These problems also result in a slow rehabilitation process, so that numerous persons are forced, for example, to stay longer than expected in the evacuation centers. They are often manifested in the duplication of tasks, the very root of confusion, and through dysfunctions, notably in relief distribution, as well as during the evacuations. But one of the most important problems seems to be the quality of the warning system. Indeed, according to the survey performed among the most threatened populations of the Pasig-Potrero basin (Gaillard & al., 1998; Gaillard, 1999), about 32% of the population did not receive a lahar warning signal in this area. It seems to be due to a lack of written consensus among scientists during the formulation of the alert messages (Janda & al., 1997) and, while only the BDCC is authorized to order the evacuation of a threatened area, to the multiplicity of the warning and information sources, justified by different reasons (political, nuisance...) (Jimenez, 1997; The Philippine Journal, 1997). This leads to wrong interpretations and to the dilution of the messages. Moreover, sometimes the signals reach the population after the lahars (Tayag & al., 1994; Malacpac, 1995).

According to some experts (Colas, 1997), it seems preferable to focus the alert at the local level by the intermediary of the local Coordinating Committees (BDCC) whose members are themselves villagers who know their sector very well. At this level, some problems of coordination and communication also appear concerning the population awareness system. Indeed, the widespread system of distribution of such information by word of mouth through the captains and the councilors of each village, does not seem very efficient. The organization of conferences or the distribution of booklets are also not very spread (Gaillard, 1999). Moreover, during the first crisis of Mt Pinatubo, old tensions between scientists, which could very well look like power struggles, often reappear.

Many cases of corruption have been pointed out concerning the misappropriation of relief goods and public market, but also about some "facilitation fees" asked by certain misrepresenting MPC personnels, to speed up the applying process for housing units (Orejas, 1998c). Very recently, the MPC Executive Director was sacked due to the various controversies that have rocked the commission since his takeover in July 1998 (graft, kickbacks, employees dismissing) (Orejas & Jimenez, 1999).

#### 4.5. *A lack of training and of means*

The organization of the response system suffers also from deficiencies inherent to the lack of training of the staff and especially the shortage of equipment and human resources. The shortages affect the reconstruction process as well as the emergency phases, but tend to be overcome with time and experience. Despite a very elaborate organization, the risk control system linked with the lahars has sometimes given false alarms, or has worked too slowly. The false warnings were generally due to a lack of training of the surveillance personnel (members of the police service or of the army), as well as too-frequent staff turnovers which prove little apt to favor learning. This resulted, in some areas, in a lack of interest and a loss of attention of the population concerned (Tayag & al., 1994). The slowness of the warning system, not including the above mentioned communication problems, has sometimes been induced by technical breakdowns which also increase the problem of the quality and maintenance of the monitoring instruments often located in remote areas. The lack of resources is, therefore, also felt in the surveillance and warning systems and have often led to the search for foreign logistic support. During evacuations, the shortage of available official vehicles often forces people to use their own means (in most cases they walk) to escape the lahars. Because of the lack of surveillance, and considering the often too-long waiting periods for distribution, the relief goods stocks are sometimes looted by the evacuees themselves or even by some unscrupulous officials (Gastardo-Conaco, 1993). Many evacuated villages have suffered this fate. Moreover, the people accommodated in the evacuation centers have greatly suffered from general poor hygienic and living conditions due to the lack of sanitary equipments, from overcrowding as well as to the shortage of food, drinking water and medicines. Finally, reconstruction is curbed because of the lack of qualified workforce and above all by the poor financial compensation given to the workers.

#### 4.6. *A combination of indirect aggravating factors*

Apart from these direct vulnerability factors in the official management system, there is also a certain number of indirect factors linked to the context surrounding the decisions. These indirect factors are added to the previous ones when they are not the very origin, limiting or restricting the scope and the efficiency of the institutional activities. We distinguish:

- *The politico-administrative factors*: they were in play from the onset of the crisis, accentuating some existing tensions and complicating the coordination and decision process. Indeed, unlike other particularly active volcanoes in the Philippines like Taal, Mayon or Bulusan volcanoes, Mt Pinatubo is located at the apex of three provinces. Because of this, the National Coordination Committee had to work - not without difficulty - with three different governors and their respective teams. Moreover, two of these governors were at loggerheads with each other at the time of the eruption. The coordination was made even more difficult by the presence of four large urban areas (Angeles City-Mabalacat, Tarlac, San Fernando and Olongapo), tens of smaller municipalities, hundreds of villages and huge American and Philippine military bases. At the time of the events, political tension between the American and Philippine governments about the renewal of the agreements for the American military presence was worsened by the crises which finally led to the withdrawal of the US troops from Clark Air Base (Pampanga), one year before the planned withdrawal of those of Subic Bay (Zambales). During the crisis, the decision-making context was also disrupted by the presence of a guerrilla movement raging on the sides of Mt Pinatubo and by the approach of the presidential elections of May 1992 (Punongbayan & al., 1997).

