MITIGATION VOLCANIC DISASTERS

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INTRODUCTION

Numerous volcanic eruptions have marred Ecuador's history, the most destructive being those of Pichincha in 1660, of Cotopaxi in the 1700's and 1800's, and of Tungurahua in the early 1900's. However, given the present expansion of the population and industry into high risk zones, future eruptions could have catastrophic effects upon its socio-economic growth.

Given this situation the UNDRO - USAID / OFDA PROJECT decided to focus primarily upon mitigating this potential danger by reinforcing three principal activities, already initiated by the Instituto Geofisico of the Escuela Politecnica Nacional:

1. Evaluating the volcanic hazards and risks,
2. Establishing permanent volcano monitoring, and
3. Improving civil defense's prevention and preparedness programs

VOLCANOLOGY

More than 200 volcanic structures are recognized in Ecuador, of which about 25 are presently considered to be potentially active. Approximately 2.5 million people live in areas that could be affected by the eruption of one or more of these volcanos. As an example, we need to cite only Cotopaxi volcano with its giant historic mudflows, which when they reoccur could sweep away more than 35,000 persons.

Since the Instituto Geofisico's creation, major advances have been more in volcano hazard and risk evaluation, volcano monitoring, and public preparedness and education.

MITIGATING VOLCANIC DISASTERS

The scientific study and vigilance of Ecuador's volcanoes employing modern techniques have provided the necessary framework and incentive to civil defense to prepare emergency plans for specific volcanoes, to carry out simulation and evacuation exercise as well as to increase public awareness.

The following text presents the progressive development of the Instituto Geofisico's program in volcano disasters. Mitigation; from hazard evaluation and volcano monitoring to public and Institutional Awareness and civil defense follow up, of three more important volcanos.

- COTOPAXI VOLCANO

1. CHARACTERISTICS OF VOLCANO

* Large stratovolcano (6000 m) with 20 km2 of glaciers and snowfields.
* 35 historic eruptions.
* Hazards include pyroclastic flows, lava flows, ashfalls.
* Principal danger is from giant debris and mud flows that have characterized most past eruptions.
* More than 35,000 people live in the high risk lahar zones.
* More than 160,000 people live in the low risk zones.
* Numerous irrigation canals, highways, gas pipelines, high tension lines, and Quito's water supply would be directly affected by an eruption.

2. EVALUATION OF HAZARDS AND RISKS

* Hazards evaluation and continual update in progress since 1975.
* Publication of first map in 1978 (1 : 100.000)
* Preparation / publication of improved maps in 1988.

  North side (1 : 50.000)

  South side (1 : 50.000)

* Preparation of 10 risk maps at 1 : 25.000 scale that cover all populated areas that could be affected by eruptive phenomena, showing high risk zones, safe areas, evacuation routes, etc.

* Preparation of probable eruption scenario and use by civil defense.

3. MONITORING ACTIVITIES

This volcano is permanently monitoring via:

* 4 telemetered seismographs.

* 2 electronic tiltmeters.

* 6 dry tilt stations.

* 10 EDM baselines.

* Geochemistry with COSPEC.

* 3 telemetered lahar detectors - (collaborative USGS - IG program to evaluate effectiveness of new lahar sensoring techniques).

* Continuing photo documentation.

4. PUBLIC AND INSTITUTIONAL AWARENESS

The Instituto carried out the following activities,

* Presentations, talks, and discussions for civil defense and local authorities, ministry delegates, general public and political leaders.

* Radio and television programs.

* Press bulletins,

* Seminars for scientists,

* Guided field trips for civil defense personnel and ministry delegates.

* Widespread distribution of hazards map, well publicized in newspapers.

* Preparation / publication / distribution of education poster

"Volcanoes and their Hazards " (1989).

* Preparation / publication / distribution of poster showing danger areas in the Chillos Valley (1990).

* Preparation / publication / distribution of poster showing danger areas in Latacunga Valley (1991).

5. CIVIL DEFENSE FOLLOW - UP

Based upon the previous activities, the National Office of Civil Defense accomplished the following:

* Preparation of emergency plans
* Coordination with regional civil defense offices.
* Desktop simulation led by Civil Defense with the participation of 6 provincial governments and the Instituto Geofisico, employing the eruption scenario prepared by Instituto Geofisico.
* Evacuation exercise in Latacunga involving 5,000 persons (1989).
* Evacuation exercise in Chillos Valley involving 3,000 persons (1989).
* Initiation of School Awareness program (1989 - 91).

- GUAGUA PICHINCHA VOLCANO

1 CHARACTERISTICS OF VOLCANO

* Stratovolcano (4900 m) with intermittent snow cover.
* Only 10 km from Quito, Ecuador's capitol city (population : 1,200.000).
* 3 historic eruptions.
* Dangers include pyroclastic flows, severe ashfalls, lahars.
* Several small villages threatened by pyroclastic flow, ashfalls, lahars.
* Quito threatened by ashfalls and secondary mudflows.

