Samoa

FY2016 Ex-Post Evaluation of Japanese ODA Grant Aid Project

"The Programme for Improving the Weather Forecasting System and Meteorological Warning Facilities"

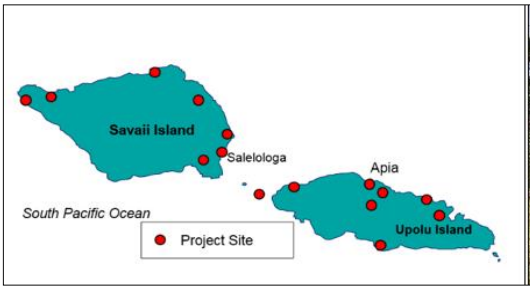
External Evaluator: Hisae Takahashi, Japan Economic Research Institute Inc.

0. Summary

This project was implemented to improve the capacity of meteorological observation and the vulnerability to meteorological disasters by installing equipment for the meteorological observation system and early warning facilities as well as conducting the necessary technical cooperation to operate and maintain the equipment. The purpose of the project is highly consistent with the development strategy and environment sector plan of Samoa, which has aimed to improve resilience to climate change and measures to meteorological disasters and the development needs of Samoa, which has been frequently damaged by natural disaster, as well as Japan's aid policy. The targets, enabling upper air continuous observation and the required weather observation for airport authority, were achieved by implementing the project. A system to transmit and receive the data needed to analyze the meteorological forecast was established and meteorological prediction was made possible based on the accurate information. Accordingly, the provision of weather information, including the movement of cyclones, storm areas and rainfall as well as disaster surge warnings issued, which were not available before implementing the project, have contributed to agricultural activities for the people as well as the Samoan tourist industry. Therefore, the effectiveness and impact of this project are high. Though the project cost was within the plan, the project period exceeded the plan due to changes in the technical cooperation period, the impact of a cyclone and applying the new scheme to provide technical cooperation. Consequently, the efficiency of the project is fair. Although the operation and maintenance of equipment provided by the project is in good condition, some minor institutional, technical and financial problems were confirmed, therefore the sustainability of the project can be judged to be fair.

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

1. Project Description



Project Locations

Data Collection Unit, Barometer, Temperature and Humidity Sensor (Le Piu Tai in Savaii Island)

1.1 Background

Samoa comprises seven small islands in addition to the main large islands of Savaii and Upolu. These two are volcanic islands with precipitous mountains, while the body of the population inhabits inshore areas, where the social infrastructure is established. Accordingly, there was urgent need to establish appropriate countermeasures for natural disasters such as destructive storms, storm surges, flooding and tsunami caused by cyclones. In fact, 12 powerful cyclones attacked over the 60 years since 1950[1] and most of the entire population of the islands was affected. In addition to the cyclones coming every few years, the islands of Samoa have experienced frequent infrastructural and agricultural losses due to destructive floods. Such an environment had made harder life to the poor who supported agriculture, one of the key Samoan industries. Thus, effective disaster prevention measures were required from a perspective of poverty alleviation.

In Samoa, meteorological information and early warnings from the Samoa Meteorology Division (SMD) is the initial information for the national institutions working for disaster prevention. Under these circumstances, the capability of the SMD was required to be strengthened, given the critical need to improve the promptness and accuracy of weather information and early warnings. However, meteorological observation of SMD at the time of the plan was mainly conducted by manual with limited equipment, which meant the necessary weather information could not be obtained on a timely basis. Accordingly, this project aiming to strengthen the disaster prevention system was implemented by improving the country's capacity for meteorological observation; introducing equipment for an automatic weather systems, weather forecast and early meteorological warnings systems.

1.2 Project Outline

The objective of this project is to improve the capacity for meteorological observation and ease vulnerability to disasters by establishing a weather observation system and meteorological warning facilities, helping expedite the quick evacuation of residents when disasters occur and

[1] Source: documents provided by JICA

tourism by improving aviation safety and stabilizing activities in agricultural and fishery sectors by utilizing meteorological data.

E/N Grant Amount / Actual Grant Amount	745 million yen / 745 million yen
Exchange of Notes Date / Grant Agreement Date	March 2010 / March 2010
Executing Agency	Ministry of Natural Resources and Environment (MNRE)/ Samoa Meteorology Division (SMD)
Project Completion	September 2015
Main Contractors	(Construction) Japan Trade & Engineering Corporation (Equipment) Japan Radio Co., Ltd. / Environmental System & Services Pty Ltd./ Japan Trade & Engineering Corporation
Main Consultants	International Meteorological Consultant Inc./ Japan Weather Association (JV)
Procurement Agency	Japan International Cooperation Center
Preparatory Survey	July 2009 – February 2010
Related Projects	・Follow up project (Installation of Automatic Weather Observation Systems in the three suburbs of Apia)（2008） ・Grant aid "The Project for Rehabilitation and Improvement of Cyclone-Damaged Ports and Foreshore Protection in Western Samoa" (1992) and "The Project for Rehabilitation of Cyclone-Damaged Ports in Western Samoa"（1997） ・Australian Agency for International Development, "South Pacific Sea Level and Climate Monitoring Project" (Installation of tide gauge at twelve sites in South Pacific (One at port in Apia of Samoa)（1991-2010）」 ・China "Samoa Integrated Geo-hazard Array"（Installation of Seismic Observation Unit and Observation Data Processing System）（2009~2011）