The political tensions are also felt in the reconstruction management, slowing down the process on the one hand, and strongly influencing the adopted strategies on the other. The political reticences are largely conditioned by the electoral stakes. They have sometimes been such (notably in the protection program of the affected zones) that, in July 1995, the director of PHIVOLCS suggested the set up of Martial Law in the three affected provinces so as to boost the rehabilitation process, and especially to express his exasperation on seeing it compromised by the numerous political interventions and the bureaucratic slownesses (The Manila Chronicle, 1995; Manila Standard, 1995).

On the other hand, we cannot say that the local politicians are particularly in favor of the resettlement centers where their powers are diluted because of the regrouping of populations coming from diverse precincts. They are, on the whole, more in favor of the engineering measures which give them a favorable image of visible men of action and which favor all forms of dealings with the swarm of private firms solicited for the construction.

As such, a huge dike built on the two banks of the Pasig-Potrero river (the famous 'Megadike') is the subject of increasingly problems about its reliability and its efficiency (fig. 5). Once more, old politico-technical quarrels are rekindled between those in favor of entire technical prevention measures (protection works) and those in favor of fewer

structural measures (resettlement aide, care, information, evacuation, etc.). At the center of these problems, there is a Philippino-American geologist whose criticisms have been widely spread by the national press. He questions, on the one hand, the exorbitant cost (about US\$30 to 35 million) of this huge work (46 km long), but above all its reliability considering that, in keeping with his predictions, the dike did not completely withstand to the lahars (numerous breaches, notably the destruction of a transverse dike which occurred in 1996, only two weeks after its inauguration), endangering the population who were mostly convinced of its reliability. The fragility of the dike is explained by the fact that only 40% of its structure is reinforced with a concrete armor. The remaining 60% is made of unreinforced material taken from lahars deposits (Agapay & al., 1997). The main detractor of this project speaks, then, of a real political, economic and financial scandal (Maicaran, 1997). Moreover, he pointed out that the reinforced portion of the dike has been built essentially to protect the urban parts of San Fernando and Angeles City for obvious political reasons linked to the voters density in these sectors. These criticisms against the government are directly aimed at the officials of roads and public works who, for their part, challenge this officially. Furthermore, the resistance to the erosion of the dike foot seems also compromised in the medium term by the illegal granulates quarrying carried out in the river bed (Malabanan & Empeno, 1997). The government was quick to reassure the population by ordering an inspection of the rehabilitation works (Alagos, 1997).

Moreover, as we have already before seen, the lahars were at the center of the 1998 electoral campaign. Some candidates described themselves as lahar fighters, or promised free housing for Mt Pinatubo victims, stirring up trouble and clouding even more the mind of the Central Luzon dwellers.

- **Cultural factors:** as we pointed out earlier, these heavily influence the behavior of the population during the evacuations as well as the policy of rehabilitation and notably of resettlement. Attachment to Mother Earth is very strong, particularly among the Aetas tribe which tries in vain to find its roots. Moreover, the language barriers between the newspapers, mostly in English, and the populations increase the difficulties in communication and information.

- **Socio-economic factors:** with respect to the permanent economic difficulties, these could only have been amplified by the reconstruction, and the loss of numerous agricultural surfaces. If a minority of people grow rich through the technical achievements, the majority of the affected population suffer and remain dependent on government and international aid. These difficulties sometimes lead to opportunist behaviors, lacking solidarity, such as the abuse of stocks, reticence on the part of certain landowners and shopkeepers to sale their land or their goods, smuggling, the refusal to pay the occupancy tax for the new lodgings; according to this last point, the authorities threatened to expel thousands of residents in September 1997 (Due, 1997).

## 5. Conclusion and outlooks

This 7-years follow-up of the consequences of this volcanic disaster shows some difficulties and disturbances especially at the socio-economic and geographic levels: population transfer, abandoning of territories, creation of new village communities, economic restructuration and difficulties etc., as well as on the psychological level (loss of identity, trauma, stress).

Concerning the institutional level, the balance of some indicators of vulnerability (*cf.* matrix of institutional dysfunction presented in **Tab.2**), enables us to highlight a definite capacity of the Philippine authorities to improve their management of the different crisis and before-crisis situations associated with this eruption and its aftermath. The same cannot be said for the rehabilitation phase. It is too rigid, technocratic, and quite often conditioned by political interests. It suffers from deficiencies and diverse dysfunctions which are also explained by the fact that the effort necessary to recover entirely is huge, covers a vast area, and cannot emanate only from the public institutions (A développeur?).