2. EVALUATION OF HAZARDS AND RISK

The Instituto has accomplished the following:

* Preparation of preliminary hazard map during 1981 crisis.
* Preparation / publication of updated map (1: 50.000) in 1988.
* Participated in preparation of lahar hazard map for Quito (1989).

* Participation in preliminary risk evaluation (1988).

* Preparation of eruption scenario (1989).

3. MONITORING ACTIVITIES

The Instituto is permanently monitoring this volcano via:

* 3 telemetered and manual seismographs.

* 4 seismographs (WWSSN Station).

* During 1988 crisis, 4 additional seismographs were installed around volcano.

* 3 telemetered electronic tiltmeters (1 damaged in explosions of 1990).

* 9 dry tilt stations.

* 12 EDM baselines.

* Geochemistry with COSPEC and traditional methods.

* Continual photo documentation.

* Frequent visits to crater.

* Results of monitoring published in annual report.

* Responded to anomalous activity of 1990 with increased monitoring activities.

4. PUBLIC AND INSTITUTIONAL AWARENESS

The Instituto carried out the following activities.

* Presentations, talks, and discussions for civil defense, ministry delegates, the Mayor of Quito, and the Governor of Province.

* Collaboration in two television programs concerning this volcano and its hazards. (Sep. 1989 ; Aug. 1990)

* Radio programs (to answer questions from public concerning possible eruption).

* Press bulletins (to dispel public concern that " nothing is being done about the volcano")

* Guided excursion for public to crater rim to explain hazards.

* Widespread distribution of hazard map, well publicized in newspapers.

* Discussion with villagers directly threatened by future volcanic unrest.

* Presentation and discussion of the eruption scenario, prepared by the Instituto

Geofisico with Civil Defense.

5. CIVIL DEFENSE FOLLOW - UP

Based upon the previous activities, the National Office of Civil Defense accomplished the following:

* Preparation of emergency plans (1989) based upon Instituto Geofisico's hazards map.
* Meetings with ministry delegates to formulate ministerial contingency plans (1989).
* Desktop simulation with representatives of the affected provinces (1990), employing Instituto Geofisico's eruption scenario.
* Formation and meetings of Scientific - Technical Committee to advise Civil Defense about on - going crises on volcano (1988, 1990): Instituto Geofisico forms nucleus of group.
* "What - to - do" meetings for those villages that could be directly affected.
* Preparation of a secondary lahar map for Quito, showing those parts of the city that could be flooded (1990).

- TUNGURAHUA VOLCANO

1. CHARACTERISTICS OF VOLCANO

* Stratovolcano (5100 m) with small glaciers and snowfields.
* 3 eruption periods during historic times.
* Dangers include pyroclastic flows, lava flows, lahars, ashfalls, and slides.
* Numerous small towns around volcano's base, with a total population of 16,000, lie in high risk zones.
* Threatens second largest hydroelectric project in Ecuador, located at foot on cone!.

2. EVALUATION OF HAZARDS

The Instituto has accomplished the following:

* Hazards evaluation in progress since 1975, with preliminary maps prepared in 1975, 1980, and 1987.

* Preparation / publication of final hazards map (1 : 50.000) in 1988.

* Detailed analysis of volcano's history, petrography, and chemistry, leading to an update of hazards evaluation in 1990, 1991, and in progress.

* Preparation of likely eruption scenario for use by Civil Defense, and local authorities.

3. MONITORING ACTIVITIES

The Instituto is permanently monitoring this volcano via:

* 1 telemetered seismograph (soon to be increased to 4)

* 2 electronic tiltmeters (to be installed in early 1992).

* 8 EDM baselines established in 1990 and 1991.

* Continued photo documentation.

* Geochemistry with COSPEC.

* Instituto Geofisico has developed telephone contact with resident observer in in 1991 to help verify felt earthquakes.

4. PUBLIC AND INSITUTIONAL AWARENESS

The Instituto carried out the following activities.

Presentations and discussions with Civil Defense, local and provincial authorities, and the general public concerning hazards.

* Press bulletins.

* Guided field trips to volcano for Civil Defense and local authorities.

* Widespread distribution of hazards map, well publicized in newspapers.

* Preparation of posters with simplified explanation of Tungurahua's hazards (in progress)

5. CIVIL DEFENSE FOLLOW - UP

* Preparation of emergency plans (began in 1989, greatly improved in 1991).

* Seminars in the 5 provinces surrounding the volcano to educate the public about effects of future eruptions.

* Preparation of educational programs of volcanic hazards for schools, teachers.

* Planning for table-top simulation in 1992.

CONCLUSIONS

During the present seminar and the observation field trips, I had the opportunity to see and understand the technology developed and applied in Japan for Disasters Prevention, which enable me to know many types of natural disasters countermeasures.

These technology can be apply and adopt in Ecuador, if the national budget permit to develop it.

