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| Country Name | Project for Enhancement of the Volcano Monitoring Capacity |
| Ecuador      |  |

### I. Project Outline

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|-----------------------------|--|---|
| Project Cost                | 352 million yen  |   |
| Project Period              | (Original) May, 2004 – April, 2007 (Extension) May, 2007 – April, 2009   |   |
| Implementing Agency         | - Geophysical Institute, Department of Geophysics, National Polytechnic University (IG: Instituto Geofísico, Departamento de Geofísica, Escuela Politécnica Nacional)  |   |
| Cooperation Agency in Japan | - National Research Institute for Earth Science and Disaster Prevention (NIED)   |   |
| Related Projects (if any)   | <u>Cooperation by other donor</u><br>- Early Warning System and Natural Risk Management (Inter-American Development Bank: IDB, 2006-11)  |   |
| Background                  | Ecuador is a sub-Andean country with 8 active volcanos. The volcano disaster management has been a key issue for the country because eruptions of volcanos extensively damage human lives and livelihoods in the piedmont areas of the volcanos by volcanic ash falls and large scale debris flows. However, since the IG's system could not monitor broadband seismic and infrasound seismic signals at the early phase of volcanic activity, it was difficult to take appropriate disaster mitigations measures which required volcanic activity report reflecting internal activities of volcano. Therefore, the government of Ecuador requested the Japanese government technical cooperation for introduction of data collection system and analytical techniques to more precisely comprehend volcanic activities. |   |
| Inputs                      | Japanese Side  | Brazilian Side  |
|                             | <ol style="list-style-type: none"> <li>1. Experts<br/>15 experts of 5 areas for Short term</li> <li>2. Trainees Received: 5 trainees</li> <li>3. Equipment: 225 million yen</li> <li>4. Local Cost: 2 million yen</li> </ol>   | <ol style="list-style-type: none"> <li>1. Counterpart: 31 persons</li> <li>2. Land and facilities: Office spaces for Japanese experts</li> <li>3. Equipment: 1,937 USD</li> <li>4. Local Cost: 0.4 million USD</li> </ol> |
| Project Objectives          | <b>Overall goal</b><br>To enhance the capacity of mitigating volcanic disasters in Ecuador.  |   |
|                             | <b>Project Objectives</b><br>To enhance the capacity of volcano monitoring at Cotopaxi and Tungurahua Volcanoes.   |   |
|                             | <b>Outputs</b> <ul style="list-style-type: none"> <li>• IG improves its capacity to obtain the data on volcanic activity including long-period and very-long-period events on a real time basis at Cotopaxi and Tungurahua Volcanoes.</li> <li>• IG improves its capacity to process and store volcanic activity data properly including long-period and very-long-period events at Cotopaxi and Tungurahua Volcanoes.</li> <li>• IG enhances its capacity to analyze precursory signals of eruptions.</li> <li>• The results of the analyses are described properly in the volcanic activity reports.</li> <li>• Improved volcanic activity reports and supplemental information are adequately received by organizations for disaster prevention.</li> </ul>   |   |

### II. Result of the Evaluation

#### Summary of the Evaluation

Volcanic activity of Tungurahua Volcano, one of the project sites, has been continuing since October, 1999. There have been concerns about damage on 20,000 people living in the piedmont and its vicinity areas of the volcano due to the danger of pyroclastic flows. Cotopaxi Volcano, another project site, has had no eruption since the last eruption 1903. However, approximately 100,000 people face threats of damage by lahars because they live on debris which occurred by the last eruption. Although these two volcanoes have been monitored by the IG's short-period seismograph network, the monitoring system could not monitor long-period and very-long period earthquakes at the beginning of volcanic activity and constrained collection and analysis of the data of early phase of volcanic activity which is critical for volcanic disaster mitigation actions, including evacuation alert for the people, based on volcanic activity report properly reflecting signs of eruptions.

The Project has achieved enhancement of capacity to data collection, data compiling and analysis, analysis of signs of eruptions, improvement of contents of volcanic activity reports as well as adequate transmission of the reports to stakeholders for the project purpose of enhancement of volcanic monitoring capacity at Cotopaxi and Tungurahua. And it has achieved improvement of countermeasures for volcanic disaster and the volcanic information transmission system of the relevant organization for disaster control and enhancement of monitoring capacity for other volcanoes, for the overall

goal of enhancement of capacity for volcanic disaster mitigation in Ecuador. As for sustainability, there was no problem observed in the project owing to the importance of risk management including volcanic disasters in the national development plans and laws, the sustaining technical capacity and the ensured budget for the volcanic monitoring and disaster control systems and volcanic monitoring activities.