In the more general field of volcanic risk prevention and control, it seems important to generalize this type of diagnosis concerning institutional vulnerability by increasing case analyses. In keeping with this goal, we suggest, in **figure 7**, a protocol of reproducible analysis partially carried out in this study. It should facilitate the comprehension and the modeling of the different institutional vulnerability systems, by privileging deductive analysis. For this, different diagnostic techniques are advised (interviews, surveys, damage reports, bibliography studies). The efficiency, scope, and relevance of the different institutional measures taken in the area of risk or crisis management - at different decision-making levels, as well as before, during and after the crises - are then deduced after confronting the behavior,

reactions and points of view of many of those involved in risk or in crisis management, be they officials or non-officials (the population, authorities, NGO's, media, etc.). This kind of observations enables us to show the different institutional factors of weakness or of obstacles, and to eventually integrate them in a more global model of vulnerability of the threatened populations. On the operational level, this can be done directly by the prescription of correction measures or solutions.

This type of analysis is therefore also concerned with the evolution in the times of the official system of disaster management (improvement, stagnation or deterioration) and enable us to understand the emergence and the functioning of possible parallel systems of control, most often non-official, as those developed by some ethnic or religious groups in the Philippines (Insauriga, 1996; Roque, 1998).

## References

- Agapay, N.C., Baesa, G.T., Digdigan, A.G., Rivera, R.L., Rodolfo, K.S. (1997) - Major reorganization of the Pasig-Potrero lahar channel, and the implications for Pampanga towns, no ed., 13p.
- Alagas, P. (1997) - Gov't engineers ordered to monitor rehab works on P 1.4 M. Megadike, in *Manila Standard*, 09/04/97.
- Anderson, M.-B. (1993) - Lessons in rehabilitation/resettlement efforts: implications for Mt. Pinatubo assistance programs - *Philippine Journal of Public Administration*, University of the Philippines, Vol.XXXVII, N°4, pp. 351-374.
- Banzon-Bautista, M.-C.-R. (1993) - *In the shadow of the lingering Mt. Pinatubo disaster* - University of the Philippines press, Manila, 292 p.
- Banzon-Bautista, M.-C.-R. (1997) - The Mount Pinatubo disaster and the people of central Luzon - in *Fire and Mud: eruption and lahars of Mt Pinatubo, Philippines*, C. Newhall and R.S. Punongbayan eds, Seattle: University of Washington Press, 1126p.
- Cervantes, D., Sapnu, R. (1997) - 2,100 lahar-displaced families get new houses, in *Philippine Daily Inquirer*, 18/12/97.
- Cola, M.-R. (1997) - Responses of Pampanga households to lahar warnings: lessons from two villages in the Pasig-Potrero river watershed - in *Fire and Mud: eruption and lahars of Mt Pinatubo, Philippines*, C. Newhall and R.S. Punongbayan eds, Seattle: University of Washington Press, 1126p..
- Crisostomo, M. (1992) - Aetas refuse to evacuate, in *Daily Globe*, 08/18/92.
- De Leon, C.-A. & Laigo, B.-L. (1993) - Flood relief and rehabilitation in Ormoc: experiences and insights of administrators - *Philippine Journal of Public Administration*, University of the Philippines, Vol.XXXVII, N°4, pp.327-335.
- DSWD (1997) - Mt Pinatubo statistics, DSWD Region III, San Fernando, 12p.
- Due, J. (1997) - Pinatubo settlers face eviction, in *TODAY*, 09/01/97.
- Ewert, J.W., Newhall, C.G. (1998) - Volcanic crisis in the Philippines: the 1991 eruption of Mt Pinatubo, Internet: CVO Homepage <<http://vulcan.wr.usgs.gov/home.html>>, 5p.
- Gaillard, J-C (1999) - *Vulnerability of population to volcanic hazards and lahars of Mount Pinatubo (Philippines): case study of Pasig-Potrero River basin (Pampanga province)*, Report on mission for CIFEG, Orléans (Fra), CIFEG, 113p.
- Gaillard, J-C, D'Ercole, R., Leone, F. (1998) - Cartographie de la vulnérabilité des populations face aux risques volcaniques et aux lahars du Pinatubo (Philippines): cas du bassin de la rivière Pasig-Potrero, in *PANGEA, Bulletin du Centre International pour la Formation et les Echanges en Géosciences (CIFEG)*, Orléans, France n°29-30, Juin-Dec. 1998.