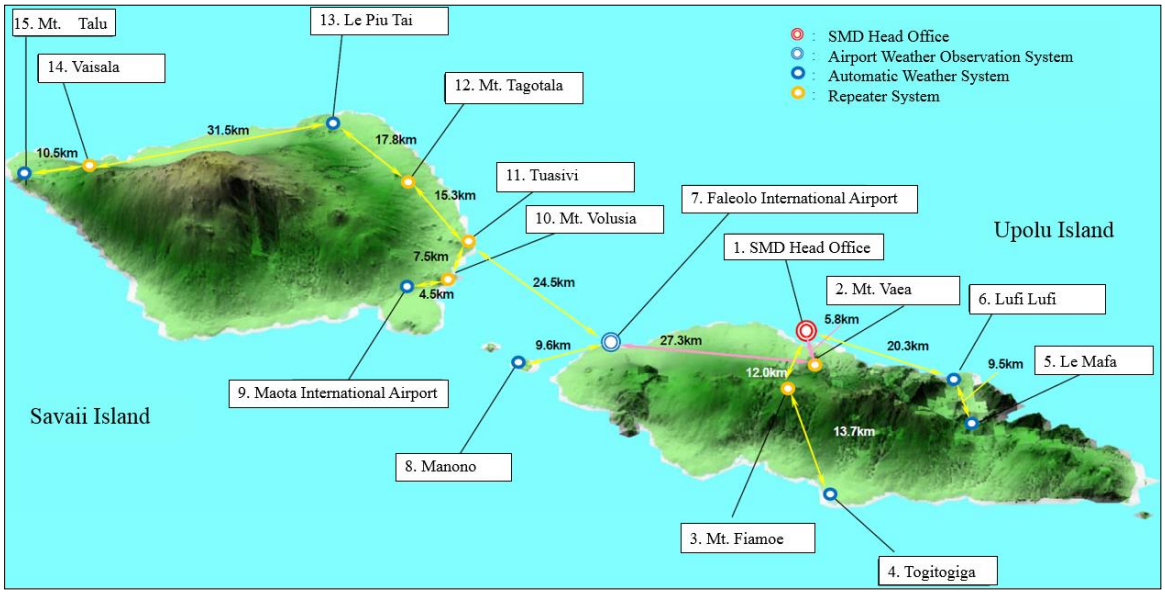


Figure 1 Site Map of the Programme for Improving the Weather Forecasting System and Meteorological Warning Facilities

Source: Document provided by JICA

2. Outline of the Evaluation Study

2.1 External Evaluator

Hisae Takahashi, Japan Economic Research Institute Inc.[2]

2.2 Duration of Evaluation Study

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

Duration of the Study: August, 2016 – October, 2017

Duration of the Field Study: October 17, 2016 –October 29, 2016 / February 19, 2017 – February 26, 2017

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

3.1 Relevance (Rating: ③[4])

3.1.1 Consistency with the Development Plan of Samoa

Strategy for the Development of Samoa (SDS) (2008-2012), a development policy at the time of planning, emphasized the need to implement aviation meteorology services in accordance with international standards and indicated an enhanced capacity on SMD. This strategy also highlighted the importance of implementing *National Adaptation Programme of Action (NAPA)* for continuous social and economic growth and particularly focused on

[2] Joined the evaluation team of Japan Economic Research Institute Inc. as a team member from Ernst & Young ShinNihon LLC.

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

[4] ③: High, ②: Fair, ①: Low

boosting measures to combat disasters caused by climate change. *The Operational Plan 2006-2008* of the Ministry of Natural Resource and Environment (MNRE) also emphasized enhancing the function of meteorological services, and laws and regulations, such as *Disaster & Emergency Management Act 2006* and *Climate Change Act 2006*, which reaffirmed to focus on mitigating disaster and the risk of climate changes, and sustain the environment[5].

SDS (2012-2016) at the time of the ex-post evaluation shows a total of 14 key major priority areas within four sectors (economic, social policies, infrastructure and the environment). The environment sector specifies strength against climate change and natural disasters as well as environmental sustainability as a priority area[6]. With the concept of priority areas indicated in the environment sector of *SDS*, the *National Environment and Development Sector Plan* (2013-2016) set out a vision of protecting Samoa's nature and environment, having strength against natural and human-caused disasters and supporting sustainable and healthy human life. In addition, while priority projects from nine areas[7] were implemented along with NAPA, this project is highly prioritized as helping establish a framework to provide accurate weather information required to implement agricultural and health-prioritized projects in this plan.

As stated above, Samoa's development strategy has kept an eye on climate change as well as emphasized to improve resilience against disasters from the time of planning through to the time of ex-post evaluation. The MNRE operational plan, law and regulations for disaster and climate change and the National Environment Sector Plan also indicate enhancing the function of meteorological services, alleviating damage caused by disasters and the need to consolidate strength against disasters. The project was implemented to improve weather observation capability as well as disaster vulnerabilities and has accordingly been deemed relevant to the development plan.

3.1.2 Consistency with the Development Needs of Samoa

At the time of planning, alongside concerns over expanding disasters caused by climate change, Samoa had to implement urgent tasks to establish appropriate measures against natural disasters such as destructive storms and storm surges caused by cyclones, and flooding and tsunamis. Therefore, despite the strong need to improve prompt and accurate weather information, early warning systems and meteorology disaster monitoring capability, the weather observation of SMD during those days was conducted mainly manually and with limited equipment. Accordingly, SMD was unable to provide upper-air observation data, distribute the national observation data to the Global Telecommunication System (GTS),

[5] Source: Documents provided by JICA
[6] Source: Samoa Ministry of Finance web site.
（http://www.mof.gov.ws/Services/Economy/EconomicPlanning/tabid/5618/language/en-US/Default.aspx）
[7] This includes Water, Agriculture, Health, Forestry, Tourism, Planning, Education, Fisheries and Industry.

receive real-time weather data, observe tsunamis caused by rising sea levels or earthquakes, announce prompt forecasts and warnings, monitor cyclones and issue pre-warnings, etc.

Samoa has suffered damage from floods, forest fires, tsunami, drought and vigorous tropical cyclones, etc. even after the project was implemented (See Table 1). The effects of Climate Change were introduced in the evaluation report of the *Intergovernmental Panel on Climate Change*. Furthermore, unusual phenomenon caused by climate change and unprecedented in Samoa were confirmed, such as hailstorms that hit Samoa in 2011 and 2016[8]. Accordingly, the need to understand accurate disaster information and weather information for proper action as warnings as well as develop an early-warning system is high, even at the time of ex-post evaluation.

Table 1 Natural Disaster Observed in Samoa

Year	Hazards (Month)
2008	Drought (May), Forest fire (September), Tsunami (November, December)
2009	Tsunami (November)
2010	Forest fire (July, August)
2011	Flood (December)
2012	Cyclone EVAN (December), Flood (December)
2014	Cyclone AMOSA (December), Flood (December)
2016	Forest fire (September)

Source: Questionnaire responses and documents provided by Fire Emergency Service Authority

3.1.3 Consistency with Japan's ODA Policy

In the Fourth Pacific Islands Leaders Meeting held in May 2006, Japan declared priority areas for its assistance plans. Based on this plan, "Education", "Environmental Conservation", "Health", "Increased Income" and "Infrastructure development" sectors were highlighted as areas of cooperation for Samoa. Among these, this project was categorized under "Environmental Conservation". The "Sendai Cooperation Initiative for Disaster Risk Reduction" adopted in the 3rd UN World Conference on Disaster Risk Reduction also agreed to observe disasters in states vulnerable to climate change, such as small islands, to provide technical cooperation and target measures to develop infrastructure for weather forecasting. This project established a weather observation and disaster warning system and as well as disaster measures, also supported fundamental measures to adapt to climate change. Accordingly, this project is consistent with key cooperation areas for Samoa.

