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Argentine Republic / Republic of Chile

FY2021 Ex-post Evaluation Report of Technical Cooperation Project

"The Project for Development of the Atmospheric Environmental Risk Management System in South America (SATREPS)"

External Evaluator: Hajime Sonoda, Global Group 21 Japan, Inc.

0. Summary

"The Project for Development of the Atmospheric Environmental Risk Management System in South America (SATREPS)" (hereinafter referred to as "the Project") was implemented in Argentina and Chile with the purpose of developing an "Atmospheric Environmental Risk Management System" which monitor and analyze the ozone layer and ultraviolet (UV) rays as well as conditions of aerosol such as volcanic ash, and provide the results in near-real-time to the meteorological agencies and other related agencies in both countries. The Project is consistent with the development plans and needs of both countries and the Japan's ODA policy, both at the time of planning and at the time of completion. Although an issue can be pointed out regarding the selection of the implementing agencies, it is not so serious as to reduce the relevance of the Project, therefore, the relevance and consistency of the Project are high. The observation network of the two countries was strengthened, and research on aerosols and ozone/UV rays, as well as analysis of atmospheric environmental risks and development of an information sharing system were promoted under the Project. However, the development of the Atmospheric Environmental Risk Management System could not be completed, and the project purpose was partially achieved. Although the overall goal was not achieved, data from the observation network enhanced by the Project are being used for atmospheric environmental risk management and related research. Therefore, a certain level of impacts has been achieved through the implementation of the Project, and the effectiveness and impact of the Project are moderately low. Although the project cost was almost as planned and the project period was as planned, outputs of the Project were achieved only partially, and therefore, the efficiency of the Project is moderately low. There are some technical and financial difficulties in sustaining the results of the Project, and the prospects for improvement and resolution are unclear. Therefore, the sustainability of the project effects is moderately low. In light of the above, the Project is evaluated to be partially satisfactory.

1. Project Description

Project Location Map

LIDAR Observation Facility of National Meteorological Service of Argentine

1.1 Background

The Andean region has many active volcanoes, and the volcanic ash scattered by eruptions not only causes damage to crops in the surrounding areas, but also seriously affects aircraft operations even in areas far from the volcanoes. For the operational safety of aircrafts, it is necessary to monitor the ever-changing volcanic ash distribution and predict its movement. In addition, the Patagonia region of Argentina and southern Chile is close to Antarctica and often falls directly under the ozone hole. UV rays cause skin cancer and cataracts, but normally the ozone layer absorbs UV rays and thus daily life is protected. However, below the ozone hole, UV rays reaching the ground directly increases, posing a serious risk to the residents of the area. Therefore, along with monitoring of the ozone hole, a prompt and appropriate response based on accurate and timely measurement of UV rays is required. On the other hand, in the Southern Hemisphere, including the Andes and Patagonia, ground-based observation networks for the atmospheric environment were not much developed compared to the Northern Hemisphere, where there are many developed countries, and there was no sufficient observation system.

Based on the above, Argentina and Chile requested technical cooperation to establish a system to monitor, properly assess, and promptly warn local communities of two major atmospheric environmental risks: aerosols and ozone/UV rays. In response to this request, the Project was implemented from April 2013 to March 2018 as the Science and Technology Research Partnership for Sustainable Development (SATREPS).

1.2 Project Outline

Overall Goal		Relevant ministries and agencies use “the Atmospheric Environmental Risk Management System” to minimize the risks and damages into the society due to UV rays, aerosols, and others.
Project Purpose		The Atmospheric Environmental Risk Management System is developed.[1]
Outputs	Output 1	Near-real-time aerosol monitoring network is developed.
	Output 2	The main properties of the aerosols focusing on source areas, types of aerosols, transportation, and seasonal variation are clarified.
	Output 3	The existing ozone and UV observation system (MM-wave radiometer, ozone LIDAR and associated instruments) are improved.[2]
	Output 4	Based on the monitoring, ozone hole variation and the dilution-mixing process of the ozone depleted air from ozone hole to the mid-latitude region of South America are analyzed.
	Output 5	An integrated analysis system of atmospheric environmental risks is developed.
	Output 6	A system to share the data analyzed at the Project with relevant ministries and agencies is developed.
Total cost (Japanese Side)		341 million yen
Period of Cooperation		April 2013 - March 2018
Target Area		Argentina, Chile (throughout)
Implementing Agency		Argentina: Institute of Scientific and Technical Research for Defense (CITEDF) Laser Application Research Department (DEILAP: then CEILAP), National Meteorological Service (SMN) Chile: Magellan University, Meteorological Direction of Chile (DMC) (Note: Both meteorological agencies were added to the implementing agencies since the March 2016 mid-term review study)
Other Relevant Agencies/ Organizations		None
Organizations in Japan		Nagoya University, National Institute for Environmental Studies (NIES)
Related Projects		Technical Cooperation “Strengthening Ozone Layer Observation” (Argentina, 2004-2007), Technical Cooperation “Project to Strengthen the Capacity to Measure the Ozone Layer and UV Radiation in Southern Patagonia and the Projection towards the Community”(Argentina, Chile, 2007-2011), “Empirical Study of Assimilation by the Southern Hemisphere Air Quality Observation Network” (Dispatch of an expert, 2009-2011), “Seminar on Ozone Layer Protection Measures II” (Thematic Training, Group Training, 2007)

[1] “The Atmospheric Environmental Risk Management System” is a system that provides data on ozone, UV, and aerosol obtained at each monitoring station in near real-time from the counterpart agencies to the relevant agencies" (Ex-ante evaluation summary).

[2] LIDAR is an acronym for Light Detection and Ranging, which stands for “light detection and ranging” or “laser image detection and ranging”. It is a remote sensing technology that uses light to analyze the distance to a distant object and the properties of that object by measuring the light scattered by pulsed laser radiation.

1.3 Outline of the Terminal Evaluation

1.3.1 Achievement Status of Project Purpose at the Terminal Evaluation

The project purpose “the Atmospheric Environmental Risk Management System is developed” is assessed as generally progressing well. The two IT platforms that comprise the system, Geo UV for UV rays and Geo Aerosol for aerosols, are expected to be completed by the end of the Project, although the development of the latter is somewhat delayed. In addition, there is currently some concern about the stable and constant operation of the observation system that is a prerequisite for system operation.

1.3.2 Achievement Status of Overall Goal at the Terminal Evaluation (including other impacts)

The likelihood of achieving the overall goal is high. A schedule has been established to have Geo UV and Geo Aerosol operational by the end of the Project, and the overall goal may be achieved within the project period.

1.3.3 Recommendations from the Terminal Evaluation

(1) Recommendations until the completion of the Project

- Improve the operational environment of LIDAR to ensure reliable and continuous acquisition of data on aerosols. The Laser Application Research Department (hereinafter referred to as “DEILAP”) and the National Meteorological Service (hereinafter referred to as “SMN”) of Argentina will agree on the transfer of LIDAR and the operational structure for them.
- Solve power supply problems related to the aerosol LIDAR in Punta Arenas, Chile.
- Complete the installation of the main server at SMN and the development of Geo Aerosol and Geo UV.
- Write research papers on research results and try to get them accepted in international journals.
- The meteorological agencies of both countries will sign an agreement to share observation data and maintain close cooperation.
- The Japanese side will provide inputs to ensure that the Project Purpose are achieved.

(2) Recommendations for post-project period

- Sustained budget and enhanced strategic research
- Actively utilize the results of the Project in other related projects
- Use of research results for policy making
- Sustainable operation and maintenance of observation networks (Argentina)
- Continued development of cooperation between the Meteorological Direction of Chile (hereinafter referred to as “DMC”) and the Magellan University (Chile)

・ Continued cooperation between Argentina, Chile, and Japan

2. Outline of the Evaluation Study

2.1 External Evaluator

Hajime Sonoda (Global Group 21 Japan, Inc.)

2.2 Duration of Evaluation Study

This ex-post evaluation study was conducted with the following schedule.

Duration of the Study: January 2022 - February 2023

Duration of the Field Study: June - July 2022

3. Results of the Evaluation (Overall Rating: C[3])

3.1 Relevance/Coherence (Rating:③[4])

3.1.1 Relevance (③)

3.1.1.1 Consistency with Development Plan of Argentina/Chile

Argentina and Chile ratified the Vienna Convention for the Protection of Ozone Layer (1985) and the Montreal Protocol (1987). The Protocol stipulates cooperation in research, systematic observation, and exchange of information on legal, scientific, and technical matters related to the substances that deplete the ozone layer, and both countries have been implementing ozone layer protection measures in accordance with these protocols. Furthermore, in August 2003, both countries signed the "Calafate Declaration" and agreed to cooperate in addressing climate change and ozone-related issues, particularly in the southern regions of both countries, and to obtain technical cooperation from the international community. The Project is positioned as an embodiment of these agreements. After the start of the Project, the two countries signed the "Maipu Treaty" in 2014, confirming that the two countries will cooperate with each other in the event of an emergency disaster. In addition, both Argentina and Chile place a high priority on UV protection for the general population and society as a whole, and both countries have established their own UV protocols and have committed themselves to thorough implementation of such measures. Therefore, the Project is consistent with the development plans of both Argentina and Chile, both at the time of planning and at the time of completion.

3.1.1.2 Consistency with Development Needs of Argentina/Chile

As described in "1.1 Background," at the time of the planning, appropriate measures were necessary in the target area to cope with such atmospheric environmental risks as volcanic ash and increased UV rays due to ozone depletion, which required the development of ground

[3] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory

[4] ④: Very High ③: High, ②: Moderately Low, ①: Low

observation networks, appropriate risk assessment, and a system that would enable prompt warning to local communities. Although DEILAP in Argentina and Magellan University in Chile, the implementing agencies at the beginning of the Project, had accumulated extensive research experience in atmospheric environment, they had limited experience in aerosol observation and analysis using LIDAR. In addition, the meteorological agencies of Argentina and Chile, which became full-fledged implementing agencies after the mid-term review of the Project, were facing challenges in improving the accuracy of observation data and observation techniques. Therefore, the promotion of research on the atmospheric environment and capacity building of related technologies in the Project are the efforts consistent with the needs of the organizations concerned in both countries. Therefore, the Project is consistent with the development needs of Argentina and Chile both at the time of planning and at the time of completion.

3.1.1.3 Appropriateness of the Project Plan and Approach

The Project did not fully achieve the purpose within the cooperation period. Furthermore, after the completion of the Project, activities to achieve the project purpose were not continued, and the overall goal was not achieved. The following situations regarding the selection of implementing agencies can be pointed out as one of the reasons for the above. However, this is not an issue that reduces the relevance of the Project.

The Project did not fully achieve its purpose because the development of the "Atmospheric Environmental Risk Management System" for aerosols was delayed due to unstable observations by LIDAR (aerosol observation device) which was designed by DEILAP of Argentina incorporating Japanese technology. LIDAR was designed as if researchers were to be stationed in the field, and its operation required a high degree of expertise and skill. In reality, although local SMN staff trained by DEILAP operated LIDAR at observation stations nationwide where LIDAR was installed, it was difficult to adjust LIDAR and to properly respond to frequent instrument malfunctions caused by severe weather conditions and power outages. In addition, the responsibility for malfunctions was not clearly defined between the two institutions,[5] and budgetary constraints at DEILAP meant that it took time for researchers to visit and deal with the malfunctions, resulting in delays in responding to the malfunctions and unstable observations by LIDAR.

The goal of the Project was to develop the "Atmospheric Environmental Risk Management System" that could be used by relevant institutions in both countries to meet the needs of citizens for life protection and disaster prevention, a goal that had not only a research aspect but also a practical nature. However, at the beginning of the Project, only the research institutes of each country (DEILAP of Argentina and Magellan University of Chile) were the implementing

[5] The observation equipment was owned by DEILAP, but the operation was outsourced to SMN, which caused confusion in the field as to who was responsible in the event of trouble.

agencies, and the meteorological agencies of both countries (SMN of Argentina and DMC of Chile), which were supposed to play an important role in observation as their routine operation, were finally added as implementing agencies in the latter half of the Project after the mid-term review. If SMN had been added to the implementing agency from the beginning, and if DEILAP had designed and built LIDAR with a full understanding of the conditions at the SMN observation sites and the capabilities of its staff, it is thought that observations could have been stabilized to some extent by creating a LIDAR with higher practicality.

3.1.2 Coherence (②)

3.1.2.1 Consistency with Japan's ODA Policy

In the Official Development Assistance Charter (ODA Charter), Japan has designated "addressing global environmental issues such as climate change and global warming, which are threats to humanity," and "protection of the people of recipient countries from threats" as important cooperation areas, and has actively promoted research, systematic observation, and exchange of information on science and technology (Articles 3 and 4, below) by ratifying the Vienna Convention and the Montreal Protocol in 1988. In the "Direction of JICA's Cooperation in the Field of Climate Change" (June 2012), JICA defines "adaptation measures" as support for risk management in recipient countries where the adverse effects of climate change are the concern. The Project is in line with the Global Issues Program under the "Environmental Conservation" development agenda for Argentina and the Climate Change Response Support Program under the "Environmental Measures with a Focus on Disaster Prevention" priority area of the Country Assistance Policy for Chile.

Based on the above, the Project is consistent with Japan's ODA policy at the time of planning.

3.1.2.2 Internal Coherence

In Patagonia and Antarctica in South America, two technical cooperation projects,[6] dispatch of experts, and thematic training had been conducted within the framework of JICA's "Climate Change Response Support Program" to address environmental and climate change issues. The projects included the introduction of ozone layer observation technology by LIDAR to DEILAP, expansion of the ozone layer observation network in the Patagonia region by DEILAP and Magellan University, and establishment of a warning system for residents in the same region by using UV signals.

Based on the experience of these two preceding technical cooperation projects, the Project was implemented with DEILAP and Magellan University as the initial implementing agencies. The

[6] Technical Cooperation "Strengthening Ozone Layer Observation" (Argentina, 2004-2007, Implementing Agency: DEILAP), Technical Cooperation "Project to Strengthen the Capacity to Measure the Ozone Layer and UV Radiation in Southern Patagonia and the Projection towards the Community" (Argentina, Chile, 2007-2011, Implementing Agencies: DEILAP, Magellan University))

observation network was expanded nationwide, and aerosol observations by LIDAR were newly started, and the “Atmospheric Environmental Risk Management System” in which observation data from across the country would be provided in near-real-time to all relevant organizations was aimed to build. In other words, the Project is a nationwide development of the ozone layer observation network, enhancement of UV observation capacity, and communication of information to local residents, which was started in the Patagonia region through the preceding technical cooperation mentioned above, with the addition of aerosol observation and risk management system. Such results of the proceeding technical cooperation as the observation equipment installed and the experience and human connections in each country, and the experience of joint observation and joint research in the Patagonia region spanning both countries provided the basis for smooth implementation of the Project, and the Project was positioned to complement and complete the objectives of the earlier technical cooperation.

Based on the above, it can be said that the Project has been implemented in a way that further enhances the results of past projects. No specific collaboration with other JICA projects in the implementation was identified. The Project also triggered the start of the third country training program “Ground-Based Remote Sensing for Latin America” at SMN from 2022.

3.1.2.3 External Coherence

No specific plans or results have been identified for collaboration with external donor projects that preceded or were implemented in parallel with the Project.

Based on the above, the Project is consistent with the development plans and needs of the both target countries. Some issues can be pointed out in the project plan and approach, but these issues do not reduce the relevance of the Project. In addition, the Project is consistent with the development cooperation policies of the Government of Japan and JICA, and was implemented on the basis of the results attained by JICA’s previous projects. Therefore, the relevance and coherence of the Project are high.

3.2 Effectiveness and Impact[7] (Rating:②)

3.2.1 Effectiveness

3.2.1.1 Achievement of Outputs

(1) Development of aerosol observation network and analysis of aerosol characteristics (Outputs 1 and 2)

Volcanic ash from large volcanic eruptions that occur every few years in the Andes Mountains affects aircraft flight schedules. In order to understand the ever-changing distribution of volcanic ash along air routes and around airports and to make short-term forecasts, it is necessary to develop a ground observation network that can monitor the situation in near-real-time and analyze aerosol characteristics such as the source, type, transport routes, and seasonal changes of aerosols. In the Project, nine LIDAR were deployed over a wide area centered on airports in Chile and Argentina to establish an observation network for volcanic ash and other aerosols, and a system was constructed to organize and transmit necessary information to related organizations to accumulate observation data and analyze aerosol characteristics.

All nine planned LIDAR were installed by April 2017. They were designed and manufactured by DEILAP, but Japanese technology was incorporated to obtain the performance required for the Atmospheric Environmental Risk Management System.[8] Although some of LIDAR types were changed due to exchange rate fluctuation and other factors during the project period, the planned performance was ensured. Thus, the establishment of LIDAR observation network (Output 1) was largely achieved.

In October 2016, SMN became fully involved in the observations, and a full-fledged regular observation system was established, starting with LIDAR that had been installed earlier. Based on the observation data, the source areas and transport pathways of three aerosol sources (volcanic ash, Patagonian dust, and forest fire aerosol) were identified. However, because the observations were not stable and data could not be obtained throughout the year, seasonal changes could not be determined. Therefore, the characterization of aerosols (Output 2) was partially achieved.

The reasons for the unstable observations by LIDAR include the frequent troubles with observation equipment due to the severe weather conditions and power outages at the observation sites. In addition, as described in "3.1.1.3 Appropriateness of the Project Plan and Approach," coordination and troubleshooting capabilities of the staff in charge of SMN were

[7] When providing the sub-rating, Effectiveness and Impacts are to be considered together.

[8] The identification of spherical and non-spherical particles based on polarization resolution measurements is useful for identifying volcanic ash, which is a non-spherical particle. The multi-wavelength high spectral resolution LIDAR is also observable in daylight, and patents have been filed in Japan and Argentina. In Japan, the patent was granted in 2017 with the NIES, the National Scientific and Technical Research Council of Argentina, and the Argentine Ministry of Defense as patent holders. In Argentina, the application was filed in 2021.

limited, and coordination between DEILAP and SMN as well as budget of DEILAP and SMN for failure response were limited.[9]

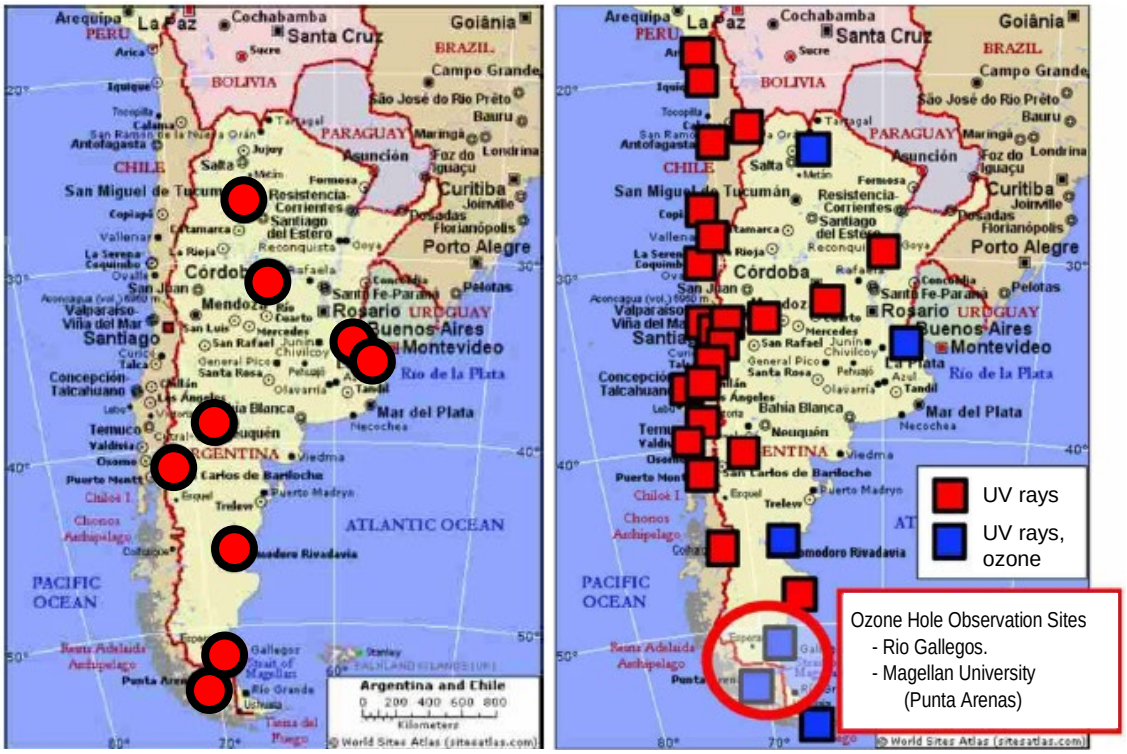


Figure 1 Aerosol (left) and UV/ozone (right) observation points

Source: JST terminal evaluation report

(2) Development of ozone and UV rays monitoring networks and research on the ozone hole (Outputs 3 and 4)

The southern tip of the South American continent, where the ozone hole arrives, includes the cities of Rio Gallegos and Ushuaia in Argentina and Punta Arenas in Chile with a combined population of about 300,000 people in these three cities. In order to provide real-time UV information and forecasts to the people in these areas, it was important to obtain detailed measurement data on the amount of ozone and UV rays at the time of entry under the ozone hole, and establish seasonal trend and inter-annual variations through observation.