- Gastardo-Conaco, C., Hernandez, L.-B, Racillo, J. & Sycip, L.-M.-Y. (1993) - Flood relief and rehabilitation in Ormoc: experiences and insights of field workers and beneficiaries - *Philippine Journal of Public Administration*, University of the Philippines, Vol.XXXVII, N<sup>o</sup>4, pp. 336-350.
- Insauriga, S.-I. (1996) - Natural disaster Management Among Major Cultural Communities in Southern Mindanao: an analysis - Thesis proposal presented to the Faculty of Graduate School, University of Santo Tomas, Manila - 3 p.
- Janda, R.-J., Daag, A.-S., Delos, P.-J., Newhall, C.-G., Pierson, T.-C., Punongbayan, R.-S., Rodolfo, K.-S., Solidum, R.-U. & Umball, J.-V. (1997) - Assessment and response to lahar hazard around Mount Pinatubo 1991 to 1993 - in *Fire and Mud: eruption and lahars of Mt Pinatubo, Philippines*, C. Newhall and R.S. Punongbayan eds, Seattle: University of Washington Press, 1126p.
- JICA, DPWH (1995) - The study on flood and mudflow control for Sacobia-Bamban/Abacan river draining from Mt. Pinatubo - Japan International Cooperation Agency/Department of Public Works and Highways/Government of the Philippines, Progress Report (3).
- Jimenez, E. (1997) - Lahar folk warned against false alarm, in *Philippine Daily Inquirer*, 06/27/97.
- Leone, F. (1996) - Impacts et gestion des crises liés à l'éruption du volcan Pinatubo (1991-1996). Contribution à l'analyse du système institutionnel philippin de réponse aux catastrophes volcaniques - in *PANGAEA, Bulletin du Centre International pour la Formation et les Echanges en Géosciences* (CIFEG), Orléans, France, pp.13-34.
- Macairan, E.Z. (1997) - Megadike has no chance against lahar, in *Manila Standard*, 09/06/97.
- Malabanan, J., Empeno, H. (1997) - Megadike may collapse due to illegal quarrying, in *The Manila Times*, 08/03/97.
- Manila Bulletin (1995) - The "Catch Basin" debate, 09/26/95.
- Manila Standard (1995) - Martial Law proposed in lahar-affected areas, 08/03/95.
- Montano, E. (1994) - Forced flight, in *People's Journal*, 09/26/94.
- MPC (nd) - Primer of Mt Pinatubo Commission, Clark Field, MPC, 15p.
- MPC (1996) - Accomplishment report covering the period June 1992 to 30 June 1996 Clark Field, MPC.
- MPC (1998a) - 1997 annual report: Life after Mt Pinatubo: New life, new home, new future, Clark Field, MPC, 24p.
- MPC (1998b) - Overview of the MPC resettlement program, Clark Field, MPC, 7p.
- MPC, TLRC (1997) - ASAHAN: Alalay sa hanapbuhay, San Fernando, TLRC, 2p.
- NDCC (1988) - Calamities and Disaster Preparedness Plan - National Disaster Coordinating Council, Department of National Defense, Republic of the Philippines, 72 p.
- NOCUM, A., (1998) - Gov't men fortifying megadike in Pampanga, in *Philippine Daily Inquirer*, 06/21/98.
- Orejas, T. (1998a) - Seven years after the blast: black future awaits Pinatubo victims, in *Philippine Daily Inquirer*, 06/16/98.
- Orejas, T. (1998b) - Pinatubo victims slam new bid to collect fees, in *Philippine Daily Inquirer*, 09/09/98.
- Orejas, T. (1998c) - Lahar victims decry extortion, in *Philippine Daily Inquirer*, 10/15/98.
- Orejas, T., Jimenez, E. (1999) - Project irregularities: Fired Pinatubo exec face raps, in *Philippine Daily Inquirer*, 01/06/99.
- Palacpac, O.S. (1995) - Warning system for laharlandia, in *Malaya*, 10/29/95.