As described above, the project is highly relevant to Samoa's development policies and the development needs of Samoa as well as Japan's ODA policy. Therefore, its relevance is high.

[8] Source: Questionnaire and Interview survey to executing agency

3.2 Efficiency (Rating: ②)

3.2.1 Project Outputs

【Japanese Portion】

The major outputs of this project included procurement and installation of weather observation systems, early-warning systems and airport weather observation systems as well as construction of ancillary facilities, consulting services and technical cooperation to operate and maintain procured equipment as well as improving the weather forecast system and service. The planned and actual outputs are as shown in Table 2 and Table 3.

Equipment was procured and installed almost as planned, except for the change in locations for installing the Automatic Weather Systems and the specifications of two antennas used for the meteorological data communication system. The reasons and measures for those changes are written as follows. Since these changes did not impact on efforts to generate the expected effects and functions of equipment which were expected at the time of project planning, it can be said that no issues due to the changes were identified.

Table2 Planed and Actual Output

（Procured and Installed Equipment, Constructed Ancillary Facilities）

	Name of the Equipment/Facility	Site	Plan	Actual
Procured and Installed Equipment				
1	Airport Weather Observation System (AWOS)	Faleolo International Airport	2	As planned
	AWOS Display System		3	
2	Automatic Weather System (AWS)	Le Mafa	1	
		Saluafata/Lufi Lufi [Note 1]	1	
		Togitogiga	1	
		Manono	1	
		Le Piu Tai	1	
		Maota International Airport	1	
		Mt. Taru	1	
	Calibration Instrument	The SMD Head Office	1	
3	Meteorological Data Communication System (including Data Repeating System)	Each Site [Note 2]	15	
4	Meteorological Data Management System	The SMD Head Office	1	
5	GTS Message Switch System		2	
6	MTSAT Data Receiving System		1	
7	Forecast Support System		2	
8	Early-Warning System		1	
9	Power Back-up System		2	
10	Wind Profiler System		1	
Ancillary Facilities				
11	Power Back-up Shed	The SMD Head Office	1	As planned
12	Equipment Shed	The SMD Head Office	1	
13	Concrete Shelter	Each Site [Note 3]	17	
14	Foundation of Wind Profiler System	The SMD Head Office	1	

Source: Document provided by JICA and interview to SMD and Consultant

Note 1: The site location for the installation was shifted from Saluafata to Lufi Lufi.

Note 2: The specifications of the antenna of the Meteorological Data Communication System (two sites) were changed.

Note 3: One concrete shelter was constructed at each site except Faleolo International Airport, where three concrete shelters were constructed.

【Changes of Output from the Original Plan】

① Changes in the Site Location:

Changes of site for installing AWS at Lufi Lufi, 800-900m away from the original site Saluafata

(Reason) The plan was to install AWS in the premises of the local church in Saluafata. However, the landowner requested to change the site when installing the equipment due to its size. Accordingly, it was decided to relocate the site to Lufi Lufi, considering the distance from the original site and the data transmission conditions.

② Changes in Antenna Specifications:

Antenna of Lufi Lufi bound for the SMD Head Office

(Reason) The distance for communication exceeded 20 km due to the change of site, reaffirming the need to change the antenna size.

Antenna of Faleolo Airport bound for Manono

(Reason) A minor packet error caused because of the difference in sea level between Faleolo airport and Manono. Accordingly, the antenna size was changed to avoid errors and boost quality.

Table 3 Planned and Actual Outputs
(Consulting Service and Technical Assistant)

	Planned	Actual
Consulting Service	Basic design, Detailed design, Support of tendering, Supervision of installed systems, Advice of operation of installed equipment and systems	As planned
Technical Assistance	1) Preparation of manual to operate and maintain equipment 2) Conducting training sessions on quality management of observed data 3) Awareness and dissemination of meteorology information 4) Improvement of the system and weather-forecasting service 5) Improved promptness and accuracy of disaster warnings 6) Providing information to meet users' needs and high Convenience	(1) ～(6) Almost as planned 【Additional item】 Repair and rehabilitation of equipment for communication and meteorology observation

Source: Documents provided by JICA, interview with SMD and Consultant

Consulting services and technical cooperation were also conducted almost as planned.

Technical cooperation components were conducted in this project to generate the benefits of procured equipment more efficiently and effectively, given the needs raised in the preparatory survey. In particular, details of how to operation and maintain procured equipment and ancillary facilities under this project were given, whereupon two members of the SMD staff

gained the necessary knowledge. The support has also helped improve the observed data by refining the methods used to check, manage and analyze the same. Accordingly, papers and reports for meteorological data, which can be used to determine mid- to long-term trends and for weather forecasts, have been regularly prepared. The means to deliver the information, which have been made easier to understand for Samoan people, have improved by preparing an SMD website, a TV weather-forecasting program and a weather icon, among others. Awareness activities on weather information and measures in the event of disaster were also conducted by holding open classes for 20,364 students in total; mainly at primary schools across Samoa. Besides, before starting technical cooperation, activities to repair and rectify equipment for data communication and meteorological observation were added after they sustained damage when cyclone EVAN hit Samoa in December 2012.

【Samoan Portion】

The following seven items were implemented as Samoan Portions as planned:

1) Flattening out access road furrows and cutting grasses
2) Cutting grasses and site preparation of each site
3) Cutting branches of high trees which obstruct the meteorological data communication system
4) Installation of fences for protection against any damage and theft of the equipment and systems
5) Securing the site for construction works
6) Demolition/relocation of the existing facilities that may obstacle during construction works
7) Providing the stable commercial power supply intake work for constructed facilities

Meteorological Data Communication System (Vaisala)

Inside the airport control tower: AWOS Display System (Faleolo International Airport)

3.2.2 Project Inputs

3.2.2.1 Project Cost

The project cost to be borne by Japan was planned as 745 million yen (E/N limit) and the actual project cost matched this total exactly (100% of the planned amount). The total project cost, including the Samoan portion, 67 million yen, was planned as 812 million yen, but the cost borne by Samoa could not be determined, which meant the total project cost could not be compared with the planned total project cost. Conversely, it was confirmed that the Samoan side had done all the works as planned without any issues. (See 3.2.1 Output)

