

Summary of Terminal Evaluation

I. Outline of the Project	
Country: Republic of Ecuador	Project Title : Project for Enhancement of the Volcano Monitoring Capacity
Issue/Sector: Disaster management	Cooperation Scheme : Technical Cooperation Project
Division in charge : Disaster Management Division II, Water Resources and Disaster Management Group, Global Environment Department	Total cost (tentative value at the time of this evaluation) : 334 million Japanese Yen
Period of Cooperation	(Original) from May 1, 2004 to April 30, 2007
	(Extension) from May 1, 2007 to April 30, 2009
Partner Country's Implementation Organization : Geophysical Institute - Department of Geophysics (IG), National Polytechnic University (Instituto Geofísico - Departamento de Geofísica, Escuela Politécnica Nacional)	
Supporting Organization in Japan : National Research Institute for Earth Science and Disaster Prevention (NIED)	
1-1 Background of the Project	
<p>In the Republic of Ecuador, one of the most important issues is the reduction of volcanic disasters. In July 2002, the Government of Ecuador (GoE) made an official request to the Government of Japan for the technical cooperation related to volcano monitoring in Ecuador. Based on this request, in May 2004, Japan International Cooperation Agency (JICA) initiated the "Project for Enhancement of the Volcano Monitoring Capacity" (hereinafter referred to as "the Project") in cooperation with the Geophysical Institute - Department of Geophysics (IG), National Polytechnic University (Instituto Geofísico - Departamento de Geofísica, Escuela Politécnica Nacional) as the implementing organization.</p> <p>Before the planned project period ended on April 30, 2007, JICA dispatched an evaluation team in November 2006 in order to confirm the achievement of the Project so far, and discuss the actions to be taken for the rest of the project period. As a result of the evaluation study, it turned out that the Project had not achieved its purpose because some activities could not have been implemented due to the volcanic eruption of Tungurahua Volcano and subsequent damages to the volcano monitoring network of the Project, which made it impossible to collect sufficient monitoring data for technical transfer of data analysis. Therefore, it was recommended to extend the project period for two years from May 1, 2007 to April 30, 2009 in order to fully achieve the project purpose. Based on this recommendation, the Record of Discussions (R/D) for the extension was signed in April 2007. Before the extended project period ended on April 30, 2009, JICA carried out a final evaluation again from April 13 to May 1, 2009.</p>	
1-2 Project Overview	
(1) Overall Goal	
To enhance the capacity of mitigating volcanic disasters in Ecuador.	
(2) Project Purpose	
To enhance the capacity of volcano monitoring at Cotopaxi and Tungurahua Volcanoes.	
(3) Outputs	
<ol style="list-style-type: none"> 1. 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. 2. 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. 3. IG enhances its capacity to analyze precursory signals of eruptions. 4. The results of the analyses are described properly in the volcanic activity reports. 5. Improved volcanic activity reports and supplemental information are adequately received by organizations for disaster prevention. 	
1-3 Inputs	
<Japanese side>	
<ol style="list-style-type: none"> 1. Short-term experts: 15 experts in the following areas were dispatched: seismic observation, seismic analysis, leader of installation of seismic observation system, volcanic disaster management, and project finalization. 2. Trainees received in Japan: 4 counterparts (five trainings) were trained in Japan for volcanic observation and data analysis. 	

3. Provision of equipment: Equipment equivalent to approx. 225,311,000 Japanese Yen was provided.
The cost of dispatching engineers for installation of the equipment was also covered.
4. Local operational cost: The Japanese side provided a part of necessary local expenses for carrying out the activities of the Japanese experts.
- The total amount of the expenses of the Project including the dispatch of the Japanese experts and installation engineers, counterpart trainings, provision of equipment and local cost is about 334 million Japanese Yen.
- <Ecuadorian side>**
1. Counterpart personnel: 31 persons were assigned as counterparts of Japanese experts
 2. Local cost: Ecuadorian side covered the costs equivalent to 406,582.39 US Dollars