- PHIVOLCS (1997) - Update on lahar hazards in the Pasig-Potrero basin (August 27, 1997), Quezon City, PHIVOLCS, 14p.
- Punongbayan, R.-S., Newhall, C.-G. (1996) - Chronique de l'éruption du Pinatubo: le dispositif d'alerte - *Stop Disasters*, IDNDR, N°25, pp.11-14.
- Punongbayan, R.-S., Newhall, C.-G., Bautista, M.-L.-P., Garcia, D., Harlow, D., Hoblitt, R.-P., Sabit, J. & Solidum, R.-S. (1997) - Eruption hazard assessments and warnings - in *Fire and Mud: eruption and lahars of Mt Pinatubo, Philippines*, C. Newhall and R.S. Punongbayan eds, Seattle: University of Washington Press, 1126p.
- Republic of the Philippines, (1978) - Presidential decree n° 1566: strengthening the Philippines disaster control, capability and establishing the national program on community disaster preparedness, Republic of the Philippines, Manila, 6p.
- RDCC III (nd) - Public awareness program at the barangay level, RDCC III, San Fernando, Pampanga, 5p.
- RDCC III (1996) - Disaster situation & preparedness update - Report, RDCC III, San Fernando, 22p.
- RDCC III (1997) - Operation plan (OPLAN) Sakolo, RDCC III, San Fernando, Pampanga, 15p.
- Rodolfo, K.-S. (1995) - *Pinatubo and the politics of lahar. Eruption and aftermath, 1991* - University of the Philippines press, Manila, 342 p.
- Roque, A. (1998) - Nueva Ecija folk build rafts for La Nina floods, in *Philippine Daily Inquirer*, 11/03/98.
- Siason, L.-L. (1996) - Mt Pinatubo: turning disaster into an opportunity for change, *Mag Negosyo*, Oct. 1996, pp. 25-40.
- Tayag, J.-C. (1994) - Volcanic disaster mitigation and development planning for the subregion affected by the Pinatubo volcano 1991-1992 eruptions and lingering hazards - Ph.D Dissertation in Urban and Regional Planning under the RONPAKU PROGRAM of the Japan Society for the Promotion of Science, Institute of Socio-Economic Planning, Tsukuba University, Japan, 276 p.
- Tayag, J.-C., Daag, A.-S., Insauriga, S.-I. & Quiambao, R.-B. (1994) - Evacuation scheme for lahar-affected/endangered areas - in *Lahar Studies: impact of the 1993 lahars and long-term lahar hazards and risks around Pinatubo volcano*, PHIVOLCS-UNESCO, pp.56-71.
- Tayag, J.-C., Insauriga, S.-I., Ringor, A & Belo, M. (1997) - People's response to eruption warning: the Pinatubo experience, 1991-1992 - in *Fire and Mud: eruption and lahars of Mt Pinatubo, Philippines*, C. Newhall and R.S. Punongbayan eds, Seattle: University of Washington Press, 1126p.
- TFMP (1991) - Rehabilitation and reconstruction program for Mt. Pinatubo-affected areas - Task Force Mount Pinatubo, Manila, Philippines, 62 p.,
- The Manila Chronicle (1995) - Editorial: Lahar and Martial Law, 07/29/95.
- The Philippine Journal (1997) - Evacuation order to come only from RDCC—PHIVOLCS, 06/04/97.
- The Philippine Journal (1998) - Pampanga execs buck toxic waste dumping in lahar areas, 03/05/98.
- TLRC (nd) - The Productivity Center (PC) lease program, San Fernando: TLRC., 11+2p.
- TLRC (1998) - Productivity Center lease program: status of occupancy and employment generation, San Fernando, TLRC, 2p.
- Today (1997) - Two Pampanga firms to dump waste water in lahar areas, 04/30/97.
- Unite, R., (1996) – World class “Furniture City” rising, in *Mag Negosyo*, Oct 1996, p.35.
- USACE (1994) - Mount Pinatubo Recovery Action Plan. Long term report. Eight river basins - United States Army Corps of Engineers, Environmental Assessment, Volume III, Republic of the Philippines.

Vizcarra, N. (1995) - Life in "Lahar World": we feel we've been abandoned by our gov't, in *Philippine Daily Inquirer*, 01/18/95.

Wolfe, E. W (1992) - The 1991 eruption of Mt Pinatubo, Philippines, in *Earthquakes and Volcanoes*, Vol. 23, n°1, pp.5-37.

	<b>Estimated (Mm3) annual sediment delivery</b>	<b>Dead and missing</b>	<b>Number of affected families</b>	<b>Number of damaged houses</b>
1991	805	957	249 371	112 236
1992	555	19	164 400	6 212
1993	505	43	353 658	6 474
1994	910	61	169 295	3 415
1995	187	97	123 792	14 490
1996	87*	6	44 597	46
1997	160**	26	224 610	285

*From the data of: PHIVOLCS (1997) and DSWD (1997).*

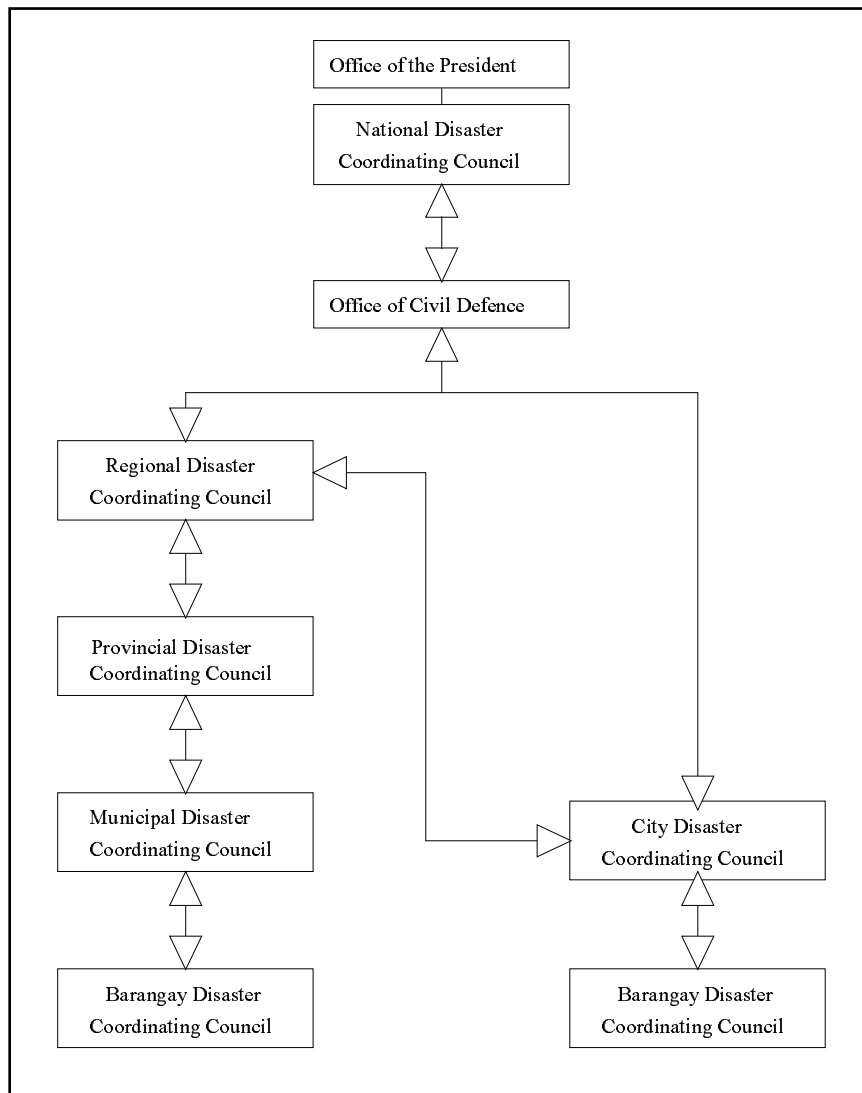
\* Total only for Pasig-Potrero and Sto Tomas-Marella Rivers.