For relevance, the Project has been highly relevant with Ecuador's development policy, development needs as well as Japan's ODA policy. For efficiency, both the project cost and the project period exceeded the plan.

In the light of above, this project is evaluated to be highly satisfactory.

## 1 Relevance

This project has been highly relevant with Ecuador's development policy, the Contingency Plan for Disaster and the National Development Plan for Better Life (2009-2012) ("reduction of social and environmental vulnerability against disasters, including volcanic disaster management"), development needs of "mitigation of disaster damage on the people living in the vicinity of volcanoes", as well as Japan's ODA policy for Ecuador to support "disaster prevention", at the time of both ex-ante evaluation and project completion. Therefore, relevance of this project is high.

## 2 Effectiveness/Impact

This project has largely achieved the project purpose of "enhancement of volcanic monitoring capacity at Cotopaxi and Tungurahua Volcanoes". Since all the monitoring networks installed by the Project have been functioning, it enables to obtain data at real time to analyze them more accurately. As a result, it brought about improvement of accuracy of volcanic information and timeliness of information transmission to the relevant organizations. In terms of the overall goal, the Project brought about placement of signs indicating danger zones, transmission of alerting information based on the guidelines as well as voluntary evacuation according to the alert information. Also, the monitoring system and knowhow introduced by the Project contributed to improvement of transmission system of volcanic information through the establishment of nationwide volcanic monitoring system in Ecuador. At the vicinity areas of Tungurahua with continuous eruption activity, no victim at the occurrence of debris flows can be verified as a tangible positive impact of the Project. On the other hand, at Cotopaxi with settled volcanic activity, there is an issue to increase awareness of the local people without strong sense of danger because of no alert information transmitted so far. Besides, there is another positive impact on promotion of alliance between IG and research institutes of Europe and USA, since IG has been highly recognized in the international community owing to the efforts to figure out the mechanism of volcanic activity and publications of literatures about Tungurahua, including its eruption mechanism. Therefore, its effectiveness/impact of this project is high.



Monitoring Point in the Mountain

### Achievement of the Project Purpose and the Overall Goal

| Outcomes  | Indicators (Target)   | Actual Achievement  |
|---|---|---|
| <b>Overall Goal</b><br>Enhancement of capacity of mitigating volcanic disaster in Ecuador | <ul style="list-style-type: none"> <li>- Guidelines on appropriate measures in case of volcanic crises of Cotopaxi and Tungurahua Volcanoes are elaborated among organizations for disaster prevention.</li> <li>- Organizations for disaster prevention take measures described in the above Guidelines.</li> <li>- People have consciousness toward the potential volcanic risk and take adequate actions.</li> </ul> | (At the time of ex-post evaluation in 2012) <ul style="list-style-type: none"> <li>- According to the hazard map elaborated by IG, the signs indicating danger zones, evacuation routes, designated places, etc. were placed in all the municipalities affected by the both volcanoes.</li> <li>- The enhanced communication protocol based on the IG's Guidelines enables to obtain real time information of volcanic activity.</li> <li>- At Tungurahua, alerting information was transmitted 700 times according to the Guidelines. At the occurrence of debris flows, the evacuations based on the alerting information resulted in no victim by the disaster.</li> <li>- The communities in the vicinity of Tungurahua organize a volcano monitoring mission by the chiefs and voluntary evacuation system based on the alerting information by IG.</li> </ul> |
|   | The Capacity to monitor other active volcanoes is improved.   | <ul style="list-style-type: none"> <li>- The nationwide volcano monitoring system was established through the establishment of volcano monitoring and early alert system at the national level by the IG Enhancement Plan aiming at expansion and modernization of services on seismology and volcanology by IG and the Project on early alert system and natural hazard management by the government of Ecuador.</li> <li>- The monitoring system and knowhow to utilize the system installed by the Project have been applied for monitoring of other active volcanoes.</li> <li>-</li> </ul>   |
|   | Transfer system of volcanic   | <ul style="list-style-type: none"> <li>- According to the Information Transmission Guidelines, the</li> </ul>   |