In the Project, the existing ozone and UV observation equipment (superconducting spectrometer for millimeter-wave) at the Southern Patagonian Atmospheric Observatory in Rio Gallegos, Argentina, was upgraded to higher precision, and new observation equipment

[9] In the Project, in principle, domestic travel expenses for staff of the implementing agencies were to be borne by the counterpart country so that the counterpart country could maintain its own activities after the Project was completed. However, frequent field trips were required to resolve a number of problems, and securing travel expenses became a major problem for the counterpart countries.

(Brewer spectrometer, narrow-band multi-wavelength UV radiometer, cloud camera, etc.) was introduced. The excimer laser was updated to continue operation of the ozone LIDAR, an important instrument that can observe the vertical distribution of ozone introduced in the preceding technical cooperation, but it was not operational because DEILAP was unable to procure the dye gas necessary for its operation. The Magellan University, Chile, assisted the ozone sonde to make periodic ozone sonde emission observations, and the data were used to confirm the accuracy of the ozone LIDAR and millimeter-wave spectrometer. The ozone and UV observation systems showed the targeted accuracy and availability. Thus, Output 3 was partially achieved.

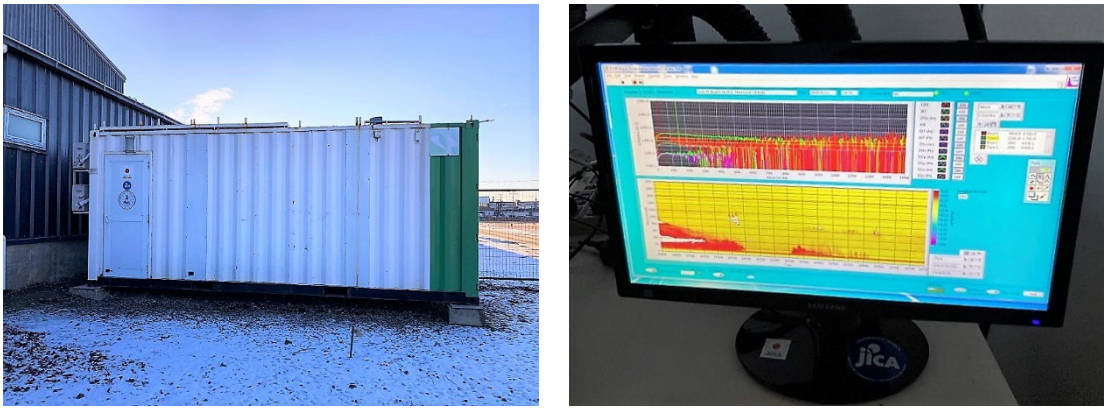
By combining the results of the chemical transport model calculations with the results of observations at Rio Gallegos and monitoring by the ozone sonde at Punta Arenas, which are inputs to the Project,[10] the shape of the ozone hole and the mechanism of ozone hole shape change have been elucidated.[11] Thus, Output 4 was largely achieved.

As DMC joined the implementing agency in the middle of the Project, its existing UV observation network was added to the Project's observation network, and DMC's know-how on UV observation was transferred to SMN and utilized in the development of SMN's observation network.

SMN's LIDAR instruments (left), instruments for UV etc. (right)

[10] The chemical transport model is one of the mass transport models that expresses changes and movement of substances in the atmosphere using mathematical equations. It predicts ozone concentrations above and near the ground by considering the movement of ozone and substances involved in its change by wind, its fall to the ground, and its change through chemical and light-induced reactions.

[11] For example, the relationship between the meteorological settings and the location of the center of the ozone hole gradually became to understand, and were able to interpret meteorologically the cause of the 2009 ozone hole's approach to South America and staying still over a period of about three weeks.



LIDAR Observation Facility at Magellan University: exterior (left),
observation data display (right)

Aerosol Observation Facility of Magellan University

(3) Atmospheric environmental risk analysis and development of information sharing system (Outputs 5 and 6)

The Project aimed to improve the accuracy of the model by incorporating satellite data into the existing mass transport model for ozone and aerosols and comparing it with ground-based observation data, with a view to providing short-term forecast information as well as a quick understanding of the current situation using near-real-time data acquired from ground-based observation networks. This was accomplished for ozone, but the short-term prediction of aerosol distribution could not be completed by the end of the Project because sufficient observational data for the analysis was not available due to low availability of LIDAR. Therefore, Output 5 was partially achieved.

The Project aimed to develop an IT platform for information sharing of the Atmospheric Environmental Risk Management systems. A server was installed at SMN, but due to information security constraints, access to the network server by external organizations was not realized. SMN and DMC proceeded with preparations for information sharing, and upon

mutual agreement, a mirror server was also set up in DMC and connection tests were conducted. However, it turned out that it was not possible to clear the information security issue, and it was not connected to SMN's server in the end. For UV rays, Geo UV was almost completed, and a UV forecast map and a near-real-time observation data map were created to be displayed in the system. On the other hand, Geo Aerosol for aerosols, although the platform itself was prepared, still required improvements in the algorithm for appropriate analysis of observation data. The types of data to be displayed to users and the method of displaying maps and other information were also not completed by the time the Project was completed.[12] Therefore, Output 6 was partially achieved.

3.2.1.2 Achievement of Project Purpose

Table 1: Achievement of Project Purpose

Project Purpose: "An Atmospheric Environmental Risk Management System" is developed.	Indicator 1: The atmospheric (ozone, UV, aerosol mainly) monitoring network and existing alert/protocol system are integrated into "the Atmospheric Environmental Risk Management System".	Results: partially achieved. Of the Geo UV and Geo Aerosol components of the "Atmospheric Environmental Risk Management System," only Geo UV was completed.
	Indicator 2: The performance of "the Atmospheric Environmental Risk Management System".	Results: partially achieved; Geo UV performed adequately, but Geo Aerosol was not completed.

The "Atmospheric Environmental Risk Management System" is a system for observing, analyzing, and sharing information on UV rays (ozone hole) and aerosols. The data obtained from the enhanced observation network will be used for research on aerosol and ozone hole, an integrated analysis system will be used to generate information necessary for risk management, and Geo UV and Geo Aerosol will be used to share information to support decision making by risk managers.

For UV rays, Geo UV has been developed to obtain near-real-time data within 15 minutes from a network of UV monitors in major cities in Argentina and Chile, and to alert relevant agencies when UV levels exceed preset levels. The system provides time series of UV index for the past hour, 12 hours, 24 hours, and one week for each monitoring station, as well as regional forecast maps of UV index over a three-day period (one for clear skies and one for cloud cover). However, Geo UV was not connected to the relevant agencies by the Project completion.

[12] The scope of the Project was to provide air traffic controllers with information that they can use to make decisions. According to DEILAP and SMN, a system like Geo Aerosol, which aims to provide a clear visual representation of volcanic ash distribution and forecasts in near-real time, is unprecedented in the world, and its development was more complicated than expected and could not be completed within the timeframe due to a lack of human resources.

For aerosols, LIDAR observation network can produce time-series plots of the vertical distribution of aerosols at each observation point. The plan was to display the risk of health hazards of aerosols near the surface (below 1 km altitude) on a map in four levels, along with the type of aerosol (air pollution, soil, etc.). It was also planned to estimate the weight concentration of volcanic ash up to an altitude of 12 km and display the risk level in four levels on a map, as well as the altitude change of volcanic ash over the past three days. However, the Project was completed without realizing these features.

Based on the above, the Project achieved its project purpose at a limited level.

3.2.2 Impacts

3.2.2.1 Continuation of Activities after Completion of the Project

After the completion of the Project, research activities were continued in both Argentina and Chile, with observation networks and linkages with JICA and Japanese cooperating organizations being maintained. However, the analysis of atmospheric environmental risks and the development of an information sharing system were not continued. The specific situation is described below.

(1) Development of observation network and analysis of aerosol characteristics

Argentinean Implementing Agencies

In Argentina, seven of the eight LIDAR were transferred to the SMN, except for one located at the DEILAP site, to create a permanent observation system in line with the recommendations of the Terminal Evaluation. The SMN has been working to ensure continuous operation through maintenance, with the help of the Japanese experts visiting and working remotely, repairing malfunctioning air conditioning and cooling systems, replacing lamps, and performing other routine maintenance work necessary to operate in severe weather conditions.

As of June 2022, two of the eight units are in constant observation; three are on standby for observations as needed and can begin observations in about 30 minutes if activated by a well-trained operator. In fact, in August 2022, they have observed smoke from a large fire and provided information to the aviation department and the public. The remaining three units are awaiting repair.[13]

LIDAR will perform as expected if adjusted correctly, but if the optical alignments are not adjusted properly, the quality of the signal will deteriorate. Since adjustment requires skill, SMN, in cooperation with DEILAP, has developed software to assist in the adjustment of the instruments, which is now being used on a trial basis. In the future, with the cooperation of the National Institute for Environmental Studies (Japanese cooperating organization; hereinafter referred to as “NIES”), SMN and DEILAP plan to improve the hardware so that it does not require complicated adjustment work. In addition, SMN is developing new software for the

[13] One LIDAR from CEILAP and two LIDAR from SMN.

algorithm to analyze LIDAR data, based on the results of the Project, in collaboration with the Brazilian National Institute for Space Research.

Regarding analysis of aerosol characteristics, six new scientific papers, which were prepared by authors including the counterparts, were published on volcanic ash movement, LIDAR observations, and aerosol analysis in books, international and domestic journals in Argentina.

Chilean Implementing Agencies

LIDAR operated by Magellan University in Chile failed in 2020 and 2021 due to power outages, but university researchers repaired and operated it, and it is now in constant observation. Research on the origin and characteristics of aerosols has been promoted at the University, recording aerosols from the fires in Australia in 2019, aerosols from the fires in central Chile, and 11 new scientific papers and presentations with the counterparts among the authors. The Project also triggered the University to collaborate with a German research institute (Leibniz Institute for Tropospheric Research).

(2) Development of ozone and UV monitoring network and research on ozone hole

Argentinean Implementing Agencies

The SMN installed a new UV observatory in October 2018 at the site where the Argentine Plains Hydrographic Institute is located. At the time of the ex-post evaluation, some of SMN's ozone and UV instruments are under repair or maintenance, but their operational status is generally good.

The ozone LIDAR at Rio Gallegos operated by DEILAP experienced a new cooling system failure without procurement of the dye gas that needed to be replaced. Subsequently, the ozone LIDAR was left inoperable due to the resignation of the locally based DEILAP researcher in charge of the Project and the fact that field visits from Buenos Aires were constrained by the pandemic of COVID-19. Due to the obsolescence of technology for this LIDAR, DEILAP plans not to reactivate the LIDAR in 2021, but to utilize one of its two lasers as an experimental facility for another division of DEILAP, and the other as part of a new aerosol LIDAR. Among the other ozone instruments at DEILAP, the Brewer spectrometer is in operation. The millimeter-wave radiometer, which was upgraded to higher accuracy under the Project, failed in 2018, but repairs are underway with the cooperation of the Japanese experts both visiting and remotely.

Research on ozone by SMN and DEILAP has been continuing even after the Project's completion, with several scientific papers published in international and national journals. In addition, joint research is underway in Argentina for the utilization of solar energy, using

SMN's observation data and observation network.[14]

Chilean Implementing Agencies

The ozone sonde has been suspended since the completion of the Project because the equipment and materials for the ozone sonde provided to Magellan University have been used up. Magellan University has published two scientific papers/presentations on ozone since the completion of the Project.

DMC operates a UV observation network and operates a UV index website. However, there is no direct involvement of the Project in this.

(3) Development of an atmospheric environmental risk analysis and information sharing system

According to SMN, development of the unfinished integrated analysis system (Output 5) and Geo Aerosol (Output 6) was halted after the Project was completed. This is because it was difficult to maintain the complex observation network dispersed over a vast area and to deploy human resources continuously due to the outflow of human resources associated with rapid inflation in Argentina[15], lack of financial resources in the government sector, and the spread of new coronavirus infections.

Observation data are stored on a server located at SMN, but due to information security restrictions, only SMN and DEILAP have direct access to this server. Other organizations are provided with data on an individual request basis.

(4) Cooperation with JICA and Japanese cooperating organizations

JICA third country training was conducted in Argentina in March 2022, with SMN and DEILAP serving as instructors and 37 participants from 7 countries.

SMN and DEILAP maintain the cooperation with the NIES initiated by the Project and have a permanent collaboration on the operation and maintenance of LIDAR since 2018 and every year except 2021, an expert from the Institute has visited Argentina to sequentially repair and adjust LIDAR in different locations.

Magellan University maintains cooperative relationships with Nagoya University and the NIES. The expert from Nagoya University had installed a millimeter-wave spectrometer at the

[14] SMN has been evaluating solar power generation efficiency with the Nuclear Energy Agency, and optimizing solar power generation forecasts with the National Science and Technology Agency's Computer Simulation Center. An evaluation of Buenos Aires' solar power generation potential with the Buenos Aires Municipal Government's Environmental Protection Agency are currently underway. In addition, SMN, together with the National Institute of Defense Science and Technology, the University of Luján, and the Nuclear Energy Agency, will implement the project "Development of Infrastructure, Calibration, and Instrument Production Capabilities for Nation-wide Measurement of Solar Energy" in order to increase the observational capacity of solar radiation.

[15] Argentina has experienced rapid inflation of 30-50% per annum since 2018. Salary increases in the government sector did not keep pace with this, resulting in an exodus of highly specialized personnel, researchers, and technicians to the private sector in SMN and DEILAP. In particular, IT technicians are in great demand in the private sector, and the exodus of personnel involved in the Project was a major blow to the continuation of activities.

Magellan University Observatory in Rio Gallegos, and joint research funded by Nagoya University's budget and the Ministry of Education's Grant-in-Aid for Scientific Research is underway using the observation equipment of the Project.[16]

3.2.2.2 Achievement of Overall Goal

The Atmospheric Environmental Risk Management System ceased operation in 2019 because Geo Aerosol was not yet complete, the completed Geo UV was not connected to the relevant agencies, and the IT technician who was managing the system at SMN left and could no longer update it. Thus, the overall goal "relevant ministries and agencies use the Atmospheric Environmental Risk Management System to minimize the risks and damages into the society due to UV rays, aerosols, and others" has not been achieved.

On the other hand, instead of Geo Aerosol and Geo UV, which were incomplete, SMN publishes some observation data on its website under the name of Savernet.[17] The only data that is routinely updated here are observations of UV rays. Apart from this, SMN and DMC publish on their respective websites the observed data of UV rays (UV index) and the forecast for the day. According to SMN and DMC, the Savernet site is hardly known to the general public, and UV data is exclusively referred to at the websites of the respective weather stations.

3.2.2.3 Other Impacts regarding Overall Goal

(1) Impact on Atmospheric Environmental Risk Management

In order to manage risks due to UV rays and aerosols, both Argentina and Chile are making use of the observation network and observation data of the Project, and are working on the following.

Argentina

SMN has been working on predicting volcanic ash movement and ash fall through a numerical model since 2017.[18] Observations from the Project were used to validate this model, and the numerical model was also included in the content of the Project's training in Japan. The model predicts volcanic ash movement and fallout based on LIDAR observations, reports from pilots and airports, and information from volcano related agencies, etc. SMN operates one of nine Volcanic Ash Advisory Centers worldwide and provides information to airlines and airports in collaboration with the Argentine Civil Aviation Authority.[19] LIDAR observation

[16] Magellan University is also collaborating with other institutions, including the National Institute of Polar Research (Japan), Hiroshima University, University of Toyama, and La Union University (France).
[17] http://data.savernet-satreps.org/
[18] FALL3D: Created by Barcelona Supercomputing Center, Spain
[19] The International Civil Aviation Organization, in cooperation with the World Meteorological Organization, has established an international airway volcanic ash monitoring system that provides volcanic eruption monitoring and

data developed under the Project will be used when necessary, such as during volcanic eruptions.

Together with the city of Vincente Lopez near Buenos Aires, SMN is implementing an UV protection program "Responsible Use of Sunlight," which includes the preparation of educational materials, educational awareness activities, installation of UV signals, an initiative started by the preceding technical cooperation and used in the Project, and real-time publication of UV indices.

The Argentine Association of Hygienists worked with the SMN on UV protection for workers, evaluating the health risks from UV, proposing a segmented UV index, and organizing a menu of UV protection measures. The new UV index is based on SMN's previous observations. The new UV index is available on the SMN website.

Chile

Magellan University forecasts UV indices for Magellan Province using the Norwegian Global Ozone Model and its own model based on historical data from satellite and ground-based observations. The information is published by the provincial authorities and warnings are issued as necessary. The collaboration between the Magellan University and the Provincial Office of the Ministry of Health, which was initiated by the preceding technical cooperation, was strengthened by the provision of UV signals through the Project. After the completion of the Project, the collaboration activities were suspended due to the change of administration and the spread of the new coronavirus infection, but at the time of the ex-post evaluation, coordination will be initiated to resume the collaboration.

(2) Impact on research on atmospheric environmental risk management

As mentioned above, studies on ozone and UV levels and aerosols based on the results of the Project are continuing in both Argentina and Chile. In addition, some of the observation data obtained by SMN, DEILAP, and Magellan University through the observation network of the Project are provided to the following international observation networks, and are used for ozone and aerosol monitoring and research worldwide.

- LATINET: South American LIDAR Network
- Pandonia Global Network: A global monitoring network using the instrument which was included in the Project for air quality, including ozone and aerosols, which is operated by NASA and the European Space Agency (ESA)
- AERONET: NASA's network for aerosol observation data

actual and forecast volcanic ash cloud information from airway volcanic ash information centers to their respective areas of responsibility, and designated nine Volcanic Ash Advisory Centers worldwide.

3.2.2.4 Other Positive and Negative Impacts

(1) Impact on the natural environment

No direct environmental impacts have been identified.

(2) Resettlement and Land Acquisition

There was no resettlement nor land acquisition by the Project.

(3) Gender Equality, Marginalized People, Social Systems and Norms/Human Well-being and Human Rights, etc.

No impacts of note regarding the above have been identified.

In the Project, aerosol and ozone/UV observation networks were strengthened in both Argentina and Chile, and research based on the data obtained, analysis of atmospheric environmental risks, and development of an information sharing system were promoted. However, the development of an atmospheric environmental risk management system based on these data could not be completed, and the project purpose was partially achieved. Although the system was partially incomplete and ceased operation in 2019, and the overall goal were not achieved, the observation data from the observation network enhanced by the Project are being used for atmospheric environmental risk management purpose and related research. Based on the above, since the Project has to some extent achieved the project purpose and overall goal, effectiveness and impact of the Project are moderately low.