\*\* Expectations.

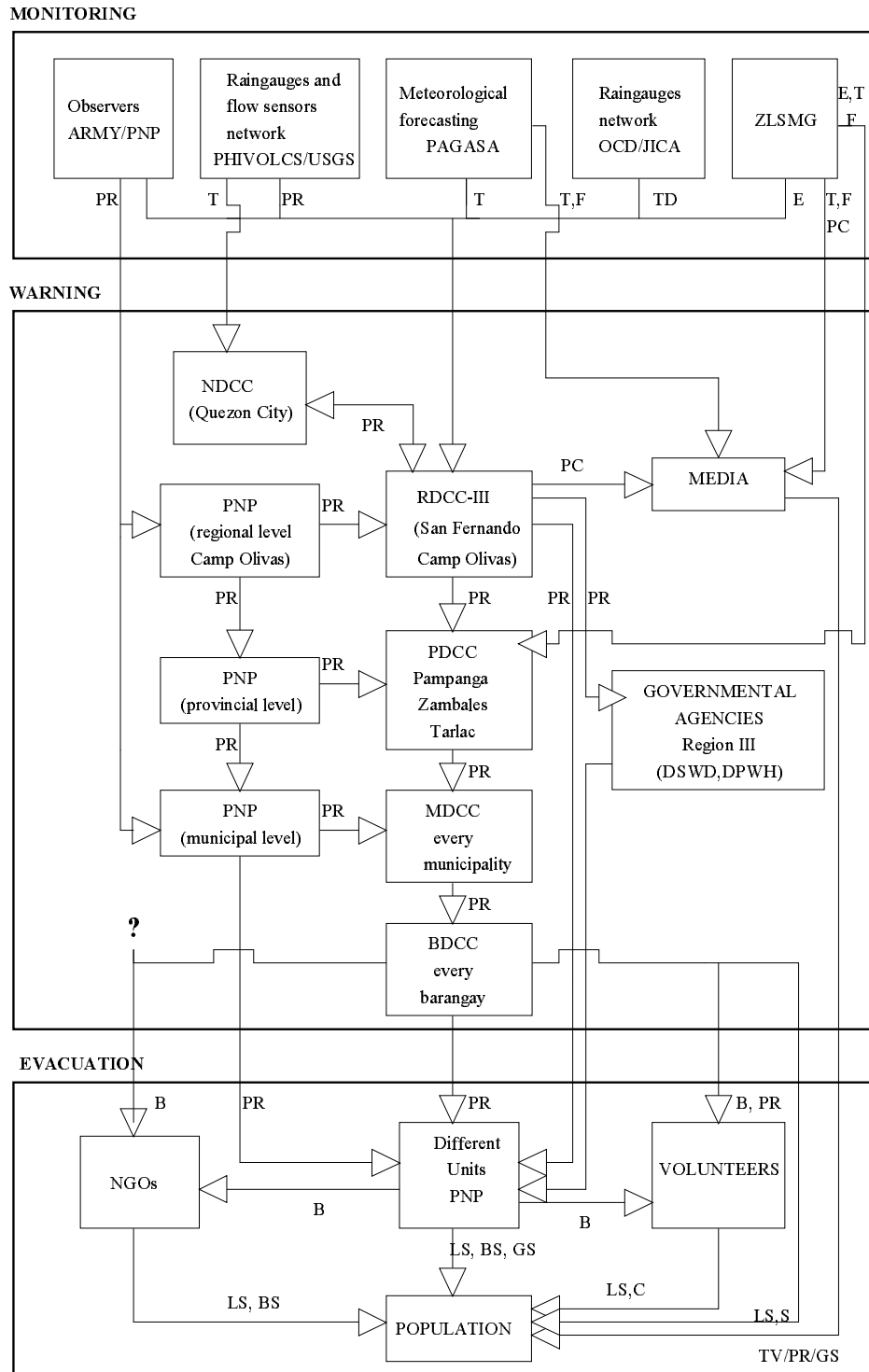
***Tab. 1: Damages and casualties of the eruption and lahars of Mt Pinatubo***