3.2.2.2 Project Period

Though the project period was expected to be 37 months[9], the actual project period was 64 months from June 2010 till September 2015, significantly longer than planned (173% of the originally planned project period). The major reasons were as follows: 1) the period for technical cooperation was modified after the planning stage till the commencement of the project, 2) The Joint Coordination Committee in March 2014 saw the need to extend the project period and make the output of project activities firmer and more effective, considering the status of progress and for the following reasons: delays in preparing project activities and the administration procedure for implementing technical assistance under the new grant aid scheme "Grant Aid for Environment Program[10]", delays in commencing technical assistance due to the convenience of the counterpart side, delay in commencing training to maintain and repair equipment damaged by cyclone. Details of each reason are given as follows:

【Changes of period for technical cooperation with the nature of meteorological observation in mind】

The preparatory survey originally defined the period for technical cooperation as 19 months. According to the procurement agent and consultant, however, the period for technical cooperation was set as 24 months when they made the contract. Though no detailed background or reason could be confirmed in official documents, the procurement agent considered that it was changed to two years to cover two rounds for each season during the project, since technical assistance was provided for meteorological observation.

【Delays for operation in line with the new scheme】

Technical cooperation for operating and maintaining the equipment was provided for the new equipment installed. The original plan was to provide technical assistance under the "Environment and Climate Change Scheme" alongside the installation of the equipment.

[9] The project period I defined as from the contract with the consultant to the completion of technical assistance.

[10] One of the grant aid program schemes established in fiscal 2008 to support countries vulnerable to the negative effects of climate change. The scheme was renamed as the "Grant Aid for Environment and Climate Change Scheme" in 2010, then the sub scheme, including this scheme, was abolished in 2015.

However, the plan and implementation of the activities got underway while seeking a better approach soon after the introduction of the new scheme. Meanwhile, the mission to revise the Project Design Matrix for technical assistance was dispatched after installing equipment, which delayed the start of activities for technical cooperation by 4.5 months.

【Delays in commencing technical cooperation because of the convenience of the counterpart】

When technical cooperation was due to start, the main SMD counterpart was studying abroad, which meant activities could not be started as planned. Furthermore, since the key person behind this project at that time, the CEO of MNRE, passed away suddenly, the project activities had to stop for a certain period[11].

【Delays caused by damage due to Cyclone EVAN】

In December 2012, Cyclone EVAN hit Samoa, which damaged the equipment procured by the project. Since it happened before the technical assistance training started, the equipment had to be repaired, resulting in a delay of four to five months for starting the training.

Some of the factors delaying the project period had an impact when proceeding with the project through trial and error by the executing agency and project experts applying the new scheme. Conversely, the planned effects were fully generated through this approach. Furthermore, experts utilized this period to repair and maintain the equipment as part of on-the-job-training, providing good opportunities to the counter personnel to gain experience in repairing and maintaining equipment.

Based on the above, although the project cost was within the plan, the project period exceeded the plan. Therefore, efficient of the project is fair.

3.3 Effectiveness[12] (Rating: ③)

3.3.1 Quantitative Effects (Operation and Effect Indicators)

(1) Operation Indicators: Enhancement of the weather-monitoring capability

Before implementing the project, SMD was not able to provide information on the direction of the cyclone to the Samoan people. This was because SMD lacked equipment to observe the upper air, as required by the World Meteorological Organization (WMO)[13]. Thanks to the project however, the direction, speed and temperature of the wind at a height

[11] Though confirming the fact with related parties, detailed reasons for the delays were not obtained.
[12] Sub-rating for Effectiveness is to be put with consideration of Impact.
[13] A specialized agency of the United Nations. It is dedicated to international standardization, improvement and coordination of meteorology services and to promote efficient exchange of meteorological information and documents among each of the member countries and regions.

of 12 km in the sky can be observed by installing a wind profiler system[14] (See Table 4). Accordingly, SMD can provide better information, such as the path of the cyclone around Samoa and El Niño events relating to the occurrence of cyclones. Moreover, it is now possible to provide upper-air observation data which is crucial to improve the accuracy of weather forecasting for meteorological organizations worldwide.

At the time of project planning, since four out of five meteorological observation territories[15] lacked observation station, the SMD headquarters was unable to receive the observed data in real time at each site, meaning the weather information at each site was not reflected in the weather forecasting. Thanks to the installed equipment, at the time of ex-post evaluation, real-time data was observed at all observation territories as planned. In addition, the number of observation points registered by the WMO also increased from nine before the project implementation to 17 points, although they were not set as indicators. Accordingly, it is confirmed that approximately twice as much information can be reported to the WMO, which helps enhance the weather-monitoring capability[16].

Table 4　Capacity for Upper-Air Observation and Capacity for Automatic Continuous Meteorology Observation

	Baseline	Target	Actual	
	2009	2016	2012	2015
	Planned Year	3 Years After Completion	Completion Year	3 Years After Completion
Capacity of Upper-Air Observation				
・Wind direction and speed in upper air	Incapable	No raining: 3-6 km high Raining: 7-9 km high	12 km high	12 km high
・Temperature		Approximately up to 1.4 km high	12 km high	12 km high
Number of observation territories in Samoa	One territory	Five all territories	Five all territories	Five all territories

Source: Documents provided by JICA and executing agency

(2) Effect indicator: Enhancement of weather forecast provision capability

Weather phenomena within each territory of weather observation in Samoa can be observed in a timely manner thanks to automatic meteorological observation, which helps SMD properly reflect weather phenomena in weather forecasting. Conversely, the number of weather and coastal forecasts provided by SMD is twice daily and has not increased since the project implementation (See Table 5). This is because providing the weather information twice (once in the morning and evening respectively) daily is considered enough when the

[14] Equipment to monitor the upper air from the ground. It can observe the vertical distribution of wind direction and speed above the observation point in real time

[15] Two sites in Upolu Island and three sites in Savaii Island.

[16] The accuracy of weather forecasting will be enhanced by transmitting data observed in the home country to the WMO and meteorological divisions overseas as well as receiving such data from other countries reciprocally.

weather condition is settled. Since the target set at the time of project planning does not match the local situation, it is considered inappropriate. Frequencies of weather forecasts are increased based on the needs when disasters occur based on the scale and circumstances of the disaster, hence it can be said that an environment to provide forecast information, by taking the present status into consideration, has been prepared.