3.3 Efficiency (Rating:②)

3.3.1 Inputs

3.3.1.1 Elements of Inputs

Table 2 shows the planned and actual inputs to the Project from the Japanese, Argentinean, and Chilean sides. In addition to the experts dispatched by the Japanese side, nine other researchers joined the joint research at partner institutions in Japan.

DEILAP contributed to the construction of the observation network by investing a large amount of money in the first half of the Project, including the construction of five LIDAR nationwide at its own expense. However, as described in “3.2.1.1 Achievement of Outputs (1) Development of aerosol observation network and analysis of aerosol characteristics (Outputs 1 and 2),” observations by LIDAR were not stable. On the other hand, the ozone LIDAR directly operated by DEILAP could not be fully operational until the Project was completed because DEILAP was unable to procure the dye gas necessary for its operation due to budget constraints. Against this backdrop, there were delays in the Project’s activities, and the outputs and project purpose

remained unachieved.

Since the mid-term review, the need to establish a regular observation system was recognized, and the meteorological agencies of Argentina and Chile were added as implementing agencies to serve as the core users of the Atmospheric Environmental Risk Management System. Human input from the meteorological agencies of both countries contributed greatly to the progress of the Project. In particular, the participation of SMN, whose main task is to conduct regular observations in Argentina, was important for the implementation of stable observations and the preparation of a system to continue observations after the completion of the Project. On the other hand, the participation of the Chilean DMC was beneficial for the establishment of the UV observation network in Argentina, but it was reported that the investment of personnel and budget for the Project, which were not originally planned, put pressure on the DMC's regular work.

Table 2: Planned and actual inputs

Elements of Input	Planned Inputs	Actual Inputs
(1) Dispatch of Experts	Expert Coordinator	1 long-term expert (resident: coordinator) 5 short-term experts (16.0 person-months)
(2) Acceptance of trainees	Training in Japan	Training in Japan: 7 courses for a total of 11 participants (7 from Argentina, 4 from Chile)
(3) Equipment	Research equipment	Observation equipment (183 million yen) Brewer spectroradiometer Excimer laser Transient recorder, etc.
(4) Operational expenses	-	42 million yen
Total project cost on the Japanese side	340 million yen	341 million yen
(5) Counterpart personnel	Counterpart personnel	Project director and project manager (One from each country) Counterpart personnel Argentina: 35 persons, Chile: 9 persons
(6) Facilities and equipment	Materials and equipment for research	Argentina: 580 thousand USD Project office, LIDAR UV observation equipment, etc. Chile: 8 thousand USD Computer, observation vehicle modification, etc.
(7) Others		Operating expenses (travel, conference, etc.) Argentina: 220 thousand USD Chile: 40 thousand USD

Source: Material provided by JICA (at the time of planning: Ex-ante Evaluation Sheet, Detailed Design Study Report, actual results: Terminal Evaluation Report)

According to the experts, communication among the implementing agencies in the two countries was not particularly problematic, in part because of the same language. However, in the first half of the Project, the experts tended to stay in the field for a limited period of time and took longer to recognize and address problems.

3.3.1.2 Project Cost

Project cost of the Japanese side was almost in line with the plan, with actual project cost of 341 million yen (100% of the plan) compared to the planned 340 million yen.

3.3.1.3 Project Period

The project period was five years, from April 2013 to March 2018, as planned.

Although the project cost was almost as planned and the project period was as planned, the efficiency of the Project is judged to be moderately low because the outputs were only partially achieved as described in "3. 2. 1. 1 Achievement of Outputs."[20]

3.4 Sustainability (Rating: ②)

3.4.1 Policy and System

The policies of both countries regarding atmospheric environmental risks at the time of project completion were maintained at the time of ex-post evaluation, and the need for monitoring atmospheric environmental risks due to UV rays (ozone hole), volcanic ash, etc. remains unchanged.[21] In Argentina, SMN is responsible for UV observation and forecasting and warning, and for monitoring volcanic eruptions and providing actual and forecast information on volcanic ash clouds to its responsible areas as a Volcanic Ash Advisory Centers. In Chile, DMC is the official organization responsible for the observation and dissemination of information on UV rays, in accordance with the law for the protection of the ozone layer. In addition, Chilean environmental law establishes standards for air pollution, including aerosols and ozone, and pollution control.

Based on the above, there are no issues with the sustainability of the policy and system aspect of the Project.

3.4.2 Institutional/Organizational Aspect

Argentinean Implementing Agencies

The organizational structure of SMN has not changed since the Project was completed.

[20] Output 1 and Output 4 were judged to be "generally achieved", while Output 2, Output 3, Output 5, and Output 6 were all judged to be "partially achieved". (3. 2. 1. 1 Achievement of Outputs)

[21] In Argentina, efforts to utilize renewable energy, including solar energy, have been intensified in recent years, and the observation network of the Project will be useful for this purpose as well.

CEILAP at the beginning of the Project was renamed DEILAP, but the actual organizational structure remains the same. The transfer of ownership of LIDAR observatories in Argentina (excluding the ozone LIDAR) from CEILAP to SMN was realized after an agreement was signed in September 2018, after project completion. Close collaboration between CEILAP and SMN has been maintained since the completion of the Project, as two of CEILAP's key counterparts have moved to SMN.

Chilean Implementing Agencies

There has been no change in the organizational structure of DMC and Magellan University since the completion of the Project, and a cooperative relationship has been maintained between DMC and Magellan University, mainly in the areas of observations and development of numerical models.

International Cooperation

The collaboration between the Argentinean and Chilean implementing agencies was not maintained after the Project was completed. This may be due to constraints caused by the pandemic of the new coronavirus infection, as well as to the outflow of human resources on the Argentine side.[22] In addition, since Chile is hardly affected by Argentina with regard to volcanic ash, DMC was not proactive in maintaining collaboration, believing that "there is no particular need for permanent collaboration with SMN" and that "it is sufficient to share information only when necessary." SMN stated that "although the scientific research need for collaboration between the two countries is obvious, it is not easy for related organizations to actually coordinate and conduct joint observations." Since the Atmospheric Environmental Risk Management System linking the two countries was virtually never completed and both countries maintain their own observation networks, the failure to maintain collaboration between the two countries does not undermine the sustainability of the actual outcome and impact of the Project.

Experts from Japanese cooperating institutions (Nagoya University and NIES) maintain cooperative relationships with SMN and DEILAP in Argentina and mainly with Magellan University in Chile.

Based on the above, there are no issues with the sustainability of the Project in institutional/ organization aspect.

[22] See "3.2.2.1 Continuation of Activities after Completion of the Project (3) Development of an atmospheric environmental risk analysis and information sharing system" and footnote 15 for more information on the outflow of human resources.

3.4.3 Technical Aspect

Argentinean Implementing Agencies

Seven of the 18 DEILAP counterparts left their jobs (two of them moved to SMN); five of the 12 SMN counterparts left their jobs (one of them passed away). Among others, the resignation of the DEILAP researcher in charge of the ozone LIDAR at Rio Gallegos and the IT specialist in charge of operating and updating the Atmospheric Environmental Risk Management System at SMN have directly affected the sustainability of the Project. It is not easy to obtain replacements for personnel who have left their positions after gaining a high level of expertise and competence through the Project.

DEILAP has the organizational and technical capacity to develop equipment and conduct observations, analysis, and research, and SMN has many years of practical experience in UV observations and a sufficient number of observers throughout the country. However, since the operation and maintenance of LIDAR requires expertise and skill, some of the observatories have not been able to conduct stable observations. On the other hand, the remaining counterparts in SMN and DEILAP are actively continuing their research activities, and communication with Japanese cooperating institutions is being maintained, so there are no particular technical challenges.

Chilean Implementing Agencies

There are no technical concerns because there have been none of the researchers left Magellan University, stable observations continue using LIDAR and other equipment after the completion of the Project, and international joint research is being conducted with Japan and other countries.

One of the four DMC counterparts has moved to the training institute for aviation human resources, while the remaining three continue to work at DMC. It should be noted that the role expected of DMC after the completion of the Project, such as providing UV observation data to the Atmospheric Environmental Risk Management System, is no longer required since Geo UV has ceased operations.

As mentioned above, in Argentina, as the resignation of some counterparts and SMN staff has seriously affected the sustainability of the Project, and the prospect of obtaining replacement personnel is uncertain. Therefore, the technical aspect of the Project has some issues.

3.4.4 Financial Aspect

Argentinean Implementing Agencies

According to SMN, due to the rapid rise in prices in Argentina, SMN’s real budget level

(budget level after taking price fluctuations into account) has decreased by about 40% since 2017. Foreign exchange fluctuations are also severe, making it difficult to purchase replacement parts and renewal of observation equipment requiring foreign currency as planned. SMN has secured minimum financial resources from the government budget and other sources, and has secured financial resources for the maintenance, renewal, and new installation of observation equipment through research projects funded by other organizations. However, this is not a stable source of financial resources.

Although financial information of DEILAP was not obtained, the situation is believed similar since it is the same government department as SMN. In fact, the fact that DEILAP did not procure the dye gas needed for the ozone LIDAR even after the Project was completed suggests that DEILAP does not have much room in its budget.

Chilean Implementing Agencies

DMC has a budget to continue its weather observation and forecasting services, but the budget for new equipment is scarce.

Magellan University has a budget to continue the necessary observations, but it is not always sufficient to repair or renew observation equipment or to install new equipment because it is necessary to obtain research projects. The ozone sonde implemented under the Project has not been able to continue because the equipment and materials have been exhausted.

As described above, the implementing agencies in both countries are in a poor financial position, and there is some concern about the financial resources to continue the observations currently being made, especially in Argentina, where the economic situation is difficult. Thus, the financial aspect of the Project has some issues.

3.4.5 Environmental and Social Aspect

There are no issues that need to be noted in terms of environmental and social aspects with regard to the sustainability of the Project.

3.4.6 Preventive Measures to Risks

There are no issues that need to be noted in terms of addressing risks for the sustainability of the Project.

3.4.7 Status of Operation and Maintenance

Most of the materials and equipment for the Project were provided to the Argentinean side; of the 13 pieces of materials and equipment costing more than 1 million yen, 6 items are in need of repair as of June 2022.

Argentinean Implementing Agencies

The operation status of observation equipment on the Argentine side is described in "3.2.2.1 Continuation of Activities after Completion of the Project." SMN is working to ensure proper operation by sequentially upgrading its observation network, including LIDAR. For the operation and maintenance of LIDAR, SMN has obtained the cooperation of experts from the NIES, and has reduced operating costs by limiting the number of LIDAR that are in operation at any given time. Some observation equipment needs to be sent to the U.S. and Europe for adjustment and repair, which involves significant costs, but SMN, together with the National Institute for Defense Science and Technology and others, has launched a project to enable the production and repair of observation equipment in Argentina.[23]

Chilean Implementing Agencies

The mirror server provided to the Chilean side could not be connected to SMN, so it is being operated at DMC for a different purpose than originally intended. LIDAR at Magellan University continues constant observations while making necessary repairs.

As described above, some minor issues have been observed in terms of the technical and financial aspects, and the prospects for improvement and resolution are unclear. Therefore, sustainability of the Project effects is moderately low.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

The Project was implemented in Argentina and Chile with the purpose of developing an "Atmospheric Environmental Risk Management System" which monitor and analyze the ozone layer and UV rays as well as conditions of aerosol such as volcanic ash, and provide the results in near-real-time to the meteorological agencies and other related agencies in both countries. The Project is consistent with the development plans and needs of both countries and the Japan's ODA policy, both at the time of planning and at the time of completion. Although an issue can be pointed out regarding the selection of the implementing agencies, it is not so serious as to reduce the relevance of the Project, therefore, the relevance and consistency of the Project are high. The observation network of the two countries was strengthened, and research on aerosols and ozone/UV rays, as well as analysis of atmospheric environmental risks and development of an information sharing system were promoted under the Project. However, the development of the Atmospheric Environmental Risk Management System could not be completed, and the project purpose was partially achieved. Although the overall goal was not achieved, data from the

[23] See footnote 14.

observation network enhanced by the Project are being used for atmospheric environmental risk management and related research. Therefore, a certain level of impacts has been achieved through the implementation of the Project, and the effectiveness and impact of the Project are moderately low. Although the project cost was almost as planned and the project period was as planned, outputs of the Project were achieved only partially, and therefore, the efficiency of the Project is moderately low. There are some technical and financial difficulties in sustaining the results of the Project, and the prospects for improvement and resolution are unclear. Therefore, the sustainability of the project effects is moderately low. In light of the above, the Project is evaluated to be partially satisfactory.

4.2 Recommendations

4.2.1 Recommendations to the Implementing Agencies

- SMN needs to properly operate LIDAR and other observation equipment installed under the Project and utilize them for the management of atmospheric environmental risks due to aerosols. It is important to work continuously on issues identified after the completion of the Project, including the urgent repair of inoperable LIDAR, the practical application of software to support the adjustment necessary for observations, hardware improvements to reduce the burden of adjustment, and improvements in analysis algorithms, while also utilizing the cooperation of external organizations.

- DEILAP, SMN, Magellan University, and DMC should continue to actively promote joint research utilizing the information obtained from the observation network developed in the Project, based on the experience gained from the collaboration. While maintaining international collaboration with Nagoya University and NIES, scientific knowledge that can be applied to risk management of aerosols, ozone, and UV rays should be obtained in both countries, and research should be conducted with practical applications in mind by the meteorological agency of both countries.

4.2.2 Recommendations to JICA

None

4.3 Lessons Learned

<u>Selection of implementing agencies with social implementation in mind</u>

In the Project, it was planned to analyze aerosol characteristics and develop an atmospheric environmental risk management system based on the assumption that aerosols would be constantly observed by LIDAR. As the Argentinean implementing agency, DEILAP, which has experience in ozone layer observation using LIDAR in an earlier technical cooperation project,

participated in the Project and was in charge of the design and fabrication of LIDAR. While, SMN, which had a nationwide observation network, was the actual operator of LIDAR in various parts of the country. However, the design of LIDAR did not adequately take the harshness of the operational environment in the field into account, such as the severe climate and frequent power outages, as well as the level of expertise and competence of the SMN staff, and this affected the achievement of the outputs, as stable observations were not possible.

In the Project, DEILAP was selected as the implementing agency on the Argentine side based on its track record of observations with research as the main objective. The objective of the Project was to develop a practical atmospheric environmental risk management system, but at the beginning of the Project, the implementing agencies were only research institutes in each country (DEILAP and Magellan University). The meteorological agencies of both countries (SMN and DMC), which were supposed to play an important role in the observation and utilization of the system as an actual business, had been participating in the Joint Coordinating Committee since the beginning of the Project, and were finally added as implementing agencies in the latter half of the Project after a mid-term review. If SMN had joined the implementing agency in Argentina from the beginning, it is possible that DEILAP would have had a good understanding of the situation at SMN observation sites and the capabilities of its staff before designing and building LIDAR, and that it would have been able to ensure stable observations by manufacturing more practical LIDAR. On the other hand, DMC reported that joining the Project in the middle of its course and investing human resources and budget that were not originally planned into it put pressure on the DMC's regular operations.

Therefore, it is important that a technical cooperation project for the purpose of social implementation not be pursued solely by research organizations, but that the organization responsible for social implementation be included in the implementing agencies from the beginning. If the need for such an organization is recognized, it is desirable to add it to the implementing organizations even in the middle of the cooperation period. In addition, it is important that the planning of a project, including the consideration of the implementation structure, not only rely on the ideas of researchers who do not necessarily have much experience in practical aspects, but also fully utilize JICA's experience in practical technical cooperation.

Follow-up cooperation for SATREPS

The terminal evaluation of the Project concluded that the project purpose would be largely achievable, with the expectation that the remaining works, including the completion of Geo Aerosol, would be completed during the cooperation period. In reality, however, Geo Aerosol could not be completed, and the project purpose was only partially achieved. While SATREPS basically does not allow for an extension of the cooperation period, the experts were aware of

the possibility that the outputs could not be achieved sufficiently within the cooperation period. In addition, the counterparts could not accurately predict whether the work could be completed within the time frame because they had never experienced it before. However, they could not tell the terminal evaluation team, which was assuming that there would be no extensions, that the work could not be completed within the cooperation period. In addition, no additional inputs were made that would have accelerated the work in the remaining period.

In light of the above, if there is no prospect of achieving outputs satisfactory during the cooperation period of SATREPS, which is basically without extension, consideration should be given to either providing additional inputs to achieve the outputs within the cooperation period, or to providing necessary follow-up cooperation by JICA alone after the Project is completed. Furthermore, in the mid-term review and terminal evaluation, it is important to examine as concretely as possible whether the planned outputs can be realized within the cooperation period, and to consider plans for the remaining period after thoroughly examining their feasibility and risks.

5. Non-Score Criteria

5.1 Performance

5.1.1 Objective perspective (N/A)

5.1.2 Subjective Perspectives (N/A)

5.2 Additionality

None

Republic of Peru

FY2021 Ex-Post Evaluation Report of
Japanese ODA Loan
"Energy Renovation Infrastructure Assistance Program"

External Evaluator: Katsunori Sawai, Global Group21 Japan, Inc.

0. Summary

This program is Financial Intermediary Loan that Corporación Financiera de Desarrollo S.A. (hereinafter referred as "COFIDE") provides the necessary funds through Intermediary Finance Institutions (hereinafter referred as "IFIs") for sub-projects which contribute to the promotion of energy efficiency for end-users, mainly private companies. In Peru, where stable power supply in the future is a key issue, efforts to improve energy efficiency, introduce renewable energy and conduct climate change countermeasures were positioned as important policies both at the time of ex-ante and ex-post evaluations, and it is consistent with Japanese aid policy and international aid trends. So, the relevance and coherence of this program are high. Although both the program cost and period were within the plan, the number of sub-loans provided was only seven, and the distorted financing was done to a specific end-user in the renewable energy component. In addition, there is no sub-loan in the energy saving component allocated 30% of total sub-loan fund. Therefore, efficiency of the program does not correspond to the plan. The reduction of greenhouse gas (hereinafter referred as "GHG") emissions, which was set as operational and effect indicators, was estimated that it was almost as planned, but this is the result of power generation capacity of the renewable energy sub-projects greatly exceeding the assumption made at the time of planning. Since no effect for the energy saving component was observed and the impact was limited, the effectiveness and impacts of the program are moderately low. COFIDE has a policy to continue to focus on strengthening and promoting green finance in the future, and although there is a room for improvement in the scheme for supporting energy saving sub-projects, there are basically no problem with COFIDE's capability as a financial institution. However, the facts that the Revolving Fund (hereinafter referred as "RF") has not been established and the secondary lending has not realized make it difficult to judge the sustainability of the effects of this program, so the sustainability is moderately low. In light of the above, this program is evaluated to be partially satisfactory.

1. Project Description

Project Location(s)

Wind Power Station Sub-project
(Source: Photographed by the author)

1.1 Background

Due to rapid economic growth in Peru, in 2019 it was necessary to double the power generation and supply capacity compared to 2010. To increase the power generation capacity, it was an issue how to promote and maintain an energy policy that further expanded the use of renewable energy sources with low GHG emissions. Regarding energy demand by sectors, the demand in production and transportation sectors had an increasing trend. However, in the production sector, since many old-fashioned facilities were in operation, the energy efficiency became poor. So, there was an urgent need to promote the effective use of energy through energy saving by the replacement and improvement of those facilities. Also, in the transportation sector, the government of Peru has worked to diffuse the use of low-emission vehicles by promoting the fuel conversion to natural gas vehicles and tightening exhaust control for diesel vehicles. But, the spread to public buses and tracks has not progressed. Since the production and transportation sectors consume a large amount of energy and GHG emissions also increase as a result, it was required to reduce the energy consumption of those sectors as a measure to reduce GHG. In addition, since the government of Peru ratified United Nations Framework Convention on Climate Change in 1992, it has been working on climate change countermeasures comprehensively by formulating the “National Environmental Policy” in 2005 and the “Action Plan for Adaptation and Mitigation against Climate Change” in 2010.