II. Evaluation Team

Members of Evaluation Team	<p><Japanese side></p> <ol style="list-style-type: none"> 1) Leader: Mr. Shinichi MASUDA, Director, Disaster Management Division II, Water Resources and Disaster Management Group, Global Environment Department, JICA 2) Project Evaluation: Mr. Ichiro SATO, Senior Program Officer, Disaster Management Division II, Water Resources and Disaster Management Group, Global Environment Department, JICA 3) Evaluation Analysis: Ms. Junko MIURA, Researcher, Social Development Department, Global Link Management Inc. 4) Interpreter: Ms. Aki HIGUCHI, Japan International Cooperation Center (JICE) <p>Note: Dr. Hiroyuki Kumagai (Senior Researcher, Earthquake Research Department, National Research Institute for Earth Science and Disaster Prevention) was dispatched to Ecuador as a short-term expert of the Project, and assisted in the evaluation study.</p> <p><Ecuadorian side></p> <ol style="list-style-type: none"> 1) Joint evaluator: Dr. Minard Hall, Professor, IG 2) Joint evaluator: Mr. Marco Eduardo Montesdeoca Freire, Risk Management Official, Risk Management Unit, Tungurahua
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Period of Evaluation	From April 13, 2009 to May 1, 2009	Type of Evaluation : Terminal Evaluation
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III. Results of Evaluation

3-1 Achievement

<Project Purpose>

To enhance the capacity of volcano monitoring at Cotopaxi and Tungurahua Volcanoes.

Indicator: The quality of the volcanic activity information to organizations for disaster prevention is improved

The Project Purpose, which is to enhance the monitoring capacity at Cotopaxi and Tungurahua Volcanoes, was achieved. The volcano monitoring network of the Project is properly functioning and generating real-time observation data, which are used for advanced analyses. As a result, IG improved volcanic activity reports as well as supplementary information, and issued them timely. For instance, at the time of the eruption of Tungurahua Volcano on August 16, 2006, IG predicted the eruption by analyzing the data in comparison with those of the eruption observed in July 2006. Accordingly, volcanic activity information was sent from IG to organizations for disaster prevention, at least, nine hours before the pyroclastic flows occurred, which greatly contributed to saving many lives.

<Outputs>

Output 1: 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.

Indicator 1-1: The data of volcanic activity including long-period and very-long-period events are acquired on a real time basis at the Institute.

The data of volcanic activity including long-period and very-long-period events have been acquired on a real time basis at IG. The counterpart researchers and technicians became capable of handling real-time data and of solving troubles of the monitoring networks. Due to the saturation of 2.4GHz band at several sections of the data transmission, telemeter equipments were replaced with the new equipments for 5GHz band in the period between June and July 2008 at the IG base station, six repeater sites, and one observation station at Cotopaxi Volcano. This replacement solved the data transmission problem and enabled IG to receive data smoothly.

Output 2: 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.

Indicator 2-1: Continuous volcanic activity data are systematically monitored, and locations of the events are determined.

Volcanic activities of Cotopaxi and Tungurahua have been monitored by using continuous data from the monitoring networks, and locations of events were determined. An automatic system to detect volcano seismic events was introduced, and the volcanic activities are systematically monitored at the both volcanoes.

Indicator 2-2: Continuous data are stored, and wave forms are systematically catalogued.

Continuous data from both the Cotopaxi and Tungurahua monitoring networks have been stored, and wave forms have been systematically catalogued. A database for seismic event data was developed.

Output 3: IG enhances its capacity to analyze precursory signals of eruptions.

Indicator 3-1: Two investigators are capable of more advanced quantitative analyses of long-period and very-long-period events and associated signals. Two other investigators can conduct same analyses under the guidance of the two investigators.

Two researchers trained in Japan became capable of more advanced quantitative analyses of long-period and very-long-period events and associated signals. In addition, two other researchers and five research students became capable of the quantitative analyses under the supervision of the two researchers trained in Japan. Based on the research results, the counterpart researchers published research papers and made presentations at international conferences.

Indicator 3-2: Capacity of analyzing other data is enhanced.

The counterpart researchers became capable of analyzing tremor signals associated with lahars.

Output 4: The results of the analyses are described properly in the volcanic activity reports.

Indicator 4: Results of the analyzed data including long-period and very-long-period events are written in the volcanic activity reports.

Results of the data analyses including long-period and very-long-period events were written in volcanic activity reports.