While information required for aviation forecasts can be obtained, the number of aviation forecast has not been regularly provided due to the lack of SMD staff (See details for Sustainability (2)). Accordingly, an aviation forecast is provided when required[17] at the time of ex-post evaluation. Although this information was not reported by SMD to the control center in the airport, data observed by SMD can be also confirmed at the airport control center among stakeholders via the AWOS display system monitor. Accordingly, a system to confirm the observed data has been prepared and the weather forecast provision capability is said to have improved.

Table 5 Number of Weather, Coastal and Aviation Forecast Provision

	Baseline	Target	Actual	
	2009	2016	2012	2015
	Planned Year	3 Years After Completion	Completion Year	3 Years After Completion
Number of weather forecast provision	Twice / day	4 times/day	Twice / day	Twice / day
Number of coastal forecast provision	Twice / day	4 times/day	Twice / day	Twice / day
Number of aviation forecast provision	0 times / day	4 times/day	Non-scheduled	Non-scheduled

Source: Documents provided by JICA and Executing Agency

3.3.2 Qualitative Effects (Other Effects)

(1) Enhancement of weather forecast and the disaster warning provision capability

Installing meteorological observation, communication and data management systems made it possible for SMD to transmit meteorological data observed in Samoa to GTS and receive data observed in numerous countries, allowing more accurate forecasting. For example, when cyclones occur, since the wind direction, rainfall and direction of a cyclone can be predicted, this has created an environment to provide warnings of meteorological disaster prediction via mobile phone text messages.

Questionnaires and beneficiary surveys[18] conducted during the ex-post evaluation with

[17] Based on the interview with SMD staff members.

[18] To complement the quantitative information, questionnaire and beneficiary surveys were conducted. Questionnaire surveys were made with 13 staff members of related institutions using weather forecasts for their services (3 staff members from related ministries, three from Hotel, two from the Fire and Emergency Service Authority, two from

related institutions and the local residents show that approximately more than 70% of related institutions having responded that the accuracy, frequency and reliability of weather forecasts had improved and greater than or equal to 80% of the local residents answered the improved weather-forecasting ability (See Table 6). Similarly, as for the disaster warning provision capacity, 70 to 80% of related institutions answered that the accuracy, frequency and reliability had improved and greater than or equal to 90% of the local residents answered that the system to deliver the meteorological alarms to the Samoan people had improved. Accordingly, it can be said that the improved capability of weather forecast and disaster warning was confirmed.

Table 6 Improved Weather-Forecasting Capacity

		Greatly improved	Improved	No change	Worse	Much worse	No answer
Related Institutions	Accuracy	30%	40%	10%	0%	0%	20%
	Frequency	22%	55%	11%	0%	0%	11%
	Reliability	50%	20%	20%	0%	0%	10%
Local residents	Accuracy	49%	42%	1%	0%	0%	1%
	Frequency	52%	37%	2%	0%	0%	1%
	Reliability	50%	38%	2%	0%	0%	1%

Source: Questionnaire and Beneficiary surveys

Table 7 Improved Capacity for Meteorology Disaster Warning Provision

		Greatly improved	Improved	No change	Worse	Much worse	No answer
Related Institution	Accuracy	36%	45%	18%	0%	0%	0%
	Frequency	36%	45%	18%	0%	0%	0%
	Reliability	27%	45%	27%	0%	0%	0%
Local residents	General	26%	71%	2%	0%	0%	0%

Source: Questionnaire and Beneficiary surveys

Note: As the wording, "capacity of alarming/warning", was not well understood by Samoan people, "the system to deliver meteorological alarms to the Samoan people" was reconfirmed with them.

(2) Enhanced ability to provide weather information to the Samoan Airport Authority

Before implementing the project, SMD manually observed meteorological information except for atmosphere pressure and was located away from the airport, which hampered the

airlines, one from the Port Authority and one from a private oil transporting company). A beneficiary survey was conducted among a total of 127 local residents in Upol, Savaii and Manono Islands (Valid response: 127). 65 of whom male and 62 female. The age breakdown was: 16-25 years old for 24 samples, 26-35 for 27 samples, 36-45 for 31 samples, 46-55 for 27 samples and over 56 for 18 samples respectively. Though evaluators attempted to obtain a list of residents from which to select respondents, such lists were unavailable. Accordingly, respondents were selected by applying the purposeful selection method at fruit and vegetable markets, fish markets, bus stops, wharves and so on.

speed of response. Under such circumstances, both SMD and the Samoan Airport Authority (SAA) made meteorological observations respectively, although this was inefficient. Furthermore, SMD conducted visual observations of visibility and cloud height as the most important elements ensuring safe take-off and landing operations, meaning that it was in a difficult situation to even observe those data during the night.

This project installed AWOS capable of observing data on a real-time basis at two sites of a runway, and an AWOS Display System in Faleolo airport displaying the same information as could be monitored with SMD. Thanks to these systems, SAA can now confirm information such as wind direction, wind speed, temperature, rainfall, cloud height and visibility, which was formerly observed manually by SMD and informed to SAA via phone. Those data are currently observed on both sides of the runway every five minutes and shown in displayed systems, allowing timely and accurate weather forecasts via the SMD observation systems. Moreover, SAA no longer needs to perform observations, which also helps reduce its workload.

(3) Enhanced data communication capacity and providing information

Meteorological data, available at the AWS installed at each site in Samoa, are transmitted to SMD via a meteorological data communication system and then distributed to the WMO GTS system via the GTS switch system. Simultaneously, since meteorological data observed by other countries can also be received the data communication capacity for transmitting and receiving meteorological observed data in Samoa is considered enhanced. It also indicates how SMD can make forecasts based on more meteorological data and trends, led to enhance forecasting accuracy in Samoa.

As well as improvements made to the observed data and forecast information, the project provided technical assistance to prepare weather icons and maps for weather forecasting as well as displaying and explaining meteorological information and reporting weather forecast services, allowing SMD to provide weather forecast programs on TV.

Information on cyclones, storms, high waves and so on is informed via mobile phone text message by utilizing the Early-Warning System. Information on alarms is shared via SMD with the Disaster Management Office (DMO), which then informs the persons in charge of major related institutions, media and representatives in each village. Within these systems, it was confirmed that their contents and frequency had improved, meaning an enhanced capacity to provide information.