Under this background, the government of Peru requested the government of Japan for a Financial Intermediary Loan to promote infrastructure for energy efficiency, and this program was implemented.

1.2 Project Outline

The objective of this program is to promote various environmental measures of end-users by

providing them (primarily private companies) with medium- and long-term financing from COFIDE through IFIs to implement sub-projects which help promote energy efficiency, as well as by providing technical assistance (consulting services) to facilitate the financed sub-projects, thereby contributing to sustainable economic development and to the mitigation of climate change.

<ODA Loan Program>

Loan Approved Amount/ Disbursed Amount	8,770 million Yen / 8,478 million Yen
Exchange of Notes Date/ Loan Agreement Signing Date	August 2012 / October 2012
Terms and Conditions	Interest Rate: 0.6% (0.01% for consulting services) Repayment Period (Grace Period): 15 years (5 years) Conditions for Procurement: General Untied
Borrower / Executing Agency	The Republic of Peru / COFIDE (Corporación Financiera de Desarrollo S.A.)
Project Completion	February 2018
Target Area	All over Peru
Main Contractor(s) (Over 1 billion yen)	---
Main Consultant(s) (Over 100 million yen)	Personal Consultant (Peru)
Related Studies (Feasibility Studies, etc.)	"Special Assistance for Project Implementation (SAPI) on the Energy Renovation Infrastructure Assistance Program Assistance Program (Financial Intermediary Loan)" in 2017
Related Project	Kreditanstalt für Wiederaufbau (KfW, Germany): Financial Intermediary Loans to COFIDE for promoting renewable energy and energy efficiency.

2. Outline of the Evaluation Study

2.1 External Evaluator

Sawai Katsunori, Global Group 21 Japan, Inc.

2.2 Duration of Evaluation Study

This ex-post evaluation study was conducted with the following schedule.

Duration of the Study: January 2022 – February, 2023

Duration of the Field Study: June 25 – July 22, 2022, October 23– 30, 2022

2.3 Constraints during the Evaluation Study

- ✓ IFIs and end-users involved in this program were not aware of the fact that sub-loans were supported by Japanese ODA Loan[1] and since the sub-loans were provided 6 to 10 years ago, there was no person in charge at that time. Therefore, enough cooperation to interview them was not obtained.
- ✓ For the evaluation of sustainability, it was intended to focus on the operation of RF. However, since the RF has not been established and there is no track record of secondary lending[2], the evaluation of each item under sustainability is not necessarily related to the sustainability of the effects of this program.
- ✓ COFIDE has requested to refrain from disclosing information related to sub-loans (end-user name, sub-loan conditions, etc.) due to confidentiality obligations of financial operations, so the description in this report had to take into consideration the request.

3. Results of the Evaluation (Overall Rating: C[3])

3.1 Relevance/Coherence (Rating: ③[4])

3.1.1 Relevance (Rating: ③)

3.1.1.1 Consistency with the Development Plan of Peru

In the planning stage of this program, due to rapid economic growth in Peru, energy demand continued increasing and it was an issue to keep a stable power supply. As one of the measures, the "Legislative Decree No.1002: Promotion of Investment for Generation of Electricity with the use of Renewable Energy" was established in 2008 and the target was set to cover 5% of the total electricity with renewable energy by 2013. "Action Plan for Energy Efficiency" and "Action Plan for Adaptation and Mitigation against Climate Change" were formulated in 2010 to aim at improving energy efficiency by 15% by 2018 and also work to reduce GHG emissions.

At the time of ex-post evaluation, in the "National Energy Plan (2014-2025)," in two case scenarios of annual GDP growth rate of 4.5% and 6.5%, the electric demand is forecasted to increase by 1.64 times and 2.12 times respectively in 2025 compared with the demand of 5,800 MW in 2014. So, the stable power supply remains an important issue. In terms of energy efficiency, the energy demand will be reduced by 14.8% with 4.5% of annual GDP growth rate and by 12.5% with 6.5% of annual GDP growth rate. Furthermore, the plan states that the policy targeting renewable energy to 5% of total electricity will be continued. On the other hand, regarding climate

[1] See "3.2.1 Financing Scheme".
[2] See "3.4.7 Status of Operation and Maintenance".
[3] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory
[4] ④: Very High, ③: High, ②: Moderately Low, ①: Low

change countermeasures, the government of Peru has been actively working on it to formulate "National Strategy for Climate Change" in 2015 and to approve "National Plan for Adaptation to Climate Change in Peru 2050" in 2021, which updated the National Strategy. In COP26[5], the government of Peru announced that CO_2 would be reduced by 40% compared to the Business as Usual[6] scenario by 2030 and carbon neutrality to be achieved by 2050.

Thus, Peru has emphasized and promoted energy efficiency policy and climate change countermeasures at the time of planning and ex-post evaluation. Therefore, this program is consistent with the country's development plan.

3.1.1.2 Consistency with the Development Needs of Peru

GHG emissions by sectors in 2016 were 41% for LULUCF (land use, land use change and forestry), 15% for agriculture, 15% for transport, 13% for power & heat, 6% for waste, 5% for manufacturing & construction, 3% for industry and 2% for building. Excluding LULUCF and agriculture, the situation of 41% for transport and 34% for power & heat was not changed so much between the time of planning and one of ex-post evaluation, so the need for GHG reduction in those sectors is continuously recognized.[7] In addition, the "National Energy Plan (2014-2025)" states that the policies would be kept to aim to ensure a stable energy supply with GHG emissions reduction in the energy sector as a whole by using renewable energy in the power generation, effective use of energy to promote the energy saving by replacement and improvement of facilities in the production sector, and by introducing public buses with natural gas and diffusion of diesel vehicles that meets the exhaust emission control in the transport sector. Furthermore, the APEC Follow-up Peer Review[8] on energy efficiency was implemented in 2020, and the above policies by the government of Peru was basically supported.

Thus, efforts to improve energy efficiency and reduce GHG emissions are issues that should continue to be addressed, so this program is consistent with Peru's development needs.

3.1.1.3 Appropriateness of the Program Plan and Approach

In this program, 30% of the sub-loan fund were allocated for the energy saving component in order to promote and diffuse energy efficiency projects targeting the small- medium enterprises (hereinafter referred as "SMEs"). However, there were no sub-loans for them. The reasons for

[5] The 26th Session of the Conference of the Parties to the United Nations Framework Convention on Climate Change at Glasgow, United Kingdom, November 2020.
[6] A base scenario in case the current economic activities will continue.
[7] See CAIT Climate Data.
[8] In 2011, APEC (Asia-Pacific Economic Cooperation) leaders agreed to a target of reducing energy per unit of GDP by 45% by 2035 compared to 2005 levels. The Peer Review on Energy Efficiency is a mechanism for providing policy advice, etc. to assist APEC member countries in achieving this target. According to the Peer Review for Peru in 2020, some necessities were pointed out, for example, to review the institutional framework including public financial support, to improve the energy efficiency of vehicles by introduction of labeling that indicates energy performance, or to promote energy efficiency in the industrial sector (ISO5000 energy management system certification, etc.).

this could be considered as follows;

- There was a mismatch between COFIDE's sub-loan conditions (interest rate, repayment period, loan size, etc.) and the end-user's needs;
- For COFIDE, which has the characteristics of a "Second Floor Bank" [9], the sub-loan scale should be more than 1 to US$ 1.5 million to meet the operating cost, while the funding needs for energy saving projects for SMEs were smaller than that;
- Because of their small scale, IFIs did not need co-financing with COFIDE, and in some cases were able to provide loans at their own risk.

In other words, there was a mismatch between the financial needs of the end-users and the program scheme under this ODA loan. This mismatch might have been avoided to some extent by conducting market research on end-users and IFIs at the time of planning. However, since the ODA loan amount was fully utilized, it cannot be said that this point lowers the evaluation of the overall relevance of this program which aims to improve Peru's energy efficiency.

3.1.2 Coherence (Rating: ②)

3.1.2.1 Consistency with Japan's ODA Policy

The government of Japan proposed "Cool Earth Promotion Program" in January 2008, and decided to actively cooperate with efforts to reduce GHG emissions by developing countries that were trying to contribute to climate stabilization. With regard to Peru, in March 2008, Mr. Yasuo Fukuda (the then Prime Minister of Japan) and Mr. Alan Garcia Perez (the then President of Peru) signed a joint statement on cooperation in environment and climate change issues at the Japan-Peru Summit Meeting. In September 2009, the Hatoyama Initiative was announced in the UN Climate Change Summit, advocating the need for finance and technology transfer for mitigation for GHG reduction and adaptation against climate change in the developing countries. Furthermore, in the rolling plan of Japanese ODA for Peru, "Addressing Global Issues" was listed as one of the priority areas, so the environmental conservation including climate change countermeasures was recognized as an important development issue. Thus, the coherence with a policy of Japanese development cooperation can be observed.

3.1.2.2 Internal Coherence

As part of "Actions for Cool Earth" formulated by the government of Japan in November 2013, JICA extended the ODA loans to Peru for "Stand-by Emergency Credit for Urgent Recovery" in FY2013, and "River Basins Flood Protection Projects in Coastal Area of Peru" and "Moquegua

[9] COFIDE is called "Second Floor Bank" because a three-step loan system is applied to lend to domestic SMEs through IFIs such as commercial banks.

Hydro Electric Plants Construction Project" in FY2014. Furthermore, the technical assistance has started in FY2021 for "Project for Establishment of Integrated Forest Management System Model for Conservation of Mountain Forest Ecosystems in the Andean-Amazon", so JICA has worked on enhancement of management capacity for LULUCF sector which accounts for more than 50% of GHG emissions in Peru. Thus, JICA has continuously tackled with the climate change countermeasures in Peru, but no specific collaboration or its results have been recognized among the projects.

3.1.2.3 External Coherence

The government of Japan extended "Non-Project Grant Aid for Provision of Japanese Next Generation Eco-Friendly Vehicles" to Peru in FY2013. The objective of this grant aid was to diffuse the next generation vehicles with high energy efficiency and low environmental impact. In COP26, the government of Japan announced financial support of up to 10 billion US$ over the next 5 years, encouraging the promotion of climate change mitigation and adaptation measures.

Germany's assistance to Peru prioritizes environmental policy and protection, the sustainable use of natural resources, and sustainable urban development that addresses climate change. KfW has provided funding to promote BIONEGOCIOS[10] in COFDE, which had the same objective as this program, and JICA and KfW cooperated and coordinated by exchanging information appropriately and holding a workshop for program promotion.

The Inter-American Development Bank's country strategy for Peru (2017-2021) lists environmental sustainability and climate change countermeasures as one of the priority issues, and technical cooperation related to "Support to the Peruvian Energy Sector Transformation" is currently being implemented. The World Bank's Country Partnership Framework (2017-2021) for Peru also lists natural resource and climate change risk management as one of the three pillars of assistance, and the loan for "Transmission Investment Plan to Support Post-COVID19 Green Economic Recovery in Peru" in 2021 was extended. In the 2030 Sustainable Development Goals (SDGs), an international framework, Goal 7 includes "By 2030, increase substantially the share of renewable energy in the global energy mix", "By 2030, double the global rate of improvement in energy efficiency" and "By 2030, promote investment in energy infrastructure and clean energy technology." Goal 13 states "Take urgent action to combat climate change and its impacts". Thus, the objective of this program, which is to support energy efficiency and climate countermeasures, is in the same direction as the Japanese government, other counties, international organization and international framework. There was collaboration and coordination with some other donors on the program implementation, but no concrete results have been observed.

[10] BIONEGOCIOS: COFIDE's financial product that has implemented since 2008 with the aim of promoting renewable energy and energy saving in small and medium-sized enterprises, and does not mean a special scheme.

Based on above, this program implementation is fully consistent with Peru's development plan and development needs, and is consistent with Japan's ODA policy. Consistency is also recognized in that JICA and other international organizations have been promoting projects related to climate change countermeasures. However, the concrete collaboration and results were not observed except for some.[11] Although it seems that there was a problem with the appropriateness of the program plan and approach, it cannot be said that the evaluation of the overall relevance was lowered. Therefore, its relevance and coherence are high.

3.2 Efficiency (Rating: ②)

3.2.1 Financing Scheme

The financing scheme of this program is shown in Figure 1.

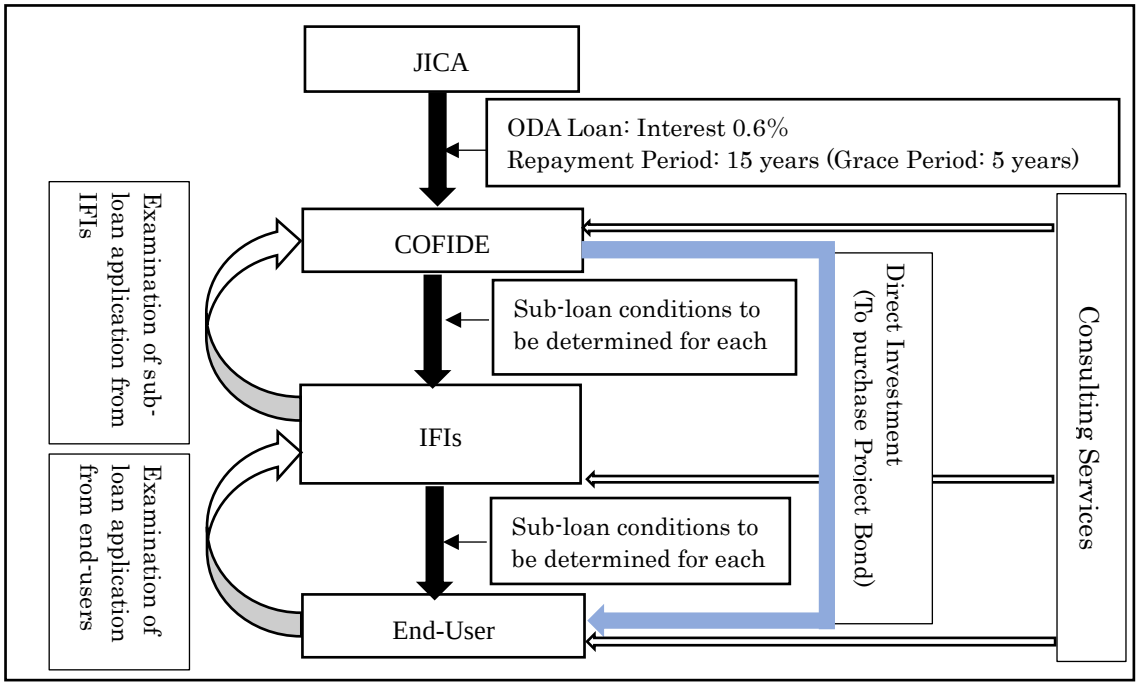


Figure 1: Financing Scheme of This Program

(Source) Created by the author from documents provided by JICA and COFIDE

As for the financing scheme in the planning stage, COFIDE extended sub-loans to end-users through IFIs. However, a method that directly provided funds to end-user without going through

[11] According to the FY2021 JICA External Ex-post Evaluation Reference, even if there is consistency with Japanese government and JICA development cooperation policy, the sub-rating for "Coherence" of the project is evaluated as ②, when no concrete collaboration, coordination and results are recognized among projects by JICA and other organizations, or within cooperation with international frameworks.

IFIs was added by purchasing "Project Bond"[12] issued by the end-user. Due to the "Basel III"[13] formulated in 2010, the finance cost raised for financial institutions, and long-term infrastructure investment likely became to result in accumulation of risk assets for them. It meant a difficulty for end-users to obtain loans from financial institutions. Also, the project financing methods were diversified. So, this additional change was appropriate. The direct investment to purchase "Project Bond" was applied to the sub-project of wind power station in this program.

The sub-loans were operated in accordance with the Operational Rules prepared after the Loan Agreement, the sub-loan selection criteria and the evaluation criteria of loan application. The target components of sub-loans were COFIGAS[14] (public buses with natural gas), low emission diesel vehicles, renewable energy and energy saving. The actual procedures to extend sub-loan were as follows;

Step 1： Loan application submitted from end-user to IFI

Step 2： Examination of the loan application by IFI. In case the IFI decides that co-financing with COFIDE is deemed desirable, the IFI submits the application to COFIDE.

Step 3： COFIDE examines the sub-loan application by the IFI and sets the sub-loan conditions, and then makes a decision to extend sub-loan to the IFI.

Step 4： The IFI extends a loan to the end-user.

Step 5： Thereafter, taking into consideration whole portfolio of COFIDE, if COFIDE determines to utilize the ODA loan for this sub-loan, COFIDE confirms that the sub-loan meet the eligibility of this program, and allocates the ODA loan fund to this sub-loan with JICA's no objection.

In the procedures mentioned above, when COFIDE examined the sub-loan, it was not considered whether the ODA loan would be utilized or not. Basically, the same procedures as the existing sub-loan examination for COFIGAS or BIONEGOCIOS were taken. COFIDE recognizes that they are using the ODA loan to promote COFIGAS and BIONEGOCIOS, and that this program cannot be operated with a special scheme independently, nor does it conduct marketing for this program. In addition, since COFIDE decides whether the ODA loan fund would

[12] A project bond is a bond issued by a business entity for the purpose of procuring the funds necessary to implement an infrastructure project. Unlike ordinary corporate bonds, the source of funds for repayment is limited to the profits obtained from the project.
[13] It stipulates the minimum capital adequacy ratio that financial institutions should maintain.
[14] COFIGAS: Financing scheme that transaction and settlements at each step related to natural gas conversion among vehicle owners/purchasers, manufacturers, inspection agencies, general financial institutions, gas sales facilities and COFIDE are automatically and systematically processed through an online system.

be used or not after providing sub-loans to IFIs, IFIs are not aware that COFIDE funds are supported by the Japanese ODA loan. Much more the end-users are completely unaware of the ODA loan. Under such a procedure, recognition as the Japanese ODA loan program would inevitably be low.

The interest rate for end-users was determined for each sub-loan based on the average market interest rate provided by the IFIs involved in the loan and taking into consideration the results of COFIDE's risk assessment. In the plan, the difference between the COFIDE's funding cost from the market and the concessional ODA loan was assumed to be reflected (e.g. interest rate differences of 3.5% to 5% for medium-sized enterprises and 10% or more for small and micro enterprises in sol, and 5 years repayment period), and the interest rate for end-users was expected to be enough lower than the market rate. Actually, it may be evaluated that the competitive loan conditions with interest rate generally below market rate could be provided, but looking at the difference between interest rates for end-users and the market average interest rates, the difference was 1.53% to 6.0% for dollar and -0.43% to 2.86% for sol. It was viewed that the degree of concessionality expected in the plan was not sufficiently ensured. The reason may be a burden of cost of currency swap[15]. Although information about the swap cost could not be obtained, it was estimated about 4.2% for the yen/dollar and about 6.4% for the yen/sol. According to COFIDE, the dollar is slightly cheaper and the sol is higher compared to raising funds from the market.

The repayment period of sub-loans were 8 to 15 years for dollars and 3.5 to 8 years for sol.

COFIDE provided sub-loans for IFIs up to 50% of the loan amount extended to end-users.

3.2.2 Program Outputs

Table 1 shows a comparison between plan and actual of sub-loans by components.

Table 1: Comparison between Plan and Actual of Sub-loans by Components

Component	Assumption in Plan	Actual
COFIGAS (procurement of natural gas (GNV) buses)	7 sub-loans 75 units of GNV buses	3 sub-loans 69 units
Low Emission Diesel Vehicle	8 Sub-loams 83 units of vehicles	1 sub-loan 65 units of buses
Renewable Energy	6 sub-loans Small Scale Power Generation, 30MW in total	3 sub-loans Hydro/Wind power/ Biomass
Energy Saving	105 sub-loans	no sub-loan

(Source) JICA appraisal material, Documents provided by COFIDE

JICA's estimate at the time of planning was to provide a total of 126 sub-loans to SMEs. Especially for the energy saving component, there was an intention to promote and diffuse energy

[15] A transaction that exchanges future cash flows (interest and principal) between different currencies. In the case of this program, a currency swap was carried out between the Yen Loan and the US Dollar/local currency Sols, and the future interest payments and principal repayment of the Yen Loan were fixed on a Yen basis.

efficiency projects to as many end-users as possible, but it seems that such an idea was not necessarily shared between JICA and COFIDE. This can be seen from the fact that COFIDE set a planned goal of providing at least 10 sub-loans after the conclusion of the L/A.