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REFERENCES

1 - Project Report

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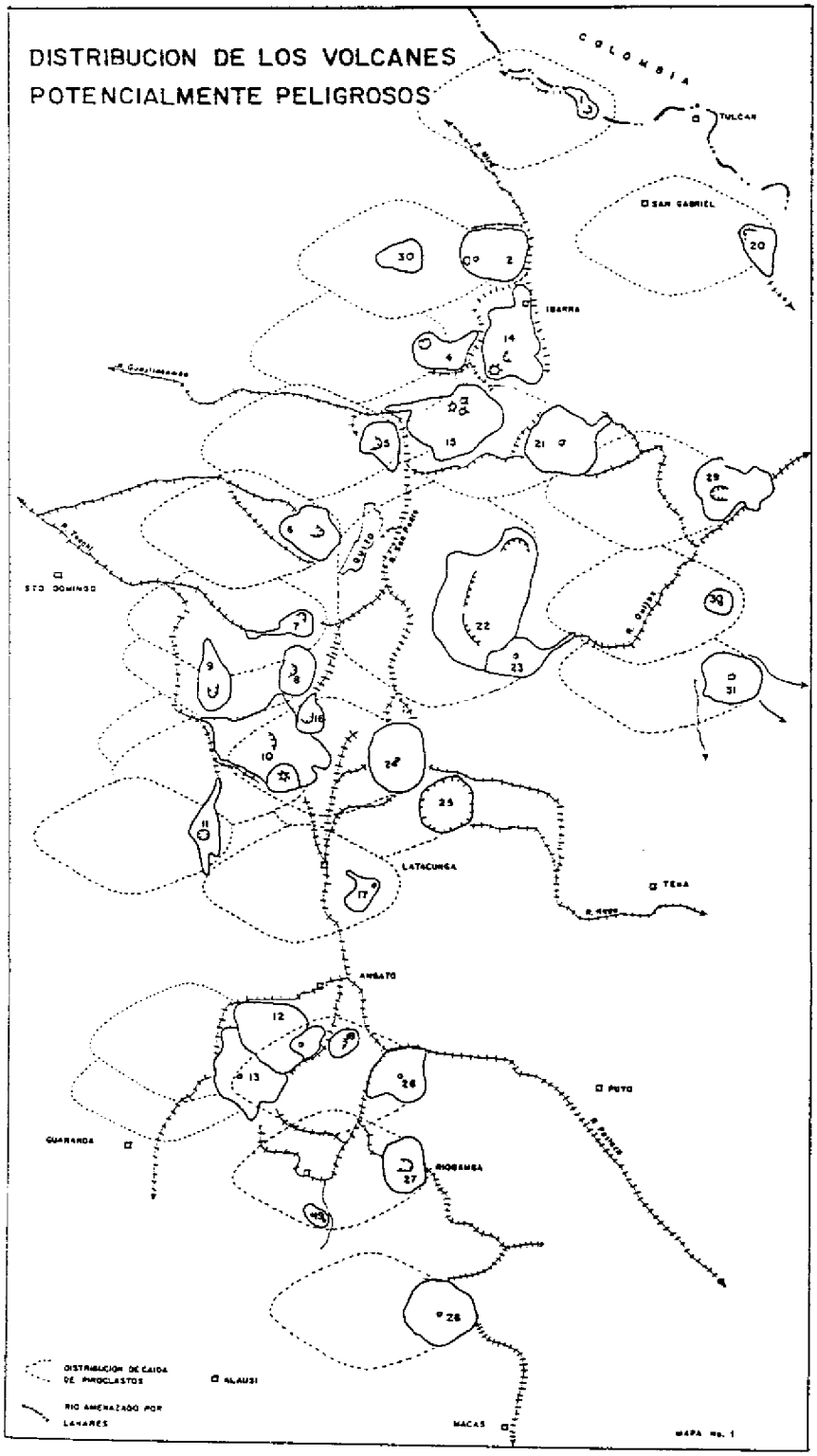
UNDRO - 1990

2 - Report

"SASAKAWA AWARD"

Instituto Geofisico - Escuela Politecnica Nacional Quito - Ecuador 1991

POTENTIALLY DANGEROUS VOLCANO DISTRIBUTION



1 V. CERRO NEGRO DE MAYASQUER
2 COMPLEJO VOLC. CHACHIMBIRO
3 V. PILAVA
4 V. GUICOCHA
5 V. PULULAHUA
6 V. GUAGUA PICHINCHA
7 V. NINAHUILCA
8 C. CORAZON
9 C. ALMAS SANTAS
10 M. ILLINIZA Y SASUYACU
11 V. GUILOTOA
12 C. PUNALICA Y CARIHUAYRAZO
13 V. CHIMBORAZO
14 COMPLEJO VOLC. IMBABURA (INCLUYE CUBILCHE)
15 V. MOJANDA
16 CERROS DE CHAUPI
17 C. PUCTIN
18 C. LLIMPI
19 C. TULABUG Y GUERAVISTA
20 V. SOCHE
21 V. CAYAMBE
22 CALDERA CHACANA
23 V. ANTISANA
24 V. COTOPAXI
25 CALDERA CHALUPAS
26 V. TUNGURAHUA
27 M. EL ALTAR
28 V. SANGAY
29 V. REVENTADOR
30 C. PAN DE AZUCAR
31 V. SUMACO