（Photos）Screens of the TV weather forecast program showing the weather icon

(4) Improved capacity to respond to Climate Change

By installing equipment which was procured in this project, including for observation, telecommunication and data management systems, SMD can understand and manage information related to climate change (analysis of climate change information, climate system trends in Samoa) and also publish monthly reports including rainfall and temperature and quarterly reports for meteorology information and weather information around Samoa such as El Niño-Southern Oscillation (ENSO)[19] and ENSO index[20]. Before implementing the project, no analysis of climate change information or preparation of documents to respond to climate change could be conducted. However, technical assistance provided training to input the data obtained into the program for analysis and control, whereupon its accuracy was reconfirmed to prepare the products. Accordingly, it helped enhance the capacity to prepare the documents for climate change, summarize the information of climate change and then publish those products.

3.4 Impacts

3.4.1 Intended Impacts

(1) A wider understanding of meteorological information and measures against disasters, development of a system to deliver information to expedite evacuation

Thanks to easily understandable explanations on weather forecasts and information on disasters through TV and radio programs, the local public responded that their understanding was considerably higher in the beneficiary survey result. In Samoa, where no TV weather forecasting existed before the project, most people predicted the weather or disasters from the appearance of the sky based on their experiences, radio and so on. As described before, TV programs for weather forecasts started after the project was implemented, whereupon information explained with icons or animations for the weather helped deepen their understanding of meteorological information or measures against

[19] A phenomenon whereby the surface pressure between the tropical western and eastern Pacific Ocean varies like a see-saw every few years. The Southern Oscillation is accompanied by changes to El Nino and La Nina and is also known as ENSO (El Niño/Southern Oscillation) alongside the El Nino.

[20] An index showing the differences in surface pressure between Tahiti and Darwin. This is also one of the standards showing the force of trade winds, where a positive value indicates a high trade wind.

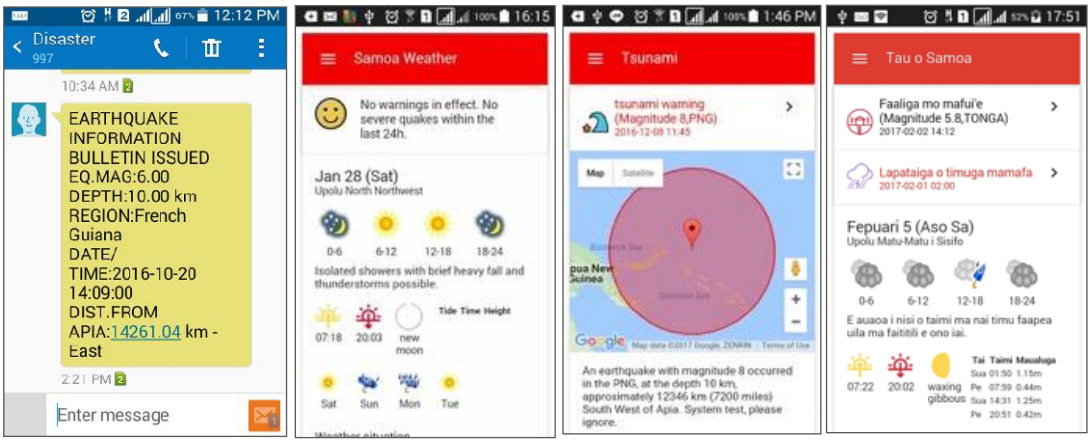
disasters. The beneficiary survey result also showed 90% of the local residents responded that the explanation of weather information via TV or radio has been getting easier to understand. Conversely, some respondents commented that some weather information was explained with technical terms which were hard to understand even now and highlighted the need to simplify the terminology used. In this project, some awareness activities on countermeasures against disasters were conducted for primary school students. In the interview survey conducted at markets and etc., it was often explained that the students who participated in these awareness activities (open classes) at schools, shared what they learned with their parents and families at home. As well as awareness activities continued by NGOs and others even after the project was completed, the technical cooperation under this project also helped improve understanding of weather information or the measures and response to disasters through open classes and etc. for Samoan people.

Moreover, SMS text messages were distributed when disasters occur to institutions involved in decision-making for disaster management and representatives of villages. The SMS message is a trigger to sound the sirens installed in each village, as such, an information delivery system to prepare evacuation was prepared. This system is acknowledged as a key measure for disasters required the emergency in Samoa. Moreover, further improvement of the measure to disasters was confirmed as SMD has worked to develop a Hazard Early-Warning Application for smartphones for further utilization by the Samoan people after the project completion. (See the Column below)

Column：Impact for improving meteorology and the disaster warning system after project completion
～Development of Hazard Early Warning Applications～

In 2012, the project installed AWS and Early warning system in SMD. Through this equipment, meteorological information for Samoan people can be provided in a format which is more easily understood. It also included swift responses to deliver the information to major institutions using the disaster information and leaders of each village via SMS in the event of disaster. Meanwhile, there have been issues such as an inability to send SMS messages to all people in Samoa due to the capacity limitations. Also, an SMS only contains up to 160 characters per message. To improve the system, SMD has worked to develop a smartphone application (App) with technical support by a JICA volunteer and an app service was finally launched from February 2017. This app was developed to complement the existing system which has been utilized and delivers early warning information to a wider scope of people in Samoa. In addition, information useful for daily life in Samoa, such as weather forecasts of every six hours, sunrise and sunset times, tide tables and so on is displayed in both English and Samoan (users can set the preference).

At the time of the ex-post evaluation, the mobile telecommunication network in Samoa had developed considerably and the number of smartphone users was increasing. Even in areas where not all people have smartphones, if a few members among neighbouring relatives, friends and acquaintances receive early warnings through their smartphones, the information is expected be shared easily in Samoa, where family and community bonds are prioritized. Accordingly, this app is expected to become an important tool for regional disaster prevention in Samoa's future.



Early warning information Issued by SMS

App Screen ① Weather forecast in four hours and four days

App Screen ② Tsunami warning An alarm will sound.

App Screen ③ Earthquake occurred in Tonga and heavy rain warning in Samoa

Source：Interview with SMD and JICA Volunteer, documents prepared by JICA Volunteer

(2) Contribution to agricultural activities

In this interview survey with farmers selling agricultural crops at the market, it was explained that farmers and local people use the weather information for their farming and

agricultural activities. For example, it was confirmed that major respondents refer to the weather forecast for agricultural activities, such as the timing of watering or seeding. Given the status of agriculture as a key industry in Samoa, contributing to agricultural activities can be indirectly considered a means of boosting national income stability. In the beneficiary survey, while approximately 13% of respondents were farmers, 33% of respondents mentioned that they used the weather information for farming or agricultural activities. This means that as well as farmers, other local people also utilized weather information to cultivate their home gardens.