In the COFIGAS component, the number of sub-loans was three, but the number of GNV buses procured was 69, roughly matching the 75 assumed in the plan. Although there was only one sub-loan for low-emission diesel component, the number of buses procured was 65 against the 83 assumed in the plan. In the renewable energy component, the sub-loans for power generation were one wind power station (total 111.6MW) and one small hydroelectric power station (total 39.1MW), which greatly exceeded the assumed total power generation capacity of 30MW in the plan. Company F, which was extended a sub-loan as the renewable energy component, went bankrupt in 2015. The reason for bankruptcy was the global ethanol price crash.[16] Although the overall investment was large and multiple financial institutions were involved, it was not due to a particular problem with loan examination process, and it seems that it was difficult to anticipate bankruptcy risk. At present, another company has taken over ethanol production business.

As for energy saving component, despite this program aimed promoting and diffusing energy efficiency projects targeting SMEs, no sub-loans were provided. It is said that IFIs did not apply for the sub-loan to COFIDE, but the following reasons may be considered, from the interviews to COFIDE and the SAPI report;

- ✓ The sub-loan conditions (interest rate, repayment period) of this program were not very attractive to SMEs;
- ✓ The financing scheme that end-user has to wait COFIDE's decision after applying for loans to IFIs is complicated and it takes time for loan examination for SMEs;
- ✓ COFIDE believes that unless an amount of sub-loan is more than US$ 1 mil. to US$ 1.5 mil., it does not meet the administrative cost, but the loan amount is too big for an energy saving project for SMEs;
- ✓ In case the sub-loan amount is small, IFIs have no incentive to co-finance with COFIDE and can provide loans on their own.

In the future, if COFIDE promotes an energy saving business in the same way as this program, it will be required to eliminate the mismatch between end-user needs and sub-loan conditions as described above.

[16] Ethanol futures closing price (Sao Paulo Commodity Exchange) averaged 2.28 US$/gallon in 2013 when the sub-loan was extended, but it dropped sharply to 2.15US$ in 2014, 1.50 US$ in 2015, 1.53 US$ in 2016, 1.49 US$ in 2017 and 1.30 US$ in 2018. (Source: Trading Economics)

Table 2: Summary of Sub-Projects

	End-user	Year extended Sub-loan	Sub-Project
COFIGAS Component			
1	A	2012	Company A operating public buses in the southern district of Lima metropolitan area procured 15 units of GNV buses. The repayment of loan was completed in 2016.
2	B	2012	Company B operating public buses in the northern district of Lima metropolitan area procured 24 units of GNV buses. The repayment of loan was completed in 2016.
3	C	2014	Company C operating public buses in Piura city and on routes connecting the surrounding cities procured 30 units of GNV buses. The pre-payment was done in 2021.
Low Emission Diesel Component			
4	D	2016	Company D operating medium- and long-distance buses connecting major cities in Peru, Guayaquil in Ecuador, and Bogota in Colombia procured 65 units of low emissions diesel buses that met EURO III standard. The pre-payment was done in 2018.
Renewable Energy Component			
5	E	2014	Company E constructed wind power stations, 30.6MW in Parinás district of Piura state and 81.0MW in Pacasmayo district of La Libertad state respectively. COFIDE purchased the project bond issued by Company E.
6	G	2013	Company G operating the power generation business in Junin state constructed flow-in type hydroelectric power plants with a total capacity of 39.1MW. The pre-payment was done in 2019.
7	F	2013	Company F producing ethanol in Paita district of Piura state has a series of processes of increasing sugarcane production ⇒ increasing ethanol production ⇒ bio-power generation using sugarcane residue. Of which, the sub-loan was used for the expansion of sugarcane field. However, Company F went bankrupt in 2015 due to the global crash in ethanol prices. The funds collected. Now another company has taken over the ethanol production business.

(Source) Documents provided by COFIDE

3.2.3 Program Inputs

3.2.3.1 Program Cost

Total program cost in the plan was 10,480 mil. Yen, of which 8,332 mil. Yen for sub-loan and 438 mil. Yen for consulting services that was equivalent to 5% of sub-loan amount. Although detailed information on actual cost was not obtained, looking only at the portion covered by the ODA loan, the sub-loan/direct investment amounted 8,332 mil. Yen which was fully utilized, and consulting services amounted 146 mil. Yen against the planned 438 mil. Yen.

Table 3: Program Cost (Unit; mil. Yen)

	Plan			Actual		
	Foreign Currency	**Local Currency**	**Total**	**Foreign Currency**	**Local Currency**	**Total**
Sub-loan/Direct Investment	8,332*	0	8,332*	8,332*	0	8,332*
Consulting Services	235*	203*	438*	n.a	n.a	146*
Commitment Charge	44	0	44	n.a	n.a	n.a
Tax	0	1,666	1,666	n.a	n.a	n.a
Total	8,611	1,869	10,480	n.a	n.a	n.a

* shows the ODA loan portion. Others by COFIDE's own fund.
Exchange rates: (Plan) 1 Sol=30.8 Yen as of September, 2010,
(Actual) 1 Sol=35.7 Yen (average during the program period)
(Source) Documents provided by JICA

Regarding the fact that the fund of sub-loan/direct investment portion was fully utilized, it is necessary to analyze the background related to the final disbursement made on the disbursement expiry date in the L/A. COFIDE had purchased a project bond issued by Company E, and had already used the ODA loan funds of US$ 25 mil. for a portion of the project bond. But the final disbursement fund was used then to replace a part of the COFIDE's own fund for the project bond with the ODA loan funds, and was treated as an additional finance for the same sub-project. It is clear that wind power station by Company E is eligible for sub-loan/direct investment under this program. However, the additional finance was not a flow to the end-user nor was a new sub-project implemented. Surplus funds generated from the concessional nature of ODA loans can be used for future financing and project formation, contributing to the soundness of COFIDE's ALM (Asset-Liability Management). It is important for Financial Intermediary Loan to ensure the soundness of the ALM of the executing agency, but that is not the original objective of this program. Therefore, it is difficult to evaluate that the program cost was used efficiently as planned just because the amount allocated for sub-loan/direct investment portion was fully disbursed.

The information on the actual annual expenditure was not obtained. Focusing on the actual use of ODA loan funds for sub-loans/direct investment, since a large amount was utilized in 2014 and 2015 for sub-loans and purchase of project bond, so it appeared to be on track in terms of amount. However, the number of sub-loan applications from IFIs had been small since 2015, and the reality was that there had been little progress in finding or forming sub-loans. It may be said that the result was behind the final disbursement mentioned above.

Table 5 shows a comparison of fund allocation by sub-loan component between the plan and actual.

Table 4: Utilization of ODA Loan by Fiscal Year (Sub-loan/Direct Investment only)

FY	No. of Sub-loan	Utilization of ODA loan funds	Remarks
2013	0	------	
2014	4	1,811 mil. Yen	incl. US$ 10 mil. for Company G
2015	2	2,690 mil. Yen	incl. US$ 25 mil. for Company E
2016	1	833 mil. Yen	Company D only
2017	0	------	
2018	(1)	2,998 mil. Yen	additional finance for Company E
Total		8,332 mil. Yen	

(Note) Fiscal year is not the year when COFIDE extended sub-loans to IFIs, but the year when COFIDE decided to allocate ODA loan funds to the sub-loans.
(Source) Documents provided by JICA and COFIDE

Table 5: Fund Allocation by Sub-loan Component

Component	Plan	Actual	
COFIGAS (procurement of GNV buses)	approx. 10%	4%	335 mil. Yen
Low-emission Diesel Vehicles	approx. 10%	10%	833 mil. Yen
Renewable Energy	approx. 50%	86%	7,164 mil. Yen
Energy Saving	approx. 30%	0%	----
Total	(8,332 mil. Yen)	100%	8,332 mil. Yen

(Source) Documents provided by JICA and COFIDE

Approximately 10% of sub-loan fund was allocated to COFIGAS, but the actual was 4%. The reason is that COFIDE financed up to 50% of sub-loan amount, while JICA calculated to assume the cost covered 100% of sub-project cost, although the number of GNV buses procured was almost in line with the assumption in the plan. For the Low-emission Diesel Vehicles, the fund was utilized as planned. Regarding the renewable energy component, in addition to the fact that the amount of each sub-loan was large compared to other components, the total amount of financing in the component expanded more as a result of the additional finance to Company E as described above. The energy saving component is as described in the section of "Program Outputs" above.

As mentioned above, although the program cost was within the plan, it can be said that the cost did not match the level of outputs produced at all, considering that the use of funds was biased toward specific end-user in the renewable energy component (Company E alone accounted for about 67% of the total) and there were no track record in the energy saving component.

3.2.3.2 Program Period[17]

According to the plan, the consultant selection process was to start in December 2012, and

[17] According to the FY2021 JICA External Ex-post Evaluation Reference, the month of project commencement shall be the month of L/A signing, unless otherwise specified in the project ex-ante evaluation sheet, etc. However, the third party evaluator decided to set the month in which the consultant selection procedure started as the month in which the program commenced based on the documents provided by JICA, such as the appraisal report, etc.

the program was to be completed by the expiry date of disbursement of February 2018 (63 months in total). The actual was that the consultant selection process began in January 2013 and the disbursement was completed on February 2018 (62 months in total). Although the program period was within the plan, it can be said that the period did not exactly match the level of outputs produced, considering that the progress to extend sub-loans was delayed as mentioned before.

3.2.3.3 Consulting Services/Technical Assistance

In the plan, in addition to the general consultant who supervised the entire program, consultants were to be employed as needed to support sub-project formation or technical examination in each component of sub-loan. The only consultants actually employed were a general consultant, four consultants for sub-project formation related to energy saving, and one consultant for sub-project formation related to rice husk power generation. However, the contract with the general consultant was cancelled in the middle of the contract period due to his unsatisfactory performance, and the results of other consulting services did not lead to the provision of concrete sub-loans, so it cannot be said that useful assistance was provided by consultants to the results. However, COFIDE recognizes that the services provided by the general consultant could be implemented by COFIDE itself and that there were no particular problems with the loan examination capability (including technical aspects) of the IFIs, so the fact that the consultants could not be employed as planned did not affect this program implementation. According to a hearing from COFIDE, since COFIDE is "Second Floor Bank", the position is that IFIs should basically conduct sub-project finding, formation and technical review related sub-loan. So, COFIDE did not recognize their necessity by itself. In addition, the end-users had no intention of actively requesting financing, and sub-projects such as a collection of small scale projects[18], that consultants attempted to formulate, involved multiple end-users, making it difficult to apply for financing under this program. These are probably the reasons why the results of consulting services were poor.

Since JICA provided a study of the Special Assistance for Project Implementation (SAPI) from March 2016 to February 2017 with the aim of supporting sub-project formation for low-emission diesel and energy saving components as the progress of COFIDE's sub-loan provision was not good. Through the study, a list of 19 candidate sub-projects including 9 for low-emission diesel and 10 for energy saving component was made, but it did not lead to the provision of a specific sub-loan. Considering that there was only one year from the SAPI study to the disbursement expiry date in the L/A, and that the candidate sub-projects must be shared with the IFIs, as well as confirmation of end-user's request for financing being required within such a period, and it was not easy to lead the results of study to concrete sub-loans.

[18] Sub-project formulated by the consultants included energy saving and renewable energy sub-projects for farmers and those for 17 universities.

As mentioned above, the program costs related to sub-loans/direct investment were fully utilized, and the program period was within the plan, but the progress to extend sub-loans was delayed, and the program cost was completely disbursed as a result of additional finance for the same sub-project. In terms of output, the number of sub-loans totalled seven, which was less than planned, and there was no record of providing sub-loans in energy saving component allocated 30% of the total sub-loan fund. Therefore, efficiency of this program is moderately low.

3.3 Effectiveness and Impacts[19] (Rating: ②)

3.3.1 Effectiveness

3.3.1.1 Quantitative Effects (Operation and Effect Indicators)

In this program, GHG emission reduction was mainly set as an indicator to measure energy efficiency. The target and actual values are shown in Table 6.

Table 6: Operation and Effect Indicators

Indicator		Target	Actual2020	
		2019	2 years after program completion	
		2 years after program completion	Whole sub-project	Contribution of this program (Considering financing ratio of ODA loan)
Reduction of GHG emissions due to the introduction of low-emission vehicles (t-CO_2/year)	COFIGAS	22,000	20,240	6,620 (*2)
	Low-emission diesel vehicles	(*1)	745	373 (*3)
Reduction of GHG emissions for Renewable Energy (t-CO_2/year)		83,000	750,531	103,870 (*4)
Sub-Total (excluding Low emission diesel vehicles)		105,000	770,771	110,490
Total		----	771,516	110,863
Improved efficiency of sub-project under energy efficiency component (per sub-project)		10% or more		

(*1) It was planned to be set at the start of the program, but was not set.

(*2) Estimated using the same assumptions as planned.

(*3) Assuming that the mileage of the procured medium- and long-distance buses is 120,000 km/ year/unit, fuel efficiency is 3 km/L, clean diesel emission factor is 2.58 kg/L, and CO_2 emissions are 10% better than the old diesel bus. (The clean diesel emission factor is according to Guideline for Calculating GHG Emissions Amount, Japanese Ministry of Environment, March 2017)

(*4) For the hydroelectric power station, it is estimated based on 139,199 t-CO_2/year in 2021 heard from end-user. And, for the wind power stations, it is estimated based on 305,666 t-CO_2/6 months in the first half year of 2022 heard from end-user.

(Source) Documents provided by JICA and COFIDE

[19] When providing the sub-rating, Effectiveness and Impacts are to be considered together.

(1) GHG Emission Reduction

In the plan, these indicators were calculated on the assumption that 100% of the sub-project cost would be covered by the ODA loan funds, but sub-project was actually co-financed by IFIs and the contribution of this program was partial. Therefore, the actual value was calculated considering the financing ratio of this program to each sub-project. As a result, GHG emission reductions were 6,620t-CO_2/year (-70% from the plan) in the COFIGAS component and 103,870 t-CO_2/year (+25% from the plan) in the renewable energy component, totalling 110,490 t-CO_2/year (+5% from the plan), which slightly exceeding the planned figure of 105,000 t-CO2/year. In total, a GHG emission reduction of 373 t-CO_2/year in the low-emission diesel component was added to this. Looking at the GHG emission reduction amount from the entire sub-projects, it was estimated that 771,516 t-CO_2/year was reduced, which greatly exceeded the planned figure. The reason can be explained by the hydro and wind power generation capacity in the renewable energy component reaching 150.7 MW, which is far higher than the 30 MW assumed in the plan.

(2) Energy Efficiency in Energy Saving Component

As for the energy saving component, the level of energy efficiency improvement through the implementation of sub-projects was used as an indicator, and an efficiency improvement of 10% or more was set as the target. However, the effect could not be recognized because of no sub-loan extended.

From the above, actual GHG emission reductions in the introduction of low-emission vehicles and the renewable energy components slightly exceeded the plan, and the effect was almost as planned, but there was no track record in the energy saving component, and no effect was obtained. Considering that the plan was to allocate 30% of the total sub-loan fund to the energy saving component, the effectiveness of this program is moderately low.

3.3.2 Impacts

3.3.2.1 Intended Impacts

As impacts of this program, (1) Improvement in the awareness of private-sector businesses for energy efficiency, (2) Strengthening of the capacity of IFIs to examine loan proposals, (3) Sustainable economic development through promotion of more efficient use of energy, and (4) Mitigation of climate change were mentioned.

(1) Improvement in the awareness of private-sector businesses for energy efficiency

There is no track record of sub-loans in the energy saving component in this program, the number of sub-loans in other components is limited, and the recognition of this program is low

among the stakeholders, so the concrete impact of improvement in the awareness of private-sector businesses for energy efficiency cannot be recognized. However, if looking at Peru as a whole, people's awareness of energy and climate change is gradually increasing, and consciousness of energy saving seems to be the same.

(2) Strengthening of the capacity of IFIs to examine loan proposals

Although the necessary support for IFIs through consulting services was planned, this was not actually done. However, according to a hearing from COFIDE, since the IFIs involved in the sub-loans of this program are familiar with the business details of end-users through their daily business, and had an experience to finance similar sub-projects, it is not that there were any problems or difficulties in sub-loan examination. As for the technical issue, a system has been established in IFIs to have it checked by experts as necessary.

(3) Sustainable economic development through promotion of more efficient use of energy

From the relationship between real GDP and GHG emissions amount shown in Figure 2, it is found that since 2010, the growth of GHG emissions has been lower than the growth of real GDP, indicating that these values tend to widen gradually from year to year. That means GDP is growing with fewer GHG emissions. In other words, it shows that the economy is growing under the energy efficiency improvement. This is also supported with Figure 3 which shows that the energy intensity (energy consumption per GDP) is on downward trend.[20] Therefore, Peru can be evaluated as striving for sustainable economic development through the improvement of energy efficiency, but in order to position it as an impact of this program, it will be limited.

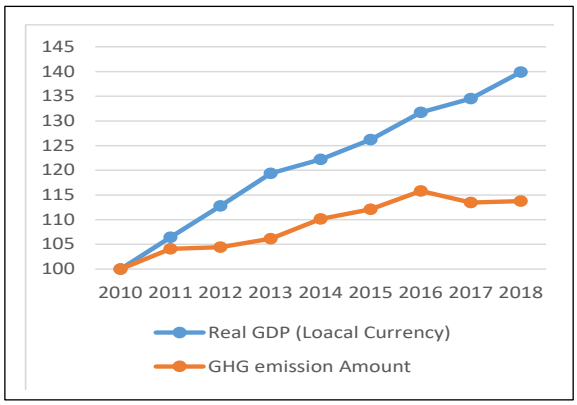


Figure 2: Real GDP and GHG Emission Amount
(2010＝100)
(Source) World Bank Statistics

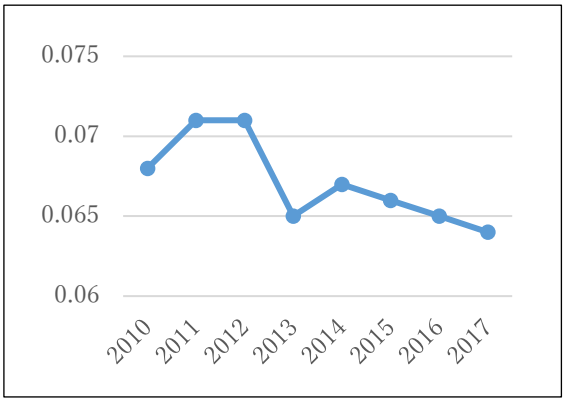


Figure 3: Energy Intensity
(Unit: toe/1000$ (2010PPP))
(Source) IEA Statistics

[20] According to IEA statistics, the Energy Intensity figure in 2017 was 0.064 for Peru, while the world average was 0.119 and the Latin American region average was 0.092. Peru is not a country with high Energy Intensity.