Output 5: Improved volcanic activity reports and supplemental information are adequately received by organizations for disaster prevention.

Indicator 5-1: Improved volcanic activity reports are regularly received by organizations for disaster prevention.

Improved regular and special volcanic activity reports were received by approximately one hundred fifty organizations for disaster prevention by e-mail or fax.

Indicator 5-2: Supplemental information is timely received by organizations for disaster prevention.

When there were active volcanic activities, supplemental information was timely received by organizations for disaster prevention through IG's special reports and more direct communication such as telephone conversations, wireless communication, and meetings. Detailed volcanic activity information was provided through the website of IG.

Indicator 5-3: Organizations for disaster prevention are satisfied with the improved reports and information.

Many organizations for disaster prevention near the volcanoes are satisfied with the improved reports and information of IG in terms of their timeliness, preciseness, and reliability, according to interviews and questionnaire survey.

3-2 Implementation Process

Since November 2006, after the previous evaluation study was conducted, the activities of the Project were carried out smoothly. Installation of the equipments at the two observation stations at Tungurahua Volcano, which had been suspended due to active volcanic activities, was completed in July 2008. In addition, the data transmission problem was solved by replacing the radio transmission equipments. This enabled IG to receive data smoothly. Although the equipments of one station at Tungurahua Volcano were stolen in June 2008, these were eventually recovered and reinstalled with security cages in April 2009. All the activities including data acquisition, accumulation and analysis were implemented smoothly in general, although data acquisition was temporarily affected by external factors such as

pyroclastic flows and ash falls from Tungurahua Volcano.

The project team managed the Project properly based on Project Design Matrix (PDM) and Plan of Operations (PO). The previous terminal evaluation report in 2006 recommended that both Japanese and Ecuadorian sides should introduce a mechanism for managing and monitoring the Project. Although a special mechanism for project management and monitoring was not additionally introduced, JICA Ecuador Office was upgraded from the Volunteer Coordination Office in 2007, and has played a more significant role to manage and monitor the project operations. This greatly contributed to the effective management and monitoring of the Project.

Although two counterpart researchers had left IG by the time of the previous terminal evaluation, two other researchers trained in Japan became capable of data acquisition, accumulation and analyses. After the previous terminal evaluation, none of the counterpart researchers left IG.

Both Japanese and Ecuadorian sides implemented the Project with high motivation. Communication between Japanese experts and Ecuadorian counterparts was generally good.

3-2 Summary of Evaluation Results

(1) Relevance

Relevance is high. This project has a high compatibility with the policy and needs of GoE in disaster management as well as the Official Development Assistance (ODA) policy of the Government of Japan (GoJ) for Ecuador.

The importance of the disaster reduction and disaster monitoring is stated in the National Development Plan for 2007-2010, Article 389 and 390 of Constitution, and the draft National Strategy for Disaster Risk Reduction for 2008-2013.

The three priority areas in the ODA policy of GoJ for Ecuador are poverty reduction, environmental protection, and disaster prevention, which were agreed at the Economic Assistance Policy Dialogue in 2005. Therefore, volcano monitoring for disaster prevention has a high compatibility with the ODA policy of GoJ for Ecuador.

Appropriateness of the approach taken by the Project was high. It was appropriate to select Tungurahua and Cotopaxi Volcanoes as the monitoring targets, whose disaster risks were the highest in Ecuador. As Japan has a comparative advantage in the volcano monitoring technologies, the cooperation in enhancing volcanic monitoring capabilities was highly relevant.

The appropriateness of IG as the counterpart organization was high. It is highly possible that IG will continue to be the only organization in Ecuador for volcano monitoring and risk analysis as designated by the President's Order 3593, which entered into force in 2003.

(2) Effectiveness

Effectiveness is high. Outputs have been achieved sufficiently as a result of the activities carried out. As the capacity of monitoring Cotopaxi and Tungurahua Volcanoes has been enhanced by the Project, it is judged that the project purpose has been achieved.