(3) Boosting the safety of aviation and tourism

For the tourist industry in Samoa, which mainly targets outdoor activities such as surfing, weather forecasts constitute indispensable information and the Samoan Tourism Association (STA) receives information on meteorological trends and the occurrence of natural disasters via SMD and DMO. According to STA, the contents and timing of the meteorological information provided have significantly improved and the information has been received well in advance of disasters following the 2013 project implementation. Accordingly, in the tourist sector in Samoa, sufficient advance information on weather trends and disasters has allowed them to propose safe plans and schedule to the tourists. Accordingly, it can be said that the project helped those in the tourism sector have a safer trip to Samoa.

Although aerodrome predictions have not made regularly, a system to provide the necessary information as required has been established. When pilots request a briefing, SMD can always provide the required information such as wind trend, volume, rainfall and visibility, etc. on a real-time basis. Accordingly and as described in 3.3 Effectiveness Qualitative Effect, it can be said that the project has also helped improve safe civil aviation operations.

3.4.2 Other Positive and Negative Impacts

(1) Impacts on the Natural Environment

To implement this project, an Environmental Impact Assessment was conducted in line with the "City Planning Management Act." Monitoring was performed based on the assessment result and a report was also prepared[21]. No complaints concerning noises and etc. were generated during the project, according to interviews with the executing agency and residents during the site survey as well as the monitoring report. Thus no negative impact on the natural environment was confirmed.

[21] Source: Interview with executing agency and confirmation of the current situation in the site survey

(2) Land Acquisition and Resettlement

No land acquisition and resettlement were generated for this project. Land within which to install the equipment for meteorological observation was leased with the landowner's consent and the absence of any issues was confirmed in an interview with the executing agency.

(3) Other Impacts: Improving the workload efficiency of SMD staff

Changes which involve observing the major data automatically instead of manually mean the efficiency of the daily work of SMD staff members has improved. Within Maota International airport in particular, SMD staff had to be dispatched to Savaii Island for weekdays to report the data to SMD, which was observed manually, by phone. At the time of ex-post evaluation, eliminating the need to dispatch the SMD staff by collecting observed data remotely helped cut costs too.

Observation of upper-air, automatic and continuous observation and weather information required for SAA is possible by installing the meteorological observation equipment. Also, a system to receive the necessary information to analyze the meteorological forecast has been established by installing data communication equipment. Based on this forecast and information, an arrangement to inform of a warning following a quick evacuation in the event of disaster was possible via the early-warning system. Furthermore, thanks to technical assistance, the accuracy of information to determine meteorological trends provided by SMD staff members as well as their presentation skills to inform weather information were improved. Accordingly, information, including the cyclone direction, storm area and rainfall, could be identified in advance and a warning could be issued before the disaster. The information required to ensure the safe operation of civil aviation is available and the capacity to provide observed meteorological information in a manner easily understood by Samoan people has been improved. This information has boosted the key industries including agricultural and tourist sectors in Samoa.

As described above, this project has largely achieved its objectives. Therefore, effectiveness and impact of the project are high.

3.5 Sustainability (Rating: ②)

3.5.1 Institutional Aspects of Operation and Maintenance

The SMD weather forecast department is responsible for the Operation and Maintenance (O&M) of meteorological observations, data communication and early-warning systems provided under this project (see Table 2). Of the 40 SMD staff members at the time of ex-post

evaluation, 16 belong to the weather forecast department. Four work for O&M of weather observation facilities and equipment (including those installed outside Apia) and two work on cleaning or cutting the grass. According to the executing agency, there is a need for six staff members for adequate O&M, which shows the shortage of technical staff members with adequate skill and knowledge in the weather observation and communication equipment provided.

A quick response team of three SMD staff members is assigned when immediate action is required in response to accidents involving machinery. Although a quick response team was also required at SAA at the time of project planning, it has not yet been properly organized due to a lack of staff. However, SMD staff members are assigned around the clock at Faleolo International Airport as the SMD equipment is installed, hence the SMD staff assigned at the airport can respond when any immediate action is required.

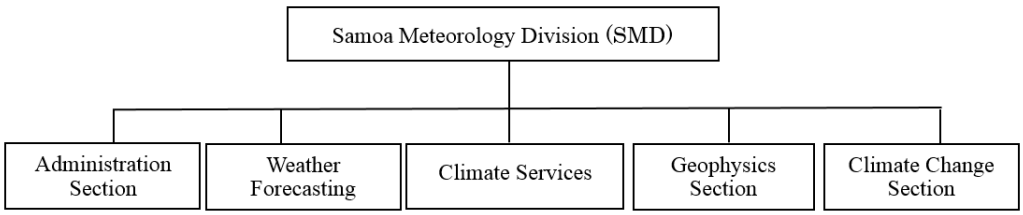


Figure 2 SMD Organization

Source: SMD Web site http://www.samet.gov.ws/index.php/staff/service1 (referred on 5/10/2017)

3.5.2 Technical Aspects of Operation and Maintenance

Training for O&M was implemented through the scheme of "Grant Aid for Environment Program" in this project. Consequently, SMD staff members obtained fundamental O&M skills in newly installed weather observation and communication systems, thanks to which they already have technical capacity in essence. It also emerged at the time of the site visit that O&M manuals provided during the trainings were utilized on a routine basis. Besides, enhancement of technical aspect was spearheaded by continued support given by JICA to build capacity in terms of meteorological observations and forecasting in Pacific Island countries[22], training sessions in equipment calibration and inspection methods supported by Australia and China, as well as technical support for weather observation by the WMO.

Conversely, locally in Samoa, there is a shortage of technical staff members with adequate knowledge required to simulate weather data, communication techniques and IT area. SMD currently has only two staff members with adequate knowledge, despite attempts to recruit for a full-time position. In this regards, the limitation of appropriate human resources on a

[22] JICA supported efforts by Fiji to improve the capacity for meteorological observations and forecasts through the Project for Reinforcing Meteorological Training Function of Fiji Meteorology Services (FMS) since 2014. Though the counterpart is FMS, Samoa is involved in the program for third country training and receives indirect benefits.

local level should be a technical issue. Currently, the shortage of human resources is filled by email communication to obtain advice from Japanese experts in this project and JICA volunteers in the IT field.

Enough spare parts necessary for the installed equipment were supplied at the time of project completion and the project was unaffected by any shortage of spare parts by the time of the ex-post evaluation. However, they still lack access to all spare parts except for batteries in Samoa, which they must procure from overseas when finishing spare parts procured as stocks of equipment. The executing agency understands available procurement routes but must consider a procurement plan considering the required budget for continuous operation ahead of time, as there are many expensive parts.