(4) Mitigation of climate change

As shown in Figure 4, it is unavoidable that Peru's GHG emissions increase along with economic growth, but recently the rate of increase has tended to be restrained. Peru can be evaluated as making efforts to mitigate climate change, that is to reduce GHG emissions, but in order to position it as an impact of this program, it will be limited.[21]

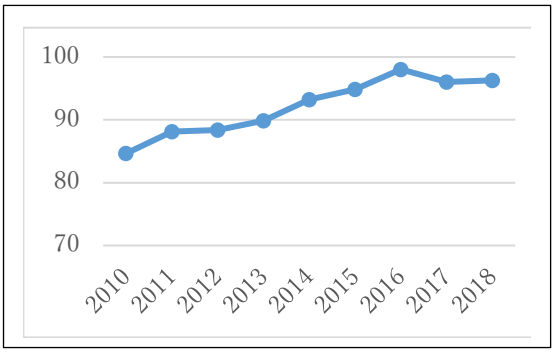


Figure 4: GHG Emission Amount (Mt))
(Source; World Bank Statistics)

3.3.2.2 Other Positive and Negative Impacts

This program was classified as Category FI[22] based on the JBIC[23] Guidelines for the Confirmation of Environmental and Social Consideration (April 2002). None of the sub-projects financed by the sub-loans corresponded to Category A in the Guidelines. The hydropower and wind power projects were classified as Category B, but appropriate environmental and social consideration were confirmed in accordance with Peru's domestic rules. In addition, none required involuntary resettlement or large scale land acquisition. No particular environmental and social impacts were recognized during the field survey.

As mentioned above, the impact of this program is considered to be limited. Considering that the effectiveness of this program was judged to be moderately low, it was only possible to confirm that the implementation of this program produced effects to a certain extent compared to the plan, and its effectiveness and impacts are moderately low.

3.4 Sustainability (Rating: ②)

The Financial Intermediary Loan provides benefits to many end-users through proper operation of RF and continuous provision of sub-loans with the same policy objective as this program. This program was also designed in this way, and in the ex-post evaluation, it was decided to evaluate the sustainability of the effects of this program based on the operational status of the RF. However, as described in "3.4.7 Status of Operation and Maintenance", the RF has not actually established. On the other hand, COFIDE is continuously working on green finance for

[21] According to IEA statistics, per capita CO_2 emissions in 2017 were 5.12 tons on average in the world and 3.43 tons in Latin America, compared to 1.55 tons in Peru. Peru is not a country with large per capita CO_2 emissions in the world.
[22] Category FI: JICA's funding of the project is provided to a financial intermediary etc.; the selection and assessment of the actual sub-projects is substantially undertaken by such an institution only after JICA's approval of the funding and therefore the sub-projects cannot be specified prior to JICA's approval of funding (or assessment of the project); and those sub-projects are expected to have potential impact on the environment.
[23] Japan Bank for International Cooperation.

the same energy efficiency projects as this program through COFIGAS and Green COFIDE (renamed from BIONEGOCIOS). Therefore, each item under evaluation of sustainability is an analysis of the COFIDE organization working on green finance, and does not necessarily directly evaluate the sustainability of the effects of this program.

3.4.1 Policy and System

The policy of the government of Peru to promote energy efficiency continues as mentioned in 3.1.1 Relevance above.

Regarding COFIDE, there is no change in promoting financial products related to green finance called COFIGAS and Green COFIDE. However, for COFIDE, a “Second Floor Bank”, there seems to be limit to the promotion of sub-loans for energy saving under this program scheme. Therefore, it can be said that there are some issues with the systems related to COFIDE’s business for energy saving component.

3.4.2 Institutional/Organizational Aspect

COFIDE is a development finance institution established by the government of Peru in 1971. It raises funds from international organizations and government agencies, etc., and provide loans to domestic SMEs through IFIs. By providing medium- and long-term funds to IFIs, COFIDE will promote financing in areas where IFIs find it difficult to take risks (i.e. infrastructure, environmental conservation, agriculture, health care, facility investment for SMEs, etc.). Such an aim of COFIDE to promote those areas has not been changed. In some cases, like this program, finance is provided by directly purchasing project bonds issued by business entity. The number of employees is generally around 200. In this program, the Business Department acted as the point of contact for receiving sub-loan applications, and carried out operations in cooperation with relevant departments such as the Finance Department and the Legal Advice Department and others as necessary. Initially, there were two staffs directly in charge, so it was always pointed out that there was a shortage of personnel. But, in fact, multiple staff members from relevant departments were involved. When it is considered that the basic position of COFIDE was to review loan applications from IFIs, there are no particular problems with its system. Therefore, there are no problems with its institutional and organizational sustainability.

3.4.3 Technical Aspect

This program was positioned to promote the exiting COFIGAS and BIONEGOCIOS, and there were no particular problems as the sub-loan examination was carried out following the same procedures as those. Technical review of sub-projects was primarily a matter of IFIs, and IFIs apply for sub-loans to COFIDE after technical examination was carried out by experts as appropriate. So, there is no problem with sustainability of technical aspects.

3.4.4 Financial Aspect

COFIDE provides financial support mainly for relatively high-risk infrastructure projects, has low margins, and is not an organization that pursues profits. Since 2011, COFIDE had increased infrastructure investment and allocated most of its portfolio to infrastructure loans. However, in 2017, a corruption scandal[24] related to public infrastructure projects came out in Peru, and the projects financed by COFIDE were cancelled or postponed. Then, COFIDE was exposed to the risk of an increase in operating costs. As a result, the non-performing loan ratio increased significantly in 2017. COFIDE had been intensively disposing of non-performing loans from 2017 to 2018, and there was also an injection of funds from the government, so financial indicators of COFIDE have been improving since then.[25] Since 2020, net income has declined due to the impact of the COVID19 pandemic, which has slightly depressed the Peruvian economy. The foreign currency rating in October 2021 was BBB (negative) by S&P and BBB (stable) by Fitch, which was almost the same as the credit rating of the government of Peru. Although COFIDE's financial situation may be affected by changes in the business environment and Peru's economic situation, it can be said that there are no particular financial problems.

Table 8: Main Indicators of COFIDE Financial Statement

(Unit: mil. US$)

	2017	2018	2019	2020	2021
Total Asset	3,695	3,296	3,155	3,438	3,141
Net Loan	1,768	1,447	1,263	1,536	1,233
Liability	3,077	2,702	2,537	2,864	2,581
Total Equity	618	577	618	574	560
Net Income	1.4	5.0	8.0	5.7	10.3
Growth Rate of Net Income	▲94.2%	277.8%	55.7%	▲28.8%	101.0%
Equity Ratio	16.7%	17.5%	19.6%	16.7%	17.8%
Return on Asset (ROA)	0.04%	0.15%	0.25%	0.16%	0.33%
Return on Equity (ROE)	0.2%	0.9%	1.3%	1.0%	1.9%
Nonperforming Loan Ratio	18.2%	6.3%	7.7%	9.6%	6.5%
Exchange Rate (Sol/US$)	3.240	3.373	3.312	3.620	3.987

(Source) COFIDE Financial Statements

3.4.5 Environmental and Social Aspect

COFIDE introduced the Environmental and Social Risk Management System (SARAS :

[24] Corruption case caused by Brazilian construction company, Odebrecht S.A.. In Peru, a total 22 cases were contracted between 2004 and 2015, and the funds that requested the padding flowed to politicians. ("Obderecht Corruption Case and Its Impact on Latin America" by Naotoshi Kinoshita and Yasufumi Hayashi, Rissho University Economics Quarterly, Vol.67, No.4, pp.69-95, March 2018)

[25] See Fitch Rating Report（September 2018）https://www.cofide.com.pe/COFIDE/pdfs/relacion_FITCH-JUN2018.pdf

Sistema de Administración del Riesgos Ambientales y Sociales) in February 2016 to strengthen checks on environmental and social impact assessments. Basically, it provides guideline related to screening, evaluation, monitoring, etc., and since they are to be applied to all financing projects of COFIDE, there is no problem with the system.

3.4.6 Preventative Measures to Risks

COFIDE had a policy to finance up to 50% of loans and 100% for project finance until 2016. From 2017, the policy was changed to 25% of loans and 50% for project finance. This is due to the guidance of FONAFE (Fondo Nacional Financiamiento de la Actividad Empresarial del Estado) which is in a position to supervise COFIDE, after many infrastructure loans became non-performing ones in 2017. Originally, COFIDE was a public institution that supported high-risk businesses, but due to the strict response to business risks, recently both the number of loan applications from IFIs and the amount of loans seem to be on the decline. However, it is considered that COFIDE's creditworthiness in the market has been kept, so there are no problems with regard to risk management.

3.4.7 Status of Operation and Maintenance

Of the six sub-loans, two were paid off as planned in 2016 and three were prepaid by IFIs between 2018 and 2021. Regarding the loan to Company F, which went bankrupt, collection of funds from IFIs has been completed. Prepayment was a decision based on the ALM of the IFIs, but since the interest rate had declined since May 2017 compared to the interest rate level at the time the sub-loan was received from COFIDE, the IFIs decided the sub-loan refinancing. Although one of characteristics of COFIDE's sub-loan was that the repayment period was relatively long, this prepayment was unavoidable considering interest rate fluctuations at that time.

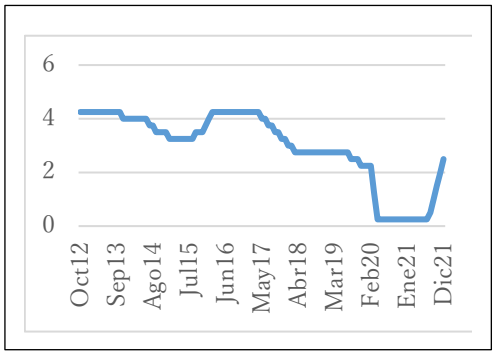


Figure 5: Official Discount Rate in Peru

(Source) SBS Statistics

RF has not been established even after four years have passed since the final disbursement of ODA loan was made, and there is no track record of secondary lending. Also, according to the L/A, it is supposed to report the utilization results of RF to JICA for five years (until February 2023) after the final disbursement of ODA loan, but there is no report. For a reason why the RF was not established, it was told by COFIDE that the first lending included a sub-loan to Company F, which had gone bankrupt, and it was waiting until a good sub-project could be replaced with. Basically, the RF is used to accumulate the repaid principal and the paid interest from the sub-loans and to promote energy efficiency projects for the same purpose as this program. In addition, since this is a financial business, it is possible that the borrower would go bankrupt and it is

unavoidable even if the first lending includes a bankruptcy case. Therefore, there is no persuasiveness in the above reason why the RF has not established. From 2013 to 2021, COFIDE received repayments of principal of over 3.3 billion Yen from sub-loans, which should be managed in RF, but were actually managed in COFIDE's general account. So, it is unclear how the repayment amount was used in COFIDE. However, COFIDE has used more than 3.5 billion Yen to repay the ODA loan by 2021, which exceeds the repayment from sub-loans. (The shortage was financed with COFIDE's own funds.) In other words, even if RF was established, it would not have accumulated enough funds to make a secondary lending. It means no revolving of funds. The reason for this was the short grace period of ODA loan of five years after the conclusion of the L/A, so there is a structural problem that the repayment of the ODA loan starts before sufficient funds are accumulated in the RF. There is no prospect that RF will be utilized in the future, and the situation is not such that the characteristics of Financial Intermediary Loan, that is RF, will be used to promote and diffuse further energy efficiency projects.

As mentioned above, COFIDE has been continuously working on and strengthening green finance, and there are no problems with COFIDE's operational management capabilities as a financial institution. However, there is a problem from the perspective of the sustainability of this program as a Financial Intermediary Loan, because the RF was not established and there is no track record of secondary lending. Also, the prospects for improvement and resolution of sub-loan operation for energy saving component will be dim. So, the sustainability of the effects produced by this program is moderately low.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

This program is Financial Intermediary Loan that COFIDE provides the necessary funds through IFIs for sub-projects which contribute to the promotion of energy efficiency for end-users, mainly private companies. In Peru, where stable power supply in the future is a key issue, efforts to improve energy efficiency, introduce renewable energy and conduct climate change countermeasures were positioned as important policies both at the time of ex-ante and ex-post evaluations, and it is consistent with Japanese aid policy and international aid trends. So, the relevance and coherence of this program are high. Although both the program cost and period were within the plan, the number of sub-loans provided was only seven, and the distorted financing was done to a specific end-user in the renewable energy component. In addition, there is no sub-loan in the energy saving component allocated 30% of total sub-loan fund. Therefore, efficiency of the program does not correspond to the plan. The reduction of GHG emissions, which was set as operational and effect indicators, was estimated that it was almost as planned, but this is the result of power generation capacity of the renewable energy sub-projects greatly

exceeding the assumption made at the time of planning. Since no effect for the energy saving component was observed, and the impact was limited, the effectiveness and impacts of the program are moderately low. COFIDE has a policy to continue to focus on strengthening and promoting green finance in the future, and although there is a room for improvement in the scheme for supporting energy saving projects, there are basically no problem with COFIDE's capability as a financial institution. However, the facts that the RF has not been established and the secondary lending has not realized make it difficult to judge the sustainability of the effects of this program, so the sustainability is moderately low. In light of the above, this program is evaluated to be partially satisfactory.

4.2 Recommendations

4.2.1 Recommendations to the Government of Peru

In this program, 30% of sub-loan was allocated to finance in the energy saving component, aiming to promote and diffuse energy efficiency projects targeting SMEs, but there was no track record of sub-loans in the energy saving component. It is thought that the reasons for this were the mismatch between COFIDE's sub-loan conditions (interest rate, repayment period, sub-loan amount, etc.) and the end-users' needs, as well as the limitations of COFIDE's operations as a "Second Floor Bank". In other words, even if COFIDE tries to support energy saving sub-projects with the same scheme as this program in the future, there will be many issues concerned. There has been a demand for funds in the energy saving sub-projects, and the APEC Follow-up Peer Review has pointed out the necessity of reviewing institutional frameworks including public financial support. So, it is expected that the government of Peru will promptly consider the institutional framework including COFIDE's roles and other supporting methods.

4.2.2 Recommendations to JICA

None.

4.3 Lessons Learned

<u>To minimize the mismatch between end-user's financial needs and sub-loan scheme</u>

In this program, there were no sub-loans in the energy saving component for SMEs that was allocated 30% of the total sub-loan funds. The reasons for this are that the sub-loan conditions provided by COFIDE, the executing agency, did not necessarily meet the needs of SMEs, and that COFIDE as a "Second Floor Bank" thinks that if the amount of sub-loan is not more than US$ 1 to 1.5 million, it will not be worth the operating cost. While, the funding needs for energy saving were smaller than that. So, it can be considered that IFIs did not need co-financing with COFIDE due to small-scale financing, and there were cases where IFIs were able to provide loans at its own risk. In other words, there was a mismatch between the financial needs of end-users and the

program scheme under this ODA loan. This mismatch could have been understood to some extent if the financial needs of end-users and IFIs had been investigated at the time of planning, and it seems that the mismatch could have been minimized. Therefore, it is important to conduct market research as much as possible at the time of planning and reflect the results in the program scheme.

Sustainability of Financial Intermediary Loan, which are not expected to utilize Revolving Funds from the beginning

It is needless to say that whether or not the RF is being operated and secondary lending is being continuously provided is an important factor in evaluating the sustainability of Financial Intermediary Loan. However, in the case of this program, since there was a structural problem such that the grace period of the ODA loan is relatively short at five years, and the repayment of the ODA loan starts before the repayment amount of sub-loans principal is sufficiently accumulated in the RF, the RF was not utilized at all. Although the utilization of RF shall be reported for five years after final disbursement of the L/A, if it is clear from the beginning that the utilization of RF will not be sufficient from the conditions of ODA loan and sub-loan, it is also a good idea to evaluate the sustainability of the program from the perspective of how similar operations with the purpose of the ODA loan in question are being undertaken by the executing agency rather than evaluating the sustainability with only the results of RF utilization.

5. Non-Score Criteria

5.1 Performance (Subjective perspectives (Look-back))

None.

5.2 Additionality

None.

Comparison of the Original and Actual Scope of the Program

Item	Plan	Actual
1. Program Outputs (1) Providing Funds for Energy Renovation Infrastructure	No. of sub-loans: 126 (according to JICA's appraisal) Sub-loan: 8,332 million Yen of which: -Fuel Conversion approx.10% -Low Emission Diesel approx.10% -Renewable Energy approx.50% -Energy Saving approx.30%	No. of sub-loans: 7 Sub-loan: 8,332 million Yen of which: -Fuel Conversion 4% -Low Emission Diesel 10% -Renewable Energy 86% -Energy Saving 0%
(2) Consulting Services	General consultant for project supervision and consultants for technical supports in each area of fuel conversion, low emission diesel, renewable energy and energy efficiency (438 million yen in total)	Employment of general consultant and consultants for renewable energy and energy efficiency (146 million yen in total)
(3) Other Technical Support	Dispatch of a Japanese expert and ODA Loan's technical assistance for training in Japan, related to energy efficiency components	Special Assistance for Project Implementation (SAPI) for project preparation of low emission diesel and energy efficiency components
2. Program Period	Dec. 2012 – Feb. 2018 (63 months)	Jan. 2013 – Feb. 2018 (62 months)
3. Program Cost Amount Paid in Foreign Currency Amount Paid in Local Currency Total ODA Loan Portion Exchange Rate	 8,611million Yen 1,869 million Yen (61 million Sol) 10,480 million Yen 8,770 million Yen 1 sol = 30.8 Yen (As of September 2010)	 n.a n.a n.a 8,478 million Yen 1 sol = 35.7 Yen (Average between January 2013 and February 2018)
4. Final Disbursement	February 2018	

Islamic Republic of Pakistan

FY2021 Ex-post Evaluation Report of

Japanese ODA Loan Project

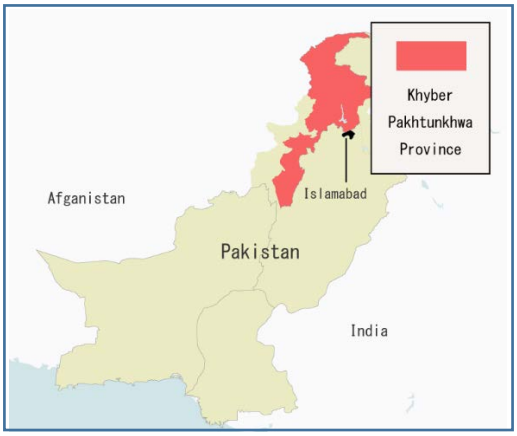
"Khyber Pakhtunkhwa Emergency Rural Road Rehabilitation Project"

External Evaluator: Hajime Sonoda, Global Group 21 Japan, Inc.

0. Summary

"Khyber Pakhtunkhwa Emergency Rural Road Rehabilitation Project" (hereinafter referred to as "the Project") was implemented to rehabilitate and restore transportation in flood-damaged areas of Khyber Pakhtunkhwa Province (hereinafter referred to as "KP Province"), located in northwest Pakistan, by rehabilitating flood-damaged roads and bridges in rural areas, thereby contributing to the early recovery of economic and social activities, alleviation of poverty in rural areas, and correction of regional disparities. The Project is consistent with Pakistan's development plans and needs both at the times of planning and ex-post evaluation. The Project was consistent with Japan's development cooperation policy at the time of planning, and therefore, its relevance and coherence are high. The outputs were appropriately selected and completed in accordance with the selection criteria at the time of planning. Although the project period slightly exceeded the plan, the project cost was within the plan, and the efficiency of the Project is high. The conditions of the targeted roads and bridges have improved compared to the pre-disaster conditions. The purpose of the Project was fully achieved as it has become possible for all types of vehicles to use the roads throughout the year and the travel speeds have increased. The increase in public transportation has made it more convenient for residents to travel outside the village, and various positive socioeconomic impacts were realized. Therefore, the effectiveness and impacts of the Project are high. There are no particular issues regarding the operation and maintenance of the Project in terms of policy/systems, institutional/organizational, technical, environmental and social aspects, and the preventative measures to risks. However, budget constraints have not allowed for adequate maintenance work. Therefore, the sustainability of the Project is moderately low. Based on the above, the Project is evaluated to be satisfactory.

1. Project Description



Project Location

District road after rehabilitation (Mardan District)

1.1 Background

From July to September 2010, Pakistan experienced heavy rains mainly in the northern part of the country, resulting in the worst flooding in the country's history, flooding the entire Indus River basin from the northwest to the south. More than 20 million people were affected, 1.9 million houses were destroyed, roads, irrigation facilities, and various other infrastructures were damaged, extensive areas of farmland were inundated, and livestock were killed. According to the flood damage and needs assessment led by the World Bank and Asian Development Bank, with the participation of JICA, the total damage was estimated at over US$10 billion.