The equipments such as broadband seismometers and microphones made possible for IG to obtain high quality real-time data from the Cotopaxi and Tungurahua monitoring networks, which could not have been obtained by short-period seismometers. The improved data quality led to the better understanding of the magmatic processes of the volcanoes. During the project extension period, the technical transfer of data analysis using the equipment provided through this Project has made a significant progress. Volcanic activity reports based on the analysis results have been timely sent to organizations for disaster prevention.

(3) Efficiency

Efficiency is high. The inputs provided by the Project have been almost fully utilized. Both Japanese and Ecuadorian sides provided adequate inputs to the Project.

The Japanese experts had strong commitment and advanced expertise, and carried out the expected technical transfer. Training in Japan was also effectively implemented. Through training courses in Japan, skills and techniques necessary for volcanic observation and data analysis were transferred to counterpart researchers, and they have been applying the skills and techniques to their routine work at IG.

The equipments supplied by the Project were well utilized for carrying out the activities. All the equipments supplied were adequate for the technical transfer. Operation and maintenance of the equipments have been good, and 4 technicians and 8 field assistants have been properly operating and maintaining the equipments.

The Ecuadorian side allocated sufficient number of personnel with adequate expertise. Although two counterpart researchers left IG after the counterpart training in Japan, two other counterpart researchers who also received counterpart training in Japan have been carrying out the project activities. The Ecuadorian side has also provided equipments and budget necessary for the project activities, which facilitated the smooth implementation of the Project.

(4) Impact

As some indicators of the Overall Goal have already been fulfilled, the enhancement of the capacity of mitigating volcanic disasters in Ecuador has been observed. Therefore, the impact of the Project is high at this point.

For example, the organizations for disaster prevention in counties and provinces, represented by the Centers for Emergency Operations (COEs), formulated and updated disaster management guidelines, i.e. contingency plan for risks including volcanic disasters, and took actions in line with the guidelines. In case of the eruptions of Tungurahua Volcano in July and August 2006, and February 2008, IG timely issued special reports and information to organizations for disaster prevention, and most of the endangered residents evacuated following the alerts by the local administrations.

Furthermore, building upon the achievement of the Project, IG started a new project funded by the National Secretariat of Science and Technology (SENACYT) to strengthen the monitoring capacity of other active volcanoes in Ecuador. Therefore, it is highly expected that the capacity of monitoring of other active volcanoes will be improved in the near future.

Unexpected positive impacts were observed in the research and social aspects.

In research aspect, it is noteworthy that the discovery of very-long-period events before eruptions accompanying pyroclastic flows at Tungurahua Volcano led to the better understanding of the eruption mechanism. It is also worth mentioning that the magmatic processes have been better understood by the analyses of very-long-period events at Cotopaxi Volcano. Based on the observation data and analysis results acquired through the project activities, academic papers dealing with Tungurahua and Cotopaxi Volcanoes were published in prestigious international journals such as "Journal of Volcanology and Geothermal Research" and "Eos Transactions of the American Geophysical Union", which contributed to a higher international reputation of IG in the field of volcano monitoring and research.

In social aspect, the enhancement of the social reliability of IG was observed. For example, the mutual understanding between the Baños Tourism Association and IG was improved by a meeting between them in November 2008 that was held as a part of project activities, despite the fact that the association had been hostile to IG because tourism business owners thought the volcanic activity information of IG would affect their business.

No negative impact was recognized so far.

(5) Sustainability

Sustainability is high in all the political, technical and financial aspects. The Ecuadorian government policy promoting volcanic disaster prevention through enhancement of volcano monitoring will be maintained. It is highly possible that the President's Order 3593 designating IG as the only organization in Ecuador for volcano monitoring and risk analysis will be maintained.

Technical sustainability is high. IG has incorporated the acquired skills and techniques by the Project in the routine work ranging from data acquisition to information dissemination. Furthermore, the development of the automatic system to analyze seismic signals and the compilation of the operation manual contributed to the enhancement of the technical sustainability. As there are four technicians who can fully operate and maintain the equipments provided by the Project and eight field assistants who can assist the technicians properly, sustainability in terms of the operation and maintenance of equipment and monitoring network is judged high. It is also expected that the counterpart researchers can continuously update their expertise in volcano monitoring and analysis through the research collaboration agreement with NIED.