3.5.3 Financial Aspects of Operation and Maintenance

SMD, responsible for equipment O&M, is supported by revenue from government. Based on the fact that the SMD annual budget increased approximately 2% at the time of planning[23], it was estimated that a 6% increase in the entire SMD budget would be required to cover all O&M costs additionally required. The SMD annual budget has now increased about 5% p.a. (see Table 8), which is still short of the budget. According to SMD staff members, although SMD requests a necessary budget for O&M to MNRE every year, only half the request is approved. They have covered budget shortfalls by diverting from the budget of other activity. However, it might not be possible to supplement by diverting the budget when consumable supplies or spare parts have to be replaced in future. The remaining supplies are scarce at the time of ex-post evaluation, despite having replaced supplies and parts by spare parts procured as supplies at this project until now. Therefore, the O&M budget should be secured instead of diverting other activity budget to facilitate equipment operation.

Table 8 SMD Budget

(Unit: thousand tala)

	2009/10	2013/14	2014/15	2015/16
Budget	**1,151**	**1,437**	**1,529**	**1,618**
Expenditure (Detail)	**1,151**	**1,437**	**1,529**	**1,618**
Personal expenses	896	980	1,034	1,086
Operation expenses	133	297	320	356
Administrative expenses	122	160	175	176

Source: Samoa Ministry of Finance, "Approved estimate of receipts and payments of the government of Samoa for the financial year"

3.5.4 Current Status of Operation and Maintenance

Based on the SMD interview and site visit, it was confirmed that equipment and their ancillary facilities under this project were effectively utilized and operated. The facility is

[23] Source: documents provided by JICA

also well maintained with cleaning and grass cutting. Daily checks suggested as part of technical support were not followed at the mandated frequency, due to a lack of human resources. However, daily mandated check items are still conducted every two or three days and this had not caused any serious issues or breakdown by the time of the ex-post evaluation. SMD properly conducted the refinishing paint of concrete shelters and responded to the broken equipment. Although no supplies and replacements except batteries can be locally procured in Samoa, all the equipment remained in operation without any problem by replacing broken parts with spare parts provided under this project. As indicated above, when all the spare parts are used, they need to procure supplies and replacement from outside Samoa. If SMD makes a proper plan and secures a budget, there will be no sustainability issues.



(Left) Concrete shelter: repainted wall by SMD (Togitogiga observation point)
(Centre) Inside the concrete shelter: Batteries (Left), Indoor units (Centre), IP phone (Mt. Talu observation point) (Right)
(Right) SMD staff working to maintain the data collection system (Le Piu Tai observation point)

In light of the above, some minor problems have been observed in terms of the institutional aspect, technical aspect and financial aspect. Therefore, sustainability of the project effects is fair.

4. Conclusion, Lessons Learned and Recommendations

4.1 Conclusion

This project was implemented to improve the capacity of meteorological observation and the vulnerability to meteorological disasters by installing equipment for the meteorological observation system and early warning facilities as well as conducting the necessary technical cooperation to operate and maintain the equipment. The purpose of the project is highly consistent with the development strategy and environment sector plan of Samoa, which has aimed to improve resilience to climate change and measures to meteorological disasters and the development needs of Samoa, which has been frequently damaged by natural disaster, as well as Japan's aid policy. The targets, enabling upper air continuous observation and the required

weather observation for airport authority, were achieved by implementing the project. A system to transmit and receive the data needed to analyze the meteorological forecast was established and meteorological prediction was made possible based on the accurate information. Accordingly, the provision of weather information, including the movement of cyclones, storm areas and rainfall as well as disaster surge warnings issued, which were not available before implementing the project, have contributed to agricultural activities for the people as well as the Samoan tourist industry. Therefore, the effectiveness and impact of this project are high. Though the project cost was within the plan, the project period exceeded the plan due to changes in the technical cooperation period, the impact of a cyclone and applying the new scheme to provide technical cooperation. Consequently, the efficiency of the project is fair. Although the operation and maintenance of equipment provided by the project is in good condition, some minor institutional, technical and financial problems were confirmed, therefore the sustainability of the project can be judged to be fair.

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

4.2 Recommendations

4.2.1 Recommendations to the Executing Agency

・Use of simple words for weather information

Technical cooperation implemented the start of a “Weather Forecast Program on TV using weather symbol and animation graphics”, which widened public understanding of weather information. However, voices from related authorities and residents persists about providing the information using easier terminology, given the jargon still used for a part of weather information. SMD must engage in further consideration to comment on weather information in understandable language.

・Securing budget for supplies and replacement parts

By the time of ex-post evaluation, the supplies and replacement parts necessary for the equipment had been provided from stocks procured at the time of project completion. However, four years have now elapsed since that time and the remaining spare parts in stock are scarce, hence SMD needs to procure additional supplies and replacement parts in the near future. SMD requires to immediately make a procurement plan for stocks from the following year onward and must submit a budget to MNRE and the Ministry of Finance showcasing its importance, reflecting the need to import all spare parts except batteries, consider budget limitation and avoid system outages due to a lack of spare parts.

・Securing human resources

SMD only has two technical staff members to analyze weather data, which hinders

efforts to ensure an appropriate number of briefings and form a rapid response team at the airport. The SMD staff members work in three shifts and more technical staff members with knowledge and experiences are required. Accordingly, SMD needs a prompt plan with appropriate recruiting activities to increase the number of staff members.

4.2.2 Recommendations to JICA

SMD had JICA volunteers with technical knowledge and experience of IT at the time of ex-post evaluation and covered the capacity and human resource shortage necessary for regular business. The SMD staff members have limited abilities in terms of the quality and quantity of IT and communication techniques, for which ongoing technical training would be required. JICA is expected to be aware of SMD's needs and help maintain and boost the capacities of SMD staff members by continuously dispatching volunteers as required.

4.3 Lessons Learned

・Flexible business activities by effectively utilizing external factors

Samoa was attacked by massive cyclone during the project, damaging equipment provided under this project. Technical cooperation with installed equipment were also delayed due to the need to restore such equipment, based on which project activities have been temporarily suspended. Meanwhile, required repair works of the equipment were conducted under the guidance of experts to the staffs of executing agency. Consequently, that period was utilized for on-the-job staff training, which has improved the capacity of staff members to executing agency. This is good practice that helped improve staff capacity through flexible responses and activities; considering effectiveness and sustainability, even under unexpected circumstances.