*Fig. 1 - Extension of the different destructive phenomena associated to the Mt Pinatubo volcano eruption and its aftermath (taken from PHIVOLCS data)*



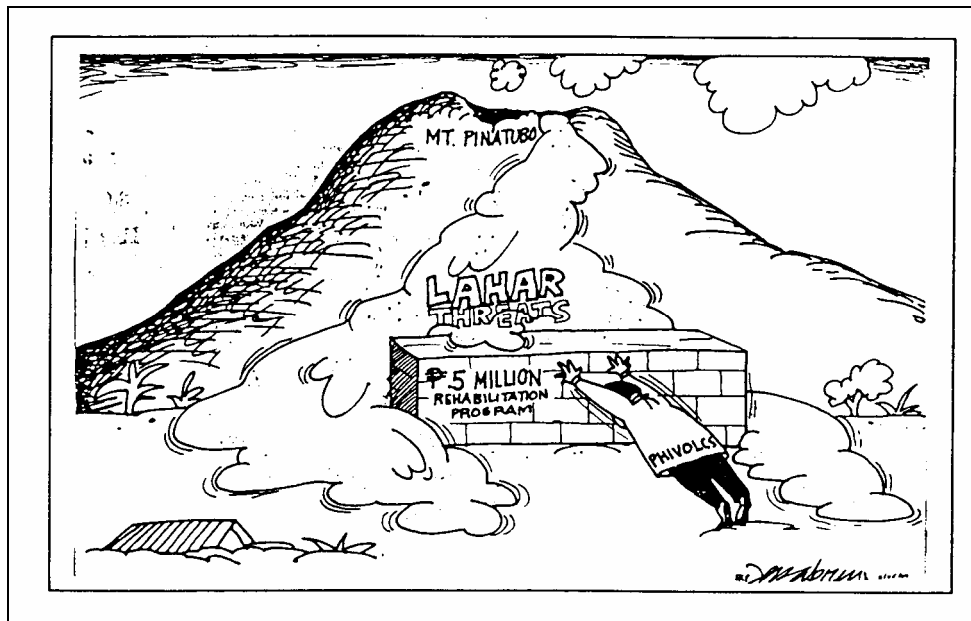
***Fig. 2 - Flow chart of the official disaster management system of the Republic of the Philippines  
(taken from NDCC, 1988)***



**Fig. 3 - Monitoring, warning (short term) and evacuation system set up for the Mt Pinatubo lahars and floods (Adapted from JICA & DPWH, 1995)**