Financial sustainability is generally high. IG's funding sources include budget allocation from the government; contributions from private sectors; support from international organizations; and income from consulting services. Therefore, it is highly expected that the maintenance and operation costs will be secured. Furthermore, the government approved a budget (nine million USD) for a new project of IG to enhance the earthquake and volcano monitoring capabilities in Ecuador. Some uncertainties remain in the government funding of this new project due to effects of the current economic crisis.

3-3 Factors that promoted the realization of project effects

(1) Factors concerning to Planning

None.

(2) Factors concerning to the Implementation Process

One of the factors that promoted realization of effects was that the Japanese experts and counterpart researchers had high motivation for enhancing the volcano monitoring capacity. Because only short-term experts were dispatched to the Project, there were many periods when Japanese experts were absent in IG. During the absence of the Japanese experts, the counterpart researchers and technicians carried out the project activities on their own, utilizing the skills transferred by the Japanese experts.

The previous terminal evaluation report in 2006 recommended that both Japanese and Ecuadorian sides should introduce a mechanism for managing and monitoring the Project. Although a special mechanism for project management and monitoring was not additionally introduced, JICA Ecuador Office was upgraded from the Volunteer Coordination Office in 2007, and has played a more significant role to manage and monitor the project operations. This greatly contributed to the effective management and monitoring of the Project.

3-4 Factors that impeded the realization of project effects

(1) Factors concerning to Planning

None.

(2) Factors concerning to the Implementation Process

The destruction of volcano monitoring equipment by the eruptions of Tungurahua Volcano between July and August 2006, and data transmission failures due to saturation of the frequency band greatly affected data collection. However, these problems were solved afterwards by rehabilitating and replacing the equipment, and IG is able to obtain monitoring data smoothly now.

The equipments of one station at Tungurahua Volcano were stolen in June 2008, but these were eventually recovered and reinstalled with security cages in April 2009.

The observation was tentatively suspended between December 2007 and February 2008 because the solar panel could not generate power due to accumulating ashes from Tungurahua Volcano.

3-5 Conclusions

The Project was implemented smoothly in the extension period of the Project. Outputs have been fully produced as expected, and the Project Purpose has been achieved. Some indicators for the Overall Goal have also been met. Therefore, the Project should be completed at the end of April 2009 as planned.

3-6 Recommendations

(1) Continuation of capacity development

Although it is desirable for IG to retain its staff members on a long-term basis from the perspective of institutional capacity development, a certain extent of turnover of personnel is inevitable. Therefore, IG should prepare for it by promoting internal knowledge and technology transfer among its personnel, particularly for those skills and techniques acquired through the Project. Furthermore, IG should keep updating its expertise in volcanic monitoring and analysis as well as exploring scientific advancement of volcano research through joint research and research exchange programs with Japanese and other overseas universities and research institutions.

(2) Maintenance and replacement of the equipments

IG, in cooperation with related authorities and organizations, should take necessary measures to appropriately maintain the volcano monitoring and analysis system and its component equipments, including anti-theft measures for the equipments installed in the field. IG should also make a fiscal and operational plan for the replacement of the equipments provided through the Project, in order to ensure the continuity of the volcano monitoring and analysis system.

(3) Outreach activities

Further to its previous efforts, IG should broadly disseminate scientific information and knowledge, acquired through the volcano monitoring and analysis, to promote better understanding of the risks of volcanic disasters among central and local organizations for disaster prevention, local risk management groups, and residents in high-risk zones.

(4) Implementation of volcanic disaster management

In order to reduce volcanic disasters, volcano monitoring of IG has to be combined with risk management and emergency response that must be strengthened by Technical Secretariat of Risk Management and local administrations in volcanic high-risk zones.

3-7 Lessons Learned

(1) The research collaboration between IG and NIED advanced IG's volcano research, which contributed to the achievements of the Project. Therefore, for a technical cooperation project with a research institution, a mechanism to promote scientific advancement will enhance the motivation of counterparts and, thus, contribute to achievements of the project.

(2) For a technical cooperation project for natural hazard monitoring and disaster reduction, close contact during normal time (in non-emergency situations) between the scientists of the natural hazard monitoring institution and the local communities/organizations for disaster prevention is important in order to provide information directly and timely in simple language, which contributes to disaster reduction.