In KP Province located in the upper reaches of the Indus River, where heavy rains were concentrated, the downpour and floods caused landslides and collapses along river shoulders, isolating rural communities and preventing residents from rebuilding their lives and carrying out economic activities such as agriculture. In response, Japan provided assistance for early recovery, including the dispatch of Japan Disaster Relief Team and medical teams and emergency humanitarian assistance. At the Pakistan Development Forum held in Islamabad in November 2010, Japan announced its policy to provide $500 million in assistance, including the Project.[1] Against this background, the Loan Agreement for the Project was signed in February 2011.

1.2 Project Outline

The objective of the Project is to rehabilitate and restore transportation in flood-damaged areas of KP Province, located in northwest Pakistan, by rehabilitating flood-damaged roads and bridges in rural areas, thereby contributing to the early recovery of economic and social activities, alleviation of poverty in rural areas, and correction of regional disparities.

[1] https://www.mofa.go.jp/mofaj/press/enzetsu/22/ekkt_1115.html

Loan Approved Amount/ Disbursed Amount	14,700 million yen / 14,554 million yen
Exchange of Notes Date/ Loan Agreement Signing Date	January 2011 / February 2011
Terms and Conditions	Interest Rate: 0.01% Repayment Period: 40 years (Grace Period: 10 years) Conditions for Procurement: General Untied
Borrower / Executing Agency	President, Islamic Republic of Pakistan / Communication and Works Department, KP Province
Project Completion	February 2016
Target Area	KP Province
Main Contractor (Over 1 billion yen)	No contracts over 1 billion yen
Main Consultant (Over 100 million yen)	National Engineering Services Pakistan Limited (Pakistan)
Related Studies (Feasibility Studies, etc.)	None
Related Projects	"Rural Roads Construction Project" (1993), "Rural Roads Construction Project (II) (Sindh)" (2008)

2. Outline of the Evaluation Study

2.1 External Evaluator

Hajime Sonoda, Global Group 21 Japan, Inc.

2.2 Duration of Evaluation Study

This ex-post evaluation study was conducted with the following schedule.

Duration of the Study: January 2022 – February 2023

Duration of the Field Study: May – July 2022 (conducted through field survey assistants)

2.3 Constraints during the Evaluation Study

Due to the pandemic of COVID-19, the field survey was conducted through local consultants. The information collected through interviews with the executing agency, interviews with local population, and field inspection was examined by the external evaluator for evaluation analysis and judgment.

3. Results of the Evaluation (Overall Rating: B [2])

3.1 Relevance / Coherence (Rating: ③[3])

3.1.1 Relevance (Rating: ③)

3.1.1.1 Consistency with the Development Plan of Pakistan

As described in "1.1 Background," the 2010 floods caused extensive damage throughout Pakistan. In response, the Government of Pakistan mobilized the military to provide relief to the victims, and the National Disaster Management Authority and Provincial Disaster Management Authorities took the lead in planning and coordinating emergency humanitarian assistance and rehabilitation projects. At the time of the planning, the KP Province Communication and Works Department (hereinafter referred to as "CWD") had set up a specialized unit for flood disaster response and rapid recovery and was preparing emergency restoration and medium- to long-term rehabilitation plans based on an assessment of the damage.

At the time of the ex-post evaluation, Pakistan's national development plan, *Pakistan Vision 2025* (prepared by the Ministry of Planning, Development and Reform in 2014), declared the country to join the ranks of upper middle-income countries by 2025 and identified "modernizing transportation infrastructure and greater regional connectivity" as one of seven development pillars.[4] In addition, KP Province's mid-term development plan, *Sustainable Development Strategy 2019-2023*, aims to leverage the competitiveness of its fruit and vegetable, tourism, and mining (marble) industries to address challenges such as poverty and malnutrition, inequality within the province, and population growth. The plan points out that poor road infrastructure is behind intra-provincial disparities and low health indicators, while in the transportation sector, the investment plan aims to strengthen interregional connectivity through efficient mobility and improved mass transit.

As a result of the above, the Project is highly consistent with Pakistan's development policy at the times of planning and ex-post evaluation.

3.1.1.2 Consistency with Development Needs of Pakistan

According to the Damage and Needs Assessment released in 2011, medium- to long-term rehabilitation and reconstruction needs across Pakistan after the 2010 floods totaled $8.9 billion. By sector, particularly large financing needs were identified in transportation and communications ($2.4 billion, including $2.1 billion for roads), followed by housing ($2.2 billion) and agriculture ($1 billion). In KP Province, 404 km of national roads, 259 km of provincial roads, and 7,690 km of district roads were damaged. This is equivalent to one-third of all roads damaged across

[2] A: Highly satisfactory, B: Satisfactory, C: Partially satisfactory, D: Unsatisfactory

[3] ④: Very High、③: High, ②: Moderately Low, ①: Low

[4] Other development pillars are: "putting people first – developing human and social capital," "achieving sustained, indigenous and inclusive growth," "democratic governance, institutional reform and modernization of the public sector," "water, energy and food security," "private sector and entrepreneurship led growth," and "developing a competitive knowledge economy through value addition."

Pakistan due to the 2010 floods. The reconstruction cost was estimated at $690 million. According to CWD, all the road sections covered by the Project were selected considering their severe post-flood damage and large beneficiary population of the road/ bridge, and thus the need and urgency for rehabilitation were high. In addition, as discussed in the effectiveness and impact section, the target roads are all considered to be fully utilized after restoration.

Based on the above, the Project is highly consistent with Pakistan's development needs at the times of planning and post-evaluation.

3.1.2 Coherence (Rating: ②)

3.1.2.1 Consistency with Japan's ODA Policy

Since disasters cause enormous damage to the lives and property of the victims and can be a major obstacle to social and economic development and poverty alleviation in rural areas, this round of disaster assistance is consistent with the focus areas of Japan's ODA policy for Pakistan at the time of planning, "ensuring human security and human development" and "achievement of balanced regional socio-economic development." In addition, JICA identified infrastructure development in the road sector as a priority issue that would contribute to improving the living conditions of the poor, increasing access to public services and markets. Therefore, the Project is consistent with Japan's ODA policy at the time of planning.

3.1.2.2 Internal Coherence

In response to the flood damage in 2010, JICA provided Emergency Grant Aid, participated in the damage and needs assessment for rehabilitation and reconstruction, and coordinated with other donors to formulate a medium- to long-term reconstruction assistance plan. Although there are a number of projects targeting transportation infrastructure in rural areas, such as the two phases of "Rural Road Construction Project" (ODA loan), which preceded the Project, no specific linkages or synergies with the Project could be confirmed. On the other hand, CWD did not point out any lack of coordination with other JICA projects.

3.1.2.3 External Coherence

JICA participated with other donors in conducting the damage and needs assessment and in developing a medium- to long-term reconstruction assistance plan, and the Project was formed based on coordination among donors. According to CWD, JICA was the only donor that conducted reconstruction projects in the road sector in the province. As for projects in other sectors, most of them were implemented through NGOs, but specific information was not available. Although specific linkages between the Project and other donor projects could not be confirmed, CWD did not indicate that there was insufficient linkage with other donors. According to CWD, the Asian Development Bank's "Road Development Sector and Sub Regional

Connectivity Project" in KP Province was completed in 2011. Subsequently, as was envisaged when the Project was planned, the staff of CWD who were involved in its implementation were engaged in the implementation of the Project to ensure smooth implementation of the Project.

Based on the above, the Project was consistent with Pakistan's development plans and development needs both at the time of planning and at the time of ex-post evaluation, and was consistent with Japan's ODA policy at the time of planning, and therefore, its relevance and coherence are high.

3.2 Efficiency (Rating: ③)

3.2.1 Project Outputs

In the Project, a list of candidate roads and bridges to be rehabilitated was prepared at the time of planning. During the implementation phase, it was planned that specific target roads and bridges would be selected from that list using the selection criteria shown in Table 1, and that rehabilitation works would be carried out within the budget. The planned and actual outputs of the Project are shown in Table 2. The planned extensions of road and bridge rehabilitation were the sum of all possible candidate roads and bridges, and in reality, about one-third of them were supposed to be rehabilitated within the budget of the Project.

Table 1 Selection Criteria for Target Roads and Bridges

- Technical feasibility is confirmed.
- High priority in terms of urgency and scale of benefits.
- National and provincial highways connected by the targeted district roads are available or scheduled for rehabilitation.
- No resettlement is involved.
- Low environmental impact.
- No safety issues in implementation.
- It has not been the subject of other rehabilitation projects.

Source: Materials provided by JICA

Table 2: Planned and Actual Outputs

Planned Outputs	Actual Outputs
Road and bridge rehabilitation (note) Provincial roads: 3 sections (171 km) District roads : 134 sections (1,476 km) Bridges: 21 bridges (2,060 m)	Road and bridge rehabilitation Provincial roads: 3 sections (101 km) District roads: 77 sections (427 km) Bridges: 10 bridges (670 m)
Supporting activities for project implementation	Supporting activities for project implementation (as planned)
Consulting Services Bidding assistance, detailed design, environmental monitoring, socioeconomic studies, capacity building for maintenance and management, etc.	Consulting Services Bidding assistance, detailed design, environmental monitoring, socioeconomic studies, capacity building for maintenance and management, etc. (as planned)

Source: Materials provided by JICA and CWD
Note: The planned value of the road and bridge rehabilitation extension is the sum of all possible candidate roads and bridges, a portion of which were planned to be rehabilitated under the Project's budget.

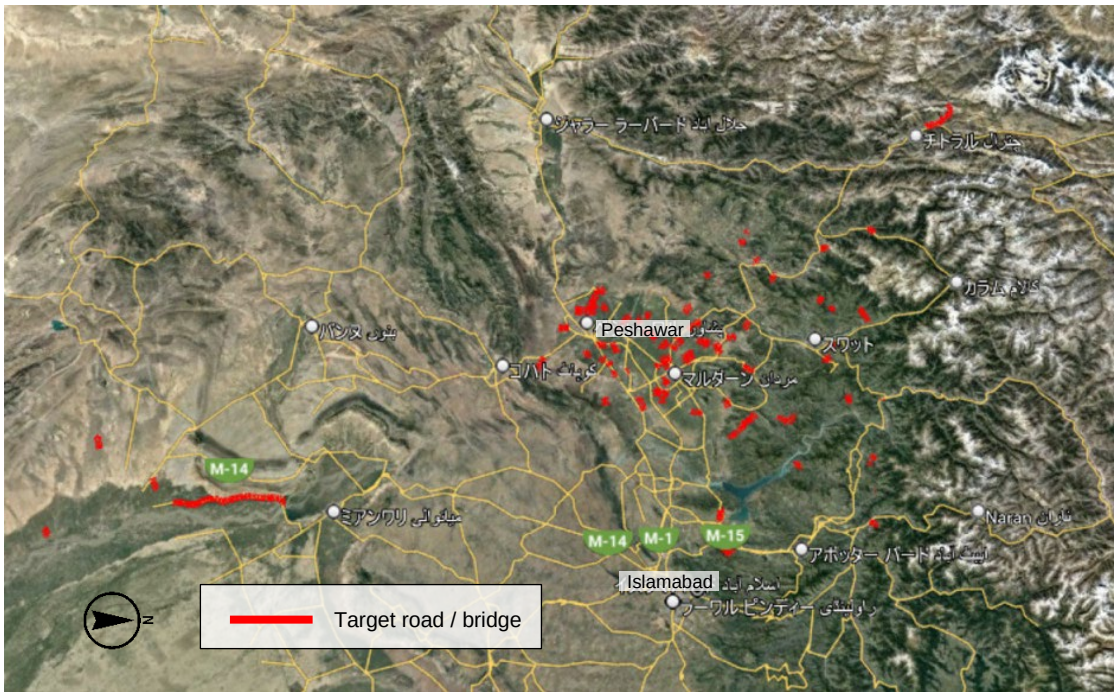


Figure 1 Location of Target Roads and Bridges

Source: Compiled from information provided by CWD

According to CWD, all target road sections and bridges were selected by CWD from the list of candidates at the time of the planning in accordance with the agreed selection criteria. The

selection results were notified to JICA after approval by the provincial government. Initial bidding was conducted for 60 road sections and 21 bridges, but competitive bidding resulted in a compressed contract amount and surplus funds. Therefore, after the change of provincial government administration in 2013, 17 new road sections were added using the surplus funds. A total of 82 contracts were awarded for civil works for the Project, but since the contract amounts were all less than 500 million yen, no contract consent process was conducted by JICA. JICA held monthly meetings with CWD from 2012 to 2015 to confirm that there were no environmental or social impacts of concern for the target roads and bridges and to resolve implementation issues.

3.2.2 Project Inputs

3.2.2.1 Project Cost

The cost for the Project was planned at 16,981 million yen (including 14,700 million yen by ODA loan). As a result of the selection and implementation of target roads and bridges within the planned project cost, the actual project cost was 15,378 million yen (91% of the plan, including 14,554 million yen by ODA loan), which was within the plan (Table 3). Since the surplus funds generated by the competition results were used to add the target roads and bridges, and the unit construction cost (construction cost per extension) for provincial and district roads and bridges was within 90% of the estimation at the time of planning, it is judged that the civil works for the Project were carried out efficiently. Expenditures for supporting activities for project implementation exceeded the plan due to the delay in implementation and the addition of a defect warranty period (one year), settlement of civil works and transfer of the works to CWD, preparation for subsequent projects, etc., which increased the workload. Land acquisition did not occur, and land acquisition costs were zero.

Table 3: Planned and Actual Project Cost

	Planned Cost		Actual Cost	
	Total	ODA loan	Total	ODA loan
Civil works (including contingency and price escalation)	13,637	13,637	13,342	13,342
Supporting activities for project implementation	139	139	264	264
Consulting services	816	816	900	900
Land acquisition	112	0	0	0
Tax and Duties	2,168	0	824	0
Interest during construction and commitment charges	108	108	48	48
Total amount	16,981	14,700	15,378	14,554

Source: Materials provided by JICA and CWD
Note: Exchange rate at the time of planning 1 Rs. = 0.98 yen (October 2010)
At the time of ex-post evaluation 1 Rs. = 1.08 yen (average rate of 2011 – 2016)

3.2.2.2 Project Period

The project period was planned to be 56 months, from the loan agreement in February 2011 to the completion of all civil works in December 2015. In fact, all civil works were completed in February 2016, resulting in a project period of 61 months from February 2011 to February 2016 (105% of the planned cost), slightly exceeding the plan.

The consultant for the Project was planned to be procured through a single-source selection considering the urgent nature of the rehabilitation after the disaster. However, the consultant's work was general in nature, and there was little basis for appointing a specific company to perform the work under a single-source selection, so the procurement method was revised, and a general competitive bidding process was used. Because of the time required for this change, the consultant contract was concluded eight months later than planned.

In bidding for civil works, bidding was once suspended because the company that planned to bid on the Project requested an update of the old official price list (Composite Schedule of Rates). A new official price list was then prepared for bidding. This delayed civil works contracts by more than six months from the planned date. However, this did not delay the opening of roads for traffic after the disaster.[5]

Construction was disrupted by flooding and earthquakes in 2015, negotiations with local residents,[6] and the deteriorating security situation due to the Taliban threat affected the progress of construction. All quarries in KP Province were temporarily closed due to rampant mining of construction materials (stones) with explosives and illegal mining; some quarries outside KP Province were also closed, which affected the progress of the construction. Although it was sometimes necessary to address the above issues individually, the detailed design and civil works for many of the target roads and bridges included in the Project were carried out in an intermittent manner, and the civil works for each target section generally took 1 to 1.5 years. Thus, the civil works of the Project was completed in a shorter period of time (43 months) than planned (46 months).

3.2.3 Results of Calculations for Internal Rates of Return (Reference only)

Since the Project was emergency assistance, the internal rate of return was not calculated.

Although the project period slightly exceeded the plan, the project cost was within the plan, and the outputs were properly selected and completed according to the selection criteria at the time of planning. Based on the above, the efficiency of the Project is high.

[5] After roads were damaged by the flood, residents first attempted to secure road access by hand. Next, CWD and local governments used heavy machinery to clear sections that were difficult for residents to access, and the minimum level of traffic was secured. Full-scale rehabilitation work by the Project was carried out after that.

[6] In some cases, residents along the target road sections demanded that the contractor construct irrigation canals, drainage channels, etc. in conjunction with the work in exchange for allowing the work to be done, which required time-consuming negotiations.

3.3 Effectiveness and Impacts[7] (Rating:③)

3.3.1 Effectiveness

3.3.1.1 Quantitative Effects (Operation and Effect Indicators)

The Project was implemented to restore and improve traffic in flood-damaged areas of KP Province by rehabilitating flood-damaged roads and bridges. Specifically, the goal was to restore the target roads and bridges to their pre-flood condition, but no quantitative targets were set at the time of planning.

According to CWD, the design principle of the facilities at the time of planning was maintained, and roads were made more durable against flood disasters by installing slope protection and drainage facilities as necessary and strengthening pavements and shoulders compared to before the disaster while considering traffic volume and cost. In designing the bridges, the height under the girders was secured to withstand larger precipitation than the previous setting.

In Pakistan, heavy monsoon rains that began in June 2022 have caused the country's worst floods since 2010, when one-third of the country was submerged, and a state of emergency was declared throughout the country in August. According to CWD, about one-fifth of the road sections of the Project were damaged by the floods, but with emergency repairs, all roads in KP Province, including these road sections, were open to traffic by September 2022. Detailed information on the damage on the road sections was not obtained. In addition, since the extent of flooding in KP Province in 2010 and that in 2022 is considered to be different, this ex-post evaluation could not analyze the extent to which disaster resilience has increased after the Project. There are no reports of damage to road sections or bridges of the Project due to rainfall or flooding before the 2022 flood.

According to CWD, the Project improved the roads and bridges beyond their pre-disaster condition and enhanced their function as roads. Specifically, the following changes were reported to have occurred before and after the Project.

- Pavement: Prior to the Project, the target road sections were asphalt pavements or with asphalt surface treatment.[8] Most of the district roads just had asphalt treatment on the surface. After the Project, most of the roads are asphalt pavements (not with asphalt surface treatment), and some slopes are concrete pavements.

- Roadway width and number of lanes: The roadway width of the target road sections increased from an average of 3.9 m before the Project to an average of 5.3 m after the Project. The roadway width increased in all target road sections. The number of lanes increased from one lane (roadway width of 3.7 m or less) to two lanes (roadway width of

[7] Sub-rating for Effectiveness is to be put with consideration of Impacts.
[8] A simple paving method in which asphalt is sprayed on gravel spread on the road surface without creating base or sub-base.

5.5 m or more) on 70% of the target roads. Some sections of provincial road were widened from two to four lanes.

- Road surface condition: According to the report of CWD, the road surface conditions of the target road sections were "good" in 30% of all sections, "needs maintenance" in 40%, and "needs rehabilitation" in 30% before the disaster. In particular, pavement surfaces on many of the district roads had deteriorated and were already heavily damaged before the disaster. All are in "good" condition at the time of the completion of the Project and ex-post evaluation.

- Ancillary facilities: Roadside ditches, culverts, and slope protection works were located on some sections of state roads before the disaster. They were installed as needed on all sections of state and local roads after the Project. However, no information was available to quantitatively compare the conditions before and after the Project.

- Bridges: 9 bridges increased in width from 5.5m to 7.3m and 1 bridge increased in width from 7.3m to 8.5m, facilitating two-way traffic. Before the disaster, 9 bridges were in "need of maintenance" and 1 bridge was in "need of rehabilitation," but all are in good condition at the time of post-project and ex-post evaluation.[9]

- Travel time and traffic volume: The time required to travel the entire road sections (total time required for each section) was reduced to 46% of the pre-project level, according to a study commissioned by CWD to the consultant.[10] This means that travel speeds increased by approximately 2.2 times from the pre-project level. In addition, the average traffic volume after the project (2018) on the target road sections increased to 153% of the pre-project (2012) level.