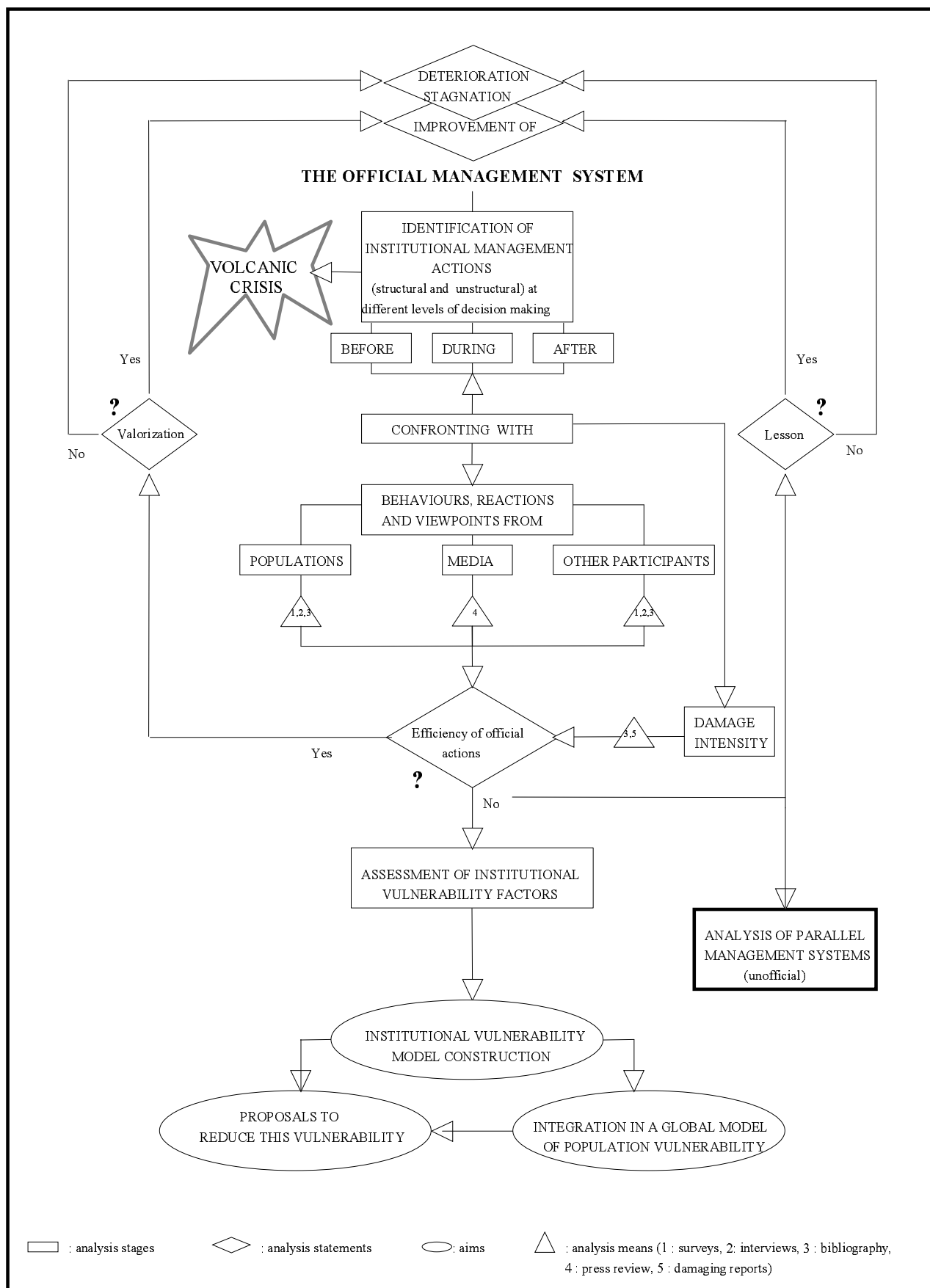
— *Participants*: PNP : Philippine National Police; PHIVOLCS : Philippine Institute of Volcanology and Seismology; USGS : United States Geological Survey; PAGASA : Philippine Atmospheric Geophysical and Astronomical Services Administration; OCD : Office of Civil Defense; JICA : Japan International Cooperation Agency; ZLSMG : Zambales Lahar Scientific Monitoring Group; NDCC : National Disaster Coordinating Council; RDCC : Regional Disaster Coordinating Council; PDCC : Provincial Disaster Coordinating Council; MDCC : Municipal Disaster Coordinating Council; BDCC : Barangay Disaster Coordinating Council; DSWD : Department of Social Welfare and Development; DPWH : Department of Public Works and Highways; NGOs : Non Governmental Organizations.

— *Communication means* : PR : Portable radio; T : Telephone; F : Fax; TD : Telemetrised data; B : Briefing; PC : Press conference; LS : Loudspeaker; BS : Bell sound; GS : Gun shooting; TV : Television, press, local or national radios.



*Fig. 4 - sketch which appeared in the Philippine press showing - with humour - the inefficiency and the high cost of protection measures prioritized by the authorities, this to the detriment of the resettlement program (in Philippine Daily Inquirer, 08/26/93)*

*Fig. 5 - The diking system set up to protect the Pasig-Potero riverside residents from lahars near San Fernando (Pampanga)*



**Fig. 6 - Methodological proposal for an analysis of the institutional vulnerability in volcanic crisis management**

		DIRECT FACTORS										INDIRECT FACTORS						TOTAL
MANAGEMENT PHASES		I C G	E C G	L C	L O D	M F D	L S	H R S	P P D	L O C	H H	F A S L	A C	P C	S E C	C C	C O R	
Pre-CRISIS*	Monitoring	0	1	0	0	0	1	0	0	0	0	0	0	1	0	0	0	3
CRISIS*	Warning	1	1	1	1	0	2	0	0	1	0	0	0	1	0	0	0	8
	Evacuation	1	1	1	1	0	2	0	0	0	1	0	2	2	2	2	0	16
Post-CRISIS	Protection	1	2	2	1	1	1	1	2	0	2	2	1	2	2	2	2	24
	Resettlement	2	2	2	2	2	2	1	1	0	2	2	1	2	2	2	1	28
TOTAL		5	7	6	5	3	8	2	3	1	5	4	4	8	6	6	3	3

\* : including June 1991 (eruption) and subsequent (lahars) losses.

**Tab. 2 - Response to the Mt Pinatubo disaster : weighting of main institutional vulnerability factors (matrix of institutional dysfunction)**

*factors importance* : 0 : no ; 1 : low ; 2 : high

— *Direct factors* : ICG : internal coordination gap ; ECG : external coordination gap ; LC : lack of communication ; LOD : lack of dialogue with population ; MFD : lack of flexibility in decision ; LS : logistic shortage ; HRS : human resource shortage ; PPD : planning/preparedness deficiency ; LOC : lack of competency ; HH : hierarchic heaviness ; FASL : lack of financial compensations/assistance/support.

— *Indirect factors* : AC : administrative constraints ; PC : political constraints ; SEC : socio-economic constraints ; CC : cultural constraints ; COR : corruption ; P : looting.