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|  | information is improved.   | information transmission routes are secured by utilization of various types of communication modes, including land lines, mobiles, satellite phones, digital radios, internet, e-mails and so on.<br>- The programs such as volcanic activity index and volcanic instability alerts based on the data acquired by the monitoring networks enable to take actions at the adequate timing. |
| <b>Project Purpose</b><br>Enhancement of capacity of volcano monitoring at Cotopaxi and Tungurahua | The quality of the volcanic activity information to organizations for disaster prevention is improved. | (At the time of project completion in 2009)<br>- All the monitoring networks installed by the Project have been functioning and acquiring data in real time for more accurate analyses.<br>- The accuracy of volcanic information and timeliness of information transmission to the relevant organizations have been improved.   |

Source: Terminal Evaluation Report and interviews with the implementing agencies.

### 3 Efficiency

The inputs were appropriate for producing the outputs of the Project although 2 experts of chief project advisor and chief advisor for monitoring networks were added to the planned 3 experts of seismography, earthquake analysis, and volcanic disaster prevention. Both the project cost and the project period were exceeded the plan (ratio against the plan: 187% and 167%, respectively) due to the necessity to procure new equipment in order to replace volcano monitoring equipment damaged by the eruption of Tungurahua in 2006 and the interruption of data collection for technical training on analysis of volcanic monitoring data by the eruption. Therefore, efficiency of this project is fair.

### 4 Sustainability



Seismograph installed at the Monitoring Point

The government of Ecuador prioritizes risk management as key issues at the national level in the National Development Plan for Better Life (2009-2013) and the Law on National Land Formation, Autonomy and Decentralization Organization legislated in 2010. IG remains the main organization to analyze volcano and earthquake risks, to monitor volcanic and seismographic activities, and to transmit information to the relevant organization in Ecuador. IG has 11 researchers specializing in volcano monitoring out of 67 personnel in total. Also, IG assigns 1 staff for implementing seminars and training courses in order to enhance understandings on information transmitted by IG of staff in the organizations responsible for disaster prevention and the local governments. The skills and knowledge on volcano monitoring and analysis transferred by the Project have been sustained by the working group of IG and taken over the

managerial staff even in the case of change in personnel. In addition, NIED has been continuously providing technical cooperation and advices after the completion of the Project. It is expected that the cooperation between IG and NIED will be continued for future. The monitoring equipment installed by the Project now can be utilized even in the case of eruption owing to the introduction of wind power generator after the malfunctions of solar panel generator by the ash falls at the eruption of Tungurahua. IG allocates 0.41 million USD to cover the cost of maintenance, consumables and services out of the total budget of 1.66 million USD from the government budget in the fiscal year of 2012. In addition, 9 million USD is allocated to the IG Enhancement Plan, jointly implemented by IG and the National Secretary of Science and Technology (SENACYT: Secretaría Nacional de Ciencia y Tecnología) for 4 year period from 2009 to 2012. In addition, IG has other financial sources, including consulting fees from research works, donation from private companies, and financial supports from donors (IDB) and a French development research institute. Therefore, with no problem in policy background, structural, technical and financial aspects of the implementing agencies, sustainability of the project effect is high.

### III. Recommendations & Lessons Learned

#### Recommendations for Implementing agency

- The interviews with the local governments for the ex-post evaluation highlighted that IG earns the trust of them by not only provision of volcanic information but also proactive involvement in the seminars and the trainings. It is expected that IG will contribute to further increase in awareness of the local governments and communities for volcanic disaster prevention through continuation and reinforcement of these activities in the future.

#### Lessons learned for JICA

- For the Project, although no long-term expert was dispatched, the short-term experts shared the volcano monitoring data and provided technical guidance for the IG researchers even during their absence from the project site. Such continuous efforts of the experts can be a key success factor of effective technical transfer.
- During the project implementation, the volcano monitoring equipment was damaged by the pyroclastic flows associated with the eruption of Tungurahua. Since the damage of equipment impeded data collection which was necessary for technical guidance on volcano monitoring data analysis, the project period was needed to extend two years. Although it is difficult to fully prevent damages by large scale pyroclastic flows, some troubles, such as malfunction of solar panel generators by ash falls, can be avoidable by countermeasures reflecting predictable risks.