3.3.1.2 Qualitative Effects (Other Effects)

The following findings were obtained from the field inspection of 10 selected subprojects and interviews with local residents conducted by the local consultants for the ex-post evaluation.[11]

- Most of the district roads targeted by the Project were damaged by flooding, erosion, and landslides caused by the 2010 floods. Moreover, many of the pavements had already been lost and the road surfaces had already been in poor condition even before the flooding, which made it almost impossible for small vehicles to pass through. In particular, during

[9] However, as discussed below, some of the bridges are scouring and may need repair.
[10] The consultant, commissioned by CWD, conducted traffic counts on each road section in 2012 and 2018, along with interviews with drivers to determine the time required for each section.
[11] Two provincial roads and eight district roads were visited. Group interviews were conducted with a total of 60 people, including community-based organizations (20 people in 2 locations, both organized for other village infrastructure projects) and roadside residents (40 people in 8 locations). Although all the interviewees were men, information about women was obtained by explicitly including questions about women.

the rainy season, the road surface became muddy, which made it difficult for even large vehicles to pass. After the Project, the road is accessible to all types of vehicles throughout the year.

- There were no instances where smooth traffic through the target road section was not possible due to the lack of connecting roads. However, on one provincial road, the road width of a bridge that was not covered by the Project remains narrow, leaving a bottleneck that does not allow two-way traffic.[12]

- Since no land acquisition was made for the Project and rehabilitation work was conducted on the existing road sites, there are sections where the width of the shoulder and roadway changes according to the width of the road sites. In addition, because the existing road alignment was maintained as is, some sharp curves and short sight distance sections remain.

Based on the above, it is judged that the objective of the Project, which is to rehabilitate and improve traffic in flood-affected areas in KP Province, has been fully achieved.

District roads before (left) and after (right) restoration (Buner District, provided by JICA)

District road culvert after rehabilitation
(Haripur District)

Bridge after rehabilitation
(Battagram District)

[12] The bridge is planned to be replaced by the State Department of Public Works.

District road after rehabilitation
(Mardan District)

Provincial road after rehabilitation
(Peshawar District)

District road after rehabilitation (Haripur District)
Public transportation for school (left), new stores (right)

3.3.2 Impacts

3.3.2.1 Intended Impacts

According to the explanations of CWD and interviews with residents conducted by local consultants, most of the district roads targeted by the Project are roads connecting villages to provincial roads, which are used by villagers for general purposes, such as commerce, agriculture, medical care, education, and administration services. Provincial roads connect KP Province to other provinces, which are relatively large in size and used for medium- and long-distance freight and passenger transportation. As for the district roads, in particular, a variety of impacts of the Project were reported, as they are now passable by all types of vehicles throughout the year. The impact of the district roads, the provincial roads, and an analysis based on statistical data are described below.

(1) Impacts of district roads

Changes in road traffic, public transport, and residents' mobility

Before the disaster, there was no public transportation or only large buses because small

vehicles could not pass. After the Project, many small buses began to operate throughout the year, and rickshaws and motorcycle cabs became able to pass through. In addition, the cost of using public transportation has decreased due to the increase in small busses and the decrease in travel time.

Some villagers have purchased new automobiles, rickshaws, or motorcycles. It was reported that more than 10% of all households have purchased a car in some villages and that most households now have a motorcycle in other villages. The number of means of transportation has increased, the cost of transportation (time and money) has decreased, and in general, the number of villagers traveling to town has increased.

Social Impacts

- Education: The number of children attending junior high and high school outside the village has increased as school vehicles (vans) have been put into service. Previously, most girls only went to elementary school in the village, but now they can go to middle school located outside the village as well.
- Health: Pregnant women and emergency patients can now be transported immediately to medical facilities in town. In villages where delivery used to be conducted in the traditional way in the village, after the Project, pregnant women can now be transported quickly and deliver their babies in the hospital. New clinics and pharmacies were opened in some villages.
- Security: Police patrols have increased, which allows police officers to come to the scene quickly. Villagers believe this has led to improved security.

Economic Impacts

- Agriculture: Accessibility by small trucks and tractor wagons has expanded the means of transporting farm products to market. Many farmers transport their crops themselves or with the help of transporters. They are able to ship more quickly, and transportation costs have decreased. Some said that it has become easier to use rental services for tillers and to procure fertilizer. On the other hand, some noted that it is becoming increasingly difficult to farm for the purpose of selling their produce because of the steep rise in prices of agricultural inputs.
- Commerce: New stores (e.g., food and commodity stores) were established in the village, and the selection of goods in existing stores was enriched. As a greater variety of food and daily necessities became available in the village, trips to the town for shopping became

less frequent. In villages with few stores, the frequency of shopping trips to the town increased as it became easier to get to the town.

- Others: It became easier to work in town or go to migrant work. Land prices along the road increased.

(2) Impacts of provincial roads

The provincial roads targeted by the Project had already been paved before the Project and accessible by all types of vehicles throughout the year. After the Project, an increase in traffic volume and the number of stores, gas stations, etc. along the roads were reported. It was noted that one provincial road would be used as a raw material transportation route to the marble industry area planned by the KP Province.

(3) Analysis based on statistical data

Based on existing statistical data, the poverty rate in rural areas of KP decreased from 25% in 2010 to 9% in 2019.[13] During the same period, there has been a slight improvement in the net enrollment rate at the middle school and a significant improvement in the percentage of pregnant women who received prenatal consultation at hospitals (Table 4). There has been a significant increase in household satisfaction with social facilities and social services, among which satisfaction with schools has increased significantly compared to the rest of the country (Table 5). It is likely that the Project contributed in part to these changes by facilitating access to facilities and services through increased mobility of residents, but quantitative verification of the contribution is difficult.

Table 4: Percentage of pregnant women who received prenatal consultation at hospitals

	Urban Area (National)	Rural Area (National)	Urban Area (KP Province)	Rural Area (KP Province)
2010	70%	50%	61%	38%
2019	76%	62%	75%	59%

Source: Pakistan Social And Living Standards Measurement, Pakistan Bureau of Statistics.

[13] According to Pakistan Institute of Development Economy. In rural areas across the country, the percentage decreased from 27% in 2010 to 10% in 2019.

Table 5: Satisfaction with social facilities and social services

		Urban Area (National)	Rural Area (National)	Urban Area (KP Province)	Rural Area (KP Province)
Health	2010	17%	38%	13%	40%
	2019	77%	65%	78%	64%
School	2010	67%	58%	5%	14%
	2019	97%	95%	98%	97%
Police	2010	11%	10%	19%	14%
	2019	56%	58%	75%	70%

Source: Pakistan Social And Living Standards Measurement, Pakistan Bureau of Statistics.

3.3.2.2 Other Positive and Negative Impacts

(1) Impacts on the Natural Environment

The Project was considered to fall under Category FI in the *JICA Guidelines for Environmental and Social Considerations* (2010). According to CWD, only those subprojects that fell under Category B or C were selected for the Project. During construction, great care was taken to address air and water pollution, noise, waste, and dust. There was no particular environmental impact as it was a rehabilitation project.

(2) Resettlement and Land Acquisition

According to CWD, there was no resettlement or land acquisition. No complaints in this relation were specifically identified.

(3) Gender Equality, Marginalized People, Social Systems and Norms, Human Well-being, Human Rights, etc.

In KP Province, it is not common for women to travel outside of the village, and since it is mostly men who use the roads, most of the benefits from the Project are enjoyed by men. However, the fact that the Project has made it possible to transport pregnant women and emergency patients to hospitals and girls to secondary schools outside the village is a particularly important impact for women, which is welcomed by the villagers.

The fact that the Project has made public transportation easier to use is an important impact for poor households that do not have private cars, motorcycles, or other means of transportation.

The objective of the Project, which was to rehabilitate and improve traffic in flood-damaged areas in KP Province, was fully achieved, as the condition of the target roads and bridges was improved from that before the disaster, all types of vehicles became able to travel on these roads

and bridges throughout the year, and the travel speed increased. The increase in public transportation enhanced the convenience of residents to travel outside the village, and various positive socioeconomic impacts were manifested. No unfavorable environmental and social impacts were observed. Based on the above, the Project has achieved its objectives, and its effectiveness and impacts are high.

3.4 Sustainability (Rating: ②)

3.4.1 Policy and System

As discussed in Section 3.1.1 Relevance, the Government of Pakistan and the KP Provincial Government consider road infrastructure maintenance to be important and have a commitment to maintaining the road network. As described in the next section, institutions and procedures for road maintenance in KP Province are well established. Therefore, there are no issues with policy and system.

3.4.2 Institutional/Organizational Aspect

Provincial roads are operated and maintained by Pakhtunkhwa Highways Authority (hereinafter referred to as "PKHA") under CWD through four local offices, and district roads are operated and maintained by CWD through four local offices. For the maintenance and management of district roads, personnel from the public works bureaus of each district are also assigned to carry out on-site work. CWD's local engineering units in charge of district roads share information and perform field work in cooperation with the district public works bureaus. Contracts for road construction and rehabilitation projects usually include a warranty period of one to three years. The construction contract for the Project included a one-year warranty period. During this period, the contractor who undertook the construction was responsible for maintenance.

For both provincial and district roads, maintenance services are outsourced. PKHA and CWD use a list of qualified registered contractors, procure contractors according to the procedures established by the Provincial Public Procurement Regulatory Authority, and enter into contracts with them. Usually, the contract is for a single year, and the engineer in charge of the site (one person is responsible for 100 to 150 km of road) checks the contractor's work and performs quality control. The contractors are paid a fee based on the volume of work performed.

There is no standardized maintenance schedule for PKHA and CWD according to the type and age of roads. Instead, the current mechanism is that, each year, the respective local office receives reports on road damage and maintenance needs from the site engineers and plans maintenance work that can be performed within the allocated annual budget.

Based on the above, there are no particular issues in terms of institutional/organizational aspect. However, it can be pointed out that, as maintenance and management work is carried out within

budgetary constraints, appropriateness of the system depends on the amount of budget available.

3.4.3 Technical Aspect

The roads and bridges of the Project were constructed using common technology in Pakistan, and no special techniques are required for their maintenance. According to the maintenance staff of CWD and PKHA, there are no particular technical problems with the maintenance work performed by outsourced contractors. In addition, as part of the consulting services for the Project, training on contract management, road design, and quality control was provided to 32 employees of CWD and PKHA. Based on the above, there are no particular issues in the technical aspects of the operation and maintenance of the Project.

3.4.4 Financial Aspect

The budget for road maintenance by PKHA and CWD is allocated from the provincial government budget. Each local office is allocated an annual budget in a lump sum. The budget amount for PKHA and CWD has generally been increasing (Table 6). In 2020-21, the budget amount was significantly reduced due to the pandemic of COVID-19 but was eventually restored to the same level as in previous years with additional subsequent allocations. According to interviews with local offices,[14] the budget amount allocated has not changed for the past three years. According to CWD, allocations are expected to increase by 10-15% annually unless there is a specific reason.

Table 6: Budget for PKHA and CWD

(Unit: million rupees)

	PKHA	CWD
2013-14	600.00	451.00
2014-15	600.00	895.00
2015-16	650.00	1140.00
2016-17	715.00	1254.00
2017-18	786.50	1379.50
2018-19	865.15	1503.88
2019-20	1200.00	2091.00
2020-21*	425.14 (1,426.00)	741.50 (2,175.00)
2021-22	1200.00	2204.00

Source: Materials provided by CWD

Note: Although the initial budget was small for 2020-21, the amounts in parentheses were eventually allocated.

[14] Interviews were conducted through local consultants at one local office of PKHA and two local offices of CWD.

According to CWD (Headquarters) and its local offices, the budgeted amount is small compared to the amount needed and is not sufficient to maintain all the target roads.[15] In particular, there is a significant shortfall when urgent repairs are required due to disasters or other reasons. From the above, although the budgeted amount for maintenance and management is generally maintained at the same level, it is not sufficient, and there are some financial challenges.

3.4.5 Environmental and Social Aspect

There are no specific environmental and social issues regarding the maintenance of the road network. If an environmental or social situation arises that requires action, the engineer in charge of the site will assess the situation, report it to the local office, and take action. If necessary, the relevant departments within PKHA and CWD will respond to the situation. Therefore, there are no particular concerns regarding environmental and social aspects.

3.4.6 Preventative Measures to Risks

As described in Section 3.3.1 Effectiveness, the Project has improved the disaster prevention performance of the target road and reduced the risk of damage due to natural disasters. If urgent repairs are required, the budget of each local office will be used to carry out the repair work. In fact, during the 2022 flood, traffic was reopened throughout KP Province in a short period of time after emergency repairs. Therefore, there are no particular issues regarding preventative measures to risk.

3.4.7 Status of Operation and Maintenance

According to CWD, both the road surface condition and bridge condition of the target roads are good. On the other hand, field inspections conducted on eight road sections and two bridges during the post-evaluation revealed the following conditions.

- The pavement surfaces were all in good condition, and the structures were generally in good condition for roads that were six to seven years old after completion. However, one section with poor shoulder conditions was observed, as well as several areas of minor damage to concrete such as causeways (low-water bridges) and culverts.
- Broken road signs and faded road markings were seen throughout the area. In addition, road ditches were blocked with dirt and debris, and the sides of the roads were not mowed, both of which indicated that necessary maintenance work was not carried out in a timely manner.

[15] No specific information on the budget required for road maintenance was obtained from CDW within the study period.

- The bridge structures are in good condition, but one of the two bridges inspected was experiencing scour. It is considered that the time for a thorough examination of the need for full-scale repair of all bridges of the Project is approaching.

From the above, the operation and maintenance status is generally good. However, there remain some areas where necessary maintenance work is not carried out in a timely manner, and there are some issues to be addressed.

From the above, no major issues have been observed in the policy and system, institutional/ organizational, technical, environmental and social aspects, and preventative measures to risks. However, as maintenance work has not been fully implemented due to budget constraints and other reasons, there are some issues in the financial aspect including the current status of operation and maintenance of the Project, which are unlikely to be improved or resolved through the efforts of CWD. Therefore, sustainability of the project effects is moderately low.

4. Conclusions, Lessons Learned and Recommendations

4.1 Conclusion

The Project was implemented to rehabilitate and restore transportation in flood-damaged areas of KP Province, located in northwest Pakistan, by rehabilitating flood-damaged roads and bridges in rural areas, thereby contributing to the early recovery of economic and social activities, alleviation of poverty in rural areas, and correction of regional disparities. The Project is consistent with Pakistan's development plans and needs both at the times of planning and ex-post evaluation. The Project was consistent with Japan's development cooperation policy at the time of planning, and therefore, its relevance and coherence are high. The outputs were appropriately selected and completed in accordance with the selection criteria at the time of planning. Although the project period slightly exceeded the plan, the project cost was within the plan, and the efficiency of the Project is high. The conditions of the targeted roads and bridges have improved compared to the pre-disaster conditions. The purpose of the Project was fully achieved as it has become possible for all types of vehicles to use the roads throughout the year and the travel speeds have increased. The increase in public transportation has made it more convenient for residents to travel outside the village, and various positive socioeconomic impacts were realized. Therefore, the effectiveness and impacts of the Project are high. There are no particular issues regarding the operation and maintenance of the Project in terms of policy/systems, institutional/organizational, technical, environmental and social aspects, and the preventative measures to risks. However, budget constraints have not allowed for adequate maintenance work. Therefore, the sustainability of the Project is moderately low. Based on the above, the Project is evaluated to be satisfactory.

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

Field inspections conducted during the ex-post evaluation showed that side drainage on district roads was not adequately cleaned and vegetation was not adequately managed. In addition, some road signs and surface markings, as well as some concrete structures, are considered in need of repair. CWD should inspect the road sections covered by the Project and implement maintenance work.

In addition, it was observed that some of the bridges had advanced scour. It is important to inspect all the 10 bridges targeted in the Project and plan and implement necessary maintenance, including addressing the scour.

In order to be able to properly maintain provincial and district roads, KP provincial government needs to make every effort to secure the necessary budget for road maintenance. As a prerequisite for this, CWD should fully examine the maintenance needs of the roads under its jurisdiction and prepare an appropriate annual plan for maintenance.

4.2.2 Recommendations to JICA

The implementation of the above recommendations should be monitored and promoted.

4.3 Lessons Learned

Rehabilitation projects of infrastructure facilities damaged by a natural disaster provide good opportunities for development

In the Project, efforts were made to increase durability against future flood disasters by installing slope protection and drainage facilities on the damaged roads and strengthening the pavement and shoulders from the pre-disaster level. It can be said that the Project was in line with the "build-back-better" concept of creating a more resilient community in the post-disaster reconstruction phase in preparation for the next disaster.[16]

The roads and bridges targeted by the Project were in poor condition prior to the disaster, and many of the district roads were difficult to pass through all year around. However, after the rehabilitation, the roads were made more functional, with all types of vehicles being able to use them throughout the year, the roadway width and number of lanes increased, and the time required for travel shortened. This has made public transportation more convenient, facilitated residents' travel outside the village, and had a variety of other desirable socioeconomic impacts.

In other words, the Project did not merely improve the roads' durability against disasters, but also improved their very function as roads, which led to various desirable impacts that promoted

[16] The concept proposed in the Sendai Framework for Disaster Risk Reduction 2015-2030, a UN document adopted at the 3rd UN Conference on Disaster Reduction held in Sendai in 2015.

the socioeconomic development of the region. This indicates that a project to rehabilitate damaged infrastructure facilities can, at the same time, be a good opportunity to promote regional development by improving infrastructure facilities to a state better than their pre-disaster condition.

Consideration of the consultant procurement method in light of the recipient country's procurement system and the scope of works

The consultant for the Project was planned to be procured through single source selection, taking into account the urgent nature of the restoration after the disaster. However, since the consultants' scope of works was general in nature and there was little basis under Pakistan's public procurement system for appointing a specific company to perform the work through single source selection, the procurement method was reviewed, and a general competitive bidding process was used. Because of the time required for this change, the consultant contract was concluded eight months later than planned.

Therefore, when a consultant is to be procured through single source selection, its appropriateness should be thoroughly discussed with the government of the recipient country from the planning stage, taking into consideration the procurement system of the recipient country and whether there are any special characteristics of the consultant's work.

5. Non-Score Criteria

5.1 Performance

5.1.1 Objective Perspective

In formulating the Project, JICA, along with other donors, played an active role by participating in the damage and needs assessment. After the start of the Project, JICA Pakistan Office continued monthly meetings with CWD for four years to contribute to the smooth implementation of the Project by reviewing the results of the selection of the target road sections and bridges, confirming that the environmental impact was minimal, monitoring the progress of procurement and construction, and discussing ways to solve problems.

5.2 Additionality (none)

(end)

Comparison of the Original and Actual Scope of the Project

Item	Plan	Actual
1. Project Outputs	Road and bridge rehabilitation (note) Provincial roads: 3 sections (171 km) District roads: 134 sections (1,476 km) Bridges: 21 bridges (2,060 m) Supporting activities for project implementation Consulting Services Bidding assistance, detailed design, environmental monitoring, socioeconomic studies, capacity building for maintenance and management, etc.	Road and bridge rehabilitation Provincial roads: 3 sections (101 km) District roads: 77 sections (427 km) Bridges: 10 bridges (670 m) (as planned) (as planned)
2. Project Period	February 2011 – December 2015 (56 months)	February 2011 – February 2016 (61 months)
3. Project Cost ODA loan Pakistan side Total exchange rate	 14,700 million yen 2,281 million yen 16,981 million yen 1 rupee = 0.98 yen (October 2010)	 14,554 million yen 824 million yen 15,378 million yen 1 rupee = 1.08 yen (Average rate for 2011-2016)
4. Final Disbursement	March 2020	

Note: The planned value of the road and bridge rehabilitation extension is the sum of all possible candidate roads and bridges, a portion of which were planned to be rehabilitated under the Project's bud